

Identification and Nesting Sites of North American Species of *Dolichoderus* Lund (Hymenoptera: Formicidae)

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Abstract

The identification of North American *Dolichoderus* species by-way-of existing keys is unnecessarily arbitrary and misdeterminations are likely between *D. mariae* and *D. pustulatus*, the latter species showing most morphological variation over its range. Diagnoses for the four described species and an undescribed form with a revised key and figures are given to aid entomologists working without identified voucher specimens. Nest data for species other than *D. pustulatus* in the Coastal Plain revealed below-ground nests or structures immediately at the ground surface. Colonies of *D. pustulatus* in Florida and southern Georgia have arboreal nests in the cavities of smaller limbs of hardwoods about swamps and marshes. No ground nests have been found and the species may occur in compound nests with another arboreal ant, *Camponotus (Colobopsis) impressus*. These observations identify several questions for further study.

Introduction

This paper provides a revised key to the known species of *Dolichoderus* Lund 1831 occurring in North America, and summarizes the data on both distributions and nest sites. An undescribed, northeastern species known by limited material is also briefly characterized and included in the key but not named. Four species have been described; namely, *D. mariae* Forel 1884, *D. plagiatus* Mayr 1870, *D. pustulatus* Mayr 1886 and *D. taschenbergi* Mayr 1866. These species were thus described by 1886 and 31 years later Wheeler (1905a, b, 1915, 1916, 1917) had revised the group, described several subspecific varieties and discussed their natural history. His principle change was to place *D. pustulatus* as a subspecies of *D. plagiatus* and his inter-

pretation remained intact for 43 years. Creighton (1950) synonymized Wheeler's subspecific forms into the four above species and again recognized *D. pustulatus* as distinct. The taxonomic scenario returned to the 1886 position and, for the above taxa, remains unmodified. The need for further literature on the identity of these species requires a brief explanation.

Wheeler's studies had accompanying descriptions and figures but are now largely unavailable and he employed a taxonomy no longer in use. Smith (1918) and Gregg (1944) gave non-illustrated keys and essentially followed Wheeler's work. Wheeler and Creighton in addition to having different taxonomic views used different diagnostic characters in large part. Creighton's key had no accompanying descriptions or figures and no later key exists. The Creighton key requires discrimination between degrees of sculptural development and, if unaccompanied by properly determined voucher specimens, is especially unclear in separating *D. mariae* and *D. pustulatus*. For sculpture of the propodeum and mesonotum, couplet three of the key uses "... coarse, deep, close-set foveolae" and "... foveolae, when present, shallow and obscure..." to depict *D. pustulatus* and *D. mariae* respectively. Actual differences between the species in sculpture of the propodeum or epinotum as named by Creighton, are less distinct than the couplet suggests. Further, the key appears to have been written using only northern specimens of *D. pustulatus* and southern specimens are somewhat different as noted below. The author earlier misidentified Florida specimens of *D. pustulatus* (Johnson, 1986), and other specimens in the Florida State Collection of Arthropods are similarly misnamed. The authority for those determinations is not given but doubtlessly arose from a similar confusion.

Since properly identified specimens are restricted to only a few institutions, a more functional key is desirable. The key given here groups the characters in a hopefully less arbitrary fashion and is supported by descriptions and figures.

The generic placement for the North American forms has been questioned. Mayr (1886) established the subgenus *Hypoclinea* including the North American forms, and the possibility of raising that name to a full genus has subsequently appeared in the literature. Lattke (1986) recently recognized the group as a distinct genus in a study concerned with neotropical ants. However, no formal revision or description of *Hypoclinea* as a genus exists and the species Lattke treats are quite unlike our northern fauna. This paper retains the genus *Dolichoderus* for the North American forms and, with this usage, the type species of the subgenus *Hypoclinea* is *Dolichoderus quadripunctatus* Linnaeus of Europe.

The great majority of specimens coming to entomologists' attention are workers. Queens are typically taken in association with workers and the key is designed to identify the worker caste. Males are rarely collected and too incompletely known for treatment in a key. Workers of *Dolichoderus* in North America may be recognized by the following characters. Total body lengths range from about 3.5 to 4.5 mm. or rarely less with no differences between species. The gaster and alitrunk are separated by a single segment, the petiole. The orifice of the cloaca is a horizontally-oriented slit, not a circular opening. The surrounding hairs do not form a distinct fringe of rather stiff erect bristles about the opening. The posterior or declivous face of the propodeum is distinctly concave in lateral view and the propodeum cuticle is thick, inflexible, and strongly sculptured. These ants occur mainly in the East with the western-most records in North Dakota and Oklahoma.

Materials and Methods

Specimens of the four known species have been studied from the George C. and J. Wheeler Collection, including material determined by well-recognized authorities on North American ants, namely M.W. Wheeler, M. R. Smith and W. S. Creighton. D. R. Smith of the U.S. National Museum kindly confirmed the determination of recently-collected Florida material of *D. pustulatus*. The undescribed form is known only by a small nest series taken recently by J.C. Trager in Massachusetts. Definitions of morphological terms appear in Torre-Bueno (1962) or most standard insect references.

A diagnostic worker description and geographic distribution for each species precedes the key. Hairs portrayed in the figures are drawn slightly thicker than true proportions so they would not become indistinct on reduction; this treatment in no way affects the use of the key. The reader should compare specimens with both the description and key in reaching determinations.

Data on nests other than observations reported for *D. pustulatus* in the South were taken from the cited literature.

Species Diagnoses

Dolichoderus mariae

Worker Diagnosis: The species is basically bicolored. The mandibles, antennae, head, alitrunk, legs, and petiole are brownish-orange and the first segment of the gaster has a variable, anterior band of this lighter color. The remainder of the gaster is dark brown to black. Intensity of color varies from callow age to maturity in ants and somewhat through time for museum specimens. I have seen museum specimens of *Dolichoderus* over 50 years of age, however, with essentially the same color as found in recently collected material. Also color interpretation varies. Wheeler (1905a) described this species as "... yellowish blood-red, and gaster black", and also as "...bright-red and blue-black bodies".

Structurally, a fine granulation sculpts the integument of head, pro- and mesothorax, and faint depressions or foveolae also occur on the head. This sculpture is weak, leaving a superficially smooth, shining surface under low to moderate magnification. A more distinct granulation sculpts the propodeum where a network of delicate ridges enclose shallow polygon-like depressions. This sculpture is weak leaving a shining propodeum in strong light. The integument of petiole and especially the gaster is smooth and reflective. No erect hairs exist on head, scapes, or body, one of the more distinctive attributes of this species. In dorsal view, the length of the propodeum distinctly exceeds its width, Fig. 1a. The lateral profile of alitrunk as in Fig. 2a. The integument within the concavity of the declivous face of propodeum with a series of fine vertical ridges or striations; some specimens have a distinct, centrally-located vertical ridge. A delicate granulation within the concavity reduces reflectivity often to a near-opaque state.

Geographic Distribution: The type locality is Vineland, New Jersey. It has been reported from Massachu-

setts west through Illinois to Minnesota and Oklahoma, and south into North and South Carolina, Georgia, Mississippi and Louisiana (Smith, 1979). A large range exists but local populations are spotty and this irregular pattern is particularly evident in the South. Misdeterminations between *D. mariae* and *D. pustulatus* in the South largely motivated this study and a closer examination of their southern distributions is appropriate. Carter (1962a,b) and Smith (1918) reported the species as common in both North and South Carolina respectively while only Wheeler (1913) records it from Georgia. Those records were from Stephens and Rabun Counties in the northeastern upland terrain. Smith (1924) reported the species in northeastern Mississippi, Lowndes County, and I have been unable to trace the Louisiana record. All records known to the author for the southern Coastal Plain were misdeterminations of *D. pustulatus*.

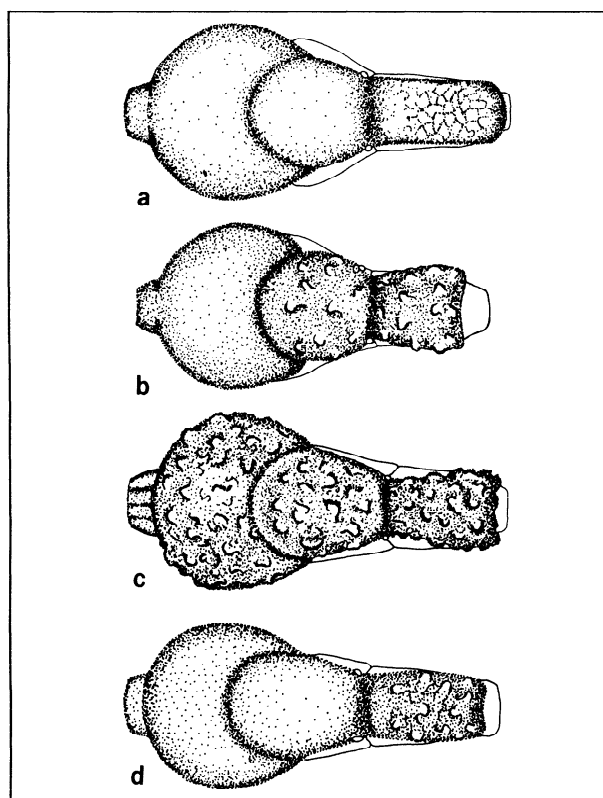


Figure 1. Dorsal views of the alitrunk for (a) *Dolichoderus mariae*, (b) *D. taschenbergi*, (c) *D. plagiatus* and (d) *D. pustulatus*.

Dolichoderus plagiatus

Worker Diagnosis: This ant has a mottled color pattern compared to the other species. The mandibles and head are dark brown to near-black, paler in callow specimens. The antennae, alitrunk, legs and petiole are brown-orange; dorsum of the alitrunk becoming dark brown in older specimens. There are laterally-spaced spots of pale brownish-orange on the first and second segments of gaster; the remainder of gaster is dark brown.

Structurally, head and complete dorsum of alitrunk are sculptured with well-defined depressions or foveolae. The pronotum is sculptured as strongly as the mesonotum, a definitive feature for this species. Granulation of the alitrunk occurs within the depressions and the surface is essentially opaque; the reflectivity of cuticle broken into small, disjunct regions. A fine granulation occurs on the petiole, and the integument of the gaster is smooth and shining. Erect hairs are numerous on head and alitrunk; a few scattered erect hairs occur on gaster, and there are short, fine erect hairs on scapes. In dorsal view, length of propodeum exceeds its width, Fig. 1c. Lateral profile of the alitrunk as in Fig. 2c. Integument within concavity of the declivous face of propodeum is smooth and highly reflective.

Geographic Distribution: The type locality is "Illinois" and the species has been reported from New Brunswick westward through Ontario, Manitoba, and North Dakota. Southward in the eastern U. S., the species reaches North and South Carolina and Georgia (Smith, 1979). The southern records show a preference for upland habitats and the species has not been documented in the southern Coastal Plain.

Dolichoderus pustulatus

Worker Diagnosis: This species is bicolored in the South, a feature enhancing its similarity to *D. mariae* in that region. Specifically, southern specimens have brownish-orange mandibles, head, antennae, legs, alitrunk and petiole; antennae and legs becoming darker with age. The gaster is dark brown to black and occasionally with small, laterally-spaced, light colored spots on the first and second segments. In the North, mature specimens are often concolored with dark brown, near black or pale orange bodies. Distinctly bicolored specimens from the North appear to be young specimens.

Structurally, a fine granulation sculpts the head behind the eyes and faint indications of shallow foveolae exist. The surface of the pronotum is impressed with a delicate punctation, though both

head and pronotum typically reflect light. Dorsum of the mesonotum with distinct depressions, its surface remaining reflective. Depressions of the propodeum are deeper and associated with stronger granulation, its surface becoming opaque. The sculpture described above is weakly developed in southern specimens, a condition again similar to *D. mariae*. The integument of both petiole and gaster is smooth and shining in strong light, though the petiole is partially granulate in northern specimens. Erect hairs are present on the head, alitrunk, and gaster. This body pilosity consists of fewer hairs in southern specimens, another variation in the direction of *D. mariae* where such hairs are absent. There are no erect hairs on the scapes. In dorsal view, the length of propodeum exceeds its width, Fig. 1d, and the lateral profile of the alitrunk is as in Fig. 2d. The integument within concavity of the declivous face of the propodeum is smooth and shining, though faintly granulate in northern specimens. The scapes, lying in natural repose above the head, surpass the occipital border in northern specimens by a smaller fraction of their length than observed in southern specimens. In lateral view, the petiole of northern specimens is more robust. These differences may only reflect geographic variability; however, differences also exist in nest behavior as discussed below and these ants deserve closer study.

Geographic Distribution: The type locality is New Jersey by restriction, see Creighton (1950), and the species as presently defined occurs from Nova Scotia westward to Illinois and Oklahoma: southward the distribution reaches Florida and Mississippi (Smith, 1979). As noted above, *D. mariae* has been documented only in the northern portions of the southern states. Creighton (1950) cited specimens of *D. pustulatus* from Brownsville in south Texas but the record was omitted by Wheeler and Wheeler (1985) in their recent checklist of Texas ants.

Dolichoderus taschenbergi

Worker Diagnosis: The insect is basically a concolorous dark often blackish ant. The mandibles and antennae are light brown; head, alitrunk, legs and petiole dark brownish-black. The gaster is dark brown but somewhat less so than head and alitrunk. Again color is interpreted widely; Wheeler (1905a) described a group of individuals as "...sparkles like a mass of jet beads".

Structurally, a fine granulation sculpts the head particularly behind the eyes where distinct but shallow foveolae also occur. A similarly delicate

granulation or punctation sculpts the pronotum. The fine sculpture and dark color generally reduce reflectivity of head and pronotum to a dull sheen. A more strongly developed granulation exists on the mesonotum plus fine, longitudinal striations. The stronger granulation continues over the propodeum with distinct depressions. The mesonotum and propodeum are essentially opaque reflecting little or no light. The integument of petiole and especially gaster is smooth and shining in strong light. There are a few erect hairs usually on head and occasionally a hair (rarely 2 or 3) on anterior of pronotum and 1 or 2 hairs occasionally on the first segment of the gaster. These hairs are shorter in length and much less numerous than observed in *D. pustulatus* or especially in *D. plagiatus* and *D. species A*. No erect hairs on scapes. In dorsal view, length and width of the propodeum are approximately equal, Fig. 1b, a characteristic of this species. The lateral profile of alitrunk as in Fig. 2b. The integument within concavity of the declivous face of the propodeum is

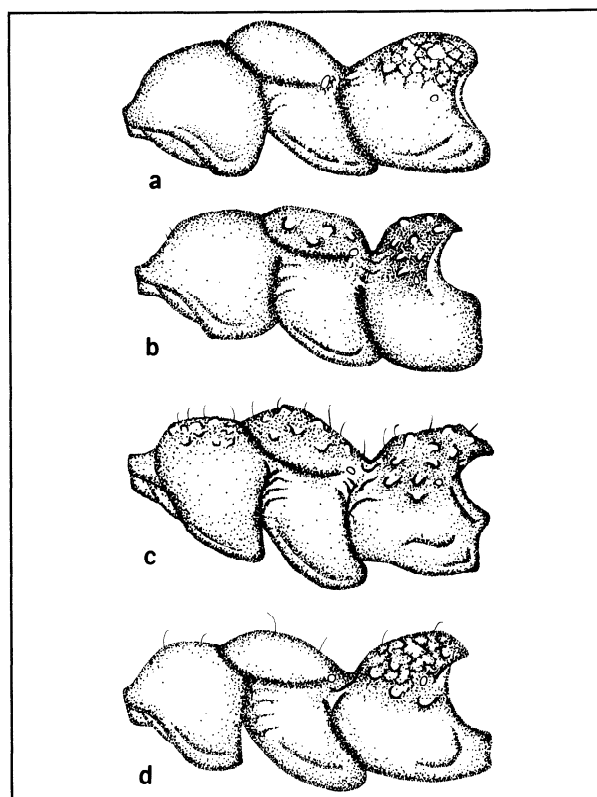


Figure 2. Lateral views of the alitrunk for (a) *Dolichoderus mariae*, (b) *D. taschenbergi*, (c) *D. plagiatus* and (d) *D. pustulatus*.

granulate and opaque though lighter in color than surrounding cuticle.

Geographic Distribution: Wheeler (1905a) gave the type locality as Louisiana; however, Mayr (1866) gave only North America in the original description. The basis of Wheeler's acquaintance with the specific state remains unknown. The species occurs from Nova Scotia westward to Manitoba and North Dakota. Southward, the ant reaches both North and South Carolina and a record exists for Mississippi (Smith, 1979). No Louisiana record exists to the author's knowledge other than Wheeler's reference to the type noted above. The southern records are particularly spotty and the species is clearly more abundant in the northern part of its range.

Dolichoderus species A

Worker Diagnosis: This diagnosis is based on a single nest series and serves only to depict the species from its better-known congeners. The ant is essentially a concolorous black insect with a highly reflective cuticle. The scapes are brown; the flagellum as well as remainder of body from mandibles to tip of gaster including legs is blackish. The alitrunk may appear dark brown with a near-black head and gaster.

Structurally, a delicate granulation overlying shallow foveolae sculptures both the head and pronotum. The cuticle of both head and pronotum is sufficiently smooth however to have a highly reflective surface. The mesonotum and propodeum are lightly punctuated with more distinct foveolae leaving a more roughened surface, particularly on the propodeum. Still, reflection is distinct from each small surface intercepting light. The surface of the petiole is strongly granulate, however, the center of its posterior surface has a smooth and reflecting area. The integument of gaster on both dorsal and ventral surfaces is exceptionally smooth and highly reflective. A number of erect hairs occur on the upper surface of the head, alitrunk, and propodeum, with erect, bristle-like hairs also scattered over the dorsal and ventral surfaces of the gaster. A few fine, erect hairs occur also on the scapes. In dorsal view, length of the propodeum exceeds its width. The integument within the declivous face of the propodeum is glassy smooth and reflective.

The near concolorous black body of this species is similar to *D. taschenbergi*; however, the alitrunk pilosity and dimensions of the propodeum clearly separate these species. Younger specimens of species A may appear mottled in color, and together with pilosity and small colony size suggest *D. plagiatus*.

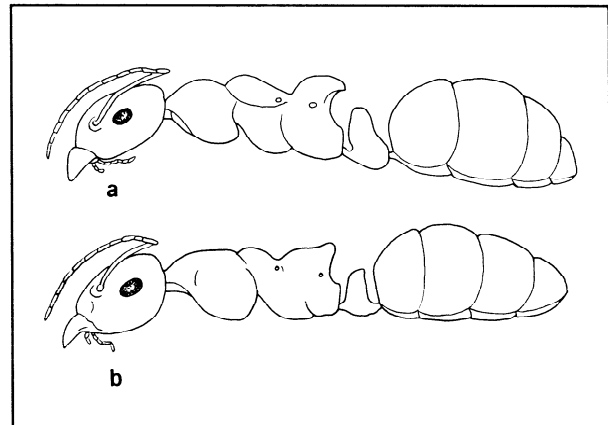


Figure 3. Lateral body profiles of workers in (a) *Dolichoderus pustulatus* and (b) *Camponotus (Colobopsis) impressus*.

However, the sculpture of the pronotum clearly separate these species. The erect hairs of the scapes distinguish this species from both *D. mariae* and *D. pustulatus*.

Geographic Distribution: The only material available to the author was taken in a pine barren of Plymouth County, Massachusetts, and its presence in similar habitats in other parts of New England is likely. The single colony was approximately 20 individuals in number, living in a nest concealed in pine litter.

Key to Workers

1. Dorsum of pronotum and mesonotum approximately equal in sculptural development (Fig. 1c) and both surfaces largely opaque; erect hairs on head, upper thoracic surface (Fig. 2c) and scapes *plagiatus*
- 1'. Dorsum of pronotum, though granulate or punctate, smoother than the mesonotum, its surface opaque or shining; erect hairs may or may not occur on body and scapes . 2
- 2(1'). In dorsal view, the propodeum's width and length approximately equal (Fig. 1b); erect hairs absent from upper surface of alitrunk or confined to anterior of pronotum; body concolored in black *taschenbergi*
- 2'. In dorsal view, the propodeum's length exceeds its width; erect hairs may or may not occur on upper surface of alitrunk; body concolored or bicolor 3

- 3(2'). No erect hairs on upper surface of alitrunk (Fig. 1a); the concave declivous face of propodeum sculptured with fine vertical striations; body bicolored *mariae*
- 3'. Several erect hairs occur over the length of the alitrunk; the concave, declivous face of propodeum smooth or granulate; body concolored or bicolored 4
- 4(3'). No erect hairs on scapes; mature adults bicolored or concolored in dark brown or orange *pustulatus*
- 4'. Erect hairs on scapes; mature adults concolored in black Species A

Nest Sites

Wheeler (1905a) noted a basic behavioral difference between the temperate zone *Dolichoderus* species in North America and the single European form *D. quadripunctatus*. The North American species were ground-nesting ants while *D. quadripunctatus* was arboreal. Wheeler (1905a, b) described nests of *D. mariae*, *D. plagiatus* and *D. taschenbergi* in Connecticut and New Jersey. Those nests were all below ground or adjacent to the ground surface in woodlands, and the ants often covered the mounds with pine needles and leaves. His information did not include observations on *D. pustulatus*, considered a subspecies of *D. plagiatus*. Smith (1930) reported on ants in Florida including information received from the coleopterist, W.S. Blatchley. For *D. pustulatus*, he quotes Blatchley's notes on the nests as "... beneath loose bark of pine logs on Long Pine Key" and "... beneath boards on the ground." Wilson (1964) and Deyrup et al. (1988) surveyed the ant fauna of the Florida Keys, the latter study associated with extensive collecting. A *Dolichoderus* species was not found in either survey and the authors do not include the species in the Keys fauna. In fact, the species is not known in the southern part of the Florida peninsula. It is possible Smith never saw the specimens and a misdetermination was most likely involved. Certainly, no other observations of North American *Dolichoderus* nests are comparable. Thirty-five years after Wheeler's early work, a more serious documentation of *Dolichoderus* natural history began. Cole (1940) described ground nests of *D. mariae*, *D. plagiatus* and *D. taschenbergi* in the Great Smoky Mountains of Tennessee. Wesson and Wesson (1940) described

nests of *D. plagiatus*, *D. taschenbergi* and the form we now know as *D. pustulatus* in Ohio. The nests of *D. mariae*, *D. plagiatus* and *D. taschenbergi* described by these authors were basically similar to Wheeler's observations. The latter study appears to be the first acceptable description for the nest of *D. pustulatus*. Those nests were at the bases of "grass clumps" made in part from carton, chewed plant tissue, and while resting on the substrate, were somewhat above-ground. A number of tropical *Dolichoderus* species build nests of carton. Gregg (1944) reported the nests of *D. mariae* in a tamarack bog near Chicago. Those structures were in the leaf bases of *Typha* sp. (cattails), presumably at or just above ground-level. Kannowski (1959), working about a bog in Michigan, observed the emergence of alates for all four described species. Unfortunately, he did not describe the nests nor indicate their location within the bog; however, the alates were described as ascending vegetation from ground level and the nests must have been similarly located. Carter (1962a, b) found the nests of all four described species in North Carolina as below-ground structures. He gave the following observations for *D. pustulatus*, "This ant prefers to nest in grassy abandoned fields, sunny fields or open dry woodlands". He notes the soil where one colony occurred as "... loose clay loam". These conditions are very different from the nests described below for the southern colonies. Wheeler and Wheeler (1963) provide the most recent observations for *D. plagiatus* and *D. taschenbergi* from North Dakota sites. The nests of *D. plagiatus* were in leaf mold, the brood of one colony being found in an acorn and another colony was directly adjacent to a nest of *Polygerus rufescens* Emery (= *P. breviceps* Emery) and *Formica fusca* Linnaeus, both ant species and a slave-maker and slave respectively. The nests of *D. taschenbergi* were described as mounds of fine thatch 22.9 to 30.5 cm. (9 to 12 inches) in diameter and 5.0 to 6.3 cm. (2 to 2.5 inches) high. Brood were found from ground level to 28 cm. (11 inches) in depth. The nests of *D. species A* was a loosely organized structure under pine litter overlying the ground surface in a Massachusetts pine barren.

Colony size varies between species. The colonies of *D. plagiatus* and *D. species A* appear to have low densities and secreted nests. Colonies of *D. mariae*, *D. pustulatus* and particularly *D. taschenbergi* have much larger numbers. In fact, *D. taschenbergi* is effective in controlling injurious larvae of various forest pests. Bradley (1972) reports success in relocating their nests in Manitoba for purposes of biological control.

These reports collectively reveal some flexibility in both nest site and general habitat; however, all studies specifically discussed nests as structures below ground or immediately at the surface. No author cited above suggested an arboreal nest site but no nests were examined in the southern Coastal Plain. Among authorities on North American ants, M.R. Smith contributed most extensively in documenting southeastern faunas. In a generic synopsis of United States ants, he also gave brief notes on their natural history (Smith, 1947). For *Dolichoderus*, he cites ground nests and also adds "...nests in hollow stems," No further elaboration was given nor the specific species identified; however, the observation is the only suggestion of arboreal nests for the U.S. species of *Dolichoderus*, and likely reflects his experience in the southern Coastal Plain. The author has located nests of *D. pustulatus* in Alachua, Levy, St. Johns and Columbia Counties of Florida and Ware County of southern Georgia. These nests were all in cavities of living limbs from hardwood trees about swamps or inland marshes and no lower than 1.37 m. (4.5 ft.) above ground level, usually at higher levels. Most nests were in willows (*Salix* sp.) and sweetgums (*Liquidambar styraciflua*), though other hardwoods are utilized. The ant has only been collected by locating foragers on the limbs, by beating or opening the arboreal nests. A specimen has never been taken on the ground. In fact, the species was unrecognized in the field for some time as foraging workers superficially resemble the non-major worker of the formicine ant, *Camponotus* (*Colobopsis*) *impressus*, well known for its arboreal habits and nests in tree limbs. Only after collecting a series of that ant and examining specimens in the laboratory was the *Dolichoderus* recognized. On several days in December, 1985, when ambient temperature was around 4.5° to 10.5° C (40° to 50°F) and no ant activity existed, a number of limbs suspected of containing nests were cut from sweetgum trees bordering a swamp in Alachua County, Florida. The limbs were taken indoors and slit lengthwise exposing the cavities. Within these cavities were adults of both *C. impressus* and *D. pustulatus* together with brood of each species. Both species were attempting to carry brood to safety. No partitions separated the cavities into chambers. The rapid escape behavior of the ants, now at room temperature, did not allow any judgment on how the species may have been grouped within a continuous cavity, though clearly they shared a compound nest. Both male and female alates of *D. pustulatus* were also present suggesting that reproductives of this species fly early in the year in Florida. Two to three delate females were also

found within a single limb cavity. No alates of *C. impressus* were present though both majors and workers were abundant. The two species were in approximately equal numbers in the shared cavities; however, *C. impressus* is encountered more frequently in general collecting experience. Also, pure nests of both species have been examined, all in stems as described, so the association is not obligatory.

The limbs were 8 to 15 mm. (0.3 to 0.6 inches) in diameter and the cavities were approximately 3 to 5 mm. (0.1 to 0.2 inches) in diameter with a few wider regions. Entrance to these cavities consists of circular openings about 1.5 to 2.0 mm. (< 0.1 inch) in diameter and spaced about 23 to 38 cm. (9 to 15 inches) apart. Each cavity had two or more entrances. If a nest cavity is bisected when cutting the limb in the field, the number of entrances can not be determined.

The enlarged, truncated heads of majors in *Colobopsis* species presumably function to close the openings to nest cavities, a behavior described as phragmosis in ant literature (Wilson, 1971). Foraging *Colobopsis* workers, on returning to the nest, use tactile stimuli for identifying themselves to the major guarding the entrance. That ant then moves aside allowing the worker to enter (Wilson, 1971). Could a behavioral association between these species result in the *Colobopsis* major opening the entrance on stimulation from a *Dolichoderus* worker? If they use the same nest cavity, some accommodation along this line is necessary. No physical barriers separated the nesting cavity and an interesting line of inquiry exists here in insect behavior.

Forel (1874, 1901) made early observations on the European arboreal species, *D. quadripunctatus*, in association with *Camponotus* (*Colobopsis*) *truncata* Spinola, on walnut trees. He noted the close similarity in body shape between workers of the two species and speculated that mimicry was involved.

The general similarity of body shape also exists between *C. impressus* and *D. pustulatus*, see Fig. 3, though no direct support of mimicry exists. These two species are found moving together along the tree limbs in columns toward foraging areas. Forel also found several different limbs on the same tree occupied by *D. quadripunctatus* and suggested only one colony existed with several nests. The same suggestion can be made for *D. pustulatus*. Torossian (1960) more recently confirmed this dispersed colony structure for *D. quadripunctatus*. Forel made no reference to compound nests for the two European species, but later noted that while they never fight, they avoid each other at close quarters (Forel,

1929). In the neotropical fauna, Forel (1898) documented a *Dolichoderus* species, usually assigned to the subgenus *Monacis*, living in a compound nest. In that case, *D. debilis* Emery and *Crematogaster parabiatica* Forel (= *C. limata parabiatica* Forel) nest in the same stem galleries keeping their brood separate but moving together in columns towards feeding areas.

Discussion

Variability in nest structure is characteristic of many ants and some species nest both below ground and in trees. For example, *Pheidole dentata* Mayr, *P. moerens* Wheeler and *Aphaenogaster texana carolinensis* Wheeler or *A. carolinensis* Wheeler (see Johnson, 1986) will nest in both sites in northcentral Florida. However, their tree nests, often 2.4 to 3.0 m. (8 to 10 ft.) in height occur in holes or crevices produced by decay. Another ant usually termed arboreal is rather intermediate, namely, *A. lamellidens* Mayr. Its nests are under bark of dead trees, in tree holes of live trees or beneath bark of tree trunks lying on the forest floor, but never underground. Further, those species nesting both in trees and near or below ground do so in the same general habitat; the differences are not geographically correlated. More characteristic arboreals such as *Campopnotus (Colobopsis)* species, *Pseudomyrmex* species, *Solenopsis (Diplorhoptum) picta* Emery, etc. nest in elongate, tunnel-like cavities within limbs, often living limbs. These cavities are excavated or at least modified in part by the ants, and no ground level nests have been found. Also, the arboreal ants are less common or absent where cold winters impose harsh temperatures about the tree limb habitat. Thus *D. pustulatus* with ground nests in the North and a true arboreal life style in the South is exceptionally flexible in nesting behavior. As noted above, morphological variability also exists between northern and southern populations. Larger series of specimens than presently exist and taken from known nest types along a north-south transect will be needed to explore these differences.

A taxonomic study of North American *Dolichoderus* species is complicated by the fact that no types are in this country and, if still extant, reside in European collections. Creighton's designation of New Jersey by restriction for *D. pustulatus* furthermore leaves no designated type specimen for the taxon having the most interesting variability.

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