A Revision of the Neotropical Ant Subgenus Myrmothrix of Genus Camponotus (Hymenoptera: Formicidae) *

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(With 13 figures and 84 tables)

Contents

Introduction

The genus *Camponotus* was established by Mayr (1861) who included 10 species. During the next 35 years more than 200 species were described by various taxonomists. Based on a combination of morphological characters and geographical distribution, Emery (1896) arranged the species then known

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into three major divisions which he claimed to be "natural groups". He further partitioned these into 26 "maniples" (similar to our subgenera), but did not formally name them. According to Creighton (1950), during the first quarter of this century the number of described taxa in the genus increased to such a large number that myrmecologists of that period, e.g. Ashmead, Emery, Forel, Santschi and Wheeler, recognized the need for establishing subgenera.

The subgenus *Myrmothrix* was proposed by Forel (1912) for only one species. Later Forel (1914a) included an additional 23 species in the subgenus. Except for two species from Asia and one from Africa the taxa were restricted to the Neotropical Region. Forel (*loc cit*) designated *Formica rufipes* Fabricius as the type of *Myrmothrix* without knowing that Wheeler (1913) previously had designated *Formica abdominalis* Fabricius as the type. Emery (1920) diagnosed 34 subgenera of *Camponotus*, most of which had been listed by Forel (1914a). Emery (1920) presented brief subgeneric descriptions and listed the species included in each subgenus. He included 16 species (exclusively Neotropical) in the subgenus *Myrmothrix* which was characterized (pages 236-37) as follows:

> Ouvrières et Femelle. — Caractères de *Myrmoturba*, mais la tête des grandes ☿ est en général massive et plutôt arrondie; celle des petites non rétrécie en arrière. Espèces grandes ou moyennes, pourvues de soles abondantes sur le corps et, à peu d'exceptions près, sur les membres. Le tégument est presque toujours mat et quelquefois revêtue d'une pubescence soyeuse. Tarses non comprimés.
>
> Une espèce fait des jardins des fourmis dans les forêts du Brésil (*C. femoratus*); d'autres des nids de carton on nichent dans la terre ou le bois pourri. Elles habitent exclusivement la régions néotropicale, excepté une forme d'Afrique qui est suspecte d'avoir été importée. J'ai éliminé de ce groupe les espèces asiatiques que Forel y avait mises, et même quelques espèces américaines, cela dans le but de lui donner plus d'homogénéité.

Emery (1925) divided the genus *Camponotus* into 38 subgenera and recognized 10 species, 14 subspecies and 12 varieties or forms in the subgenus *Myrmothrix*. Only two additional species have been included in the subgenus, one by Santschi (1939) and the other by Kempf (1960). Except for these two studies no one has worked with *Myrmothrix* since Emery's comprehensive treatment.

The cosmopolitan distribution and the large number of species included in *Camponotus*, the widespread polymorphism of its species, and the paucity of biological information for most species make revisionary studies for this genus difficult. The most practical approach is to study each subgenus separately. A group of species that is relatively distinct morphologically and geographically would seem to be the best starting point. The subgenus *Myrmothrix* is such a group because it is exclusively New World, and primarily Neotropical in distribution, and it can be distinguished from all other *Camponotus* of this region by the numerous, long, erect, brownish or golden hairs that are conspicuous on all surfaces of the antennal scapes and the legs.

Because of detailed ecological and behavioral studies being conducted in the tropics, it has become necessary to reevaluate the taxonomy of many species of animals, including ants. Unless the species involved are precisely known, the significance of such studies is suspect. Thus, a taxonomic revision of the subgenus *Myrmothrix* should provide an important step in the clarification of the Neotropical ant fauna.

This study has two primary objectives:

1. *An assessment of the taxa included in the subgenus Myrmothrix and their redescription.* Creighton (1938) was the first to comment on the quadrinomial nomenclature used by Emery (1925), and later (1950) restricted the nomenclature of North American ants to the trinomial system. In 1961, the rules of zoological nomenclature were modified, limiting the scientific name to a trinomen. Wilson and Brown (1953) criticized the arbitrary use of the subspecies as a taxonomic category and urged restraint in its use. Myrmecologists of Emery's time (especially Forel and Santschi) separated species on the basis of minute morphological variations and described many specimens as subspecies, varieties or forms. These descriptions were seldom sufficient to clearly delineate taxa and the phenetic relationships among them. Therefore, an objective of the present study is to investigate interspecific and intraspecific variation in an attempt to clarify the taxonomy of the species included.

2. *Preparation of a key to the taxa in the subgenus Myrmothrix.* Emery (1925) included only names of taxa and pertinent references in his revision. No one has attempted to construct a key to the species of this subgenus. Such a key would be useful, not only to other systematists, but also to ecologists, ethologists, and others studying tropical faunas.

During the last three years myrmecologists have presented new view concerning the taxonomic status of subgenera of *Camponotus*. For exammple, Baroni-Urbani (personal communication, 1971) believes that most of the described subgenera

of *Camponotus* should be placed in synonymy because many of the subgenera are intergrading, and as a result are difficult to distinguish from each other. This idea is not the novelty of present-day myrmecologist; it was stated clearly by Emery (1920, page 229), "Tout en reconaissant que ses coupes sont en partie artificielles". Despite this statement, Emery's scheme has been in continuous use to the present. Creighton (1950, page 361) said:

> It is clearly impossible to secure sharp distinction between many of the subgenera, yet most students of ants have been willing to accept this fact for the sake of stability and ease of handling which Emery's arrangement permits.

To state now, that many subgenera are intergrading, without stating to what extent the arrangement is arbitrary, is simply repeating what Emery recognized. Although not explicitly stated by Emery, his arrangement provided stability to the taxa. The major difficulty encountered by Emery was that by the time he had decided to divide *Camponotus* into subgenera, Forel (1914a) had already created several subgenera and had given a list of the species which he had assigned to them. Through more thorough study of the genus, Emery (1925) improved those divisions of the species as best he could. However, he did not completely reject the ambiguity which Forel had introduced.

The tenet of synonymizing seems to be a hasty decision upon which to act, especially at a stage when extensive knowledge concerning morphological variation and ecological and genetic diversity of most species of *Camponotus* is unavailable. The first step towards achieving this goal is to reassess the validity of all of the species Emery included in the various subgenera. Once this has been accomplished, the validity of the subgenera should be critically examined. Emery's scheme should be retained until a more logical scheme can be presented, one which whould provide not only stability, but also convenience in use.

One of the major problems that myrmecologists must consider is that of polymorphic species. Synonymization of the various subgenera of *Camponotus* should not be based on our failure to adequately understand the taxonomy of polymorphic species. Extensive studies of polymorphism within species are needed, and these could then provide firm bases for taxonomic studies. It is with this precept that I have sought the solution of polymorphism within each of the species of *Myrmothrix* studied. Therefore, in the present study, the morphological characters of each species have been studied in detail and each has been evaluated to determine if its placement in the subgenus is acceptable based on those characters given by Emery (1920).

This study is based on specimens obtained from museums throughout the world. However, many species of *Myrmothrix* are poorly represented in collections. Nevertheless, I have been able to organize previously scattered information and to clarify the interspecific relationships of many taxa.

Materials and Methods

Ants of the genus *Camponotus* are polymorphic in a graded size series of major (largest), media (intermediate) and minor (smallest) workers. Separation of workers into these categories is difficult because variation in their size is gradual. Since the taxonomy of *Camponotus* is based largely upon major workers, separation of specimens into these categories of workers is essential before one can begin identification.

After the workers were separated into the various categories measurements of the following nine characters were recorded for specimens in good condition for each group of workers: head width, head length, scape length, pronotum width, metatibial length, Weber's length, maximum eye length, maximum eye width and interocular space (see Appendix for glossary). Four indices were calculated from these measurements: cephalic index, scape index, ocular index and pronotum index. In addition, characters of males and females were measured in instances where these could be associated with workers of their species. However, because of the lack of males and females for certain of the included species, a generalized scheme of differential diagnosis cannot be presented for males and females. As a result these were not included in any of the statistical analyses. Morphological characters were described and recorded with the expectation that they could be used by future students of this group. All measurements were made with a Bausch and Lomb BV-B73 zoom microscope with 10× oculars and 1× objectives.

All mathematical computations were done on an IBM-360/40 digital computer at the University of North Dakota. The range, mean, variance and standard deviations were computed for the nine variables and four indices with the aid of a computer program (MSDCC) available at the University of North Dakota Computer Center. The data were also analyzed using discriminant function analysis (Dixon and Anderson, 1958). Indices were not used in

this and subsequent analyses to avoid redundancy. However, their range, mean, standard deviation and variance have been given under MSDCC results for the use of myrmecologists. A (DISCAN) program was used to calculate the means of the variables in each group, a pooled dispersion matrix, common means of variables, generalized Mahalanobis D-square, and coefficients of discriminant functions of each member in each group. The program was used to calculate a set of linear functions from the data on the groups for the purpose of classifying individuals into one of the several groups included in the study. The classification of an individual into a group is performed by evaluating each of the calculated linear functions, then finding the group for which the value is the largest. However, this program assumes that on the basis of predictor variables used the individual will be correctly classified in one of the groups. To do this, groups must exist (in the data) prior to the analysis. Therefore, splitting of the workers into their categories did meet the prerequisite for this analysis. The classification results of this analysis, the generalized Mahalanobis D-square, and the discriminant functions with their constants and the respective coefficients for each one of the nine predictor variables are given under the species where this analysis has been used. The following points are important with regard to these coefficients:

1. The magnitude of the coefficients determines which variables are the most critical in distinguishing one group from the other.

2. The negative and positive signs with each coefficient also contribute in assessing the value of these variables. For example, if the coefficient of a variable in the major workers' group had a negative sign whereas the coefficients of the same variable in the other two groups (media and minor) were positive, then the majors can be separated from the other two groups on the basis of that particular variable.

3. If two coefficients of the same variable in different groups differ in their magnitude but have identical variance (as recorded under MSDCC), they can be used effectively for the discrimination of those two groups.

4. Conversely, if the coefficients of the same variable in different groups have almost identical value but have different variance, the variable is of little importance or else is inadequate for discrimination.

5. The constants and coefficients can be used to determine the subcaste to which an isolated specimen belongs. This can be accomplished by first recording the measurements of the nine variables, then multiplying each variable with its respective coefficient in each group and adding the figures. The group that will come out with the highest value will be the one to which the specimen will belong.

The Mahalanobis D-square is a measure of distance between the groups which differ in the means of their characters but have an identical dispersion matrix. The higher the value the better the discrimination of the group.

It should be clarified that according to Rohlf (1965) and Reyment (1969), in taxonomy, the term "classification" indicates the act or result of creating or defining taxa according to some principles (for example, general classification, plylogenetic classification or a special classification). In statistical literature it means the assignment of elements into *a priori* defined classes. This latter act is identification. The discriminant function analysis is, therefore, an identification of workers to their respective *a priori* groups. The data will enable us to correctly identify them in regard to their correct location along the minor, media or major line that best separates these groups.

The data were subjected to a multivariate analysis of variance (MANOVA) (Cooley and Lohens, 1962) to determine whether differences existed among the three groups of workers of the same species. This test had the advantage of allowing an overall test of difference on multiple criterion variables. The data were analyzed into two sets. One set consisted of minors and medias and the other of medias and majors. In those species where only the minors and the majors were discernible, the data were run only in one set, that is, majors and minors. The results of this analysis provide the investigator with two F values, one for the test of homogeneity of variance-covariance and the other for the test of generalized analysis of variance. In addition to these two F values, a Lambda value is also provided. If the calculated value of F for the test of homogeneity of variance-covariance is relatively close to the table value, the specimens in each group deviate only slightly from their mean. In other words the groups are homogeneous. In the generalized analysis of variance, if the calculated F value is higher than the table value, then the groups differ significantly. The Lambda value varies between 0 and 1. A low Lambda value indicates that the variables used were

adequate functional discriminators; a high Lambda value indicates that the variables were inadequate.

After determining that the groups of workers in each species could be discriminated, the data were subjected to a multiple regression procedure known as the backward elimination procedure (STWMULT) and described by Draper and Smith (1966). The purpose of this analysis was to determine which of the variables lent the most towards predicting the criterion, which in this case was the group membership (minors, medias and majors). In general, the variables are eliminated in reverse order as to their contribution to predicting the criterion. As a by-product a multiple correlation ($= R$) can be found at every stage a variable is eliminated in computation. The data were run in two sets, minors and medias and medias and majors, in each species. The correlation matrix of the variables and the results of multiple regression are given under each species in the form of tables. To find out the order of the predictors, the tabularized variables are read from bottom to top. In this analysis some clarification of R seems to be in order. This notation R refers to the product moment correlation between the actual values of the dependent variates in multiple regression; its values are given by the regression equation. It measures the closeness of the representation by the regression line and may be regarded as the maximum of the correlation coefficients between the dependent variable and all linear functions of a set of two or more of the independent variates. The coefficient is essentially non-negative; the quantity R^2 is actually the one which occurs in practice. The R^2 value indicates the amount of accounted variance between any two groups of workers used in that set in regard to how different they are from each other.

Since the purpose of these analyses was to refine the taxonomy of individual species by defining the major workers by their biometrical parameters, aside from their general morphological features, these analyses are good only for the species in which they have been used. Therefore, it is not possible to compare the results of these analyses in one species with those in another species.

All drawings were made by using the grid method.

Reference Collections

The cooperation of museum curators and of individual myrmecologists throughout the world has been essential in the present study. Almost all of the *Myrmothrix* types were in European collections, but travel to Europe was not possible. In most instances it was possible to borrow specimens from type series as well as identified material in each of these museum and private collections. These specimens are identified by locality, collector and collection in the section or species.

The collections from which material was received on loan and the curator who arranged the loan are identified below. In the section on species to follow the collection is identified by an abbreviation which is enclosed in parentheses below.

American Museum of Natural History, New York; Dr. Jerome J. Rosen, Jr. and Dr. Marjorie Favreau. (AMNH).

British Museum (Natural History), London, England; Dr. Barry Bolton. (BM).

California Academy of Sciences, San Francisco, California; Dr. Paul H. Arnaud, Jr. (CAS).

Dr. William S. Creighton, P. O. Box 1421, La Feria, Texas. (CRTN).

Hope Department of Entomology, University Museum, Oxford, England; Professor G. C. Varley. (OXFORD).

Institut für angewandte Zoologie der Universität Würzburg, Würzburg, West Germany, Professor K. Gösswald. (IAZUW).

Instituto Miguel Lillo, San Miguel de Tucuman, Argentina; Dr. Kenneth J. Hayward. (MIGUEL).

Dr. Walter W. Kempf, Caixa Postal 5650, São Paulo, Brazil. (KEMPF).

Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts; Dr. John F. Lawrence. (MCZ).

Muséum d'Histoire Naturelle, Basle, Switzerland; Dr. W. Wittmer and Dr. C. Baroni-Urbani. (SANT).

Muséum d'Histoire Naturelle, Geneva, Switzerland; Dr. Cl. Besuchet. (FOREL).

Muséum National d'Histoire Naturelle, Paris, France; Madame J. Casevite Weulersse. (PARIS).

Naturhistorisches Museum, Zoologische Abteilung, Vienna, Austria; Dr. Max Fischer. (MAYR).

Secretaria da Agricultura, Departamento de Zoologia, São Paulo, Brazil; Dr. José Henrique Guimarães. (GUIAM).

United States National Museum, Washington, D.C.; Dr. David R. Smith. (USNM).

Universitetets Zoologiske Museum, Copenhagen, Denmark; Dr. Borge Petersen. (DANK).

Dr. Neal A. Weber, Swarthmore College, Swarthmore, Pennsylvania. (WEBER).

Zoologisches Museum der Humboldt Universität, Berlin, East Germany; Dr. E. Königsmann. (HUMB).

Dr. Paul B. Kannowski, Department of Biology, University of North Dakota, Grand Forks. (PBK).

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The other members of my advisory committee, Professors Alan M. Cvancara, Harry L. Holloway, S. M. Jalal and Dwayne A. Ollerich offered many valuable suggestions during the preparation of the dissertation. Their service is sincerely appreciated. I am also grateful for advice on taxonomy that was provided by Professor William Wrenn and advice on statistical methods that was given by Professor John Williams.

The loan of material from museums and private collections throughout the world was essential to the completion of this study. The assistance of the museum curators and individual collectors, all of whom are listed in the section on Reference Collections, is gratefully acknowledged.

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Subgenus **Myrmothrix** Forel, 1912

Camponotus subgenus *Myrmothrix* Forel, 1912, Mem. Soc. Ent. Belg. *20*:91. Wheeler, 1913, Ann. N. York Acad. Sci. *23*:81. Forel, 1914a, Rev. Suisse Zool. *22*:260. Emery, 1920, Rev. Zool. Afric. Bruxelles. *8*:236-237. Emery, 1925, Formicidae (Formicinae), *Genera Insectorum* 107-109.

Type species. *Camponotus abdominalis* (Fabricius). Designated by Wheeler (1913).

Diagnosis

Major worker. Pilosity long, erect or suberect, abundant on body, especially antennal scape and legs. Pubescence of varying density all over body. Head excised along posterior margin, narrowing anteriorly below compound eyes; clypeal carina distinct; mandibles somewhat shiny, conspicuously striated, punctate with long piliferous hairs and bearing six teeth. Scape narrow at base, thickened towards apex, maximum thickeness about 0.34 mm and maximum length about 1.1 × the head length measured from antennal fossa to occipital border.

Media worker. Hairs of moderate thickeness and of varying density all over body. Head in full face view similar to major worker, occipital border feebly emarginate medially, clypeus sometimes emarginated anteriorly. Antennal scape usually uniform in thickeness, sometimes slightly swollen towards apex but always flattened, with a maximum thickeness of about 0.2 mm and a maximum length of 1.08× the length of head measured from antennal fossa to occipital border.

Minor worker. Lateral margins of head appearing parallel or subparallel, head sometimes slightly convex, slightly narrowed posteriorly, with occipital angles not pronounced. Antennal scape cylindrical, sometimes slightly thicker at apical end but not flattened, with a maximum thickeness of about 0.1 mm and a maximum length of about 1.75 times the length of head measured from antennal fossa to occipital border.

Female. Similar in appearance to the major worker except for larger size and alitrunk structures; head trapezoidal, broader behind than in front, with almost parallel lateral margins and slightly ocnvex occipital border. Antennal scape narrow at base, thickened towards apex, with punctures and sparse bristle-like hairs. Scutum free of hairs. Petiole usually narrow at base, broader towards apex and slightly emarginated at top. Evidently always winged; wings hyaline.

Male. Pilosity long, sparse, but not as long and thick as in major workers. Antennal scape cylindrical with hairs of varying density. Eyes appearing large in relation to head size. Mandibles with two indistinct teeth. Propodeu mdemarcated in base and declivity. Mayrian furrow lacking. Petiole thick and notched in center. Evidently always winged, wings hyaline.

Camponotus hannani Forel, 1900

(Figure 1)

Camponotus hannani Forel, 1900, Biol. Centr. Amer. 3: 131. Description of major worker. Type locality: Kingston, Jamaica. Location of type material: Forel Collection at Museum d'Histoire Naturelle, Geneva. Forel, 1902, Bull. Ann. Ent. Belg. 46: 170. Nesting in Jamaica. Forel, 1907, Mitt. Naturh. Mus. Hamburg 24: 11. Description of male. Wheeler, 1917, Bull. Mus. Comp. Zool. 51 (13): 468. Description of female. Figures of head of major worker and female.

Camponotus hannani race *willardi* Forel, 1900, Biol. Centr. Amer. 3: 132. Description of minor and media workers. Type locality: Jamaica. Location of type material: Forel Collection at Museum d'Histoire Naturelle, Geneva. New Synonymy.

Type material examined. The following type material from the Forel Collection was examined. The measurements of each specimen are listed in Table 1 for *C. hannani* and in Table 2 for *willardi*. Since their value lie within the range of the species as such, their means, etc., have not been given.

1. Seventeen syntypes of *Camponotus hannani* Forel: (a) Two males labelled, "Cotype, Jamaica, Collector C. G. Gagzo. 4. VI. 1905. ded. 5. VIII. 1905" (for measurements see under male). (b) Two major and one minor workers labelled, "Type, *C. abdominalis* F. r. *hannani* Forel Jamaica, Jard. bot. (Forel)". (c) Seven major, one media and four minor workers labelled, "Cotype, *C. abdominalis* F. r. *hannani* Forel, Jamaique, Jard. bot. Forel".

2. Six syntypes of *Camponotus hannani* Forel r. *willardi*: (a) Three media workers labelled, "Type, *C. hannani* For. r. *willardi*, Jamaique (Copper)". (b) Three media workers labelled, "Cotype, *C. hannani* Forel r. *willardi*, Jamaique (Copper)".

Distribution. This species has so far been reported only from Jamaica.

Localities from which specimens have been examined. The first name is the name of the locality and in parenthesis the name of the collector followed by the location or source of material in capital letters. All localities are in Jamaica. Newton 3000' (C. T. Brues: MCZ, AMNH) workers associated with female and male; Cinchona (Anonymous: MCZ, AMNH); Liguanea plain (C. T. Brues: MCZ, AMNH); Moneague (F. C. Paulmier: MCZ); Kingston (Mich. Grablem and A. Wight: MCZ); Montego Bay (E. A. Andrews and A. Wight: MCZ, AMNH); Balaclava (Wight: MCZ, AMNH); S. W. side main range Blue Mountains (Darlington: MCZ); besides the above, several workers from Jamaica were intercepted from banana trash by C. A. Davis at Boston, Mass., and by W. W. Chapman at philadelphia, Pa., and on log woods by C. E. Prince at

TABLE 1

Measurements (mm) and indices of the various body parts of type material of *C. hannani*

	Syntypes (workers)														
	Majors									Media	Minors				
	1	2	3	4	5	6	7	8	9	1	1	2	3	4	5
Head width	2.90	3.09	3.09	3.13	3.13	3.17	3.29	3.33	3.29	2.28	1.47	1.59	1.55	1.43	1.86
Head length	3.21	3.37	3.56	3.52	3.33	3.48	3.52	3.56	3.48	2.51	1.90	2.01	1.97	1.90	2.32
Scape length	2.90	2.94	2.98	2.90	2.94	3.01	2.01	2.94	3.01	2.71	2.36	2.44	2.36	2.24	2.32
Pronotum width	1.82	1.93	2.09	2.01	2.01	2.01	2.09	2.17	2.09	1.70	1.16	1.31	1.28	1.12	1.24
Metatibial length	3.17	3.48	3.17	3.40	3.48	3.56	3.49	3.48	3.52	3.17	2.60	2.67	1.86	2.44	2.98
Weber's length	3.98	4.18	4.26	4.10	4.26	4.26	4.26	3.99	4.18	3.56	2.70	2.63	2.94	2.82	3.25
Maximum eye length	0.62	0.66	0.62	0.66	0.66	0.66	0.66	0.66	0.66	0.58	0.42	0.46	0.46	0.46	0.54
Maximum eye width	0.46	0.50	0.46	0.46	0.50	0.54	0.46	0.46	0.50	0.42	0.35	0.39	0.39	0.35	0.39
Interocular space	1.78	1.93	1.97	1.93	1.97	1.97	2.05	2.13	1.97	1.43	0.97	1.00	0.97	0.89	1.12
Cephalic index	90	92	87	89	94	91	93	93	94	90	77	79	78	75	80
Scape index	100	95	96	92	94	95	92	88	92	119	160	154	152	156	125
Ocular index	75	76	75	70	76	82	70	70	76	73	82	83	83	75	71
Pronotum index	63	62	67	64	64	63	63	65	63	74	79	83	82	78	66

TABLE 2

Measurements (mm) and indices of the various body parts of type material of *C. hannani* r. *willardi*

Variable	Syntypes (media workers)					
	1	2	3	4	5	6
Head width	2.17	2.01	1.90	2.09	2.01	2.05
Head length	2.51	2.32	2.24	2.40	2.32	2.28
Scape length	2.59	2.67	2.60	2.55	2.67	2.71
Pronotum width	1.62	1.51	1.39	1.55	2.24	1.35
Metatibial length	3.02	2.94	2.82	2.90	3.01	2.90
Weber's length	3.36	3.25	3.21	3.21	3.06	3.21
Maximum eye length	0.58	0.54	0.54	0.54	0.54	0.54
Maximum eye width	0.42	0.42	0.39	0.39	0.43	0.39
Interocular space	1.32	1.28	1.20	1.32	1.28	1.28
Cephalic index	86	86	84	87	86	89
Scape index	119	132	136	122	132	132
Ocular index	73	78	71	71	78	71
Pronotum index	75	75	73	74	111	66

Baltimore, Maryland, (found in USNM); and from orchid plants at Bermuda (C. A. Baker Lot 47-6301: USNM).

Major worker. General body color yellow, deep yellow brown or chestnut brown; pilosity long, suberect, golden yellow, abundant on head, dorsum of alitrunk, petiole and gaster. Standing hairs on head variable in length and distribution: longest hairs restricted to vertex and sides of frontal carinae, hairs on occipital region, clypeus and mandibles shorter and more abundant; scape covered with short, suberect hairs of moderate density; tibial pilosity short, stiff, suberect, golden yellow, and abundant. Yellow, suberect and appressed pubescence moderately dense on head, very dense on gaster; head broader behind, excised along the occipital border, sides gradually converging anteriorly below the compound eyes; mandibles deep orange, convex, shiny, and with abundant elongated piligerous foveolae and 6 blackish-brown teeth, apical tooth longest; lower genae deep brown; antennal scape flattened in basal 1/3, maximum width about 0.34 mm, length about 1.3 times head length from antennal fossa to occipital border, clypeal carina distinct, extending the entire length; anterior lobes of clypeus pronounced, clypeus clearly notched in middle; eyes rounded, rather oval, and located above middle of head; alitrunk in dorsal profile evenly convex, compressed behind; promesonotal suture strongly impressed, metanotal groove feebly marked laterally; propodeum declivity appearing flat when viewed posteriorly; petiole small, oval, lower than level of propedeum, convex in front, flat behind, with entire, rounded, moderately sharp border; in some specimens flattened or depressed on crest. Gaster oval, each segment with golden yellow band and erect golden yellow pilosity.

Media worker. Sculpture, pilosity and general coloration similar to major worker; head 1-1/5 times as long as broad; shape of head in full-face view similar to major worker; occipital margin feebly emarginate medially; in relation to head size eyes appearing rather large and convex; clypeus carinate, anterior border straight, not clearly notched in middle; antennal scape flattened from base to apical end, apparently of uniform thickeness, maximum thickeness about 0.23 mm; about 1.8 times head length from antennal fossa to occipital border, bearing delicate, short, suberect hairs over all the surface.

Minor worker. Scape, mandibles and anterior border of frons lighter brown than in major worker; head about 1-1/5 times as long as broad; in full-face view sides appearing subparallel to parallel; head narrowed posteriorly, occipital angles not pronounced, occipital border almost straight; antennal scape cylindrical, sometimes slightly swollen at apical end, not flattened; measuring about 1.75 times head length from antennal fossa to occipital border, maximum thickness about 0,15 mm.

Statistical Analyses

The workers of this species were available in sufficient number for statistical analysis (Tables 3 through 10).

Results of MSDCC.

TABLE 3

Range, mean, standard deviation and variance of the various body measurements (mm) and indices in workers of *C. hannani*

Variable	Statistic	Minor n = 50	Media n = 21	Major n = 80
1. Head width	Range	1.31-1.85	1.85-2.63	2.83-3.37
	Mean	1.62	2.17	3.11
	S.D.	0.12	0.20	0.16
	Variance	0.01	0.04	0.02

TABLE 3 — Continued

Variable	Statistic	Minor n = 50	Media n = 21	Major n = 80
2. Head length	Range	1.86-2.32	2.24-2.98	3.02-3.75
	Mean	2.01	2.49	3.43
	S.D.	0.11	0.20	0.15
	Variance	0.01	0.04	0.02
3. Scape length	Range	2.09-2.67	2.27-2.71	2.27-3.09
	Mean	2.41	2.58	2.94
	S.D.	0.11	0.12	0.11
	Variance	0.01	0.01	0.01
4. Pronotum width	Range	1.08-1.55	1.35-2.24	1.82-2.17
	Mean	1.27	1.59	2.01
	S.D.	0.09	0.18	0.09
	Variance	0.01	0.03	0.01
5. Metatibial length	Range	1.86-2.86	2.27-3.25	3.09-3.68
	Mean	2.53	2.91	3.38
	S.D.	0.22	0.19	0.14
	Variance	0.05	0.04	0.02
6. Weber's length	Range	2.27-3.29	3.06-3.79	3.56-4.45
	Mean	2.94	3.37	4.08
	S.D.	0.17	0.19	0.18
	Variance	0.03	0.04	0.03
7. Maximum eye length	Range	0.42-0.54	0.50-0.62	0.54-0.69
	Mean	0.47	0.55	0.62
	S.D.	0.03	0.03	0.04
	Variance	0.00	0.00	0.00
8. Maximum eye width	Range	0.35-0.42	0.39-0.46	0.42-0.54
	Mean	0.38	0.42	0.48
	S.D.	0.02	0.02	0.03
	Variance	0.00	0.00	0.00
9. Interocular space	Range	0.89-1.16	1.20-1.70	1.70-2.20
	Mean	1.04	1.37	1.99
	S.D.	0.06	0.13	0.10
	Variance	0.00	0.02	0.01
10. Cephalic index	Range	75-89	83-91	84-95
	Mean	80	87	91
	S.D.	4.31	2.55	2.43
	Variance	16.91	5.43	5.91
11. Scape index	Range	125-173	87-137	79-103
	Mean	150	120	95
	S.D.	10.62	13.30	4.60
	Variance	112.90	176.99	21.21
12. Ocular index	Range	71-92	62-86	61-92
	Mean	81	76	77
	S.D.	4.87	6.11	4.98
	Variance	23.69	37.35	24.81
13. Pronotum index	Range	66-91	66-111	61-70
	Mean	79	74	64
	S.D.	4.32	9.42	1.93
	Variance	18.69	88.65	3.71

Results of DISCAN.

TABLE 4

Correlation matrix of nine variables (see table 3) for total sample — minors, medias and majors of *C. hannani* *

Variables	1	2	3	4	5	6	7	8	9
1	1.00								
2	0.99	1.00							
3	0.91	0.90	1.00						
4	0.97	0.96	0.90	1.00					
5	0.92	0.91	0.86	0.89	1.00				
6	0.96	0.97	0.89	0.94	0.90	1.00			
7	0.90	0.91	0.84	0.89	0.85	0.92	1.00		
8	0.89	0.89	0.84	0.89	0.82	0.88	0.85	1.00	
9	0.99	0.99	0.91	0.96	0.91	0.96	0.89	0.88	1.00

* (n = 151).

TABLE 5

Discriminant analysis of minors, medias and majors of *C. hannani*

Actual Groups	Classification Using the Predictor Variable		
	Minors	Medias	Majors
Minors	50	0	0
Medias	0	21	0
Majors	0	0	80

It can be seen from the prior table that all the workers were correctly classified.

TABLE 6

The discriminant functions with their constants and the respective coefficients for nine variables of *C. hannani*

	Discriminant Functions		
	Minors	Medias	Majors
Constants	–369.97	–440.53	-602.45
Coefficients:			
Head width	–105.67	– 98.18	– 93.55
Head length	66.35	64.10	96.22
Scape length	142.31	145.07	161.08
Pronotum width	16.26	25.55	22.03
Metatibial length	47.38	51.06	51.73
Weber's length	28.78	28.47	25.98
Maximum eye length	67.89	92.38	54.99
Maximum eye width	365.10	363.43	390.74
Interocular space	36.43	53.28	73.37

Results of MANOVA.

TABLE 7

Multivariate analysis of variance for minors and medias of *C. hannani*

Test Performed	Results
H_1	Homogeneity of variance-covariance matrix
F_1	45 (df, numerator)
F_2	5222 (df, denominator)
F	2.36 (Table value 1.73)
H_2	Generalized analysis of variance
F_1	9 (df, numerator)
F_2	61 (df, denominator)
Lambda (λ)	0.03
F	27.42 (Table value 3.69)

TABLE 8

Multivariate analysis of variance for medias and majors of *C. hannani*

Test Performed	Results
H_1	Homogeneity of variance-covariance matrix
F_1	45 (df, numerator)
F_2	4518 (df, denominator)
F	2.82 (Table value 1.73)
H_1	Generalized analysis of variance
F_1	9 (df, numerator)
F_2	91 (df, denominator)
Lambda (λ)	0.13
F	68.70 (Table value 3.38)

TABLE 9

Stepwise discrimination between minors and medias of *C. hannani*

Step	Variable Eliminated	R	R^2
1	None (Full model)	0.89	0.80
2	Maximum eye width	0.89	0.80
3	Head length	0.89	0.80
4	Head width	0.89	0.80
5	Metatibial length	0.89	0.80
6	Weber's length	0.89	0.79
7	Maximum eye length	0.88	0.79
8	Pronotum width	0.88	0.77
9	Scape length	0.86	0.75
10	Interocular space		

In the above table, apparently interocular space is the most important variable in predicting whether a given specimen is a minor or a media worker. According to the sequence of variables as shown in the table, maximum eye width is the least important, but it should be noticed that the variables maximum eye width, head length, head width, and metatibial length have identical correlation values which means that any one of these variables can be used as a predictor by leaving aside any other three variables and we can have equally effective prediction.

TABLE 10

Stepwise discrimination between medias and majors of *C. hannani*

Step	Variable Eliminated	R	R^2
1	None (Full model)	0.93	0.87
2	Weber's length	0.93	0.87
3	Metatibial length	0.93	0.87
4	Pronotum width	0.93	0.87
5	Interocular space	0.93	0.87
6	Maximum eye width	0.93	0.87
7	Head width	0.93	0.86
8	Maximum eye length	0.92	0.86
9	Scape length	0.92	0.85
10	Head length		

The above table reveals that head length is seemingly the best predictor followed by scape length, maximum eye length and then head width. The variables maximum eye width, interocular space, pronotum width, metatibial length and Weber's length all have almost an identical *R*-value, which means that each one of these is essentially equally effective in prediction of the group membership next to head width. It can also be noticed that these variables have a high degree of intercorrelation. Thus, any one of these predictors can be used for prediction on a basis which is equally as effective as any other; in fact, the group of predictors is not significantly more effective than any single variable (in regard to maximum eye width, interocular space, pronotum width, metatibial length and Weber's length).

Female. Resembling major worker in color, sculpture and pilosity; head narrower than thorax, slightly broader behind than in front, with rather straight sides and occipital border, about 1-1/3 times longer than broad (when measured below compound eyes); antennal scape narrower and less flattened than major worker; clypeal lobe rectangular with anterior border notched; scape gradually enlarging towards apical end, with very few scattered, short, suberect hairs; thorax narrow and elongated; mesonotum longer than broad, central area free of pubescence; propodeum divided into base and declivity; in anterior view petiole with a distinct median emargination, sides more or less straight; standing hairs few, confined to posterior border of each gastric segment. Wings pale, with yellow veins and pterostigma.

The various measurements from the single specimen are: head width 2.63 mm; head length 3.10 mm; scape length 2.83 mm; metatibial length 3.10 mm; Weber's length 4.9 mm; fore femur length 2.55 mm; fore femur width 0.69 mm; maximum eye length 0.77 mm; maximum eye width 0.62 mm; interocular space 1.89 mm; cephalic index 85; scape index 73; and fore femur index 27.

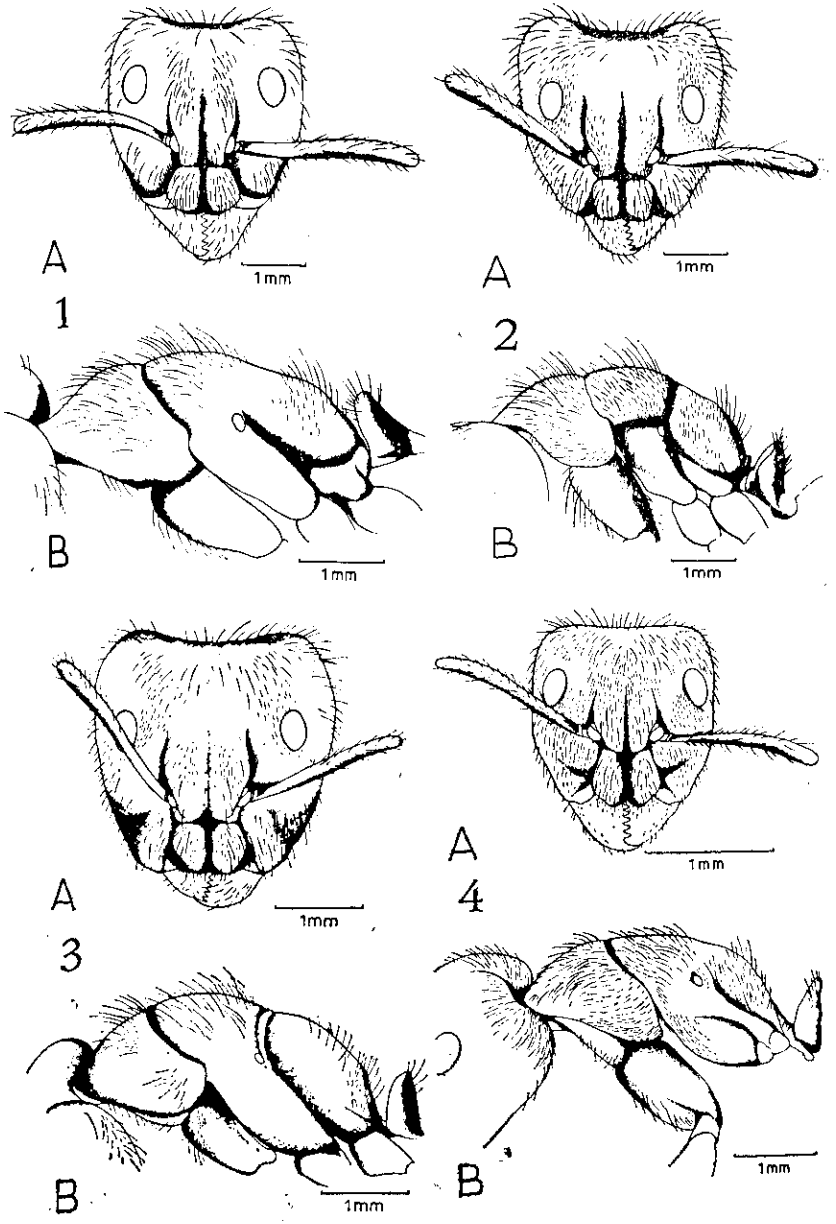
Male. General body color varies from reddish yellow to yellowish red; pilosity long, moderately thick, scanty, over entire body, not as thick as of major worker and female; tibial hairs short and suberect; scape of antenna cylindrical with numerous scattered hairs; head narrowed posteriorly, occipital border straight; eyes appearing large in relation to head size; mandibles with two teeth; thorax with long, reddish yellow hairs; propodeum divided into base and declivity; petiole thick and deeply cut in center; wings pale, veins and pterostigma yellowish. The measurements (mm) ot two specimens examined are the following: Head width 0.93 (0.97), head length 1.35 (1.39), scape length 1.78 (1.82), Weber's length 3.33 (3.25), maximum eye length 0.58 (0.54), maximum eye width 0.38 (0.35), interocular space 0.81 (0.81).

Biology. The nesting habit of this species has been briefly described by Forel (1900, 1902). He found this species inhabiting the foot of trees in the Botanical Gardens of Kingston, Jamaica, and living in those parts of the tree trunks from which the bark had been removed. The nest aperture was usually closed with a coarse, ligneous "cardboard" similar to that made by *Crematogaster stolli.*

Synonymy. The type material of *willardi* is comprised of media workers which show slight color difference as compared to media workers of *hannani.* However, this difference is actually the species variation and as such *willardi* does not deserve any special taxonomic status.

Differential diagnosis: *Camponotus conspicuous* Fr. Smith (subgenus *Tanaemyrmex*) has been reported to occur sympatrically with *Camponotus hannani* in several localities in Jamaica. Although both species superficially resemble each other, the following diagnostic differences between them are evident.

C. hannani	C. conspicuous
Major worker:	
Head broad posteriorly and narrowing gradually anteriorly below the level of compound eyes; occipital border deeply excised with rounded occipital angles; cheeks without any oblique impression.	Head trapezoidal, with broadly excised posterior border, and sides straight in the middle and rounded anteriorly; cheeks with an oblique impression.
Scape flattened, also thickened slightly above the base, with moderately dense suberect or oblique, thick hairs all over the surface.	Scape flattened, thickening gradually towards apical end; mostly bare in pilosity; tips with a few short, erect hair.
Anterior border of clypeus notched in the middle, with prominently pronounced lobes.	Anterior border of clypeus rectangular, with margin entire and not notched in the middle.
Tibiae with long, thick, suberect golden yellow pilosity.	Tibiae with few, yellow, short and suberect hairs.
Media and minor worker: Did not have enough material for comparison.	
Male:	
Base of propodeum 1/2 times the length of declivity.	Propodeum convex, of gradual declivity.
Thoracic dorsum with long yellow hairs.	Thoracic dorsum hairless.
Petiole thick, lower than level of propodeum, deeply cut in the center.	Petiole thick, lower than level of propodeum, with margins entire.
Female:	
Propodeum distinctly marked into base and declivity; declivity about twice the length of base, petiole thick, cut in the center.	Propodeum convex, sloping, without distinct base and declivity petiole thick, flattened dorsally appearing subrectangular when observed from above.



Camponotus (*Myrmothrix*), major worker
A. Front view of head. B. Lateral view of alitrunk. Fig. 1. *hannani*. Fig. 2. *bugnioni*. Fig. 3 .*cingulatus*. Fig. 4. *femoratus*.

Camponotus bugnioni Forel, 1900

(Figure 2)

Camponotus bugnioni Forel, 1900, Biol. Centr. Am. 3: 131. Description of major and minor workers. Type locality: Colombia: Forests at the foot of Sierra Nevada of Santa Marta and Dibulla of Santa Marta. Location of type material: Forel Collection at Museum d'Histoire Naturelle, Geneva. Forel, 1902, Bull. Ann. Soc. Ent. Belg. 46: 170. Notes on biology in Dibulla, Colombia. Forel, 1914b, Neuchatel Mem. Soc. Sci. Nat. 5 (2): 14. Descriptive notes. Distribution in Colombia. Kutter, 1931, Mitt. Schweiz. Ent. Ges. 15: 62-63. Description of female. Santschi, 1936. Rev. Ent. Rio de Janeiro. 6: 196. Description of male.

Type material examined. Nine syntypes: (a) One major and two minor workers labelled, "Type; *C. bugnioni* For., Dibulla, Columbia (Forel)". (b) One major and two minor workers labelled, "Cotypus; *C. bugnioni* Forel, Georgetown, Mortirod Sierra Nevada (Forel)". (c) One major and two minor workers labelled, "Cotypus; *C. bugnioni,* Pied Sierra Nevada, Columbia (Forel)". For measurements see Table 11.

Distribution. This species has so far been reported only from Colombia.

Localities from which the specimens have been examined. The first name is the name of the locality and in parenthesis the name of the collector followed by the location or source of material in capital letters. Mortirod Sierra Nevada (Anonymous: FOREL); Dibulla (Anonymous: FOREL); Pied Sierra Nevada (Anonymous: FOREL); Georgetown Anonymous: FOREL): Medellin (C. N. Ballok: USNM) workers associated with males; and vicinity of Barranca Bermeja (J. Archer: MCZ) workers associated with females.

Major worker. General body color deep brown black; head yellowish red, flagellum, genae, epistome, mandibles, dorsum of pronotum, mesonotum and tarsi brownish, more or less rusty; lateral margins of clypeus and lower genae blackish; clypeus bifid posteriorly, emarginated anteriorly, lateral angles of epistoma lobes dentiform. Clypeus with 22+ golden yellow hairs; golden yellow hairs between frontal carinae and occipital margin number 14+; occipital border with blackish hairs; mandibles rather dull conspicuously striated, punctate and finely reticulated with long piliferous yellow hairs; mandibles consist of brownish orange base and 6 blackish teeth. Head, narrow anteriorly, broad posteriorly, deep blackish brown at clypeus level, remaining orangish, more glossy in front and with abundant punctures on genae and occiput. Gular area brownish black with yellow pilosity. Alitrunk, scale and legs brownish black, trochanters of foreleg

TABLE 11

Measurements (mm) and indices of the various body parts of type material of *C. bugnioni*

Variable	Syntypes (Workers)								
	Majors			Minors					
	1	2	3	1	2	3	4	5	6
Head width	2.98	3.06	3.25	1.59	1.39	1.35	1.32	1.55	1.24
Head length	3.17	3.13	3.37	1.86	1.70	1.70	1.59	1.82	1.59
Scape length	2.28	2.40	2.40	2.05	1.90	1.97	1.97	2.09	1.82
Pronotum width	1.78	1.86	2.05	1.24	1.16	1.08	1.39	1.24	1.04
Metatibial length	2.51	2.59	2.71	2.13	2.01	2.09	2.05	2.13	1.97
Weber's length	3.56	3.48	3.79	2.67	2.59	2.51	2.44	2.59	2.44
Maximum eye length	0.58	0.62	0.62	0.50	0.43	0.46	0.43	0.46	0.43
Maximum eye width	0.46	0.46	0.42	0.42	0.39	0.39	0.39	0.39	0.35
Interocular space	1.82	1.93	2.05	1.01	0.93	0.89	0.89	1.01	0.85
Cephalic index	93	97	96	85	82	79	83	85	78
Scape index	77	78	74	129	136	146	150	135	147
Ocular index	80	75	69	85	91	83	91	83	82
Pronotum index	60	61	63	78	83	80	106	80	84

yellow; propodeum with abrupt declivity, 2 times length of base; thick, suberect pilosity over entire pronotum, mesonotum, declivity and base; scale slightly notched in center. Pubescence, short, appressed and beneath pilosity; each gastric segment with a golden yellow band and hairs, latter of varying length.

Media worker. Resembles major worker in head shape, pilosity and sculpture; scape blackish, maximum thickness 0.23 mm; mandibles with blackish teeth; occipital border shallowly emarginate; thick hairs all over body, densest on gaster.

Minor worker. Deep dark brown and shiny; mandibles 6 toothed; clypeus carinated, anterior border emarginated; head convex between compound eyes, declivous towards occipital border and front side; flagellum, tibiae and tarsi slightly lighter; scape brownish, maximum thickness about 0.15 mm; head, alitrunk, legs and gaster with abundant, erect, golden yellow hairs; gaster with short and appressed pubescence; pilosity, longer on gaster than rest of body parts, densest on last two segments.

Statistical Analyses

The workers of this species were available in reasonable number, therefore, the data have been statistically analyzed (Tables 12 through 19).

Results of MSDCC.

TABLE 12

Range, mean, standard deviation and variance of the various body measurements (mm) and indices in workers of *C. bugnioni*

Variable	Statistic	Minor n = 41	Media n = 16	Major n = 62
1. Head width	Range	1.27-1.82	1.59-2.17	2.27-3.40
	Mean	1.45	1.83	2.83
	S.D.	0.13	0.16	0.23
	Variance	0.02	0.02	0.05
2. Head length	Range	1.55-1.93	1.86-2.32	2.27-3.40
	Mean	1.76	2.06	2.96
	S.D.	0.11	0.16	0.21
	Variance	0.01	0.02	0.05
3. Scape length	Range	1.86-2.24	2.05-2.40	2.05-2.63
	Mean	2.05	2.22	2.31
	S.D.	0.09	0.09	0.10
	Variance	0.01	0.01	0.01
4. Pronotum width	Range	1.01-1.35	1.28-1.59	1.62-2.17
	Mean	1.17	1.43	1.79
	S.D.	0.09	0.11	0.10
	Variance	0.01	0.01	0.01
5. Metatibial length	Range	1.62-2.32	2.09-2.63	2.28-2.90
	Mean	2.12	2.29	2.47
	S.D.	0.15	0.15	0.18
	Variance	0.02	0.02	0.03
6. Weber's length	Range	2.21-2.79	2.63-3.21	3.02-3.99
	Mean	2.50	2.83	3.41
	S.D.	0.15	0.20	0.17
	Variance	0.02	0.04	0.03
7. Maximum eye length	Range	0.42-0.58	0.50-0.66	0.54-0.77
	Mean	0.49	0.53	0.61
	S.D.	0.03	0.04	0.04
	Variance	0.00	0.00	0.00
8. Maximum eye width	Range	0.31-0.42	0.39-0.46	0.39-0.54
	Mean	0.39	0.41	0.45
	S.D.	0.02	0.02	0.04
	Variance	0.00	0.00	0.00
9. Interocular space	Range	0.81-1.12	1.01-1.35	1.55-2.09
	Mean	0.95	1.16	1.79
	S.D.	0.07	0.10	0.13
	Variance	0.01	0.01	0.02
10. Cephalic index	Range	71-94	85-93	87-114
	Mean	82	88	96
	S.D.	4.43	2.31	5.98
	Variance	19.63	5.37	35.74
11. Scape index	Range	120-167	102-139	75-97
	Mean	142	123	82
	S.D.	10.43	9.73	5.98
	Variance	108.84	94.77	35.73

TABLE 12 — Continued

Variable	Statistic	Minor n = 41	Media n = 16	Major n = 62
12. Ocular index	Range	64-85	70-85	65-82
	Mean	78	77	75
	S.D.	5.03	3.71	5.13
	Variance	25.32	13.75	26.37
13. Pronotum index	Range	70-103	79-98	55-76
	Mean	81	87	63
	S.D.	5.86	6.33	3.95
	Variance	34.38	40.07	15.63

Results of DISCAN.

TABLE 13

Correlation matrix of nine variables (see table 12) for total sample — minors, medias and majors of *C. bugnioni* *

Variable	1	2	3	4	5	6	7	8	9
1	1.00								
2	0.98	1.00							
3	0.80	0.79	1.00						
4	0.96	0.96	0.83	1.00					
5	0.74	0.76	0.74	0.76	1.00				
6	0.95	0.95	0.82	0.94	0.75	1.00			
7	0.87	0.88	0.79	0.85	0.75	0.86	1.00		
8	0.80	0.80	0.71	0.80	0.64	0.79	0.81	1.00	
9	0.98	0.98	0.81	0.97	0.75	0.96	0.88	0.81	1.00

* (n = 119).

TABLE 14

Discriminant analysis of minor, media and major workers of *C. bugnioni*

Actual Groups	Classification Using the Predictor Variable		
	Minors	Medias	Majors
Minors	41	0	0
Medias	0	16	0
Majors	0	0	62

It can be seen from the prior table that the workers were correctly classified. Generalized Mahalanobis D-square = 2309.84.

TABLE 15

The discriminant functions with their constants and the respective coefficients for nine variables of *C. bugnioni*

	Discriminant Functions		
	Minors	Medias	Majors
Constants	-338.50	-337.19	-367.18
Coefficients:			
Head width	- 28.10	- 22.73	- 11.43
Head length	55.34	49.99	51.58
Scape length	223.14	228.12	190.08
Pronotum width	21.93	47.45	50.05
Metatibial	31.27	29.70	18.71
Weber's length	74.44	81.79	78.79
Maximum eye length	27.49	18.22	20.36
Maximum eye width	314.56	274.83	166.38
Interocular space	-254.49	-261.01	-177.77

Results of MANOVA.

TABLE 16

Multivariate analysis of variance for minors and medias of *C. bugnioni*

Test Performed	Results
H_1	Homogeneity of variance-covariance matrix
F_1	45 (df, numerator)
F_2	2850 (df, denominator)
F	1.92 (Table value 1.73)
H_2	Generalized analysis of variance
F_1	9 (df, numerator)
F_2	47 (df, denominator)
Lambda (λ)	0.2613
F	14.76 (Table value 3.69)

TABLE 17

Multivariate analysis of variance for medias and majors of *C. bugnioni*

Test Performed	Results
H_1	Homogeneity of variance-covariance matrix
F_1	45 (df, numerator)
F_2	2524 (df, denominator)
F	2.10 (Table volue 1.73)
H_2	Generalized analysis of variance
F_1	9 (df, numerator)
F_1	61 (df, denominator)
Lambda (λ)	0.127
F	51.91 (Table value 3.69)

Results of STWMULT.

TABLE 18

Stepwise discrimination between the minors and medias of *C. bugnioni*

Step	Variable Eliminated	R	R^2
1	None (Full model)	.86	.74
2	Metatibial length	.86	.74
3	Head length	.86	.74
4	Interocular space	.85	.73
5	Scape length	.85	.72
6	Maximum eye width	.84	.71
7	Weber's length	.83	.69
8	Maximum eye length	.80	.65
9	Head width	.77	.60
10	Pronotum width		

Table 18 shows that the pronotum width and head width are the most important variables for the prediction of media and minors. The rest of the variables viz., maximum eye length, Weber's length, maximum eye width, scape length, interocular space, head length and metatibial length are as effective as a group in predicting whether a specimen is a media or minor worker as each one of them is singly.

Table 19 shows that for the descrimination between a media and a major worker the interocular space is the most important variable followed by scape length, maximum eye length, metatibial length, head width, maximum eye length, pronotum width, head length and finally Weber's length. In conclusion except for

interocular space all of the other variables are singly as effective as they are as a group in predicting whether a worker is a major or media.

TABLE 19

Stepwise discrimination between media and major workers of *C. bugnioni*

Step	Variable Eliminated	R	R²
1	None (Full model)	.93	.87
2	Weber's length	.93	.87
3	Head length	.93	.87
4	Pronotum width	.93	.87
5	Maximum eye length	.93	.87
6	Head width	.93	.87
7	Metatibial length	.92	.86
8	Maximum eye length	.91	.83
9	Scape length	.90	.81
10	Interocular space		

Female. General body color black, head orange brown; flagellum, latrum of alitrunk and legs reddish brown; mandibles, genal area above mandibles base, scape, area immediately surrounding ocelli, more or less rest of entire alitrunk very dark brown; gaster blackish; head duller than alitrunk and gaster, latter less sculptured but shinier than in major worker; scale thick, rectangular, with slight cut in center; golden yellow pilosity less pronounced, particularly alitrunk and gaster with scanty pilosity, posterior border of each gastric segment with a golden yellow band preceeded by a row of long, suberect, yellowish hairs, rest of segment with very few short hairs; whitish pubescence extremely short and appressed on gaster. The measurements (mm) of two specimens are a sfollows: Head width 2.67 (2.71), head length 2.94 (2.86), scape length 2.32 (2.28), metatibia length 3.17 (3.06), Weber's length 4.84 (5.02), fore femur length 2.32 (2.13), fore femur width 0.62 (0.70), maximum eye length 0.81 (0.77), maximum eye width 0.62 (0.58), interocular space 1.93 (1.90), cephalic index 90 (97), scape index 87 (82) fore femur index 27 (33).

Male. Medium sized, brown, rather dull; mandibles, flagellum, tibio-tarsal joints reddish; scutellum and gaster rather glossy, latter blackish; head elongate, convex, narrowed behind compound eyes; petiole thick, rectangular, slightly emarginate in

center; propodeum divided into base and declivity, declivity about 1-1/2 times length of base; scutellum deprived of hairs; pilosity long, abundant on posterior part of petiole and gaster. The various body measurements (mm) of two specimens are as follows: Head width 0.85 (0.81), head length 1.35 (1.32), scape length 1.59 (1.66), pronotum width 1.47 (1.51), metatibial length 2.24 (2.17), Weber's length 3.21 (3.17), maximum eye length 0.54 (0.54), maximum eye width 0.42 (0.42), interocular space 0.73 (0.81).

Biology. Forel (1900, 1902) found this species under stones and fallen tree trunks. It has been described as an aggressive ant. Some specimens examined in MCZ have a label stating that they were collected from an abandoned paper wasp nest in vicinity of Barranca Bermeja, Colombia.

Differential diagnosis. This species can be separated from the remaining taxa of *Myrmothrix* by combination of the following characters: Body color blackish; head orangish, deep brown black at clypeal level; pilosity golden yellow, occipital border with black hairs; propodeum with abrupt declivity, two times length of base.

Camponotus cingulatus Mayr, 1862

(Figure 3)

Camponotus cingulatus Mayr, 1862, Verh. Zool. bot. Ges. Wien 12: 661. Description of worker. Type locality: Santa Catarina, Brazil. Location of type: Mayr Collection at Naturhistorisches Museum, Vienna, Austria, and Zoologisches Museum der Humboldt Universitat, Berlin. Forel, 1896, Smithsonian Report for 1894, p. 482. Nesting in Rio de Janeiro, Brazil. Luederwaldt, 1926, Rev. Mus. Paulista 14: 297. Nesting in Sao Paulo, Brazil.

Camponotus cingulatus v. *bambusarum* Forel, 1902, Ann. Soc. Ent. Belg. 46: 176. Description of worker. Type locality: Rio de Janeiro, Brazil. Location of type material: Forel Collection at Museum d'Histoire Naturelle, Geneva, and Zoologisches Museum der Humboldt Universitat, Berlin. Santschi, 1922, Ann. Soc. Ent. Belg. 62: 109. Reported major workers from Santa Catarina, Hammonia, Bahia and Itabuna in Brazil. New Synonymy.

Camponotus cingulatus v. *damocles* Forel, 1909, Deut. Ent. Zeitschr. p. 264. Workers and male. Type locality: San Bernardino, Paraguay. Location of type material: Forel Collection at Museum d'Histoire Naturelle, Geneva. Forel, 1911, Deut. Ent. Zeitschr. p. 310. Recorded from Castro and Paraná in Brazil. Luederwaldt, 1926, Rev. Mus. Paulista. 14: 297. Biology in Sao Paulo, Brazil. New Synonymy.

Camponotus cingulatus v. *myster* Santschi, 1922, Ann. Soc. Ent. Belg. 62: 109. A macroergate. Locality: Santa Catarina and Blumenau, Brazil. Location of material: Unknown. New Synonymy.

Camponotus (Myrmothrix) cingulatus Mayr *brunneiventris* Santschi, 1922, Ann. Soc. Ent. Belg. 62: 109. Workers. Locality: Santa Cruz de la Sierra, Bolivia. Location of material: Santschi Collection at Naturhistorisches Museum, Basel. Santschi, 1925, Bull. Ann. Soc. Ent. Belg. 65: 245. Records from Pará and Monte Alegre in Brazil. New Synonymy.

Camponotus (Myrmothrix) cingulatus Mayr st. *brunneiventris* Sants. var. *postniger* Santschi, 1925, Bull. Ann. Soc. Ent. Belg. 65: 246. Workers. Type locality: Paraná, Rio Negro, Brazil. Location of type material: Santschi Collection at Naturhistorisches Museum, Basel. New Synonymy.

Camponotus (Myrmothrix) cingulatus Mayr var. *fissa* Stitz, 1933, Mitteil. Deut. Ent. Ges. 4 (5): 72-73. Description of worker and figure of clypeus. Locality: Rio de Janeiro (Petropolis), Brazil. Location of material: Uuknown. New Synonymy.

Type material examined. The following type material was examined:

1. (a) Two syntype workers labelled, "Brasilien; *Camponotus cingulatus* Mayr; Type", from Museum der Humboldt Universität. (b) One female (gaster missing) labelled, "Blumenau, Brazil 1885, Hetschko; *Camponotus cingulatus* det. Mayr, Type", from the Mayr Collection. The body measurements are given in Table 23.

TABLE 20

Measurements (mm) and indices of the various body parts of type material of *C. cingulatus*

	Syntypes			
	Majors Workers 1	2	Female	
Head width	1.20	1.51	Head width	2.20
Head length	1.78	2.01	Head length	2.77
Scape length	2.28	2.48	Scape length	2.40
Pronotum width	0.93	1.08	Metatibial length	2.86
Metatibial length	2.40	2.27	Weber's length	4.45
Weber's length	2.71	2.94	Fore femur length	2.24
Maximum eye length	0.42	0.46	Fore femur width	0.54
Maximum eye width	0.35	0.39	Maximum eye length	0.66
Interocular space	0.73	0.89	Maximum eye width	0.50
Cephalic index	67	75	Interocular space	1.62
Scape index	190	164	Cephalic index	80
Ocular index	82	83	Scape index	109
Pronotum index	77	72	Fore femur index	24

2. (a) Two paratypes one media worker and one female labelled, "Brasilion (?); *C.* (*Myrmothrix*) *cingulatus* Mayr *bambusarum;* Paratype", from Museum der Humboldt Universität. For measurements see Table 24. (b) One major, one media and one minor workers labelled, "Typus; *C. cingulatus* Mayr, Prov. Rio (Goldi)". Two minor workers labelled, "Cotypus; *C. cingulatus* Mayr, Prov. Rio (Goeldi)". One female labelled, "Cotypus; *C. cingulatus* Mayr, Prov. Rio de Janeiro, November 87 (Goeldi)". These six syntypes and three more workers labelled, "*cingulatus*", were sent under *bambusarum* from the Forel Collection. For measurements see Table 22 and for discussion see synonymy.

TABLE 21

Measurements (mm) and indices of the various body parts of type material of *C. cingulatus* v. *bambusarum*

Paratypes			
Media Worker		Female	
Head width	2.32	Head width	2.86
Head length	2.82	Head length	3.13
Scape length	2.40	Scape length	2.71
Pronotum width	1.47	Metatibial length	3.44
Metatibial length	Metaleg missing	Weber's length	4.95
Weber's length	3.29	Fore femur length	2.59
Maximum eye length	0.58	Fore femur width	0.70
Maximum eye width	0.42	Maximum eye length	0.81
Interocular space	1.47	Maximum eye width	0.58
Cephalic index	82	Interocular space	1.97
Scape index	103	Cephalic index	91
Ocular index	73	Scape index	95
Pronotum index	63	Fore femur index	27

3. One major and one minor worker labelled, "Typus; *C. cingulatus* Mayr v. *damocles* Forel, San Bernardino, Paraguay (Fiebrig)", from the Forel Collection. For measurements see Table 23. Along with this type material specimens from Prov. Rio (= Rio de Janeiro) and from Castro Parana were sent as a part of the type series but they did not have any label of "type" or "cotype". However, their measurements have been recorded in Table 24. For discussion on these specimens see synonymy.

4. Two minor workers labelled, "Typus; Parana Br. Rio Negro (Reichensperger); *Camponotus* (*Myrmothrix*) *cingulatus brunneiventris* v. *postniger* Sants", from the Santschi Collection. The measurements are given in Table 25.

Distribution. This species has been reported mainly from Brazil. There is one record of its occurrence in Paraguay but that appears to be suspect.

Localities from which specimens have been examined. The first name is the name of the locality and in parenthesis the name of the collector followed by the location or source of material in capital letters. *Brazil:* St. Cath (G. Mayr: MAYR) females associated with workers; Blumenau (Hetschko: MAYR), (Moeller: FOREL); Rio de Janeiro (Goldi:

TABLE 22

Measurements (mm) and indices of the various body parts of material of *C. cingulatus* v. *bambusarum*

	Major	Media		Minors			Female	
	1	1	2	3	1	2	3	4	
Head width	3.52	2.82	2.44	2.67	1.20	1.20	1.55	1.35	Head width 2.94
Head length	3.71	3.09	2.98	3.06	1.78	1.74	2.09	2.05	Head length 3.17
Scape length	2.63	2.51	2.36	2.24	2.32	2.32	2.48	2.51	Scape length 2.67
Pronotum width	2.01	1.70	1.43	1.62	0.97	0.97	1.24	1.12	Metatibial length 3.40
Metatibial length	3.25	3.09	2.67	2.98	2.32	2.44	2.32	2.79	Weber's length 5.30
Weber's length	4.26	3.71	3.37	3.44	2.67	2.67	2.98	2.98	Fore femur length 2.59
Maximum eye length	0.62	0.58	0.58	0.54	0.46	0.42	0.46	0.46	Fore femur width 0.66
Maximum eye width	0.46	0.42	0.42	0.39	0.35	0.31	0.39	0.39	Maximum eye length 0.77
Interocular space	2.13	1.70	1.59	1.66	0.81	0.77	0.97	0.89	Maximum eye width 0.58
Cephalic index	94	91	81	87	67	69	74	66	Interocular space 1.97
Scape index	74	89	97	84	193	193	160	185	Cephalic index 92
Ocular index	75	73	73	71	75	72	83	83	Scape index 91
Pronotum index	57	60	58	61	80	80	80	83	Fore femur index 25

TABLE 23

Measurements (mm) and indices of the various body parts of type material of *C. cingulatus* v. *damocles*

	Syntypes (Workers)	
	Major	Minor
Head width	3.02	1.20
Head length	3.25	1.62
Scape length	2.24	1.82
Pronotum width	1.70	0.85
Metatibial length	2.86	1.93
Weber's length	3.64	2.24
Maximum eye length	0.66	0.42
Maximum eye width	0.50	0.39
Interocular space	1.82	0.81
Cephalic index	93	74
Scape index	74	152
Ocular index	76	91
Pronotum index	56	71

TABLE 24

Measurements (mm) and indices of the various body parts of material of *C. cingulatus* v. *damocles*

	Prov. Rio de Janeiro			Castro, Parana	
	Media	Minors		Media	Minor
Head width	2.55	1.39	1.28	2.55	1.35
Head length	2.78	2.05	1.93	2.98	1.86
Scape length	2.20	2.27	2.44	2.20	2.17
Pronotum width	1.70	1.20	1.08	1.51	1.01
Metatibial length	3.17	2.86	2.51	2.71	2.24
Weber's length	3.95	3.40	2.79	3.37	2.63
Maximum eye length	0.62	0.54	0.54	0.54	0.46
Maximum eye width	0.50	0.42	0.42	0.42	0.39
Interocular space	1.62	0.93	0.81	1.70	0.93
Cephalic index	86	68	66	86	73
Scape index	86	163	191	86	160
Ocular index	81	78	78	78	83
Pronotum index	67	86	85	59	74

MAYR), (Goldi: HUMB), (Goldi: FOREL): Castro, Parana (V. Ihering: FOREL and HUMB); Santos (Anonymous: FOREL); Parana, Rio Negro (Reichensperger: SANT); Petropolis (Borgmeier: OXFORD), (F. Ohaus: HUMB); São Paulo (Ihering:

OXFORD); Unknown (Anonymous: OXFORD) female associated with workers; Caravelas, Bahia (Joseph: FOREL). *Paraguay*: San Bernardino (Fiebrig: FOREL).

TABLE 25

Measurements (mm) and indices of the various body parts of type material of *C. cingulatus brunneiventris* v. *postniger*

	Syntypes (Minor Workers)	
Head width	1.93	1.08
Head length	2.13	1.43
Scape length	1.74	1.59
Pronotum width	1.20	0.81
Metatibial length	2.01	1.74
Weber's length	2.36	1.97
Maximum eye length	0.35	0.35
Maximum eye width	0.31	0.23
Interocular space	1.24	0.66
Cephalic index	91	76
Scape index	90	146
Ocular index	89	67
Pronotum index	62	75

Major worker. Head yellowish red, alitrunk and gaster reddish yellow, gastric segments bordered with brick red or blackish brown bands; sometimes specimen entirely yellowish, or smoky, when smoky, gastric bands indistinct. Front of head, scape and legs usually lighter in color than rest of body. Pilosity yellowish, moderately thick, long, moderate to very dense on head including genae and gular area, scape, alitrunk and gaster. Pubescence short, prominent, as dense as pilosity and all over body. Head broad posteriorly, narrowed anteriorly, with occipital margin deeply excavated and occipital angles well pronounced. Mandibles light brown or deep brown, glossy and coarsely punctate with six black teeth. Clypeus with color of head or slightly lighter, carinated, slightly to deeply emarginated at both ends of clypeal carina, flatly edvanced in front. Head very finely punctate, appearing dull, somewhat shiny in lower genal area. Eyes ovate and flat. Alitrunk arched in front, dull, striped not punctate; propodeum compressed and at a lower level than mesonotum, base longer than declivity; promesonotal suture well marked, metanotum separated from mesonotum by a clear suture. Scape ovate, narrow, lower than level of propodeum, rather thickened from base through middle, with margins entire and rather bluntly rounded dorsally. Gastric segments marked with yellow bands with black or reddish brown edges on its both sides.

Media worker. Head yellowish, blackish at vertex and lower genae, alitrunk lighter in color, gaster yellowish black. Pilosity and pubescence yellowish, scattered on head, denser on alitrunk and gaster, densest on pronotum. Head narrow anteriorly, broad posteriorly, occipital angles well prononcued. Propodeum slightly flat dorsally, and at a lower level than mesonotum. Scape thick, convex in front and flat behind with margins entire and thickened. Gastric segments with abundant pilosity and pubescence and each segment bordered with yellow and blackish bands.

Minor worker. Head, pronotum, dorsum of mesonotum, flagellum, scape, trochanter, tibiae and tarsi rusty brown or dark red or smoky. Appearance dull or slightly shiny. Mandibles, border of epistome, rest of body and appendages brownish black, gastric segments at borders dull, bordered with deep brown black bands. First two gastric segments with yellow spots at base. Scape of uniform thickeness; mandibles with six teeth; head slightly narrow at occipital border, lateral sides appearing parallel, convex at vertex. Base of propodeum longer than declivity, scape short, thick and slightly higher than level of propodeum. Pilosity and pubescence yellowish, all over body, densest on head, scape and tibiae.

Statistical Analyses

Only five major workers were available for examination in this species. This number is too small to run any other analysis except MSDCC in the present study. Therefore, DISCAN and STWMULT have been performed only on medias and minors (Tables 26 through 31).

Results of MSDCC.

TABLE 26

Range, mean, standard deviation and variance of the various body measurements (mm) and indices in workers of *C. cingulatus*

Variable	Statistic	Minors n = 33	Medias n = 23	Majors n = 5
1. Head width	Range	1.08-1.86	1.93-2.82	2.63-3.52
	Mean	1.31	2.43	2.98
	S.D.	0.18	0.24	0.30
	Variance	0.03	0.05	0.09
2. Head length	Range	1.43-2.44	2.13-3.13	3.09-3.71
	Mean	1.83	2.78	3.27
	S.D.	0.21	0.30	0.23
	Variance	0.04	0.09	0.05
3. Scape length	Range	1.59-2.71	1.74-2.63	2.24-2.63
	Mean	2.25	2.30	2.41
	S.D.	0.22	0.19	0.17
	Variance	0.05	0.03	0.03
4. Pronotum width	Range	0.81-1.28	1.16-1.70	1.54-2.01
	Mean	1.03	1.46	1.70
	S.D.	0.12	0.14	0.16
	Variance	0.01	0.02	0.03
5. Metatibial length	Range	1.74-2.98	2.01-3.17	2.86-3.32
	Mean	2.41	2.28	3.05
	S.D.	0.29	0.24	0.20
	Variance	0.08	0.06	0.04
6. Weber's length	Range	1.97-3.40	2.36-3.95	3.32-4.2
	Mean	2.70	3.28	3.63
	S.D.	0.29	0.33	0.33
	Variance	0.08	0.11	0.11
7. Maximum eye length	Range	0.35-0.54	0.35-0.62	0.54-0.6
	Mean	0.45	0.54	0.60
	S.D.	0.05	0.05	0.04
	Variance	0.00	0.00	0.00
8. Maximum eye width	Range	0.23-0.42	0.31-0.50	0.42-0.5
	Mean	0.36	0.41	0.45
	S.D.	0.04	0.04	0.03
	Variance	0.00	0.00	0.00
9. Interocular space	Range	0.66-1.20	1.20-1.70	1.70-2.1
	Mean	0.84	1.51	1.84
	S.D.	0.11	0.16	0.16
	Variance	0.01	0.02	0.02
10. Cephalic index	Range	66-81	80-107	85-94
	Mean	71	88	91
	S.D.	3.69	5.34	3.61
	Variance	13.65	28.55	13.06
11. Scape index	Range	145-193	84-112	74-91
	Mean	174	95	81
	S.D.	16.37	7.89	6.61
	Variance	267.97	62.29	43.76

TABLE 26 — Continued

Variable	Statistic	Minors n = 33	Medias n = 23	Majors n = 5
12. Ocular index	Range	67-91	64-89	73-78
	Mean	81	76	75
	S.D.	4.90	5.14	1.20
	Variance	23.98	26.44	3.99
13. Pronotum index	Range	69-87	55-67	53-61
	Mean	79	60	57
	S.D.	4.48	2.92	2.70
	Variance	20.09	8.51	7.30

Results of DISCAN.

TABLE 27

Correlation matrix of nine variables (see table 26) for total sample — minors and medias of *C. cingulatus* *

Variable	1	2	3	4	5	6	7	8	9
1	1.00								
2	0.97	1.00							
3	0.37	0.48	1.00						
4	0.97	0.96	0.45	1.00					
5	0.75	0.79	0.70	0.79	1.00				
6	0.86	0.91	0.66	0.92	0.89	1.00			
7	0.82	0.88	0.62	0.86	0.85	0.92	1.00		
8	0.67	0.75	0.59	0.73	0.77	0.83	0.87	1.00	
9	0.99	0.98	0.36	0.96	0.74	0.86	0.82	0.69	1.00

* (n = 61).

TABLE 28

Discriminant analysis of minors and medias of *C. cingulatus*

Actual Groups	Classification Using the Predictor Variable	
	Minors	Medias
Minors	33	0
Medias	1	22

The above table shows that there is only one misclassification of the media. Apparently this has happened because the measurements of this specimen were more like minors.

Generalized Mahalanobis D-square = 229.89.

TABLE 29

Discriminant functions with their constants and the respective coefficients for nine variables in minors and medias of *C. cingulatus*

	Discriminant Functions	
	Minors	Medias
Constants	-10.63	-20.04
Coefficients:		
Head width	- 4.12	20.69
Head length	- 3.30	- 1.75
Scape length	8.74	3.06
Pronotum width	11.27	- 4.33
Metatibial length	0.26	7.90
Weber's length	- 3.93	- 6.91
Maximum eye length	3.31	9.84
Maximum eye width	21.03	-16.32
Interocular space	4.44	- 1.79

Results of MANOVA.

TABLE 30

Multivariate analysis of variance for minors and medias of *C. cingulatus*

Test Performed	Results
H_1	Homogeneity of variance-covariance
F_1	45 (df, numerator)
F_2	7393 (df, denominator)
F	1.37 (Table value 1.35)
H_2	Generalized analysis of variance
F_1	9 (df, numerator)
F_2	46 (df, denominator)
Lambda (λ)	0.083
F	56.26 (Table value 2.72)

Results of STWMULT.

TABLE 31

Stepwise discrimination between minors and medias of *C. cingulatus*

Step	Variable Eliminated	R	R2
1	None (Full model)	0.95	0.91
2	Interocular space	0.95	0.91
3	Head length	0.95	0.91
4	Pronotum width	0.95	0.91
5	Maximum eye width	0.95	0.91
6	Maximum eye length	0.95	0.91
7	Metatibial length	0.94	0.90
8	Scape length	0.94	0.89
9	Weber's length	0.92	0.84
10	Head width		

In the above table head width and Weber's length are the most important variables in predicting whether a given specimen is minor or media worker. The remaining seven variables are almost as good independently as they are as a group in prediction of a minor or media worker in *cingulatus*.

Female. General body color yellowish, scape dark brown, lower genae, mandibles and anterior border of clypeus blackish, legs deep brownish yellow, tarsi dusky, gaster yellowish bordered with yellow and black bands. Head trapezoidal, narrow in front, broad behind, slightly convex posteriorly, occipital angles not well pronounced. Basal 1/3 of scape narrow, distal 2/3 thickened with small punctures all over surface. Scale narrow at base, broad and rounded towards upside with margins thickened, slightly emarginated dorsally with few erect hairs on each side. Pilosity yellowish, moderately thick, erect to suberect and scattered all over body. Frontal brace of pronotum and scutum of mesonotum shiny and with few hairs. Tibiae and tarsi with long hairs, in abundance. Pubescence short, yellow, thinner than pilosity. For measurements see Tables 20, 21 and 23.

Male. Unknown.

Biology. Forel (1869) stated that Dr. Goeldi observed *cingulatus* as a regular inhabitant of the hollow internodes of bamboo plants in Rio de Janeiro, Brazil. Luederwaldt (1926) reported this species inhabiting a termite nest in the state of São Paulo, Brazil.

Synonymy. While surveying the literature on this species I have come across a plethora of names attached to this taxon since its designation in 1862. I have synonymized all such names under *cingulatus*. The following comments are added to each synonymized name to explain why this has been done.

1. *C. cingulatus* v. *bambusarum*. Forel (1902) designated this taxon with the remarks that these specimens were collected by Goeldi in the vicinity of Rio de Janeiro and they differ from the typical *cingulatus* because of dark color, less dull thorax and bigger size. I have been able to study the specimens which Forel had used. The material was comprised of one major worker, three medias and four minors and was sent to me under *bambusarum* from Forel's type series. Unfortunately none of these specimens have a handwritten label in Forel's writing. One pin has a label of "Typus" and a handwritten label of *C. cingulatus* Mayr, while the other two pins have labels of "cotype" besides the labels of *C. cingulatus* Mayr. In this situation it is questionable whether these specimens represent the type material of *cingulatus* or that of *bambusarum*. Since *cingulatus* was described by Mayr, its type should be in his collection. In Mayr's collection I came across one female with a label of "Type" which is on a piece of white paper written in red ink. Mayr in his description of *cingulatus* points out that the type was deposited at Vienna. Therefore, it can be assumed that the material under reference (from the Forel Collection) is actually Mayr's *cingulatus* and Forel's *bambusarum*. This assumption gets further strength from the fact that all the specimens of *cingulatus* from the Forel Collection are very uniform in the appearance of bands on the gastric segments and most of these are either minor or media workers. It seems to me that what Forel did was to separate some specimens from the material which Mayr had labelled *cingulatus* and designated them as *bambusarum*. Forel admitted in his description that he was separating these specimens from the *cingulatus* series because they were bigger and were of different color. The examination of two syntypes, one media worker and one female from Museum der Humboldt revealed that the female syntype resembles the female of *cingulatus* in the Mayr Collection and the syntype media worker resembles the media workers in the Forel Collection. This evidently confirms that the specimens which have been sent to me under *bambusarum* from the Forel Collection are those which he designated *bambusarum* even though they do not bear the labels of this name.

In any case it seems that Forel missed two important things in this whole process:

a. The color of the workers of *cingulatus* varies a lot. One can come across workers with brick red bands on the gaster to workers which are entirely smoky, which makes the bands indistinct. In some the gaster is blackish and the anterior part, especially the alitrunk and the head region, are brownish red or reddish brown. Forel's concept as can be deduced from the material included under *cingulatus* in his collection seems to cover only those specimens which have light brown bands on the gaster while Mayr's *cingulatus* does cover some parts of the total color variation (if not the entire variation), at least enough to make Forel's designation of *bambusarum* go into synoynmy with *cingulatus*.

b. Workers of *cingulatus* seem to occur in a more graded series of their size than any other species included in *Myrmothrix*.

Since color is not a very good character for the diagnosis of this species I have chosen a combination of characters which are more consistent in this species and which are commonly found in all the specimens, regardless of color pattern. These criteria are: scape in major worker thinner, not flattened at base; clypeus cut in center anteriorly and posteriorly; petiole thick at base through middle, smoothly rounded along margins with slightly pointed tip dorsally; propodeum well marked from mesonotum and slightly at lower level; pilosity moderately thick all over head.

2. *Camponotus cingulatus* v. *damocles*. The specimens received from the Forel Collection are mounted on three pins. On one pin there is one major and one minor worker with a locality label of San Bernardino, Paraguay. The seocnd pin has three specimens which were collected from Prov. Rio (= Rio de Janeiro) by Goeldi. The third pin has only two specimens collected from Castro, Paraná in Brazil. Here we have three pins each from a different locality and collected by a different person. Only the specimens from Paraguay are labelled as "Type". The specimens from Paraguay and Prov. Rio show blackish or smoky two specimens collected from Castro, Paraná in Brazil. Here we have yellowish red head and alitrunk, and black gaster. The gaster color in specimens from the latter locality resembles the former. It should be recalled that the specimens labelled *cingulatus* and represented in the Forel Collection have also been collected by Goeldi from Prov. Rio, and the specimens of both *cingulatus* and *damocles* have the locality labels written by the same person. It seems that again Forel had obviously erected this taxon using color as a criterion. For instance, Forel stated in his original description that head of major worker very roasted, as long as broad, with sides convex. Entirely dark brown, only front of head, legs and scape of antennae light brown. It can be seen that most of his original description is the description of color. A critical examination of these specimens revealed that the major worker of *damocles* shares the same gross morphological attributes of *cingulatus* which have already been alluded to under *bambusarum*. At this time it seems pertinent to point out that Forel seems to have split the series of *cingulatus* into three parts, using color, size variation and the differences in locality; the one he kept as *cingulatus*, to another he gave the name *bambusarum*, and the third he described as *damocles*. It is very admirable that Forel had such a highly intense sense of analysing and using even the lightest variation. However, his excessive use of slight variation has masked the gross morphology and, hence, has very adversely affected the taxonomy of this species.

3. *C. cingulatus* v. *myster*. This taxon was described by Santschi (1922) from the type locality of *cingulatus*. I have not seen any specimen of this taxon, but Santschi's description and his own comments clearly state that this is one of the abnormal forms of *cingulatus* which is called "macroergate". The characters of this abnormal specimen lie between those of worker and female. Such forms evidently have no taxonomic status. At the end of his description even Santschi himself made a comment that this actually does not seem to deserve any special status but he still described it.

4. *C. cingulatus* v. *brunneiventris* was erected by Santschi (1922) on specimens from Bolivia. It appears that the most obvious reason for his designation of this taxon was that the specimens were from a different locality than that of typical *cingulatus*. I have examined the specimens from his collection and compared with his original description, scape is slightly pilous and gaster entirely rusty brown; smaller than variety *bambusarum*, with head and thorax lighter in color. The specimens and the description do not show more than one phase of variation in this species.

5. *C. cingulatus* st. *brunneiventris* var. *postniger*. This was described by Santschi (1925) based upon specimens from Paraná, Rio Negro in Brazil. The characters which are given by Santschi are those of the

minor worker. I have seen the syntypes of *postniger* and they are essentially identical to *brunneiventris* which he had described three years earlier. The only difference is that they come from different localities. His main emphasis in the description of this taxon is that the specimens have two yellow spots at the base of the first two gastric segments. This character is evidently not enough to create a new taxon. It is very common in minor workers and accasionally also in slightly bigger workers in which the yellow spots are found only on the first gastric segment.

6. *C. cingulatus* var. *fissa*. A taxon erected by Stitz (1933) has a description that coincides with syntype workers of *bambusarum* and *postniger* and also with other minor workers. Apparently Stitz has taken too much pain to describe the banding pattern on the gastric segment which is not a very reliable character. Further he has given a figure of the clypeus telling that it is bifid on either side — a characteristic which is found in every worker of this species. I have not seen the specimen, but the validity of this taxon becomes further doubtful when one finds that this taxon is based on only one specimen collected from Petropolis in the state of Rio de Janeiro. A look at the type locality of the various taxa attached to *cingulatus* reveals that most of these were described either from the state of Rio de Janeiro or from some close-by locality. The addition of *fissa* by Stitz is, therefore no surpise in that respect.

Differential diagnosis. The following ocmbination of characters helps to set apart this taxon from the rest of the species included in this study: scape in major worker thinner, not flattened at base; clypeus emarginated at both ends of clypeal carina; petiole thick at base through middle, smoothly rounded along margins with slightly pointed or tapering tip dorsally; propodeum well marked from mesonotum and slightly at lower level. Pilosity yellow, thick and all over body, denser on scape and head; pubescence short and similar to pilosity in distribution.

Camponotus femoratus (Fabricius, 1804)

(Figure 4)

Formica femorata Fabricius, 1804, Syst. Piez., p. 397. Description of female. Type locality: Brazil. Location of type material: Universitetets Zoologiske Museum Copenhagen.

Camponotus (*Formica*) *femoratus*, Roger, 1862, Berl. Entom. Zeitschr. 6: 3. Redescription of Fabricius type material. Forel, 1904, Rev. Suisse Zool. 12: 49-51. Description of major and minor workers. Crawley, 1916, Ann. Mag. Nat. Hist. 17 (8): 376. Recorded from British Guiana (= Guyana). Wheeler, 1921, Ecology. 2: 89-102. A new case of Parabiosis. Santschi, 1929, Ann. Soc. Cien. Argentina 107 (4): 313. Distribution up to Parana reported. Kempf, 1959, Studia Ent. Petropolis 2: 217. Reported as principal constructor of fungus gardens in Amazone, Brazil.

Type material examined. One syntype female labelled, "*Formica femorata*, Esseguibr Smidt, Mus. de Schistedt". The measurements of the various body parts are: head width 2.67 mm; head length 2.67 mm; scape length 2.13 mm; metatibia length 2.90 mm; Weber's length 4.37 mm; fore femur length 2.17 mm; fore femur width 0.54 mm; maximum eye length 0.7 mm; maximum eye width 0.46 mm; interocular space 1.82 mm; cephalic index 100; scape index 80; and fore femur index 25.

Distribution. This species has been reported mainly from Amazone, Brazil, but I have also studied some specimens from Guyana and one specimen from Surinam.

Localities from which the specimens have been examined. The first name is the name of the locality in a country and in parenthesis the name of the collector followed by the location or source of material in capital letters. *Brazil:* Amazonas (Ule: FOREL) females only; Amazonas (Anonymous: FOREL); Pará (Goldi: FOREL); Pará (Anonymous: MAYR) workers associated with female; Manaos (= Manaus) Goeldi: FOREL); Unknown (Anonymous: OXFORD). *Guyana:* N. W. British Guiana (Anonymous: FOREL); Unknown (Anonymous: OXFORD). *Surinam:* Unknown (Anonymous: FOREL).

Major worker. General color black and dull; front of head, flagellum, coxae, trochanters, femora and pronotum light brown; body densely and finely reticulated-punctated; sides of head slightly more reticulated and subopaque; scape, tarsi, scale and gaster finely granulated and more or less shiny with fine piliferous punctuations dispersed all over; head almost as long as wide (when measured across the eyes), broadly concave posteriorly, moderately retracted in front, moderately convex on sides, with marked occipital angles; occipital angles not sharp, rather little compressed on sides. Scape narrow in basal half, not flat, thickened in distal half, 1/4 towards apex of equal thickness, about 1.03 times length of head measured from antennal fossa to occipital border. Eyes located in middle of head. Pronotum very obtusely bordered, slightly convex with a weak longitudinal groove in middle; pro-mesonotal suture distinct, meso-metanotal suture not distinct; mesonotum and base of metanotum in profile forming a slightly convex line; when observed from above, back of alitrunk forming a narrow isoceles triangle, base of pronotum forming its angles and extremity of basal face of metanotum forming top of triangle; propodeum steeply declivous, declivity longer than base. Scale with margins entire, not cut, rather slightly indented from above.

Pilosity yellowish white, moderately long, and slightly undulating, found on entire body including genae and legs; scape and tibiae with short, spread out and rather obtuse hairs. Pubescence pale yellow, long, rather coarse, quite abundant on

gaster, on head and pronotum constituting a quite yellowish tomentum but not covering sculpture entirely; scape and tarsi with fine pubescence.

Minor worker. General body color black, front of head, mandibles, flagellum, pronotum, femoro-tibial joints, femora and tarsi ferruginous; sculpture as in major worker. Head opaque, alitrunk little less opaque, gaster somewhat shiny with sub-metallic reflection under pubescence. Head with sides convex, occipital margin sub-straight, clypeus somewhat shiny, convex and obtusely carinated with short lateral corners, not cut anteriorly; mandibles with 6 teeth and finely striped with few punctures. Alitrunk narrowed behind, compressed at metanotum, declivity longer than base and forming an obtuse and strongly rounded angle in profile; pro-mesonotal suture distinct, meso-metanotal suture indistinct. Scale thick, convex in front, flat behind. Pilosity more abundant than majors; pubescence little less than majors but distribution same.

Statistical Analyses

The specimens of majors and minors were available in sufficient number to permit all the desired analyses (Tables 32 through 37).

Results of MSDCC.

TABLE 32

Range, mean, standard deviation and variance of the various body measurements (mm) and indices in *C. femoratus*

Variable	Statistic	Minor n = 17	Major n = 14
1. Head width	Range	1.01-1.62	1.74-2.48
	Mean	1.31	2.07
	S.D.	0.20	0.21
	Variance	0.04	0.04
2. Head length	Range	1.16-1.90	1.86-2.63
	Mean	1.47	2.17
	S.D.	0.20	0.24
	Variance	0.04	0.06
3. Scape length	Range	1.20-1.90	1.93-2.36
	Mean	1.65	2.05
	S.D.	0.17	0.11
	Variance	0.03	0.01

TABLE 32 — Continued

Variable	Statistic	Minor n = 17	Major n = 14
4. Pronotum width	Range	0.74-1.16	1.20-1.62
	Mean	0.95	1.38
	S.D.	0.12	0.12
	Variance	0.01	0.01
5. Metatibial length	Range	1.51-2.13	1.97-2.63
	Mean	1.84	2.27
	S.D.	0.17	0.18
	Variance	0.03	0.03
6. Weber's length	Range	1.59-2.28	2.27-3.06
	Mean	1.95	2.59
	S.D.	0.21	0.27
	Variance	0.04	0.07
7. Maximum eye length	Range	0.35-0.42	0.42-0.54
	Mean	0.37	0.46
	S.D.	0.03	0.04
	Variance	0.00	0.00
8. Maximum eye width	Range	0.27-0.31	0.27-0.39
	Mean	0.28	0.34
	S.D.	0.02	0.03
	Variance	0.00	0.00
9. Interocular space	Range	0.70-1.12	1.20-1.66
	Mean	0.91	1.40
	S.D.	0.12	0.15
	Variance	0.01	0.02
10. Cephalic index	Range	86-95	92-100
	Mean	89	95
	S.D.	2.97	2.22
	Variance	8.82	4.94
11. Scape index	Range	113-139	91-124
	Mean	127	100
	S.D.	10.12	8.96
	Variance	102.41	80.31
12. Ocular index	Range	70-89	58-82
	Mean	77	74
	S.D.	5.62	5.96
	Variance	31.62	35.50
13. Pronotum index	Range	67-77	58-76
	Mean	73	67
	S.D.	3.14	4.01
	Variance	9.88	16.10

Results of DISCAN.

TABLE 33

Correlation matrix of nine variables (see table 35) for total sample — minors and majors of *C. femoratus*

Variables	1	2	3	4	5	6	7	8	9
1	1.00								
2	0.99	1.00							
3	0.92	0.92	1.00						
4	0.97	0.96	0.90	1.00					
5	0.91	0.92	0.92	0.89	1.00				
6	0.96	0.96	0.91	0.93	0.88	1.00			
7	0.91	0.91	0.82	0.91	0.85	0.88	1.00		
8	0.85	0.38	0.81	0.87	0.77	0.84	0.81	1.00	
9	0.99	0.99	0.91	0.97	0.91	0.96	0.94	0.86	1.00

* (n = 31).

TABLE 34

Discriminant analysis of minors and majors of *C. femoratus*

Actual Groups	Classifications using the Predictor Variables	
	Minors	Majors
Minors	17	0
Majors	1	13

This species is of small size and, hence, one major worker is more like a minor in its measurements and, thus, has been classified as a minor. Generalized Mahalanobis D-square = 65.28.

TABLE 35

The discriminant functions with their constants and the respective coefficients for nine variables of *C. femoratus*

	Discriminant Functions	
	Minors	Majors
Constants	–11.42	– 5.99
Coefficients:		
Head width	– 1.10	– 0.50
Head length	12.58	1.48
Scape length	– 1.52	2.84
Pronotum width	–24.90	0.93
Metatibial length	18.91	0.29
Weber's length	9.02	0.80
Maximum eye length	8.76	29.42
Maximum eye width	69.45	10.87
Interocular space	–47.21	–11.10

Results of MANOVA.

TABLE 36

Multivariate analysis of variance for minors and majors of *C. femoratus*

Test Performed	Results
H_1	Homogeneity of variance-covariance matrix
F_1	45 (df, numerator)
F_2	2538 (df, denominator)
F	1.60 (Table value 1.52)
H_2	Generalized analysis of variance
F_1	9 (df, numerator)
F_2	21 (df, denominator)
Lambda (λ)	0.17
F	11.58 (Table value 3.40)

Results of STWMULT.

TABLE 37

Stepwise discrimination between minors and majors of *C. femoratus*

Step	Variable Eliminated	R	R^2
1	Full model (None)	0.91	0.83
2	Maximum eye width	0.91	0.83
3	Interocular space	0.91	0.83
4	Pronotum width	0.91	0.83
5	Metatibial length	0.90	0.82
6	Scape length	0.90	0.82
7	Weber's length	0.90	0.82
8	Maximum eye length	0.90	0.81
9	Head length	0.88	0.77
10	Head width		

The above table shows that for the separation of minors and majors the most important variable is head width followed by head length. The remaining seven variables are almost equally as effective as they are as a group for the discrimination of minors and majors in this species.

Female. Black with weak metallic glimmer; entire body with thick, short, yellow, moderately dense hairs, gaster richly clothed; coxae, trochanters and femora yellowish orange; femora at apex, tibiae and tarsi brownish orange; color of coxae, trochanters and femora forming contrast with rest of body; flagellum brownish; head, scape, alitrunk and gaster blackish; head trapezoidal, slightly narrow anteriorly, wide posteriorly, convex laterally, occipital margin straight to substraight; occipital corners rounded but not prominent; scape thin at base, thick towards apex, apical 2/7 of uniform thickness. Scape punctate with moderately thick, thinly scattered, rather short, yellowish hairs. Epistomal carina prominent only in central 1/3, appearing obliterated both towards anterior and posterior margins. Clypeus not cut, rather arched forming lateral lobes in front, emarginated posteriorly and bearing a deep longitudinal impression. Clypeus with more than 14 long hairs and numerous short hairs. Mandibles deep brownish black, striated, with long hairs and 6 black teeth. Frons with 15+ long, thick hairs in between frontal carinae up to occipital margin. Pubescence copious, long, whitish but not masking cuticle. Eyes oval, somewhat rounded and laterally placed.

Area immediately surrounding compound eyes with rather long, diluted pubescence. Genae with short, thick, scattered hairs. Occipital margin with copious rather mixed thin pubescence and moderately thick pilosity. Pubescence in this area prominently visible, long and mixed with pilosity. Entire fronto-lateral brace of pronotum bears thick, copious, short light yellowish hairs, scutellum with thinly distributed hairs. Scale rounded, convex in front, concave behind, slightly emarginate dorsally. Propodeum with abrupt declivity, base about 1/4 as long as declivity. Legs with short, rather yellowish hairs all over. Wings dull, yellowish brown. Gaster oval, each segment with yellow band and copious hairs on dorsum. The measurements (mm) of one specimen in Mayr collection and two (in parentheses) in the Forel collection are as follows: Head width 2.71 (2.40, 2.36), head length 2.79 (2.44, 2.40), scape length 2.17 (2.01, 2.09), metatibial length 2.98 (2.69, 2.59), Weber's length 3.99 (3.87, 3.87), fore femur length 2.24 (2.09, 1.93), fore femur width 0.62 (0.54, 0.58), maximum eye length 0.70 (0.66, 0.62), maximum eye width 0.54 (0.50, 0.46), interocular space 1.82 (1.74, 1.74), cephalic index 97 (98, 98), scape index 80 (84, 88), fore femur index 27 (26, 30).

Male. Unknown.

Biology. Forel (1904) reported that he found this ant forming large ant gardens between epiphytes of *Streptocalyx* and *Codonanthe* in Manaos in March, 1903, and that the natives called these ant gardens "Tracua". Wheeler and Bequaert (1929) reported that he found members of this species living parabiotically with *Crematogaster* (*Orthocrema*) *limata* F. Smith. Kempf (1959) reported that this species is very common in the forests of Amazones where they are known as the principal constructors of ant gardens suspended from the tops of trees.

Differential diagnosis. See *C. punctatus*.

Camponotus rufipes (Fabricius), 1775

(Figures 5 adn 6)

Formica rufipes Fabricius, 1775, Syst. Ent. p. 391, No. 4. Description of worker. Type locality: Brazil. Location of type material [1]: British Museum (Natural History), London. Latreille, 1802, Hist. Nat. Fourmis, p. 110, No. 8. Description of worker [2]. Fred. Smith, 1858, Cat. Hym. Brit. Mus. 6: 43-44. No. 146. Description of major and minor worker and female from Brazil.

Camponotus rufipes, Mayr, 1862, Verh. Zool. bot. Ges. Wien 12: 663. Additional description of worker, male and female from Brazil. Rudow, 1914, Ent. Rundsch. 30: 135-137. Nesting in South America. Mann, 1916, Bull. Mus. Comp. Zool. Harvard 60: 476. Nesting in Brazil. Eidman, 1936, Arb. Physiol. angew. Ent. Berlin 3: 95-96. Further description, colony formation and nesting habits in Itatiaia, Brazil. Costa, 1942, Rev. Agron. Porto Alegre, Brazil 6: 568-69. Description and notes on habits. Kusnezov, 1952, Acta Zool. Lilloana, Tucuman 12: 236. Distribution in South America and notes on nests.

Formica merdicola Lund, 1831, Ann. Sc. Nat. 23: 129. Notes on habits of ants of Brazil. (Synonymy in doubt, after Emery's *Genera Insectorum*).

Formica herrichi Mayr, 1853, Verh. Zool. bot. Ver. Wien 3: 113. Description of worker. (Synonymy after Emery's *Genera Insectorum*).

Camponotus rufipes var. *alpina* Emery, 1905, Bull. Ent. Soc. Ital. 37: 187. Description of worker. Locality: Pampa Grande (Salta), Argentina. Location of material: Forel Collection at Museum d'Histoire Naturelle, Geneva. N e w S y n o n y m y

Camponotus rufipes F. v. *magnifica* Forel, 1913, Bull. Soc. Vaud. Sc. Nat. 49: 249-50. Description of worker and a record of mermis-affected worker. Type locality: Cordoba, Argentina. Location of type material: Forel Collection at Museum d'Histoire Naturelle, Geneva. Santschi, 1915, Ann. Soc. Ent. France 84: 513. Observation of workers from Cordoba, Tolumbo, Salta, and Cerro San Bernardo, Argentina, and a record of pseudogyne. Bruch, 1922, La Plata Rev. del Mus. 26: 210-11. Description of nests and notes on habits. N e w S y n o n y m y.

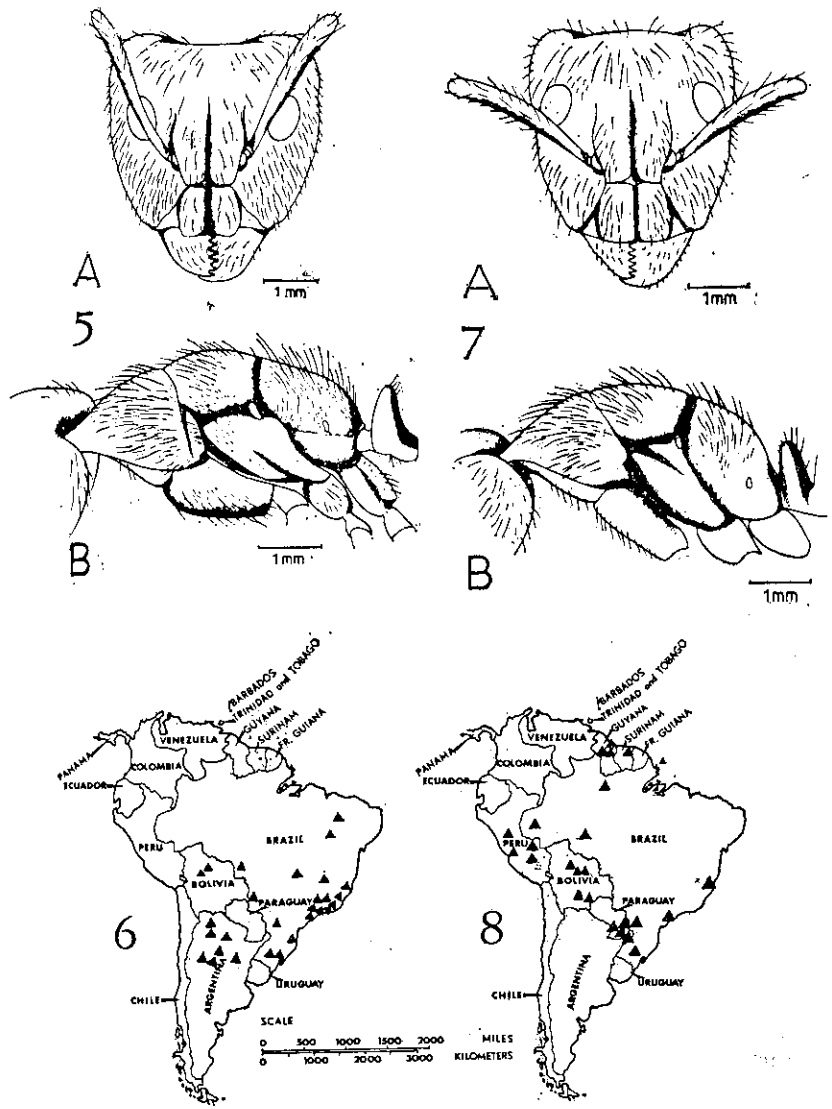
Camponotus (*Myrmothrix*) *rufipes* F. forma *cajurensis* Luederwaldt, 1918, Rev. Mus. Paulista 10: 53. Description of worker. Locality: Alto de Serra, S.P. Brazil. Location of material: Unknown. N e w S y n o n y m y.

Camponotus (*Myrmothrix*) *rufipes* F. v. *subrufescens* Santschi, 1929, Ann. Soc. Cient. Argentina 107 (4): 314. Description of worker. Type locality: Rio Negro (only workers) and Minas Geraes (worker and male). Location of type material: Santschi Collection at Naturhistorisches Museum, Basel. N e w S y n o n y m y.

T y p e m a t e r i a l e x a m i n e d. 1. One syntype major labelled, "Ex-Banks *rufipes*, Type". Its measurements are: head width 3.56 mm; head length 4.46 mm; scape length 4.04 mm; pronotum width 2.24 mm; metatibial length 5.66 mm; Weber's length 5.56 mm; maximum eye length 0.85 mm; maximum eye width 0.66 mm; interocular space 2.13 mm; cephalic index 77; scape index 97; ocular index 77; and pronotum index 63.

2. Four syntypes: (a) One major and one minor worker labelled, "Typus: *Camponotus* (*Myrmothrix*) *rufipes* v. *magnifica* For., S. Cordoba (Bruch)". (b) Two major workers labelled "Cotypus; *Camponotus* (*Myrmothrix*) *rufipes* v. *magnifica* For., S. Cordoba (Bruch)". For measurements see Table 38.

[1] See discussion on type material of *rufipes*.
[2] Description does not agree with Fabricius or with the accepted concept of *rufipes*.



Camponotus (*Myrmothrix*)
Fig. 5. *rufipes*: A. front view of head of major worker. B. lateral view of alitrunk. Fig. 6. Distribution of *rufipes*. Fig. 7. *renggeri*: A. front view of head of major worker. B. lateral view of alitrunk. Fig. 8. Distribution of *renggeri*.

TABLE 38

Measurements (mm) and indices of the type material of *C. rufipes* v. *magnifica*

Variable	Syntypes (Workers) Major 1	2	3	Medi
Head width	4.14	3.95	3.44	2.0
Head length	4.02	0.02	3.33	2.4
Scape length	3.44	3.40	3.13	2.7
Pronotum width	2.48	2.44	2.13	1.5
Metatibial length	4.29	3.91	3.79	3.1
Weber's length	4.60	4.64	4.26	3.4
Maximum eye length	0.77	0.81	0.73	0.5
Maximum eye width	0.46	0.54	0.54	0.5
Interocular space	2.59	2.43	2.16	1.2
Cephalic index	102	98	103	8
Scape index	83	86	91	13
Ocular index	60	67	73	8
Pronotum index	60	62	62	7

3. Three syntypes: (a) One major worker labelled, "Typ. *Camponotus rufipes* F. *subrufescens* Santschi det. 1929; Paran Rio Negro (Reichensperger)". (b) One major worker and o male labelled, "Type; *Camponotus rufipes* F. v. *subrufesce* Santschi det.; Minas Gerais, E. Luja". For measurements s Table 39.

TABLE 39

Measurements (mm) and indices of the type material of *C. rufipes* v. *subrufescens*

Variable	Major[a]	Syntypes Major[b]	Ma
Head width	4.45	3.71	1.0
Head length	4.57	3.87	1.5
Scape length	3.33	3.10	2.0
Pronotum width	2.86	2.40	
Metatibial length	4.06	3.75	2.2
Weber's length	4.88	4.37	3.5
Maximum eye length	0.77	0.74	0.5
Maximum eye width	0.58	0.50	0.4
Interocular space	2.86	2.48	1.1
Cephalic index	97	96	
Scape index	86	80	
Ocular index	75	68	
Pronotum index	64	64	

[a]Specimen from Parana', Rio Negro.
[b]Specimens from Minas Gerais.

Distribution. This species has been reported from Argentina, Brazil, Bolivia and Paraguay (Fig. 6).

Localities from which specimens have been examined. As the body color in this species varies from blackish to rusty brown, it was considered more appropriate to separate the Brazilian specimens into two groups based on color and record the localities for each group. Under each country the first name is the name of the locality and in parenthesis the name of the collector followed by the source of material in capital letters. *Argentina:* Cordoba (W. M. Davis: MCZ), (Biraben: SANT); Chaco, Zapaller (Mallo: USNM), (H. L. Parker: USNM); Salta (C. S. Orcnard: USNM); Vera (H. L. Parker: USNM); Sunhel, Jujuy (Cockerell: USNM); Forniala (Lizar: SANT); Argentina E. R. (MacDonagh: SANT). *Bolivia:* Rio y Leorne (Lizer and Deletang: SANT); Rio Guapay (Anonymous: SANT); Isiamas (W. N. Mann: USNM). *Brazil:* (a) Blackish specimens: Brasília (W. L. Brown: MCZ); Castro-Paraná (B. Finzi: MCZ) females associated with workers; Petrópolis (T. Barbour: MCZ); Ceará-Mirim, Rio Grande do Norte (W. M. Mann: USNM); Caviuna, Paraná (A. Maller: AMNH); Mendes, Est. Rio, Brasilien (Eidmann: IAZRW); Unknown (Goeldi: FOREL); Rio de Janeiro (Anonymous: FOREL), (Naegeli: FOREL); Piracicaba (Luja: SANT); Rio Negro, Paraná (Reichensperger: SANT) female; Unknown (E. Garbe: SANT). (b) Brownish specimens: Petrópolis (D. G. Fairchild: USNM); Alto da Serra, São Paulo (H. V. Ihering: USNM); Rio Grande, São Paulo (H. V. Ihering: USNM); Quinta, Rio Grande do Sul (E. G. Holt: USNM); São Paulo (N. L. Krauss: USNM), (Brown: MCZ); Corumbá, Matto Grosso (Anonymous: MCZ), E. Garbe: SANT); Ouro Preto (N. L. Krauss: USNM); Alto Itatiaia, Serra do Itatiaia (E. G. Holt: USNM) female associated with workers; Minas Gerais (Anonymous: MCZ), (E. Luja: IAZRW); Agudos, S. P. (W. W. Kempf: MCZ); São Leopoldo (J. W. Stahl: MCZ); Espírito Santo (Fruehstorfer: MAYR); Piracicaba (E. Luja: SANT). *Paraguay:* Unknown (Silvestri: SANT).

Major worker. General body color varying from deep blackish to rusty brown; mandibles blackish, legs ferruginous. Appearance dull; entire body clothed with golden yellow hairs of varying length. Mandibles each bearing 6 stout teeth and regularly striped with fine and coarse points. Clypeus sharply carinated, granular, squarish, with broad but bent out frontal

edge and a narrow back edge. Scape strongly dilate and flat with basal 1/5 narrow, thickened towards apex and with small punctures all over. Eyes rounded, flat, medium sized and located half the length of the head. Alitrunk rounded in front, compressed behind, somewhat gradually arched from front to back; pro-mesonotal suture deeply marked, meso-metanotal suture slightly marked. Legs weakly glossy, quite often with tibiae and/or tarsi dusky. Scale narrow at base, wide and round near top or weakly pointed with margins entire in black specimens, flatly notched in center or with dentate margins in reddish brown specimens, each lateral margin with six-seven prominent hairs. Pubescence long, thick, copious, somewhat brighter in brownish specimens, short and scanty in blackish specimens, thin in specimens from high elevations. Gaster ovate, thickly spotted but quite opaque without silky reflection, margins of each segment rufo-testaceous.

Media worker. Resembles major in sculpture, color, pilosity and pubescence. Basal 1/6 of scape narrow, remaining 5/6 thick and flat. Eyes located above the middle of head. Clypeus carinated, slightly notched posteriorly, emarginate anteriorly. Coxae, trochanters, femora brownish; tibiae and tarsi blackish brown. Scale slightly flattened behind, convex in front, rounded on sides, thin below, thick above. Gaster oval, each segment with yellowish band along posterior margin.

Minor worker. Resembles major and media in sculpture and color, differs in size and form. Basal 1/5 of scape slightly narrow, apical 4/5 almost of uniform thickness. Head convex, slightly narrow in front and behind eyes, occipital border weakly indented. Scale with six-seven hairs on each lateral side. Distribution of hairs like major. Legs brownish, tibiae and tarsi blackish. Gaster oval, each segment with yellowish border and sometimes preceded by a blackish band.

Statistical Analyses

Sufficient specimens for analysis were available only from Brazil; therefore, statistical analyses have been done only on those. The number of specimens from Argentina, Bolivia and Paraguay was too small, hence, only the localities from which specimens were examined have been listed, and no biometric data have been used for any analysis (Tables 40 through 47).

Results of MSDCC.

TABLE 40

Range, mean, standard deviation and variance of the various body measurements and indices in *C. rufipes* from Brazil

Variable	Statistic	Minor n = 64	Media n = 29	Major n = 43
1. Head width	Range	1.04-2.01	1.82-2.98	3.02-4.18
	Mean	1.58	2.32	3.60
	S.D.	0.17	0.33	0.29
	Variance	0.03	0.11	0.08
2. Head length	Range	1.59-2.40	1.97-3.75	2.44-4.53
	Mean	1.95	2.66	3.69
	S.D.	0.18	0.44	0.31
	Variance	0.03	0.19	0.10
3. Scape length	Range	1.86-2.67	1.78-3.25	2.71-3.44
	Mean	2.30	2.60	3.02
	S.D.	0.18	0.27	0.17
	Variance	0.03	0.07	0.03
4. Pronotum width	Range	1.04-1.55	1.43-2.32	2.01-2.67
	Mean	1.30	1.72	2.27
	S.D.	0.12	0.21	0.15
	Variance	0.01	0.05	0.02
5. Metatibial length	Range	2.20-3.56	2.27-3.75	2.24-4.29
	Mean	2.66	3.01	3.47
	S.D.	0.25	0.31	0.34
	Variance	0.06	0.10	0.12
6. Weber's length	Range	2.13-3.68	2.59-4.45	2.71-5.09
	Mean	2.73	3.38	4.28
	S.D.	0.35	0.35	0.42
	Variance	0.12	0.12	0.17
7. Maximum eye length	Range	0.42-0.59	0.50-0.73	0.46-1.28
	Mean	0.50	0.57	0.70
	S.D.	0.03	0.05	0.11
	Variance	0.00	0.00	0.00
8. Maximum eye width	Range	0.31-0.50	0.39-0.54	0.35-0.58
	Mean	0.40	0.45	0.51
	S.D.	0.04	0.04	0.05
	Variance	0.00	0.00	0.00
9. Interocular space	Range	0.93-1.35	1.20-2.39	1.08-3.68
	Mean	1.10	1.57	2.36
	S.D.	0.10	0.30	0.35
	Variance	0.01	0.08	0.12
10. Cephalic index	Range	61-94	67-102	85-151
	Mean	81	88	98
	S.D.	5.74	7.20	9.47
	Variance	32.96	51.81	89.75
11 Scape index	Range	125-189	82-140	74-97
	Mean	146	113	84
	S.D.	13.89	16.72	6.04
	Variance	193.08	279.66	35.54

TABLE 40 — Continued

Variable	Statistic	Minor n = 64	Media n = 29	Major n = 43
12. Ocular index	Range	61-100	67-115	42-88
	Mean	79	79	74
	S.D.	7.47	9.10	9.04
	Variance	55.85	82.84	81.72
13. Pronotum index	Range	71-107	64-92	58-74
	Mean	82	74	63
	S.D.	5.40	6.25	3.01
	Variance	29.15	39.07	9.08

Results of DISCAN.

TABLE 41

Correlation matrix of nine variables (see table 40) for total sample — minors, medias and majors of *C. rufipes* *

Variables	1	2	3	4	5	6	7	8	9
1	1.00								
2	0.97	1.00							
3	0.87	0.88	1.00						
4	0.98	0.97	0.88	1.00					
5	0.83	0.84	0.83	0.85	1.00				
6	0.91	0.90	0.82	0.91	0.80	1.00			
7	0.82	0.80	0.77	0.80	0.76	0.79	1.00		
8	0.77	0.80	0.74	0.78	0.75	0.77	0.73	1.00	
9	0.96	0.95	0.85	0.95	0.81	0.91	0.81	0.79	1.00

* (n = 136).

TABLE 42

Discriminant analysis of minors, medias and majors of *C. rufipes*

Actual Groups	Classification Using the Predictor Variables		
	Minors	Medias	Majors
Minors	63	1	0
Medias	7	17	5
Majors	0	4	39

Table 42 shows that there is more misclassification in case of medias than of either of the other subcastes of workers. This can be attributed to two main fectors. Firstly, the workers used

in this analysis come from various localities which are far apart in Brazil and they varied considerably in size. For example, the measurements of the majors from certain localities are very close to those of the medias from other localities. Likewise, some medias are larger than other medias but on the basis of the scape thickness they can be classified as medias. The second factor is the size variation within the same propulation. It is because of this variation that several infra-specific taxa have been described in the literature (see synonymy).

Generalized Mahalanobis D-square = 650.97.

TABLE 43

The discriminant functions with their constants and the respective coefficients for nine variables of *C. rufipes*

	Discriminant Functions		
	Minors	Medias	Majors
Constants	–25.17	–24.63	–26.15
Coefficients:			
Head width	–16.91	–12.00	3.72
Head length	– 6.97	– 3.82	– 0.07
Scape length	15.44	10.89	6.17
Pronotum width	10.41	14.72	7.39
Metatibial length	5.88	3.28	– 0.08
Weber's length	2.39	2.19	1.85
Maximum eye length	8.09	7.30	7.69
Maximum eye width	39.08	35.27	24.38
Interocular space	0.26	– 2.03	– 8.21

Results of MANOVA.

TABLE 44

Multivariate analysis of variance for minors and medias of *C. rufipes* from Brazil

Test Performed	Results
H_1	Homogeneity of variance-covariance matrix
F_1	45 (df, numerator)
F_2	11938 (df, denominator)
F	2.62 (Table volue 1.52)
H_2	Generalized analysis of variance
F_1	9 (df, numerator)
F_2	62 (df, denominator)
Lambda (λ)	0.17
F	33.07 (Table value 2.41)

TABLE 45

Multivariate analysis of variance for medias and majors of *C. rufipes* from Brazil

Test Performed	Results
H_1	Homogeneity of variance-covariance matrix
F_1	45 (df, numerator)
F_2	10562 (df, denominator)
F	3.99 (Table value 1.52)
H_2	Generalized analysis of variance
F_1	9 (df, numerator)
F_2	83 (df, denominator)
Lambda (λ)	0.28
F	22.96 (Table value 2.41)

Results of STWMULT.

TABLE 46

Stepwise discrimination between the minors and medias of *C. rufipes* from Brazil

Step	Variable Eliminated	R	R^2
1	None (Full model)	0.84	0.71
2	Interocular space	0.84	0.71
3	Maximum eye length	0.84	0.71
4	Head length	0.84	0.71
5	Pronotum width	0.84	0.71
6	Scape length	0.84	0.71
7	Weber's length	0.83	0.70
8	Maximum eye width	0.82	0.68
9	Metatibial length	0.82	0.67
10	Head width		

Table 46 shows that head width is the most important variable for the separation of minor and media workers in *rufipes*. Metatibial length, maximum eye width and Weber's length are the next most useful discrimination of these two groups. Scape length, pronotum width, head length, maximum eye length and interocular space are individually as effective as they are as group for the separation of minor and medias. The table also shows that the degree of correlation among the various variables is quite high.

TABLE 47

Stepwise discrimination between the medias and major workers of *C. rufipes* from Brazil

Step	Variable Eliminated	R	R^2
1	None (Full model)	0.91	0.83
2	Head length	0.91	0.83
3	Weber's length	0.91	0.83
4	Maximum eye length	0.91	0.83
5	Pronotum width	0.91	0.83
6	Scape length	0.90	0.82
7	Metatibial length	0.90	0.82
8	Maximum eye width	0.90	0.81
9	Interocular space	0.89	0.80
10	Head width		

Table 47 shows that head width followed by interocular space are the most important predictors for media and major workers in this species. Out of maximum eye width, metatibial length, scape length, pronotum width, maximum eye length, Weber's length and head length each variable is independently as effective in the separation of these two groups as they are as a group. The variables also show a high degree of correlation and, hence, there is only a slight difference in the R value as the variables are dropped at each step. This table when compared with the table of minors and medias also indicates that the variables show a higher degree of correlation in these two groups than they do in the case of minors and medias.

Female. Resembles major worker in sculpture, body color and hairs. Coxae, trochanters, and femora orangish brown, tarsi dusky. Head trapezoidal, slightly concave at posterior margin, occipital angles broadly rounded, not pronounced; eyes located beyond middle of head. Basal 1/7 of scape thin and narrowed, thickened towards apex, small elongated punctures all over. Alitrunk elongated; scutellum with two parapses and one centrally incomplete suture; propodeum divided into base and declivity of equal length. Scale circular, thickened at base, convex in front, flat behind, very weakly indented on top. Long yellow hairs in abundance on scape, head, fronto-lateral brace of pronotum, meso- and metanotum and gaster, lacking on area immediately surrounding compound eyes. Pubescence short and abundant all over body. The measurements of two females from Castro, Paraná, Brazil, are the following: Head width 3.13 (3.02), head length 3.44 (3.29), scape length 2.67 (2.82), metatibial length 3.40

(3.40), Weber's length 5.53 (5.68), fore femur length 2.79 (2.71), fore femur width 0.77 (0.77), maximum eye length 0.81 (0.77), maximum eye width 0.54 (4.62), interocular space 1.93 (2.24), cephalic index 91 (92), scape index 85 (93), fore femur index 28 (28).

Male. General body color varies from black to reddish brown; mandibles, flagellum, and legs brown or light brown; scape black with articular joint yellowish. Long vertical hairs moderately abundant on head, thorax and gaster, lacking on legs; pubescence moderate, thick and more dilute than hairs. Sculpture of head, alitrunk and gaster resembling major worker and female. Mandibles indistinctly toothed, fine and shagreened. Clypeus weakly carinated, not cut along anterior margin. Scale thick, broader than high, emarginated dorsally. Tibiae with yellow, long and bristle-like hairs. The measurements (mm) of two male specimens from Brazil are as follows: Head width 1.08 (1.04), head length 1.51 (1.47), scape length 1.90 (1.97), metatibial length 2.51 (2.67), Weber's length 3.33 (3.48), maximum eye length 0.54 (0.54), maximum eye width 0.43 (0.35), interocular space 1.01 (1.01).

Biology. The following brief account is taken from Bruch (1922) who has described the nesting process of *rufipes* (under the name *magnifica*) occuring in Alta Gracia, Cordoba (Argentina). He observed that when a new colony is formed the queen normally takes refuge beneath a stone, where she makes a small and smooth excavation of elliptical shape about 2 centimeters long and of shallow depth. In case the contact of the stone with the ground is not perfect, the queen then builds up an obstacte from ground particles and vegetation fragments. Bruch (*loc cit*) recorded that the eggs are small (0.8 mm long and 0.45 mm wide), white, almost always transparent and have a lustrous surface. The first generation workers are usually 5-10 minor or media individuals. More than one colony can be found underneath the same stone or log or other refuge. Usually the ant hills are built with dry horse feces. A nest can measure about 50-70 centimeters in diameter at the base and be of 40-50 centimeters in height. The nest is usually well pasted with only small openings in the lower part of the nest. The workers are aggressive when disturbed. Close to the lake area in Cordoba, they prefer to hunt for *Chimarrha canosa* Nar. (Trichoptera).

Eidman (1936, page 95) states about *rufipes* that "the nests are of very varied type in their manner of construction and are so much different from each that one can hardly hold them for the dwelling of the same species. Preferably they are built in rotten wood and for that reason they are found in old tree stumps and natural hollows in the tree trunks".

A detailed study on the distribution of this species in Argentina has been done by Kusnezov (1952). According to his observations this species represents an exceptional phenomenon among the Argentina species of the genus *Camponotus* because of its extraordinary instinct in the plasticity of the nest building. No other species of *Camponotus* makes its own nest in a superficially well accentuated form as does *rufipes*.

He observed the nests of this species hanging from trees in the surroundings of Puerto Pilcomayo. In some places such nests measured about 50 centimeters in diameter. The nests were composed of dry branches. A single colony could contain about 6-8 thousand adults. When the individuals were bothered, they defended themselves furiously. Kusnezov (*loc cit*), however, points out that although this species shows great variability in the nest construction, its occurrence is linked with the humid environment. If this species ever dispersed to a place which had low humidity, it could not establish itself there. He substantiates his arguments with the record on the occurrence of this species in Cebilar, east of Tucuman province. Here the species could not be found after two years of its first record, because in that area the humidity contents are not high enough for the species to establish itself.

His studies also show that the distribution of this species in Argentina cannot be attributed to the thermic condition. For example, besides its occurrence in Misiones which is a warm region, it also occurs in the northeast side of the province which is at an altitude of about 1000-1500 meters above sea level and has a comparatively mild climate. But it has seldom been found in the arid part of Argentina, such as the western part of the province Presidente Peron (Chaco) and Formosa. He calls *rufipes* a thermophilous and mesophilic species. He also points out that in places with little sunlight and at high altitude the species compensates for the lack of necessary heat for the development of its off-spring by constructing superficial nests. He believes that such construction serves the same function as does the conic nest construction by the species of the genus *Formica* in the forest region of the northern hemisphere, i. e., to accumulate heat. Kusnezov concludes that his speculations do not afford a complete explanation of actual dispersion of *rufipes* in Argentina because this species has not occupied the territory of Pampa' and the province of Buenos Aires which are also humid places in Argentina.

From this one can conclude that *rufipes* is a mesophilic species with somewhat restricted distribution, being very typical in the Misiones landscape but also occurring in hill-like formations in the northeast of Argentina at higher elevations. Its occurrence in the above areas is partly determined by the relatively humid environment with forest-like vegetation or in the mountain prairies, which though with short vegetation are at least green all the year round. The meridional limits of the species are hill-like regions of the province of Cordoba and the province of Entre Rios.

Kusnezov (1952) gives the list of places in Argentina where he has found the nests of the species. Besides constructing nests in the branches of trees in areas where there is either a danger of flood or too dense shade on the ground, it also constructs nests underneath stones at the base of some herbaceous plants. The nest is usually made up of dry vegetation. On occasions the nests are found in a fallen tree or a rotten trunk of *Eryngium* sp. or a hollow stem of "Turtutu".

Synonymy. This species was originally described by Fabricius (1775) based upon specimens from Banks' Collection from Brazil. Frederick Smith (1858) re-examined the original specimens and improved the Fabricius description. Based upon the collection of Mr. Borelli's voyage to Argentina and Paraguay, Emery (1894) described three suspecies of *rufipes;* subspecies *rufipes* typical, subspecies *renggeri* and subspecies *lessonai*. Since then some additional infraspecific taxa have been described.

In order to put the taxonomy of *rufipes* on more sound footing it seems desirable that the validity of the taxonomic status of the various published names be checked.

1. *C. rufipes* v. *alpina* was described by Emery (1905) from Pampa Grande (Salta) 2000 m. The distinguishing feature given by Emery is that pubescence is scarce and short on the body, especially the gaster. I have observed specimens bearing Emery's handwritten label of *C. rufipes* v. *alpina* in Forel's type material and their measurements are given in Table 54. The character pointed out by Emery is one of the common characters of this species in black colored specimens and, therefore, is not worthy of the importance which Emery has given to it.

TABLE 48

Measurements (mm) and indices of the material of *C. rufipes* v. *alpina*

Variable	Media	Workers Major	Workers Minor	Minor	Minor
Head width	1.93	3.91	1.82	1.85	1.62
Head length	1.97	3.83	2.13	1.97	1.93
Scape length	2.44	2.98	2.32	2.39	2.24
Pronotum width	1.51	2.36	1.51	1.47	1.35
Metatibial length	2.71	3.13	2.63	2.63	2.63
Weber's length	2.91	4.29	2.67	2.59	2.39
Maximum eye length	0.54	0.66	0.50	0.54	0.50
Maximum eye width	0.42	0.58	0.42	0.42	0.39
Interocular space	1.20	2.44	1.19	1.23	1.12
Cephalic index	98	102	85	94	84
Scape index	126	76	127	129	138
Ocular index	78	88	84	78	77
Pronotum index	78	60	83	79	83

2. *C. rufipes* v. *magnifica* was described by Forel (1913) from Cordoba (Argentina). The criteria used in erecting this taxon were the brownish color of the tibiae and the larger size of the workers. Apparently Forel's concept of *rufipes* was that *rufipes* had only blackish tibiae and tarsi. Since in the specimens from Cordoba he noticed a difference in color, he designated a new taxon. After observing several series of specimens, I have come to believe that the color of the tibiae and tarsi is not a fixed character in *rufipes*. The legs can be brownish with dusky tibiae and tarsi, or only the tarsi are dusky, or the entire leg may be light brownish in color. For instance in specimens from Bolivia the color of the legs even approaches to yellowish white, which is very close to the color in *renggeri*. The difference of size is apparently due to large sized workers, most of which are larger than what Forel had for *alpina*. The measurements of the type material of *magnifica* are given in Table 38.

3. *C. rufipes* form *cajurensis* was described by Luederwaldt (1918) from Brazil with an assertion that this form was even mentioned by Forel (1911) but it was less known (probably meaning that the specimens were not collected in enough numbers) at that time in the region of Serra do Mar (near Alto de Serra, São Paulo State) and São Paulo.

Luederwaldt described this taxon as differing from the type (= *rufipes*) by vermillion (= dark red) color of body, especially the abdomen (= gaster), and by the color of hairs which are rather golden yellow and not vermillion (probably meaning brighter). He did not designate any type. I have not been able to locate his material. However, I have five major workers from Alto de Serra and some others from São Paulo which fit quite well in the description of this taxon. Both characters which Luederwaldt used to erect this taxon are very variable in *rufipes* and, therefore, it can very safely be considered that he had actually described one aspect of total variation of these two characters. For instance the color of this species may vary from dull black to rusty brown and similarly the color of hairs may be light brown to dark brown. The measurements of these specimens have been incorporated in total computational sample for *rufipes*.

4. *C. rufipes* v. *subrufescens* was described by Santschi (1929). He mentioned that his specimens showed some characters close to *magnifica*, but that the gaster had a tendency to become brownish red as in variety *cajurensis*. The type specimens were collected from Rio Negro (Paraná) and to them some additional specimens were added from Minas Gerais. I have observed 2 syntype workers and one allotype male representing both localities and their respective measurements are listed in Table 39. Besides I have also examined additional material from these two localities. It is worth noticing that only one syntype worker from Rio Negro is as big as the biggest of *magnifica* while the other syntype is comparatively smaller. Taking into consideration the spectrum of variation in body color, size and pilosity, the bases for erection of this taxon are too weak.

It seems pertinent to point out at this time that when *rufipes* was designated and even during the subsequent years the concepts of ecological and geographical variation were not well understood. As a result even a specimen showing a slight variation from the accepted static concept of typical form was pinned as a new variety or form. It could also be rationalized by stating that these people most probably described the variation pattern of a taxon by giving a varietal status. The occurrence of ecological variation in *rufipes* has been emphatically pointed out by Kusnezov (1952).

5. *C. rufipes lessonai* was described by Emery (1894). I did not have any other specimen except the two syntypes labelled, "*Camponotus rufipes* subsp. *lessonai* Emery, Asunción, Paraguay, Borelli Collector". These specimens differ from *rufipes* material in being of small size, having a slender, little compressed and bare scape. They have a short and scattered pilosity which is not very conspicuous. In brief, these specimens do not show any character which could help to link them with *rufipes*. In view of this, it is proposed that *lessonai* should be transferred to another subgenus of *Camponotus*.

My conclusions of synonymizing the above infraspecific taxa of *rufipes* and the proposal of transferring *lessonai* are further strengthened by the elaborate key to the varieties of *rufipes* given by Santschi (1929). While working with this key, the *lessonai* separates out after the first couplet from all other taxa on the basis that it has head width less than 4.4 mm while the rest of the taxa have more than 4.4 mm. Further, it is only *lessonai* that does not have strongly dilated scapes. Santschi's key seems quite elaborate and convincing for he has used the species variation so effectively that the key looks very impressive. However, the value of this key becomes quite apparent once one has studied series of specimens which show all gradations from one extreme to the

other! Although Santschi (*loc cit*) included *renggeri* in his key as one of the subspecies, in the subsequent years this taxon has been given specific status because of certain fixed characters. For additional comments see differential diagnosis.

Discussion of the type material of Camponotus rufipes. I have examined the type specimen, but it does not conform to the accepted concept of *rufipes*. I have the following arguments in favor of this view:

1. All the identified material in the British Museum labelled as *rufipes* conforms with my views and that this had been confirmed by Barry Bolton (personal communication, 1972) who had written to me:

> I have had a look at the other *rufipes* material (= other than the type specimen) [1] in the British Museum and all of the specimens are covered, as you say, with abundant light brown to dark brown hairs. One of the specimens bears a label in Fred Smith's handwriting stating, '*rufipes* Fab. compared with type in coll. Banks'.

Since Fabricius' own description is quite insufficient, it seems more sensible to follow what Fred Smith says in his description.

2. All the infra-specific taxa, some of which have been synonymized in the present study, conform to the presently accepted concept of *rufipes*.

3. The type specimen which has been sent to me from the British Museum differs from the other *rufipes* material [2] in the following respects:

a. In the type the lateral portions of the head are subparallel and the head is longer than broad; in the *rufipes* material the head is convex at the sides, narrow anteriorly and broad posteriorly.

b. In the type the antennal scape is slightly flattened and is gradually thickened towards apex whereas in the other material the scape is strongly dilated.

c. In the type the occipital border is sharply indented in the center showing the occipital corners as two raised humps whreas the occipital corners are smoothly rounded and the occipital border is not sharply cut in the other material.

d. The type has very short bristle-like but diluted pilosity all over the body while the other material has an abundance of pilosity and pubescence in varying density. The pubescence in the type is scanty to absent.

e. The type specimen is slightly shiny but the accepted concept of *rufipes* is of a dull appearance.

f. The scape is about 1.6 times the length of head measured from antennal fossa to occipital border in the type specimen but is only about 1.04 times as long in most major workers of the other material.

Mr. Bolton has also informed me that this is the only specimen which they have from the Banks Collection (because Fabricius mentions in his original description that the specimen is from Banks Collection) and the specimen is labelled as "Ex-Banks", but not in Fabricius' own handwriting, rather someone else's. In this situation I have, therefore, resorted to what Lindroth (1957) did about the type material of Linnaeus in Carabid beetles. He has stated that, "if description and authentic specimens disagree, the former is decisive". Mayr (1969) has stated, "It was customary in several European museums in the first half of the nineteeenth century to substitute new type-specimens whenever the old ones became faded or were damaged by insect pests". Perhaps this is what happened in the case of *rufipes*.

[1] Comment in parentheses mine.

[2] *rufipes* material means that material other than the type specimen. This includes all the material sent by various museums either as *rufipes* or as its infra-taxa.

However, should these propositions be accepted, then the designation of a neotype seems the appropriate step. But before a neotype can be designated, it is pre-requisite that I check all possible resources to determine that no syntype of *rufipes* exists in any other museum of the world. So far I have checked only with Dr. Borge Peterson of the Universitetets Zoologiske Museum, Copenhagen, Denmark, who has informed me that they have only a pin labelled as *rufipes*, probably indicating that the specimen has been damaged or destroyed. The decision to designated a neotype is deferred until a thorough inquiry has been made and all the requirements and recommendations of Commission and Code of Zoological Nomenclature have been satisfied.

In the absence of a type that conforms with the accepted concept of *rufipes*, a question can be raised as to how the other names can be synonymized if the type is not known. The most appropriate answer is that the act of synonymy only indicates that all these taxa and the material on which they are based refer to the same taxon. The data so accumulated will remain valid whether we call this material *rufipes* or something else. However, it seems in the interest of stability of concept and retrieval of information that *rufipes* be retained as it is understood by most people.

Differential diagnosis. See *C. renggeri*.

Camponotus renggeri Emery, 1894

(Figures 7 and 8)

Camponotus rufipes F. subsp. *renggeri* Emery, 1894, Bull. Mus. Zool. Torino. 9 (186): 2-3. Description of worker and female. Type locality: San Bernadino, Paraguay. Location of type material: Forel Co'lection at Museum d'Histoire Naturelle, Geneva. Forel, 1904, Rev. Suisse Zool. 12: 45. Recorded from state of Amazonas, Brazil. Forel, 1909, Deut. Ent. Zeitschr, p. 265. Recorded male, female and workers from San Bernadino, Paraguay.

Camponotus renggeri, Luederwaldt, 1918, Rev. Mus. Paulista 10: 53. Raised to species level. Wheeler, 1923, Ark. Zool. 15 (7): 5. Records from Santa Amelia, Rio Autaz and Manaos, Brazil. Borgmeier, 1934, Arq. Inst. Biol. Veget. Rio de Janeiro 1 (2): 111. Recorded from coffee plantations in French Guiana. Menozzi, 1935, Redia Florence 21: 202. Record of major worker from Guyana and incorrect spelling of *renggeri* as *reuggeri*. Kusnezov, 1952, Acta Zool. Lilloana, Tucuman 12: 183. Distribution and nesting habits in Argentina.

Type material examined. Three syntypes comprising one major and two minors were examined from the Forel Collection. The specimens were labelled, "Cotypus, *Camponotus rufipes* subsp. *renggeri* Em. Paraguay". For measurements see Table 49.

Distribution. This species is distributed in Argentina, Bolivia, Brazil, Colombia, Guyana, Paraguay and Peru. A detailed account of the distribution of this species in Argentina has been given by Kusnezov (1952) (cf. Fig. 8).

TABLE 49

Measurements (mm) and indices of the type material of *C. renggeri*

	Syntypes (Workers)		
	Major	Minors	
		1	2
Head width	3.21	1.78	1.62
Head length	3.33	2.05	2.05
Scape length	3.37	2.82	2.59
Pronotum width	2.13	1.47	1.35
Metatibial length	3.48	2.05	2.98
Weber's length	4.37	3.40	3.17
Maximum eye length	0.69	0.54	0.50
Maximum eye width	0.54	0.42	0.39
Interocular space	1.97	1.16	1.08
Cephalic index	96	87	79
Scape index	104	158	159
Ocular index	78	78	76
Pronotum index	66	82	83

Localities from which the specimens have been examined. I had the opportunity to observe specimens from Bolivia, Brazil, Guyana and Paraguay in reasonable number and, hence, recorded their measurements. Only a few specimens were obtained from Argentina and Colombia, and these specimens have not been included in the tables of measurement. Under each country the locality is followed by the name of collector and the collection in parentheses. *Argentina:* Posadas (Silvestri: FOREL). *Bolivia:* Isiamas (W. M. Mann: USNM) female associated with workers; Ixiamas (M. L. Lopez: USNM) female associated with workers; Espia Rio Beni (Anonymous, W. M. Mann: USNM); Rurrenabaque, Beni (W. M. Mann: USNM) female associated with workers; Charubamba (N. Holinoren: USNM); Canamina (W. M. Mann: USNM); Cavinas, Beni (W. M. Mann: USNM); Rosario Bolivia (Rocuque) (W. M. Mann: USNM). *Brazil:* Santa Maria, Rio Grande do Sul (White: MCZ); Pará (W. L. Brown: MCZ), (W. M. Mann: USNM, MCZ); Porto Velho, Rio Madeira (Mann and Baker: USNM); Ilha Mexiana (Hagmann: FOREL); Rio Paraná, State Amazonas (Goeldi: FOREL); Espírito Santo (Fruehnsterfer: FOREL). *Colombia:* Unknown (Cattleya: USNM). *Guyana:* Kartabo (S. C. Crawford: MCZ); Berbice (Mayr: MCZ); Georgetown (H. O. Lang: MCZ); Paramaribo (Stohel: USNM). *Paraguay:* San Bernardino (P. Jordan, K. Fiebrig: OXFORD), (Anonymous: MAYR) female associated with workers, (K. Fiebrig: IAZRW); Paraná R. (K. Fiebrig: MCZ, AMNH); Pastorea (D. Wees: MCZ); Bonpland (Jorgensen: FOREL); Sa. Trindad (Zurcher: SANT); Rio Yguazu (Wees: MCZ); Unknown (Silvestri: SANT). *Peru:* Huanuco Airport (W. L. Brown: MCZ); Hazienda Quicacan near Ambo (Ch. T. Townsend: USNM, MCZ); Machu Picchu (W. L. Brown: MCZ); Dept. Junin (W. F. Walsh: MCZ); Chanchamayo (G. N. Walcott: USNM); Dept. Loreto (W. L. Walsh Jr.: MCZ); Paltaybamba (W. M. Wheeler gift: MCZ).

Major worker. General body color deep black; condyle, basal stem and basal margin of scape deep yellow orange; flagellum light brown; mandibles blackish brown; coxae, trochanters and proximal part of femora yellowish orange making strong contrast with body color; distal part of femora, femoro-tibial joint, tibiae and tarsi brownish black. Sculpture shiny. Scape narrowed at base, basal 1/3 flat; about 1.27 times the head length measured from antennal fossa to occipital border; maximum width 0.43 mm, with short, suberect, moderately stiff hairs scattered over surface. Dorsum with 20+ hairs. Mandibles with suberect piligerous hairs, teeth blackish, apical tooth longer than others. Head narrow anteriorly, broad posteriorly, occipital border deeply excised, occipital angles well pronounced, sides of head with longitudinal piligerous pits. Clypeus notched in middle. Gular region with thick and long pilosity, pilosity above eyes thick, suberect, extending to occipital angles and genae but diluted in between eyes, rather longer than on occipital border. White appressed pubescence all over body, more dense on gaster. Pro- and meso-notum gradually declivious. Pro-mesonotal suture deeply marked, meso-propodeal groove feebly marked. Propodeum demarcated into base and declivity, latter flattened posteriorly; pilosity restricted to posterior region. Dorsum of alitrunk, petiole and gastric segments with long, suberect pilosity. Number of hairs on flexor surface 12+. Petiole with moderately thick margins convex in front, flat behind. Gaster oval, posterior margin of each segment bordered by golden yellow band; pilosity and pubescence on second and third segments, found only centrally.

Media worker. General body color similar to major worker; scape, flagellum, clypeus and lower part of genae light brown; tibiae and tarsi lighter than major. Clypeus notched in middle. Mandibles with 6 teeth. Sides of head parallel, occipital margin straight or else with very shallowly curved margin. Maximum thickness of scape 0.17 mm; scape about 1.75 times the length of head measured from point of antennal fossa to

occipital margin. Petiole flat behind and convex in front. Gastric segments with very thick and appressed pubescence. First tarsal segment with a small, thick spine-like structure.

Minor worker. Body shiny and black as in major worker. Color of head slightly lighter at anterior genal level; scape brownish black. Coxae, trochanters and femora yellowish forming a contrast with body color; tibiae and tarsi brownish. Head narrow at occipital border, occipital angles not well defined. Petiole convex in front, flat behind, thick at base becoming thin towards top, slightly emarginated at top. Long and yellowish pilosity on scape, cheeks, vertex, alitrunk, legs and gaster. Pubescence long, prominent and whitish. Scape cylindrical and of uniform thickness, with maximum thickness 0.19 mm and 1.8 times length of head measured from antennal fossa to occipital border.

Statistical Analyses

The specimens used in this study consisted of only minors and majors from Brazil, Guyana, Paraguay and Peru. However, specimens from Bolivia included three kinds of workers. Therefore, only MSDCC (Tables 56 and 57) has been performed on workers from the first four countries while all the analyses have been performed on workers from Bolivia (Tables 50 through 59).

Results of MSDCC.

TABLE 50

Range, mean, standard deviation, and variance of various body measurements (mm) and indices in the minor workers of *C. renggeri* from different countries

Variable	Statistic	Brazil n = 14	Guyana n = 24	Paraguay n = 22	Peru n = 10
Head width	Range	1.24-1.70	1.35-2.05	1.35-2.09	1.24-1.94
	Mean	1.49	1.62	1.61	1.57
	S.D.	0.11	0.16	0.18	0.22
	Variance	0.01	0.02	0.03	0.04
Head length	Range	1.35-2.09	1.78-2.55	1.74-2.40	1.32-2.28
	Mean	1.87	2.07	2.05	1.96
	S.D.	0.21	0.18	0.18	0.26
	Variance	0.04	0.03	0.03	0.07

TABLE 50 — Continued

Variable	Statistic	Brazil n = 14	Guyana n = 24	Paraguay n = 22	Peru n = 10
Scape length	Range	1.66-2.59	1.80-2.86	2.05-2.90	1.62-2.86
	Mean	2.36	2.46	2.54	2.51
	S.D.	0.23	0.20	0.20	0.32
	Variance	0.05	0.04	0.04	0.10
Pronotum width	Range	1.04-1.53	1.16-1.66	1.20-1.62	0.97-1.55
	Mean	1.22	1.31	1.38	1.31
	S.D.	0.10	0.11	0.11	0.16
	Variance	0.01	0.01	0.01	0.02
Metatibial length	Range	2.28-3.68	1.97-3.17	2.05-3.21	1.86-3.17
	Mean	2.75	2.63	2.72	2.74
	S.D.	0.32	0.30	0.26	0.38
	Variance	0.10	0.09	0.07	0.14
Weber's length	Range	2.27-3.68	2.17-3.56	2.63-3.75	1.93-3.87
	Mean	2.75	2.86	3.24	2.84
	S.D.	0.34	0.33	0.26	0.55
	Variance	0.11	0.11	0.07	0.30
Maximum eye length	Range	0.35-0.58	0.50-0.66	0.46-0.58	0.35-0.97
	Mean	0.50	0.55	0.53	0.56
	S.D.	0.06	0.03	0.03	0.15
	Variance	0.00	0.00	0.00	0.02
Maximum eye width	Range	0.31-0.46	0.35-0.50	0.35-0.46	0.27-0.46
	Mean	0.39	0.49	0.42	0.41
	S.D.	0.04	0.03	0.03	0.55
	Variance	0.00	0.00	0.00	0.00
Interocular space	Range	0.89-1.12	0.89-1.28	0.89-1.28	0.85-1.39
	Mean	1.01	1.06	1.07	1.04
	S.D.	0.06	0.09	0.11	0.15
	Variance	0.00	0.00	0.01	0.02
Cephalic index	Range	72-102	74-83	72-87	71-94
	Mean	80	78	78	80
	S.D.	7.98	2.22	5.63	6.58
	Variance	63.66	4.91	31.69	43.24
Scape index	Range	153-176	130-177	132-211	131-183
	Mean	158	152	159	161
	S.D.	10.38	11.28	17.50	15.98
	Variance	107.69	127.25	306.09	225.49
Ocular index	Range	61-100	68-85	69-92	48-85
	Mean	78	77	80	75
	S.D.	8.43	4.94	5.78	10.76
	Variance	71.11	24.44	33.39	115.69
Pronotum index	Range	73-89	69-87	72-111	76-89
	Mean	82	81	86	84
	S.D.	4.04	3.76	8.36	4.11
	Variance	16.32	14.18	69.89	16.85

TABLE 51

Range, mean, standard deviation, and variance of various body measurements (mm) and indices in the major workers of *C. renggeri* from different countries

Variable	Statistic	Brazil n = 25	Guyana n = 8	Paraguay n = 14	Peru n = 11
Head width	Range	2.36-3.74	2.55-3.56	3.06-3.87	2.21-3.41
	Mean	3.33	3.22	3.48	2.87
	S.D.	0.36	0.39	0.25	0.45
	Variance	0.13	0.15	0.06	0.20
Head length	Range	2.67-4.18	2.98-3.87	2.90-3.87	2.27-3.83
	Mean	3.67	3.53	3.65	3.18
	S.D.	0.35	0.30	0.26	0.46
	Variance	0.12	0.09	0.07	0.21
Scape length	Range	2.27-3.79	2.79-3.33	2.71-3.37	2.82-3.33
	Mean	3.09	3.14	3.19	3.12
	S.D.	0.36	0.18	0.15	0.16
	Variance	0.13	0.03	0.02	0.02
Pronotum width	Range	1.70-2.55	1.66-2.36	2.05-2.40	1.66-2.24
	Mean	2.19	2.09	2.23	1.98
	S.D.	0.23	0.24	0.11	0.19
	Variance	0.05	0.06	0.01	0.03
Metatibial length	Range	2.51-4.22	2.98-3.83	2.55-3.87	3.67-3.87
	Mean	3.58	3.58	3.53	3.56
	S.D.	0.32	0.27	0.34	0.17
	Variance	0.10	0.07	0.12	0.03
Weber's length	Range	3.68-5.22	3.33-4.41	3.17-5.34	2.06-4.68
	Mean	4.33	4.00	4.61	4.07
	S.D.	0.45	0.38	0.47	0.44
	Variance	0.20	0.15	0.22	0.19
Maximum eye length	Range	0.58-0.81	0.62-0.77	0.62-0.81	0.58-0.73
	Mean	0.72	0.71	0.72	0.65
	S.D.	0.05	0.05	0.06	0.05
	Variance	0.00	0.00	0.00	0.00
Maximum eye width	Range	0.46-0.62	0.43-0.62	0.46-0.70	0.46-0.54
	Mean	0.54	0.53	0.56	0.52
	S.D.	0.04	0.05	0.05	0.02
	Variance	0.00	0.00	0.00	0.00
Interocular space	Range	1.70-2.48	1.62-2.28	1.90-3.52	1.39-2.13
	Mean	2.15	2.00	2.31	1.79
	S.D.	0.19	0.24	0.38	0.26
	Variance	0.03	0.05	0.14	0.06
Cephalic index	Range	83-95	83-96	87-108	84-97
	Mean	90	91	95	90
	S.D.	3.52	4.31	5.81	5.34
	Variance	12.40	18.61	33.86	28.61
Scape index	Range	71-119	87-111	83-105	44-135
	Mean	93	98	92	111
	S.D.	10.52	7.84	6.27	15.00
	Variance	110.70	61.49	39.37	225.04

TABLE 51 — Continued

Variable	Statistic	Brazil n = 25	Guyana n = 8	Paraguay n = 14	Peru n = 11
Ocular index	Range	55-86	68-80	66-94	60-100
	Mean	75	74	78	79
	S.D.	6.99	3.81	7.03	7.78
	Variance	48.85	14.49	49.38	60.61
Pronotum index	Range	61-68	61-67	56-69	61-78
	Mean	66	65	64	70
	S.D.	2.05	1.90	3.11	5.14
	Variance	4.18	3.62	9.64	26.41

TABLE 52

Range, mean, standard deviation and variance of the various body measurements (mm) and indices of the workers of *C. renggeri* from Bolivia

Variable	Statistic	Minors n = 41	Medias n = 11	Majors n = 34
1. Head width	Range	1.35-2.01	2.05-2.98	2.67-4.29
	Mean	1.54	2.40	3.54
	S.D.	0.16	0.33	0.34
	Variance	0.03	0.11	0.11
2. Head length	Range	1.43-2.51	2.27-3.48	3.06-4.53
	Mean	1.99	2.97	3.88
	S.D.	0.21	0.42	0.30
	Variance	0.04	0.18	0.09
3. Scape length	Range	1.97-3.02	2.94-3.25	2.40-3.56
	Mean	2.53	3.08	3.25
	S.D.	0.19	0.08	0.24
	Variance	0.04	0.01	0.06
4. Pronotum width	Range	1.01-1.51	1.59-2.13	1.82-2.55
	Mean	1.28	1.83	2.27
	S.D.	0.12	0.17	0.17
	Variance	0.01	0.03	0.03
5. Metatibial length	Range	2.21-3.25	2.63-3.83	2.32-3.94
	Mean	2.65	3.32	3.61
	S.D.	0.50	0.35	0.32
	Variance	0.25	0.12	0.10
6. Weber's length	Range	2.27-3.68	3.40-4.64	3.79-5.18
	Mean	3.02	3.96	4.60
	S.D.	0.31	0.33	0.33
	Variance	0.09	0.11	0.11
7. Maximum eye length	Range	0.42-0.62	0.58-0.73	0.62-0.81
	Mean	0.51	0.64	0.73
	S.D.	0.04	0.04	0.05
	Variance	0.00	0.00	0.00
8. Maximum eye width	Range	0.35-0.50	0.46-0.58	0.42-0.66
	Mean	0.41	0.51	0.55
	S.D.	0.04	0.03	0.05
	Variance	0.00	0.00	0.00

TABLE 52 — Continued

Variable	Statistic	Minors n = 41	Medias n = 11	Majors n = 34
9. Interocular space	Range	0.81-1.66	1.28-2.01	1.62-2.48
	Mean	1.04	1.62	2.22
	S.D.	0.14	0.31	0.19
	Variance	0.02	0.09	0.04
10. Cephalic index	Range	71-100	67-99	84-100
	Mean	77	81	91
	S.D.	4.86	8.28	3.95
	Variance	23.62	68.54	15.61
11. Scape index	Range	133-184	106-149	62-110
	Mean	165	130	92
	S.D.	12.55	15.48	10.48
	Variance	157.58	239.64	109.75
12. Ocular index	Range	66-71	70-88	58-100
	Mean	68	80	75
	S.D.	7.06	5.45	8.06
	Variance	49.84	29.66	64.98
13. Pronotum index	Range	76-91	66-94	59-70
	Mean	84	77	64
	S.D.	3.39	7.26	2.76
	Variance	11.51	52.75	7.60

Results of DISCAN.

TABLE 53

Correlation matrix of nine variables (see table 52) for total sample — minors, medias and majors of *C. renggeri* from Bolivia *

Variables	1	2	3	4	5	6	7	8	9
1	1.00								
2	0.98	1.00							
3	0.85	0.86	1.00						
4	0.98	0.98	0.86	1.00					
5	0.77	0.77	0.71	0.77	1.00				
6	0.96	0.96	0.84	0.96	0.78	1.00			
7	0.92	0.93	0.84	0.93	0.71	0.90	1.00		
8	0.84	0.85	0.78	0.86	0.70	0.82	0.83	1.00	
9	0.98	0.98	0.83	0.98	0.79	0.95	0.91	0.84	1.00

* (n = 86).

TABLE 54

Discriminant analysis of minors, medias and majors of *C. renggeri* from Bolivia

Actual Groups	Classification Using the Predictor Variable		
	Minors	Medias	Majors
Minors	41	0	0
Medias	2	9	0
Majors	1	1	32

The above table shows that there are some misclassifications for the medias and the major workers. On examination of the original data it was found that these specimens showed measurements closer to the group in which they have been classified.

Generalized Mahalanobis D-square = 651.22.

TABLE 55

The discriminant functions with their constants and the respective coefficients for nine variables of *C. renggeri*

	Discriminant Functions		
	Minors	Medias	Majors
Constants	-40.80	-27.27	-16.70
Coefficients:			
Head width	15.17	- 7.06	- 5.06
Head length	0.91	5.02	- 1.14
Scape length	5.34	7.36	5.44
Pronotum width	5.63	15.71	4.89
Metatibial length	- 3.44	- 3.65	0.04
Weber's length	- 1.27	2.77	3.66
Maximum eye length	29.81	19.42	23.31
Maximum eye width	- 7.51	- 1.83	11.63
Interocular space	- 1.78	- 2.95	- 2.77

Results of MANOVA.

TABLE 56

Multivariate analysis of variance for minors and medias of *C. renggeri* from Bolivia

Test Performed	Results
H_1	Homogeneity of variance-covariance matrix
F_1	45 (df, numerator)
F_2	1126 (df, denominator)
F	2.28 (Table value 1.52)
H_2	Generalized analysis of variance
F_1	9 (df, numerator)
F_2	42 (df, denominator)
F	15.80 (Table value 2.72)
Lambda (λ)	0.23

TABLE 57

Multivariate analysis of variance for medias and majors of *C. renggeri*

Test Performed	Results
H_1	Homogeneity of variance-covariance matrix
F_1	45 (df, numerator)
F_2	1183 (df, denominator)
F	1.54 (Table value 1.52)
H_2	Generalized analysis of variance
F_1	9 (df, numerator)
F_2	35 (df, denominator)
F	12.69 (Table value 2.89)
Lambda (λ)	0.23

Results of STWMULT.

TABLE 58

Stepwise discrimination between the minor and media workers of *C. renggeri* from Bolivia

Step	Variable Eliminated	R	R^2
1	None (Full model)		
2	Weber's length	0.88	0.77
3	Interocular space	0.88	0.77
4	Maximum eye width	0.88	0.77
5	Maximum eye length	0.88	0.77
6	Metatibial length	0.87	0.76
7	Head length	0.87	0.76
8	Scape length	0.87	0.76
9	Head width	0.87	0.76
10	Pronotum width	0.86	0.76

Table 58 shows that apparently the pronotum width followed by head width are the most useful variables for the prediction of minor or media workers in this species. The rest of the variables, for example, scape length, head length, metatibial length and maximum eye length are bracketed as one group while maximum eye width, interocular space and Weber's length are bracketed as another group in sequence of their importance for the prediction of workers. In both of these groups each variable is independently as effective as they are as a group for the discrimination of media and minor.

TABLE 59

Stepwise discrimination between the medias and majors of *C. renggeri* from Bolivia

Step	Variable Eliminated	R	R^2
1	None (Full model)	0.87	0.76
2	Interocular space	0.87	0.76
3	Head length	0.87	0.76
4	Scape length	0.87	0.76
5	Pronotum width	0.87	0.76
6	Maximum eye with	0.87	0.76
7	Maximum eye length	0.86	0.74
8	Metatibial length	0.85	0.72
9	Weber's length	0.82	0.67
10	Head width		

Table 59 shows that the head width is the most important variable for the separation of media and major workers followed by Weber's length, metatibial length and maximum eye length. The rest of the variables, maximum eye width, pronotum width, scape length, head length, and interocular space are independently as effective as they are as group. In other words any one of these variables can be kept while throwing out the rest and the results with our prediction equation will be the same.

Female. Body color of major worker, scape black, flagellum brownish; gaster shiny and brownish black, each gastric segment with yellow band posteriorly. Head trapezoidal, occipital border straight, corners rounded. Head and alitrunk rough in appearance, dorsum of mesothorax smooth. Propodeum demarcated into base and declivity, both of equal length. Legs and alitrunk not as shiny as of major worker. Thick, golden yellow pilosity all over head; tibiae and tarsi with thick hairs. Each gastric segment

with thick, suberect, golden yellow pilosity, dense on posterior margin, scanty in the central part. The measurements (mm) and indices of three females from Bolivia are as follows: Head width 3.17 (3.09, 3.17), head length 3.71 (3.48, 3.52), scape length 2.82 (2.98, 3.09), metatibial length 3.29 (3.44, 3.71), Weber's length 5.88 (5.95, 5.80), fore femur length 2.86 (2.90, 2.86), fore femur width 0.77 (0.81, 0.77), maximum eye length 1.04 (0.93, 0.89), maximum eye width 0.73 (0.69, 0.73), interocular space 2.17 (1.86, 2.24), cephalic index 85 (89, 90), scape index 89 (96, 97), fore femur index 27 (28, 27).

Male. Slender, light brown. Scape cylindrical, deep brownish black. Eyes bulging out and appearing bigger relative to head size. Meso-propodeal groove very clearly marked laterally. Propodeum gradually declivous. Petiole thick and cut in center. Body clothed with whitish long hair all over. Gastric segments bordered with golden yellow band.

Measurements recorded from a single male specimen from Bolivia are: head width 1.20 mm, head length 1.66 mm, scape length 2.32 mm, pronotum width 2.01 mm, metatibial length 2.90 mm, Weber's length 3.90 mm, maximum eye length 0.73 mm, maximum eye width 0.46 mm, interocular space 1.04 mm, cephalic index 72, and scape index 193.

Biology. Luederwaldt (1926) reported this species nesting in rotten wood and more rarely in the soil in the State of São Paulo, Brazil. The nests were usually constructed from the residue of "*capim*". He also observed one colony under the wall of a house at near Salto Grande, São Paulo, Brazil. Kusnezov (1952) recorded the nests of this species in the hollow trunk of a Urera tree in the perennial subtropical forests at Salta (Urundel) and in refuge underneath a chunk of rotting wood at Arroyo del Diablo (Urundel) in Argentina. He observed its nests in dry tree trunks, in rotting wood, in Urera trees and in a "cane" at Eldorado in Misiones. In Loreto he observed this species visiting houses at night all the year round. He also observed a colony of this species in the neighborhood of colonies of different species of ants in a "marmelero" tree at Iguazu in the province of Misiones.

Differential diagnosis. *Camponotus rufipes* and *C. renggeri* can be separated on the basis of the following characters:

1. In *rufipes* the body is robust and the general body color varies from blackish to rusty brown, but it is always dull or opaque in appearance. On the other hand *renggeri* is slender, swift, always black and has a silyk reflection.

2. The pilosity on the gaster is dense in the case of *rufipes* while it is thinner in *renggeri*. Pubescence is testaceous, longer and copious in *rufipes*, but is whitish, short and scanty in *renggeri*.

3. The color of legs in *rufipes* may be brownish, with tibiae and tarsi dusky, or tarsi only dusky or even slightly yellowish brown, but this color never makes a strong contrast with the general body color. It appears only as a lighter hue fo the body color. In case of *renggeri* the coxae, trochanters and femora are whitish yellow while tibiae and tarsi are brownish black and this color makes a strong contrast with the general body color. As a matter of fact the color of the legs and the silky appearance are the key characters for the separation of two species. The only fixed character about *rufipes* seems to be the dull appearance as most of the other characters vary to some extent.

Camponotus sericatus Mayr, 1887

(Figure 9)

Camponotus sericatus Mayr, 1887, Verh. Zool. bot. Ges. Wien 37: 515-516. Description of worker. Type locality: Santa Catarina, Brazil. Location of type material: Mayr Collection at Naturhistorisches Museum, Vienna, Austria. Santschi, 1939, Rev. Ent. Rio de Janeiro 10: 328. Recorded two workers from Santa Catarina, Blumenau, Brazil, showing differences from typical form. Kempf, 1960, Studia Ent. Petropolis 3: 385-86. Redescription. Figures of head and thorax of worker in profile. Designated lectotype.

Type material examined. One minor worker labelled, "St. Cath. Coll. G. Mayr; *C. sericatus* det. G. Mayr; *Camponotus sericatus* Mayr, Lectotype".Two minor workers labelled, "St. Cath. Coll. G. Mayr; *C. sericatus* det. G. Mayr; *Camponotus sericatus* Mayr, Paratypus". In one paratype gaster is missing. For measurements see Table 60.

TABLE 60

Measurements (mm) and indices of the type material and other specimens of *Camponotus sericatus*

	Lectotype	Paratype	Paratype	Minor	Media
Head width	1.55	1.39	1.43	1.47	2.24
Head length	2.09	2.01	2.05	2.01	2.40
Scape length	2.36	2.36	2.40	2.36	2.20
Pronotum width	1.28	1.20	1.31	1.31	1.55
Metatibial length	2.40	2.32	2.44	2.44	2.48
Weber's length	3.40	3.48	3.10	3.44	3.71
Maximum eye length	0.54	0.50	0.50	0.50	0.66
Maximum eye width	0.42	0.39	0.39	0.39	0.46
Interocular space	1.08	1.01	1.04	1.04	1.55
Cephalic index	74	69	70	73	93
Scape index	152	169	167	160	98
Ocular index	78	77	77	77	70
Pronotum index	82	86	92	89	69

The above table shows that the head width and the interocular space differ in the minor and the media workers. The various indices also show differences in the two kinds of workers. Because

so few specimens were available for examination, no definite conclusions can be drawn from this table.

Distribution. This species has so far been reported only from Brazil.

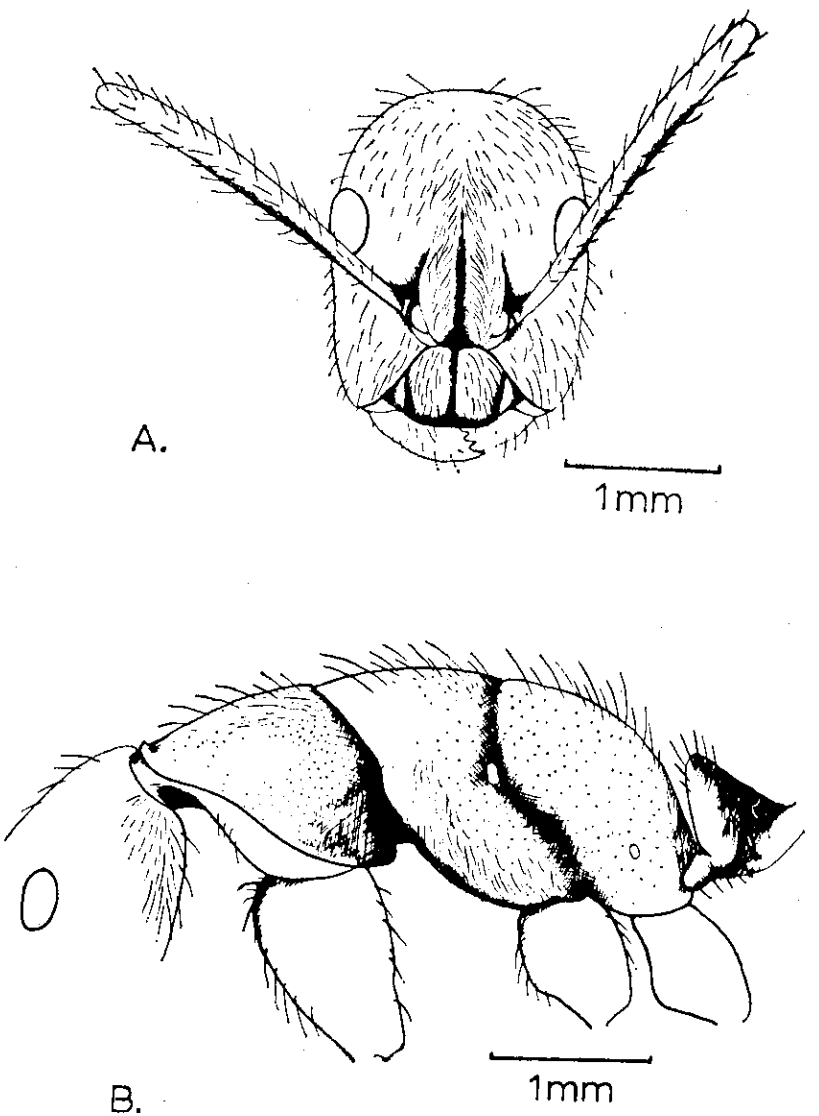
Localities from which specimens have been examined. The material other than types consisted of one minor and one media worker (gaster missing). All specimens are from Santa Catarina, Brazil, and were obtained from the Mayr Collection.

Major worker. Unknown.

Media worker. Because I have examined only one specimen from which the gaster was missing, only a fragmentary description can be given: weakly glossy; head and alitrunk black; scape and legs yellowish brown; clypeus, lower genae and mandibles brownish. Head broader behind, narrowed in front; clypeus broad and flatly cut anteriorly, narrowed and emarginate posteriorly. Scape slightly thickened towards apex, with a maximum width of 0.19 mm and 1.16 times length of head from antennal fossa to occipital border. Scale thick, short, convex in front, concave behind, slightly emarginated dorsally. Pilosity yellowish white, thick, long and slightly undulating, denser on scape and legs, scanty on other parts. Pubescence yellowish white, long and dense; densest on frons, occiput and vertex, diluted on other parts. For measurements see Table 60.

Minor worker. Weakly glossy; fuscous brown to nearly black; mandibles, anterior portion of clypeus and genae reddish brown; scape and legs yellowish brown; flagellum, coxae, femora and tibiae lighter; petiole and gaster brown, tip of latter yellowish red. Oblique to erect hairs of medium thickness, nearly uniform but of short length, rather abundant on body and appendages. Pubescence dense and silky on head and gaster, sparse on dorsum of alitrunk, absent on sides. Head elongate; mandibles with six teeth, smooth and shiny with sparse, fine punctures and fine vestigial striae near apical border. Clypeus with a medium longitudinal keel, its anterior margin broadly rounded in middle, laterally emarginate. Length of scape 1.48-1.55 times the length of head measured from antennal fossa to occipital border, maximum width of scape 0.15-0.19 mm.

Vertex and occiput flattened and depressed, posterior portion of head sub-conical, sides behind eyes strongly converged, occipital



Camponotus (*Myrmothrix*) *sericatus*, lectotype.
Fig. 9. A. front view of head. B. lateral view of alitrunk.

border transverse. Dorsum of head and clypeus rugulose, sparsely and coarsely punctate, somewhat shiny. Scape ruguiose. Alitrunk in profile as shown in Figure 13, dorsum scarcely arcuate. Pronotum and mesonotum sparsely, basal face and sides of alitrunk

deeply punctate, sutures well marked and quite shiny, vestigially coriaceo-reticulate. Declivous face of propodeum, coxae, femora and tibiae finely coriaceous and shiny. Petiolar scale low, bluntly rounded at apex, thick, with coriaceous sculpture and shiny. Gaster finely but superficially rugulose-punctate, somewhat shiny.

Statistical Analyses

Because only a few specimens were available, no statistical analysis could be performed.

Female. Unknown.

Male. Unknown.

Biology. Unknown.

Discussion of the type material of sericatus. According to Kempf (1960) this species was placed in subgenus *Myrmothrix* because of long erect or oblique hairs on the scapes and the legs. However, he also suggested that the sub-conical depressed posterior half of the head was transitional to some species of subgenus *Tanaemyrmex*. I agree with Kempf's view that the placement of this species in the subgenus *Myrmothrix* is debatable. However, this judgment should be based on pilosity which is yellowish white, less thick and less dense in this species contrary to golden yellow, thick and abundant in most of the taxa of *Myrmothrix*. I have some reservations about the use of shape of head in this decision. The following combination of characters which Kempf has mentioned as diagnostic for this species are as a matter of fact the distinctive features of minor workers of this taxon:

Erect or oblique pilosity on scape and legs; uniform and relatively short standing hairs on head and thorax; sub-conical flattened occiput; scarcely arcuate dorsum of thorax (= alitrunk); low thick petiolar scale; coarse and relatively sparse punctulae on head and thorax (= alitrunk), fine superficial punctulae on gaster.

Differential diagnosis. See under discussion.

Camponotus abdominalis (Fabricius) 1804

(Figure 10)

Formica abdominalis Fabricius, 1804, Syst. Piez., p. 409. (Non Latreille). Description of worker. Type locality: Brazil. Location of type material: Universitetets Zoologiske Museum, Copenhagen, Denmark.

Camponotus abdominalis, Dalla Torre, 1893, Cat. Hym. 7: 219. Listed *abdominalis* in *Camponotus*. Forel, 1900, Biol. Centr. Amer. 3: 131. Synonymy, notes on biology in Colombia and distribution in America. Forel, 1902, Ann. Soc. Belg. 46: 107. Notes on biology in Colombia. Wheeler, 1916, Bull. Amer. Mus. Nat. Hist. 35: 14. Reported from British Guiana (= Guyana), fungus growth in workers. Mann, 1916, Bull. Mus. Comp. Zool. 60: 476. Further records in Brazil. Wheeler, 1923, Ark. Zool. 15 (7): 5. Recorded from Amazones, Brazil. Luederwaldt, 1926, Rev. Mus. Paulista 14: 293. Notes on biology in São Paulo, Brasil. Borgmeier, 1934, Arq. Inst. Biol. Veget. Rio de Janeiro. 1: 111. Reported from Dutch Guiana (= Surinam). Menozzi, 1935, Redia Florence 21: 207. Records from British Guiana (= Guyana). Wheeler and Wheeler, 1953, Ent. Soc. Amer. Ann. 46: 196. Larval characters given. Kempf, 1959, Studia Ent. Petropolis 2: 217. Notes on distribution in Brazil.

Formica atriceps Fred-Smith, 1858, Cat. Hym. Brit. Mus. 6: 44. Description of major and minor workers. Type locality: Para, Santarem, Rio., Brazil. Location of type material: British Museum (Natural History), London.

Camponotus atriceps Mayr, 1862, Verh. Zool. bot. Ges. Wien. 12: 660. Description of worker and female from Brazil. Transfer of *atriceps* to *Camponotus*. Roger, 1862, Berl. Ent. Zeitschr. 6: 285. Suggested using *atriceps* rather than *abdominalis*. Roger, 1863, Berl. Ent. Zeitschr. 7: 145. Described female under name of *taeniatus*. Forel, 1879, Bull. Soc. Vaud. Sci. Nat. 16: 76. Notes on variation. Forel, 1884, Bull. Soc. Vaud. Sci. Nat. 20: 339. Color variation, notes on distribution in Brazil, Venezuela, Colombia and Panama. Indicated that *taeniatus* Roger is based on a female of *atriceps*. Emery, 1890, Ann. Soc. Ent. France 10 (6): 70. Record of a female from Caracas, Venezuela. Santschi, 1936, Rev. Ent. Rio de Janeiro 6: 208. Notes on misidentification of *atriceps* and its separation from *abdominalis*. Kusnezov, 1952, Acta Zool. Lilloana, Tucuman 12: 197. Recorded in Argentina; head figured. New Synonymy.

Formica esuriens Fred-Smith, 1858, Cat. Hym. Brit. Mus. 6: 54. Description of major and minor workers. Type locality: Mexico. Location of type material: British Museum (Natural History), London. Mayr, 1862, Verh. Zool. bot. Ges. Wien 12: 658. Description of worker and female as *C. vulpinus*.

Camponotus esuriens, Mayr, 1863, Verh. Zool. bot. Ges. Wien 13: 398. Notes on synonymizing *vulpinus* with *esuriens*. Norton, 1868a, Amer. Nat. 2: 59. Nesting habits in Mexico. Norton, 1868a, Proc. Essex. Instit. 6: 1 (Comm.). Description of female and male from Mexico. Forel, 1879, Bull. Soc. Vaud. Sci. Nat. 16: 76. Notes on distribution. Forel, 1884, Bull. Soc. Vaud. Sci. Nat. 20: 340. Notes on color variation and distribution. Forel, 1900, Biol. Centr. Amer. 3: 133. Distribution, notes, habitats, Mexico, Guatemala, Nicaragua and Panama. Kutter, 1931, Mitt. Schweiz. ent. Ges. 15: 62. Notes on distribution and color variation based on specimens introduced in Basel with banannas from Santa Marta, Colombia. Wheeler, 1932a, Proc. Calif. Acad. Sci. 21 (4): 63. Record of a female (identity not indicated) from Isabel Island in Mexico. Wheeler, 1934, Pan Pacific Entomologist 10: 138. Identity of 1933 specimens from Isabel Island as *esuriens*. Santschi, 1936, Rev. Ent. Rio de Janeiro 6: 213. Further description of worker; relationship with *ustulatus* and *stercorarius* indicated. New Synonymy.

Formica floridana Buckley, 1886, Proc. Entom. Soc. Phil. 6: 161. Description of worker. Type locality: Florida. Location of type material: None known to exist. Forel, 1884, Bull. Soc. Vaud. Sci. Nat. 20: 340. Description of worker under the name *C. atriceps* st. *yankee*. Mayr, 1886, Verh. Zool. bot. Ges. Wien 36: 423. Synonymized *yankee* with *floridanus*.

Camponotus floridanus, Dalla Torre, 1893, Cat. Hym. 7: 231. Transferred *floridanus* to *Camponotus*. Emery, 1893, Zool. Jahrb. Syst. 1: 760. As subspecies of *abdominalis*. Wheeler, 1910, Ann. N. York Acad. Sci. 20: 325. Synonymy, description of major and minor workers and female; distribution notes. Wheeler, 1932b, Jour. N. York ent. Soc. 40: 15. Florida records, notes on nesting habits. Santschi, 1936, Rev. Ent. Rio de Janeiro 6: 213-214. Further description. Schneirla, 1944, Amer. Mus. Novitates No. 1261, pp. 3-5. Behavior and ecological notes in south-central Florida. Smith, 1947, Amer. Midl. Naturalist 37 (3): 604. Major worker figures. Creighton, 1950, Bull. Mus. Comp. Zool. Harvard 104: 396. Synonymy, range in the United States. New Synonymy.

Formica fulvacea Norton, 1868a, Amer. Nat. 2: 60. Figure of worker and nesting habit in Mexico. Type locality: Cordova, Mexico. Location of type material: Unknown. Norton, 1868b, Proc. Essex. Instit. 6: 2 (Comm.). Description of major and minor workers from Mexico.

Camponotus esuriens var. *fulvaceus* Mayr, 1870, Sitzber Akad. Wiss. Wien 61: 377. Transferred to *Camponotus*, listed Mexico as habitat. New Synonymy.

Camponotus atriceps (Smith) var. *atricipito-esuriens* Forel, 1879, Bull. Soc. Vaud. Sci. Nat. 16: 77. Description of one worker as intermediate form. Locality: Cordova and Orizaba, Mexico. Location of type material: Forel Collection at Museum d'Histoire Naturelle, Geneva. Forel, 1900, Biol. Centr. Amer. 3: 132. Listed as variety of *abdominalis*. New Synonymy.

Camponotus atriceps (Smith) st. *stercorarius* Forel, 1884, Bull. Soc. Vaud. Sci. Nat. 20: 340. Description of worker, female and male, notes on nesting habits. Type locality: Central America (probably Guatemala). Location of type material: Forel Collection at Museum d'Histoire Naturelle, Geneva. Forel, 1900, Biol. Centr. Amer. 3: 133. Habitat and nesting habits. Wheeler, 1907, Bull. Amer. Mus. Nat. Hist. 23: 276. Records in British Honduras. Forel, 1922, Rev. Suisse Zool. 30: 99-100. Description of specimens from Peru as *wagneri*. Mann, 1922, Proc. U.S. Nat. Mus. 61 (13): 53. Additional records from British Honduras. Wheeler, 1923, Ark. Zool. 15: 5. Recorded from Rio Autaz, Amazonas, Brazil. Wheeler, 1933, Psyche 40: 28. Description of mermithergate from Guerrero, Mexico. Santschi, 1936, Rev. Ent. Rio de Janeiro 6: 213. Synonymy of *wagneri*. New Synonymy.

Camponotus atriceps (Smith) st. *ustulatus* Forel, 1884, Bull. Soc. Vaud. Sci. Nat. 20: 339. Description of worker. Type locality: Retaluleu, Guatemala. Location of type material: Forel Collection at Museum d'Histoire Naturelle, Geneva. Forel, 1900, Biol. Centr. Amer. 3: 132. Habitats and distribution in Central America. Wheeler, 1907, Bull. Amer. Mus. Nat. Hist. 23: 276. Record from British Guiana (= Guyana). Santschi, 1936, Rev. Ent. Rio de Janeiro 6:

211-212. Further description of worker from Guatemala and first description of male and female from Panama Canal Zone. Staercke, 1945, Ent. Ber. 11: 265. Record from Paramaribo, Dutch Guiana (= Surinam), comparison with *atriceps*. New Synonymy.

Camponotus abdominalis var. *mediopallidus* Forel, 1900, Biol. Centr. Amer. 3: 132. Description of worker and female. Type locality: Dibulla, Department of Santa Marta, Colombia. Location of type material: Forel Collection at Museum d'Histoire Naturelle, Geneva. Crawley, 1916, Ann. Mag. Nat. Hist. 17 (8): 376. Recorded from Issororo, N. W. District, British Guiana (= Guyana). Santschi, 1922, Ann. Soc. Ent. Belg. 62: 107. Recorded from Maracaibo, Venezuela. Borgmeier, 1934, Arq. Inst. Biol. Veget. Rio de Janeiro 1: 111. Recorded from Paramaribo, Dutch Guiana (= Surinam). Santschi, 1936, Rev. Ent. Rio de Janeiro 6: 209. Further description of type material. New Synonymy.

Camponotus abdominalis var. *costaricensis* Forel, 1900, Biol. Centr. Amer. 3: 132. Description of worker. Type locality: Golfe Dulce, Costa Rica. Location of type material: Forel Collection at Museum d'Histoire Naturelle, Geneva. Forel, 1914b, Neuchatel Mem. Sci. Nat. 5: 13. Record from Colombia, comparison with *ustulatus*. Menozzi, 1927, Ent. Mitteil. 16: 339. First description of female. Santschi, 1936, Rev. Ent. Rio de Janeiro 6: 212. Further description, comparison of female with *ustulatus*, new records from Panama and Colombia. New Synonymy.

Camponotus abdominalis ssp. *cupiens* Forel, 1908, Verh. Zool. bot. Ges. Wien 58: 410. Description of major aud minor workers and female. Type locality: São Paulo, Brazil. Location of type material: Forel Collection at Museum d'Histoire Naturelle, Geneva. Luederwaldt, 1926, Rev. Mus. Paulista 14: 293. Observations on biology in São Paulo, Brazil. Santschi, 1936, Rev. Ent. Rio de Janeiro 6: 210. Further notes. Santschi, 1939, Rev. Ent. Rio de Janeiro 10: 328. Additional records from Brazil. New Synonymy.

Camponotus abdominalis ssp. *fuchsae* Forel, 1908, Verh. Zool. bot. Ges. Wien 58: 409. Description of major and minor worker and female. Type locality: São Paulo, Brazil. Location of type material: Forel Collection at Museum d'Histoire Naturelle, Geneva. Luederwaldt, 1926, Rev. Mus. Paulista 14: 293. Notes on biology in São Paulo, Brazil. Santschi, 1936, Rev. Ent. Rio de Janeiro 6: 213. Further description. Kusnezov, 1952, Acta Zool. Lilloana, Tucuman 12: 236. Recorded in Argentina. New Synonymy.

Camponotus abdominalis transvectus Wheeler, 1910, Ann. N. York Acad. Sc. 20: 326-327. Description of major and minor worker, male and female. Type locality: Harlingen, Texas (as corrected by Creighton, 1950). Location of type material: Forel Collection at Museum d'Histoire Naturelle, Geneva. Santschi, 1936, Rev. Ent. Rio de Janeiro 6: 213. Indicated closer to *esuriens*. Creighton, 1950, Bull. Mus. Comp. Zool. Harvard 104: 396. Correction of type locality. New Synonymy.

Camponotus (*M.*) *abdominalis mediopallidus* v. *laevilatus* Santschi, 1922, Ann. Soc. Ent. Belg. 62: 108-109. Description of worker and female. Type locality: São Paulo, Brazil. Location of type material: Forel Collection at Museum d'Histoire Naturelle, Geneva Borgmeier, 1927, Arch Mus. Nacion. Rio de Janeiro 29: 14. Typographical error of *laevilatus* as *laevitatus*. Santschi, 1936, Rev. Ent. Rio de Janeiro 6: 209. Further description. New Synonymy.

Camponotus (*M.*) *abdominalis* F. St. *rabidus* Santschi, 1922, Ann. Soc. Ent. Belg. 62: 107-108. Description of major and minor workers and female. Type locality: Peru. Location of type material: Santschi Collection at Naturhistorisches Museum, Basel. Santschi, 1936, Rev. Ent. Rio de Janeiro 6: 214. Further description of workers, comparison with *abdominalis* and *mediopallidus*. New Synonymy.

Camponotus (*Myrmothrix*) *abdominalis* F. st. *depressidens* Santschi, 1922, Ann. Soc. Ent. Belg. 62: 107. Description of major and minor workers. Type locality: Haut Gasevene, French Guiana. Location of type material: Santschi Collection at Naturhistorisches Museum, Basel, and Museum National d'Histoire Naturelle, Paris. Santschi, 1936, Rev. Ent. Rio de Janeiro 6: 211. Further description. New Synonymy.

Camponotus (*Myrmothrix*) *abdominalis* subsp. *romani* Wheeler, 1923, Ark. Zool. 15: 5. Description of worker. Type locality: Amazonas (Chicago in Rio Japurá), Brazil. Location of type material: Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts. Santschi, 1936, Rev. Ent. Rio de Janeiro 6: 215. Further description. New Synonymy.

Camponotus (*Tanaemyrmex*) *abdominalis* F. var. *fumata* Stitz, 1933, Mitteil. Deuts. Ent. Ges. 4 (5): 71. Description of worker. Type locality: Venezuela. Location of type material: Unknown. Santschi, 1936, Rev. Ent. Rio de Janeiro 6: 209. Further description. New Synonymy.

Camponotus (*M.*) *abdominalis floridanus* v. *defrictus* Santschi, 1936, Rev. Ent. Rio de Janeiro 6: 214. Description of major and minor workers. Type locality: Cuevas Vace, Mexico. Location of type material: Santschi Collection at Naturhistorisches Museum, Basel. New Synonymy.

Camponotus (*M.*) *mediopallidus* v. *flavobasalis* Santschi, 1936, Rev. Ent. Rio de Janeiro 6: 209-210. Description of major worker and female. Type locality: Minas Gerais, Brazil. Location of type material: Santschi Collection at Naturhistorisches Museum, Basel. New Synonymy.

Camponotus (*M.*) *abdominalis cupiens* v. *luisae* Santschi, 1936, Rev. Ent. Rio de Janeiro 6: 210. Description of major worker. Type locality: Rio de Janeiro, Brazil. Location of type material: Santschi Collection at Naturhistorisches Museum, Basel. New Synonymy.

Camponotus (*M.*) *abdominalis floridanus* v. *panamanus* Santschi, 1936, Rev. Ent. Rio de Janeiro 6: 214. Description of worker. Type locality: Bella Vista, Panama. Location of type material: Santschi Collection at Naturhistorisches Museum, Basel. New Synonymy.

Camponotus (*M.*) *abdominalis* st. *epistomatus* Santschi, 1936, Rev. Ent. Rio de Janeiro 6: 208-209. Description of worker. Type locality: Hayoz 26, Colombia. Location of type material: Santschi Collection at Naturhistorisches Museum, Basel. New Synonymy.

Camponotus abdominalis st. *cupiens* v. *missionensis* Santschi, 1939, Rev. Ent. Rio de Janeiro 10: 328. Description of worker. Type locality: Misiones, Argentina. Location of type material: Santschi Collection at Naturhistorisches Museum, Basel. Kusnezov, 1952, Acta Zool. Lilloana, Tucuman 12: 198. Records from Argentina. New Synonymy.

Type material examined. 1. One syntype major worker labelled, "Essequibo Smidt, Mus. J. Lund, *Formica abdominalis* Fabr." Its measurements are: head width 3.87 mm, head length 3.99 mm, scape length 2.82 mm, pronotum width 2.24 mm, metatibial length 3.56 mm, Weber's length 4.84 mm, maximum eye length 0.73 mm, maximum eye width 0.54 mm, interocular space 2.32 mm, cephalic index 97, scape index 73, ocular index 74, and pronotum index 58.

2. One holotype worker labelled, "Type; *atriceps* Sm. Type; Holotype, B. M. Type Hym. 11.923". Its measurements are: head width 3.21 mm, head length 3.48 mm, scape length 2.51 mm, pronotum width 1.97 mm, metatibial length 3.17 mm, Weber's length 3.95 mm, maximum eye length 0.73 mm, maximum eye width 0.58 mm, interocular space 2.09 mm, cephalic index 92, scape index 78, ocular index 79, and pronotum index 61.

3. One holotype worker labelled, "*Formica esuriens* Smith, max., Typus; *Camponotus abdominalis* F.; *abdominalis* F. ssp. *esuriens;* Holotype B. M. Type. Hym. 11.921". Its measurements are: head width 2.83 mm, head length 2.98 mm, scape length (antennae missing), pronotum width 1.62 mm, metatibial length 2.90 mm, Weber's length 3.48 mm, maximum eye length 0.58 mm, maximum eye width 0.46 mm, interocular space 1.66 mm, cephalic index 95, ocular index 80 and pronotum index 57.

4. (a) Three syntype females and three syntype males labelled "Typus; r. *C. stercorarius; C. stercorarius* Forel, Guatemala (Stoll)". (b) Three syntype workers labelled "Typus; *C. stercorarius* Forel, Guatemala". (c) Two syntype workers (one major and one media) labelled "Typus; *C. abdominalis* r. *stercorarius* For. Perou, Andre; *C. stercorarius* For. r. *bahai*". It seems that *bahai* is only a manuscript name. For measurements see Table 61 and 62.

TABLE 61

Measurements (mm) and indices of the type material of *C. stercorarius*

	Syntype Females				Syntype Males		
	1	2	3		1	2	3
Head width	2.67	2.78	2.71	Head width	0.98	0.81	0.98
Head length	2.94	3.10	3.02	Head length	1.35	1.24	1.35
Scape length	2.55	2.55	2.63	Scape length	1.78	1.55	1.78
Metatibial length	3.17	3.25	3.02	Metatibial length	2.44	2.40	2.44
Weber's length	5.30	5.46	5.22	Weber's length	3.29	2.86	3.33
Fore femur length	2.51	2.51	2.13	Maximum eye length	0.58	0.50	0.54
Fore femur width	0.70	0.66	0.66	Maximum eye width	0.46	0.39	0.42
Maximum eye length	0.85	0.85	0.81	Interocular space	0.81	0.73	0.85
Maximum eye width	0.66	0.66	0.66				
Interocular space	2.01	1.97	1.93				
Cephalic index	91	90	90				
Scape index	96	92	97				
Ocular index	77	77	81				
Fore femur index	28	26	31				

TABLE 62

Measurements (mm) of the type material of *C. stercorarius*

	Syntypes Workers Minors		
	1	2	3
Head width	1.31	1.28	1.28
Head length	1.74	1.70	1.78
Scape length	1.97	2.13	2.13
Pronotum width	1.08	1.08	1.08
Metatibial length	2.28	2.44	2.28
Weber's length	2.63	2.55	2.67
Maximum eye length	0.50	0.50	0.50
Maximum eye width	0.42	0.42	0.39
Interocular space	0.89	0.85	0.85
Cephalic index	75	75	72
Scape index	150	167	167
Ocular index	85	85	77
Pronotum index	82	85	85

5. (a) Three syntype workers (one major, one media and one minor) labelled "Typus; *C. ustulatus* Forel, Retaluleu. Guatemala (Stoll)". (b) Nine syntype workers (five media and four minor) labelled "Cotypus; *C. ustulatus*, Retaluleu, Guatemala (Stoll)". For measurements see Table 63.

6. Seven syntypes consisting of one female, two majors, one media and three minors labelled "Typus; *C. abdominalis* v. *mediapollidus*, Dibulla, Columbia (Lallemand)". For measurements see Table 64.

TABLE 63

Measurements (mm) and indices of the type material of *C. ustulatus*

	Syntypes Workers Minors										Major
	1	2	3	4	5	6	7	8	9	10	11	1
Head width	1.51	1.74	1.55	1.66	1.47	1.59	1.39	1.43	1.51	1.70	1.59	3.40
Head length	1.97	2.13	1.97	1.78	1.90	2.09	1.90	1.86	1.93	2.17	2.05	3.52
Scape length	2.44	2.51	2.40	2.44	2.51	2.32	2.36	2.40	2.48	2.67	2.63	2.98
Pronotum width	1.24	1.43	1.31	1.35	1.24	1.31	1.12	1.24	1.24	1.39	1.35	1.97
Metatibial length	2.63	2.90	2.82	2.63	2.59	2.77	2.48	2.79	2.71	2.90	2.86	3.48
Weber's length	3.09	3.09	2.98	3.21	2.94	3.17	2.79	2.82	2.94	3.25	3.13	4.26
Maximum eye length	0.54	0.58	0.54	0.58	0.50	0.58	0.50	0.54	0.54	0.54	0.58	0.73
Maximum eye width	0.42	0.46	0.46	0.46	0.42	0.46	0.46	0.38	0.46	0.50	0.42	0.58
Interocular space	0.97	1.04	0.97	1.04	0.97	0.97	0.89	0.93	0.97	1.04	1.01	2.01
Cephalic index	76	82	78	93	77	76	73	77	78	78	78	97
Scape index	161	144	155	146	171	146	169	167	164	157	166	87
Ocular index	78	80	86	80	85	80	92	71	86	93	73	79
Pronotum index	82	82	85	81	84	83	80	86	82	82	85	58

TABLE 64

Measurements (mm) and indices of the type material of *C. mediopallidus* from the Forel Collection

	Syntypes							Female
	Majors		Media	Minors				
	1	2	1	1	2	3		
Head width	3.79	3.56	2.51	1.51	1.86	1.81	Head width	3.10
Head length	3.91	3.75	2.79	2.01	2.17	2.17	Head length	3.17
Scape length	2.82	2.59	2.48	2.36	2.40	2.44	Scape length	2.55
Pronotum width	2.28	2.17	1.74	1.28	1.55	1.39	Metatibial length	3.29
Metatibial length	3.13	3.33	2.67	2.67	2.71	2.71	Weber's length	5.45
Weber's length	4.49	4.64	3.56	2.98	3.21	3.17	Fore femur length	2.32
Maximum eye length	0.73	0.54	0.62	0.50	0.58	0.54	Fore femur width	0.81
Maximum eye width	0.73	0.54	0.50	0.42	0.42	0.46	Maximum eye length	0.81
Interocular space	2.36	2.28	1.51	1.01	1.24	1.12	Maximum eye width	0.62
Cephalic index	97	95	90	75	85	83	Interocular space	2.17
Scape index	74	73	98	156	129	134	Cephalic index	97
Ocular index	74	74	81	85	73	86	Scape index	82
Pronotum index	60	61	69	85	83	77	Ocular index	76
							Fore femur index	35

7. (a) One syntype female labelled "Typus; Costa Rica, Great Island (H. Nepperschmidt leg.) ded. 30. III. 1895.; *C. abdominalis* r. *costaricensis* For." (b) Three syntype workers (one major, one media and one minor) labelled "Typus; *C. abdominalis* F. v. *costaricensis*, Golfo Dulce, Costa Rica (Pittier)". For measurements see Table 65.

TABLE 65

Measurements (mm) and indices of the type material of *C. abdominalis costaricensis*

	Syntypes				
	Major	Media	Minor		Female
Head width	3.10	2.44	1.43	Head width	3.01
Head length	3.21	2.71	1.90	Head length	3.17
Scape length	2.77	2.63	2.24	Scape length	2.71
Pronotum width	1.97	1.66	1.12	Metatibial length	3.40
Metatibial length	3.10	2.86	2.48	Weber's length	4.95
Weber's length	3.64	3.48	2.79	Fore femur length	2.59
Maximum eye length	0.66	0.62	0.50	Fore femur width	0.73
Maximum eye width	0.46	0.39	0.62	Maximum eye length	0.85
Interocular space	1.90	1.47	0.93	Maximum eye width	0.62
Cephalic index	96	90	75	Interocular space	2.17
Scape index	89	108	156	Cephalic index	95
Ocular index	82	75	77	Scape index	90
Pronotum index	64	68	78	Ocular index	73
				Fore femur index	28

8. (a) One female syntype labelled "Typus; *C. abdominalis* r. *cupiens*, S. Paulo-Brazil (Ihering)". (b) Two syntype minor workers labelled "Typus; *C. abdominalis* r. *cupiens* For., Type, S. Paulo, Brazil (Ihering)". For measurements see Table 66.

TABLE 66

Measurements (mm) and indices of the type material of *C. abdominalis cupiens* from the Forel Collection

	Syntypes			
	Minor Workers			Female
	1	2		
Head width	1.62	1.47	Head width	3.29
Head length	2.09	1.86	Head length	3.33
Scape length	2.40	2.36	Scape length	2.63
Pronotum width	1.20	1.20	Metatibial length	3.40
Metatibial length	2.67	2.51	Weber's length	5.60
Weber's length	3.02	2.79	Fore femur length	2.59
Maximum eye length	0.50	0.50	Fore femur width	0.81
Maximum eye width	0.42	0.42	Maximum eye length	0.85
Interocular space	1.08	0.97	Maximum eye width	0.66
Cephalic index	78	79	Interocular space	2.24
Scape index	148	160	Cephalic index	99
Ocular index	85	85	Scape index	80
Pronotum index	74	81	Ocular index	77
			Fore femur index	31

9. (a) One male labelled "Cotype, *C. abdominalis* r. *fuchsae* S. Paulo, Brazil (Ihering)". (b) One female and two minor workers labelled "Typus, *C. abdominalis* F. r. *fuchsae* For., S. Paulo, Bres. (Ihering)". (c) Two majors and four minors labelled "Cotype, *C. abdominalis* F. r. *fuchsae* For. S. Paulo, Bres. (Ihering)". For measurements of workers only see Table 67.

TABLE 67

Measurements (mm) and indices of the type material of *C. abdominalis fuchsae*

	Syntype Workers							
	Majors		Minors					
	1	2	1	2	3	4	5	6
Head width	3.37	3.52	1.86	1.74	1.62	1.74	1.90	1.74
Head length	3.48	3.64	2.13	2.09	1.93	2.05	2.13	2.05
Scape length	2.94	2.98	2.36	2.28	2.28	2.40	2.32	2.36
Pronotum width	2.13	2.01	1.32	1.24	1.24	1.32	1.32	1.28
Metatibial length	3.33	3.48	2.77	2.63	2.52	2.67	2.52	2.65
Weber's length	4.18	4.06	2.94	2.90	2.86	2.94	3.13	2.90
Maximum eye length	0.70	0.73	0.54	0.58	0.54	0.54	0.54	0.54
Maximum eye width	0.54	0.54	0.46	0.42	0.42	0.42	0.42	0.42
Interocular space	2.05	2.09	1.12	1.12	1.01	1.08	1.16	1.12
Cephalic index	97	97	87	83	84	85	89	85
Scape index	87	85	127	131	140	138	122	135
Ocular index	78	74	86	73	78	78	78	78
Pronotum index	63	57	71	71	76	75	69	73

10. One major, one media and one minor syntype workers labelled "Cotypus; *C. abdominalis* r. *transvectus* Wheeler; Escuinapa, Sinaloa, Mexico, (J. H. Batty)". For measurements see Table 68.

TABLE 68

Measurements (mm) and indices of the type material of *C. abdominalis transvectus*

	Syntype Workers		
	Major	Media	Minor
Head width	3.87	2.24	1.58
Head length	3.60	2.55	1.93
Scape length	2.82	2.67	2.28
Pronotum width	2.17	1.62	1.16
Metatibial length	3.29	2.77	2.40
Weber's length	4.26	3.40	2.98
Maximum eye length	0.73	0.62	0.54
Maximum eye width	0.54	0.46	0.42
Interocular space	2.36	1.39	0.97
Cephalic index	107	88	82
Scape index	73	119	144
Ocular index	74	75	78
Pronotum index	56	72	73

11. One female and three workers labelled "Type; São Paulo (João Lima), XII. 1920; *Camponotus abdominalis* v. *laevilatus* Sant." For measurements see Table 69.

TABLE 69

Measurements (mm) and indices of the type material of *C. mediopallidus* v. *laevilatus*

	Syntypes				
	Majors				Female
	1	2	3		
Head width	3.25	3.44	3.68	Head width	2.90
Head length	3.56	3.79	3.79	Head length	3.21
Scape length	2.67	2.60	2.71	Scape length	2.44
Pronotum width	1.89	2.01	2.20	Metatibial length	3.10
Metatibial length	3.40	3.40	3.49	Weber's length	5.26
Weber's length	4.14	4.14	4.64	Fore femur length	2.55
Maximum eye length	0.73	0.70	0.77	Fore femur width	0.77
Maximum eye width	0.58	0.54	0.58	Maximum eye length	0.81
Interocular space	2.05	2.44	2.28	Maximum eye width	0.62
Cephalic index	91	91	97	Interocular space	2.05
Scape index	82	75	74	Cephalic index	90
Ocular index	79	78	75	Scape index	84
Pronotum index	58	58	60	Ocular index	76
				Fore femur index	30

12. One worker labelled "Type; Brésil, Rio de Janeiro, P. Germain, 1883; *Camponotus abdominalis* Fab., A. Cabrera; *Camponotus* (*Myrmothrix*) *abdominalis* v. *luisae* Sants." Its measurements are: head width 3.21 mm, head length 3.25 mm, scape length 2.59 mm, pronotum width 1.86 mm, metatibial length 3.10 mm, Weber's length 3.68 mm, maximum eye length 0.70 mm, maximum eye width 0.58 mm, interocular space 2.01 mm, cephalic index 99, scape index 81, ocular index 83, and pronotum index 58.

13. Two workers labelled "Perou; *Camponotus abdominalis* v. *rabidus* Sants." For measurements see Table 70.

TABLE 70

Measurements (mm) and indices of the type material of *C. abdominalis rabidus*

	Syntype Major Workers	
	1	2
Head width	3.13	2.67
Head length	3.63	3.06
Scape length	2.27	2.63
Pronotum width	2.13	1.78
Metatibial length	Missing	3.06
Weber's length	4.26	3.64
Maximum eye length	0.66	0.66
Maximum eye width	0.50	0.46
Interocular space	2.09	1.70
Cephalic index	86	87
Scape index	72	98
Ocular index	76	70
Pronotum index	68	67

14. Four workers labelled "Type; Museum Paris, Guyane, Haut-Carsevenne, F. Geay 1898; *Camponotus abdominalis* st. *depressidens* Sant." For measurements see Table 71.

TABLE 71

Measurements (mm) and indices of the type material of *C. abdominalis* st. *depressidens*

	Syntype Major Workers			
	1	2	3	4
Head width	3.40	2.94	3.83	4.06
Head length	3.56	3.29	3.99	4.14
Scape length	2.44	2.52	2.55	2.63
Pronotum width	1.93	1.86	2.24	2.36
Metatibial length	3.09	2.90	3.33	3.44
Weber's length	3.71	3.68	4.26	4.41
Maximum eye length	0.62	0.66	0.74	0.77
Maximum eye width	0.54	0.50	0.58	0.58
Interocular space	2.01	1.74	2.36	2.48
Cephalic index	96	89	96	98
Scape index	71	85	67	65
Ocular index	87	76	79	75
Pronotum index	57	63	59	58

15. One syntype worker labelled "*romani;* Rio Japura; Amazone, (Roman); MCZ Cotype 21563". Its measurements are: head width 2.59 mm, head length 2.90 mm, scape length 2.36 mm, pronotum width 1.62 mm, metatibial length 2.98 mm; Weber's length 3.40 mm, maximum eye length 0.62 mm, maximum eye width 0.50 mm, interocular space 1.58 mm, cephalic index 89, scape index 91, ocular index 81, and pronotum index 63.

16. Two workers labelled "Type; Mexique (Hagmann); *C. abdominalis* v. *mediopallidus* F. Forma (Hagmann); *C. abdominalis floridanus defrictus* Sant." See Table 72 for measurements.

TABLE 72

Measurements (mm) and indices of type material of *C. abdominalis floridanus* v. *defrictus*

	Syntype Workers	
	Major	Minor
Head width	3.79	1.90
Head length	3.87	2.40
Scape length	2.94	2.77
Pronotum width	2.28	1.55
Metatibial length	3.68	2.90
Weber's length	4.52	2.94
Maximum eye length	0.81	0.66
Maximum eye width	0.62	0.50
Interocular space	2.36	1.16
Cephalic index	98	79
Scape index	77	104
Ocular index	76	76
Pronotum index	60	82

17. One female (gaster missing) and four workers labelled "Type; Minas Gerais, (E. Luja); *Camp. abdominalis mediopallidus* For. v. *flavobasalis* Sant." See Table 73 for measurements.

TABLE 73

Measurements (mm) and indices of type material of *C. mediopallidus flavobasalis*

	Syntype Workers Major 1	Major 2	Media 3	Media		Female
Head width	3.60	3.79	3.69	2.40	Head width	3.21
Head length	3.60	3.68	3.64	2.63	Head length	3.25
Scape length	2.59	2.63	2.61	2.59	Scape length	2.71
Pronotum width	2.17	2.24	2.20	1.70	Metatibial length	Hind legs missing
Metatibial length	3.13	3.21	3.17	2.98	Weber's length	5.49
Weber's length	4.26	4.18	4.22	3.49	Fore femur length	2.71
Maximum eye length	0.73	0.77	0.75	0.62	Fore femur width	0.77
Maximum eye width	0.58	0.58	0.58	0.50	Maximum eye length	0.85
Interocular space	2.24	2.20	2.22	1.47	Maximum eye length	0.85
Cephalic index	100	103	101	91	Interocular space	2.13
Scape index	72	72	72	108	Cephalic index	99
Ocular index	79	75	77	81	Scape index	84
Pronotum index	60	59	59	71	Ocular index	68
					Fore femur index	28

18. Three workers labelled "Typus; Panama City, Bella Vista, G.C. Wheeler; *C. abdominalis esuriens* Sm.; *C. abdominalis floridanus* v. *panamanus* Sant." For measurements see Table 74.

TABLE 74

Measurements (mm) and indices of the type material of *C. abdominalis floridanus panamanus*

	Syntype Major Workers 1	2	3
Head width	3.48	3.68	3.02
Head length	3.56	3.64	3.17
Scape length	2.71	2.82	2.59
Pronotum width	2.05	2.17	1.86
Metatibial length	3.13	3.25	3.02
Weber's length	3.87	3.98	3.56
Maximum eye length	0.74	0.74	0.62
Maximum eye width	0.54	0.54	0.50
Interocular space	2.17	2.24	1.82
Cephalic index	98	101	95
Scape index	78	77	86
Ocular index	74	74	81
Pronotum index	59	59	61

19. One syntype worker labelled "Type; Colombien Hyoz 26; *Camponotus abdominalis epistomatus* Sant." Its measurements are: head width 3.87 mm, head length 3.75 mm, scape length (antenna missing), pronotum width 2.48 mm, metatibial length 3.29 mm, Weber's length 4.45 mm, maximum eye length 0.73 mm, maximum eye width 0.54 mm, interocular space 2.40 mm, cephalic index 103, ocular index 74, and pronotum index 64.

20. Two syntype workers labelled "Type; Argentina Mis. Iguazu, (Dr. Goetsch); Dr. F. Santschi det. 1938 *Camp.* (*M.*) *abdominalis* st. *cupiens* For. v. *misionensis* Sant." It appears that the name *misionensis* has been added on the label which was originally of *cupiens*. See Table 75 for the measurements.

TABLE 75

Measurements (mm) and indices of the type material of *C. abdominalis* st. *cupiens* v. *misionensis*

	Syntype Workers Media	Minor
Head width	2.77	1.55
Head length	3.13	1.86
Scape length	2.36	1.90
Pronotum width	1.85	1.16
Metatibial length	2.67	2.40
Weber's length	3.87	2.86
Maximum eye length	0.62	0.50
Maximum eye width	0.50	0.39
Interocular space	1.90	1.01
Cephalic index	88	83
Scape index	86	122
Ocular index	81	77
Pronotum index	68	75

Localities from which the specimens have been examined. Under each country the first name is the name of the locality and in parenthesis the name of the collector followed by the location or source of material in capital letters. *Argentina:* Colin (J. Daguerre: USNM); Caroline, Misiones (N. Kusnezov: USNM, KEMPF); Chaco (H. L. Parker: USNM); Chaco de Santiago del Estero, Rio Salado (Wagner: PARIS); Delicia, Misiones (A. Kovacs: AMNH); Eldorado, Misiones (A. Kovacs: AMNH), (N. Kusnezov: KEMPF); Loreto, Misiones (N. Kusnezov: MIGUEL, KEMPF); Roque S. Peña, Chaco (N. Kusnezov: KEMPF); Iguazú, Misiones (Goetsch: SANT).

Bolivia: Ivon, Beni (W. M. Mann: USNM); Espia, Rio Beni Boliv. (W. M. Mann: USNM); Rurrenabaque, Beni (W. M. Mann: USNM); Yapacani, Santa Cruz (J. D. Candia: MCZ); Rio Grande a Santa Cruz (Lizer et Deltong: SANT). *Brazil:* Barbosa, S. P. (J. Diniz: KEMPF); Campos do Jordão, S. P. (Anonymous: KEMPF); Agudos (W. W. Kempf), (J. Johnscher: KEMPF); Ubatuba (P. C. Montouchet: KEMPF, GUIAM); Lapa, S. P. (A. Carvalho: KEMPF); Caraguatatuba, S. P. (J. Bastos: KEMPF), (Anonymous: KEMPF, GUIAM); Coleção Campos Seabra, Barueri, S. P. (K. Lenko: KEMPF); Guaratingueta, S. P. (Hug. Back: KEMPF); Venceslau Braz (Yamashita: KEMPF); São Paulo (J. Lima: SANT); Itanhaem, S. P. (Spitz: KEMPF); São Paulo (W. W. Kempf: KEMPF), (Ihering: FOREL); Rio Claro, S. P. (W. E. Kerr: KEMPF); Orlândia, S. P. (K. Lenko: KEMPF); Mun. de Iporanga, S. P. (Lenko and Reichart: KEMPF); Rio Grande, S. P. (Wacket: KEMPF), (H. V. Ihering: KEMPF); Pedreiras, S. P. (Schwebel: KEMPF); Ypiranga (Hahesdenwoods: SANT), (V. Ihering: FOREL); Campinas, Goyas (Schwarzmaier: KEMPF); São Patricio, Go. (H. Reichardt: KEMPF); Anápolis, Go. (W. W. Kempf: KEMPF); Trindade, Go. (Schwarzmaier: KEMPF), (Forel: FOREL); Catalão, Go. (W. W. Kempf: KEMPF); Faz. Cachoeirinha Jatai, Go. (Anonymous: KEMPF); Brasilia D. F. (H. S. Lopes: KEMPF); Rio de Janeiro (H. S. Lopes: KEMPF), (A. Goeldi: FOREL), (P. Germain: SANT); Bahia (Anonymous: FOREL), (Felder: MAYR); Utiariti, Rio Papagaio, MT. (Lenko and Pereira: KEMPF); Chapada, MT. (Frei Canuto: KEMPF); Mendes, Tres Lagoas, MT. (Jose: KEMPF); Amazonas (A. Goeldi: FOREL); Benjamin Constant, Amazonas (K. Lenko: KEMPF); Manaus, Amazonas (K. Lenko: GUIAM, KEMPF); Manaus (H. A. Beatty: USNM); Manaus to Itacoatiara, Amazonas (W. L. Brown: MCZ); Ponta Negra N. of Manaus, Amazonas (W. L. Brown: MCZ); Marianil, Rio Branco Rd., Manaus M (W. L. Brown: MCZ); Manaus (Mann and Baker: MCZ); Pará (W. L. Brown: MCZ), (W. M. Mann: USNM, MCZ), (A. Goldi: FOREL); Independência, Parahyba (Mann and Heath:USNM); Monte Alegre, Pará (Reichensperger: IAZRW); Benevides, Pará (Gounelle: PARIS); Marco da Légua, Pará (Gounelle: PARIS); Utinga, Belém, Pará (Oliveira and Wygodzinsky: MCZ); Pirelli Plantation, Pará (Anonymous: MCZ); Utinga, Belém, Pará (P. F. Darlington: MCZ); Belém, Pará, Reserva Guamá (K. Lenko: KEMPF); Santarém (Anonymous: BM); Rio Madeira (Mann and Baker: MCZ, USNM); Porto Velho, Rio Madeira (Mann and Baker: USNM); União Rio Madeira (W. M. Mann: USNM); Rio Grande do Norte (Fletcher: MCZ); Ceará-Mirim, Rio Grande do Norte (W. M. Mann: USNM, MCZ); Baixa Verde, Rio Grande do Norte (Mann, J. Mitchel); Ceará (Roche: FOREL); Baturité, Ceará (Anonymous: AMNH); Paraná, Rio Negro (Reichensperger: SANT); Serra do Navio, Terr. Amapá (K. Lenko: KEMPF, GUIAM); Salvador, BA., (W. W. Kempf. Becker: KEMPF); Salvador (N. L. H. Krauss: USNM); Corupá, St. Cath. (A. Maller: AMNH); St. Cath. (Anonymous: MAYR, FOREL); Barro Alto, Est. Minas (José Blaser: MCZ); Monte Alegre (Reichensperger: SANT); Bagola (Leidig: MAYR); Minas Gerais (E. Luja: SANT); Brasilien (E. Andre: PARIS); Natal (W. M. Mann: MCZ); Xingu, Matto Grosso (Alvarenga and Werner: KEMPF); Recife, Pa. (Borgmeier: KEMPF); Quissamã (Bolameiol: SANT); Unknown (Anonymous: MAYR); Unknown (E. Andre: PARIS). *British Honduras:* Belize (N. L. H. Krauss:USNM); Manatee (J. D. Jonson: AMNH); Tegucigalpa (F. J. Dyer: AMNH, USNM); La Ceiba (F. J. Dyer: AMNH); Stann Greek Rd. (Robin Andrews: MCZ); Progreso (D. Bates: MCZ); Beque Viejo (Stanton: MCZ); Unknown (Stadelmann Sulirana: MCZ). *Colombia:* Magdalena (H. Y. Gouldman: USNM), (Gallegon: USNM); Don Diego (Forel: OXFORD); St. Antonio (Forel: OXFORD, FOREL); Rio Porce (N. A. Weber: WEBER); Nolken (Anonymous: MAYR); Rio Frio (Geo. Salt: MCZ), (Darlington: MCZ); Dibulla (Lallemand: FOREL); St. Cruz, St. Marta (Anonymous: FOREL); St. Antonio, Nevada (Forel: FOREL); Sierra Nevada, Santa Marta (Anonymous: SANT); Hayoz 26 (Reichensperger: SANT). *Costa Rica:* Crosi, altitude M 1200 ft (A. Alfro: USNM); Tilara (A. Alfro: USNM); Santa Clara (A. Alfro: WEBER), (G. C. Wheeler: SANT); Matina (A. Alfaro: WEBER); Perganda (Anonymous: MCZ); Halleivla (Anonymous: MCZ); Navarro Faro (W. M. Mann: USNM); San José (F. Nevermann: USNM); La Fuente (A. Alfaro: MCZ), (Anonymous: WEBER); Hamburg Farm (C. P. Dodge: MCZ); Turrialba (R. Andrews: MCZ); Port Limon (W. M. Wheeler: MCZ); Tres Rios (Anonymous: USNM), (F. Nevermann: USNM); San Jose (Dr. Nauck: IAZRE), (W. M. Wheeler, A. Alfaro and L. Hare: MCZ); Guapiles (F. Nevermann: USNM); Great Island (H. Nepperschmidt: FOREL); St. Jose (Biolley: FOREL); Golfo Dulce, Pittier: FOREL); Unknown (Hoboken: USNM); Unknown

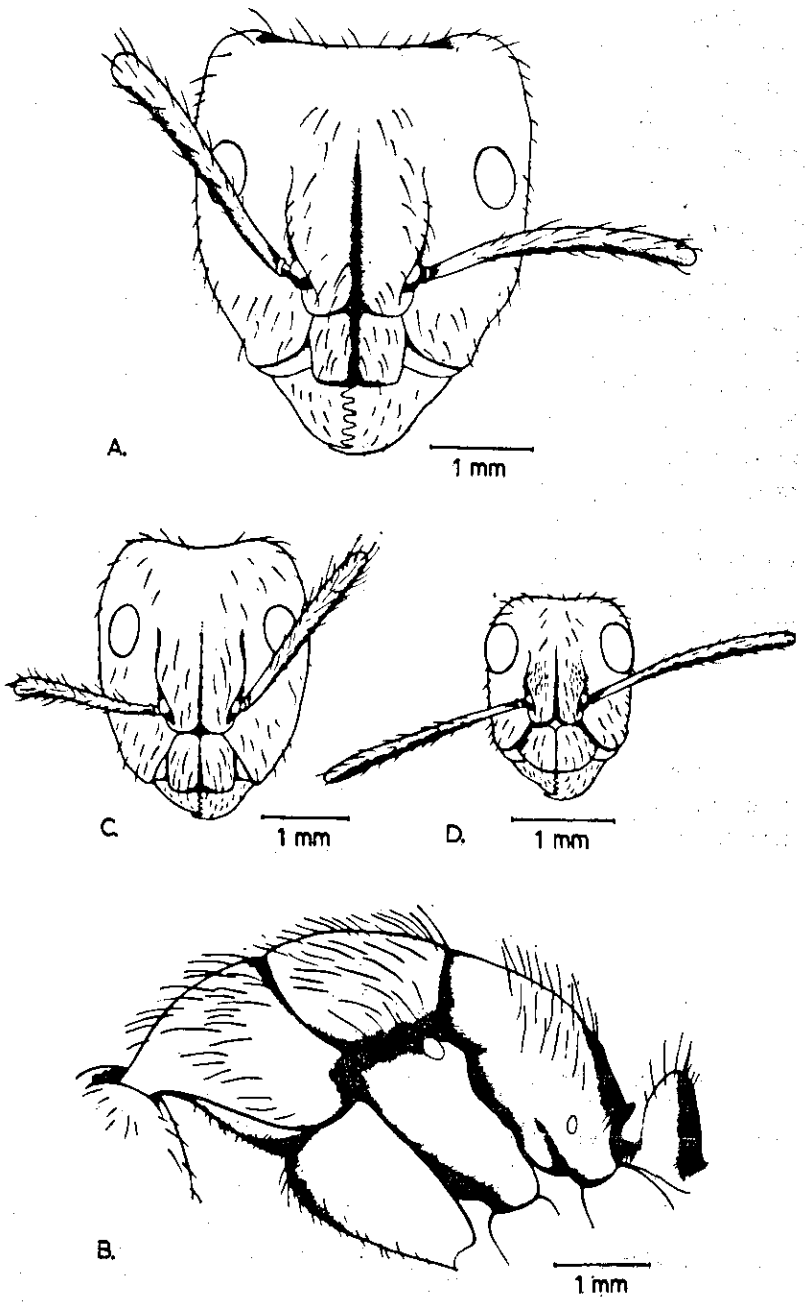
(Anonymous: MAYR); Unknown (Tonduz: FOREL). *Cuba:* Cayama (E. A. Schwarz: USNM); Unknown M. K. Kistiub: USNM). *Ecuador:* Gualaquiza (W. Von. Nageu: MCZ); Macora (T. Townsend: MCZ). *French Guiana:* Env. de St. Georges Oyapock (F. Geay: PARIS); Guanaby (F. Geay: PARIS); Riviere Lunier (F. Geay: PARIS); St. Jean du Maroni (R. Benoits: PARIS); Haut. Casevene (F. Geay: PARIS); Unknown (R. Benoist: PARIS). *Guatemala:* Guatemala City (Wheeler: AMNH), (Stoll: FOREL); Escuintla (Wheeler: AMNH); Dept. Solola, Pacific slope 3000' (Anonymous: AMNH); Retaluleu (Stoll: MAYR, FOREL); Antigua (Stoll: FOREL); Capetillo bei Ratiqua (Stoll: FOREL). *Guyana:* Kurupung (H. O. Lang: MCZ); Matapa Falls (S. C. Crawford: MCZ); Cuyuni, R. (W. J. Laudrre: MCZ); Mazaruni R. (R. E. W: MCZ); Forest Stlmt. R. Mazaruni 284 (N. A. Weber: WEBER); Jaov, Island (W. M. Wheeler: MCZ); Essequibo River, Near Akarnukrz Rapids (W. G. Hussler: AMNH); Courantyne, R. (N. A. Weber: WEBER); Georgetown (N. A. Weber: WEBER), (Anonymous: FOREL); New River (J. Myer: WEBER); Tukeit (Anonymous: AMNH); Kartabo (W. M. Wheeler: AMNH, MCZ), (S. C. Crawford:MCZ); Haut Carsevenne (F. Geay: PARIS); Wenatnul (W. J. Laudrre: MCZ); Hills Estate (S. C. Crawford: MCZ); Paxerampa Mt. (M. J. Laudrre: MCZ); Bartica Dist. (E. Emerson: MCZ); Fort Marie Curaçao (Vermount: MCZ). *Honduras (Spanish):* Copau, (P. Richand: AMNH). *Mexico:* Escuinapa, Sinaloa (J. H. Batty: AMNH, FOREL); San Luis Potosi (W. S. Creighton: CRTN); Tusapan (G. C. W. Clenolon: AMNH); Manzanillo, Colima (Townsend: AMNH); Chamela, Bay (Anonymous: AMNH); Acapulco Anonymous: AMNH); Itzimna, Yucatan (J. C. and D. Pallister: AMNH); Tehuantepec, Oaxaca (T. MacDougal: AMNH); Finca el Mirador, Huatusco, V. C. (Wegner: AMNH); Jesus Carranza V. C. (M. Guerra: AMNH); Palomanes, Oaxaca, Mex (Petrunkevitch: AMNH); Pergande, Tepic (Anonymous: CAS); Mazatlan (G. R. Wilson: CAS); Magdalena I, Tres Marias (Keifer: CAS); Vera Cruz (J. Camelog: USNM), (G. N. Ross: MCZ); Cuevas Vaca (W. M. Wheeler, Hagmann: SANT); Motzorongo, V. C. (H. Osborn: USNM); Chilpancingo (Anonymous: AMNH); Huascatojal (W. M. Mann: USNM); Mor Acatilapa (Flint Andortiz: USNM); Cordoba (Sichel: MAYR), (E. Andre: PARIS), (Anonymous: FOREL); Bilimek (Anonymous: MAYR); Mexico (Wheeler: MAYR); Perganda (E. Andre: PARIS); Cuernavaca (W. M. Mann, N.

Krauss, E. G. Smyth: USNM), (Wheeler: FOREL); Orizaba (Anonymous: FOREL); Muadoo (Ross: FOREL); Unknown (Petrunkevitch: AMNH), (Ross: FOREL). *Nicaragua:* Chontal (Janson: USNM); Managua (Rene: USNM); Unknown (W. Fluck: AMNH). *Panama:* Panama (J. Beaumont: MCZ); Barro Colo. Is. C. Z. (G. C. Wheeler, W. C. Allee: MCZ); (Zetek: USNM), (G. C. Wheeler: SANT); Bella Vista (G. C. Wheeler: SANT); Mt. Hope Nr. Colon, C. Z. (Wheeler: MCZ); Taboqilla, I. Panama (W. M. Wheeler: AMNH); Otoque, I., Panama (W. M. Wheeler: AMNH); Ancon, C. Z. (I. Melino: USNM); Pedro Miguel, C. Z. (C. H. Ballow: USNM); Rocknella (R. C. Shannon: USNM); Gamboa, C. Z. (E. J. Hambleton: USNM); Aqua Clara Res. Fort Davis, C. Z. (G. C. Wheeler: SANT); Changuinola Is. (G. C. Wheeler: SANT); Unknown (C. F. Davis: AMNH). *Paraguay:* San Bernardino (K. Fiebrig: IAZRAW). *Peru:* Avispas, Madre de Dios (Pena: MCZ); Middle Rio Ucayali (H. Bassler: AMNH); Lower Rio Huallaga (Anonymous: AMNH); Perou (Andre: FOREL), (J. de Gaule: SANT); Chiclayo (Anonymous: FOREL); chanchamayo, Anashirone R. (C. A. Portocarrero: KEMPF). *Surinam (= Dutch Guiana):* King Fred Falls, Courentye, R. Surinam (N. A. Weber); Izmal Yucatan (G. F. Gaumer: USNM); Unknown (A. Revne: USNM); Unknown (Anonymous: USNM); Unknown (E. Andre: PARIS); Unknown (W. M. Wheeler: MCZ). *Trinidad:* Trinidad (Wheeler, Thaxter and N. Weber: MCZ); Port of Spain (R. Thaxter: MCZ); (H. Busck: USNM); Great Falls (R. Finzi: MCZ); St. Augustine (Darlington: MCZ), (N. A. Weber: WEBER); Mayaro Bay (N. A. Weber: WEBER); Arina-Blanchissguse, B. D. (N. A. Weber: WEBER): Salybia Bay, East Coast (N. A. Weber: MCZ); Mt. St. Benedict (N. A. Weber: WEBER); Arrua Forest, Reserve S. of Flacina (N. A. Weber: WEBER); V. Fitzgerald (N. A. Weber: WEBER); Maracas Valley (Fitzgerald D. J.: WEBER); Nariva Swamp (N. A. Weber: WEBER); Gasparee Is. Pt. Baleine (N. A. Weber: WEBER); Gulf of Paria (N. A. Weber: WEBER); Annandale Estate, Curanana Bay (N. A. Weber: WEBER); Toco (H. M. Rahwer: USNM). *United States:* Paraside, Key (W. M. Wheeler: MCZ); St. Mary's Georgia (Bangs: MCZ); Lakeland, Ga. (A. H. Beyer: MCZ); Henderson R. Marco Collin Co (G. Fairchild: MCZ); Brunswick (Anonymous: MCZ); Albany, Ga. (S. O. Hill: MCZ); Florida (M. Tread: FOREL); Florida (Pengande: FOREL), (P. B. Kannowski: PBK); Gainsville, Fla. H. L. Krauss: USNM); Miami, Fla. (W. H. Sligh: USNM);

Lagona Madre 25 mi S. E. of Harlington, Texas (Dettar: USNM); Brownsville, Texas (F. C. Bishop: USNM), (J. D. Mitchel: USNM); Hamlin Grera, Texas (Anonymous: USNM); La Feria, Texas (W. S. Creighton: CRTN). *Venezuela:* Yaracuy Riv. E. S. Felipe (F. A. Mcciure: USNM); Caracas (C. N. Ballon: USNM); Cuautla (E. G. Smyth: USNM); Maracaibo (E. Poirier: PARIS); Orinoco Delta (N. A. Weber: WEBER); Caicara Riv. Orinoco (G. K. Oherie: AMNH); Sarare (F. Geay: PARIS, SANT); Unknown (H. Pittier: USNM); Unknown (Anonymous: USNM).

Major worker. General body color extremely variable; in type specimen head and alitrunk deep brownish black; mandibles deep brown; scape black; coxae, trochanters, basal part of femora and gaster yellowish, making contrast with head and alitrunk; tibiae and tarsi reddish. Mandibles with six teeth, apical tooth longest; scape punctate, basal 1/3 narrow; frontal margin of clypeus, lower genae and mandibles shiny; clypeus notched in middle. Frontal carinae elevated, frons with 64 + hairs; scape with suberect hairs all over, front side with 24 + hairs; pilosity though prominent on frons, denser on occipital angles; clypeus with 14+ hairs, lower genae with 5-6 short, suberect bristle-like hairs measuring about 1/4 length of hairs on frons; area immediately surrounding compound eyes devoid of hairs; thickest pilosity on pronotum; tibiae and tarsi bearing long hairs all over. Propodeum indistinctly demarcated into subequal base and declivity; scale convex in front, concave behind, narrow at base, expanded above with rounded margins, margins entire not cut dorsally. Gaster ovate, shiny, very finely punctate, smooth in appearance, each segment bordered with golden yellow band; pilosity moderate, number of hairs 27+ on second gastric segment; pubescence whitish, beneath pilosity, suberect and rather curved in middle.

Media worker. General body color varying from pale yellow to completely black; head and gaster sometimes deep blackish brown, scale and alitrunk light brown; coxae and trochanters pale yellow; femora, tibiae and tarsi brownish. Head longer than broad with parallel to slightly convex sides; mandibles six-toothed, glossy, smooth, often with scattered punctures; scape slender, usually of uniform thickness, sometimes slightly thickened towards apical end. Pilosity moderately thick, erect and yellowish. Gastric segments bordered with blackish or yellow or both blackish and yellowish bands.



Camponotus (Myrmothrix) abdominalis.
Fig. 10. A. front view of head of major worker. B. lateral view of alitrunk of major worker. C. front view of head of media worker. D. front view of head of minor worker.

Minor worker. In specimens resembling the type: head deep dark brown; frons, vertex and area immediately inside compound eyes deep blackish brown; scape deep brown; coxae, trochanters and femora yellowish, tibiae and tarsi brownish; gaster yellowish. Head narrow posteriorly, lateral margins appearing parallel in front view, occipital margin shallowly and triangularly emarginated, occipital angles broadly rounded, not pronounced. Scape cylindrical, of uniform thickness, except slightly thickened towards apex, maximum thickness of about 0.15 mm, length 1.8 times the length of head from antennal fossa to occipital margin. Compound eyes oval, slightly wider posteriorly, narrowed anteriorly. Lateral margins of head with 12-15 prominently visible hairs, gular area with only a few hairs; pronotum with long pilosity and scattered pubescence; coxae, trochanters, tibiae and tarsi with long yellowish hairs all over; yellow or blackish band on each gastric segment preceded by a row of yellow hairs; pubescence on gaster yellow, not appressed, rather slightly raised. Mesonotum and metanotum compressed behind; scale thick with margins entire; gaster ovate.

Statistical Analyses

Since this species is very widely distributed and shows a tremendous amount of variation, a random sample of workers has been used for the analyses (Tables 76 through 83).

Results of MSDCC.

TABLE 76

Range, mean, standard deviation and variance of various body measurements (mm) and indices in *C. abdominalis*

Variable	Statistic	Minors n = 103	Medias n = 30	Majors n = 101
1. Head width	Range	1.08-1.85	1.66-2.51	2.44-4.33
	Mean	1.45	2.04	3.19
	S.D.	0.16	0.22	0.46
	Variance	0.02	0.05	0.21
2. Head length	Range	1.51-2.32	2.01-2.82	2.71-4.45
	Mean	1.86	2.36	3.37
	S.D.	0.16	0.22	0.41
	Variance	0.02	0.05	0.17

TABLE 76 — Continued

Variable	Statistic	Minors n = 103	Medias n = 30	Majors n = 101
3. Scape length	Range	1.93-2.90	2.09-2.86	2.13-3.02
	Mean	2.28	2.48	2.63
	S.D.	0.17	0.15	0.17
	Variance	0.03	0.02	0.03
4. Pronotum width	Range	0.93-1.55	1.20-1.74	1.59-2.44
	Mean	1.18	1.49	1.96
	S.D.	0.11	0.14	0.22
	Variance	0.01	0.02	0.05
5. Metatibial length	Range	1.82-3.06	2.27-3.17	2.27-3.83
	Mean	2.46	2.76	3.13
	S.D.	0.21	0.20	0.29
	Variance	0.04	0.04	0.08
6. Weber's length	Range	2.27-3.37	2.94-3.75	3.17-4.76
	Mean	2.77	3.23	3.88
	S.D.	0.22	0.21	0.37
	Variance	0.05	0.04	0.13
7. Maximum eye length	Range	0.43-0.58	0.50-0.70	0.54-0.85
	Mean	0.51	0.59	0.68
	S.D.	0.03	0.04	0.06
	Variance	0.00	0.00	0.00
8. Maximum eye width	Range	0.35-0.66	0.39-0.50	0.42-0.73
	Mean	0.42	0.46	0.53
	S.D.	0.04	0.03	0.05
	Variance	0.00	0.00	0.00
9. Interocular space	Range	0.77-1.24	1.04-1.55	1.47-2.51
	Mean	0.94	1.26	1.96
	S.D.	0.09	0.14	0.29
	Variance	0.01	0.02	0.08
10. Cephalic index	Range	54-93	80-94	85-107
	Mean	78	86	94
	S.D.	4.30	3.44	3.87
	Variance	18.48	11.86	14.97
11. Scape index	Range	129-183	94-143	65-108
	Mean	158	122	83
	S.D.	14.76	13.44	9.00
	Variance	217.79	180.80	81.08
12. Ocular index	Range	71-113	72-87	59-136
	Mean	82	78	78
	S.D.	5.84	3.84	8.18
	Variance	34.12	14.72	66.90
13. Pronotum index	Range	66-114	61-85	54-70
	Mean	82	73	62
	S.D.	5.81	4.55	3.28
	Variance	33.75	20.77	10.74

Results of DISCAN.

TABLE 77

Correlation matrix of nine variables (see table 83) for total sample — minors, medias and majors of *C. abdominalis* *

Variables	1	2	3	4	5	6	7	8	9
1	1.00								
2	0.99	1.00							
3	0.91	0.90	1.00						
4	0.97	0.96	0.90	1.00					
5	0.92	0.91	0.86	0.89	1.00				
6	0.96	0.97	0.89	0.94	0.90	1.00			
7	0.90	0.91	0.82	0.89	0.85	0.92	1.00		
8	0.89	0.89	0.84	0.89	0.82	0.88	0.85	1.00	
9	0.99	0.91	0.91	0.96	0.91	0.96	0.89	0.88	1.00

* (n = 234).

TABLE 78

Discriminant analysis of minors, medias and majors of *C. abdominalis*

Actual Groups	Classifications using the Predictor Variables		
	Minors	Medias	Majors
Minors	94	9	0
Medias	3	27	0
Majors	0	2	99

The above table shows that there is misclassification in all the three cases. This can be attributed mainly to two things. The first is that the workers used in this analysis come from localities which are far apart, as a result the workers are likely to show some variation in their size. For example, in some localities the measurements of majors are close to those of medias. Such specimens when analysed are likely to be shown to be medias in discriminant analysis. The same thing applies to the other workers.

Generalized Mahalanobis D-square = 1598.74.

TABLE 79

The discriminant functions with their constants and the respective coefficients for nine variables in *C. abdominalis*

	Discriminant Functions		
	Minors	Medias	Majors
Constants	–40.07	–45.89	–57.63
Coefficients:			
Head width	–21.64	–11.57	– 4.70
Head length	6.52	4.17	17.00
Scape length	18.13	18.14	14.16
Pronotum width	2.15	9.29	1.54
Metatibial length	– 1.64	3.21	–10.78
Weber's length	4.06	4.96	1.22
Maximum eye length	62.02	64.54	73.23
Maximum eye width	35.55	25.61	30.99
Interocular space	3.33	– 7.35	– 2.16

Results of MANOVA.

TABLE 80

Multivariate analysis of variance for minors and medias of *C. abdominalis*

Test Performed	Results
H_1	Homogeneity of variance-covariance matrix
F_1	45 (df, numerator)
F_2	9781 (df, denominator)
F	1.89 (Table value 1.35)
H_2	Generalized analysis of variance
F_1	9 (df, numerator)
F_2	123 (df, denominator)
Lambda (λ)	0.33
F	27.57 Table value 2.41)

TABLE 81

Multivariate analysis of variance for medias and majors of *C. abdominalis*

Test Performed	Results
H_1	Homogeneity of variance-covariance matrix
F_1	45 (df, numerator)
F_2	9834 (df, denominator)
F	2.27 (Table value 1.35)
H_2	Generalized analysis of variance
F_1	9 (df, numerator)
F_2	121 (df, denominator)
Lambda (λ)	0.37
F	22.99 (Table value 2.41)

Results of STWMULT.

TABLE 82

Stepwise discrimination between the minors and medias of *C. abdominalis*

Step	Variable Eliminated	R	R^2
1	None (Full model)	0.81	0.66
2	Metatibial length	0.81	0.66
3	Head length	0.81	0.66
4	Pronotum width	0.81	0.66
5	Weber's length	0.81	0.66
6	Maximum eye width	0.81	0.66
7	Interocular space	0.81	0.66
8	Maximum eye length	0.81	0.66
9	Scape length	0.81	0.66
10	Head width		

The above table shows that head width is the most important variable for the separation of minor and media workers in *abdominalis*. The remaining eight variables are individually as effective as they are as group for the prediction of group membership of minors and medias.

TABLE 83

Stepwise discrimination between the medias and majors of *C. abdominalis*

Step	Variable Eliminated	R	R^2
1	None (Full model)	0.79	0.63
2	Maximum eye length	0.79	0.63
3	Maximum eye width	0.79	0.63
4	Interocular space	0.79	0.63
5	Weber's length	0.79	0.63
6	Scape length	0.78	0.62
7	Pronotum width	0.78	0.61
8	Head width	0.77	0.60
9	Metatibial length	0.75	0.56
10	Head length		

The above table shows that head length and metatibial length are the most important variables for the discrimination of medias and majors of *abdominalis*. The remaining variables have almost identical R^2 value, which means that they are equally effective for the discrimination of the two kinds of workers. In other words the group of predictors is not more effective than the individual predictor.

Female. Head, alitrunk and gaster deep blackish brown; head more blackish on frons, vertex and in area immediately surrounding compound eyes; scape blackish; mandibles orangish at base; trochanters and basal 2/3 of femora yellowish; distal 1/3 of femora, tibiae and tarsi brownish; coxae, trochanters and femora contrasting with body color. Head with a transverse depression immediately below compound eyes; very thinly punctate. Mandibles with six teeth and punctate; clypeus emarginated anteriorly, carinated and with a slight notch on posterior margin. Propodeum divided into base and declivity, declivity two times the base in length; scale rounded with margins entire. Gaster ovate. Frons with long yellow hairs; hairs on occipital border shorter; area immediately surrounding compound eyes lackind pilosity and pubescence; mandibles with long hairs; genae with very few short hairs, and short, whitish pubescence; clypeus with 22+ hairs; tibiae with moderately long, suberect, widely dispersed hairs; each gastric segment with a golden yellow band preceded by a row of long, yellow hairs. Pubescence on dorsum of gaster thin, short, whitish and appressed, denser towards lateral margins. Wings hyaline, veins yellow. For measurements see Tables 61, 64, 65, 66, 69 and 73.

Male. Head blackish; clypeus and mandibles light yellowish brown; scape, alitrunk and gaster brownish. Hairs scattered over head, about 16 on frons; scutum and gaster with abundant, long, erect, yellowish hairs; legs with short, bristle-like hairs. Clypeus broad in front, narrowed behind; mandibles indistinctly toothed. Scutum with a deep depression in center, lateral sutures or furrows extending about half its length; propodeum indistinctly marked into base and declivity, declivity a little longer than base; scale thick with sides broadly rounded and deeply cut in center. Gaster ovate, slightly elongate in shape; each gastric segment bordered with a yellow band. Wings hyaline, veins yellow. The measurements of two male specimens are the following: Head width 0.89 (0.96), head length 1.35 (1.39), scape length 1.70 (1.82), Weber's length 2.98 (3.40), maximum eye length 0.54 (0.62), maximum eye width 0.42 (0.46), interocular space 0.77 (0.85).

Biology. Forel (1900) observed this species living in the hollow or rotten trees in Colombia. Forel (1902) reported that he had observed this species living in rotten trunks in Trinidad and that it was quite aggressive in behavior. Wheeler (1916) observed some workers of *abdominalis* attacked by a fungus, *Cordyceps unilateralis* Tuel, in British Guiana (= Guyana). Santschi (1922) recorded the workers of this species occurring in the nests of *Polybia pugmaea* F. in French Guiana. Some specimens in the Museum National d'Histoire Naturelle Paris have a label "Fourmis cracra ou couae invades the nests of wasps. Nocturnal (F. Geay, 1900)". Luederwaldt (1926) reported this species from São Paulo, Brazil, as being very aggressive. Schneirla (1944, page 3) from his studies in southcentral Florida reported: "This ant is one of the most successfully and widely adapted of all in the region, with very numerous nests in a variety of situations ranging from pine stands at the sand hills to low open areas near bogs and ponds". William Creighton (personal communication, 1972) has informed me that in Texas this species nests in trees or stumps where there is rotten wood close to the surface of the soil. The species of trees involved seem to make little difference.

Synonymy. A thorough survey of the literature has revealed that some 23 infraspecific names have been attached to this species since 1804. Occasionally, some of these names have been raised even to the species level. Based upon an examination of the type material of these taxa and thousands of other specimens from a wide geographical range, I conclude that all such names were based on various aspects of the total variation of the species. Because of its wide distribution *abdominalis* displays great variation in size and color of its workers in different parts of its geographical distribution. This phenomenon has caused myrmecologists in the past to use different names to represent different patterns of variation. As a matter of fact, *abdominalis* is one of those cases where Ludwig's Theorem (1950) can be most defittingly applied to explain the species variation. A detailed account of the application of this theorem in *abdominalis* has been included in the section on Discussion.

In the following pages a characterization has been given for all taxa which have been synonymized. After the description the bases for synonymizing the name have been added. This approach has been used exclusively for this species for the following two reasons:

1. Most of the descriptions are of the infraspecific level and have appeared in languages other than English. An English translation will make the comparison of these descriptions easier. A critical comparison will demonstrate how previous taxonomists used the same characters with some distortion or modification or else how they have utilized even an insignificant variation in the color of this species to raise a new taxon.

2. These descriptions, when reviewed together, serve as a good example of how previous authors have restricted the use of one segment of the total variation in comparing with another segment with a complete disregard of the total species variation.

Camponotus atriceps. This was characterized as ochraceous, with head black; in some examples head and alitrunk more or less fusco-ferruginous; head very large, much wider than alitrunk and deeply emarginated behind; clypeus with a central longitudinal carina, anterior margin broadly and deeply notched; mandibles armed with five blunt teeth; flagellum ferrugineous; alitrunk rounded in front, compressed and much narrowed behind; gaster ovate, narrower than head; scale ovate, rounded and somewhat narrowed above; insect sprinkled thinly with long erect ferrugineous hairs. A comparison of the type material of *atriceps* and *abdominalis* revealed that both are similar in every respect except that in *atriceps* the head is blackish while in the *abdominalis* both head an alitrunk are blackish. The above description, therefore, is not more than a part of *abdominalis*. For measurements refer to type material examined.

Camponotus esuriens. This was characterized as head, alitrunk, legs and scale ferrugineous; gaster nigro-fuscous; head very large, much wider than thorax, deeply excavated behind, clypeus with a central longitudinal carina, a shollow notch at anterior border; mandibles darker than head, scape blackish, flagellum red; alitrunk paler than head, narrowed behind; apex of propodeum oblique; tibiae and tarsi slightly fuscous; gaster thinly sprinkled with long, erect, ferruginous hairs; scale compressed, narrow, its margin entire. I have examined the holotype worker and its measurements are recorded under type material examined. This specimen is yellowish except for the gaster which is blackish. The antennae are missing and the vertex of the head is slightly rusty colored. The description given above represents the general characteristics of *abdominalis*. The specimen evidently shares several features in color with *floridanus*. Mayr (1863) stated that the head of the workers in *esuriens* is punctate. Although I did not see any punctures in the holotype, this character and the above description of the holotype bring this taxon very close to *floridanus*. Santschi (1936) stated that *esuriens* differs from *abdominalis* by having the escape more compressed and blackish like the gaster, which groups it with *ustulatus* and *stercorarius*. Actually in *abdominalis* the color of the scape varies with the color of the specimen and also with the subcaste to which the specimen belong. Therefore, Santschi's assertion is not valid as a diagnostic feature. Further, the thickness or thinness of the scape also depends on the size of the worker in any subcaste. Santschi (*loc cit*), however, did indicate that the sides of the head are pilous which probably is one of the less varying characters in *abdominalis*.

Camponotus floridanus. This was characterized as gaster black, the rest yellowish-red; head subcordate, rounded above, occiput emarginate, with posterior angles rounded; two short channels a little diverging extend back from clypeus to vertex; antennae inserted a little in front of vertex; long, filiform and little enlarged towards apical joint; eyes of medium size, circular, placed on top near sides and little back of middle, prominent; mandibles reddish-brown, curved inwards and toothed, apical tooth long, acute; under surface of head (= gular region) sinuate; prothorax narrower than head, rounded above, in front and at sides, widest near front; mesothorax compressed, narrowed backwards, not depressed; metathorax narrowed behind and descends gradually to pedicle; scale large, vertical and wedgeshaped; gaster broad, ovate, subacute, margins of segments slightly hyaline; legs long, slender; thorax throughout rather thickly sprinkled with long gray hairs. Wheeler (1910) has given a well documented description of this taxon which can be called a typical description of a specimen unknown to science. However, it should be pointed out that neither the above description nor that of Wheeler (*loc cit*) have much diagnostic value. Both of them dwelled upon the variation of color pattern in the specimens which they designated *floridanus*. I have come across specimens from Panama which resemble in color and also in various other features the *floridanus* specimens. These specimens are typical of the grading series common in *abdominalis*. The most important consideration which could be used as justification for the designation of *floridanus* is the geographical isolation of these specimens from the rest of continuum of the *abdominalis*. However, the resemblance of *floridanus* specimens with those of Panama indicates that originally the species was established in Florida by being imported either from Panama or some other area in South or Central America. Even Wheeler (*loc. cit*) in his description mentions one colony in the New York Botanical Garden, evidence suggesting that this species is capable of becoming established in a new area. One character which Wheeler has pointed out is the lack of hairs on the cheeks, but Santschi (1936) stated that he had observed two hairs on the cheeks of *yankee* Forel, which is a synonym of *floridanus*. I have observed several specimens from Florida and am convinced that sometimes hairs are thinly scattered and other times thickly scattered on the cheeks. The remaining description of the head being punctate and other information about the color variation is mostly superfluous and does not refer to any fixed character. The two descriptions mainly refer to the general morphology of a portion of the total species population without providing any differential diagnosis from *abdominalis*. However, some characters such as scape flattened at base but not dilated, enlarged towards tip, not exceeding posterior margin of head; clppeus carinated; alitrunk unevenly arched, base and with yellowish bands give strong support for its being *abdominalis*. The female does not differ from that of *abdominalis*. About the male Wheeler (1910) has stated "the male, which I have not seen is described by Mayr as indistinguishable from that of typical *abdominalis* of Brazil and it is probably very much like the male of subspecies *transvectus*".

Camponotus abdominalis race *esuriens* var. *fulvaceus*. This was characterized as color ochre-yellow, scape black; flagellum, mandibles, band on segments of gaster, tibiae and tarsi piceous; clypeus carinate; head quadrate, slightly excavated behind; alitrunk compressed behind; declivity not abrupt; scale rounded, modest, body covered with long scattered pale hairs. This description is not of much value for separation from *abdominalis*. It is almost the same as that of *esuriens* or that of *defrictus*. The figure of a worker given by Norton (1868a) does not

actually represent the major worker as Norton has indicated. It rather appears to be that of a minor worker, in which the scape exceeds in length the occipital margin of the head, and the pilosity is not very thick on the body. The description is, however, that of a major worker.

Camponotus atriceps var. *atricipito-esuriens*. This taxon has not been characterized but rather described as a transitional form. It was based on specimens from Cordova and Orizaba, Mexico. I have examined some specimens from these localities in the Forel Collection which show a slight difference from typical *abdominalis* in the color of the head and alitrunk. Such differences are apt to occur if the specimens are from another locality. Since Forel did not designate any type, the validity of this taxon is doubtful. I have examined several specimens from Mexico in which color is graded from one series to the other. It seems, therefore, that this name was given to one of the variants of the population of *abdominalis*.

Camponotus atriceps r. *stercorarius*. This was characterized as entirely brown black; alitrunk lighter, flagellum and legs light brown. The author also stated that Stoll found this variety as well as varieties passing to *esuriens* frequently in the vicinity of Guatemala and Antigua, Guatemala. Apparently it indicates that even in the type locality of this taxon there were various gradations in specimens either resembling *esuriens* of other names attached to *esuriens*. *Besides the type material*, I have examined specimens from several other localities, for example, from Argentina, Brazil, Costa Rica, Guatemala and also from Mexico. The most important thing which I noticed is that such color variants occur as a regular part of the populations in most localities where *abdominalis* has been recorded. For measurements see Table 61 and 62.

Camponotus atriceps r. *ustulatus*. This was characterized as pale reddish yellow; flagellum and posterior border of gastric segments more dark; vertex of head, scape, tarsi, tibiae and extremities of femora brownish smoky; among minor workers hinder part of head brownish; mandibles dull; densely and finely punctate in major workers, more feebly so in minors. In addition, Forel (1884) stated that it resembles *atriceps* in shape, pilosity and sculpture. I have examined the type material and their measurements are listed in Table 63. The specimens represent one phase of color variation in *abdominalis*.

Camponotus abdominalis var. *mediopallidus*. This variety was originally separated from *abdominalis* on the basis of the following characters: differs from type by black pigmented gaster, bordered with yellowish; alitrunk, scale and coxae pale testaceous yellow; pilosity pale and less thick; alitrunk more shiny and less sculptured; deserves perhaps to form a race. Santschi (1936) added that the "sides of the head have abundant, erect pilosity, the occipital margin is more accentuated than in *abdominalis* and the occipital angles are more prolonged". I have examined the type material and their measurements are given in Table 64. If such specimens were not also found with the typical *abdominalis*, then this taxon could be considered as a valid species, but examination of a series of workers from Brazil which apparently represent the locality of typical *abdominalis* leads to the conclusion that such specimens occur along with the specimens in which the head and alitrunk are black. Therefore, the description of *mediopallidus* is actually one phase of the total variation of *abdominalis*. The specimens from Brazil show that this kind of variation is but one aspect of the total gradation in the species. It is also noteworthy to point out that specimens from Brazil which apparently resemble those of *mediopallidus*

in color but are much smaller in size were also examined. Such specimens do not differ from those to which the name *mediopallidus* has been given except in size. For more detail see discussion of *abdominalis romani* and of *lenkoi*.

Camponotus abdominalis var. *costaricensis*. This was described as a race of *abdominalis* by Forel (1900). He took the following characters into consideration: major worker more robust and larger than *abdominalis*; head and alitrunk reddish brown, a color which makes transition to *ustulatus*. According to Forel (1900) *ustulatus* is more clear than *costaricensis* and with dull and densely sculptured mandibles. Finally, he stated that *costaricensis* differs from *ustulatus* only by the more obscure color of the alitrunk. The measurements of the type material are given in Table 65. I have come across similar kinds of specimens in a graded series from Brazil and further, Santschi (1936) has reported the occurrence of specimens of the same color from Fort Davis, Aqua Clara in Panama and Sierra Nevada and San Antonio in Colombia. The description of the female does not deviate from that of the female of *abdominalis*.

Camponotus abdominalis st. *cupiens*. The description given by Forel (1908) is actually the description of minor and media workers of *abdominalis*. The measurements of the type material are given in Table 66. What Forel (1908) described as the major worker is actually the media worker and as such his discription stands no comparison with the major worker of *abdominalis*. He has stressed the variation in color which is a poor character in *abdominalis*.

Camponotus abdominalis subspecies *fuchsae*. This was characterized as head very large and convex: 3.6 mm broad and 3.5 mm long (excluding mandibles); scape broad, flat, refracted and long, passing back of head by three times its width; pilosity reddish and thick; pubescence somewhat thin. The diagnosis given by Forel (*ibid.*) as "black, mandibles brownish black, flagellum and legs light brown, femoral joints yellow brown". Forel described *cupiens* and *fuchsae* in the same year and both taxa have the same type locality, São Paulo, Brazil. The specimens represented in the type material still carry the labels written by H. von Ihring. A further analysis (Tables 66 and 67) also indicates that he used some minor workers to designate *cupiens* and some major and minor workers to designate *fuchsae*. The color difference which he recognized actually represents part of interpopulation variation. Both of these taxa were evidently based on the blackish specimens of *abdominalis* which are found abundantly in the area of São Paulo. An examination of several series of specimens from São Paulo revealed that such color shades are very common in the specimens from this locality, and as such are not worthy of taxonomic designation.

Camponotus abdominalis transvectus. This taxon was separated from *floridanus* and not from *abdominalis* on the basis of the following characters: smaller average size, foveolae on cheeks elongated and deeper, cheeks and sides of head with erect hairs; vertex of head very dark brown or blackish; hairs somewhat more abundant, especially on antennal scape; pubescence longer and more conspicuous. At the end of his discription Wheeler (1910) stated that the exact status of this taxon was not known to him because of the extreme variability of the species. The same form which Wheeler took from Cuernavaca was identified by Forel as "*C. abdominalis* new subspecies between *esuriens* F. Smith and *mediopallidus* Forel". Wheeler (1910) further pointed out that he had some specimens from Tusapan, Mexico, in which the head

of both the major and minor workers was yellowish red like the alitrunk and legs. Also, numerous specimens collected at Guadalajara, Mexico, had paler heads and no hairs on the sides of the head, and those he considered to represent a transition to *floridanus*. These statements lead me to believe that Wheeler was confused concerning the status of this taxon. Recently Dr. W. S. Creighton has sent me some specimens which he determined as *transvectus* from Mexico. It is quite interesting to note how incomplete Wheeler's description is when one looks at Creighton's specimens. If Creighton's three series are separately examined, there is ample likelihood of considering them as three separate taxa based upon color variation. However, all series grade into each other. The specimens can be deep brownish in color or yellowish red (as in *floridanus*) or brownish black (as in *stercorarius*). As a matter of fact, these specimens are an excellent example of the color variation in this species. Since a geographically limited portion of the total population of this species shows this much variation, the total variation can hardly be guessed. But the difficulty is that one cannot draw a line to separate the taxa unless one ignores an intermediate level variation, which is what the authors of infraspecific taxa of *abdominalis* have done. For measurements of type material, see Table 68.

Camponotus abdominalis v. *laevilatus*. This taxon was characterized as brownish red yellow; head, mandibles and scape black; segments of gaster bordered by brown band; trochanters and base of femora lighter; middle of head dull, its borders smooth, glossy; scape exceeds in length the occipital border by two times its width; top of scale blunt. Santschi (1936) linked it with *mediopallidus* as a variety because of the glossy sculpture of gaster. However, he emphasized the fact that the sides of head are more pilous in these specimens than in *abdominalis* and *mediopallidus*. It can be seen that the original description of *laevilatus* does not deviate much from that of *abdominalis*. The type specimens have trochanters which are lighter in color and the segments of the gaster are bordered by colored bands — characters which are fixed in *abdominalis*. The density of pilosity on the sides of the head stressed by Santschi varies with the size of the workers. If the workers are of medium size the pilosity usually is long and dense, and in some cases the major and media or large-sized media workers may have pilosity of the same density. The fact to be stressed is that workers do have pilosity on the sides of the head. For measurements of type material, see Table 69.

Camponotus abdominalis st. *rabidus*. This was characterized as color of gaster resembles *abdominalis;* front of head rusty yellow; mandibles reddish; pilosity absent on sides of head, far apart on scale, more thick on tibiae; declivity almost as long as base; resembles *floridanus* and *esuriens* in color of gaster which is more rusty. I have examined the types of this taxon and its measurements are listed in Table 70. Since there are only two specimens and I did not have access to more but seven minor workers, nothing can be said about the variation in specimens from Peru. However, the subequal base and declivity, the abundance of pilosity on the tibiae, as well as the general body appearance relate these specimens to *abdominalis*. The statement that the sides of the head lack hairs is incorrect. The sides of the head do have hairs, but they are short and scanty.

Camponotus abdominalis st. *depressidens*. This form was characterized as having the head, scape, mandibles and gaster black; head dull, slightly retracted in front, feebly crescented posteriorly; frontal carinae

shorter than *mediopallidus;* epistome narrow in front, carinae feeble; mandibles shiny, punctate, depressed in terminal half, teeth blunt; scape scarcely reaching posterior border; alitrunk short, convex from neck to base of scale, epinotal angles obliterated, suture well marked; pilosity on sides of head abundant but shorter than *mediopallidus* whose color it resembles. This description can be challenged on several bases. First, color is a highly variable character. Second, the shape of the head and the length of the frontal carinae, alitrunk and scape depend on the size of the specimens used. The rest of the description generally fits the characteristics of *abdominalis*. For measurements see Table 71.

Camponotus abdominalis subsp. *romani*. This was characterized as resembling the typical form but decidedly smaller; largest worker measuring 8.5 mm; the small worker 5-6 mm; head of former often brown behind but sometimes dark brown or blackish throughout; remainder of body uniformly dull yellowish brown; legs paler; gaster non-fasciate; upper surface of head more shiny and much more finely shagreened than in typical *abdominalis*. The characters indicated by the author, such as the head being finely punctate may seem important because they have been associated with the small size of the specimens. I have come across specimens of this kind from Amapá, Brazil, which resemble in size the *romani* type and have finely punctate heads. The small sized workers seem to occur as a part of the *abdominalis* populations and as such do not deserve a separate status. It should be pointed out that in some localities the heads of the workers are punctate regardless of size, therefore, the findings of the author of *romani* are not unique in this respect. I will, therefore, put this name in synonymy with *abdominalis*. For measurements see under type material examined.

Camponotus abdominalis var. *fumatus*. This was characterized as having the head, alitrunk, scale and basal segments of gaster dark reddish brown; legs and gaster yellow brown; gastric segments bordered with narrow brown band; scape of antennae dark brown, flagellum brownish red; pilosity like the principal type. Because this description does not separate these specimens from those of *abdominalis* in northern South America, I have synonymized *fumatus* under *abdominalis*.

Camponotus abdominalis floridanus v. *defrictus*. This taxon was characterized as having the head and scape blackish, gaster brownish black, segments narrowly bordered with yellowish; mandibles brownish red, dull; pilosity reddish, lacking on sides of head, scanty on cheeks; gaster faintly shiny. The measurements of the type material are given in Table 72. The specimens on which this taxon was based were sent by Forel to Santschi identified as *mediopallidus*. At the end of the description, the author mentions that *defrictus* could be regarded as a transitional form one of which was mentioned by Forel (1879) as *atriceps-esuriens*. In other words, Santschi did not believe that these specimens represented a distinct taxon. The characters listed are not of diagnostic value, as they are applicable to other specimens within the species. Since variation shown by these specimens is one aspect of the variation in *abdominalis*, I have synonymized *defrictus* under *abdominalis*.

Camponotus mediopallidus v. *flavobasalis*. This is characterized as alitrunk, scale, base of gaster and coxae light rusty yellow; head, femoro-tibial joint and rest of gaster deep brown, scape black, flagellum, tibiae and tarsi reddish brown; body smooth and shiny except vertex of head which is dull, gaster little shiny; mandibles smooth, with scattered dots; pilosity reddish, abundant, present on all sides of head and scape;

propodeum slightly notched; scape reaches posterior border of head; media worker with mandibles and propodeum brownish red; yellow spot at base of gaster extending to front of second tergite. An analysis of description of *flavobasalis* leads to the conclusion that the only characters which are comparatively fixed are the color of the coxae and tarsi and the abundance of pilosity on the sides of the head. The rest of the description is one aspect of the variation that occurs in *abdominalis*. It has been pointed out by the author that this taxon differs from *mediopallidus* by a more broad head, and a slightly yellowish color at the base of the gaster. Actually this description (Santschi, 1936) is the difference between two individual specimens, and not between the two taxa. I have examined the type material and am convinced that the specimens are of *abdominalis* although they are different in coloration than the typical *abdominalis*. For measurements of the type material, see Table 73.

Camponotus abdominalis cupiens v. *luisae*. This was characterized as reddish yellow or rusty; head red brown, bands red to light brown; gaster light; three oblique reddish brown bands on the laterum of alitrunk; vertex and scape faded reddish brown; head dull, remaining glossy; pilosity reddish, long and abundant, fine and short on scape and sides of head; mandibles convex, bent, with coarse dots and few striae, rest smooth and glossy; epistome finely reticulate, dull behind, smooth and glossy in front with piliferous points, hardly notched in front; scape more cylindrical than among *abdominalis*, hardly surpassing lobes of posterior angles of head; pro-mesonotal suture well marked, mesonotum not marked in profile; epinotal angles very much round. I have examined the type and its measurements are given under type material examined. The specimen is of *abdominalis*. This taxon was erected by Santschi by separating this specimen from those which Forel had designated *cupiens*. It appears to me that the most probable reason was that *cupiens* was based on specimens from São Paulo while this specimen was from Rio de Janeiro.

Camponotus abdominalis floridanus v. *panamanus*. This was characterized as head 3.5 x 3.5 mm; scape 2.8 mm; hind tibiae 3.3-3.5 mm; color of *floridanus* but gaster rather blackish, brownish behind becoming brownish yellow towards base; sides of head smooth except cheeks which have some scattered hairs; this form makes transition to *esuriens* by hairless sides of head. This description reveals that Santschi (1936) attached this taxon to *floridanus* because the specimens had black gasters. In addition to the syntypes, I have examined several specimens from Bella Vista, Panama, collected by G. C. Wheeler, the type locality and the original collector of the specimens on which *panamanus* is based. The specimens resemble in every respect those which have been called either *esuriens* or *floridanus* in literature. It is not clear why he did not attach *panamanus* to *esuriens* instead of *floridanus*. All of these specimens are actually the localized variations of the *abdominalis* population. For measurements of the type material see Table 74.

Camponotus abdominalis st. *epistomatus*. This was characterized as having a reddish yellow head, mandibles and epistome reddish brown; teeth, anterior border of cheeks and basal two tergites of gaster blackish brown; coxae yellowish; middle of head dull, rest glossy; pilosity reddish, long and rather abundant on body, more rare on the flexor surface of coxae, short but thick on sides of head. This taxon is based on only one specimen, the measurements of which are given under type material examined. The description is a good illustration of the color pattern

of the specimen but in all aspects fits within the limits of the variation of *abdominalis*.

Camponotus abdominalis st. *cupiens* v. *misionensis*. This was characterized as having workers resembling *costaricensis* with bands bordering the gaster as large as in *cingulatus;* head red brown; anterior border of head, mandibles, scape and posterior border of tergites of gaster blackish; alitrunk, flagellum, tarsi and gaster more or less reddish; cheeks and scape with long hairs. At the end of the description the author states that it is placed in between *cupiens* and *luisae*. I have examined several specimens from Misiones, Argentina, sent to me by the Instituto Miguel Lillo, Tucuman, Argentina, which fit the description. The types of *misionensis* show some unusual color patterns on the gaster. This phase of variation is an abberant one, but is not worthy of separate status. Most Argentina specimens from Misiones show a deep brown color, a color which has been used to designate *stercocorius*, but the rest of the characters are that of *abdominalis*. The color pattern does not resemble that of the types of *costaricensis*. For measurements of type material see Table 75.

Differential diagnosis. — This taxon can be differentiated from the rest on the basis of the following combination of characters: abundant pilosity on scape, legs and all over body; propodeal base and declivity subequal in length; coxae, trochanters and femora lighter in color; each gastric segment always with some sort of bands; may be black, golden yellow or both.

Camponotus lenkoi Kempf, 1960

(Figure 11)

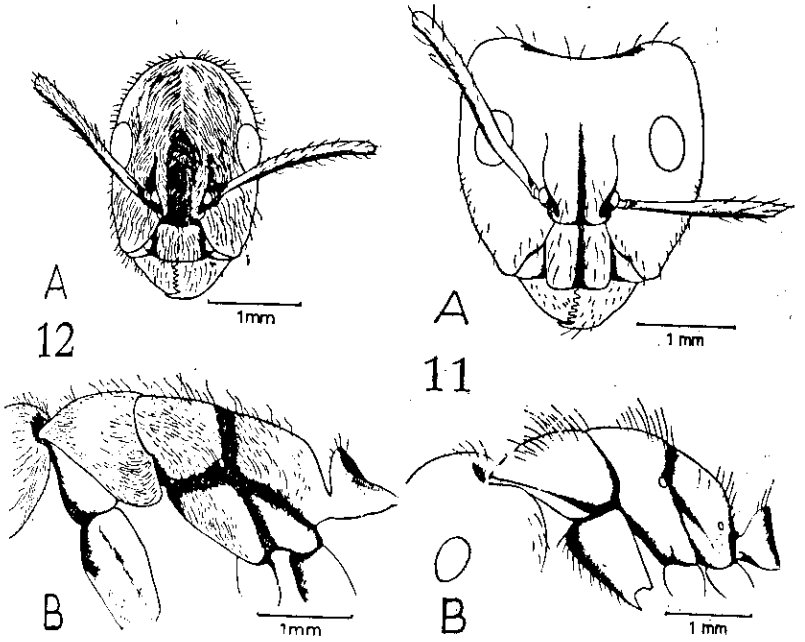
Camponotus lenkoi Kempf, 1960, Studia Ent. Petropolis 3: 398-99. Description of major and minor workers. Type locality: Territory of Amapá, Brazil. Location of type material: Kempf Collection at São Paulo, Brazil.

Type material examined. One major worker (holotype) and three minor workers (paratypes) from the Amapari River Km 185, territory of Amapá, Brazil, collected by J. Lane on July 9, 1959. The various measurements are recorded in Table 84.

Distribution. So far known only from territory of Amapa, Brazil.

Localities from which specimens have been examined. Since this species is only known from the type material, no other material was available for examination.

Major worker. Head, scape and gaster blackish; mandibles brownish, base and teeth blackish; alitrunk, legs and petiole brownish yellow; alitrunk and femora with reddish markings. Sculpture weakly reticulated, shiny. Clypeus triangularly cut in front with lateral lobes sharp and pointed; posteriorly, clypeus rounded at corners, centrally emarginate and with a deep longitudinal depression in center; clypeal carina feeble. Mandibles



Camponotus (*Myrmothrix*)
Fig. 11. *lenkoi*, major worker holotype: A. front view of head. B. lateral view of alitrunk. Fig. 12. *punctatus*, type specimen: A. front view of head. B. lateral view of alitrunk.

TABLE 84

Measurements (mm) and indices of type material of *C. lenkoi*

	Holotype	Paratype		
	Major Worker	Minor Worker	Minor Worker	Minor Worker
Head width	2.77	1.55	1.62	1.55
Head length	2.94	1.89	1.93	1.82
Scape length	2.17	2.17	2.13	2.24
Pronotum width	1.70	1.24	1.31	1.24
Metatibial length	2.71	2.28	2.55	2.28
Weber's length	3.37	2.79	2.77	2.63
Maximum eye length	0.62	0.54	0.54	0.54
Maximum eye width	0.54	0.43	0.43	0.43
Interocular space	1.55	0.97	1.01	0.97
Cephalic index	93	81	84	85
Scape index	79	140	131	145
Ocular index	87	78	78	78
Pronotum index	62	80	81	80

with 5 teeth, scattered deep punctures and golden yellow hairs all over. Basal 1/2 of scape flat and thin, distal half not flattened, rather thickened; scape about 1.09 times the length of head from antennal fossa to occipital border with a maximum thickness of 0.23 mm. Frons irregularly strio-reticulate, scape and occipital area with longitudinal foveolae. Pubescence on head, short, suberect, scattered and denser than pilosity. Lateral surfaces of head with not more than 7-8 short hairs; few hairs of varying length on frons. Eyes rounded and placed above middle of head length. Head convex at eye level, narrow above and below; occipital border shallowly concave, occipital angles rounded but not sharply demarcated. Promesonotal suture quite distinct, meso-metanotal suture not quite distinct; alitrunk smoothly arched; propodeum not clearly demarcated into base and declivity; thoracic spiracle oblong. Petiole thick, with front convex and rear flat, margins entire. Tibiae with spines at distal end. Alitrunk and femora with deep longitudinal striations. Gaster oval, each gastric segment with more than 24 long yellowish hairs and bordered by a golden yellow band; pubescence on gaster very short.

Minor worker. Head, scape and gaster brownish black; front of head, clypeus and mandibles of lighter color; alitrunk, legs and petiole yellowish. Sides of head sub-parallel, converging and narrowed at occipital corners and shallowly emarginated posteriorly. Eyes rounded and placed posterior to middle of head. Scape cylindrical, with maximum thickness of 0.15 mm and about 1.6 times length of head from antennal fossa to occipital border; moderately thick hairs all over scape. Head, alitrunk and legs with moderately thick and short pilosity; gaster with thicker and longer pilosity. Clypeus with about 20 or more hairs, frons with 18 or more hairs. Pubescence on head and gaster whitish yellow, short and appressed. Alitrunk (except prothorax) and femora with reddish striations as in major worker. Scale of petiole flat, depressed behind and convex in front with margins entire. Apical end of tibiae with 3-4 spines. Each gastric segment with 20 or more hairs and bordered posteriorly with a yellowish band.

Female and Male unknown.

Discussion of the type material of lenkoi. See under differential diagnosis.

Differential diagnosis. This species resembles the phenotype of *abdominalis* which previously was called *mediopallidus*, in color but differs from that in having scarce pilosity and in being of smaller size. Also the color of the legs in *abdominalis* is not uniform as in this species; rather the tibiae and tarsi are brownish or blackish. The following combination of characters should serve as a diagnosis for *lenkoi*: much smaller in size, pilosity scarce on all parts especially head; hairs on cheeks short, oblique like bristles; back of thorax and lateral sides of gaster have scanty to complete lack of pilosity; pubescence on gaster minute, short and very dispersely arranged. Scape blackish, flattened in basal half. Minor workers differ from majors in the head shape which is not massive but rather is more elongated and in the shape and color of the scape which is cylindrical and of deep brown color. On the basis of above characters retention of this taxa seems quite justified. However, in view of the paucity of the material it does not seem to be a very sound judgment. If on examination of additional material it is found that the characteristics of the major workers coincide with those of *abdominalis* workers then *lenkoi* should go in synonymy with *abdominalis*.

Camponotus punctatus Forel, 1912

(Figure 12)

Camponotus punctatus Forel, 1912, Mem. Soc. Entom. Belg. 20: 76. Description of worker. Type locality: Brazil. Location of type material: Forel Collection at Museum d'Histoire Naturelle, Geneva.

Type material examined. One specimen labelled "Typus, Tp. *Camponotus punctatus* Forel, *Camponotus femoratus* Mayr, Bras." The measurements and indices of the various body parts are: head width 1.55 mm, head length 2.13 mm, scape length 2.44 mm, pronotum width 1.32, metatibial length 2.44 mm, Weber's length 3.41 mm, maximum eye length 0.54 mm, maximum eye width 0.43 mm, interocular space 1.16 mm, cephalic index 72, scape index 157, ocular index 78, and pronotum index 75.

Distribution. Reported only from Brazil.

Localities from which specimens have been examined. Only this type specimen was available for examination.

Major worker. Unknown.

Minor worker. General color black, shiny; legs, antennae and front of head reddish yellow; body densely punctate, spots clear, separated by smooth intervals; pilosity prominent and dense on scape and tibiae, scanty on gaster; pubescence whitish, long and coarse, forming fluffs on frons and segments of gaster. Mandibles smooth, punctate, moderately curved; with 6 teeth, apical tooth long, ultimate and fenultimate teeth short; clypeal carina feeble, frontal carinae when viewed from epistomal suture appear elevated and diverging; head broader below compound eyes than at occipital border, vertex and lateral sides slightly convex, occipital border slightly concave; scape measuring 1.5

times length of head from antennal fossa to occipital border with a maximum thickness of 0.31 mm. Alitrunk widest at pronotum, laterally compressed posteriorly, propodeal base longer than declivity; scale thick, erect, convex in front and flat behind; tibiae with spines towards distal end. Gaster elongated, each segment with thick, dense, long, whitish yellow pubescence and a golden yellow band at posterior border.

Female and Male unknown.

Discussion of the type material of punctatus. Although I have some doubts about the validity of this taxon, I am retaining it for the time being. Probably this name should go in synonymy with *sericatus*. Both *punctatus* and *sericatus* are based on minor workers in which head is narrow behind the compound eyes and the frontal carinae appear elevated when observed from the front. They both have punctate bodies and are very much alike in their body measurements. In both cases the propodeal base is longer than the declivity. The significant difference noticeable on first glance is that *punctatus* is more robust than *sericatus* and has fluffs of hairs on the frons whereas *sericatus* is less robust and lacks the fluffs of hairs. However, should the examination of additional material, especially of major workers in both cases, show that the presently known difference in their morphology is actually within the range of the species variation, then *punctatus* will go in synonymy with *sericatus*.

Differential diagnosis. This specimen was actually sent to Forel by Mayr under the name *Camponotus femoratus* and the specimen still has that original label, but because of difference in sculpture it was given specific status by Forel. I have examined the type of *femoratus* and hereby give the following combination of characters to distinguish *punctatus* from *femoratus*: it superficially resembles *femoratus* in color and pubescence but is larger in size and elongated in form. The alitrunk is elongated. The pubescence is thicker and longer especially on the head gaster where it forms fluffs on the frons. There are small rounded punctures all over the body, dense on head, alitrunk and gaster; these punctures are separated by smooth intervals. The color of scape and legs is brownish.

Taxa of uncertain status

Because of the lack of type material and/or of adequate specimens, certain taxa assigned to *Myrmothrix* could not be adequately evaluated. References and brief descriptions are given below for each of these taxa.

Camponotus abdominalis nocens Wheeler, 1911

Camponotus abdominalis Fabr. subsp. *nocens* Wheeler, 1911, Bull. Mus. Comp. Zool. Harvard 54: 171-172. Type locality: Grand Etang and Richmond Hill, West Indies. Location of type material: Unknown.

Discussion. The characters given by Wheeler (1911) for this taxon included: hairs long, erect, much less abundant than in typical *abdominalis*, confined to vertex, clypeus, gula, mandibles, thoracic dorsum, border of petiole, surface of gaster and fore coxae, lacking on the scape and legs. These characters indicate a strong deviation of this taxon from *abdominalis* and I have no reason to support Wheeler on its affinity to *abdominalis*. During a recent visit to the American Museum of Natural History in New York, I examined some specimens identified as *nocens* from Grand Etang in Dr. W. S. Creighton's collection. I have the following comments on these specimens:

1. Contrary to Wheeler's description there are hairs on the scape, but they are confined to the apical end.
2. The hairs on the head are few and relatively inconspicuous.
3. Two or three hairs are present on genae.
4. The clypeus is not emarginated.

Based on Wheeler's description and on my examination of the specimens in the Creighton Collection, it seems evident that this taxon is not closely related to *abdominalis* and probably does not belong in the sugenus *Myrmothrix*. This taxon then is accorded uncertain status until the type material can be located and examined.

Camponotus cordiceps Santschi, 1939

Camponotus cordiceps Santschi, 1939, Rev. Ent. Rio de Janeiro 10: 327-28. Description of major and minor workers. Head of major worker figured. Type locality: Misiones, Loreto, Argentina. Location of type material: Santschi Collection at Naturhistorisches Museum, Basel. Kusnezov, 1952, Acta Zool. Lilloana, Tucuman 12: 208. Head of major worker figured.

Discussion. In his description Santschi (1939) noted that the pilosity was erect, reddish, long and abundant on the body including the cheeks and appendages and the pubescence was scattered over the gaster, characteristics which link it with *abdominalis*. On the other hand he described the frontal furrow as being indistinctly impressed and the scape as being compressed, slender, cylindrical and bent in the basal half but enlarged and thickened in the distal half, features distinguishing it from *abdominalis*. The type specimens were not available and no other material from Argentina could be associated with this description during this study. The status of *cordiceps* shall remain uncertain until such time as the types can be examined.

Camponotus opaciceps Roger, 1863

Camponotus opaciceps Roger, 1863, Berl. Ent. Zeitschr. 7: 141-142. Description of a female. Type locality: Brazil. Location of type material: Unknown.
Camponotus abdominalis Fabr. r. *opaciceps*, Forel, 1897, Trans. Ent. Soc. London, Part III, pp. 297-98. Attached to *abdominalis* and stated that it is close to *C. sharpi*.

Discussion. One female, three males and three minor workers were sent to me from the Forel Collection identified as *opaciceps*. The female and the males are labelled "*C. abdominalis* F. r. *opaciceps* Roger (Grenodor)". The three minor workers are labelled "*C. abdominalis* r. *opaciceps* Rog., Fracatal, Venezuela (Andre)". Unfortunately, the female from the Forel Collection does not agree with the characteristics described by Roger. For instance, one of the key characters in Roger's (1863) description is that the antennal scape does not have any hairs on it, but the specimen from Forel's material has hairs on the scape. Roger's description mainly covers the generalized features of an ant with no emphasis on diagnostic characters. In this description he compared his specimen to the female of *C. exasperatus* Smith a taxon which was transferred to the genus *Polyrhachis* by Emery (1925).

The above specimens from the Forel Collection do appear to be typical of *abdominalis*. Since I have no verifiable specimens of *opaciceps*, the status of this taxon will remain uncertain until I have examined the type specimen or else have some additional material which fits Roger's description.

Taxonomic Key for the Separation of Species

The key presented below is applicable only to those species whose validity as members of the subgenus *Myrmothrix* has been determined in the present study. This key has been constructed using a multiple character approach. To construct a key based only on single dichotomous characters is quite difficult in a group of polymorphic species. This key is designed to be functional for workers regardless of subcaste. The major workers of certain species, for example *punctatus* and *sericatus*, are unknown. However, since the workers on which these taxa are based show quite distinct characters, the key can be used effectively.

Key to Workers

1. Body covered with short, scanty, whitish yellow hairs all over; pubescence long, thick, and quite prominent; appearance with a metallic glimmer, slightly shiny or dull. 2
— Body covered with long, abundant, erect or suberect golden yellow hairs, especially on the scape, alitrunk and legs; pubescence short, thin and underneath pilosity; appearance shiny or dull. 3

2. Body slightly shiny, densely punctate; pronotum without a depression in center; pubescence whitish yellow, forming fluffs on frons and segments of gaster. ..... *punctatus*
— Body with a metallic luster, without clearly visible punctures; pronotum with a central depression; pubescence whitish yellow, not forming fluffs on frons or segments of gaster. ..... *femoratus*

3. General body color uniformly deep blackish brown, head yellowish red; occipital border with blackish hairs, rest of pilosity golden yellow; propodeal declivity about two times the length of base. .... *bugnioni*
— General body color and head color never in this combination; occipital margin without blackish hairs, all pilosity golden yellow; propodeal declivity less than two times the length of base. 4

4. Pro-mesonotal suture well marked, metanotum defined by the presence of meso-metanotal suture. ..... *cingulatus*
— Pro-mesonotal suture distinct and more deeply marked than mesonotal groove, metanotum not clearly defined. 5

5. General body color always uniformly yellowish, or yellowish brown; scape, mandibles and genae deep brown; abundant pilosity all over; geographical area only Jamaica. ..... *hannani*
— General body color not uniformly yellowish or yellowish brown, at least some parts with other color; scape, mandibles and genae of varying color; geographical area other than Jamaica. 6

6. General body color deep blackish brown or black; coxae, trochanters and proximal part of femora yellowish orange making a contrast with the body color; pilosity golden yellow, moderately abundant all over body; appearance silky. ..... *renggeri*
— General body color varied; coxae, trochanters and proximal parts of femora lighter in color, never making a strong contrast with the body color; pilosity abundant; appearance never silky. 7

7. General body color deep black to rusty brown; legs brownish, pilosity golden yellow, abundant all over; appearance dull. ..... *rufipes*
— General body color varied; legs slightly ligher than body color, tibiae and tarsi sometimes slightly darker than rest of legs; pilosity abundant or sparse; appearance shiny. 8

8. Head deeply narrowed and flatly cut behind, not excavated at occipital border; very few hairs on lateral surfaces of alitrunk. ..... *sericatus*
— Head not deeply narrowed behind, occipital border deeply excavated; lateral surfaces of alitrunk with abundant pilosity all over. 9

9. Frons with more than 32 hairs; scape of varying thickness; propodeal base and declivity indistinctly demarcated and subequal; hairs of varying length and abundant all over. ..... *abdominalis*
— Frons with not more than 10-12 hairs; scape usually narrow in basal half; propodeal base and declivity not distinctly separated; hairs short and less numerous all over. ..... *lenkoi*

Discussion

The taxonomy of social insects is difficult because of the occurrence of two or more functionally different castes within the same sex in a species. Such a species is said to be polymorphic. According to Wilson (1953), the term "polymorphism" has been

applied usually to one or the other of two almost completely separate phenomena. In genetics it is defined as the condition of two or more distinctive and discontinuous genetic types existing in a population (Ford, 1940). In the study of social insects it is defined as the existence within an individual colony of two or more phases or castes belonging to the same sex, without particular regard to their genetic and environmental origin (Wilson, 1953). The definition emphasizes: (a) the coexistence of two or more castes within the same sex, which are functionally different, and (b) the stability of the castes. In ants, the castes are stable throughout their life.

Mayr (1963) proposed the term "polyphenism" for the type of polymorphism found in social insects. However, the term "polymorphism" has consistently been used in myrmecology since it was first applied by Emery (1896). Wilson (1971) contended that a change in terminology hardly seems necessary. To reinforce his earlier (1953) definition, he stated (p. 136):

> It is a strong rule, but perhaps not an ineradicable part of the definition of polymorphism, that all the castes make their appearance in the course of development of each normal, mature colony. Slight continuous variation in color, pilosity, spine shape, sculpture, and so forth, if it does not meet these requirements, would not ordinarily be classified as polymorphism.

In the taxonomy of social insects, therefore, in addition to the problem of caste polymorphism, a taxonomist is also faced with infraspecific variation related to ecological and geographical variation in species of broad distribution. This latter aspect of variation has been extensively used by geneticists to narrate the phenomenon of polymorphism. However, geneticists differ among themselves on the concept of polymorphism and its significance. For instance, Da Cunha and Dobzhansky (1954) measured polymorphism by heterozygosity, that is, the number of inversion heterozygotes per individual or the number of distinct inversions in the population. On the other hand, Carson (1955) measured polymorphism by the property of the genotype in which inversions block free recombination. In other words, Carson was concerned with cytological polymorphism. A third kind, lacking in both Da Cunha's and Dobzhansky's and Carson's approaches, was that populations which are cytologically homozygous may be polymorphic with respect to many genes of ecological significance. This kind of phenomenon was referred to as ecological polymorphism by Levins (1963). The strategy of the population

geneticist has usually been to choose clear cut genetic markers such as chromosomal inversions, recessive lethals or, more recently, allozymes in order to establish the pattern of variation and then to search for the ecological significance of these patterns; ecologists, however, select traits of obvious adaptive significance and only secondarily consider the genetic basis of the patterns (Sammeta and Levins, 1970). Therefore, population geneticists and ecologists, even when looking at the same organism, do not generally study the same trait, Sammeta and Levins, 1970). On the other hand, a taxonomist who deals mainly with museum specimens analyzes the ecological and/or geographical variation in a little different way than the ecologist or the geneticist does. He tends to recognize the features of consistent value in separating species and lumps the characters showing inconsistencies under variation whether it is due to ecological factors or geographical isolation. And on the basis of perceptible phenotypic differences between populations, he arrives at the total degree of differentiation. He assumes that if such populations are crossed, the genetic incompatibility will reinforce his assumption. In other words, he uses the general morphological continuities and discontinuities as raw material to form the basis of taxa which are intuitively supposed to reflect the total variation of a species gene pool without having a real test of his assumption.

In delimiting the various taxa in the subgenus *Myrmothrix,* I was confronted with two basic problems: caste polymorphism and ecological or geographical variation. The use of discriminant function analysis helped to resolve the problem of caste polymorphism as explained in Materials and Methods. With this analysis I was able to find out whether a type specimen was a major, media or minor worker. It became clear that certain of the nominal taxa were based only on the different worker subcastes of the same species. The problem of geographic variation was more difficult. The use of clines and subspecies provides the two main approaches which commonly have been used to describe species variation. In clinal variation one looks for a gradient in some attribute or group of attributes which varies continuously within the geographical range of the species or with some environmental factor. According to Sammeta and Levins (1970) studies of clinal or ecotypal variation assume that different population differ genetically without the particular kinds of genetic differences being considered. Notable works on the successful use of clines are those of Petersen (1947) and of Guilham (1956).

Several workers have supported or else have successively demonstrated the use of subspecies to delineate species variation. Of particular significance in this respect are: Mayr (1954), Parkes (1955), Durrant (1955), Smith and White (1956), and Willis (1967). Sokal (1965) described the statistical methods applicable to the analysis of variation in taxonomy. However, his work did not add a new approach to the analysis of infraspecific variation. Before one resort to any of the above approaches, the extent and intensity of variation should be evaluated.

When the present study was initiated, about 50 published names at the specific and infraspecific levels were included in *Myrmothrix*. These names might give any taxonomist an illusion of the tremendous amount of variation and also some curiosity about the evolutionary forces at display in such a group of organisms. However, a study of the various type specimens and additional material from many localities suggests the following reasons for the abundance of specific and infraspecific names.

1. Certain names were applied to the worker subcastes of the same species. For instance, *willardi* was applied to media workers of *hannani*. Comparison of Tables 1 and 2 reveals that the *willardi* type material is comprised of only media workers whereas the *hannani* type material consisted of major workers and only one media worker. Evidently the reason why Emery kept this media with *hannani* was its resemblance in color to that of major workers. The media workers which differed in color from the majors were designated as *willardi*. A similar case is that of *cupiens* and *fuchsae*, variants of *abdominalis*. In this case minor workers slightly varying in color were used to designate the two infraspecific taxa.

2. Certain names were given to specimens having slight individual variation in color. For instance, in *cingulatus*, the variants *bambusarum* and *damocles* differed from typical yellowish *cingulatus* in being of darker color. In *rufipes*, the infraspecific taxon *magnifica* was described because the specimens had brownish tibiae, contrary to the belief that *rufipes* has only blackish tibiae. Likewise, variants *cajurensis* and *subrufescens* were described for specimens having a dark red color of their body contrary to the belief that *rufipes* is only blackish. A similar situation is true for *atriceps, esuriens, stercorarius, ustulatus, mediopallidus, costaricensis* and *panamanus*, all variants of *abdominalis*, in which color was used to designate these taxa. In the original descriptions of these taxa the authors usually

compared one variant with another with disregard to the total species variation.

3. A few names were created to indicate those specimens that represented intergrading forms. Examples of these are *atricipito-esuriens, fulvaceus, defrictus*, and *misionensis*, all variants of *abdominalis*.

4. Some abnormal forms were described as a separate taxon, although such forms do not deserve a special taxonomic status. For example, *myster* is based on a macroergate of *cingulatus*.

5. Specimens from a locality other than the type locality were described as representing a new taxon. Examples are *brunneiventris*, a variant of *cingulatus* and *lusiae*, a variant of *abdominalis*.

6. A few taxa were described on the basis of a meager number of available specimens, remote from other collections. For instance *fissa*, a variant of *cingulatus*, was based on only one specimen, without taking into consideration even the taxa previously described from the same locality. Similar cases are those of *fumatus* and *epistomatus*, both variants of *abdominalis*, based on only a few specimens.

7. Slight differences in intensity of pilosity were used to designate a few taxa. For instance, *floridanus, laevilatus* and *rabidus*, variants of *abdominalis*, were described on the basis of slight differences in pilosity.

8. The shape of the head of workers of different sizes of the same species was used to designate new taxa. For instance, *depressidens* and *flavobasalis*, both variants of *abdominalis*, were described on the basis of the above character.

9. Specimens of smaller size, although coexisting with bigger specimens or else coming from one extreme of the species distribution, have been used to designate new taxa. Examples are *romani* and *transvectus*, both variants of *abdominalis*.

10. Inadequate descriptions and the lack of described diagnostic features made species determination difficult. These deficiencies have resulted in the addition of names at the infraspecific level. The various infraspecific names attached to *cingulatus, rufipes* and *abdominalis* are partly the result of this lacuna.

11. The persistent practice of myrmecologists such as Forel, Santschi and Wheeler to use an infraspecific taxonomic category for any deviation from the typological type concept has evidently resulted in the accumulation of a large number of unnecessary

names. For instance, many of the 23 infraspecific level names proposed for *abdominalis* represented minor deviation based upon this concept.

Aside from *abdominalis* there is hardly an indication in the rest of the species that variation could be used to indicate a cline or to recognize any sub-population as a subspecies. *Camponotus abdominalis* is the most widely distributed of all the species, ranging from Texas and North Carolina to northern Argentina. The extent of phenotypic variation in this species is so great that just in Brazil eight names were given to the varions body color forms, e.g., *abdominalis, atriceps, cupiens, flavobasalis, fuchsae, laevilatus, lusiae* and *romani*. Most of these names were given to specimens collected in the vicinity of São Paulo. Examination of several colony series from São Paulo and other nearby areas revealed that several phenotypic forms coexist in this area. Completely blackish to completely brownish-yellow specimens occur there. Analysis of population from the extreme north and the extreme south of this species distribution showed the extent of variation to be much less than that in Brazil. For instance, specimens from Texas and Florida (both being near the northern limits of this species) show uniformity in their phenotype in their respective areas. However, as this species is traced into Mexico, the variation increases. A similar situation exists in specimens from northern Argentina (near the southern limit of range) where most of the specimens are largely blackish brown.

Based upon the specimens examined in this study the present pattern of variation in *abdominalis* does not seem to indicate either distinctive clinal variation or conventional subspecies variation. This variability seems to fit Ludwig's Theorem (1950) which states that the greatest variation in the species can be found in the central part of its distribution with progressively lesser deviations away from the center and in peripheral areas. This phenomenon may result from the following:

a. Each gene composition may have a definite value at each locality.

b. Different species structures (= phenotypic forms) may prevail in different localities.

c. Each peripheral population shows less variability because of its reduced genetic diversity.

d. It could be a result of physiological cline. For instance, "... Ledyard Stebbins has postulated that it is probable that

most species with a continuous range that includes more than one altitudinal or latitudinal climatic belt will possess clines of physiological features adapting them to the particular characteristics of their habitat range (Boughey, 1968, page 75).

Based on the above 11 considerations I have placed several names in synonymy. Most of the synonymized names have been referred to in illustrating these points. The following ten species are recognized as valid for the subgenus *Myrmothrix*.

C. abdominalis (Fabricius), 1804
C. bugnioni Forel, 1900
C. cingulatus Mayr, 1862
C. femoratus (Fabricius), 1804
C. hannani Forel, 1900
C. lenkoi Kempf, 1960
C. punctatus Forel, 1912
C. renggeri Emery, 1894
C. rufipes (Fabricius), 1775
C. sericatus Mayr, 1887

One species, *C. lessonai* has been excluded from the subgenus *Myrmothrix* and three species, *C. nocens, C. cordiceps* and *C. opaciceps*, have been accorded uncertain status. In conclusion, the 50 published names have been reduced to 10 valid species and 3 of uncertain status.

Summary

The taxonomy of the ants of the subgenus *Myrmothrix* of the genus *Camponotus* has been studied based upon the specimens obtained from museum collections throughout the world. Approximately 5,200 specimens representing diverse localities throughout the range of this exclusively neotropical subgenus were examined during this study.

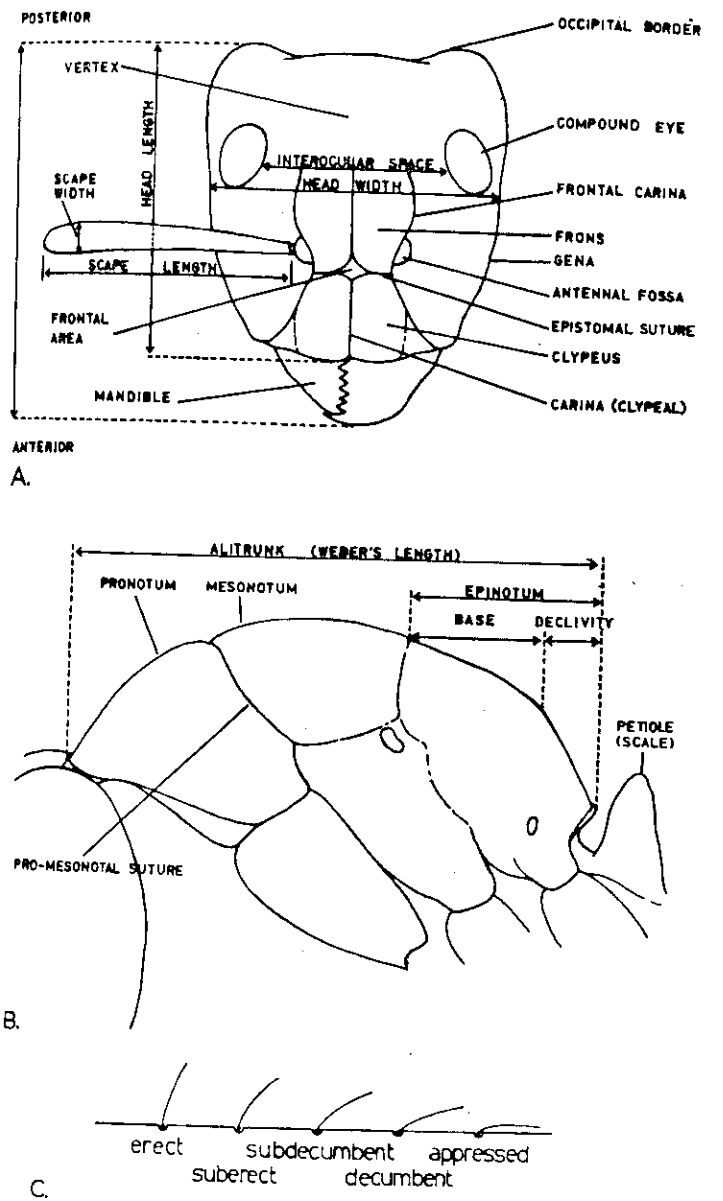
Each of the specimens of the type series which were available as well as large series of workers (when available) of all subcastes were examined in order to describe the morphological characteristics of each taxon. Nine structures and four morphological indices were measured in order to provide comparative data of a quantitative nature. Discriminant function analysis was applied to these measurements and proved to be a very useful tool in classifying the workers.

Prior to this study 50 names existed to represent taxa (species, subspecies and varieties) in this subgenus. One species, *C. lessonai*, has been excluded from the subgenus *Myrmothrix*. The remaining 49 names have been reduced to 13 taxa based upon examination of all specimens received and careful study of the original descriptions. Ten of these taxa are recognized as distinct species; no subspecies are recognized. Each of these species has been re-described and characterized and the limits of variation in selected measurements given. A key to

the species, based upon the worker caste, has been constructed. Three species (*C. abdominalis nocens, C. cordiceps,* and *C. opaciceps*) could not be adequately recognized in the absence of types and are accorded uncertain status.

The following is a list of recognized species with new synoynmy as determined by this study:

1. *C. abdominalis* (Fabricius), 1804
   = *abdominalis* var. *costaricensis* Forel, 1900, n. syn.
   = *abdominalis* spp. *cupiens* Forel, 1908, n. syn.
   = *abdominalis cupiens* var. *lusiae* Santschi, 1936, n. syn.
   = *abdominalis cupiens* var. *misionensis* Santschi, 1939
   = *abdominalis* st. *depressidens* Santschi, 1922, n. syn.
   = *abdominalis* st. *epistomatus* Santschi, 1936, n. syn.
   = *abdominalis floridanus* var. *defrictus* Santschi, 1936, n. syn.
   = *abdominalis floridanus* var. *panamanus* Santschi, 1936, n. syn.
   = *abdominalis* ssp. *fuchsae* Forel, 1908, n. syn.
   = *abdominalis* var. *fumatus* Stitz, 1933, n. syn.
   = *abdominalis* var. *mediopallidus* Forel, 1900, n. syn.
   = *abdominalis mediopallidus* var. *laevilatus* Santschi, 1922, n. syn.
   = *abdominalis* st. *rabidus* Santschi, 1922, n. syn.
   = *abdominalis* subsp. *romani* Wheeler, 1923, n. syn.
   = *abdominalis transvectus* Wheeler, 1910, n. syn.
   = *atriceps* (Fred. Smith), 1858, n. syn.
   = *atriceps* var. *atricipito-esuriens* Forel, 1879, n. syn.
   = *atriceps* r. *stercorarius* Forel, 1884, n. syn.
   = *atriceps* st. *ustulatus* Forel, 1884, n. syn.
   = *esuriens* (Fred-Smith), 1858, n. syn.
   = *floridanus* (Buckley), 1886, n. syn.
   = *fulvaceus* (Norton), 1868a, n. syn.
   = *mediopallidus* var. *flavobasalis* Santschi, 1936, n. syn.
2. *C. bugnioni* Forel, 1900
3. *C. cingulatus* Mayr, 1862
   = *cingulatus bambusarum* Forel, 1902, n. syn.
   = *cingulatus brunneiventris* Santschi, 1922, n. syn.
   = *cingulatus* st. *brunneiventris* var. *postniger* Santschi, 1925, n. syn.
   = *cingulatus* var. *damocles* Forel, 1909, n. syn.
   = *cingulatus* var. *fissa* Stitz, 1933, n. syn.
   = *cingulatus* var. *myster* Santschi, 1922, n. syn.
4. *C. femoratus* (Fabricius), 1804
5. *C. hannani* Forel, 1900
   = *hannani* r. *willardi* Forel, 1902, n. syn.
6. *C. lenkoi* Kempf, 1960
7. *C. punctatus* Forel, 1912
8. *C. renggeri* Emery, 1894
9. *C. rufipes* (Fabricius), 1775
   = *herrichi* (Mayr), 1853
   = *merdicola* (Lund), 1831
   = *rufipes* var. *alpina* Emery, 1905, n. syn.
   = *rufipes* forma *cajurensis* Luederwaldt, 1918, n. syn.
   = *rufipes* var. *magnifica* Forel, 1913, n. syn.
   = *rufipes* var. *subrufescens* Santschi, 1929, n. syn.
10. *C. sericatus* Mayr, 1887



Camponotus (Myrmothrix)

Fig. 13. A. Diagram of the head of a major worker in full face view. B. Diagram of the alitrunk of a major worker from lateral side. C. Angular inclination of hairs, terminology and illustration after Wilson (1955).

Glossary

Some of the terms used in the present study have been defined below for clarification purposes. If the definition has been taken from another source, the author and year have been given in parenthesis at the end.

Abdomen. The hindmost of the three main body divisions in insects.

Alitrunk. That part of the body of the higher Hymenoptera usually termed "thorax" by nonspecialists. It is embryologically derived from the true thorax and the first segment of the abdomen; they are fused into a single structure in the adult. A more recent term for alitrunk is mesosome, but long-term usage of alitrunk in ant taxonomy has prompted its continued use in this study (Wing, 1968). See Figure 13.

Allopatric populations. Populations of taxa that are sufficiently remote from each other geographically so that any point on the range boundary of one is separated from any point on the range boundary of another by a distance greater than the sum of the natural cruising ranges of the reproductive castes of each. In the strict sense, allopatric species could be those fulfilling the above cited criteria for all contained demes of each taxon (Wing, 1968).

Angular inclination of hairs. Terminology relative to the inclination of both pilosity and pubescence is shown in Figure 13C which has been redrawn from Wilson (1955).

Antennal fossa. "The alveolus or cavity in the head capsule seating the antenna" (Dicke, 1962). See Figure 13.

Cephalic index (CI). 100(HW)/HL.

Clypeus. "A facial sclerite lying between the epistomal suture and the junction of the labrum with the head capsule; usually the region lying below the epistomal suture or anterior tentorial pits" (Dicke, 1962). See Figure 13.

Coxa (pl. Coxae). "The basal segment of the leg, by means of which it is articulated to the body" (Torre-Bueno, 1937).

Delimitation. "In taxonomy, a formal statement of the characters of a taxon which sets its limits" (Mayr, 1969).

Deme. A localized interbreeding population.

Epinotum. See propodeum and Figure 13.

Epistomal suture. "A transverse cranial suture bearing the anterior tentorial pits and demarcating the clypeus and the frons" (Dicke, 1962).

Femur (pl. femora). "The thigh; usually the stoutest segment of the leg, articulated to the body through trochanters and coxa and bearing the tibia at its distal end" (Torre-Bueno, 1937).

Femur Index (FI). 100(FW)/FL. Applicable to females (= queen) only, in this study.

Femur length (FL). Maximum length of the fore femur of female.

Femur width (FW). Maximum width of the fore femur of female.

Flagellum. "The distal annulations or segments of the antenna beyond the scape in ants" (Dicke, 1962).

Flexor surfaces. Surfaces which are brought together when a jointed structure is bent a joint.

Foveolate. "Surface that shows deep depressions with well marked sides. Foveolae may be described as rounded or elongate and are called piligerous foveolae when they surround the bases of the hairs" (Sparks, 1941).

Frons. "A facial area of the head dorsad of the epistomal suture and between the compound eyes" (Dicke, 1962).

Frontal area. A small median triangular plate on the anterior surface of the head, just above the clypeus. See Figure 13.

Frontal carina. A carina or ridge forming the median boundary of the antennal fossa. See Figure 13.

Gaster. "A special term occasionally applied to the metasoma, or terminal major body part of ants" (Wilson, 1971).

Gena (pl. Genae). "The cheek; the part of the head on each side below the eyes, extending to gular suture" (Torre-Bueno, 1937). See Figure 13.

Gula. "The ventral sclerite of the prognathous head bounded by the postoccipital (or gular) suture; probably a sclerotized expansion of the ventral cervex" (Dicke, 1962). The posterior surface of the head.

Head length (HL). Maximum measurable length of the head, held in perfect full-face view, from the anteriormost point of the clypeal border to occipital border, or to an imaginary straight line connecting posterior corners of head. See Figure 13.

Head width (HW). Maximum measurable width of the head from gena to gena immediately below the compound eyes in full-face view. See Figure 13.

Index. This term, as applied in various scientific disciplines, has emcompassed many widely divergent arithmetic combinations. In a more strict sense, index usually denotes the quotient of two minimal or maximal dimensions of a single anatomical structure, expressed as a percentage, and usually set up so as to make the resulting figure less than 100. Both femur and cephalic index are used in this study in conformity with this stricter definition. Neither the scape nor pronotum index is, however, an index, *sensu stricto*. Since in each case their dimensions are taken from two separate structures, it is more proper to call these ratios. There would seem to be little

merit, however, in proposing to change their formal designations to ratios at this late date (modified from Wing, 1968).

Major worker. "A worker of the largest subcaste" (Wheeler and Wheeler, 1963).

Mandibles. "The most anterior of the gnathal appendages; in the mandibulate forms, the jaws employed principally for cutting, crushing and grinding solid food" (Dicke, 1962). See Figure 13.

Maximum eye length (EL). Maximum measurable length of the compound eye.

Maximum eye width (EW). Maximum measurable width of the compound eye.

Media worker. A worker intermediate in size between majors and minors.

Meso-propodeal suture. The transverse seam separating the mesonotum from the propodeum. See Figure 13.

Mesothorax. The second segment of the thorax. See Figure 13.

Metatibial length (MTL). The maximum length of the metathoracic tibia.

Metathorax. "Collectively, the entire last or third metamere of the thorax" (Dicke, 1962).

Minor worker. A worker of the smallest subcaste.

Occiput. "A posterior sclerotized region of the head set iff by an occipital suture and lying between the vertex and genae and the postocciput" (Dicke, 1962). See Figure 13.

Occipital. Pertaining to the occiput, or uppermost part of the head.

Pedicel. The one (the petiole) or the two segments (the petiole plus the postpetiole) of the base of the abdomen (in ants) which are reduced and either modified or bearing an erect or inclined scale (modified from Wheeler and Wheeler, 1963). See Figure 13.

Perfect full-face view. To orient the head of the specimen in such a way that it has the maximum area visible along both the length and the width axes.

Petiole. In ants, a pedicel formed of only one segment.

Pilosity. The longer, reclinate, suberect or erect hairs found on the body of all castes.

Pleura. "Collectively the sclerites that comprise the lateral aspects of the thorax, between the tergum and sternum" (Dicke, 1962).

Polymorphism. In ants defined as the occurrence of nonisometric relative growth occurring over a sufficient range of size variation within a normal mature colony to produce individuals of distinctly different proportions at the extremes of the size range (Wilson, 1971).

Promesonotal suture. "The transverse seam separating the pronotum from the mesonotum" (Wheeler and Wheeler,1963). See Figure 13.

Pronotum. The upper surface of the prothorax. See Figure 13.

Propodeum. An equivalent of the term epinotum as used by earlier myrmecologists. It is embryologically the first segment of the abdomen, which in the higher Hymenoptera becomes fused with the posterior thorax to form the alitrunk of the adult.

Prothorax. "The entire or first metamere of the thoracic tagma" (Dicke, 1962).

Pubescence. The minute, appressed tomentum which may cover the whole or portions of the body and appendages. Pubescence usually underlies the pilosity and is short and delicate in most species.

Pterothorax. "That portion of the specialized thorax which supports and manipulates the flight mechanism; specially the mesothorax and metathorax of flying insects" (Dicke, 1962).

Scape. "In ants, the greatly elongated basal segment of the antenna" (Wheeler and Wheeler, 1963). See Figure 13.

Scape index (SI). 100(SL)/HW.

Scape length (SL). Maximum measurable length of scape excluding the articular condyle and neck. See Figure 13.

Shagreened. A surface roughened with minute tooth-like projections or close set roughened. Shagreen may be striate or reticulate (modified after Sparks, 1941).

Standing hairs. "Pilosity that forms an angle at 45 degree or more with the cuticular surfact, i. e., subdecumbent, suberect, or erect" (Wing, 1968).

Sympatric populations. Populations of two or more taxa that overlap or are so close geographically, that the maximum distance between the ranges is equal to or less than the sum of the natural cruising ranges of the reproductive castes.

Thorax. The body region behind head which bears legs and wings (if present). "The ambulatory tagma of an insect's body composed of three metameres and bearing the legs and wings" (Dicke, 1962).

Tibia (pl. tibiae). The fourth division of an insect's leg between the femur and the tarsus.

Tomentum. "A form of pubescence composed of matted, woolly hair" (Torre-Bueno, 1937).

Trochanter. The small leg segment between coxa and femur.

Vertex. The top of head, between compound eyes and in front of occipital margin. "The cranial area above the frons and between the compound eyes" (Dicke, 1962).

Weber's length of alitrunk (WL). Maximum measurable midline length of alitrunk from anterodorsal margin of pronotum to flange on posteroventral apex of propodeum. In practice, this measurement is often taken from the side.

Literature Cited

Baroni-Urbani, C. 1971. Personal communication.

Blackwelder, R. E. 1967. Taxonomy: A Text and Reference Book. John Wiley and Sons, Inc. New York. 698 p.

Bolton, B. 1972. Personal communication.

Borgmeier, T. 1927. Catalogo systematico e synonymico das formigas do Brasil 2ª Parte. Subf. Pseudomyrmicinae, Myrmicinae, Formicinae. Arch. Mus. Nacion. Rio de Janeiro 29: 69-164.

— 1934. Contribuição para o conhecimento da fauna mirmecológica dos cafezais de Paramaribo, Guiana Holandesa (Hymenoptera: Formicidae). Arq. Inst. Biol. Veget. Rio de Janeiro 1 (2): 93-111.

Boughey, A. S. 1968. Ecology of Populations. The MacMillan Company. 135 p.

Bruch, C. 1922. Estudies mirmecológicos 1. La Plata Rev. del Mus. 26: 175-211.

Buckley, S. B. 1886. Description of new species of North American Formicidae. Proc. Entom. Soc. Phil. 6: 152-161.

Carson, H. L. 1955. The genetic characteristics of marginal populations of *Drosophila*. Cold Spr. Harb. Symp. Quant. Biol. 20: 276-287.

Cooley, W. W. and P. R. Lohens. 1962. Multivariate Procedures for the Behavioral Sciences. New York. 211 p.

Costa, G. 1942. Ordem Hymenoptera. Rev. Agron. Porto Alegre, Brazil 6: 568-569.

Crawley, W. C. 1916. Ants from British Guiana. Ann. Mag. Nat. Hist. 17 (8): 366-378.

Creighton, W. S. 1938. On formicid nomenclature. Jour. New York Ent. Soc. 46 (1): 1-9.

— 1950. Ants of North America. Mus. Comp. Zool. Bull. Harvard 104: 396.

— 1972. Personal communication.

Da Cunha, A. B. and T. Dobhansky. 1954. A further study of chromosomal polymorphism in *D. willistoni* in its relation to environment. Evolution 8: 119-134.

Dalla Torre, K. W. 1893. Cat. Hym. (= Catalogus Hymenopterorum hucusque descriptorum systematicus et synonymicus) 7: 219.

Dicke, J. D. 1962. An Outline of Comparative Insect Morphology. A manuscript, Department of Entomology, University of Wisconsin, Madison. 356 p.

Dixon, W. J. and T. W. Anderson. 1958. Introduction to Multivariate Statistical Analysis. John Wiley and Sons, Inc., New York.

Draper, N. R. and H. Smith. 1966. Applied Regression Analysis. John Wiley and Sons, Inc., New York. 407 p.

Durrant, S. D. 1955. In Defense of the Subspecies. Syst. Zool. 4 (4): 186-90.

Eidmann, H. 1936. Oekologisch-faunistische Studien an südbrasilianischen Ameisen. Arb. Physiol. angew. Ent. Berlin 3: 26-114.

Emery, C. 1890. Voyage de M. E. Simon au Venezuela. (Decembre 1887-April 1888). Ann. Soc. Ent. France 10 (6): 55-70.

— 1893. Tabulation of the N. American species and varieties. Zool. Jahrb. Syst. 7: 760-778.

— 1894. Viaggio del dottor Alfredo Borelli nella Republica Argentina e nel Paraguay VIII. Formiche pp. 1-4. Boll. Mus. Zool. Torino 9 (186): 2-3.

— 1896. Saggio di un catalogo sistematico dei generi *Camponotus, Polyrchachis* e affini. Mem. Acad. Sc. Bologna (Italy) 5: 761-780.

— 1905. Studi sulle formiche della fauna neotropica XXVI. Formiche raccolte dal Prof. F. Silvestri nell' Argentina e nelle regioni Limitrofe dell'Uruguay, del Brasile, del Paraguay e del Cile. Firenze. Bull. Ent. Soc. Ital. 37: 107-194.

— 1920. Le Genre "*Camponotus*" Mayr, Nouvel Essai de sa subdivision en sous-genres. Rev. Zool. Afric. Bruxelles, 8: 229-260.

— 1925. Hymenoptera. Fam. Formicidae. In P. Wytsman *Genera Insectorum*, fasc. 183. V. Verteneuil and L. Desmet, Brussels.

Fabricius, J. C. 1775. Syst. Ent. p. 391.

— 1804. Syst. Piez. Pp. 305-428.

Ford, E. B. 1940. Polymorphism and taxonomy. In the New Systematics (J. Huxley, ed.), pp. 493-513. Oxford University Press, London and New York.

Forel, A. 1879. Etudes Myrmécologiques en 1879. Bull. Soc. Vaud. Sc. Nat. 16: 53-107.

— 1884. Etudes Myrmécologiques en 1884. II. Description d'espèces nouvelles ou peu connues. Bull. Soc. Vaud. Sci. Nat. 20: 320-340.

— 1896. Ants nests. Smithsonian Report for 1894. Pp. 479-505.

— 1897. Quelques Formicides de l'Antille de Grenada recoltées par Mr. H. H. Smith. Trans. Ent. Soc. London. Part III. Pp. 297-300.

— 1900. Biol. Centr. Amer. (= Biologia Centrali Americana) Hymenoptera. 3: 1-169, 4 Pls.

— 1902. Quatre notices Myrmécologiques 1. Les *Camponotus* de mon voyage en Colombia et aux Antilles. Bull. Ann. Soc. Ent. Belg. 46: 107-182.

— 1904. Miscellanea Myrmécologique. Rev. Suisse Zool. 12: 1-52.

— 1907. Formiciden aus dem Naturhistorischen Museum in Hamburg. Mitt. Naturh. Mus. Hamburg. 24: 1-20.

— 1908. Ameisen aus São Paulo (Brasilien), Paraguay, etc., gesammelt von Prof. H. Von Ihering, Dr. Lutz, Dr. Fiebrig, etc. Verh. Zool. bot. Ges. Wien. 58: 340-418.

— 1909. Ameisen aus Guatemala usw, Paraguay and Argentinien II. Paraguay Deut. Ent. Zeitschr. 239-269.

— 1911. Ameisen des Herrn Prof. V. Ihering aus Brasilien (São Paulo usw. nebst. einigen anderen. Deut. Ent. Zeitschr. Pp. 285-312.

— 1912. Formicidae Neotropiques Part IV. Sous-famille Camponotinae. Mem. Soc. Entom. Belg. 20: 59-92.

— 1913 Fourmis d'Argentine, du Brésil, du Guatemala et de Cuba. Bull. Soc. Vaud. Sc. Nat. 49: 203-250.

— 1914a. Le genre *Camponotus* Mayr et les genres voisins. Rev. Suiss Zool. 22: 257-276.

— 1914b. Quelques fourmis de Colombie. Neuchatel Mem. Soc. Sci. Nat. 5 (2): 9-14.

— 1922. Glanures myrmécologiques en 1922. Rev. Suiss Zool. 30 (3): 87-102.

Fred-Smith. 1858. Cat. Hym. Brit. Mus. (= Catalogue of Hymenopterous Insects in the Collection of the British Museum) 6: 43-54.

Gilham, N. W. 1956. Geographic variation and the subspecies. Syst. Zool. 5 (3): 110-120.

Kempf, W. W. 1959. Insecta Amapaensia-Hymenoptera. Formicidae. Studia Ent. Petropolis 2: 209-218.

— 1960. Miscellaneous studies on Neotropical ants. (Hymenoptera: Formicidae). Studia Ent. Petropolis 3: 385-400.
Kusnezov, N. 1952. El genero *Camponotus* en la Argentina (Hymenoptera: Formicidae). Acta Zool. Lilloana. Tucuman 12 (1951) 1952.
Kutter, H. 1931. Verzeichnis der entomologischen Arbeiten von Prof. Dr. August Forel. Mitt. Schweiz. ent. Ges. 15: 60-63.
Latreille, P. A. 1802. Hist. Nat. Fourmis.
Levins, R. 1963. Theory of fitness in a heterogeneous environment. Developmental Flexibility and Niche Selection. Am. Nat. 97: 75-90.
Lindroth, C. H. 1957. The linnaean species of Carabid beetles. J. Linn. Soc. Zool. 43: 325-341.
Ludwig, W. 1950. Zur Theorie der Konkurrenz. Die Annidation (Einnistung) als fünfter Evolutionsfaktor, Neue Ergeb. Probleme Zool. Klatt. Festschrift. 516-537.
Luederwaldt, H. 1918. Notas myrmecologicas. Rev. Mus. Paulista 10: 31-60.
— 1926. Observações biológicas sobre formigas brasileiras especialmente do Estado de São Paulo. Rev. Mus. Paulista 14: 185-304.
Lund, P. W. 1831. Lettre sur les Habitudes de quelques Fourmis du Brésil, addressée a M. Audouin, Ann. Sc. Nat. 23: 113-138.
Mann, W. M. 1916. The Stanford Expedition to Brazil. 1911, John C. Branner, Director. The ants of Brazil. Bull. Mus. Comp. Zool. Harvard 60: 399-490.
— 1922. Ants from Honduras and Guatemala. Proc. U.S. Nat. Mus. 61 (13): 1-54.
Mayr, E. 1954. Notes on nomenclature and classification. Syst. Zool. 3: 86-89.
— 1963. Animal species and evolution. Belknap Press. Harvard University Press, Cambridge, Massachusetts. 797 p.
— 1969. Principles of Systematic Zoology. McGraw-Hill Book Company, New York. 426 p.
Mayr, G. 1853. Beiträge zur Kenntniss der Ameisen. Verh. Zool. bot. Ges. Wien. 3: 101-114.
— 1861. Die Europäischen Formiciden. Wien.
— 1862. Myrmecologische Studien. Verh. Zool. bot. Ges. Wien. 12: 649-766.
— 1863. Formicidarum Index Synonymicus. Verh. Zool. bot. Ges. Wien. 13: 385-460.
— 1870. Formicidae novograndensis. Sitzber. Akad. Wiss. Wien. 61: 370-417.
— 1886. Die Formiciden der Vereinigten Staaten von Nordamerika. Verh. Zool. bot. Ges. Wien. 36: 419-464.
— 1887. Südamerikanische Formiciden. Verh. Zool. bot. Ges. Wien. 37: 511-632.
Mennozzi, C. 1927. Formiche raccolte dal Sig. H. Schmidt nei dintorni di San Jose di Costa Rica. Ent. Mitteil. 16: 336-345.
— 1935. Spedizione del Prof. Nello Beccari nella Guiana Britannica, Hymenoptera-Formicidae. Redia Florence 21: 189-203.
Norton, E. 1868a. Notes on Mexican Ants. Amer. Nat. 2: 56-73.
— 1868b. Description of Mexican ants noticed in the American Naturalist April 1868. Proc. Essex. Instit. 6: 1-10.
— 1879. Notas Sobre las Hormigas Mexicanas. Nat. Mex. 3: 179-190.
Parkes, K. C. 1955. Sympatry, Allopatry and subspecies in birds. Syst. Zool. 4 (1): 35-40.
Petersen, B. 1947. Die geographische Variation einiger Fennoskandischer Lepidopteren. Zool. Bidrag. 26: 329-531.

Reyment, R. A. 1969. Biometrical Techniques in Systematics. Pages 543-594. In Systematic Biology. Publication No. 1892, National Academy of Sciences, Washington, D.C.
Roger, J. 1862. Synonymische Bemerkungen. Berl. Entom. Zeitschr. 6: 283-298.
— 1863. Die neue aufgeführten Gattungen und Arten meines Formicidenverzeichnisses nebst Ergänzung einiger früher gegebenen Beschreibungen. Berl Ent. Zeitschr. 7: 131-214.
Rohlf, F. J. 1965. Multivariate methods in taxonomy. Proc. IBM Sci. Comp. Symp. Statistics, IBM, White Plains, New York. 323 p.
Rudow. 1914. Die Wohnungen der Ameisen. Ent. Rundsch. 30: 135-137.
Sammeta, K. P. V. and R. Levins. 1970. Genetics and Ecology. Ann. Rev. Genetics 1: 469-488.
Santschi, F. 1915. Description de Fourmis nouvelles. Ann. Soc. Ent. France 84: 497-513.
— 1922. Camponotus néotropiques. Ann. Soc. Ent. Belg. 62: 97-124.
— 1925. Nouveaux Formicids brésiliens et autres. Bull. Ann. Soc. Ent. Belg. 65: 221-247.
— 1929. Nouvelles fourmis de la république Argentine et du Brésil Ann. Soc. Cien. Argentina 107 (4): 273-316.
— 1936. Contribution a l'étude des fourmis de l'Amérique du sud. Rev. Ent. Rio de Janeiro 6: 196-218.
— 1939. Etudes et descriptions de fourmis néotropiques. Rev. Ent. Rio de Janeiro 10: 312-330.
Schneirla, T. C. 1944. Behavior and ecological notes on some ants from South-Central Florida. Amer. Mus. Novitates No. 1261, Pp. 3-5.
Smith, H. M. and F. N. White. 1956. A case for the Trinomen. Syst. Zool. 5(4): 183-190.
Smith, M. R. 1947. A generic and subgeneric synopsis of the United States ants based on the workers. Amer. Midl. Naturalist 37 (3): 521-648.
Sokal, R. R. 1965. Statistical methods of systematics. Biol. Rev. 40: 337-391.
Sparks, S. D. 1941. Surface anatomy of ants. Ann. Ent. Soc. America 34 (3): 572-579.
Stärcke, A. 1945. Mededeeling over Cephalotes atratus Latr. (Hym. Form). Ent. Ber. 11: 263-266.
Stitz, H. 1933. Neue Ameisen des Hamburger Museums (Hym. Form.) Mitteil. Deut. (= Deuts.) Ent. Ges. 4 (5): 67-75.
Torre-Bueno, J. R. de la. 1937. Glossary of Entomology. Brooklyn Entomol. Soc. 336 p.
Wheeler, G. C. and J. Wheeler. 1953. The ant larvae of the subfamily Formicidae. Ent. Soc. Amer. Ann. 46: 175-217.
— 1963. The Ants of North Dakota. University of North Dakota, Grand Forks. 326 p.
Wheeler, W. M. 1907. A collection of ants from British Honduras. Bull. Amer. Mus. Nat. Hist. 23: 271-277.
— 1910. The North American ants of the genus *Camponotus* Mayr. Ann. N. York Acad. Sc. 20 (6): 295-354.
— 1911. Ants collected in Grenada, W. I. by C. T. Brues. Bull. Mus. Comp. Zool. Harvard 54: 167-172.
— 1913. Corrections and additions to "list of type species of the genera and subgenera of Formicidae". Ann. N. York Akad. Sc. 23: 77-83.
— 1916. Ants collected in British Guiana by the expedition of the American Museum of Natural History during 1911. Bull. Amer. Mus. Nat. Hist. 35: 1-14.

— 1917. Jamaican ants collected by Prof. C. T. Brues. Bull. Mus. Comp. Zool. Harvard 51 (13): 457-471.
— 1921. A new case of Parabiosis on the Ant-Gardens of British Guiana. Ecology 2: 89-103.
— 1923. Wissenschaftliche Ergebnisse der Schwedischen entomologischen Reise des Herrn Dr. A. Roman in Amazonas 1914-1915. Ark. Zool. 15 (7): 1-6.
— 1932a. The Templeton Crocker expedition of the California Academy of Sciences, 1932. Formicidae of the Templeton Crocker Expedition. Proc. Calif. Acad. Sci. 21 (4): 4-63.
— 1932b. A list of Florida ants with descriptions of new forms. Jour. N. York ent. Soc. 40: 1-17.
— 1933. Mermis parasitism in some Australian and Mexican ants. Psyche 40 (1): 20-31.
— 1934. Ants from the Islands of the West Coast of Lower California and Mexico. Pan Pacific Entomologist 10: 132-144.
Wheeler, W. M. and J. C. Bequaert. 1929. Amazonian myrmecophytes and their ants. Zool. Anz. 82: 10-39.
Willis, H. L. 1967. Bionomics and zoogeography of tiger beetles of saline habitats in the Central United States (Coleoptera: Cicindelidae). Sci. Bull. University of Kansas. 47: 145-313.
Wilson, E. O. 1953. The Origin and Evolution of Polymorphism in Ants. Quart. Rev. Biol. 28 (2): 136-156.
— 1955. A monographic revision of the ant genus *Lasius*. Bull. Mus. Comp. Zool. Harvard 113: 1-205.
— 1971. The Insect Societies. The Belknap Press of Harvard University Press, Cambridge, Massachusetts. 548 p.
Wilson, E. O. and W. L. Brown. 1953. The subspecies concept and its taxonomic application. Syst. Zool. 2: 97-111.
Wing, M. W. 1968. Taxonomic revision of the Neartic genus *Acanthomyops* (Hymenoptera: Formicidae). *Memoire, Cornell University Agricultural*