Taxonomy and Diagnosis of *Conomyrma insana* (Buckley) and *C. flava* (McCook) (Hymenoptera: Formicidae)

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ABSTRACT

Documentation is developed for *Conomyrma insana* (Buckley) and *C. flava* (McCook) as valid names for two abundant species of ants in the United States. Taxonomic history, synonymies, diagnostic criteria, distribution and natural history for both species are reviewed. The intraspecific variability, particularly important for *C. flava*, is summarized. Neotype and lectotype specimens are designated for *C. insana* and *C. flava* respectively, and a key provided for all known *Conomyrma* species in the United States.

INTRODUCTION

This paper gives diagnostic criteria for two widely distributed ant species in the United States, *Conomyrma insana* (Buckley) and *C. flava* (McCook). These species are prominent, abundant ants and are ecologically significant, but current literature gives unsatisfactory definitions for their recognition. Both species were described from the United States well over a hundred years ago but, for the greater part of that time, lay in synonymy. In 1973 and 1984, both *C. insana* and *C. flava* respectively emerged as distinct species in the literature, still without definitive criteria, and junior synonyms were subsequently described.

Conomyrma is a genus in the subfamily Dolichoderinae and the type species is *C. pyramica* (Roger) of South America. In the ant fauna of the United States, members of the worker caste may be recognized by the following attributes. No constriction exists between the first and second segments of the gaster; the pedicel consists of a single segment, the petiole; the cloacal orifice is a transversely- oriented slit not surrounded by a ring of stiff, bristle-like hairs; the declivous face of the propodeum is straight or slightly curved in lateral profile, its cuticle thin without strong sculpture; the propodeum's upper surface bears a distinct tooth-like protuberance, the cone, pointing upward; the maxillary palp's third segment is as long or longer than total length of succeeding segments. All species nest in the soil of relatively open habitats.

MATERIALS AND METHODS

The majority of specimens contributing to this study were collected by the author at localities given in Tables 1 and 2 and shown geographically in Figure 1. Collections were taken directly at nest entrances by aspirator, some nests being excavated. Queens, in the alate phase, were obtained just before darkness when they emerge to the ground surface moving about the nest area preceding their mating flight; often they return below ground without flying. All nest series were retained separately. In this fashion, members of each series represent one colony and coexisting variants in single colonies identified. These methods and the ants' abundance allow collection of large samples from most colonies. Where possible, sufficient numbers were taken from each nest to reflect frequencies of different variants. Florida specimens were collected from 1983 through the fall of 1988. Material from other sites were taken in June and July of 1988 specifically for this study. In addition, several nest series were available for study from the G.C. and J. Wheeler Collection taken at various dates in their on-going study of ant larvae.

Dr. D. R. Smith, U. S. National Museum, Dr. D. Otte, the Philadelphia Academy of Science, Dr. C. Besuchet, Museum d'Histoire naturelle of Geneva, Switzerland, and C. Beeman, Texas Historical Society, all kindly provided specimens or researched information for this study. Their individual contributions are identified below. Dr. J.C. Trager gave the author voucher specimens associated with

TABLE 1. Localities for 30 nest-series of *Conomyrma insana*. Number of nests sampled and number of nests where alate queens found designated by n and q respectively.

STATE County	SAMPLE	STATE County	SAMPLE
TEXAS		FLORIDA	
Henderson	2n, 1q	Alachua	10n, 4q
Williamson	2n, 1q	Highlands	1n
		Levy	1n
LOUISIANA[1]		Marion	2n
Beauregard	1n	Okaloosa	2n
		St. Johns	3n
MISSISSIPPI		Suwannee	2n, 2q
Covington	1n		
GEORGIA			
Crisp	2n		
Franklin	1n		

[1]Parish, not county

his earlier study of southeastern *Conomyrma* (Trager, 1988).

The section on Taxonomic and Distributional History reviews, in chronological order, the different nomenclatural interpretations. This review is necessary to properly interpret the literature. A few direct quotations appear and terms, in parentheses within a quotation, are added by the author to clarify meanings; for example, current morphological terms have changed. Both taxa were described incompletely, no type specimens are known and no redescription, later than 1879, exists. Therefore, the classical association of specimen and name is not possible. The rationales for establishing these associations appear under Formal Determinations with Species Accounts where the species are discussed in the order of their original description; namely, *C. insana* and *C. flava* respectively.

All morphological terms are defined in standard insect references or Torre-Bueno (1962). The term alitrunk, for fused thorax and propodeum, is used following recent hymenopteran literature. Metric dimensions were taken on selected series of the worker samples identified below. All queens were measured for the traits discussed. These dimensions were measured with a Wild MS Stereo Microscope and ocular micrometer using 10X eye pieces and 50X objective. The head length, HL, viewing the head's upper or anterior surface perpendicular to its longitudinal axis or frontal view, is maximum length from clypeus' apical border to vertex. The Weber Length, WL, is alitrunk length in dorsal view from pronotum's anterior margin exclusive of cervical flange, usually not visible, to the metapleural flange's posterior margin. The HWL dimension is the HL + WL sum. Other dimensions, not required in the diagnoses, were taken for comparison to data reported by Trager (1988) and have definitions from that study. All specimens were mature adults involving no recognizable minima or nanitic ants, the initial workers of incipient colonies,

TAXONOMIC AND DISTRIBUTIONAL HISTORY

Original Descriptions: Buckley (1866) described, in an incomplete fashion, *C. insana* as *Formica insana* from "central Texas", and the species was subsequently referred to the genus *Dorymyrmex*. McCook (1879) described *C. flava* as "*D. flavus* n. var ", namely a variety of *C. insana*, from the "Southern States", and he redescribed that taxon under the name *D. insanus*. The Buckley Collection was later lost; however, two Buckley specimens of *C. insana* were in the Philadelphia Academy of Science when McCook worked, allowing an identification of the species. His 1879 study appeared in

a volume compiled by Comstock on insects and the cotton plant and specifically addressed ants observed to feed on destructive species. Specimens were obtained over an extensive region from numerous collectors, and McCook describes the area as ". . . extending from the Atlantic coast to Central Texas, embracing the States of North Carolina, Georgia, Alabama, Tennessee, Arkansas, Louisiana and Texas." The only southeastern state absent from the list is Florida where little cotton was grown at the time. Unfortunately, he did not identify the states where each species was specifically taken. For *C. insana,* he stated ". . . widely spread throughout tropical and subtropical America." For *C. flava,* he gave "Southern States." McCook personally collected and observed the ants in Texas, but these statements clearly show he did not limit these species to Texas or the southwestern area.

McCook's redescription of *C. insana* included figures of the insect's lateral and dorsal profiles plus the head's upper surface, the frontal or full-facial view. Drawings in the Comstock volume were credited to G. Marx and T. Pergande but the artist for ant figures was not specifically named. The figure shows less mesonotal angle, in lateral profile, than is typical of the species; however, proportions of head, petiole and eyes are rather unlike *Conomyrma* leaving the reader to question the figures' overall accuracy.

The most distinguishing criterion given for the two species in both original descriptions was color. Buckley, for *C. insana,* initiated his description with "Color black or brownish-black . . .", the remainder of his statement adding little to the diagnosis. McCook gave "Abdomen, tip of scale (petiole) and cone, femur, tibia, vertex and flagellum, black or blackish. The face, except vertex, scape, tarsus, thorax (alitrunk) brown or brownish." For *C. flava,* he states, ". . . a uniform honey-yellow", and ". . . apex of abdomen (gaster) and flagellum of the antennae are tipped with a blackish hue". He adds the colors are ". . . quite permanent". McCook did consider structure and observed for *C. flava,* "The cone (of the propodeum) is evidently higher than the thorax (pro- and mesothorax)", a feature repeated by Forel (1899). The reason for this observation is puzzling as the same condition exists in *C. insana* and exists in the accompanying figure of that species. McCook then disturbs his reader by noting the alitrunk, thorax in his usage, of *C. flava* differs in shape from *C. insana* but without clarification and no figures of *C. flava* were given. This question is resolved below in Species Accounts.

Behavorial differences also exist between the two species. Buckley, for *C. insana,* drew attention to its "very active and war-like" behavior referring to it as the "crazy ant". McCook also noted its "erratic", "vigorous and active" nature. In later years, McCook (1909) treated *C. flava* as a distinct species.

Revisions: The history of these species is intricately connected to *C. pyramica,* described from Brazil as *Prenolepis pyramica* by Roger (1863). Shortly later, Mayr (1866) defined the genus *Dorymyrmex* for the group including *D. pyramicus* and all related North American species were referred to this genus for 107 years. Only seven years after the description of *D. flavus* in 1879, Mayr (1886) placed both *D. insanus* and *D. flavus* in synonymy with *D. pyramicus*. This treatment was revised 13 years later by Forel (1899) in recognizing *flavus* as a race or subspecies and *insanus* as a synonym of *D. pyramicus* respectively. This interpretation remained essentially unmodified for 51 years; however, other taxonomic refinements were made. Pergande (1895) described *D. pyramicus* var *nigra* from south-central Mexico referring to dark-bodied ants, and several authors later applied the name to specimens in the United States. Three other subspecies were recognized in the United States up to 1944, but only one, *D. pyramicus flavopectus* Smith from south Florida, played a role in this history.

The first reviser of *Dorymyrmex* in the United States was Creighton (1950). He placed both *insanus* and *flavus* in synonymy with *D. pyramicus* and continued recognition of *D. pyramicus flavopectus*. The species, *D. pyramicus,* was then thought to range from the United States to Argentina. The European workers, Mayr and Forel, (1) had no opportunity to observe live colonies and (2) worked with museum specimens probably not grouped into nest series. The dark-bodied specimens of *flavus* were likely interpreted as intermediates with the blackish *insanus*. Creighton worked at a time when many names existed for North American ants based largely on color, a practice he deplored. He valued field observations; however, he was not acquainted with all concerned taxa. For *D. pyramicus,* including *insanus* and *flavus* as synonyms, he stated "The insect is exceeding rare in the Gulf Coast region and Florida. There it is replaced by the subspecies *flavopectus*." He clearly confused the yellowish *flavus*, a very common insect over most of the South with *flavopectus*. The true *flavopectus* lives in a limited habitat, the sand scrub of south Florida and possesses a very characteristic bicolored body pattern.

Two years after Creighton's work, Kusnezov (1952) working mainly with South American forms suggested *Conomyrma* as the subgenus for forms in North America. He also described *C. wheeleri* Kusnezov from Arizona based on two specimens. The name was never subsequently used. Wilson

TABLE 2. Localities for 92 nest-series of *Conomyrma flava*, arranged as in Table 1.

STATE County	SAMPLE
TEXAS	
Bastrop	3n
Grayson	1n
Llano	3n
Lubbock[2]	1n
McLennon	1n
Newton	2n
Rusk	1n
Smith	1n
Tyler	2n
Washington	2n, 1q
Williamson	3n
LOUISIANA[1]	
Beauregard	2n
St. Tammy[2]	2n
MISSISSIPPI	
Jackson	1n
Simpson	2n
ALABAMA	
Baldwin	1n
Choctaw	2n
Conecuh	1n
Mobile	2n
GEORGIA	
Chatham	1n
Crisp	1n
Hart	1n
NORTH CAROLINA	
Robeson	1n
FLORIDA	
Alachua	20n, 6q
Calhoun	2n, 1q
Clay	1n
Columbia	4n
Flagler	5n, 1q
Hendry	1n
Highlands	1n
Leon	3n
Levy	3n, 1q
Marion	3n
Nassau	3n
Okaloosa	2n
Santa Rosa	2n, 1q
St. Johns	5n, 2q

[1] Parish, not county. [2]Site not shown on map in Figure 1.

(1957) shortly later used the name *Conomyrma* as a genus for North American species and questioned Creighton's synonymies. Twenty-three years after Creighton's work, Snelling (1973) again revised the United States fauna. The study (1) formally elevated the subgenus *Conomyrma* Forel 1913 to full generic status for all North American forms, (2) restricted the true *C. pyramica* (Roger) to South America or well south of the United States, and (3) recognized three species in the United States, *C. bicolor* (Wheeler), *C. flavopectus* (Smith), and *C. insana* (Buckley). The species, *C. bicolor*, occurs in the west and appears distinct from both *C. flava* and *C. insana*. No synonyms were assigned to *C. flavopectus* but the names *flavus* and *pyramicus* in the U. S. literature, *nigra*, *wheeleri* and two subspecific taxa not affecting ants in the United States were placed in synonymy with *C. insana*. Objectives (1) and (2) above plus recognition of *C. bicolor* appear as well-supported contributions. His treatment of *C. insana* and *C. flavopectus* was troubled. An angular lateral profile of the alitrunk alone defined *C. insana*. The alitrunk criterion is inconsistent within some colonies and other attributes posed further difficulties. All specimens with a smoothly convex upper margin to the alitrunk were named *C. flavopectus*. Ants clearly distinct from the true *C. flavopectus* were so-named. Again, the true *flavopectus* was unrecognized and the variability of ants known as *C. insana* not mentioned.

These taxonomic changes may be summarized as follows. Buckley's *Formica insana*, described in 1866, was reassigned to *Dorymyrmex* and fell into synonymy with *D. pyramicus* in 1886. The name remained in this state for 87 years until it resurfaced as *C. insana* in 1973 though without satisfactory distinction. McCook's *D. flavus* was described in 1879, treated as a variety or subspecies of *D. pyramicus* from 1899 until 1950, then synonymized with that species. In 1973 the form was reassigned as a synonym of *C. insana*.

Following the 1973 revision, W.F. Buren discovered undescribed *Conomyrma* species in Florida and recognized the inappropriate usage of *C. flavopectus* in earlier studies. He died before publishing his findings. By restricting the name *C. flavopectus* to the ant described by Smith (1944), the remaining southeastern species were thought with one exception, *C. grandula* (Forel), to be undescribed. Buren also concluded that McCook's *flavus* was a distinct species. Cokendolpher and Francke (1984) studied the karyotype in specimens determined as *C. flava* from Kerr County, Texas. The authority for their determination was based on the statement "*Conomyrma flava* determined to be a valid species by the late William F. Buren (J.C. Trager, pers. comm.)". No further documentation or diagnosis of the species was given and Buren's concept of *C. flava* remains unknown.

Following Buren's death Trager (1988) revised *Conomyrma* in the southeastern United States giving keys, descriptions and figures for determinations. Two new forms, *C. medeis* Trager and *C. reginicula* Trager were named and are very similar to *C. insana*. He notes the workers are difficult to recognize but concludes "the queens are separated by consistently distinctive morphological and metric characteristics, and I do not hesitate to state that they are all good species". Characteristics separating these new taxa from *C. insana* were however not given. He notes *C. insana* is ". . . a western species" and his westernmost specimens for the new forms were from west Florida. Trager (1988) also commented on behavior stating for one form, "*C. medeis* is a highly aggressive ant which allows few other ants to nest within its territories", an observation reminiscent to the earlier comments by Buckley and McCook.

Trager recognized *C. flava* as distinct based on "*C. flava* was recently reported as (a) species distinct from *C. insana* (Cokendolpher and Francke, 1984)", namely the unsupported recognition by those authors cited above. Another new southeastern form, *C. bureni* Trager was described and comments were given on separating it from *C. flava*. He notes for *C. flava*, "most workers of any nest series, the mesonotum has distinct dorsal and declivous faces", and for *C. bureni*, ". . . rarely shows even a trace of distinct basal and declivous faces in mesonotal profile". He also notes the males of *C. flava* may have smaller ocelli than *C. bureni* males, a night-flying species. He depicts *C. flava* as "Texas and southern plains-state species very similar to *C. bureni* in gross worker morphology and in its ecology." His westernmost record for *C. bureni* was Franklin County, Mississippi.

Distributions: The distributions reported by Trager (1988) suggest both *C. insana* and *C. flava* are western forms and disjunct from similar species in the Southeast. The evidence from the original descriptions and later faunal studies do not support that interpretation. Buckley's *insana* fell into synonymy in 1886 and regional surveys did not use the name until 1973. After that date, authors clearly referring to black-bodied *C. insana* reported the species from South Carolina (Van Pelt and Gentry, 1985), Florida (Nickerson, et. al. 1975a, 1975b; Buren, et. al. 1975; Nickerson, et. al. 1977), Louisiana (Markin, et. al. 1974), Arkansas (Roe, 1973), and Texas (Wheeler and Wheeler, 1985). The states of Mississippi and Georgia are included using pre-1973 records clearly identifying black *Conomyrma*, and recent collections reported below confirm those states in the species range. Thus the literature and recent collections point to a continuous distribution of *C. insana*-like ants across the southeastern United States as implied by McCook (1879).

During the period *D. pyramicus flavus* was recognized, 1899 to 1950, several regional surveys were prepared. In examining some papers of that era, the reader will encounter the name *D. pyramicus flavus* Pergande. An ant of that name was never described by Pergande and it is clear that McCook's *flavus* was intended by all authors. The usage traces to W.M. Wheeler who also miscited a *Crematogaster* species to Pergande (Johnson, 1988). Also, McCook's name is not infrequently spelled as MacCook.

From the lists, one finds *D. pyramicus flavus* reported in South Carolina (Smith, 1918, 1934), Georgia (Wheeler, 1913), Florida (Wheeler, 1932; Van Pelt, 1948), Mississippi (Smith, 1924), Tennessee (Dennis, 1938; Cole, 1940), Oklahoma (Smith, 1935) and Texas (Mitchell and Pierce, 1912; Smith, 1936). In the hymenopteran catalog compiled before Creighton's revision, Smith (1951) reported the range as "approximately southern half of the United States." Thus *C. flava*, while recognized as *D. pyramicus flavus* was viewed as occurring all across the southeastern United States reflecting McCook's observation "Southern States".

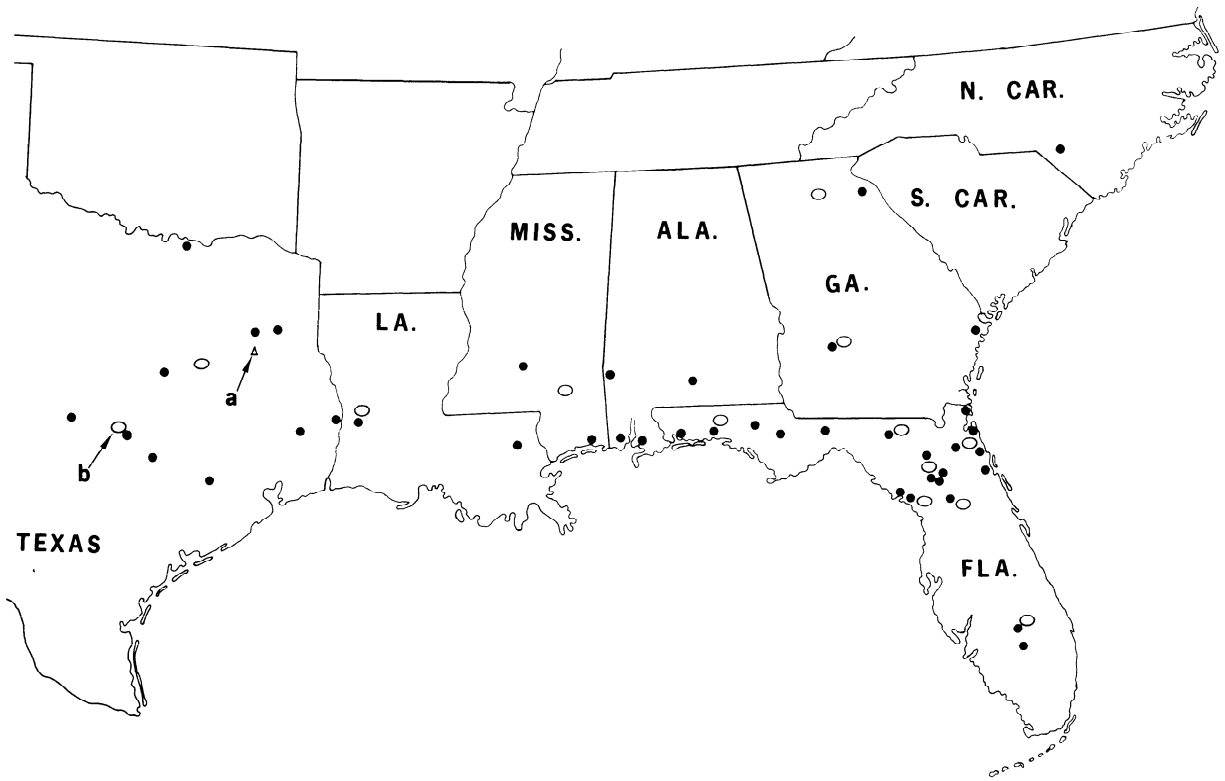

Figure 1. Geographic distribution of collection sites identified in Tables 1 and 2 for *Conomyrma insana* (open ovals) and *C. flava* (closed circles). Lectotype and neotype sites for *C. flava* and *C. insana* shown as a and b respectively.

NATURAL HISTORY

A study of colony attributes in these species with complete citations will appear in a separate report; the review given here, however, orients the reader to the ants discussed. Both *C. insana* and *C. flava* nest in open, often disturbed terrain lacking closed forest canopy and frequently occur about human developments. Nests are in sandy or friable soils particularly about patchy, poorly developed sod; sites of poor drainage with high clay content such as mud flats bordering marshes are avoided. Nest entrances are surrounded by symnetrically-shaped craters of excavated soil and the entrance hole is usually larger in diameter for *C. flava* than with *C. insana*. A polydome colony structure exists in both species but its documentation in *C. flava* requires extended observations over the 24 hour daily cycle.

Colony number of *C. flava* is higher than observed for *C. insana;* however, larger worker populations per colony often develop in the latter species. On favorable days, large numbers of *C. insana* workers are active about the nest complex. Within this maze of ants, one or several distinct columns typically exist involving individuals moving toward foraging sites and others returning to the nest area. Still other workers are moving in apparent disorganized fashion between different nest entrances exhibiting "erratic" or "crazy" behavior. These activities are typically without recognizable purpose. The ants' black bodies on light-colored soils attract notice to their activity. Other species chancing near such nests are quickly attacked contributing to earlier authors' comments on aggression. This activity occurs throughout diurnal hours in the warm season, often extending into the night.

Workers are also active about *C. flava* nests but numbers are generally fewer and their yellowish bodies on the typically light-colored soils attract less notice. The observer also notes a less frantic "erratic", "crazy," pace to their movements. The activity may include columns of moving workers but such concerted, oriented behavior is often absent. Independent foraging by the workers is more charac-

teristic of this species. A peak of worker activity often develops in the late afternoon that has not been noted in *C. insana*. The activity of *C. insana* on ground surface declines rapidly with the onset of cool weather whereas *C. flava* workers forage on mild days throughout the winter, at least in the southern part of the range.

Both species feed on honey-dew from various homopterans, scavenge small invertebrate remains and attack small, soft-bodied prey, Within this array of nutritional sources, at least temporary differences in food preference exist both between the two species and conspecific colonies. Mixed nests of *C. insana* and *C. flava* have been reported where the former species was described as a temporary social parasite (Buren, et. al. 1975). I have observed both species living in intimate sympatry in fields about Gainesville, Florida, for several years. In this time, I have found two such mixed nests. In one nest, alate queens of *C. flava* existed. Both nests were abandoned within one month following the initial observation. Clearly, the parasitism is not obligate for *C. insana* and appears to be an uncommon condition with unclear consequences for reproduction.

Mating flights of *C. flava* in Florida may occur from late May into early September, prehaps later in more southern sites. Alates emerge near dusk and fly just before full darkness. My limited observations of alates in Texas indicate a similar pattern of activity. Mating flights of *C. insana* are poorly known. Alates will emerge from nests at dusk, circle or parade about the nest area attended by many workers but re-enter the nests without flying. At this writing, I have observed only one flight occurring shortly after midnight in late July.

SPECIES ACCOUNTS

Conomyrma insana (Buckley)

Dorymyrmex pyramicus (Roger), 1863. p. 160. [= *Conomyrma pyramica* (Roger)]. Most U.S. records of dark-bodied specimens prior to 1973 reflect *C. insana*.
Formica insana Buckley, 1866. p. 165.
Dorymyrmex pyramicus var *smithi* Cole, 1936. p. 120.
Conomyrma wheeleri Kusnezov, 1952, p. 438.
Conomyrma medeis Trager, 1988. p. 25.
Conomyrma reginicula Trager, 1988. p. 27.

Species Diagnosis

The worker of *C. insana* has a slight to distinctly concave occipital border; the head, alitrunk and gaster predominately dark brown to black; lateral mesonotal profile angular; no erect pilosity on alitrunk; the propodeal dorsal surface anterior to cone slightly uplifted in a convex swelling. The queen is bicolored; namely, orange to reddish-brown head and alitrunk with black gaster; the occipital border is clearly concave; the HWL is 3.58 or less.

Formal Determination: Buckley's 1866 description and McCook's 1879 redescription both characterized *C. insana* rather incompletely. No type specimen, if ever designated, has survived; however, both authors stressed its blackish color. *Conomyrma insana* is fortunately the only black-bodied *Conomyrma* described or reported in or near Texas, its type locality, and is distinct from smoky-grey specimens of *C. flava*. The black-bodied *Conomyrmas* from Texas, Florida and intervening sites share morphological attributes and exhibit similar behavior. Snelling's (1973) criterion for *C. insana* is compromised since *flavus* was a synonym. Trager (1988) gave a more complete description of *C. medeis*, a junior synonym of *C. insana*, and is the best portrayal of the species. The attributes include an angular mesonotum, the structural trait referred indirectly to *C. insana* by McCook as explained shortly.

Specimens Studied: Localities for *C. insana* specimens collected in this study appear in Table 1 involving 30 nest series over four states from the Atlantic Coast of Florida to central Texas; the geographic dispersion of these sites appears in Figure 1. The total sample consisted of 425 workers and 21 queens. Numbers taken per nest ranged from 8 to 43 workers and 1 to 8 queens where this caste was found. Sites for queens appear in Table 1. The type locality was "central Texas" and the Williamson county site, designated b in Figure 1, is near the geographic center of that state. I am designating a neotype worker and queen from that locality to be deposited in the U.S. National Museum.

WORKER ATTRIBUTES

Color and Pilosity: The head and alitrunk are dark brown, the gaster is black or darker than rest of body. The head's upper surface is near-black in some specimens and brown of the alitrunk extends downward over lateral sides to and including the coxae. Appendages are also black or dark brown, and eyes are dark grey. Pilosity of upper alitrunk and gaster is a fine pubescence dulling the cuticle's reflectivity noticeably in some specimens. No erect hairs exist on upper alitrunk and gaster surfaces.

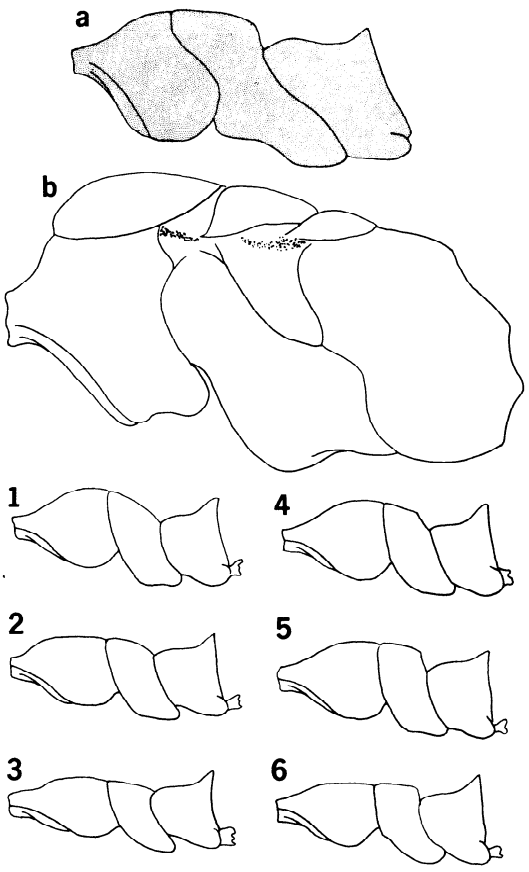

Figure 2. Alitrunk profiles in left lateral view. *Conomyrma insana* worker, a, and queen, b. Variability in worker profiles of *C. flava*, 1 to 6. See text for dimensions.

Alitrunk Profile and Propodeal Cone: The alitrunk profile in lateral view has an angular intersection of the dorsal and declivous faces of the mesonotum. See discussion of *C. flava* regarding McCook's early reference to alitrunk shape. A small convex bulge typically occurs anterior to the cone on the propodeum's surface, Figure 2 A. Variability of alitrunk and cone is minor, consisting mainly of a more convex pro- and mesonotal profile in some specimens.

Occipital Border: The head's occipital border must be examined with its longitudinal axis parallel to the line of vision. The border is clearly to slightly concave.

From 38 and 34 workers from Henderson County, Texas, and Alachua County, Florida, respectively, 24 and 30 or 63.1 and 88.2 per cent possessed clearly concave borders. The 13 workers from Franklin County in northern Georgia included 9 ants, 69.2 per cent, with distinctly concave borders, The concave head is shown in Figure 4 A.

Metric Dimensions: Trager (1988) gave dimensions and their ratios of several structures for 25 specimens each of his taxa, *C. medeis*, and *C. reginicula* in Florida. I measured the two Texas and Florida samples cited above, 38 and 34 ants respectively, for those dimensions. The range of values in both samples overlap both upper and lower extremes given by Trager for both above taxa and means did not differ between Florida and Texas. The one dimension most indicative of size is HWL, defined above, and the overall mean of both samples was 2.18 mm from a range of 1.88 to 2.44 mm. The HL range was 0.78 to 1.08 with a mean value of 1.02 mm. The WL range was 1.08 to 1.36 mm. with a mean of 1.28 mm. No geographic variability was evident and further measurements were not made.

QUEEN ATTRIBUTES

Color and Pilosity: The queen is distinctly bicolored. The head, alitrunk, petiole, anterior part of the gaster's first segment and appendages are orange or, in museum specimens, reddish brown. Remainder of gaster is black. Pilosity similar to workers.

Occipital Border: This border in all queens studied is clearly concave and the head is broader than long, see Figure 4 B. The HL mean length was 1.20 mm. from a range of 1.08 to 1.24 mn.

Alitrunk and Body Dimensions: The alitrunk in a queen has no propodeal cone and the profile, in left lateral view, appears in Figure 2 B. Trager (1988) characterized queens largely on metric dimensions using HTL, total length index, equal to HL + TL. The term, HL, identifies head length but TL was undefined. His values agree however with HL + WL sums. The HWL dimension of queens ranged from 2.90 to 3.58 mm.; the range given for *C. medeis* was 3.24 to 3.50 mm, and the range for *C. reginicula* was 2.76 to 2.94 mm. The sample of 21 queens available in this study gives little insight on possible geographic variability; however, such variation is unlikely since the largest and smallest specimens were both taken from the same colony in Henderson County, Texas. The queen is smaller than seen in *C. flava*.

Buckley (1866) noted the thoracic width exceeded head width. Thorax width is variable and larger in young alate queens than in older, nonalate specimens when the flight muscles are no

longer used. The thoracic width comparison has therefore little or no taxonomic value.

SYNONYMY

The above synonymy treats names used in the United States fauna. The black or dark-bodied *D. pyramicus* cited in faunal lists are mostly *C. insana*. Cole (1936) described *D. pyramicus* var *smithi* from Nebraska. The description presents an ant quite similar to *C. insana*. Worker specimens from Grand Isle, Nebraska, close to the Cole collection site and in the Wheeler Collection, are similar to *C. insana* excepting a slight purplish hue in color. Trager (1988) used the name *C. smithi* as a distinct species but without supporting documentation. I follow Snelling (1973) in placing this name in synonymy with *C. insana*. The taxon, *C. wheeleri* Kusnezov, has never been used following its description and I agree with Snelling that it is also synonymous with *C. insana*.

Trager kindly gave the author identified workers of his new taxa, *C. medeis* and *C. reginicula*. Workers of both forms are consistent in all respects with *C. insana* from central Texas. Descriptions of queens for both *C. medeis* and *C. reginicula* likewise portray the *C. insana* queens from Texas though a larger size variation exists as noted. Queens from Alachua County, Florida, the type locality for both *C. medeis* and *C. reginicula* are indistinguishable from queens collected in Texas. The description of *C. reginicula* was based on small queen size though only four queens were available. The lower range of size, HWL, in *C insana* was 2.90 mn and the size range for *C. reginicula* was 2.76 to 2.94 mm, thus 1 to 3 queens of *C. reginicula* were smaller than observed in my material. However, the observed overlap clearly compromises this single difference. Recognition of both *C. medeis* and *C. reginicula* in the Southeast was made without comparable material from Texas and intervening sites. Both taxa are clearly synonyms of *C. insana* (Buckley).

DISTRIBUTION

Locality for the neotype is Williamson County, Texas. The range of *C. insana* extends across the southeastern United States from the Atlantic Coast into west Texas. The northernmost colonies have not been determined but the species, as *C. medeis*, was reported in North Carolina. The species also occurs in the western United States but subsequent study may find additional dark-bodied *Conomyrma* in that region. The species also extends southward into Mexico.

Conomyrma flava (McCook)

Dorymyrmex pyramicus (Roger), 1863. p. 160. [= *Conomyrma pyramica* (Roger)]. U.S. records of yellow-bodied specimens prior to 1973 reflect *C. flava*.

Dorymyrmex flavus McCook, 1879. p. 186.

Dorymyrex pyramicus var *flavus* Mayr, 1886. p. 433.

Dorymyrmex pyramicus var *nigra* Pergande, 1895. p. 871, Dark-bodied *C. flava* occasionally recorded under this name prior to 1950.

Dorymyrmex pyramicus subsp. *flavus* Forel, 1899. p. 103.

Dorymyrmex pyramicus flavopectus M. R. Smith, 1944. p. 15. [= *Conomyrma flavopectus* (M. R. Smith)]. Many records from 1950 to 1988 reflect *C. flava*.

Conomyrma edeni Tryon, 1986. p. 340. nomen nudum.

Conomyrma bureni Trager, 1988. p. 19.

SPECIES DIAGNOSIS

The worker of *C. flava* has a straight to slightly convex occipital border; alitrunk is predominately yellow or dark grey dorsally with light color on lower pleural surfaces; head and gaster variable in color with yellow predominate in most colonies. Lateral mesonotal profile convex to flat with angle on posterior of mesonotum; one or two erect hairs on pronotal shoulders in some west Texas specimens; propodeal dorsal surface anterior to cone without a convex swelling. The queen is monocolored with yellow-brown to dark grey; the occipital border is straight to slightly convex; the HWL is 3.56 mm or greater.

Formal Determination: Snelling (1973) characterized *C. insana* with an angular mesonotal profile and included *flavus* as its synonym. Trager (1988) described the eastern counterpart of *C. insana* as *C. medeis* and *C. reginicula* and also commented on *C. flava*. He depicted an angular profile for both species; however, McCook (1879) implied the existence of different thoracic shapes for *C. insana* and *C. flava*. No author made reference to studying McCook's specimens. McCook referred to (1) specimens sent to Forel in Switzerland and (2) Buckley's specimens at the Philadelphia Academy of Science. The cotton insect project was sponsored by the Department of Agriculture and its specimens would likely exist in the U. S. National Museum. From these possibilities, Dr. C. Besuchet kindly examined the Forel Collection at the Museum d'Histoire naturelle in Geneva and reports McCook specimens are available but the species

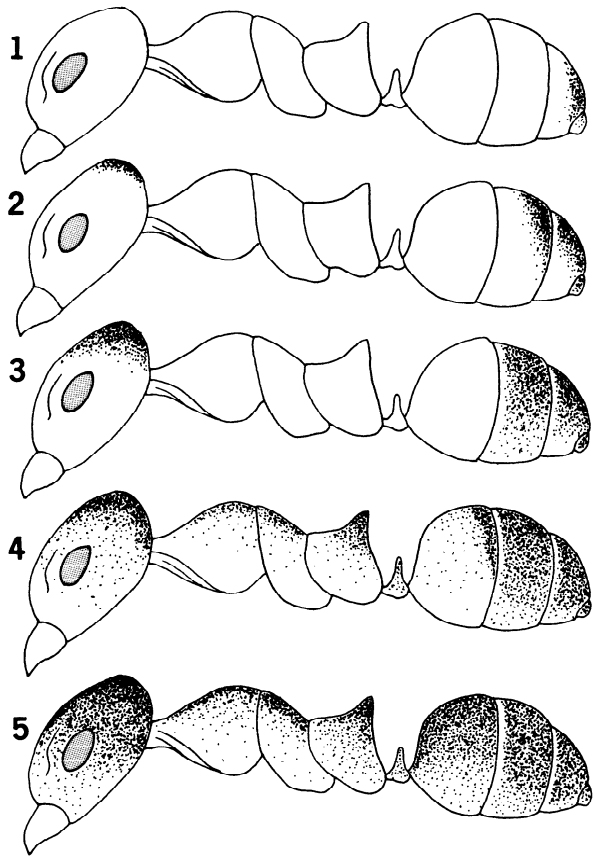

Figure 3. Variability in color pattern of *Conomyrma flava* workers. Light and dark areas are yellow and grey-black respectively.

concerned here are not present. Dr. D. Otte at the Philadelphia Academy of Science reports that one McCook specimen exists labelled "*Dorymyrmex insanus* var *flavus* McC." from Larissa, Cherokee County, Texas. Dr. D. R. Smith of the U. S. National Museum found six additional specimens with the Larissa locality, clearly labelled "McCook det." and named "*Dorymyrmex insanus* Buckley var *flavus* McC.". Recall, McCook originally presented *flavus* as a variety of *insanus*. No date was given for any of these specimens. However, Larissa, Texas, no longer exists and Cynthia J. Beeman, historian with the Texas Historical Society, kindly researched its past. Larissa was a community about 10 miles north of the present day Jacksonville and was abandoned in the mid 1880s following a meningitis epidemic. Thus the specimens were taken in approximately the correct period and further, the U. S. National Museum specimens bear an additional label reading "Ants destroying cotton worms". I have no doubt these specimens were part of the material McCook examined when describing *D. flavus* and I have had the opportunity to study these specimens.

The six ants are poorly mounted; however, all specimens are "honey-yellow" as described and two ants are positioned to clearly reveal the alitrunk. The alitrunk profiles of both individuals differ from the black-bodied *C. insana* as McCook implied. These specimens have alitrunk profiles similar to the taxon *C. bureni* Trager, slightly less convex than some *C. bureni* specimens but clearly not angular as seen in *C. insana*. As shown below, *C. flava* is variable in alitrunk profile while *C. insana* is consistent in shape. McCook probably mounted only a small number of specimens and was unaware of the variability. He considered his *flavus* and Buckley's *insana* as non-angular and angular in mesonotal profile respectively.

McCook's specimens thus identify *C. flava* and the nest series reported here reveal its variability from Texas to the Atlantic Coast. The specimens studied include representatives from the area mentioned in the original description, "Southern States" and the type locality of its synonym *C. bureni*. Unlike *C. insana*, workers of *C. flava* exhibit notable variation. Body color and propodeal cone shape vary without clear geographical correlation. Alitrunk shape and pilosity vary with a recognizable geographic pattern. All variants coexist however in single colonies and the magnitude of this variation is given below.

Specimens Studied: Localities for *C. flava* specimens collected in this study appear in Table 2 involving 92 nest series over seven states from the Atlantic Coast to central Texas; the geographic dispersion of these sites appears in Figure 1. The total sample consisted of 1,508 workers and 42 queens. Numbers taken per nest ranged from 10 to 60 workers and 1 to 10 alate queens where this caste was found. Sites for queens appear in Table 2. I am designating one of McCook's specimens in the U.S. National Museum as a lectotype. The site, Cherokee County, Texas, is designated a in Figure 1.

WORKER ATTRIBUTES

Color and Pilosity: Typical patterns of body color appear in 1 and 2 of Figure 3. In such ants, head, alitrunk, petiole and anterior half to four-fifths of the gaster are yellow. The posterior half or fifth of the gaster, and distal portions of antennal flagellae

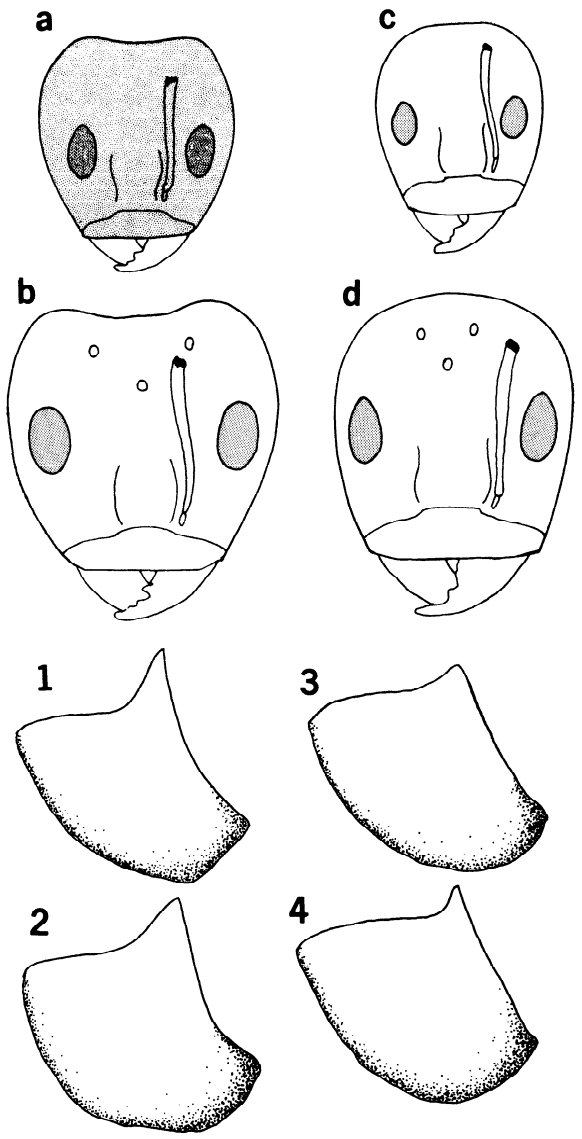

Figure 4. Frontal head views, a - d. *Conomyrma insana* worker, a; queen, b. *C. flava* worker, c; queen, d. See text for dimensions. Propodeal cone variability, in left lateral view, of *C. flava* workers, 1 - 4.

are dark grey to black. The head's posterior upper surface may be infuscated. Coxae and legs are yellow, and eyes are dark grey. The lectotype has pattern 1. Other individuals possess more dark body pigment as portrayed in patterns 3 to 5. These patterns are not changes with age, all patterns exist in ants with fully hardened cuticles. Pattern 5 appears intermediate between paler specimens and *C. insana* doubtlessly contributing to earlier views on synonymy. In *C. insana*, dark brown in equal intensity occurs over the complete alitrunk with coxae and legs as dark or darker in color. The gaster lacks yellow pigment and is typically darker than head and alitrunk. In dark *C. flava* a dark pigment of the alitrunk is restricted to the dorsal portion with light brown or yellow on the lateral sides, the coxae and legs are also pale brown or yellow and lighter in color than the alitrunk. The anterior part of the gaster often has a small band of yellow and is not darker than rest of body.

Specimens with patterns 4 and 5 occur in colonies throughout the area studied but usually in frequencies of 3 per cent or less. Disjunct sites exist where dark specimens occur in much higher frequencies. Colonies along the Atlantic Coast of north Florida may have 80 per cent of the worker force with patterns 4 and 5. Colonies in Bastrop County, Texas, exist with 25 per cent dark workers. In all such colonies, typical morphs, patterns 2 and 3, also occur. These variations in color pattern have no correlation with alitrunk and propodeal cone shape given below.

The varietal name, *nigra* Pergande was used for darker specimens in the United States by several authors. That trinomial, named for ants in southern Mexico, should not be applied to ants in the United States. The variation in our fauna does not reflect a subspecies as all patterns occur in single colonies.

Pilosity on the upper body surfaces consists mainly of a very fine pubescence becoming thin on sides of the head and more dense on the gaster. Reflectivity of gaster's cuticle is distinctly reduced in many specimens. Erect hairs on the pronotum characterize some neotropical species Snelling (1973), and occur in some *C. flava* specimens. Some specimens from seven colonies in Llano, Williamson and Grayson Counties, Texas, possess on each pronotal shoulder 1 or 2 fine erect hairs. The frequency per colony of such ants ranges from 12.0 per cent (3 of 24) in Grayson County to 58.3 per cent (14 of 24) in Llano County. As variation in the western part of the distribution becomes known, this trait will require consideration.

Alitrunk Profile and Propodeal Cone: Alitrunk profile, in lateral view, was the principle structure used in earlier studies. The range of variation appears in 1 to 6 of Figure 2. Classification of ants into categories 2 and 3 or 4 and 5 is subjective; however, four less ambiguous classes exist. Non-angular and angular mesonota occur in profiles 1, 2, 3 and 4, 5, 6 respectively. Non-angular profiles may be convex, 1, or straight 2,3; likewise, angular profiles may be convex, 4, 5 or straight, 6. All four profiles occur together in the same colony but frequencies differ. Percentages among all specimens per state for each of the four categories appear in Table 3. Note, the non-angular and angular profiles

TABLE 3. Geographic variation in alitrunk morphology of *Conomyrma flava* workers.

STATE (Sample Size)	PROPORTIONS			
	NON-ANGULAR		ANGULAR	
	CONVEX	FLAT	CONVEX	FLAT
TEXAS (396)	5	13	38	44
LOUISIANA (58)	16	29	29	26
MISSISSIPPI (79)	27	28	20	25
ALABAMA (87)	63	17	12	8
GEORGIA (81)	83	13	0	4
NORTH CAROLINA (27)	78	15	7	0
FLORIDA (780)	82	15	2	1

are most abundant in the East and West respectively. The maximum frequency of non-angular ants in the Southeast exceeds the maximum frequency of angular ants in Texas. For Texas, the largest angular frequency, 91 per cent (32 of 35), was from Llano County while the Smith County sample discussed below possessed only 12 per cent (5 of 42) angular ants. For the Southeast, the low frequency of angular ants requires samples of 40 or more specimens from individual nests to include angular representatives. A typical southeastern colony from Alachua County, Florida, was represented by 51 workers, consisting of 49 and 2 non-angular and angular ants respectively.

I was unaware of McCook's specimens when collecting the Texas material. I did obtain the colony from Smith County adjoining Cherokee County to the North and the distance between the two collections would be about 20 miles, though separated in time by greater than 100 years. If no major changes in the populations have occurred, the Smith County sample should be quite similar to populations when McCook's specimens were taken. From a population having only 12 per cent angular specimens, it is not surprising that McCook did not note angular *C. flava*. The lectotype has a non-angular, rather straight profile as in 2 of Figure 2. Confusion between angular *C. flava* and *C. insana* could result if alitrunk shape alone is examined. The propodeal surface anterior to the cone in *C. insana* has a convex curvature, Figure 2 A, rarely seen in *C. flava*, Figure 2, 1 to 6.

Shape of the propodeal cone in lateral view exists in profiles shown in Figure 4. All cone profiles have been encountered from Florida west into Texas, and coexisting in the same colony. Profile 4 was found in 60 per cent or greater in some Texas colonies while other colonies in that state exhibited frequencies of 10 per cent or less. In Florida, most individuals have cone profiles 1, 2 or 3; profile 4 is 15 per cent or less in a typical southeastern colony. Cone shape thus varies within colonies and in a patchy geographic pattern. The lectotype has a cone shape near 4 of Figure 4.

Occipital Border: The border is typically straight, viewed perpendicular to the head's longitudinal axis, Figure 4 C. A small minority of ants have slightly convex borders. The lectotype border appears straight. This attribute is the most consistent structural difference between workers of the two species.

Metric Dimensions: Trager (1988) gave dimensions for 12 structures or ratios in 25 specimens of the taxon, *C. bureni*. I measured the Smith County, Texas, colony and a colony from Alachua County, Florida, 42 and 40 workers respectively, for the same structures. The range of values in both samples fully embrace the values given for *C. bureni*, and no differences existed between the Texas and Florida colonies. The most useful measure of size is HWL and the mean values in mm. for the Texas and Florida samples were 2.0 and 2.3 respectively. The overall range in this dimension was 1.90 to 2.48 mm. In some Florida colonies, the mode of worker size occurs near the lower range. Position of the lectotype on its point does not allow an accurate measurement but the HWL dimension is very close to the above values.

QUEEN ATTRIBUTES

Color and Pilosity: The queen is yellowish-brown, not bicolored; however, the gaster when enlarged appears banded as the light-colored intersegmental membranes become visible. This pattern exists in both Texas and Florida colonies charac-

terized by typical workers, patterns 1 and 2 of Figure 3. In Florida colonies having high frequencies of dark-bodied workers, patterns 4 and 5 of Figure 3, the queens have dark-grey upper body surfaces. The pubescence of queens is similar to the workers and no erect, pronotal hairs have been seen in queens.

Occipital Border: The border is straight or slightly convex and the head is only slightly wider than long, Figure 4 D. The HL mean length was 1.22 mm from a range of 1.16 to 1.29 mm.

Alitrunk Profile and Body Dimensions: The lateral profile of the queen in *C. flava* is similar to the profile of the queen of *C. insana*, Figure 2 B; however, dimensions differ. The HWL given for *C. bureni* based on 10 queens was 3.58 to 3.70 mm. (Trager, 1988). In this study based on 42 queens, the dimension was 3.56 to 3.72 mm. As the largest *C. insana* HWL was 3.58 mm, only a small degree of overlap exists between the two species with *C. flava* having the more robust queen.

Notes On Male Eye Size

Day-flying insects are thought to have smaller eyes than night-flying forms and Trager (1988) suggested eye size of *C. flava* males was smaller than in *C. bureni* though no data were given. The latter form was known to fly at dusk and into nocturnal hours. I have frequently observed the initiation of mating flights in Alachua County, Florida, begining during the pale light intensity of dusk. Trager thus implied that *C. flava* of Texas was likely a day-flying species. On June 17, 1988, I observed a mating flight in Washington County, Texas. The timing and behavior was similar in all respects to flights in Florida. A comparison of 5 and 15 males from Texas and Florida respectively revealed no differences in eye size.

SYNONYMY

The above synonymy treats names used in the United States fauna. The yellow-bodied *D. pyramicus* cited in faunal lists are mostly *C. flava*. The references to *C. flavopectus* after 1973 are assignable to *C. flava* except Deyrup and Trager (1986) and Trager (1988). The name, *C. edeni* Tyron, was used once without description, figures or deposited specimens and is a nomen nudum. The basis for placing *C. bureni* in synonymy with *C. flava* has been developed in preceeding sections. Basically, the attributes of that taxon are found throughout the area studied, in the lectotype and samples close to the lectotype locality.

DISTRIBUTION

Locality of the lectotype is Cherokee County, Texas. The range occurs from the Atlantic Coast westward into Texas and beyond with unclear boundaries. The northernmost colonies in the East occur in New Jersey (Wheeler, 1905), and the northern margin of the range in the West is poorly known. The species occurs in Mexico and some western states but these distributions are incompletely known. Earlier faunal work did apply the name to these ants (Cole 1942).

DISTINGUISHING *CONOMYRMA* SPECIES IN THE UNITED STATES

At the present time, seven species of *Conomyrma* are recognized in the United States. One species occurs in the West, *C. bicolor* (Wheeler) and, as the knowledge of the western fauna increases, additional forms may be expected from that region. Four species occur in the East or Southeast, *C. bossuta* Trager, *C. elegans* Trager, *C. flavopectus* (M.R. Smith) and *C. grandula* (Forel). The two species, *C. flava* (McCook) and *C. insana* (Buckley) are widely distrubuted.

Key to Workers of *Conomyrma* Species in the United States

1a. Occipital border concave, when viewed from above and perpendicular to head's longitudinal axis; body and legs dark brown to black, gaster having slightly darker hue; mesonotal profile in lateral view with distinct dorsal and declivous faces; small bulge anterior to cone visible in lateral profile of propodeum; widely distributed . . . . . *insana*

b. Above combination of characters lacking 2

2a. In lateral view, alitrunk appears distinctly elongate and promesonotal profile flat; body yellow (rarely small infuscation on terminal segment of gaster); propodeal cone a low, blunt tooth; declivous face of propodeum, in lateral profile, straight over upper three-fourths; south Florida . . . . . *elegans*

b. In lateral view, alitrunk not elongate and promesonotal profile convex or mesonotal profile angular with distinct dorsal and declivous faces; body color and propodeal cone variable 3

3a. Mesonotal profile, in lateral view, angular with distinct dorsal and declivous faces 4

b. Mesonotal profile, in lateral view, non-angular, the promesonotal surface forming a smoothly curving convex margin . . . 7

4a. Upper surface of gaster with very weak pubescence consisting of widely-spaced, fine hairs; dorsum of gaster smooth and reflective in strong light; body typically bicolored with head and alitrunk yellow, gaster dark brown (darkness of gaster occasionally restricted to posterior half); anterior part of promesonotal profile swollen into a bulge in some south Florida specimens; Southeastern . . . . . *bossuta*

b. Upper surface of gaster with pubescence of closely-set, short hairs (magnification of 25x or greater necessary to verify this trait in some specimens of *C. grandula*); body color variable and no bulge on promesonotal surface 5

5a. Clypeus lacks median, longitudinal ridge or carina, the surface curving smoothly across its transverse axis; head and alitrunk light, reddish-yellow, gaster dark brown to black; Southwestern . . . . . *bicolor*

b. Clypeus with median, longitudinal blunt ridge or carina; body color variable but without distinct bicolored pattern described above 6

6a. Pubescence on surface of gaster consists of very fine, short hairs (clear definition requires 25X or greater magnification); dorsal cuticle of gaster smooth, somewhat reflective through fine pubescence; body color brown to dusky tan without distinct bicolored attribute and little or no difference in color intensity between dorsal and ventral regions, gaster slightly darker and legs with same color as alitrunk; Eastern . . . . . *grandula*

b. Pubescence on surface of gaster consists of closely-spaced, tapering hairs (defined with 12X magnification); dorsal cuticle of gaster dull and non-reflective due to stronger pubescence; body color typically yellow, usually with small, dark infuscation on posterior of gaster, or dark brown may infuscate dorsal parts of head and alitrunk leaving ventro-lateral regions and legs paler in color; widely distributed . . . . . *flava*

7a. Body with distinct bicolored pattern, head and gaster completely dark brown separated by a contrasting light yellow alitrunk; sand scrub habitat in central and south Florida . . . . . *flavopectus*

b. Body yellow with dark color absent or restricted to terminal segments of gaster or dark pigment infuscated over upper portions of both head and alitrunk; bicolored pattern described above never seen; widely distributed . . . . . *flava*

Note, *C. flava* is identified above in both the angular and non-angular mesonotal groups. The species most likely to be confused is *C. grandula*. Some specimens of that species are quite dark in color resembling *C. insana* but possess convex occipital borders unlike the concave border in the latter species. Unlike other *Conomyrma* species, *C. grandula* is rather shy and less active in exposed areas.

LITERATURE CITED

Buckley, S.B. 1866. Descriptions of new species of North American Formicidae, Part I. Proc. Entomol. Soc. Philadelphia 6: 152-171.

Buren, W.F., J.C. Nickerson, and C.R. Thompson. 1975. Mixed nests of *Conomyrma insana* and *Conomyrma flavopecta* - evidence of social parasitism. (Hymenoptera: Formicidae). Psyche 82: 306-314

Cokendolpher, J.C., and O.F. Francke. 1984. Karyotype of *Conomyrma flava* (McCook) (Hymenoptera: Formicidae). J. New York Entomol. Soc. 92: 349-351.

Cole, A.C. 1936. Descriptions of seven new western ants (Hymenoptera: Formicidae). Entomol. News 47: 118-121.

Cole, A.C. 1940. A guide to the ants of the Great Smoky Mountains National Park, Tennessee. Amer Midl. Nat. 24: 1-88.

Cole, A.C. 1942. The ants of Utah. Amer. Midl. Nat. 28: 358-388.

Creighton, W.S. 1950. The Ants of North America. Bull. Mus. Comp. Zool., Harvard 104: 1-585.

Dennis, C.A. 1938. The distribution of ant species in Tennessee with reference to ecological factors. Ann. Entomol. Soc. Amer. 31: 267-308.

Deyrup, M., and J. Trager. 1986. Ants of the Archbold Biological Station, Highlands Co., Florida (Hymenoptera: Formicidae). Florida Entomol. 69: 206-228.

Forel, A. 1899. Hymenoptera III. Biologia Centrali-Americana, London. R. H. Porter, Dulau and Co. 169p.

Johnson, C. 1988. Species identification in the eastern *Crematogaster* (Hymenoptera: Formicidae). J. Entomol. Sci. 23: 314-332.

Kusnezov, N. 1952. El estado real del grupo *Dorymyrmex* Mayr. Acta Zool. Lilloana 10: 427-448.

Markin, G.P., J. O'Neal, and H.L. Collins. 1974. Effects of mirex on the general ant fauna of a treated area in Louisiana. Environ. Entomol. 3: 895-898.

Mayr, G. 1866. Myrmecologische Beiträge. Sitzb. K. Akad. Wiss. Wien. Math. Naturw. Cl. 53: 484-517.

Mayr, G. 1886. Die Formiciden der Vereinigten Staaten von Nord-Amerika. Verh. Zool.-bot. Gesell. Wien 36: 419-464.

McCook, H.C. 1879. Formicariae. p. 182-189: *In* J.H. Comstock. Report on Cotton Insects. U. S. Dept. Agr. Entomol. Report. 511p.

McCook, H.C. 1909. Ant communities and how they are governed. A study in natural civics. Harper and Brothers Publ., N. Y. xx + 321p.

Mitchell, J.D., and W.D. Pierce. 1912. The ants of Victoria County, Texas. Proc. Entomol. Soc. Wash. 14: 67-76.

Nickerson, J.C.E., H. Cromroy, W.H. Whitcomb, and J.A. Cornell. 1975a. Colony organization and queen numbers in two species of *Conomyrma*. Ann. Entomol. Soc. Amer. 68: 1083-1085.

Nickerson, J.C.E., W.H. Whitcomb, A.P. Bhatkar, and M.A. Naves. 1975b Predation on founding queens of *Solenopsis invicta* by workers of *Conomyrma insana*. Florida Entomol. 58: 75-82.

Nickerson, J.C., C.A. Rolph Kay, L.L. Buschman, and W.H. Whitcomb. 1977. The presence of *Spissistilus festinus* as a factor affecting egg predation by ants in soybeans. Florida Entomol. 60: 193-200.

Pergande, T. 1895. Mexican Formicidae. Proc. Calif. Acad. Sci. 5: 858-896.

Roe, R.A. 1973. A biological study of *Solenopsis invicta* Buren, the red imported fire ant, in Arkansas with notes on related species. M. S. Thesis Univ. of Arkansas, Fayetteville. 135p.

Roger, J. 1863. Die neu aufgefuhreten Gattungen und arten meines Formiciden Verzeichnisses. Berliner Entomologische Zeit. 7: 131-214.

Smith, M.R. 1918. A key to the known species of South Carolina ants, with notes (Hym.). Entomol. News. 29: 17-29.

Smith, M.R. 1924. An annotated list of the ants of Mississippi (Hymenoptera). Entomol. News 35: 47-54; 77-85; 121-127.

Smith, M.R. 1934. A list of the ants of South Carolina. J. New York Entomol. Soc. 42: 353-361.

Smith, M.R. 1935. A list of the ants of Oklahoma. Entomol. News 46: 235-241.

Smith, M.R. 1936. A list of Texas ants. J. New York Entomol. Soc. 44: 155-170.

Smith, M.R. 1944. Additional ants recorded from Florida, with descriptions of two new subspecies. Florida Entomol. 27: 14-17.

Smith, M.R. 1951. Family Formicidae. Pp. 778-875 *in* C.F.W. Musebeck, K.V. Krombein, and H.K. Townes. (eds). Hymenoptera of America north of Mexico-synoptic catalog. U.S. Dept. Agric. Mono. 2: 1420p.

Snelling, R. R. 1973. The ant genus *Conomyrma* in the United States. Nat. Hist. Mus. Los Angeles Co. Contr. Sci. 238: 1-6.

Trager, J. C. 1988. A revision of *Conomyrma* (Hymenoptera: Formicidae) from the southeastern United States, especially Florida, with keys to the species. Florida Entomol. 71: 11-29.

Tyron, E.H., Jr. 1986. The striped earwig, and ant predators of sugarcane rootstock border in Florida citrus. Florida Entomol. 69: 336-343.

Van Pelt, Jr. , A.F. 1948. A preliminary key to the worker ants of Alachua County, Florida. Florida Entomol. 30: 57-67.

Van Pelt, A., and J.B. Gentry. 1985. The ants (Hymenoptera: Formicidae) of the Savannah River Plant, South Carolina. Publ. Savannah River Plant, Nat. Environ. Res. Park Prog. 1-56.

Wheeler, G.C. and J. Wheeler. 1985. A checklist of Texas ants. Prairie Nat. 17: 40-64.

Wheeler, W.M. 1905. An annotated list of the ants of New Jersey. Bull. Amer. Mus. Nat. Hist. 21: 371-403.

Wheeler, W.M. 1913. Ants collected in Georgia by Dr. J.C. Bradley and Mr. W.T. Davis. Psyche 20: 112-117.

Wheeler, W.M. 1932. A list of the ants of Florida with descriptions of new forms. J. New York Entomol. Soc. 40: 1-17.

Wilson, E.O. 1957. Sympatry of the ants *Conomyrma bicolor* (Wheeler) and *C. Pyramica* (Roger). Psyche 64: 76.