A MONOGRAPH OF THE NEARCTIC SPECIES OF THE ALBOFASCIATUS GROUP OF THE GENUS ANTHRAX SCOPOLI (DIPTERA:BOMBYLIIDAE)

by

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INTRODUCTION

The genus Anthrex Scopoli is one of many little studied genera in the family Bombyliidae (Diptera). The albofasciatus group may be considered typical of the genus in North America in that there are a number of undescribed forms end in that the older described species have been poorly defined and confused. Eleven names have been proposed to date for species in this subgenus, two of which are synonyms. The poor descriptions of the earlier writers, however, have resulted in misconceptions of many of the species. Osten Sacken (1877), for example, in his paper on the western Diptera, listed Anthrax limatulus Say from five localities in the western United States. Examination of the Osten Sacken collection has shown that three taxa were included in this series, none of which belong to A. limatulus as here defined. In addition, four taxa from the western United States have been lumped under Anthrax varius Fab., a European species.

In this study three previously described species are relegated to subspecies and eight new species and subspecies ere described. Redescriptions are included of the previously described species with special consideration being given to externally visible characters of the male genitalia. Further data are given on the distributions of the species. A detailed study of the biology of Anthrax limatulus fur (O. S.) with descriptions of the larval steges and pupa is included along with notes on the biologies of other taxa where they are known.

SYSTEMATICS

There has been considerable confusion regarding the status of the generic name Anthrax. Aldrich (1926) discussed the case in full and the

following account is taken largely from his paper. The genus was originally established by Scopoli (1763) with only one species, Musca morio Linnaeus (1758). Linnaeus' brief description of morio clearly indicates a well-known European bombyliid with half-black wings and there is little question as to its identity. However, one of several bibliographic references added by Linnaeus refers to a distinctly different fly described by him in the first edition of Fauna Suecicae (1746). This insect was later described by Schrank (1781) as Musca anthrax. The two species are generically distinct; the former has half-black wings and the third antennal segment simple and bare at the tip, whereas the latter has the wings infuscated to a greater extent and has a distinct style with a distal tuft of hairs.

It is clear that Scopoli was referring to Linnaeus' 1746 species when he described the genus Anthrax since not only does the description of the wing agree, but he mentions the tuft of hairs at the tip of the antennae.

Macquart, in 1840, erected a new genus, Spogostylum [later emended to Spongostylum by Agassiz (1848)] for S. mystaceum, a South American species having a tuft of hairs at the tip of the antennae, which he also described. Subsequently, Schiner (1860) established the genus Argyromoeba [emended by Loew (1872) to Argyramoeba] for three Old World species, Anthrax tripunctatus Wiedemann, A. varius Fabricius and A. aethiops Fabricius, which also possess this character. Anthrax tripunctata Wiedemann was designated as the type-species of Argyramoeba by Coquillett in 1910. [Sack (1909) designated Musca anthrax Schrank as the type-species of Argyramoeba, but since this species is not one of the original three which Schiner placed in the genus, his designation is invalid. In fact, Musca anthrax is the type-species of Anthrax Scopoli, so Argyramoeba in the sense of Sack

(nec. Schiner) is an absolute synonym of Anthrax.7

The genus Anthrax was based on morio Linnaeus and the species of Anthrax in the present sense were included under either Argyramoeba or Spongostylum until 1902. In that year Bezzi (1902) decided that the real type-species of Anthrax should be Musca anthrax Schrank since Scopoli expressly mentioned the tuft of hairs on the tip of the antennae. This interpretation was gradually accepted and the genera Spongostylum and Argyramoeba have been considered synonyms or allied genera by most recent authors. Anthrax in the old sense has been replaced by Villa Lioy.

The International Code of Zoological Nomenclature gives no set rule for determination of the type-species where a species is misidentified in type citation. Article 70 of the Code (Stoll, et al., 1961; p. 73) states as follows:

> Article 70. Identification of the type-species.--It is to be assumed that an author correctly identifies the nominal species that he either (1) refers to a new genus when he establishes it, or (2) designates as the type-species of a new or of an established genus.
>
> (a) Misidentified type-species.--If a zoologist considers that such a species was misidentified, he is to refer the case to the Commission to designate as the type-species (by use of its plenary powers if necessary [Art. 79] whichever species will in its judgment best serve stability and uniformity of nomenclature....

Article 70 is based on International Commission of Zoological Nomenclature Opinion 65 which was issued in 1914 (Stiles, p. 152). Since Bezzi's discovery was made in 1902 and the Code leaves ample room for liberal interpretation in favor of the existing nomenclature, it seems desirable to retain the name Anthrax as it is now interpreted without referring the case to the Commission.

Numerous species of Anthrax (sensu Bezzi) occur in all of the major faunal regions of the world. The group as a whole is very diverse in structura and consequently several authors hava made attempts to segregate the specias into smaller groups, usually on the basis of superficial and highly variable characters. This has resulted in confusion and misinterpretation and few authors have applied the various names proposed in the same way.

Most of the authors in the late 1800's and early 1900's placed species of Anthrax either in Spongostylum or Argyramoeba, or separated the two genera on the basis of the number of submarginal cells, the former with three, the latter with two. The first attempt to divide Anthrax into smaller groups was made by Williston (1896) who proposed the name Coquillettia for Spongostylum vandykei Coq., a North American species with call R_4 divided by a crossvein. Coquillettia was preoccupied by Uhler (1890) and has been replaced by Dicranoclista Bezzi (1924). The separation has met with general approval and Dicranoclista is at present regarded as a distinct genus.

Sack (1909) proposad eight new genera in the subfamily Anthracinae, Satyramoeba, Anthracamoeba, Leucamoeba, Chalcamoeba, Molybdamoeba, Psamatamoeba, Chionamoeba and Chrysamoeba, for various Palaarctic species and groups of species. In addition, he restricted Spongostylum to those spacies with thrae submarginal cells and Argyramoeba to those species with the base of tha wing black and with the second antennal segmant lenticular.

Becker (1913) recognized two genera in the subfamily Anthracinae, Spongostylum and Anthrax, which he separated on the basis of the number of submarginal cells. Under tha genus Anthrax he placed Satyramoeba, Leucamoaba

and Argyramoeba Schiner (nec. Sack) as subgenera. Anthracamoeba, Chrysamoeba, Molybdamoeba and Psamatamoeba were considered as synonyms of Argyramoeba Seck (nec. Schiner) were considered as synonyms of Anthrax (sensu strictu). Becker placed the genus Chionemoeba in the Anthracinae tentetively.

Bezzi (1924) divided the Anthracinee into three genera, Anthrax, Spongostylum and Dicranoclista (see above). However, he used different criteria for separating the genera Anthrax and Spongostylum. He included under Anthrax those species with the base of the third entennal segment broader than the second end with its margin produced, with the tip of the abdomen of the male covered with silver scales, end with the base of the wing with a broad black pettern. Spongostylum was distinguished by the presence of a globular base of the third antennal segment inserted into a cup-like second segment which is as broad as the base of the third, by the absence of a distinct covering of silver scales on the tip of the abdomen of the male and by the wing pattern which is reduced to dark spots on the bifurcetions and crossveins. Bezzi correctly noted that the character of the number of submarginal cells was not of generic value since species were known which were obviously closely related in all other cherecters, but which differed in the number of submarginel cells. Also, in this work, the genus Chionemoeba Sack was assigned to the Lomatiinae. Bezzi declined to recognize the subgenera which Becker differentieted in his paper.

Most subsequent euthors dealing with the Old World Anthracinae followed the example of Bezzi in the discrimination of Anthrax and Spongostylum. Some euthors, however, used the name Argyramoeba for those species which Bezzi assigned to Spongostylum. In addition, Hesse (1956) erected the genus

Xeramoeba for X. apricaria, a new South African species.

Paramonow (1957) made the first attempt to separate groups within the Anthracinae on the basis of the male genitalia. He placed those Palearctic species having the apex of the gonocoxites distinctly lobed and with the gonostyli arising dorsad to those lobes in the genus Spongostylum. This is approximately the same group which is covered in the present work.

Authors dealing with the North American representatives of the subfamily Anthracinae have made no attempt to segregate the species into smaller groups (other than Dicranoclista) and have placed the entire group under Anthrax, Spongostylum (as Spogostylum) or Argyramoeba.

In this paper, Anthrax is also interpreted in a very broad sense as including all of the North American species of Anthracinae other than Dicranoclista vandykei (Coquillett) and D. fasciatus Johnson and Johnson (1960). It seems preferable to retain the several names used by the Old World authors as subgenera, rather than genera, at least until a thorough, world-wide revision can be made at the generic level.

Anthrax in the present sense should not be confused with Anthrax (auctt.) (type-species: Musca morio Linnaeus) which has been replaced by Villa Lioy.

Genus Anthrax Scopoli

TYPE-SPECIES--Musca anthrax Schrank (as Musca morio Linnaeus)

Anthrax Scopoli, 1763, p. 590; Bezzi, 1902, p. 192; 1908, p. 34; Becker, 1913, p. 445; Bezzi, 1924, p. 158; 1925, p. 217; Aldrich, 1926, pp. 12-15; Paramonov, 1936, p. 3, 69; Engel, 1937, p. 420; Hesse, 1956, p. 359.

Spogostylum Macquart, 1840, p. 331; Williston, 1896, p. 65; Aldrich, 1905, p. 1444.

Spongostylum, emend., Agassiz, 1848, p. 1008; Sack, 1909, p. 510; Kertesz, 1909, p. 58; Bezzi, 1924, p. 167; Paramonov, 1957, p. 123.

Argyromoeba Schiner, 1860, p. 51; Bigot, 1892, p. 347.

Argyramoeba, emend., Loew, 1872, pp. 114, 119; Sack, 1909, p. 524; Kertesz, 1909, p. 59; Coquillett, 1910, p. 510; Bezzi, 1925, p. 221; Hesse, 1956, p. 364.

Anthracamoeba Sack, 1909, p. 515.

Chrysamoeba Sack, 1909, p. 516.

Satyramoeba Sack, 1909, p. 517.

Molybdamoeba Sack, 1909, p. 519.

Leucamoeba Sack, 1909, p. 520.

Chalcamoeba Sack, 1909, p. 522.

Psamatamoeba Sack, 1909, p. 536.

Head slightly narrower than thorax, hemispherical or almost globular. Occiput wide above, narrowed below, deeply bilobate posteriorly. Eyes indented posteriorly, separated dorsally by 1.5-3.5 times the width of the ocellar tubercle, least in the male; ocellar tubercle hemispherical or slightly elongate longitudinally. Front narrow above, widened below; female with a shallow longitudinal depression dorsally. Face slightly protruding or nearly even with the eyes in lateral view, width greatest above; epistomal margin obtusely angular or evenly rounded. Oral cavity deep; proboscis short, not extending beyond the oral cavity; labellae large, fleshy; palpi short, clavate, with long, fine setae apically. Antennae situated approximately one-third of the way from the oral margin to the vertex, separated by a

distance approximately equal to the distance between the sockets end eye margins; first segment cylindrical or expanded inwardly toward the epex, the width slightly greater or slightly less than the length; second segment short, about half the length of the first segment or less, globular, lenticular or saucer-shaped; third segment bulbous basally, the styliform portion bisected, forming a distal style which has a circlet of setae at the epex; first segment covered with numerous setae, second segment with a line of setae on the upper, lower and outer edges. Front covered with numerous, fine setae end sparse scales, scales sometimes lacking on the upper one-third; face covered with coarse setae and sometimes a few erect scales, upper half bare in some groups; occiput covered with small, sperse, semi-recumbent setae end sperse scales, the scales densest along the eye margin; posterior margin of occiput with a dense fringe of short, erect pile.

Mesonotum and scutellum covered with appressed sceles and fine, erect setae, the scales longer end semi-recumbent along the lateral and posterior margins; humeral celli and anterior margin of mesonotum with a fringe of long pile and fine setae; lateral margins of mesonotum, post-alar celli and posterior mergin of scutellum with macrochaetae. Prosternum and propleurae with long, dense pile; mesopleurae, anterior half of pteropleurae and sternopleurae covered with pile, fine setae and erect scales, some macrochaetae usually present on the first two and some recumbent scales on the last; hypopleurae end metapleurae usually bare, but sometimes with a patch of hairs or scales behind or below the spiracle; a distinctive tuft of hairs present behind the wings.

Coxae and trochanters covered with coarse setae and semi-erect scales and/or hairs. Femora and tibiae covered with scales and rows of macrochaetae, most numerous on the hind pair of legs and rarely absent on the fore and middle femora; tarsal claws and pulvilli well developed.

Wings pigmented with very light to very dark brown areas, the extent and character of the markings extremely variable between species and groups of species, usuelly dark basally, often with apical spots or bands, rarely almost hyaline. R-m crossvein loceted at 1/5, 2/5, 1/2 or 3/5 of the distance from the origin to the bifurcation of vein M_{1+2}; vein R_{2+3} usually arising at the r-m crossvein or somewhat before or after, rarely arising proximally more than the length of the r-m crossvein. Veins R_{2+3} and R_4 usually with spurs at their basal angles, the latter sometimes extending across to vein R_{2+3}, thus forming a sectoral crossvein and three submarginal cells. M crossvein sometimes with spurs at its basal and medial angles, the latter rarely extending to the wing margin or vein Cu_1+M_3 forming a fifth posterior cell. Cell R_5 narrowly to widely open; cell 1A narrowly open to closed and short petiolate. Contact of cells $1M_2$ and Cu_1 one-half to three times the length of the base of cell Cu_1. Cell 2A usually about equal to cell 1A in width, but rarely as much as 1 1/2 times broader or greatly reduced. Calypteres well developed, fringe composed of hairs.

Abdomen with seven visible segments. First tergum with dense pile laterally and scales and sparse setae medially along the posterior margin; lateral margins of terga two and three and sometimes four and five covered with pile and/or erect scales as well as long setae; lateral margins of remaining terga with long setae and some recumbent scales. Discs of terga

two through seven covered with sparse, long setae and recumbent scales, the latter unicolorous or forming a more or less complicated pattern of bands and spots of contrasting light and dark scales. Venter with sparse, long setae and sparse scales.

Eighth tergum of female lined with long dense hairs; seventh sternum with a dense patch of soft hairs interiorly at the distal margin; ninth tergum with a ring of stiff spines surrounding the paraprocts. Ninth sternum with a pair of hatchet-shaped sclerites on either side of the gonopore and the openings of the spermathecal and colleterial glands; three spermathecae present, uniting apically into a common duct or emptying separately into the genital chamber.

Male genitalia symetrical, inverted, the gonocoxites dorsad. Gonocoxites of the male genitalia united mesally, narrowing apically, sometimes divided distally forming flattened lobes; bases forming broad, vertical rounded lobes. Gonostyli formed of basal and distal segments, the distal segments projecting distally or dorsally. Intromittent organ formed of bands extending from the dorso-proximal and ventro-mesal margins of the gonocoxites; apex enlarged, forming a complex terminal structure produced above and around the apex of the aedeagus. Aedeagus bulbous basally, tapering to the gonopore; large basal and lateral apodemes present; lateral apodemes arising laterally from the base of the aedeagus with the concave surfaces formed distally; basal apodeme arising from the ventral aspect of the base of the aedeagus, broad, round, formed parallel to the meson, with a ridge extending ventrally from the base and enlarged laterally to form dactylate lobes near the base. Ninth tergum forming a hood over the

intromittent structures, the lateral margins tapered to their attachment with the gonocoxites.

All of the Nearctic species of the subfamily Anthracinae are placed in the genus Anthrax with the exception of Dicranoclista vandykei (Coq.) and D. fasciatus J. & J. Dicranoclista differs from Anthrax in North America in having a crossvein bisecting cell R_4 and in having some pile on the discs of the abdominal terga.

The albofasciatus group of the genus Anthrax is quite distinct from related groups in North America. Despite this fact, it does not seem advisable to employ a subgeneric name for the group at the present time. In the Palearctic region there have been a number of names proposed for various species and groups of species, but they have not been applied consistently by the various authors and considerable confusion has resulted. In addition, the Palearctic species of the albofasciatus group are not nearly so well-defined from the other groups as in the Nearctic region and many intermediate species are known. Consequently, it has not been possible to determine with the limited material readily available which name, if any, should apply to the North American species.

Anthrax albofasciatus Group

Body generally black; tibiae and genitalia usually dark red, lateral and posterior margins of abdominal terga and portions of the sterna sometimes red-orange. Head hemispherical; eyes separated by about 2.5 times the width of the ocellar tubercle in the male, 3.0 to 3.5 times its width in the female. Face projecting slightly above the level of the eyes, the epistomal margin obtusely angular. Scales on front entirely light colored, or light

below and dark medially and dorsally. Epistomal margin lined with coarse black setae, and at least a few erect, light scales, some gold setae often present; upper part of face bare medially or sometimes covered with sparse setae. Occiput entirely covered with light scales or with small patches of black scales along the eye margin. Fringe of pile on the posterior margin of the occiput entirely light, entirely black or black above and light below, a tuft of white hairs sometimes present behind the vertex, especially in the male. Antennae black with black setae; first segment narrow basally, enlarged mesad at the apex, about as long as the width at the apex; second segment lenticular, about twice as wide as long; base of the third segment bulbous, one to one and one-third times the width of the second segment; styliform portion of the third segment arising from the outside edge of the basal portion, one to two times the length of the basal portion, one to three times the length of the style; tuft of hairs usually about as long as the style (Plate III, Figs. 2-18).*

Mesonotum covered with a complex pattern of black and white, and sometimes yellow or gold scales, or uniformly covered with yellow scales; scutellum uniformly covered with yellow scales or with white or gold scales along the margins and mesally and black scales on the remainder of the disc. Pile on proeternum and propleurae variable in color; pile on anterior margin of mesonotum and humeral calli yellow or white, mixed with black setae. Pile and scales on sternopleurae, pteropleurae and anterior half of mesopleurae yellow, white or black; setae gold or black. Postalar tuft of pile variable in color. Metepleurae bare or with some light scales behind and below the spiracle. Coxae covered with semi-erect scales and black or gold setae.

* All Plates are in Appendix.

Scales on femora variable in color, usually truncata and recumbent; fore femora with a row of bristles toward the base on the antero-ventral side, middle femora with a more or less complete antero-ventral row, hind femora with an antero-ventral row of bristles in the female and additional antero-dorsal and postero-ventral rows in the male. Fore and middle tibiae with black scales anteriorly and light scales posteriorly; hind tibiae entirely covered with black scales.

Wings with a basal infuscation and usually with discrete apical spots; basal infuscation restricted to the extreme base of the wing or extending out as far as the bases of cells R_1 and $1M_2$, rarely extending along the veins and more weakly in the cells almost to the apex of the wing; apical spots sometimes atrophied except at the bases of cells R_{2+3} and R_5, and in cell R below the base of vein Rs in those forms with the least basal infuscation, sometimes present at the bases of cells R_4, M_1, $2M_2$, Cu_1 and $1M_2$, rarely a discrete spot present on vein 2A halfway between its base and apex. Short spurs extending basad from the basal angles of veins R_{2+3} and R_4, the latter sometimes joining vein R_{2+3} to form a sectoral crossvein; a small spur rarely present at the basal angle of the medial crossvain. R-m crossvein located 1/2 or 3/5 the distance from the origin to the bifurcation of vein M_{1+2}; anastamosis of cells $1M_2$ and Cu_1 one to one and one-half times the width of the base of cell Cu_1; anal call narrowly open. Cell 2A one to one and one-half times the maximum width of cell 1A. Calypteras unpigmented (Plate V).

Sides of first abdominal targum covered with dense white or yellowish-white setae; some black setae and rarely some black pile present posteriorly; some black, yellow or white pile usually present on the sides of segment two,

occasionally on segments three and four; terga two through seven with black setae along the margins and often with some erect or semi-erect, scales. Discs of terga two through four covered with linear and lanceolate scales of variable color and pattern anteriorly, with submedial and sublateral spots of larger white scales on the posterior margins; posterior terga mostly covered with large white scales, especially in the male, the white scales not densely overlapping. Venter covered with sparse, long setae and sparse scales.

Apex of the gonocoxites bifurcate, forming distinct apical lobes covered with setae; distal segments of the gonostyli arising vertically above the bases of the lobes of the gonocoxites; basal segments of the gonostyli inconspicuous, rounded dorsally, or rarely produced acutely apicad. Apex of the intromittent organ produced vertically or sometimes up to 45 degrees proximally; dorsal part with medial and lateral proximal projections and often with lobes and teeth on the distal face; a distinct process usually formed above the tip of the aedeagus, often with teeth present; ventrolateral parts usually well-developed and rounded, sometimes extending beyond the tip of the aedeagus (Plates I, II; Plate III, Fig. 1).

The Nearctic species of the albofasciatus group may be separated from species of the other groups most readily by the male genitalia. The gonocoxites are bifurcate apically, forming two distinct lobes, and the distal segments of the gonostyli arise vertically above the bases of the lobes (Plates IV, VI) in the albofasciatus group, whereas, in the other groups the gonocoxites are only indistinctly bi-lobed if at all and the distal segments of the gonostyli arise distally from the gonocoxites. The maculation of the wings of the species of the albofasciatus group consists of a basal infuscation and apical spots at the bases of some or all of cells R_3 and R_5,

R_4, M_1, $2M_2$, Cu_1, and $1M_2$, and in cell R below the origin of vein R_1 (Plate V). In some taxa the maculation may be greatly reduced and the wings may appear almost hyaline. In other groups, the pigmentation is restricted to a well-defined basal and/or anterior infuscated area, or, if spots are present they are more numerous and occur at points other than those listed above.

A group of Neotropical species typified by Anthrax trimaculatus Macquart appears to be closely related to the albofasciatus group. These species have the gonocoxites bifurcate and have spots on the wings at the points cited for the albofasciatus group, but they have in addition a distinct, isolated spot present medially in cell R_3 below the tip of vein Sc.

The first Nearctic species in the albofasciatus group to be described was limatulus Say (1829), a species indigenous to the forests of the eastern United States. Shortly thereafter, Macquart (1834) described a new species from Georgia which he named analis. This name was used by Say (1823) for a species in another group, however, and Macquart (1840) subsequently proposed the name albofasciatum for his species.

Several other new species were described in the late 1800's under Argyramoeba. Loew (1869) described pauper and obsoleta from Illinois and Missouri, respectively, the latter being a synonym of limatulus Say. Osten Sacken described fur in 1877 from Texas and daphne in 1886 from Sonora, Mexico. Bigot (1892) described varicolor from "Amerique du Nord: Colombie".

Between 1900 and 1920 species of Anthrax were placed by different authors in either Argyramoeba or Spongostylum. Cresson (1919) described Spongostylum vierecki from southern New Mexico and western Texas (as Spogostylum). The last

two species of the albofasciatus group to be described were plesia Curran (1927) from British Columbia, Canada and nidicola Cole (1952) from California, both of which were placed in Anthrax (sensu Bezzi).

No revisions have been attempted on any of the groups of Anthrax in North America, but several keys have been published. Osten Sacken gave keys to the known species of Anthrax in the western United States in 1877 and to those in Mexico and Central America in 1886. Coquillett (1894) published a key to most of the described species of Anthrax in the United States. Curran's 1927 paper conteined a key to the species of Anthrax in the Canadian National Collection in addition to his description of plesia and Maughan (1935), in her study of the Utah Bombyliidae, included a key to the species of Anthrax found in that state.

The albofasciatus group may be subdivided into two subgroups on the basis of both the oviposition preference of the females and morphology. The limatulus subgroup consists of two species, Anthrax limatulus Say end A. nidicola Cole, the former composed of six subspecies. The females of these two species oviposit in the cells of those species of bees and wasps inhabiting vertical banks or nesting under bridges. The albofasciatus subgroup consists of A. albofasciatus Macquart with four subspecies, A. aureosquamosus, n. sp., with two subspecies, A. varicolor (Bigot) with two subspecies, A. plesia Curran and A. pauper (Loew). The females of these species, as far as known, oviposit in the cells of those species of bees and wasps nesting in horizontal surfaces.

It seems probable that all of the Nearctic representatives of the albofasciatus group are comparatively recent immigrants from the Palearctic

region. The two subgroups discussed above may have been derived from two separate stocks, however, since they are quite distinct in both their oviposition behavior and morphology. A. nidicola appears to be a relict species restricted to the central valley of California and adjacent, ecologically similar areas of southern California. It may be of a separate and older derivation from A. limatulus.

ECOLOGY AND DISTRIBUTION

Species of the albofasciatus group are generally distributed throughout North America with the exception of the Arctic tundra, alpine areas and the West Indies. Specimens from Honduras in central America to the Mackenzie Delta on the Arctic Ocean have been studied. The taxa occupy a variety of habitats, coniferous or deciduous forests, deserts or grasslands. In general, each taxon occupies an area characterized by a particular vegetation zone indicating that the factors which determine the distribution of the taxa are primarily climatic. Only rarely is it possible to collect two taxa in the same area.

Maps have been prepared to illustrate the distributions of each species and subspecies. Each dot represents a locality from which a specimen has been seen by the author. Possible limits of distribution are indicated by solid lines and less certain boundaries are indicated by dotted lines. The ranges mostly indicate areas which are ecologically similar to areas from which specimens have been observed. The ranges have been derived from vegetation maps of the areas in question for the most part. The distribution of Anthrax nidicola is not illustrated since it is known from only a few localities.

Generally, the species are to be found frequenting rocky and sandy areas during the hottest part of the day. Those species occurring in forested areas are generally found near clay banks or bridges, in dry streambeds, along car-tracks or in other open areas where bees and wasps are nesting. Certain subspecies of A. limatulus are very rarely collected in the field and are known primarily from specimens reared from the nests of Anthophora bees and "mud dauber" wasps. No specimen of the genus Anthrax has been observed by the author to feed in the adult stage. Robertson (1928) has listed "Argyramoeba albofasciatus Macquart" and "Argyramoeba oedipus Fabricius" as feeding on various flowers.

BIOLOGY

Very little information is available on the biology of the albofasciatus group. A few studies have been made on species in other groups in the genus in North America. Shelford (1913) studied the life cycle of Anthrax analis Say, a parasite of tiger beetles (Coleoptera, Cicindellidae). Malloch (1915) described the larva and pupa of analis. Hall (1954) made notes on the biology of A. irroratus Say which he reared from a Hymenopteron nesting in an old Anobiid burrow in a log. Hurd (1959) reviewed the known facts concerning the biology of A. tigrinus (DeGeer), a parasite of carpenter bees. Numerous other host records have been published.

In the albofasciatus group the first host for a Nearctic species was recorded by Osten Sacken (1877) when he described A. limatulus fur from "the nest of a Mud-wasp" (probably Trypoxylon politum Say). Malloch (1917) described the pupa of limatulus limatulus Say without reference to the host from which it was reared. Frison (1922) noted that this subspecies had been reared

from the nests of Anthophora abrupta Say. Rau (1916) recorded e species of Anthrax, either limatulus limatulus or l. fur, as having been reared from the nests of Sceliphron caementarium (Drury). A. limatulus artemesia, n. ssp., was reported as having emerged from the cells of Dianthidium curvatum sayi Cockerell by Custer (1928). Flies which were probably this subspecies were reported as having been reared from the nests of Dianthidium curvatum sayi by Hicks (1926) and from the cells of Anthophora occidentalis Cresson by Mickel (1928).

Linsley and MacSwain (1942) published notes on the behavior and biology of A. limatulus vallicola, n. ssp., a parasite of Anthophora linsleyi Timberlake. Cole (1952) described A. nidicola from a series of specimens reared from Anthophora bees. Linsley, MacSwain and Smith (1952) discussed the biology of this species.

In this paper the results of a study undertaken during the summer of 1958 and the winter of 1958-59 on the biology end life cycle of A. limatulus fur are reported. It was found that the larvae of this subspecies exhibit little host specificity, being able to feed on the larvae of a number of unrelated species of Hymenoptera. This is probably generally true of the species of the albofasciatus group, if not of the genus es a whole, and any apparent host specificity is probably the result of the selective oviposition behavior of the female flies.

In the albofasciatus group details of the life cycles and host records are known only for those species end subspecies in the limatulus subgroup. All of these species, as far as is known, parasitize bees end wasps which nest in vertical banks and under bridges. The species of the limatulus subgroup are restricted to these rather uncommon sites and

consequently are rarely collected in the field. A. limatulus larrea is an exception since only one reared specimen has been studied. The majority of the specimens studied of nidicola and the other subspecies of limatulus were reared.

The biology of the species of the albofasciatus subgroup is completely unknown. The only observations made on this subgroup by the author were on A. pauper. A single female was observed ovipositing in holes and crevices in a sandy area near Manhattan, Ks. The female was taken into the laboratory and placed in e cage with sand in the bottom and blackened gelatin capsules embedded in the sand to serve as oviposition sites. The female died within a few hours, however, and no eggs were obtained. Attempts to aspirate eggs from the oviposition sites in the field were also futile. Since the species of the albofasciatus subgroup observed by the author all are found in open areas it seems probable that they are parasites on bees and wasps nesting in horizontal surfaces and that the females prefer these surfaces for oviposition as was observed with the female of pauper.

CHARACTERS AND VARIATIONS

Approximately 1,100 specimens have been studied during the course of this work. These represent the majority of the preserved specimens present in North American museums. All except about 20 of these specimens have been assigned with relative certainty to the various taxa recognized. The few which it was not possible to place represent intermediates between subspecies, genetic aberrants and possibly some representatives of distinct species or subspecies too poorly represented to be recognized.

The relative rank of the individual taxa may be open to question in some instances. In general, where two closely related taxa occur allopatrically they are considered to be subspecies unless they occupy quite different habitats. In several cases intermediates have been noted from the areas where the distributions of two taxa overlap which lends credence to the supposition that they are subspecies. Few clines have been noted among the characters studied and the taxa generally exhibit little morphological variation. Where variation does occur it usually appears to be randomly distributed or is local in nature.

It seems probable that the majority of the existing Nearctic species and subspecies in the albofasciatus group have been recognized in this study. Almost all of the gross ecological areas in the United States are occupied by one or more species. It is possible, though, that new forms may be found in such ecologically diverse areas as California or in poorly collected areas such as the Great Basin and Mexico.

The characters selected for emphasis in the key and the diagnoses of the species are those which are usually best preserved and most easily interpreted. Characters of the vestiture of the dorsum of the thorax and the abdomen as well as the scales on the legs have been subordinated to other characters whenever possible since the scales and pile are easily rubbed off. Characters of the wings are used for the most part since they can be easily interpreted by persons without any special knowledge of the group.

The Comstock-Needham system has been followed exclusively for the naming of the veins and cells of the wings. The presence or absence of a complete sectoral crossvein between veins R_{2+3} and R_4 is a valid specific

character in the albofasciatus group. In the two species which normally possess this character only one specimen has been found in which the crossvein is incomplete. The species which do not normally possess a complete sectoral crossvein have a spur at the basal angle of vein R_4. In rare instances this spur may be abnormally connected with vein R_{2+3}, but in these cases the crossvein is distinctly angled instead of evenly curved and usually has a short spur at the angle, and tha wings usually have othar spurious crossveins or abnormal spurs when an abnormal crossvein is present.

The pigmentation of the wings varies from dark brown to light yellow or gray. With the exception of A. plesia and A. albofasciatus daphne (O. S.) the species or subspecies with lighter and less estensive pigmentation occur in desert and grassland areas while those with darker and more extensive pigmentation occur in forested areas. The pigmentation consists of a basal infuscation and e number of more or less distinct apical spots, some of which may be reduced or absent. The basal infuscation usually fills the bases of cells C, R, M, 1A and 2A and all of cell Sc. In tha albofasciatus subgroup it is most extensiva in albofasciatus albofasciatus, a. picea and a. cascadensis in which it may fill all of cells C, Sc, R and M, and the basal halvas of cells R_1, 1A and 2A. In the lightest colored species and subspecies it may be restricted to narrow areas along the veins at tha bases of cells C, Sc, R, M and 1A. In the limatulus subgroup it is most extensive in l. limatulus in which it fills cells C, Sc, R, and M, the basal portions of cells R, 1A and 2A, and extends into the apical and posterior portions of the wings along tha veins. In the western subspecies of limatulus the amount of infuscation is reduced not so much by a restriction of the pigmented area as by a reduction in the intensity of the pigment from dark brown to light

yellow or gray. The basal infuscation is somewhat variable within subspecies and is difficult to describe, so it has not been emphasized as a taxonomic character.

The maculation of the wings, on the other hand, is easily interpreted and is usually quite constant within subspecies. The maculation consists of six basic spots, at the bases of cells R_3 and R_5, R_4, M_1, $2M_2$ and Cu_1, and in cell R below the base of cell R_1. In addition, there is an isolated area of infuscation medially on vein 2A which extends into both cells 1A and 2A in aureosquamosus. The spots at the bases of cells R_3 and R_5 are always fused and the spot at the base of cell Cu_1 is often joined across the base of cell $1M_2$ with the spot at the base of cell R_1. The spot on vein 2A in aureosquamosus probably has developed secondarily by isolation of an area of the basal infuscation. The spot is unique to this species although a few specimens of albofasciatus albofasciatus have been seen which have a similar, partially isolated spot. The basal infuscation may extend out as far as the middle of cells 1A and 2A in albofasciatus picea and a. cascadensis, but in both the distal area of infuscation retains a broad connection with that at the base. There may be an isolated infuscated area medially in cell 1A in varicolor varicolor, but in this case it does not extend into cell 2A.

The maculation may be reduced either by a general reduction in the intensity of the pigmentation or by reduction of the apical spots, although both often occur simultaneously. The spot at the base of cell M_1 is the most unstable followed by those at the bases of cells $1M_2$ and R_4.

Other characters of the wings such as the situation of the r-m and m crossveins, the open or closed states of cells R_5 and 1A, and tho pigmentation

of the calypteres have not been found to be of value in distinguishing the species and subspecies. This is probably due to the fact that the members of the elbofasciatus group are all very closely related, while the characters of the pigmentation noted above are quantitative rather than qualitative and are subject to greater variation.

The male genitalia have been found to be very valuable characters in the albofasciatus group. They are quite variable, even between subspecies, but still are remarkably constant within these taxa. In several populations in California, however, specimens have been noted which have distinct forms of genitalia but are essentially identical in other respects to specimens with the normal genitalia form. An aberrant form of Anthrax albofasciatus cascadensis in northwestern California forms a relatively high percentage of the population and has been noted from several localities, but the other aberrations noted have been represented by only one or a few specimens from one or two localities. These aberrant forms and the intermediates found between A. albofasciatus cascadensis and albofasciatus daphne made the analysis of the species of the elbofasciatus subgroup in California very difficult. It may be possible that these variants actually represent distinct taxa with extremely local distributions, but it seems more probable that they are simply genetic aberrations which have increased in frequency in isolated populations. The latter hypothesis seems most tenable since specimens with typicel genitalia have been collected along with the variants in several cases. Additional variants will probably be found in other isolated populations in the southwestern United States when this area is more intensively collected. The individual aberrations are discussed under each taxon.

The terminology used in describing the parts of the genitalia is an artificial one, since the homologies of parts are not known even among other genera of the family Bombyliidae. The various parts mentioned in the key and descriptions are labelled in Plate I, Fig. 1. The forms of the distal segment of the gonostyli and the distal lobes of the gonocoxites have been particularly useful as taxonomic characters since they are easily visible on pinned specimens and are quite variable between taxa. These structures have been photographed and are represented in Plates IV and VI. A. limatulus columbiensis is not pictured since only one male is known of this subspecies and its genitalia were dissected.

The distal segments of the gonostyli are formed dorsad to the distal lobes of the gonocoxites and project laterally somewhat. They are photographed in ventro-lateral view perpendicular to their longitudinal plane. In lateral view, as they are figured in the drawings of the genitalia, their form is somewhat distorted. The distal lobes of the gonocoxites are photographed in ventral view (since the male genitalia of Anthrax are inverted, this is in dorsal view in relation to the body of the insect).

The apex of the intromittent organ is of very complex structure in the albofasciatus group and exhibits many good diagnostic characters. The dorsal part terminates in a medial and two lateral lobes which may be bluntly or sharply angled or curved. The apical face of the dorsal part may have a pair of teeth or lobes present. These lobes have their greatest development in A. varicolor varicolor. There is usually a distinct process above the tip of the aedeagus which is quite variable from taxon to taxon. It may take the form of a transverse ridge or a snout-like process with pairs of teeth, or it may appear as a simple spur in lateral view. The entire

dorsal part may be formed vertically or at a proximal angle; the distal face may be nearly flat or bulbously produced. The ventro-lateral parts vary as to the distance which they extend forward, sometimes obscuring the apex of the aedeagus in lateral view and sometimes leaving it entirely exposed.

Other characters of the male genitalia were found to vary somewhat between species, but these variations were difficult to interpret and consequently are not emphasized. The female genitalia also possess some sclerotized parts, the spermathecee and a pair of hatchet-shaped sclerites on either side of the apex of the spermathecal duct. The hatched-shaped sclerites were found to exhibit some variation, but it could not be correlated with other characters. The spermathecae were not found to vary significantly in form in the specimens examined.

There is a general difference in the vestiture of the body between the limatulus subgroup and the albofasciatus subgroup. The former has the pattern of scales on the dorsum of the thorax and abdomen rather simple with only two colors of scales, black or yellow and white, usually present; the latter usually has e complex pattern of black, gold and white scales. Some characters of the vestiture have been valuable for the differentiation of species and subspecies. The color of the prosternal and post-alar tufts of pile is often a good taxonomic character. The first is a discrete tuft of hairs present in front of the fore coxae, the second is situated behind the base of the wings. Either of these tufts may be black, white, gold, yellow or of mixed colors. The color of the fringe of pile on the posterior margin of the occiput has been used to differentiate taxa in some cases. This is often a difficult character to see, but it is best discernible when viewed from a posterior angle.

The shape of the antennae has not been utilized in the classification of this subgroup. As may be seen from Plate III there is little variation in their structure. The shape of the antennae is of much greater value for the higher classification within the genus. The size of the body is an extremely variable characteristic of this subgroup, but the variation seems to be due to the size of the host rather than to any intrinsic differences among the species. The chaetotaxy has also been found to vary, but no discrete differences have been noted.

KEY TO THE ALBOFASCIATUS GROUP OF THE GENUS ANTHRAX

1a. Sectoral crossvein present as an evenly curved vein (Plate V, Figs. 5-7) (if short spurs are present on the crossvein or the wings show other evidence of abnormal venation, take 1b)..... 2

1b. Sectoral crossvein absent 4

2a. Sides of abdominal terga two and three with only black setae and scales; no bushy yellow pile present 3

2b. Sides of abdominal terga two and three with bushy yellow pile. Scales on the body predominantly yellow and white. Halteres entirely yellow. Wings without spots at the bases of cells R_4 and M_1 (Plate V, Fig. 7) ..... nidicola Cole

3a. Wings with distinct, dark brown spots at the bases of cells R_4, M_1 and $2M_2$ (Plate V, Fig. 5). Post-alar tuft of pile yellow, black or mixed yellow and black. Distinct bands of gold or yellow scales present on the abdomen. Arizona and southern California to Washington ..... varicolor varicolor (Bigot)

3b. Wings with the spots at the bases of cells R_4, M_1 and $2M_2$ reduced to faint clouds or absent (Plates V, Fig. 6). Postalar tuft of pile white or light yellow. Light scales on the dorsum of the abdomen white or light yellow. Southern California to Texes ..... varicolor vierecki Cresson

4a. Wings with an isolated spot medially on vein 2A extending into both cells 1A and 2A. Large spots present at the bases of cells R_4 and M_1 (Plate V, Fig. 8). Prosternal pile white..... 5

4b. Wings without an isolated spot medially on vein 2A extending into both cells 1A and 2A; if an indistinct infuscated area is present it either does not extend into cell 2A or is broadly connected with the infuscation at the base of cell 1A, or the prosternal pile is partially black..... 6

5a. Apex of distal segment of gonostyli narrow and truncate (Plate IV, Fig. 14). Utah and Washington south to Lake Tahoe end San Frencisco in California.

..... aureosquamosus aureosquamosus Marston, n. sp.

5b. Apex of distal segment of gonostyli with two low tubercles end a sharp distal projection (Plate IV, Fig. 13). Baja California north to San Francisco.

..... aureosquamosus chaparralus Marston, n. ssp.

6a. Base of cell R_4 with a distinct spot or cloud; cell M_1 with or without e cloud or spot (if a very faint cloud is present at the base of cell R_4 and no cloud is present at the base of cell M_1, take 6b) 15

6b. Spots or clouds absent from the bases of cells R_4 end M_1 7

7a. Fringe of pile on upper half of posterior margin of occiput bright yellow or gold (occasionally the pile may be brown or grey on the lower half) 8

7b. Fringe of pile on the posterior margin of the occiput predominantly dull brown or black (a small tuft of white hairs may be present behind the vertex) 11

8a. Sides of second and third abdominal terga with abundant yellow pile 9

8b. Sides of second end third abdominal terge with black setae and black, white or yellow scales on the sides; very few, if eny yellow hairs present 10

9a. Femora with numerous light-colored scales. Distal segment of gonostyli bluntly angulate apically, not styliform (Plete IV, Fig. 5). Central California...*limetulus vallicola* Marston, n. ssp.

9b. Scales on femora usually entirely black. Distal segment of gonostyli with a sharply pointed, styliform apex (Plate V, Fig. 3). Great Plains and Great Basin.

..... *limatulus artemesia* Marston, n. ssp.

10a. Abdomen without black scales; scales predominantly dark yellow. Apex of distal segment of gonostyli styliform, bending sharply distad (Plate I, Fig. 4). Eastern Washington, northeastern Oregon and northwestern Idaho.

..... *limatulus columbiensis* Marston, n. ssp.

10b. Abdomen with distinct bands of black scales; light scales on thorax and abdomen light yellow or white. Apex of distal segment of gonostyli short, blunt (Plate IV, Fig. 4). Southern California to western Texas.

..... *limatulus larrea* Marston, n. ssp.

11a. Cell M entirely infuscated with yellow or brown although usually lighter distally; darker infuscation at the base and apex not distinctly defined. Costal cell entirely infuscated (Plate V, Figs. 1, 2). Post-alar tuft of pile white..... 12

11b. Cell M with a distinct medial hyaline area; infuscation at the base and apex distinctly defined. Costal cell usually not entirely infuscated. Post-alar tuft of pile black or white..... 13

12a. Mesonotum with very little, if any, gold or yellow scales. Infuscation on wings often darker along the veins; cells in the outer half of the wings subhyaline (Plate V, Fig. 1)

..... *limatulus limatulus* Say

12b. Mesonotum with distinct spots and bands of yellow or gold scales. Infuscation on wings not darker along the veins; cells in the outer half hyaline (Plate V, Fig. 2)..*limatulus fur* (Osten Sacken)

13a. Fringe of pile on posterior margin of occiput black with light tips, without a distinct tuft of white hairs behind the vertex. Distal segment of gonostyli ovate and with a beaked apex (Plate IV, Figs. 15, 16). Distal lobes of the gonocoxites with long black or yellow setae (Plate VI, Figs. 15, 16)..... 14

13b. Fringe of pile on posterior margin of occiput usually with a distinct tuft of white hairs behind the vertex. Distal lobe of each gonostylus quadrangular basally with a styliform apex (Plate IV, Fig. 12). Distal lobes of the gonocoxites with short, black setae (Plate VI, Fig. 12) (females take 13a)..... albofasciatus daphne (Osten Sacken), male

14a. Prosternal tuft of pile white; post-alar tuft of pile usually black, white in specimens from southern California. Distal lobes of the gonocoxites with abundant yellow setae (Plate VI, Fig. 16). Pine and cedar forests in the western United States and southwestern Canada ..... plesia Curran

14b. Prosternal tuft of pile black; post-alar tuft of pile white. Distal lobes of the gonocoxites with black setae (Plate VI, Fig. 15). Sandy areas in the Great Plains and northeastern United States..... pauper (Loew)

15a. Cells in outer half of wings hyaline; infuscation not darker along the veins; costal cell usually not infuscated..... 16

15b. Cells in outer half of wing subhyaline, smoky; infuscation darker along veins; costal cell entirely infuscated (Plate V, Fig. 1) Distal segment of gonostyli quadrangular basally with a styliform apex (Plate IV, Fig. 1). Distal lobes of the gonocoxites broad, flat and separated medially by the width of one lobe or less (Plate VI, Fig. 1).....*limatulus limatulus* Say

16a. Fringe of pile on posterior margin of occiput not distinctly lighter behind the vertex. Spot at base of cell R_4 large. Post-alar tuft of pile usually black or mixed black and white. Distal lobes of the gonocoxites separated medially by more than the width of one lobe. Distal segment of gonostyli with a beaked or gradually tapering apex..... 17

16b. Fringe of pile on posterior margin of occiput usually with a distinct tuft of light hairs behind the vertex. Spots on the wings small, cloud-like (Plate V, Fig. 12). Post-alar tuft of pile usually white. Distal lobes of the gonocoxites flat, separated medially by the width of one lobe or less (Plate VI, Fig. 12). Distal segment of gonostyli quadrangular basally with a styliform apex. Western United States.
.....*albofasciatus daphne* (Osten Sacken)

17a. Cell M_1 with a large spot at the base (Plate V, Figs. 10, 11). Distal lobes of the gonocoxites more than twice as long as the width of one lobe at the base (Plate VI, Figs. 10, 11). Canada and western United States..... 18

17b. Cell M_1 with the spot at the base usually reduced to a cloud or absent, occasionally large and distinct in specimens from southeastern United States (Plate V, Fig. 9). Distal lobes of the gonocoxites less than twice as long as the width of one lobe (Plate VI, Fig. 9). Southeastern Canada to Central America.....albofasciatus albofasciatus Macquart

18a. Distal lobes of the gonocoxites separated medially by less than the width of one lobe (Plate VI, Fig. 10). Distal segment of gonostyli beaked at the apex (Plate IV, Fig. 10). Cell M usually entirely infuscated in both sexes (Plate V, Fig. 10). Spruce and fir forests in Canada and along the Canadian border in northeastern and northwestern United States.

.....albofasciatus picea Marston, n. ssp.

18b. Distal lobes of the gonocoxites separated medially by more than the width of one lobe (Plate VI, Fig. 11). Distal segment of gonostyli tapering gradually to the apex (Plate IV, Fig. 11). Males and usually females with cell M not entirely infuscated (Plate V, Fig. 11). Western United States.

.....albofasciatus cascadensis Marston, n. ssp.

DIAGNOSES AND DESCRIPTIONS OF SPECIES

Anthrax limatulus limatulus Say

Anthrax limatulus Say, 1829, p. 157; Osten Sacken, 1858, p. 41; Johnson, 1925, p. 108.

Argyramoeba limatule (Say), Coquillett, 1894, p. 95; Johnson, 1895, p. 325; Kertesz, 1909, p. 65.

Spogostylum limatulus (Say), Aldrich, 1905, p. 223; Johnson, 1913, p. 55.

Argyramoeba obsoleta Loew, 1869, p. 29; Osten Sacken, 1877, p. 242; Osten Sacken, 1878, p. 90; Rau, 1916, pp. 36, 37.

Spogostylum obsoletum, Cole, Malloch end McAtee, 1924, p. 185.

Spogostylum elbofascietum, Malloch, 1917, p. 395; Frison, 1922, p. 152 (nec. Say, 1829, misident.).

Diagnosis. Wings without sectoral crossvein; basal infuscation brown, filling cells C, Sc, R and M; dark spots usually present at the bases of cells R_4, M_1 and $2M_2$ (Plete V, Fig. 1). Fringe of pile on posterior margin of occiput black with light tips. Post-aler tuft of pile white; prosternal tuft usually bleck. Mesonotum, scutellum and second abdominal tergum with few, if any, gold scales. Femora entirely covered with black sceles. Distal lobes of gonocoxites broad, ebout one and one-half times es long as wide, curved on the outer margins, elmost straight on the inner margins and separated medially by slightly less then the width of one lobe; apices with minute black setae (Plate VI, Fig. 1). Distal segments of gonostyli almost twice as high as the width et the bese, more or less quadrangular basally with en ecuminate apex which is slightly bent outwerd (Plate IV, Fig. 1).

Mele. Integument generally black, grey to blue-green pollinose; tibiee, proximel tersal segments, genitelia and distal margins of the apical abdominal terga reddish-orenge; ebdominal sterna mostly orange with black spots which increase in size enteriorly. Scales on head sparse, white on lower helf of front, face end occiput; upper half of front usually with bleck scales

leterally and white scales medially elthough the area of black scales may sometimes be expanded mesad. Setae on head bleck. Fringe of pile on posterior margin of occiput black with light tips.

Mesonotum mostly covered with lineer black scales, white or gold scales sometimes present submedially on the enterior half and extending inward from the lateral mergins in front of the bases of the wings; rust-colored scales sometimes present between the dark end light scales. Margins mostly covered with linear, semi-recumbent white scales, a few rust-colored scales usually present in front of the bases of the wings end on the enterior margin. Scales on pleurae end coxae usually black although some white ones may be present on the upper half of the sternopleurae, the pteropleurae and the mesopleurae. Prosternal tuft of pile black; pile on pleurae and anterior margin of mesonotum black and white or yellowish-white; post-alar tuft white. Scutellum with white sceles on the posterior margin and linear black scales on the anterior margin end disc.

Wings infuscated with brown basally and enteriorly out to a line extending from the tip of the subcoste through the bases of cells R_5 end Cu_1 into the center of cell 2A before feding to subhyaline or hyaline apically and posteriorly; infuscation often darker elong the veins; spots of darker pigmentation usually present at the beses of cell R_3, R_4, R_5, M_1, $2M_2$ and Cu_1 although those at the bases of cells R_4 and M_1 may be reduced or ebsent in specimens from the western edge of the renge. Sectoral crossvein absent (Plate V, Fig. 1).

First abdominal tergum with curly white scales leterally end bleck scales medially on the posterior margin; laterel margins covered with dense white pile although a few bleck hairs may be present posteriorly. Second, third

and fourth terga entirely covered with linear black scales with the exception of two submedial and two lateral patches of cuneate white scales on the posterior margins and a medial crescent-shaped line of white scales connecting the submedial patches of white scales. Fifth tergum with the white scales on the posterior margin expanding anteriorly on the sides and with the medial, crescent-shaped line absent. Sixth and seventh terga covered with cuneate white scales with the exception of medial spots of linear black scales and a few lanceolate black scales mixed with the white where the two come together. Venter entirely covered with sparse linear black scales and black setae.

Male Genitalia. Tips of the gonocoxites broad, about one and one-half times as long as wide, curved on the outer margins, almost straight on the inner margins and separated medially by slightly less than the width of one lobe; apices with minute black setae (Plate VI, Fig. 1). Distal segments of gonostyli almost twice as high as the width at the base, more or less quadrangular basally and narrowing abruptly to the styliform apex; distal margin curved convexly, proximal margin almost straight on the basal two-thirds before curving concavely to the apex; apex slightly bent outward (Plate IV, Fig. 1). Dorsal half of the apex of the intromittent organ bent slightly forward, distinctly convex both longitudinally and transversely; medial proximal projection bluntly rounded, broadly separated from the narrow, blunt lateral proximal projections; apical face with a short, transverse medial ridge. Medial process above the aedeagus projecting slightly forward, with a pair of dorsal teeth and a transverse apical flange. Ventro-lateral parts of the apex of the intromittent organ folded before the apex, thus forming a

dorso-ventral ridge; apex angular, projecting only slightly past the tip of the aedeagus (Plate I, Fig. 1).

Female. Similar to male. Integument of abdomen entirely black. White scales less extensive on posterior abdominal terga. Prosternal tuft of pile white in one specimen.

Body Length.

Male--Range: 8.4-11.2 mm; $\bar{x}$: 10.3 mm; s.d.: 1.10 mm; n: 4.

Female--Range: 9.1-11.4 mm; $\bar{x}$: 10.3 mm; s.d.: 1.10 mm; n: 7.

Wing Length.

Male--Range: 9.4-12.7 mm; $\bar{x}$: 10.9 mm; s.d.: 1.12 mm; n: 6.

Female--Range: 9.7-11.7 mm; $\bar{x}$: 11.0 mm; s.d.: 0.82 mm; n: 7.

Distribution. The small number of specimens of A. limulatus limulatus available along with the type localities of limulatus and obsoletus, its synonym, indicate that the subspecies inhabits areas dominated by oak and other hardwoods in the eastern United States as far west as eastern Texas and central Missouri (Map I). No specimens have been seen from the Appalachian mountains. It probably occupies the habitat along small streams where it is parasitic on anthophorid bees in clay banks and on mud-daubers nesting under bridges. If this is true, it replaces limulatus fur ecologically as well as geographically (Map I).

New Material Examined. Alabama: Morgan Co., 2♂, Decatur, VI-10-1942 (J. Lane).

Arkansas: Arkansas Co., ♀, VIII-18-1927 (David G. Hall).

Delaware: ♀, Water Gap (Mrs. A. T. Slosson).

Georgia: Fulton Co., ♂, Atlanta, VIII-3-1935 (P. W. Fattig); ♂, ♀, Atlanta, VI-13-1936 (P. W. Fattig). ♂, ♀, "Georgia" (Osten Sacken); ♂, "S. Georgia" (Morrison).

Illinois: Fayette Co., 2♂, ♀, Ramsey, IV-1-1956 (reared).

Louisiana: Madison Co., ♂, Tallulah, VII-15-1926.

Maryland: Prince George Co., ♀, Beltsville, VII-18 (F. C. Pratt); ♀, Beltsville, IX-1944 (Frank R. Smith).

Mississippi: Clay Co., ♂, West Point, VIII-4-1922. Oktibbeha Co., ♀, State College, VI-6-1906; ♀, State College, IX-29-1919 (F. M. Hull); ♀, State College, VI-11-1921 (C. N. Velverton).

Missouri: Crawford Co., ♀, Huzzah, (P. Rau). Saint Louis Co., ♀, Saint Louis, VIII-14-1910 (P. Rau); ♂, Saint Louis, VI-1911 (P. Rau). Shannon Co., ♀, Eminence, VII-20-1942 (P. Rau). ♂, "Mo." (Osten Sacken).

North Carolina: ♂, "N. C.".

South Carolina: Spartenburg Co., ♀, Spartenburg, VIII-30-1912.

Texas: Cherokee Co., ♂, VI-28-1958 (R. H. & E. M. Painter). Nacogdoches Co., ♂, ♀, VIII-14-1950 (R. H. Painter).

Virginia: Accomack Co., ♀, New Church, V-1935 (L. D. Anderson). Fairfax Co., ♀, Falls Church, IX-10 (N. Banks). King William Co., ♀, VII-1908 (C. W. Johnson).

Types. A. limatulus limatulus was originally described by Say (1829) from specimens collected in Indiana. The types have since been destroyed. In 1861 Loew described the same species as Argyromoeba obsoletum from a "male" collected in Missouri. However, through some error made by Loew or Osten Sacken the specimen labelled as type in the Museum of Comparative Zoology is a female.

Dates of Occurence. April 1 (Fayette Co., Illinois) to September 29 (Oktibbeha Co., Mississippi).

A. limatulus limatulus is most closely related to limatulus fur. Although the two approach one another closely where their ranges meet, they can usually be separated by the presence of abundant yellow scales on the mesonotum, scutellum and second abdominal tergum in l. fur and by the presence of distinct spots at the bases of cells R_4 and M_1 in l. limatulus. These spots are occasionally absent in specimens from the western edge of the range and in this case the presence or absence of gold scales must be relied upon.

Host Records. The pupa of A. limatulus limatulus was described by Malloch (1917, p. 395) (as Spongostylum albofasciatum) without reference to the host. Frison (1922, p. 152) recorded limatulus (as A. albofasciatus) as a parasite of Anthophora abrupta Say (Hymenoptera; Apidae) in Illinois. In the material studied by the author there are specimens reared from the nests of Anthophora abrupta (=Anthophora sponsa Smith) and "mud daubers", presumably Sceliphron caementarium (Drury) or Chalybion californicum (Saussure) (Hymenoptera; Sphecidae).

Pupa (Plate III, Fig. 21). Integument yellowish-hyaline with yellow setae and dark brown, black-tipped tubercles. Frontal tubercles united basally, formed in a straight line; anterior pair acuminate and very slightly curved posteriorly with a sharp mesal ridge basally; medial pair acuminate and slightly curved anteriorly, with anterior and posterior ridges; a sharp ridge connecting the second and third pairs of tubercles. Papilla at the base of the third pair of tubercles cylindrical and acuminate. Facial sclerite about four times longer than its narrowest width, broadly emarginate posteriorly; anterior tubercles united basally, compressed antero-posteriorly, bluntly acuminate, slightly incurved, sharply rounded laterally and with a

sharp mesal ridge slightly curved anteriorly and extending to the meson; posterior tubercle binary, antero-posteriorly compressed, the two apices slightly bent posteriorly.

Thoracic spiracle composed of ten sections, with a very small medial spot, the postero-lateral sections reduced in size, giving the entire spiracle an ovoid shape; spiracle sessile with a sharp antero-dorsal flange. Abdominel spiracles like those on the thorax, but with the segments reduced in size on the ventral side, and with the flange continuing around from the dorsal to the ventral side where it is broadened and flattened.

Anal tubercles moderately long, narrowly separated medially. Bases of the tubercles with sharp, triangular, slightly incurved processes dorsally and ventrally; small, flat sharply pointed processes present on the inner margin of the ventral side of the tubercles about one-third of the way from the base to the apex; sharp denticles present dorsally and ventrally about two-thirds of the way from the base to the apex, from which the tubercles taper outwardly to a sharp point. Medial process posteriorly on the ninth tergum well-developed, more or less as long as wide, rounded, truncate or shallowly bifurcate apically.

The numbers of abdominal setae and dorsal spines are given in Table 1.

Table 1. Ranges of the numbers of setae and dorsal spines on the abdominal segments of six pupae of Anthrax limatulus limatulus Say.

Segment	I	II	III	IV	V	VI	VII	VIII
Tergal Spines	-	13-15	12-14	11-13	9-11	-	-	-
Tergal Setae	12-16	12-16	12-13	11-14	11-15	13-17	12-17	2-7
Pleural Setae	7-11	12-18	11-14	13-15	12-16	12-14	11-16	2-7
Sternal Setae	-	4-7	4-7	5-8	6-10	6-10	8-13	10*

* male only.

No diagnostic characters have been found for the separation of the pupae of the five subspecies of A. limatulus, although a certain amount of inter-subspecific variation does occur. These differences are discussed under the appropriate subspecies. The pupa of A. limatulus differs from that of A. nidicola most distinctly in the structure of the anal tubercles which are rather long and narrow with dorsal and ventral denticles mesally in the former and rather short and broad with a sharp curved ridge mesally in the latter.

Anthrax limatulus fur (Osten Sacken)

Argyramoeba fur Osten Sacken, 1877, p. 244; Osten Sacken, 1878, p. 90; Coquillett, 1894, p. 95; Kertesz, 1909, p. 244.

Spogostylum fur (O. S.), Aldrich, 1905, p. 222; Rau, 1916, pp. 36, 37.

Diagnosis. Wings without a sectoral crossvein; infuscation light brown, filling the costal and subcostal cells and most of cells R and M; distinct spots absent from the bases of cells R_4 and M_1 (Plate V, Fig. 2). Prosternal tuft of pile white or black; post-alar tuft white. Femora entirely covered with black scales. Mesonotum with abundant yellow scales. Fringe of pile on posterior margin of occiput black with light tips. Distal lobes of the gonocoxites about one and one-half times as long as wide, broadly curved on the outer margins, slightly curved or straight on the inner margins and separated medially by three-fourths to one times the width of one lobe; apices with minute black setae (Plate VI, Fig. 2). Distal segments of gonostyli about one and one-half to two times as high as the width at the base, more or less quadrangular basally with a styliform epex which is bent outward (Plate IV, Fig. 2).

Male. Integument generally black, tibiae and genitalia usually dark red although they may be red-orange; venter of abdomen black or red-orange with black mottling. Scales on face and occiput white or yellowish-white, on front mostly yellow with a few black scales sometimes present on the lateral margins of the upper half. Setae on head black. Fringe of pile on posterior margin of occiput usually black with light tips; specimens from the western edge of the range may have some yellow hairs present.

Mesonotum covered with linear yellow and yellowish-white scales with the exception of a narrow medial band of black scales on the anterior half and two submedial spots on the posterior half connected with a medial transverse band. Margins with mixed black and gold semi-recumbent hair-like scales. Scales on pleurae yellow or yellowish-white, on coxae white or yellowish-white. Prosternal tuft of pile black or white; pile on pleurae and anterior margins of mesonotum mixed black and yellow or white; postalar tuft of pile white. Setae on pleurae black; macrochaetae mostly black, a few gold ones sometimes present on the mesopleurae and pteropleurae. Scutellum with curly white scales on the posterior margin; anterior margin with linear yellow scales laterally and yellow or black scales medially; disc with black, yellow or mixed black and yellow scales.

Wings with light brown infuscation usually extending from the base out to a line running from the tip of the subcosta through the bases of cells R_5 and Cu_1 into the basal one-third of cell 2A; the apical part of cell R and the base of cell R_1 sometimes with hyaline areas. Cell $2M_2$ and rarely cell R_4 with small coulds at the bases. Spots of darker pigmentation present at the bases of cells R_3 and R_5, Cu_1, and in cell R below the base of R_1. Sectoral crossvein absent (Plate V, Fig. 2).

Femora mostly covered with black scales, a few white scales present on the posterior margins of the fore and middle pairs. Fore and middle tibiae with black scales anteriorly and white scales posteriorly; hind tibiae entirely covered with black scales.

First abdominal tergum with linear, curly white scales laterally, and with white, gold or black scales medially on the posterior margin; lateral margins with dense white pile, a few gold or black hairs present posteriorly. Second, third and fourth terga sometimes entirely covered with linear black scales with the exception of two submedial and two sublateral spots of curly, lanceolate white scales on the posterior margin and a crescent-shaped line of white or yellow scales connecting the two submedial spots; gold scales sometimes replacing the black on the second tergum along the anterior and posterior edges, thus restricting the black scales to a medial transverse band. Third and fourth terge sometimes with the crescent-shaped line of scales expanded anteriorly and laterally to cover the central portions of the segments. Fifth tergum with lanceolate end cuneate white scales on the posterior margin expanded anteriorly on the lateral portions of the segment; medial area covered with black or mixed black and yellow linear scales. Sixth and seventh terga entirely covered with white or yellowish-white cuneate end lanceolate scales with the exception of medial spots of linear black scales. Venter covered with sperse gold, white or black linear scales; setae mostly black, a few gold ones present on the posterior margins.

Male Genitalia. Distal lobes of the gonocoxites about one and one-half times as long as wide, curved on the outer margins, slightly curved or straight on the inner margins and seperated medially by three-fourths to one times the width of one lobe; apices with minute black setae (Plate VI, Fig. 2).

Distal segments of gonostyli about one and one-half to two times as high as the width at the base, more or less quadrangular basally with a styliform apex; distal margin slightly undulate or curved convexly, proximal margin slightly convex on the lower half before dropping abruptly to the base of the styliform tip; apex slightly curved outward (Plate IV, Fig. 2). Dorsal part of the apex of the intromittent organ slightly convex both longitudinally and transversely, medial proximal projection bluntly rounded and widely separated from the narrow, truncate lateral proximal projections; a short medial transverse ridge sometimes present on the apical face. Medial process above the aedeagus projecting slightly in front of the dorsal part, with a pair of sharp teeth dorsally and a transverse flange apically. Ventro-lateral parts of the apex of the intromittent organ folded forward thus forming a dorso-ventral ridge; apex sharply angled and extending only slightly past the tip of the aedeagus (Plate I, Fig. 2).

Female. Similar to male. Venter of abdomen usually entirely black although the seventh sternum may be dark red. Fewer white scales present on the posterior abdominal terga.

Body Length.

Male--Range: 7.9-10.1 mm; $\bar{x}$: 8.7 mm; s.d.: 0.74 mm; n: 12.

Female--Range: 8.2-9.8 mm; $\bar{x}$: 9.0 mm; s.d.: 0.48 mm; n: 12.

Wing Length.

Male--Range: 9.0-11.2 mm; $\bar{x}$: 9.8 mm; s.d.: 0.67 mm; n: 12.

Female--Range: 9.3-11.3 mm; $\bar{x}$: 10.3 mm; s.d.: 0.63 mm; n: 12.

Distribution. A. limatulus fur occupies a narrow range between limatulus limatulus and limatulus artemesia. It occurs along wooded streams in areas dominated by tall-grass prairies or oak-hickory forests

from central Texas through eastern Oklahoma, eastern Kansas and probably into northwestern Missouri, southeastern Nebraska and southwestern Iowa. It is a parasite on "mud dauber" wasps nesting under bridges and in buildings and probably also on anthophorid bees (Map I).

New Material Examined. Kansas: Cherokee Co., ♀, 1915 (R. H. Beamer). Dickinson Co., 2♂, Chapman, VI-28, VII-1-1959 (N. Marston) (reared). Douglas Co., ♂, Lawrence, VIII-19-1933 (R. H. Painter). Labette Co., ♂ (R. H. Beamer). Leavenworth Co., 6♂, 3♀, VII-3-VII-23-1940 (R. H. Painter) (reared). Marshall Co., ♀, Marysville, III-3-1959 (N. Marston) (reared). Neosho Co., ♀, VI-27-1920 (Grace O. Wiley). Osage Co., 2♀, VIII-9-1940 (R. H. Painter) (reared). Riley Co., ♂, Manhattan, VIII-4-1929 (R. H. Painter); ♀, Manhattan, VII-20-1933 (J. O. Rowell); ♀, Manhattan, VIII-16-1933; 2♂, 6♀, VI-4-29-1939 (R. H. Painter) (reared); 5♂, 2♀, VII-21-VIII-18-1958 (N. Marston) (reared); 13♂, 10♀, Manhattan, III-12-VII-6-1959 (N. Marston) (reared).

Texas: Blanco Co., ♀ (C. W. Johnson). Brown Co., ♀, Brownwood, VIII-22-1921 (F. M. Hull); 2♂, Brownwood, VIII-1,7-1950 (R. H. Painter) (reared). Coleman Co., ♀, Valvera, VIII-30-1924 (R. H. Painter). Dimmit Co., 2♂, 3♀, V-19-30-1960 (N. Marston) (reared). Mills Co., ♂, VII-20-1931 (R. H. Painter).

Types. A. limatulus fur was originally described by Osten Sacken (1877) from a male and two females reared from the nests of an Organ-Pipe Mud Dauber, Trypoxylon sp. at Dallas, Texas. The types, which are well preserved, are in the collection of the Museum of Comparative Zoology.

Dates of Occurrence. June 27 (Neosho Co., Kansas) to August 30 (Coleman Co., Texas).

One specimen from Washington Co., Arkansas and one from Shannon Co., Missouri are intermediate between A. limatulus limatulus and limatulus fur. The Arkansas specimen lacks the yellow pile and scales on the thorax and abdomen characteristic of l. fur but has the infuscation of the wings like it, that is, without the bases of cells R_4 and M_1 infuscated; the specimen also lacks the spot at the base of cell $2M_2$. The specimen from Missouri has distinct spots at the bases of cells R_4 and $2M_2$ but also has white and gold scales on the thorax. Three other specimens from Stafford Co., Kansas show intermediate characters between limatulus fur and limatulus artemesia. These specimens have the wings infuscated as in the former but with lighter pigment, almost yellow in the centers of the cells. The body also has abundant gold scales, but not as extensive as in artemesia.

A. limatulus fur may be distinguished from limatulus limatulus by the absence of spots at the bases of cells R_4 and M_1 and by the presence of abundant yellow scales on the mesonotum. Specimens of limatulus from the western edge of its range may have the spots at the bases of cells R_4 and M_1 reduced or absent and in this case the presence or absence of yellow scales must be relied upon to differentiate the subspecies. A. limatulus fur differs from limatulus artemesia in having only black setae on the sides of the second, third and fourth abdominal terga; the latter has abundant yellow or gold pile on the sides of these terga.

Host Records. A. limatulus fur was originally described by Osten Sacken (1877, pp. 243-245) from six specimens "bred from the nest of a mud-wasp in Texas, forming tubes of clay five or six inches long, pasted together like organ-pipes" (very probably Trypoxylon politum Say). All of the reared specimens in the collections studied by the author have emerged from

"mud-dauber" nests where they presumably parasitized Sceliphron caementarium (Drury) and Chalybion californicum (Saussure) (Hymenoptera; Sphecidae). However, this subspecies has also been reared by the author from larvae collected in the cells of a species of Rygchium (Hymenoptera; Vespidae) and a species of Osmia (Hymenoptera; Megachilidae) made in old Sceliphron nests. It is probable that A. limatulus fur also parasitizes Anthophorid bees nesting in clay banks.

Oviposition and Adult Behavior. Observations on the oviposition behavior of A. limatulus fur were made during the summer of 1958 at a bridge southeast of Manhattan, Kansas. The bridge was a concrete structure about eighteen feet wide and twelve feet long built over a small, permanent stream. Of the wasps nesting under the bridge, the dominant species was Sceliphron caementarium (Drury), while a few of Chalybion californicum (Saussure), Trypoxylon politum Say, Rygchium sp. and Polistes sp. were present.

On August 18, a female of A. limatulus fur was observed to fly under the bridge and begin ovipositing in an old abandoned nest. She flew close to the ceiling keeping her body at approximately an 80 degree angle from the horizontal. Her metathoracic legs were extended back and above her abdomen. To lay an egg, she hovered in front of the intended site from one-half to three inches away and, by a quick forward jerk of the abdomen, flipped the egg toward the objective. An adhesive coating on the eggs causes them to adhere to any surface with which they come in contact.

The female was promiscuous in depositing her eggs. The majority of the oviposition sites were small holes in the concrete and holes or cracks in old Sceliphron nests. The stimulus prompting the female to oviposit was

evidently a black spot or a darkened area. The female completely ignored an artificial nest (a shell vial covered with modeling clay) until the inside of the vial was covered with black mud. Thereafter, she flipped egg after egg into the vial. The reflection from the inside of the vial may have made the opening unrecognizable to the insect. In one instance the fly flipped eggs at the black spots on the wing-tips of a moth, Lycomorpha pholus Drury, resting on the wall. The fly even followed the moth when it moved away to avoid the pelting!

On August 19, a female fly was again observed ovipositing under the bridge. Notes were taken on the length of the periods of oviposition and resting, the number of eggs laid, and the sites of oviposition (Table 2).

The female laying on August 19 worked more slowly than the one on the 18th, probably because the 19th was a cloudy day and cooler. The first female observed layed eggs for about two minutes then rested about one minute and also seemed to be laying more eggs during each period. No data were taken the first day, however,

Between the periods of oviposition the female flew out from under the bridge and usually alighted on the bridge abutment or on the concrete rail. She usually rested in one place until she went back under the bridge. No Anthrax were observed feeding, though there were many flowers nearby that could have supplied food for the flies. No males were seen at that time, but on August 8, two specimens which might have been mating were seen on an abutment.

The number of eggs which one female can lay must be very high. If a female were to lay eggs at the same rate between 8:00 A.M. and 4:00 P.M. as it did during the period it was observed it could easily lay one thousand

Table 2. The oviposition of Anthrax limatulus fur (O. S.) under a bridge at Manhattan, Kansas between 3:00 and 4:00 P.M., August 19, 1958.

Time					No. of Eggs	
Fly Arrived	Fly Left	Time Present (minutes)	Time Away	Oviposition Site	Per Site	Per Stay
3:07				1. Old Sceliphron nest	4	
				2. Artificial nest	3	
				3. Shirt and face	4	
				4. Old Sceliphron nest	7	
	3:10	3				18
3:17			7	1. Old Sceliphron nest	2	
				2. Side of new Sceliphron nest	12	
				3. Bits of mud on the wall	4	
	3:21	4				18
3:25			4	1. Old Polistes nest	2	
				2. Holes in concrete	2	
				3. Bits of mud on the wall	8	
	3:26	1				12
3:30			4	1. Old Polistes nest	2	
				2. Bits of mud on the wall	7	
				3. Hole in concrete	1	
				4. Bits of mud on the wall	7	
	3:31	1				17

Teble 2. (concl.)

Time					No. of Eggs	
Fly Arrived	Fly Left	Time Present (minutes)	Time Away	Oviposition Site	Per Site	Per Stay
3:42			11	1. Old Sceliphron nest	4	
				2. Old Polistes nest	2	
				3. Bits of mud on the wall	4	
	3:43	1				10
Total		10	26			75
Mean		2	5.2		4.7	15

eggs in a day. And, if the females observed on August 18 end 19 were one and the same, an estimated output of 2,000 eggs per individual female would be conservative. The density of the eggs in suitable spots was effectively shown while eggs were being acquired for rearing studies. An aspirator was used to suck the eggs from holes in the cement, old Sceliphron nests and other oviposition sites. Approximately 400 eggs were collected from about six holes on August 19. On September 7, about one hundred eggs were taken from about ten sites. These figures give some indicetion of the biological potential of the species.

With this high potential, the host population would be almost wiped out if it were not for the evident high mortality rate of the young larvae. Of the seventy-five eggs laid while the female was being observed on August 19, none, with the exception of three laid in an artificial nest, were situated where the larvae would have had e chance to survive, unless some of

the old nests were re-used by other wasps or the first instars were able to crawl to a fresh nest. Also, in rearings, no more than one larva was observed to survive on the host, even when five larvae were introduced on to the young wasp larva. Just what causes this mortality is not known, although it is possibly fratricidism on the part of the larvae before they begin feeding.

Life Cycle. The eggs of A. limatulus fur hatch over a prolonged period. From some 400 eggs collected on August 19, 1958, larvae were still emerging on September 6, eighteen days leter. From about 100 eggs collected on September 7, larvae were still emerging on September 25, agein eighteen days later. Whether these eggs were laid in a short time, or whether they represented ovipositions ranging over several weeks is not known, but, since the hatchings tapered off gradually, it mey be assumed that there is some variation in the incubation period. This would be a great advantage to the organism in parasitizing secondary inhabitants of the Sceliphron nests which might not re-use an old nest until several weeks after the parasite's eggs were deposited.

The young larva emerges through the end of the egg. The hole is opened with the mouth-hooks and enlarged as the larva forces the front part of its body through. When the front half of the larva is out, it crawls away, dragging the empty shell until it becomes wedged, enabling the lerve to pull out the remainder of its abdomen.

The first instar larvae are very ective, moving about much lika caterpillars by alternetely extending the thoracic segments, securing a hold with the mandibles and drawing the rest of the body up in an undulatory

motion and securing a hold with the proleg-like pseudopods. The larvae do not utilize the thoracic and anal hairs for locomotion.

As mentioned before, the young larvae are very active, crawling at a rapid pace and seldom stopping. This might enable larvae from misplaced eggs to find a host, but the probability is low. However, with the large number of eggs laid, a few might survive which otherwise would not. Within the cell, the first instar larvae wander about until the host molts for the first time (four days after hatching from the egg), then they attach themselves between either the first and second or second and third thoracic segments and feed irregularly for a day or more. After feeding at this point they again move about, mostly on the host's back, and feed only sparingly. Any larvae which move off their host or onto its venter are easy prey, or may be webbed to the wall when the wasp larva spins its cocoon. On about the ninth day after the host larva begins its cocoon, or about 20 days after the host begins feeding, the Anthrax larva molts to the second instar (Table 3).

In molting, the larva inserts the mandibles in the host's tissue, splits its skin down the back, and pulls out of the old skin, leaving it attached to the host by the mandibles.

The second instar larva is very different in form and behavior from the first instar. It is thickened and grub-like, having lost its thoracic and anal setae and the abdominal pseudopods. Its behavior befits its form; the larva being sluggish, moving about very little and feeding constantly. After molting, the larva grows rapidly, about 0.5 mm per day and the drain soon begins to show on the host which shrinks in size as the parasite grows.

About seven days after the first molt, the Anthrax larva molts to the third instar. Both in form and behavior, the third instar is like the

second. The grub feeds constantly and grows rapidly, about 2.5 mm per day. The host soon becomes a limp sac. When the wasp larva is almost empty, the parasite starts at the anal end and completely drains the tissues, moving forward toward the head until all that is left is the depleted skin.

Table 3. Length of larval stages of Anthrax limatulus fur (O. S.) reared from eggs taken at Manhattan, Kansas on August 19, 1958.

Larva No.	Stage	1st Instar	2nd Instar	3rd Instar	Total
6	1st	25	9	1	35
8	egg	18	6	2	26
9	egg	18	7	5	30
11	1st	18	7	7	32
Mean		19.7	7.3	3.8	30.8

The punctures of the mandibles of the parasite apparently do not injure the host in any way, for the parasite will repeatedly stop feeding and resume at a different spot without any apparent loss of fluid from the host through the punctures.

A. limatulus fur seems to overwinter primarily as a full-grown larva within the nest, but, in some cases, the first instar larva may overwinter. Two first instar larvae put on hosts on September 13 did not molt to the second instar until December 30 and January 2. These larvae grew normally after molting and ceased feeding on January 9 and 12, respectively. In addition, on April 19, 1959, two first instar larvae were found on overwintering Rygchium larvae and another was found on e Sceliphron larva. The

parasite larvae molted to the second instar about two weeks later and finished feeding on May 7, 8 and 11.

A possible explanation of this retarded development is that the host larva produces some substance within its body at about the time it voids its fecal pellet which initiates the molting process in both the host and parasite. This substance would not be produced in a larva preparing to overwinter, but would be produced later in the winter when the larva is ready to pupate. The parasite larva would also molt at that time. This hypothesis also explains the fact that the parasite larva does not molt until the host is full-grown.

About seven days before pupation the mature larva begins to elongate and assume the crescentic shape characteristic of the pupa. Just prior to pupation the setae, spines and tubercles on the pupa can be seen through the transparent integument of the larva. At pupation, the larval integument is broken and the pupa emerges by posterior to anterior undulating contractions of the body. Upon emerging the body wall of the pupa is transparent, but it rapidly becomes opaque yellow.

Six to eight days prior to emergence the eyes of the pupae begin to darken followed by the wings and abdominal segments. The day before emergence these structures are completely black. The length of the pupal stage of 30 individuals reared in the laboratory varied from 21-26 days with a mean of 24.0 days.

Emergence in the laboratory generally takes place between 9:30 A.M. and 1:30 P.M. The only freshly emerged individual observed in the field was found at about 2:00 P.M. At the moment of emergence the pupal skin breaks down the middle of the thorax and laterally between the head and thorax and

the adult crawls out and onto some vertical surface. The wings become fully expanded in about two minutes. About two hours elapse before the adult is fully developed and ready to fly.

Under natural conditions the pupa is encased in the nest of its host, often of very hard clay, through which it must bore before it can emerge. The pupa probably anchors itself inside the cell with its caudal tubercles and the dorsal spines on the abdomen. The cephalic tubercles are pressed against the wall of the cell and the pupa bores through by short rotating movements of the anterior portion of the body. When the thorax and anterior abdominal segments are free the adult emerges leaving its exuvia protruding from the cell.

It is necessary for the pupae to be anchored to allow the adults to emerge. Pupae placed in glass containers were unable to emerge unless they were placed on tissue paper to which they could adhere with the abdominal spines and caudal tubercles.

Egg. The eggs of A. limatulus fur are bluntly oval, about 0.50 mm long and 0.29 mm wide. The shell is coated with a mucilaginous substance to which small particles of sand adhere, thus obscuring the surface.

First Instar. Length 1.1-1.3 mm on hatching, 1.5-2.0 mm at first molt.

Body elongate, slender, tapering slightly anteriorly and posteriorly. Body twelve-segmented; all segments except last approximately equal in length, terminal segment short and conical. Head directed antero-ventrally; thorax appearing "humped". Integument transparent, color milky-white from internal tissues (Plate III, Fig. 20).

Head conical, basal part with two pairs of setae, one above, one below (Plate III, Fig. 20a). Antennae and cardo of maxillae not discernible.

Maxillee short, fleshy; palpi two-segmented, protruding downward, second segment reduced. One seta on basel segment of palpi, one on stipes above. Mouthhooks composed of two segments, apical segment sickle-shaped, directed ventrally parallel to meson and partially enclosed by maxillae, basal segment oblong, narrowed medially. Labrum short, pointed, formed above and between mandibles. Hypopharyngeal skeleton bifurcate in lateral view, each piece long, narrow, sharp end extending to the apex of segment two; upper piece thicker at base.

Second Instar. Length 1.5-2.0 mm at first molt; 4.8-5.0 mm at second molt. Similer in structure to the third instar.

Third Instar. Length 4.8-6.0 mm et first molt; 12-17 mm when full-grown (Plete III, Fig. 19). Integument hyaline, the fet body giving the larva a milky color. Body cylindricel, crescent-shaped, the segmental lines deeply emarginate, without projections, spines or processes; first thoracic segment and first through seventh abdominal segments with broad, low, pleural protuberances. Eighth abdominal segment small, atteched to the lower part of the seventh segment, thus forming a ledge upon which the posterior spiracles are located; ninth segment small.

Head shallowly invaginated, flat, largely membrenous. Dorsal plate of hypopharyngeal skeleton broad, flet posteriorly, narrowing et the segmental line to the rectangular apical portion; ventro-lateral sclerites with e short dorsal arm articulating with the dorsel plate, a short, upcurved anterior erm articuleting with the basal sclerite of the mouth hooks, end a long narrow, clavate ventrel arm (Plete III, Figs. 19a, 19b). Antennae small with a relatively large basal segment and a minute, pelp-like second

segment. Maxillae small, ovoid, with a very small, indistinct inner lobe and a minute, one-segmented palp. Mouthhooks composed of a vertical, sharply pointed apical part and a bar-like basal part which is narrowed medially.

Prothoracic spiracle crescent-shaped with the open side posterior, with eleven bar-like sclerotic spots. Caudal spiracle round with eight bar-like sclerotic spots. Caudal spiracle round with eight bar-like sclerotic spots mesally. Thoracic and caudal setae absent.

Pupa. No significant differences have been found between the pupae of limatulus limatulus and limatulus fur. In some specimens there are greater numbers of setae on the various abdominal segments, but the ranges within the subspecies broadly overlap.

Anthrax limatulus artemesia Marston, n. ssp.

Argyramoeba daphne, Coquillett, 1894, p. 95 (nec. Osten Sacken, 1886, misident.).

Spogostylum daphne, Mickel, 1928, p. 73; Custer, 1928, p. 124 (nec. Osten Sacken, 1886, misident.).

"Villa (Anthrax) sp.", Hicks, 1926, p. 250.

Diagnosis. Wings without a sectoral crossvein; basal infuscation very light yellow or sometimes absent, usually filling the costal and subcostal cells; grey or yellow spots present at the bases of cells R_3 and R_5, Cu_1, $1M_2$ and in cell R below the base of R_1 (Plate V, Fig. 3). Prosternal tuft of pile gold, yellow or white, a few black hairs sometimes present; postalar tuft of pile white. Mesonotum, scutellum and abdomen covered with linear white, yellow or gold scales; black scales absent except rarely in

medial spots on the posterior margins of the abdominal terga. Scales on femora usually entirely black, rarely yellow or white on the posterior margins and basal halves of the anterior margins. Pile on posterior margin of occiput gold or yellow with light tips. Distal lobes of the gonocoxites one and one-half to two times as long as wide, curved on the outer margins with a slight emargination sometimes present near the apex, slightly curved on the inner margins and separated medially by about the width of one lobe; apices with minute black or yellow setae (Plate VI, Fig. 3). Distal segments of gonostyli about twice as high as the width at the base, with a sharply pointed styliform, outwardly bent apex (Plate IV, Fig. 3).

Male. Integument generally black, grey or bluish pollinose; tibiae very dark red, genitalia red. Scales on the head yellow. Setae on front black, on oral margin black with a few gold ones laterally, on occiput gold. Fringe of pile on posterior margin of occiput yellow with light tips.

Scales on disc of mesonotum yellow; hair-like, semi-recumbent white scales present on margins. Pile on prosternum and pleurae yellow, on anterior margin of mesonotum white, post-alar tuft white. Fine setae on sternopleurae black, mixed black and gold on the pteropleurae end mesopleurae. Sparse scales on pleurae yellow, on coxae white. Macrochaetae on thorax mixed black and gold. Scutellum with curly, linear white scales on the posterior margin and lateral aspects of the anterior margin; remainder covered with linear yellow scales.

Femora and tibiae mostly covered with black scales, a few yellow scales on the posterior margins near the bases of the femora and a few white scales mixed with the black on the posterior margins of the fore and middle tibiae.

Wings with the basal infuscation very light yellow, filling the costal and subcostal cells and extending out to the r-m crossvein, the base of cell Cu_1 and the middle of cell 1A; grey spots present at the bases of cells R_3, R_5, $2M_2$ and Cu_1 and in cell R below the base of R_1. Sectoral crossvein absent (Plate V, Fig. 3).

First abdominal tergum with abundant yellowish-white pile on the lateral margins; second and third terga with less dense light yellow pile on the lateral margins; terga four through seven without yellow pile on the lateral margins, but with a few gold setae. First abdominal tergum with curly, linear white scales on the posterior margin expanding anteriorly toward the sides. Second, third and fourth terga entirely covered with linear yellow scales with the exception of fringes of curly, linear and lanceolate white scales on the posterior margins and some white scales on the lateral margins of the fourth tergum. Fifth, sixth and seventh terga covered with cuneate and oblanceolate white scales with the exception of medial areas of linear yellow scales which are broadest on the fifth and reduced to a medial line on the seventh tergum. Venter with sparse, linear, yellowish-white scales and mixed gold and black setae.

Male Genitalia. Distal lobes of the gonocoxites one and one-half to two times as long as wide, curved on the outer margins with a slight emargination sometimes present near the apex, slightly curved on the inner margins and separated medially by about the width of one lobe; apices with minute black or yellow setae (Plate VI, Fig. 3). Distal segments of gonostyli about twice as high as the width at the base, tapering slightly about halfway to the tip before narrowing abruptly on the proximal margin to the sharply pointed, styliform apex; apex bent outward at about a 60 degree angle

(Plate IV, Fig. 3). Dorsal part of the apex of the intromittent organ approximately vertical; medial proximal projection curved broadly back and bluntly rounded, widely separated from the narrow, truncate lateral lobes; apical face with a short, transverse ridge above a lightly sclerotized area. Medial process above the aedeagus projecting slightly beyond the dorsal part, with a pair of teeth dorsally and a transverse flange at the apex. Ventro-lateral parts of the apex of the intromittent organ folded apically, thus forming a dorso-ventral ridge; apex rounded, not extending beyond the tip of the aedeagus (Plate I, Fig. 3).

Female. Similar to male. Macrochaetae on thorax and scutellum mostly gold.

Variation. The posterior abdominal sterna may be orange mottled with black. The light scales and pile on the body vary from gold to yellowish-white. The scales on the femora vary from entirely black to yellow or white on the posterior margins and basal halves of the anterior margins. The dark clouds on the wings vary from grey to light yellow. Rarely there may be a few black scales in medial spots on the posterior margins of the second, third and fourth abdominal terga. One specimen from Saguache, Colorado has the fringe of pile on the posterior margin of the occiput black with light tips below and yellow with light tips above.

Body Length.

Male--Range: 6.0-11.0 mm; $\bar{x}$: 8.2 mm; s.d.: 1.34 mm; n: 13.

Female--Range: 4.3-9.2 mm; $\bar{x}$: 7.8 mm; s.d.: 1.42 mm; n: 13.

Wing Length.

Male--Range: 6.6-12.2 mm; $\bar{x}$: 8.9 mm; s.d.: 1.50 mm; n: 13.

Female--Range: 5.3-10.4 mm; $\bar{x}$: 8.7 mm; s.d.: 1.63 mm; n: 13.

Distribution. A. limatulus artemesia is a plains and desert insect occurring in areas dominated by short grasses and sage-brush throughout the Great Plains and Great Basin north of the Colorado River. It also ranges into southern New Mexico, southeastern Arizona and into the northern and central parts of Mexico. It is primarily a parasite of "mud daubers" nesting under bridges and anthophorid bees nesting in sand and clay banks. It is allopatric to limatulus fur on the east and to limatulus larrea on the south and west.

Holotype. ♂, Lamar, Prowers Co., Colorado, VI-5-1959 (N. Marston) (reared).

Allotype. ♀, Lamar, Prowers Co., Colorado, VII-4-1959 (N. Marston) (reared).

Paratypes. Colorado: Boulder Co., ♀, IV-8-1926 (Charles H. Hicks) (reared); ♂, 2♀, I-25, I-27, II-15-1927 (Charles H. Hicks) (reared); ♂, 5 mi. E. Longmont, VII-19-1936 (U. Lanham). Denver Co., ♂, Denver, VI-13-1900 (C. W. Johnson); ♂, Denver, VI-9-1902. Larimer Co., ♂, ♀, Ft. Collins, VII-11-1904 (reared). Prowers Co., ♀, Holly, VII-22-1957 (N. Marston); ♀, Lamar, V-30-1959 (N. Marston) (reared). Saguache Co., 2♂, Saguache, VIII-1, 11-1937 (R. H. Painter). Teller Co., ♀, Florissant, VIII-28-1907 (S. A. Rowher).

Kansas: Clark Co., ♀, 15 mi. S. Mineola, VII-26-1958 (N. Marston) (reared). Ellsworth Co., ♂, VII-12-1923 (R. H. Beamer). Meade Co., ♀, VII-23-1933 (R. H. Painter). Seward Co., 2♂, VI-29-1929 (R. H. & E. M. Painter); 2♀, VII-6, VIII-3-1929 (R. H. Painter) (reared).

Nebraska: ♀, "Bad Lands, Mouth of Monroe Canyon", VI-21-1911 (R. W. Dawson).

New Mexico: Hidalgo Co., ♀, U. S. 80 S. of Rodeo, VII-1-1958 (R. H. Painter) (reared). Santa Fe Co., ♂, Santa Fe, Aug. (Cockerell).

Texas: Cameron Co., ♂, Brownsville, June. Lubbock Co., ♂, 3♀, Lubbock, III-17-1950 (J. C. Porter) (reared); 3♀, Lubbock, 1949, (J. C. Porter) (reared). Pecos Co., ♂, Girven, VIII-4-1931 (R. H. Painter).

Utah: Beaver Co., ♀, Beaver Canyon. Iron Co., ♀, Parowan, VIII-6-1950 (G. E. Bohart).

Wyoming: Fremont Co., ♀, Lander, August (Roy Moodie). Sweetwater Co., 3♀, Green River, VII-2-1920.

MEXICO: Chihuahua, ♂, 5 mi. W. Parrita, IX-2-1956 (D. D. Linsdale). Distrito Federal, ♀, Mexico City, III-1917 (B. Muller). Zacatecas, ♀, 1.5 mi. S. Fresnillo, VIII-6-1954 (J. W. MacSwain).

Other Material Examined. Colorado: Boulder Co., ♀, V-16-1926 (Charles H. Hicks) (reared); ♂, ♀, I-24, IV-2-1927 (Charles H. Hicks) (reared). Costilla Co., ♀, VI-20 (S. C. McCampbell). Crowley Co., ♂, ♀, Crowley VIII-4-1933 (James). Denver Co., ♀, Denver, VI-8-1904. Douglas Co., ♂, Parker, VII-26-1905 (reared).

Kansas: Clark Co., ♀, S. of Mineola, VII-30-1958 (N. Marston) (reared). Ellsworth Co., ♂, VII-12-1923. Seward Co., 10♂, 4♀, VII-24-VIII-12-1929 (R. H. Painter) (reared).

Nebraska: Douglas Co., ♀, Omaha, VII-8-1914 (L. T. Williams). Sioux Co., ♂, Glen, VIII-20-1906 (L. Bruner).

New Mexico: Santa Fe Co., ♂, Santa Fe, Aug., 1867 (Cockerell).

Texas: Bexar Co., 4♂, 2♀, Helotes, VII-1-1917 (C. W. Johnson). Lubbock Co., ♀, Lubbock, 1949 (J. C. Porter).

Utah: Davis Co., ♀, Bountiful, IX-13-1941 (D. Ashdown). Grand Co., ♀, Moab, IX-1 (L. K. Gloyd).

Wyoming: Niobrara Co., ♂, 40 mi. N. Lusk, VII-1895.

MEXICO: Tamaulipas, ♀, Ciudad Victoria, VI-7-1939 (P. Rau).

Types. The holotype and allotype are in the collection of the author. Paratypes may be found in the collections of the author, R. H. Painter, the University of Kansas, the United States National Museum, the University of Nebraska, the Canadian National Collection, the University of California and in the Museum of Comparative Zoology, Harvard University.

Dates of Occurrence. March (Distrito Federal, Mexico) to September 13 (Davis Co., Utah).

A. limatulus artemesia can be readily distinguished from limatulus fur, limatulus larrea and limatulus columbiensis by the presence of light-colored pile on the sides of the second, third and fourth abdominal terga. In addition, larrea and fur have black scales on the anterior portions of the proximal abdominal terga whereas artemesia only rarely has a few black scales medially on the posterior margin and lacks them on the anterior portions of the terga. A. l. artemesia may usually be distinguished from l. vallicola by the predominance of black scales on the femora.

A specimen from St. Johns, Arizona is intermediate between limatulus artemesia and limatulus larrea. It has black pile on the sides of abdominal terga two, three and four as does larrea, but lacks black scales on the discs of the terga and has the scales and hairs on the thorax gold as in artemesia. The male genitalia are intermediate between the two subspecies. They closely resemble the male genitalia of limatulus columbiensis. A female from Monterrey, Nuevo Leon, Mexico also appears to be an intermediate between limatulus artemesia and limatulus larrea. It has the light pile on the

sides of the second abdominal tergum characteristic of the former subspecies and the black scales on the abdomen characteristic of the latter subspecies.

Host Records. Custer (1928, p. 124) has recorded A. limatulus artemesia (as Spogostylum daphne) on Dianthidium curvatum sayi Cockerell (Hymenoptera; Megachilidae). Among the specimens examined by the author there are individuals reared from Dianthidium curvatum sayi, Anthophora occidentalis Cresson (Hymenoptera; Apidae), "cells of Anthophora occidentalis parasitized by Melecta californica miranca (Fox)", and "mud daubers". The author has reared this species from the cells of Sceliphron caementarium (Drury), Chalybion californicum (Saussure) and Trypoxylon texense (Saussure) (Hymenoptera; Sphecidae) in "mud dauber" nests collected under bridges.

Pupa. The pupae of Anthrax limatulus artemesia exhibit considerable intrasubspecific variation, but some consistent differences from limatulus limatulus are evident. The posterior tubercles of the facial sclerite are usually higher and more deeply emarginate medially; the anterior tubercles are somewhat longer and the internal ridges often do not meet on the meson. The spiracles of several specimens have only eight or nine sections. The anal tubercles are of the same form, but somewhat shorter; the tubercle on the posterior half of the ninth tergum is almost always deeply emarginate medially. The ranges of the number of setae and dorsal spines are given in Table 4.

Table 4. Ranges of the numbers of setae and dorsal spines on the abdominal segments of 18 pupae of Anthrax limatulus artemesia, n. ssp.

Segment	I	II	III	IV	V	VI	VII	VIII
Tergal Spines	-	13-16	13-17	13-15	11-14	-	-	-
Tergal Setae	13-17	14-20	15-18	15-20	14-20	22-28	20-26	10-17
Pleural Setae	11-12	13-21	14-23	12-24	13-23	15-22	17-22	6
Sternal Setae	-	5-7	7-8	5-7	5-8	8	14-17	14-16*

* male only.

Anthrax limatulus larrea Marston, n. ssp.

Argyramoeba fur, Osten Sacken, 1886, p. 105 (nec. Osten Sacken, 1877, misident.).

Diagnosis. Wings without a sectoral crossvein; basal infuscation yellow; yellow or light brown spots present at the bases of cells R_3 and R_5, Cu_1 and in cell R below the base of R_1 (Plate V, Fig. 4). Prosternal tuft of pile mostly black in the male, mostly white or light yellow in the female; post-alar tuft of pile white. Second and third abdominal terga with black setae on the lateral margins, few if any light hairs present. Distinct bands and patches of black scales present on the abdomen. Scales on the femora entirely black in the male, mostly black in the female. Fringe of pile on posterior margin of occiput mostly yellow with light tips. Distal lobes of the gonocoxites one to one and one-half times as long as wide, curved on the outer margins with slight emarginations before the apices, straight on the inner margins and separated medially by about one-half the width of one lobe or less; apices with minute black or yellow setae (Plate VI, Fig. 4). Distal segments of gonostyli about as broad as high basally and with a short, bluntly pointed styliform apex which is bent outward at almost a right angle to the base (Plate IV, Fig. 4).

Male. Integument generally black; grey to blue-grey pollinose; tibiae and proximal tarsal segments reddish, genitalia red-orange, sterna three through seven mottled with black, red and orange. Sixth and seventh terga and posterior margins of the third, fourth and fifth terga red-orange. Scales on head lanceolate, yellowish-white; setae black. Fringe of pile on posterior margin of occiput yellow with light tips above, brown with light tips below.

Mesonotum with linear yellow, gold and white scales, darkest in a medial stripe and two sublateral spots on the anterior half and in two submedial stripes and two lateral spots on the posterior half; lateral margins of mesonotum with semi-recumbent, linear, hair-like white and yellowish-white scales. Pleurae with sparse, semi-recumbent, lanceolate scales, black on the lower half of the sternopleurae, yellow on the upper half of the sternopleurae, the pteropleurae and mesopleurae; coxae with semi-recumbent, lanceolate, yellow or white scales. Fine setae on pleurae black. Prosternal pile mostly yellowish-white, a few black hairs present; pile on pleurae and anterior margin of mesonotum yellowish-white; post-alar tuft white. Macrochaetae mostly black, a few gold ones present on the pteropleurae and mesopleurae. Scutellum with recumbent, lanceolate white scales on the posterior margin and lateral aspects of the anterior margin; disc and medial portion of the scutellum with linear, yellow and gold scales. Cuneate scales on femora and tibiae black.

Wings mostly hyaline; basal infuscation yellow, filling the costal and subcostal cells and extending slightly into the bases of cells R, M and 1A; light brown spots present at the bases of cells R_3 and R_5, Cu_1 and in cell R below the base of R_1 (Plate V, Fig. 4).

Pile on the lateral margins of first abdominal tergum yellowish-white, a few yellow hairs and slender white scales present posteriorly; posterior terga with only black setae on the lateral margins, no light pile present. Posterior margin of first abdominal tergum with linear and lanceolate, curled, semi-recumbent yellowish-white scales which are most abundant toward the lateral margins. Second tergum with a wide band of linear yellow scales

broken medially by a line of black scales; anterior band followed by a narrow band of black scales and a band of yellow scales; posterior margin with cuneate white scales and a few small, narrow black scales medially. Third tergum with a narrow anterior band of black scales followed by a band of yellow scales; posterior margin with two submedial and two sublateral spots of cuneate white scales separated by spots of narrow black scales. Fourth tergum with an anterior band of yellow scales followed by a band of black scales which expands laterally; posterior margin with cuneate white scales and a few black scales medially. Fifth, sixth and seventh terga with cuneate yellow and yellowish-white scales laterally and on the posterior margins; medial area covered with mixed yellow and black, linear and lanceolete scales which are reduced to a narrow line on the seventh tergum. Venter with sparse, linear end lanceolate black scales and black setae.

Male Genitalia. Distal lobes of the gonocoxites one to one and one-half times as long as wide, curved on the outer margins with slight emarginations before the apices, straight on the inner margins and separated medially by one-half the width of one lobe or less; apices with minute black or yellow setae (Plate VI, Fig. 4). Distal segments of gonostyli about as broad as high basally and with a short, bluntly pointed, styliform apex which is bent outward at almost a right angle to the base (Plate IV, Fig. 4). Dorsal part of the apex of the intromittent organ bulbously convex; medial proximal projections acuminate, apical face with a short transverse ridge with a medial angularity. Medial process above the aedeagus not extending beyond the dorsal part, with two short, bimodal flanges above the apex. Ventro-lateral parts of the apex of the intromittent organ broader than

the height of the dorsal part and extending past both the dorsal part and the medial process above the aedeagus; apices very broadly rounded, almost truncate (Plate I, Fig. 6).

Female. Similar to male. Abdomen entirely black. Prosternal pile mixed brown and white. Fore and middle femora and tibiae with white scales on the posterior margins. Third abdominal tergum with only linear and lanceolate yellow scales anteriorly.

Variation. There may be a few black scales on the lateral margins of the upper front. The extent of red and orange pigment on the ground color of abdomen of the male varies as does the pattern of the mottling on the sterna. The fringe of pile on the posterior margin of the occiput is usually yellow with white tips although sometimes it may be black or brown with light tips below and occasionally white with yellow bases above. The pile on the prosternum varies from entirely black or brown to entirely yellow or white. The macrochaetae on the pteropleurae and mesopleurae may be almost entirely black or almost entirely gold. The posterior femora of the female may have a few white scales basally on the posterior margins. The spots on the wings vary from yellow to light brown.

Body Length.

Male--Range: 7.9-10.0 mm; $\bar{x}$: 9.3 mm; s.d.: 0.60 mm; n: 13.

Female--Range: 5.2-9.6 mm; $\bar{x}$: 8.6 mm; s.d.: 1.14 mm; n: 11.

Wing Length.

Male--Range: 9.2-10.6 mm; $\bar{x}$: 10.0 mm; s.d.: 0.33 mm; n: 13.

Female--Range: 6.1-10.4 mm; $\bar{x}$: 9.4 mm; s.d.: 1.10 mm; n: 11.

Distribution. A. limatulus larrea is a desert insect occupying areas dominated by creosote bush and associated desert plants from southern

Californie to western Texas (Map I). One specimen has been seen from Davis Creek, Modoc Co., California which indicates that this subspecies may range farther north along the west edge of the Great Basin than is indicated on the distribution map. It is allopatric to limatulus artemesia on the north and the two range together in different habitats and at different times of the year in the eastern portion of the range. A. limatulus larrea has been reared from the nests of anthophorid bees and probably has the same parasitic relationships as limatulus artemesie.

Holotype. ♂, Rillito, Pima Co., Arizona, V-2-1935 (A. J. Basinger).

Allotype. ♀, same data as holotype.

Paratypes. Arizona: Maricopa Co., 3♀, 20 mi. S. Gila Bend, IV-13-1961 (R. H. & E. M. Painter); ♀, 10 mi. S. Gila Bend, IV-26-1956 (D. M. Tuttle). Pima Co., 3♂, 3♀, Organ Pipe Nat'l Mon., IV-14,15-1961 (R. H. & E. M. Painter); ♂, ♀, 4 mi. W. Sells, IV-15-1961 (R. H. & E. M. Painter); ♀, W. side Papago Res., IV-26-1955 (D. M. Tuttle); ♂, ♀, Rillito, V-2-1935 (A. J. Basinger); ♂, Sabino Canyon, V-5-1955 (G. D. Butler); ♂, ♀, Tucson, IV-24-1937 (W. Benedict). Pinal Co., ♂, 4 mi. W. Casa Grande, IV-9-1961 (R. H. & E. M. Peinter). Sante Cruz Co., 2♂, 10 mi. NW Nogales, IV-27-1961 (R. H. & E. M. Painter). Yuma Co., ♀, Palm Cn., Kofa Mts., III-14-1961 (R. H. & E. M. Painter); ♀, Datelend, IV-12-1955 (Butler & Werner); ♀, 10 mi. E. Aztec, IV-12-1955 (Butler & Werner).

California: Inyo Co., ♂, Surprise Canyon, Panamint Mts., IV-24-1957 (P. D. Hurd). Imperial Co., 2♂, Fish Creek Mts., IV-1, 20-1955 (W. R. M. Mason, D. F. Hardwick). Modoc Co., ♀, Davis Creek, VII-10-1922 (C. L. Fox). Riverside Co., ♂, Blythe, IV-24-1955 (W. R. M. Mason); ♂, Palm Springs, IV-2-1916 (C. L. Fox); ♀, 4 mi. E. Shavers Well, IV-9-1952 (E. G. Linsley);

♂, 10 mi. S. Vidal, IV-15-1947 (E. G. Linsley) (reared). San Diego Co., ♂, ♀, Borrego, IV-26-1954 (P. D. Hurd); ♂, ♀, Split Mt., Anza Desert State Park, IV-1-1955 (W. R. M. Mason, W. R. Richards); 3♂, Yaqui Well, IV-25-1949 (L. W. Quate).

New Mexico: Dona Ana Co., 2♂, Las Cruces, V-10 (D. W. Coquillett); ♂, Las Cruces, V-13 (S. Steel); 3♂, ♀, Socorro, 1916 (Williston).

Texas: El Paso Co., ♀, El Paso, IV-28-1927 (J. O. Martin).

Types. The holotype and allotype are deposited in the collection of R. H. Painter. Paratypes may be found in the collections of the author, R. H. Painter, Jack C. Hall, the University of Kansas, the U. S. National Museum, the Canadian National Collection, the University of California and the Museum of Comparative Zoology, Harvard University.

Dates of Occurrence. March 14 (Yuma Co., Arizona) to June 10 (Modoc Co., California).

A. limatulus larrea may be distinguished from l. artemesia and l. vallicola by the absence of light pile on the sides of the second and third abdominal terga and by the presence of black scales on the abdomen; it may be distinguished from l. columbiensis by the presence of black scales on the abdominal terga. A. albofasciatus daphne, the most similar subspecies of albofasciatus, may be readily distinguished from limatulus larrea by the presence of spots or clouds at the bases of cells R_4, M_1 and $2M_2$, and by the presence of distinct bands of black scales on the mesonotum.

Host Records. Rearing records for limatulus larrea have not been noted in the literature. However, one specimen in the collection of the University of California was reared from the cell of a species of Anthophora (Hymenoptera; Apidae).

Pupa. The only pupal skin available of this subspecies is of a very small specimen and has a reduction in setal numbers associated with small size. Otherwise, it differs from the pupa of limatulus limatulus in having the processes on the underside of the anal tubercles one-third of the way from the base to the apex produced perpendicular to the tubercles as sharply pointed ridges, and in having the anal tubercles somewhat shorter and separated medially by the width of one tubercle. The numbers of abdominal spines and setae are given in Table 5.

Table 5. Numbers of setae and dorsal spines on the abdomen of a pupa of Anthrax limatulua larrea, n. ssp.

Segment	I	II	III	IV	V	VI	VII	VIII
Tergal Spines	-	11	11	11	10	-	-	-
Tergal Setae	9	12	13	10	12	17	13	2
Pleural Setae	5	8	9	11	9	10	8	5
Sternal Setae	-	4	5	7	5	6	8	-

Anthrax limatulua vallicola Marston, n. ssp.

Anthrax sp., nr. fur, Linsley & MacSwain, 1942, p. 411.

Diagnosis. Wings without a sectoral crossvein; basal infuscation very light yellow, filling cells C, Sc and the bases of cells R, M and 1A; light yellow spots present at the bases of cells R_{2+3}, R_5, Cu_1, $2M_2$ and extending from the base of vein Rs across cell R to the base of cell $1M_2$ (Plate V, Fig. 3). Fringe of pile on posterior margin of occiput gold with yellow

tips. Post-alar tuft of pile yellowish-white; prosternal tuft of pile yellow. Masonotum, scutellum and anterior abdominal terga covered with tomentose yellow scales. Femora mostly covered with yellowish-white scales, a few black scales sometimes present apically on the anterior side. Sides of second and third abdominal terga covered with yellow pile. Distal lobes of the gonocoxites about one and one-half times as long as wide, curved on the outer margins, practically straight on the inner margins and separated medially by about the width of one lobe (Plate VI, Fig. 5). Distal segments of the gonostyli semi-quadrangular on the basal two-thirds from which the proximal margin attenuates to the distal margin to form a bluntly pointed apex which is bent sharply outward (Plate IV, Fig. 5).

Male. Integument generally black, grayish pollinose; tibiae very dark red, genitalia red. Setae on front black above and gold on either side of the antennae; setae on face mixed gold and black; occipital setae gold. Scales on front and face linear and semi-recumbent, yellowish-white on the face and the upper two-thirds of the front, golden-yellow around the bases of the antennae; occiput with short, lanceolate yellowish-white scales. Fringe of pile on posterior margin of occiput gold basally, yellow apically.

Scutellum and disc of mesonotum covered with fine black setae and very fine, recumbent scales; lateral margins of mesonotum covered with very fine, dense, semi-recumbent, yellowish-white scales; macrochaetae on mesonotum and scutellum mixed gold and black. Pleurae covered with fine, erect, yellowish-white pile and gold setae; a few gold macrochaetae present dorsally. Pile on prosternum, propleurae and anterior margin of mesonotum

yellow, a few black setae intermixed on the latter. Post-alar tuft of pile yellowish-white. Coxae covered with gold and black setae and sparse, linear white scales.

Wings with the basal infuscation very light yellow, filling the costal and subcostal cells and the extreme base of the wing. Light yellow spots present at the bases of cells R_{2+3}, R_5, Cu_1, $2M_2$ end extending from the bese of vein Rs across cell R to the base of cell $1M_2$. Sectoral crossvein absent (Plate V, Fig. 3).

Femora and tibiae covered with yellowish-white scales, a few black scales intermixed, especially anteriorly and apically on the femora.

Sides of first, second and third abdominal terga covered with dense, yellow pile; sides of fourth through seventh terga covered with yellow setae, some yellow hairs present on the fourth tergum. Discs of abdominel terge covered with yellow to white scales, darkest and fine tomentose on the anterior portions of the segments, lanceolete and ovate to obovate on the posterior margins of the segments and broadly over terga five, six and seven. Discal portions of the terga covered with sperse, long black setae; lateral portions covered with yellow setae. Venter covered with long yellow setae and dense yellowish-white sceles, linear enteriorly, lanceolete posteriorly.

Male Genitalia. Distal lobes of the gonocoxites about one and one-half times es long as wide, curved on the outer margins with a slight emargination before the apex, practically straight on the inner margins, end separeted medially by the width of one lobe or less; apices with minute reddish-brown setae (Plate VI, Fig. 5). Distel segments of the gonostyli semi-quadrengular on the besal two-thirds from which the proximal margin

attenuates to the distal margin to form a bluntly pointed apex which is bent sharply outward (Plate IV, Fig. 5). Dorsal part of the apex of the intromittent organ bulbously convex; medial proximal projection horizontal, bluntly angulate, lateral proximal projections short, lobate; apical face with a horizontal, scale-like projection which curls upward at the tip. Medial process above the aedeagus not projecting beyond the dorsal or lateral parts, with an apical flange which forms sharp angles laterally. Ventrolateral parts of the apex of the intromittent organ short, with a medial depression separating the incurving ventral portion from the dorsal, outwardly flaring portion (Plate I, Fig. 5).

Female. Front with only a few gold setae on either side of the antennae.

Variation. The setae on the face vary from entirely gold to almost entirely black. The post-alar tuft of pile may be yellow or white. One specimen has the pile and scales on the venter of the abdomen predominantly black and has a few black hairs on the prosternum and propleurae.

Body Length.

Male--Range: 9.0-12.1 mm; $\bar{x}$: 10.8 mm; n: 6.

Female--Range: 10.4-12.1 mm; $\bar{x}$: 11.0 mm; n: 8.

Wing Length.

Male--Range: 9.5-13.4 mm; $\bar{x}$: 11.8 mm; n: 6.

Female--Range: 10.4-13.2 mm; $\bar{x}$: 11.4 mm; n: 8.

Distribution. A. limatulus vallicola inhabits the central valley of California and adjacent areas in southern California where it is allopatric to limatulus larrea (Map I). It is a parasite of Anthophora bees.

Holotype. ♂, Kern Co., California (H. K. Morrison).

Allotype. ♀, Los Angeles Co., California, September (D. W. Coquillett).

Paratypes. California: Contra Costa Co., ♀, Pittsburg, IV-25-1939 (G. E. Bohart & J. W. MacSwain) (reared); ♀, Pittsburg, V-10-1939 (J. W. MacSwain) (reared). Kern Co., 2♂, ♀, Bakersfield, III-30-1941 (reared); ♂, 20 mi. E. Bakersfield, III-30-1941 (E. G. Linsley & J. W. MacSwain) (reared); ♀, Grapevine Canyon, Walker Pass, IV-8-1940 (J. W. MacSwain) (reared). Mariposa Co., 2♀, Exchequer Dam, V-2-1961 (R. R. Snelling) (reared). Tulare Co., ♀, Sequoia National Park, V-27-1950 (L. W. Isaak).

Other Material Examined. California: Kern Co., 3♂, 2♀, Bakersfield, III-30-1941 (reared); ♂, Grapevine Canyon, Walker Pass, IV-8-1940 (reared).

Types. The holotype and allotypes are in the collection of the U. S. National Museum. Paratypes may be found in the collections of the author, Jack C. Hall and the University of California.

Dates of Occurrence. All but three of the specimens studied were reared in the laboratory. Of these three, one was without a date label, the other two were collected on May 27 (Tulare Co., California) and in September (Los Angeles Co., California).

A. limatulus vallicola is almost identical with limatulus artemesia externally, but the male genitalia indicate a closer affinity to limatulus larrea. A. l. vallicola may usually be separated from artemesia by the presence of numerous light colored scales on the femora and from larrea and columbiensis by the absence of black pile on the sides of the second and third abdominal terga. It is easily separated from A. nidicola by the absence of the sectoral crossvein.

Host Records. Notes were made on the biology of A. limatulus vallicola (as Anthrax sp., nr. fur (O. S.)) by Linsley and MacSwain (1942, pp. 403, 411) during a study of the parasites, predators and inquiline associates of Anthophora linsleyi Timberlake (Hymenoptera; Apidae). They noted that mating takes place during the warmest part of the day and that the female hovers in front of the nests, depositing two or three eggs in each without discrimination between new and old nests. The young larvae were observed to attach themselves at an intersegmental membrane behind the head and to defer feeding until the host was in the prepupal or, occasionally, the pupal stage. The pupae cut their way to the surface by rotary motions of the head. At two nesting sites in California 3.9 and 4.34% of the nests of the Anthophora bees were parasitized by vallicola. In addition, epecimens studied by the author were reared from the nests of Anthophora bomboides stanfordiana Ckll and A. abruptella Ckll.

Pupa. The pupal skins examined of A. limatulus vallicola are very similar to those of limatulus limatulus, but differ in the following characters. The facial sclerite is slightly wider and shorter (2.9-3.6 times longer than wide) than in limatulus. The anterior tubercles on the facial sclerite are slightly higher and the interior ridges do not meet medially; the posterior tubercle is deeply and non-angularly emarginate with the two lobes bluntly rounded. The anal tubercles are shorter in some specimans; the tubercle on the posterior half of the ninth tergum is well-developed and bifid apically. All of the specimens available are large, and consequently the numbere of setae and spines are relatively large. The ranges are given in Table 6.

Table 6. Ranges of the numbers of setae and dorsal spines on six pupae of Anthrax limatulus vallicola n. ssp.

Segment	I	II	III	IV	V	VI	VII	VIII
Tergal Spines	-	16-17	15-17	13-16	10-15	-	-	-
Targal Setae	14-19	14-19	14-15	13-18	15-20	19-25	18-24	4-6
Pleural Setae	9-10	15-16	14-17	14-16	13-15	16-20	16-18	4-10
Sternal Setae	-	3-7	5-11	5-10	5-10	7-12	11-14	4-13*

* male only.

Anthrax limatulus columbiansis Marston, n. ssp.

Diagnosis. Wings without a sectoral crossvein; basal infuscation very light yellow, filling cells C and Sc and the bases of cells R, M and 1A; small light brown spots present at the bases of cells R_3, R_5, $1M_2$ and Cu_1 (Plate V, Fig. 3). Fringe of pile on posterior margin of occiput black below, yellow with light tips above. Post-alar tuft of pile light yellow; prosternal tuft predominently black. Mesonotum, scutellum and anterior abdominal terga covered with tomentose yellow scalas. Femora covered with black scalas. Sides of second and third abdominal terga without yellow pile. Distal lobes of the gonocoxites one end one-half times as long as wide, curved on the outer margins, straight on the inner margins and separated medially by about the width of one lobe; apices with minute brown setae. Apex of the distal segment of the gonostyli dactylate, bent at a right angle distally and slightly laterally (Plate I, Fig. 4).

Male. Integument black, brown and grey pollinosa. Head lacking. Mesonotum and scutellum covered with fine black setae and recumbent and

semi-recumbent, tomentose yellow scales. Sternopleurae, mesopleurae and anterior half of pteropleurae covered with fine black setae and fine, erect yellow pile. Prosternal pile black, a few yellow hairs present; propleural pila mixed black and yellow; anterior margin of mesonotum covered with black setae and a few linear yellow scales.

Femora and tibiae covered with recumbent, lanceolate-truncate black scales and with black bristles.

Wings with basal infuscation light yellow, filling cells C and Sc, and extending into the bases of cells R, M and 1A. Cells R_3, R_5, $1M_2$ and Cu_1 with small, light brown spots at their bases. Sectoral crossvein absent.

First abdominal tergum covered with danae yellow pila laterally, with a few black setae and linear, curly yellow scales medially. Second and following terga with black pile and setae latarally, a few yellow scales present on two and three. Discs of second and following terga covered with sparse, black setae and yellow scales, the scales short, lanceolate-truncate or ovate-truncata along the posterior margins of two through four and over most of five through saven, linear medially and anteriorly on two through four and medially on five through seven. Venter covered with long black setae and sparse, linear yellow scales.

Male Genitalia. Distal lobes of the gonocoxites one and one-half times as long as wide, curved on the outer margins and slightly emarginate near the apex, straight on the inner margins and separated medially by about the width of one loba; apices with minute brown setae. Distal segments of the gonostyli twice as long as the width at the base; distal and proximal margins

forming sharp ridges which meet on the proximal margin two-thirds of the way to the apex to form a triangular basal plane from which the apical portion is derived interiorly; apex dactylate, sharply curving distally and slightly curved laterally. Dorsal part of the apex of the intromittent organ vertical, the edges curved proximally; medial proximal projection broadly rounded; lateral proximal projections lobate; distal face with a shallow medial depression crossed by a very narrow transverse ridge. Medial process above the aedeagus produced beyond the dorsal part and above the latero-ventral parts, with three pairs of short teeth above the apex. Ventro-lateral parts of the apex of the intromittent organ broad, extending beyond the dorsal part and even with the medial process above the aedeagus; divided into two parts, a lower, outer, incurving portion and a dorsal, interior portion which flares outward (Plate I, Fig. 4).

Female. Front covered with semi-recumbent, lanceolate yellow scales and sparse black setae. Epistomal margin covered with black setae and a few linear, yellow scales. Occiput coverad with short, lanceolate scales, black in small spots above and below the emargination, yellow elsewhere. Fringe of pile on posterior margin of occiput gold with yellow tips above, black below.

Body Length. The allotype, the only complete specimen available has a body length of 13.1 mm.

Wing Length. The holotype male has a wing length of 11.1 mm; the allotype and paratype females have a wing length of 13.2 and 12.1 mm, respectively.

Distribution. This subspecies apparently inhabits the grasslands area in eastern Washington, northeastern Oregon and northwestern Idaho (Map I).

Holotype. ♂, Lewiston, Nez Perce Co., Idaho, IV-1953 (W. F. Barr) (reared).

Allotype. ♀, Central Grade, Nez Perce Co., Idaho, IV-10-1954 (A. R. Gittins) (reared).

Paratype. ♀, Lewiston, Nez Perce Co., Idaho, III-28-1953 (W. F. Barr) (reared).

This subspecies is being described from only three specimens, a male and two females. The holotype male and paratype female are headless, but otherwise in excellent condition. The allotype female is slightly greasy. The holotype and allotype are in the collection of the University of California. The paratype is in the collection of the author.

All three specimens were reared from the nests of Anthophora (Hymenoptera; Apidae) and have the pupal skins pinned with them. The pupal skins of A. limatulus columbiensis are inseparable from those of limatulus artemesia and the numbers of setae and spines fall within the ranges listed in Table 4.

A. limatulus columbiensis may be readily separated from both limatulus artemesia and limatulus vallicola by the absence of yellow pile on the sides of abdominal terga two and three. It differs from limatulus larrea in the absence of black scales on the abdomen and in the generally darker yellow color of the scales on the thorax and abdomen.

Anthrax nidicola Cole

Anthrax nidicola Cole, 1952, p. 126; Linsley, MacSwain & Smith, 1952, p. 275.

Diagnosis. Wings with sectoral crossvein present; maculation consisting of e distinct spot at the base of cell Cu_1, an aggregate of spots at the bases of cells $1R_3$ and R_5 end e spot extending from the base of cell R_1 across cell R and slightly into cell $1M_2$ (Plate V, Fig. 7). Second, third and fourth abdominal terga with abundent yellow pile on the lateral margins. Light scales on legs light yellow or white; black scales occupying from one-third to one-half of the anterior surfaces of the fore and middle femore; hind femora with only a few bleck sceles apically. Fringe of pile on posterior margin of occiput yellow with light tips. Distel lobes of the gonocoxites undulate on the inner margins end folded inward on the outer mergins (Plate VI, Fig 6). Distal segments of gonostyli concave on the distal margin, convex on the lower helf of the proximal margin, undulate on the upper half; apex narrow and truncate, twisted outwardly (Plete IV, Fig. 6).

Male. Integument generelly bleck, grey pollinose; tibiae, genitalia, apical sterna and distel margins of the epicel terga and proximal sterne orange; basal tarsal segments reddish. Scales on head mostly yellowish-white, a few black scales present laterally on the upper front. Setae on oral margin mixed black end gold, remainder of setae on head black. Fringe of pile on posterior margin of occiput yellow or gold with white tips.

Mesonotum with linear and lanceolate mostly yellow sceles, e few black scales present in a medial line and two sublateral spots on the anterior

half and in two submedial spots on the posterior half; hair-like scales on the margins of the mesonotum white. Pile on prosternum, pleurae and the anterior margin of the mesonotum white or light yellow; post-alar tuft white. Scales on pleurae and coxae white. Fine setae on pleurae yellow. Scutellum with lencaolate end cuneate, white or yellowish-white scales on the margins and median line; remainder of disc with lanceolete yellow or gold scales.

Wings hyaline with light brown maculation. Basal infuscation light yellow, filling all of the subcostel cell, the costel cell to the humeral crossvein and extending out to but not into the bases of cells R, M and 1A. Maculation consisting of a distinct spot at the base of cell Cu_1, an aggregete of spots at the bases of cells $1R_3$ end R_5 and a spot extending from the base of cell R_1 across cell R slightly into cells M and $1M_2$; light clouds sometimes present at the bases of cells R_4 and $2M_2$. Sectorel crossvein present (Plate V, Fig. 7).

Fore and middle femore with black scales occupying from one-third to one-half of the enterior margins, hind femora with only a few black scales at the tip; remainder of femora covered with yellowish-white to yellow scales. Fore and middle tibiae with sparse bleck scales anteriorly and white scales posteriorly; posterior tibiae with mixed white and black scales, the white predominating proximally and posteriorly, the black predominating distally and anteriorly.

First abdominal tergum with dense yallowish-white pile on tha lateral margins; posterior margin with linaar and lanceolate, curly white scales which expand anteriorly toward the lateral mergins. Second tergum with an anterior band of linear yellow scales followed by a medial band of gold or black lenceolate scales, anothar band of lanceolete yellow scales and a

fringe of oblanceolate yellowish-white scales on the posterior margin; a few black scales sometimes present in a medial and two sublateral spots on the posterior margin. Third and fourth terga with oblanceolate yellow scales anteriorly; posterior margin with a medial and two sublateral spots of black scales separated by yellowish-white scales. Fifth, sixth and seventh terga mostly covered with cuneate yellowish-white scales, some oblanceolate yellow scales present medially on the fifth and sixth. Sides of terga two through six with yellow pila and elongate yellowish-white scales most abundant anteriorly. Venter covered with oblanceolate white scales and gold setae.

Male Genitalia. Ninth tergum and genitalia enlarged in relation to those of the other species in the limatulus group. Distal lobes of the gonocoxites broadly convex, undulate on the inner margins, and folded on the outer margins; apices with only a few fine yellow hairs (Plate VI, Fig. 6). Proximal segments of gonostyli with a narrow, sharp distal projection reaching beyond the distal segments. Distal segments one and one-half to two times as high as the width at the base; distal margin concave, proximal margin convex on the lower half, undulate on the upper half; apex narrow, truncate and twisted outwardly (Plate IV, Fig. 6). Dorsal half of the apex of the intromittent organ reclining about 45 degrees, broadly convex transversely and slightly undulate longitudinally; medial proximal projection long and rounded at the apex, lateral proximal projections large and bluntly pointed. Medial process above the aedeagus projecting well beyond the gonopore, apex broad with a medial groove and a narrow flange on either side, a short ventral lobe present on each side of the gonopore.

Ventrolateral parts of the apex of the intromittent organ broad, angular at the apices and extending to a point even with the tip of the aedeagus (Plate III, Fig. 1).

Female. "With the same basic coloring and marking as in the male. Less pile on the pleurae, and pile of coxae more white. Dorsum of the abdomen mottled with white tomentose patches, and with spots of black tomentum on tergites II, III and IV; some brownish tomentum scattered on dorsum. More blackish pile on abdomen than in male, some black pile mixed with the yellowish on venter. Genital segment with close-set, incurved, golden pile." (Cole, 1952, p. 127).

Body Length.

Male--Range: 5.6-8.2 mm; $\bar{x}$: 6.4 mm; s.d.: 1.06 mm; n: 11.

Wing Length.

Male--Range: 5.5-8.8 mm; $\bar{x}$: 6.7 mm; s.d.: 1.10 mm; n: 13.

Distribution. A. nidicola was described by Cole (1952) from specimens reared from the nests of the anthophorid bees, Diadasia consociata Timberlake and D. bituberculata (Cresson) (Hymenoptera; Apidae). The male holotype and 15 male paratypes were collected at Tracy, San Joaquin Co., California, V-3-VI-21-1949 (J. W. MacSwain, E. G. Linsley, R. E. Smith). The female allotype was collected at Palo Verde, Imperial Co., California, IV-8-1949 (P. D. Hurd). Cole also had a specimen from Cottonwood Spring, Riverside Co., California, April 26 (L. W. Quate) and two from Redlands, September, 1914 (F. R. Cole). Of these, 11 of the paratypes, the specimens from Redlands and the specimen from Cottonwood Spring have been examined as well as an additional specimen from Davis, Yolo Co., California, VIII-24-1952 (E. I. Schlinger) and one from Pittsburgh, Contra Costa Co., California, XI-4-1954

(J. W. MacSwain). Tha specimen from Cottonwood Spring has proved to ba varicolor vieracki and the allotypa may also ba this species judging from the description.

The small number of racords availabla for this species makas it impossible to giva an accurata dascription of tha range of the insact but it probably occurs throughout tha Sacramento and San Joaquin valleys and some distance into southern California.

Tha types are in the collection of the University of California.

Dates of Occurrence. April 8 (Imperial Co., California)? to November 4 (Contra Costa Co., California).

A. nidicola may easily be distinguished from varicolor viarecki and varicolor varicolor by the presence of bushy, yellow pila on tha sides of the second and third abdominal segments. It differs from all other specias in the albofasciatus group in having a complete sectoral crossvein.

Host Records. Tha typa saries of A. nidicola was reared from the nests of Diadasia consociata Timberlake (Hymenoptera; Apidaa). Notes wera made on tha biology of nidicola by Linsley, MacSwain and Smith (1952, 175-176).

Pupa. Integumant yellowish-hyaline with yallow setae and dark brown, black-tipped tubercles. Frontal tubercles united basally, formed in a straight line and evanly saparated; anterior pair accuminata, straight, with indistinct posterior and external ridges; medial pair accuminate and slightly curved forward, with indistinct internal and anterior ridges and a sharp posterior ridga connecting with the posterior tubercles; posterior tubarcles accuminata, distinctly curved forward, with anterior, posterior and interior ridges. Papilla at the base of the third pair of tubercles cylindrical and

accuminate. Facial sclerite about four times longer than its narrowest width, truncate posteriorly with a medial ridge running from the posterior tubercles to the posterior margin; anterior pair of tubercles united basally, slightly compressed antero-posteriorly, accuminate, slightly incurved, with weak posterior and internal ridges, the latter not extending to the meson. Posterior tubercle binary, the two lobes obtusely bent posteriorly, longer than wide, and evenly rounded.

Thoracic spiracle sessile, composed of eight sections, medial spot small, the postero-ventral sections slightly reduced in size, with a sharp flange anteriorly and dorsally. Abdominal spiracles like the thoracic, but with the antero-ventral sections slightly reduced in size and with the flange continuing entirely around the spiracles and broadened and flattened antero-ventrally.

Anal tubercles short, separated medially by less than the width of one tubercle; a sharp lateral ridge with sharply angulate ends extending ventrally at the base of the tubercles; tubercles sharply pointed, with a sharp ridge curving ventro-medially from the tip and then recurving dorsally to meet an oblique ridge at a sharp point two-thirds of the way from the base to the apex of the tubercles; tubercles flat ventrally, with additional exterior and dorsal ridges about two-fifths of the way from the base to the apex. Medial process posteriorly on the ninth tergum small, simple, acute.

The numbers of setae and dorsal spines are given in Table 8. The two pupal skins of this species available diverge widely in their setal numbers, probably due to the difference in size.

The pupa of A. nidicola differs from those of the subspecies of A. limatulus in having the anal tubercles rather short and broad with a sharp,

EXPLANATION OF MAP I

Upper Left.

Anthrax varicolor varicolor (Bigot), distribution (horizontal lines).

Anthrax varicolor vierecki (Cresson), distribution (vertical lines).

Upper Right.

Anthrax limatulus limatulus Say, distribution (vertical lines).

Anthrax limatulus fur (Osten Sacken), distribution (horizontal lines).

Lower Left.

Anthrax limatulus artemesia Marston, n. ssp., distribution (horizontal lines).

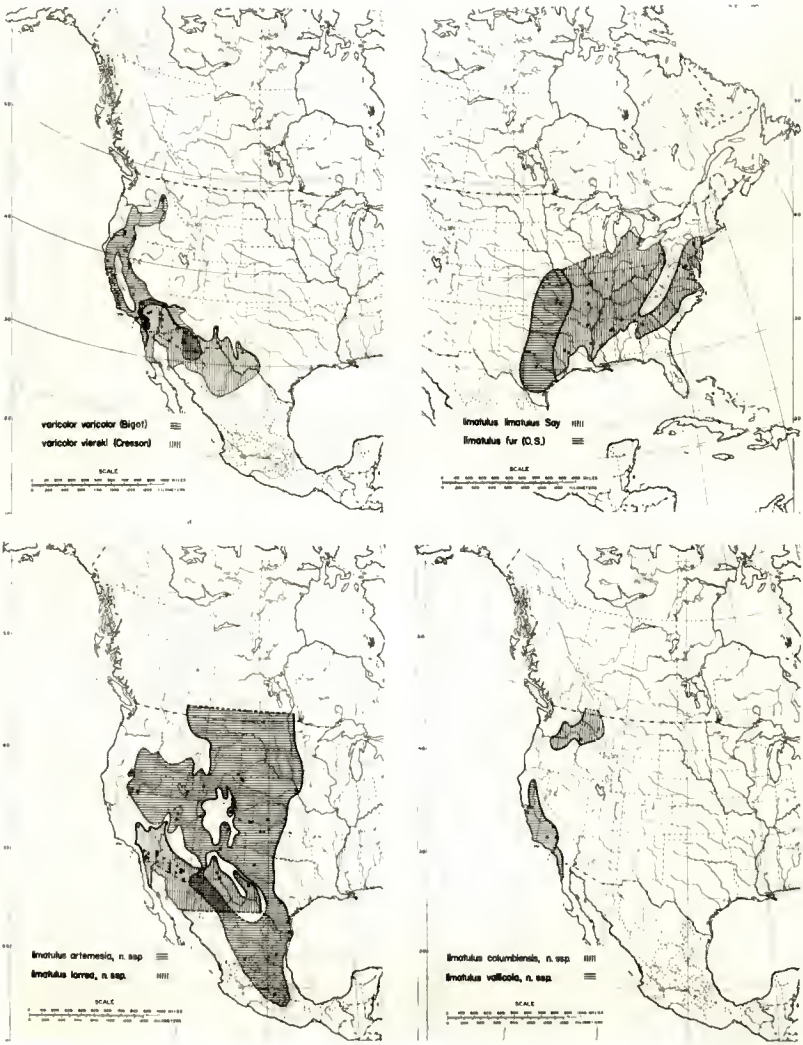
Anthrax limatulus larrea Marston, n. ssp., distribution (vertical lines).

Lower Right.

Anthrax limatulus columbiensis Marston, n. ssp., distribution (vertical lines).

Anthrax limatulus vallicola Marston, n. ssp., distribution (horizontal lines).

MAP I


varicolor varicolor (Bigot)
varicolor vierecki (Cresson)
SCALE
limatulus limatulus Say
limatulus fur (O.S.)
SCALE
limatulus artemesia, n. ssp.
limatulus torrei, n. ssp.
SCALE
limatulus columbiensis, n. ssp.
limatulus vallicola, n. ssp.
SCALE

curved ridge mesally instead of rather long with sharp denticles mesally.

Table 8. Ranges of the numbers of setae and dorsal spines on the abdomen of two pupae of Anthrax nidicola Cole.

Segment	I	II	III	IV	V	VI	VII	VIII
Tergal Spines	-	14-17	13-16	12-13	10-12	-	-	-
Tergal Setae	10-13	10-11	9-14	8-12	7-13	14-18	17-25	5-6
Pleural Setae	6-10	9-13	9-14	8-15	8-15	8-14	9-19	10-14
Sternal Setae	-	6-9	9-15	8-12	7-13	8-10	10-15	5-7

Anthrax varicolor varicolor (Bigot)

Argyramoeba varicolor Bigot, 1892, p. 347; Kertesz, 1909, p. 69.

Spogostylum varicolor (Bigot), Aldrich, 1905, p. 224.

Anthrax varicolor (Bigot), Painter & Painter, 1962, p. 81.

?Anthrax varius, Priddy, 1939, p. 45 (nec. Fabricius, 1794; misident.).

Diagnosis. Sectoral crossvein present, isolated spots present at the bases of cells $2R_3$ and R_4, M_1, $2M_2$ and in the middle of cell 1A (Plate V, Fig. 5). Prosternal tuft of pile white, post-alar tuft of pile black or mixed gold and black. Light colored scales on femora white to yellowish-white in both sexes; black scales on the posterior femora absent or restricted to a small patch at the apex. Distal lobes of gonocoxites of male genitalia fairly broad, only slightly curved or straight on the inner and outer margins and separated by less than the width of one lobe (Plate VI, Fig. 13).

Distal segments of gonostyli ovate, tapering slightly to an obtuse apex (Plate IV, Fig. 7).

Male. Integument generally black, greyish pollinose; distal margins of apical abdominal segments, genitalia, femora, tibiae and proximal segments of tarsi orange. Scales on lower front, face and lower half of occiput white; scales on upper front mostly gold with a few black scales laterally; scales on upper occiput gold. Setae mostly black, gold laterally on oral margin. Fringe of pile on posterior margin of occiput black with white tips above, yellow with white tips below, or entirely yellow with light tips.

Anterior half of mesonotum with a medial and two sublateral bands of black scales separated by two bands of gold scalas and two spots of white scales; posterior half of mesonotum with black scales except a narrow medial band and two short, incomplete sublateral bands of mixed gold and white scales; margins with linear, erect white scales and a few gold scales. Coxae and pleurae with white scales. Pile on prosternum white; on pleurae mixad yellow and white with a few black hairs; on antarior margin of mesonotum white with black setae and a few black hairs; post-alar tuft of pile black, gold or mixed. Setae on starnopleurae gold above, mixed black and gold balow; on mesoplaurae, pteropleurae and coxae mixed black and gold. Scutallum with white, tomentose scales on the anterior margin either sida of the center; disc with two lateral spots of black scales connected along the anterior margin; remainder of disc and posterior margin covered with gold scales.

Wings hyaline with dark brown maculation; basal infuscation extending into cells R, M, 1A and 2A, and filling the costal cell to the humeral

crossvein; subcostal cell lightly pigmented. Large spots present at the bases of cells $2R_3$ and R_4, cell M_1, cell $2M_2$ and sometimes in the middle of cell 1A. Aggregates of spots extending from vein R_1 around the bases of cells $1R_3$ and R_5, and from the base of cell R_1 to the base of cell Cu_1. Sectoral crossvein present (Plate V, Fig. 5).

Scales on fore and middle femora yellowish-white except a black patch on the apical one-half of the anterior surface; scales on hind femora white proximally, becoming yellow distally, a few black scales present apically on the anterior margin. Fore and middle tibiae with black scales anteriorly, white scales posteriorly; hind tibiae with mixed black and white scales.

First abdominal tergum with gold scales medially and white scales laterally on the posterior margin; lateral tufts of pile mostly white with some black hairs posteriorly. Second abdominal tergum with a narrow band of gold scales on the anterior margin followed by a wide band of black scales and a narrow band of gold scales; posterior margin with a medial spot of mixed gold and black scales, two sublateral spots of black scsles, two lateral spots of white scales and two submedial spots of white scales joined above the medial spot. Third tergum with a medially interrupted narrow band of gold scales on the snterior margin; posterior margin with a medial and two sublateral spots of black scales, and two lateral and two small submedial spots of white scales. Fourth tergum with a narrow band of gold scales on the anterior margin followed by a medial and two sublateral spots of black scales, two submedial spots of white scales and a few white scales on the lateral margins. Terga five through seven with white scales laterally and medial spots of gold scales; a few black scales medially on five and six. Venter with sparse white scales and a few yellow scales medially.

Male Genitalia. Distal lobes of the gonocoxites fairly broad, only slightly curved or straight on the inner and outer margins, and separeted by less than the width of one lobe; setae on the tips black, yellow or black apically and yellow proximally (Plate VI, Fig 13). Distal segments of gonostyli ebout twice as long as wide and tapering to a bluntly rounded epex, upper half slightly twisted proximally (Plete IV, Fig. 7). Dorsal part of the epex of the intromittent organ with two lerge lobes erising from the dorsal face and curving proximally and ventrally; medial proximal lobe broadly truncate, leteral proximal lobes sharply pointed. Entire dorsal part either vertical or bending distelly; mediel process above the aedeagus long end usuelly extending to or pest the dorsal part. Ventroleterel parts of the intromittent organ narrow, sharply pointed and extending little if any past the tip of the eedeagus (Plate I, Fig. 8).

Female. Similar to male. Post-alar tuft of pile entirely black. Spots on wings larger. Bleck patches of scales on the fore and middle femora occupying the apical four-fifths of the anterior mergins; on the hind femora, the apical one-fifth of the anterior margin.

Body Length.

Male--Range: 5.6-9.1 mm; $\bar{x}$: 8.1 mm; s.d.: 1.00 mm; n: 16.

Female--Range: 5.6-9.0 mm; $\bar{x}$: 7.6 mm; s.d.: 1.08 mm; n: 18.

Wing Length.

Male--Range: 6.0-10.0 mm; $\bar{x}$: 8.7 mm; s.d.: 1.06 mm; n: 16.

Female--Range: 6.2-10.1 mm; $\bar{x}$: 8.2 mm; s.d.: 1.17 mm; n: 18.

Distribution. A. varicolor varicolor occurs in forested areas from Washington south to southern Californie end eestward into eastern Arizona.

In southern California and Arizona where both subspecies occur together, varicolor varicolor occupies wooded areas, whereas varicolor viereki occurs in the desert shrub zone (Map I).

New Material Examined. Arizona: Pima Co., ♀, 4 mi. SW Cartaro, III-5-1961 (E. M. Painter); ♂, Sabino Canyon, IV-5-1955 (G. D. Butler); 3♂, Sabino Canyon, Santa Catalina Mts., III-9-1961 (Rover); 13♂, 3♀, Sabino Canyon, Santa Catalina Mts., III-12-1961 (R. H. & E. M. Painter); ♂, Tucson, III-29-1952 (G. Butler); ♂, 2♀, 10 mi. N. Tucson, IV-1-1961 (R. H. & E. M. Painter). Pinal Co., ♀, 5 mi. S. Ray, IV-5-1961 (R. H. & E. M. Painter). 2♂, Seven Springs Ranger Station, IV-20-1938 (S. E. Crumb).

California: Contra Costa Co., ♂, 2♀, Mt. Diablo, IV-22-1951 (M. Wasbauer). Fresno Co., ♂, ♀, 12 mi. W. Coalinga, IV-8-1951 (P. D. Hurd). Inyo Co., ♂, Argus Mts., V-22-1937 (N. W. Fraser). Kern Co., ♀. Lake Co., ♀, Blue Lakes V-16-1922 (E. P. Van Duzee). Los Angeles Co., ♀, Monrovia Canyon, IV-19-1931 (C. H. & D. Martin); ♀, Placeritacy, IV-20-1940 (M. M. Barnes); 2♂, 3♀, Tanbark Flat, VI-17-24-1950 (H. M. Graham, R. C. Bechtel, J. C. Hall, J. W. MacSwain); 3♂, 6♀, Tanbark Flat, VI-17-20-1956 (R. M. Bohart, H. R. Moffitt, J. F. Stage, R. C. Bechtel, R. W. Bushing); ♀, Westwood Hills, V-9-1940 (M. M. Barnes & E. Brookman). Lassen Co., ♀, Hallelujah Jct., VII-4-1949 (P. D. Hurd). Mendocino Co., ♀, Yorkville, IV-30-1924 (E. P. Van Duzee). Monterrey Co., ♂, 2♀, Arroyo Seco Camp, V-5, VI-6-1956 (D. J. Burdick, R. M. Bohart); ♂, ♀, Bradley, IV-27-1919 (E. P. Van Duzee); ♂, 2♀, Hastings Nat. Hist. Reservation, Santa Lucia Mts., Jamesburg, V-26-1935 (Michener); ♀, Hastings Nat. Hist. Reservation, VI-15-1938 (C. D. Michener); ♂, Stone Cn., IV-27-1919 (E. P. Van Duzee). Napa Co., 7♂, 4♀, Samuel Spr., V-15-31-1951 (J. C. Hall, E. I. Schlinger); 4♂, 3♀,

Samuel Spr., V-28,30-1953 (J. C. Hall, E. I. Schlinger, J. C. Downey); ♀, Samuel Spr., V-13-1956 (B. M. Fidel). Nevada Co., 2♂, 3♀, Boca, VI-28-VII-3-1954 (E. I. Schlinger, R. C. Blaylock, J. C. Downey, R. H. Goodwin); ♀, Boca, VI-11-1959 (R. M. Bohart). Riverside Co., ♀, Palm Springs, IV-3-1925 (E. C. Van Dyke); ♀, Pinon Flat, V-15-1941 (E. C. Van Dyke); ♂, 6 mi. E. Temecula, IV-11-1950 (L. W. Quate); ♀, White Water, III-27-1955 (W. R. M. Mason). San Benito Co., ♂, Idria, VI-14-1955 (C. D. MacNeil); ♂, ♀, Pinnacles National Monument, IV-24-1948 (J. W. MacSwain). San Bernadino Co., ♀, Crestline, V-23-1936 (E. G. Linsley); 3♀, 2 mi. W. Phelan, V-22-1957 (J. C. Hall); ♀, Hills W. of Redlands, III-29-1923. San Diego Co., 2♀, Culp Canyon, IV-4-1959 (J. C. Hall & E. I. Schlinger); ♀, Guatay, V-8-1953 (F. X. Williams); ♂, Plum Canyon, Anza Desert State Park, IV-4-1959 (J. C. Hall). San Francisco Co., ♂, San Francisco (H. Edwards). San Luis Obispo Co., 2♂, Atascadero, IV-26-1919 (E. P. Van Duzee); ♀, 6 mi. NE Santa Margarita, VI-11-1958 (E. G. Linsley). Santa Clara Co., ♂, Mt. Hamilton, VI-2-1933; ♂, Palo Alto, V-19-1940 (E. S. Ross). Santa Barbara Co., ♀, 38 mi. E. Santa Maria, VI-20-1952 (E. H. & L. D. Beamer, W. La Berge, A. Wolf, C. Liang, C. Weiner). Shasta Co., ♀, Hat Creek P. O., VI-20-1955 (J. W. MacSwain). Sonoma Co., ♂, Cazadero, III-21-1924. Tulare Co., ♂, ♀, Lemoncove, IV-14-1950 (J. W. MacSwain). Yolo Co., ♂, ♀, Bear-Cache Cr. Jct., IV-30-1954 (R. C. Bechtel). 2♂, "California" (S. W. Williston); ♀, "Paraiso Sgrs.", IV-15-1934 (L. S. Stevin).

Oregon: Klamath Co., ♂, Klamath Falls, V-10-1924 (C. L. Fox); ♀, Klamath Lake, VI-24-1924 (C. L. Fox). Lake Co., ♂, Warner Mts., VI-20-1922 (E. C. Van Dyke).

Washington: Whitman Co., ♂, ♀, Colfax, VII-9-1925 (C. L. Fox); ♂, Pullman, VII-11-1925 (C. L. Fox); Wawawai, V-21-1947 (G. Batchelor).

Types. The type male is in the Bigot collection in the British Museum (Naturel History). The type locality cited by Bigot was "Amerique du Nord: Colombie". Peinter & Painter (1962), however, state that although the specimen bears no label with the word "Colombie", the word may refer to the Columbia River since Bigot had e number of specimens from the northwestern United States. The type wing pictured by Painter & Painter is somewhat lighter than is typical for this subspecies, but the specimens available from the northern part of the renge are generelly lighter then those from the south.

Dates of Occurrence. March 5 (Pima Co., Arizona) to July 11 (Whitman Co., Washington).

Four specimens which have e distinct type of genitalia but which are inseparable externally from varicolor varicolor have been studied from Semuel Spring, Nape Co., California and Bryson, Monterrey Co., California. The specimens from Samuel Spring were collected elong with typical specimens of the subspecies. In the aberrant specimens, the distal lobes of the gonocoxites are more than twice as long as wide, slightly curved on both the inner end outer margins, end separated by slightly more than the width of one lobe. The distel segments of the gonostyli are bilobed with a slight undulation between. The proximal lobe is short end obtusely pointed whereas the distal lobe is longer, narrow and knobbed at the tip. The dorsal part of the apex of the intromittent organ is flet end projects slightly proximad. The medial proximal projection is smell and acutely pointed; the laterel proximal projections are evenly rounded end indistinct. There ere two

short, sharp, tooth-like lobes on the distal face. The projection surrounding the aedeagus is short and extends only slightly past the dorsal part. The ventro-lateral parts of the intromittent organ are short and broadly rounded apically, extending slightly past the tip of the aedeagus.

A. varicolor varicolor differs from varicolor vierecki in having large, distinct spots instead of clouds on the wings. In addition, there is usually at least a small amount of pigment in the center of cell 1A. A. varicolor varicolor may be readily distinguished from nidicola by the absence of light pile on the sides of the second and third abdominal segments. It may be distinguished from A. albofasciatus cascadensis and A. chaparralus by the presence of a sectoral crossvein.

Anthrax varicolor vierecki (Cresson)

Spogostylum vierecki Cresson, 1919, p. 180.

Diagnosis. Sectoral crossvein present; isolated clouds, sometimes very faint, present at the bases of cells $2R_3$ and $2M_2$; a cloud sometimes present at the base of cell M_1 (Plate V, Fig. 6). Prosternal and post-alar tufts of pile white or light yellow. Light colored scales on femora white in female, yellowish-white in male; black patch of scales on anterior margin of posterior femora small, intermixed with light scales. Distal lobes of gonocoxites of male genitalia narrow, only slightly concave on inner margin, separated by the width of one lobe (Plate VI, Fig. 14). Distal segments of gonostyli twice as high as wide, tapering apically, with a slight infolding near the middle on the proximal margin (Plate IV, Fig. 8).

Male. Integument generally black, greyish pollinose; tarsi, genitalia and posterior margins of distel abdominal segments reddish; tibiae reddish or yellow. Scales on face, lower front and occiput yellowish-white; upper part of front with black scales, sometimes reduced in number. Setae on head black. Fringe of pile on posterior margin of occiput predominantly black with light tips; white or yellow behind the vertex.

Anterior half of mesonotum with a medial band and two leteral patches of black sceles; posterior half with two lateral bleck petches; remainder of sceles yellowish-white; linear, semi-erect scales elong margins white. Lineer scales on sternopleurae end coxae white. Pile on anterior margin of mesonotum end prosternum white, on pleuree and coxae white or yellowish, e few black hairs sometimes present on prosternum and propleurae. Setae mostly black, sometimes yellow on upper half of sternopleurae. Margins of scutellum with white scales; disc with bleck scales except a medial line of yellow scales and a few yellow scales between the white and black.

Wings hyaline with light brown maculation. Basal infuscation extending out to the humeral crossvein and the bases of cells R, M, 1A and 2A; costel cell hyaline except at extreme base, subcostal cell infuscated. Isolated clouds at the bases of cells $1R_3$ end R_5, $2R_3$ and R_4, $2M_2$, Cu_1 and sometimes et the base of M_1; a spot in cell R below the base of cell R_1 sometimes extending elong the base of cell $1M_2$ (Plate V, Fig. 6).

Fore and middle femora with the apicel patch of black scales covering from one-half to two-thirds of the anterior margins, remainder covered with yellowish-white scales; hind femora with the apical black petch of scales covering from one-third to one-half of the enterior margin and with some light scales intermixed, remainder covered with yellowish-white scales.

Fore and middle tibiae covered with dark scales anteriorly and light scales posteriorly; hind tibiae generally covered with sparse black scales and with a few white scales posteriorly.

First abdominal tergum white pilose laterally, with a few black hairs intermixed on some specimens; posterior fringe of scales white sublaterally, becoming yellowish-white or yellow medially. Second tergum with a narrow anterior band of yellow scales followed by a band of black scales and a band of dirty yellow scales; posterior margin with a medial and two indistinct sublateral black patches of scales, and two submedial and two lateral patches of white scales. Third and fourth terga with dirty-yellow scales anteriorly and white scales posteriorly except a medial patch of black scales and two sublateral black patches, the latter reduced or absent in most specimens. Fifth, sixth and seventh terga entirely covered with white scales except a medial patch of yellow scales on segments five and six. Venter entirely covered with white scales and mixed black and yellow setae.

Male Genitalia. Distal lobes of gonocoxites narrow, about three times as long as broad and only slightly curved or straight on both the outer and inner margins; separated medially by one to one and one-half times the width of one lobe; setae on apical portion of lobes short and black (Plate VI, Fig. 14). Distal segments of gonostyli about twice as high as wide and tapering apically; distal margin broadly curved; proximal margin bi-undulate and folded inward just above the middle in most specimens (Plate IV, Fig. 8). Dorsal part of apex of intromittent organ with two large lobes extending distally or laterally but not ventrally from the dorsal face; medial process above aedeagus extending beyond the dorsal part in most specimens; ventro-

lateral parts of intromittent organ widely separated from the dorsal parts and projecting little if any past the tip of the aedeagus in lateral view (Plate I, Fig. 7). The male genitalia of varicolor vierecki approsch those of vericolor varicolor where their rsnges overlap, but in all specimens examined the lobes on the dorsal pert of the distal part of the intromittent organ are shorter and extend apically or leterally insteed of downward and backward.

Femele. Similer to male. Spots on wings larger; the spot at the bsses of cells $1R_3$ and R_5 extending across cell R_1; the spot in cell R below the base of R_1 extending along the base of cell $1M_2$ and sometimes narrowly connected with the spot at the base of cell Cu_1. Pile on pleurae darker, distinctly yellow in some specimens. Yellow scales on scutellum and abdomen derker, more extensive, almost completely replacing the black scsles on the disc of the scutellum and the second abdominal tergum in some specimens; white scsles less extensive on the posterior ebdominel terga.

Distribution. A. varicolor vierecki occurs in desert arees from the tip of Texas and southern New Mexico across northwestern Mexico and southern Arizona into southern California (Mep I). It is allopatric to varicolor varicolor in Arizona and California, the latter apparently occurring in less arid areas. The two subspecies have been collected together near Tucson, Arizone and in one case e female of vierecki was collected mating with a male of vericolor, indicating that the two subspecies probably hybridize in that eree, although no intermediates were observed among 15 specimens from that collection (Mep I).

New Material Examined. Arizona: Cochise Co., ♀, Douglas, V-4-1938 (W. W. Jones). Maricopa Co., ♂, Tempe, April (D. K. Duncan). Mohave Co., ♂, Topock, IV-13-1958 (E. G. Linsley). Pima Co., 2♂, April (D. K. Duncan); ♂, Organ Pipe Nat. Mon., IV-14-1961 (R. H. & E. M. Painter); 5♂, 2♀, 37 mi. W. Sells, III-18-1961 (R. H. & E. M. Painter); ♀, Tucson, V-24-1937 (W. Benedict); 2♀, 14, 23 mi. NE Tucson, III-23-1961 (R. H. & E. M. Painter); 4♂, 3♀, 10 mi. N. Tucson, IV-1-1961 (R.H. & E. M. Painter); 8♂, 4♀, 10 mi. N. Tucson, IV-3-1961 (R. H. & E. M. Painter). Pinal Co., ♀, 10 mi. SW Standfield, III-13-1961 (R. H. & E. M. Painter). Yavapai Co., 2♀, 5 mi. N. Wickenberg, V-2,10-1937 (L. K. Gloyd). Yuma Co., ♂, 43 mi. N. Yuma, III-14-1961 (R. H. & E. M. Painter); 2♂, ♀, 4 mi. E. Tacna, III-15-1961 (R. H. & E. M. Painter).

California: Inyo Co., ♀, Little Lake, V-8-1958 (L. A. Stage). Riverside Co., ♂, Cottonwood Spring, IV-26-1959 (L. W. Quate); ♂, Palm Springs, III-25-1916 (C. L. Fox); ♀, Thousand Palms, III-16-1955 (W. R. Richards); ♂, ♀, Thousand Palms, IV-17-1955 (W. R. M. Mason); ♂, 2♀, White Water, III-27-1955 (W. R. Richards). San Bernadino Co., ♀, Cronise Vy., IV-29-1956 (J. Powell); ♂, Kramer Hills, IV-19-1958 (J. Powell); ♀, Manix, IV-25-1953 (P. D. Hurd); ♀, Needles, IV-3-1951 (J. W. MacSwain); 4♂, 3♀, Vidal Junction, IV-3-1951 (E. G. Linsley); 3♂, 2♀, 27 mi. N. Vidal, IV-13-1958 (J. W. MacSwain); ♂, ♀, Yermo, IV-25-1953 (P. D. Hurd). San Diego Co., 2♂, ♀, Borrego, IV-11-1952 (E. G. Linsley, J. W. MacSwain), ♂, 4 mi. W. Julian, IV-23-1951 (E. J. Taylor); ♂, Yaqui Well, IV-25-1949 (L. W. Quate). ♀, Split Mtn., Anza Desert State Park, IV-1-1955 (W. R. M. Mason).

New Mexico: Dona Ana Co., ♂, ♀, Las Cruces, IV-25-1954 (L. D. Beamer). Socorro Co., 2♂, ♀, Socorro, 1916 (J. M. Aldrich).

Texas: Reeves Co., ♀, Pecos, V-15-1927 (J. O. Martin).

Dates of Occurrence. March 13 (Pinal Co., Arizona) to May 24 (Pima Co., Arizona).

Types. The type male and nine paratypes were collected at Alamagordo, New Maxico. An additional eight paratypes were collected at El Paso, Texas. The type is located at the Academy of Naturel Sciences of Philadelphia (A.N.S.P. No. 6203). One of the paratypes from El Paso, Texas was seen in the collection of R. H. Painter.

A. varicolor vierecki differs from varicolor varicolor in having the wings only faintly clouded with light brown pigment instead of distinctly spotted with dark brown, and in lacking pigment in the center of cell 1A. A. varicolor vierecki differs from A. nidicola in lecking the bushy yellow pile on the sides of the posterior abdominal segments. It may be distinguished from ell other species in the albofasciatus group by the presence of a complete sectoral crossvein.

Anthrax albofasciatus albofesciatus Macquart

Anthrax analis Macquart, 1834, p. 407 (preocc., Sey, 1823).

Anthrex albofesciatus Macquart, 1840, p. 345; Osten Sacken, 1858, p. 38; Johnson, 1925, p. 108; Painter, 1930, p. 794; Painter & Painter, 1962, p. 68.

Argyramoebe albofasciate (Macquart), Osten Sacken, 1877, p. 242; Osten Secken, 1878, p. 89; Coquillett, 1894, p. 96; Johnson, 1895, p. 325; Kertesz, 1909, p. 59.

Spogostylum albofasciatum (Macquart), Aldrich, 1905, p. 222; Johnson, 1913, p. 54.

Anthrax antecedens Walker, 1852, p. 193; Osten Sacken, 1858, p. 39; Painter & Painter, 1962, p. 71.

Argyramoeba antecedens (Walker), Ostan Sacken, 1877, p. 242; Osten Sacken, 1878, p. 89.

Argyramoeba obsolata Coquillett, 1894, p. 95; Kertasz, 1909, p. 59 (nec. Loew, 1869; listed as synonym of albofasciata (Macquart)).

Spogostylum obsolatum, Aldrich, 1905, p. 222 (nec. Loew, 1869; listed as synonym of albofasciatum (Macquart)).

Spogostylum limatulus, Cole, Malloch & McAtee, 1924, p. 185 (nac. Say, 1829; misident.).

Diagnosis. Wings with sectoral crossvein absent; isolated spots present at the basas of calls R_4 and $2M_2$; spot at the basa of cell M_1 usually indistinct or absent; calls 1A and 2A with a large infuscatad area (Plate V, Fig. 9). Prosternal tuft of pile black or with a few white hairs presant; post-alar tuft of pile black, whita or mixed. Light scales on femora yellow or gold; black scales covering from one-half of the anterior surfaces to all of the posterior femora. Distal lobes of the gonocoxites from ona to one and one-half times longer than wide, straight or slightly curved on the inner margins or somatimas folded inward; setae on apicas fine, aither light, black or black apically and light basally (Plata VI, Fig. 9). Distal segments of gonostyli ovate, with a distinct beak pointing proximally or disto-proximally (Plate IV, Fig. 9).

Male. Integument generally black, grey or blue-green pollinose; fore and middle tarsi yellow to orange, hind tarsi and genitalia red to orange, distal abdominal segments black with the posterior margins orange in eastern specimens, entirely orange in western and Central American specimens. Scales on front white or yellowish-white below, black above, the area of black scales largest in southeastern specimens, smallest in western and northern specimens. Scales on face and occiput white in southeastern specimens, yellowish-white in western and northern specimens. Setae black; posterior fringe of pile on occiput black with light tips, a few white hairs sometimes present behind the apex, but not forming a distinct tuft.

Scales on the mesonotum not occurring in well-defined bands, predominantly black in Florida specimens, predominantly gold and white in western specimens. Erect, linear scales on margins of mesonotum mixed gold and white; on pleurae yellow with a few black scales sometimes present; on coxae white or mixed black and white. Prosternal tuft of pile black or mixed black and white; post-alar tuft black in the southeastern part of the range, white in the northern, western and Central American specimens; pile on remainder of pleurae and anterior margin of mesonotum mixed black and white, black and yellow, or black, yellow and white. Setae on pleurae black. Scutellum usually with white scales on the posterior margin and lateral aspects of the anterior margin; disc usually covered with black scales medially and with a few gold scales between the black and white; the black scales sometimes restricted to the medial area of the anterior margin and largely replaced by gold scales on the disc in specimens from the northern and western portions of the range.

Wings hyaline with dark brown maculation. Basal infuscation extending into the bases of cells R, M, 1A and 2A, and out to the humeral crossvein in the costal cell; subcostal cell entirely infuscated. A distinct spot present at the base of cell R_4; cell $2M_2$ with a small or indistinct spot at the base; cell M_1 usually without a spot at the base but occasionally with an indistinct cloud or rarely with a large spot. An aggregation of spots extending from the r-m crossvein to vein R_1 and from the base of cell Cu_1 to the base of cell R_1; apical infuscation in cell M usually extending halfway to the base, occasionally entirely filling the cell. A large spot present in the middle of cells 1A and 2A, rarely united with the basal infuscation. Sectoral crossvein absent (Plate V, Fig. 9).

Entire femora usually covered with black scales, although occasionally with gold scales occupying the posterior surfaces and up to one-third of anterior surfaces in specimens from northern part of the range. Fore and middle tibiae entirely covered with black scales or with black scales anteriorly and light yellow or white scales posteriorly; hind tibiae with black scales.

First abdominal tergum with white scales laterally and black or gold scales medially. Pile on lateral margins mostly white, a few black or gold hairs usually present posteriorly. Southeastern specimens with the second and third terga entirely covered with black scales with the exception of two submedial and two lateral tufts of white scales, and with the fourth tergum entirely covered with black scales with the exception of two lateral patches of white scales; specimens from the northern and western parts of the range with an additional medial transverse band of gold scales on the second, third and fourth terga. Fifth, sixth and seventh terga entirely

covered with white scales except medial spots of black scales and a few gold scales between black and white scales; black scales reduced in number or absent in some specimens from northern and western portions of the range. Venter mostly covered with sparse black scales in southeastern specimens, with sparse yellow or gold scales in western and northern specimens; second and third sterna usually with a small patch of white scales laterally; fifth, sixth and seventh sterna sometimes with a few scattered white scales.

Male Genitalia. Distal lobes of the gonocoxites one to one and one-half times longer than wide, slightly curved or straight on the inner margins and broadly curved on the outer margins or slightly folded inward in some specimens; lobes separated medially by one to one and one-half times the width of one lobe; apical setae black, yellow, or black apically and yellow proximally (Plate VI, Fig. 9). Distal segments of gonostyli ovate with a distinct beak at the apex projecting proximally up to 45 degrees from the vertical. Distal margin very broadly rounded, sometimes protruding above the beak; proximal margin indented about halfway to the apex of the beak (Plate IV, Fig. 9). Dorsal part of the apex of the intromittent organ reclining at about a 45 degree angle, almost flat longitudinally, slightly convex transversely; medial and lateral proximal projections acute, in the same plane as the remainder of the dorsal part; apical face with a pair of angular teeth near the middle; medial process above the aedeagus not distinctly projecting, with only a slight convexity above the apex. Ventro-lateral parts of the intromittent organ evenly curved ventrally and not projecting past the medial process above the aedeagus (Plate II, Fig. 3).

Female. Similar to male. Wings more extensively infuscated, cell M usually entirely filled, cell R usually more than three-fourths filled and cell R_1 usually filled past the base of cell R_3. White scales less extensive and black scales more extensive on distal abdominal terga.

Body Length.

Male--Range: 3.8-7.8 mm; $\bar{x}$: 5.6 mm; s.d.: 1.00 mm; n: 22.

Female--Range: 3.5-8.1 mm; $\bar{x}$: 5.7 mm; s.d.: 1.28 mm; n: 22.

Wing Length.

Male--Range: 4.4-8.8 mm; x: 6.0 mm; s.d.: 1.04 mm; n: 22.

Female--Range: 3.7-8.8 mm; x: 6.1 mm; s.d.: 1.43 mm; n: 22.

Distribution. A. albofasciatum occurs in forested areas in southeastern Canada, throughout the eastern United States, along the Gulf Coast of Mexico and into Central America (Map II).

New Material Examined. Alabama: Washington Co., ♀, Leroy VII-11-1917 (J. Bequaert).

Colorado: Larimer Co., 4♂, 3♀, Bellvue VII-18-1961 (N. Marston); ♀, Bellvue VIII-5-1961 (N. Marston).

Connecticut: Hartford Co., 2♂, Avon Old Farms, Avon, VI-16-1929.

District of Columbia: ♂, Washington, VII-11 (J. M. Aldrich).

Florida: Alachua Co., ♂, ♀, IV-12, V-6-1955 (H. V. Weems); ♂, ♀, Gainesville IV-20, V-14-1924 (T. H. Hubbell, M. M. Richardson); ♂, Gainesville, V-11-1930. Broward Co., ♂, Ft. Lauderdale, IV-17-1928 (D. M. Bates). Dade Co., ♀, Biscayne Bay (Mrs. A. T. Slosson). DeSoto Co., ♂, Arcadia, IV-2-3-1953 (W. R. M. Mason). Duval Co., 2♂, ♀, Jacksonville, IV-13 (Mrs. A. T. Slosson); ♂, Jacksonville (C. W. Johnson); ♀, Jacksonville.

Highlands Co., ♂, III-16-1951 (H. V. Weems). Levy Co., 4♂, Cedar Key, V-7-1955 (H. V. Weems). Orange Co., ♀, V-1957 (H. V. Weems); ♀, Gotha, III-1896. Palm Beach Co., ♀, Lake Worth (Mrs. A. T. Slosson). Santa Rosa Co., ♂, VIII-12-1955 (F. W. Mead). ♂, Archbold Biol. Sta., IV-6-1956 (H. V. Weems). ♀, "Florida" (C. W. Johnson).

Georgia: Chatham Co., ♂, Savannah, V-9. Lamar Co., ♂, Milner, VIII-25-1957 (J. G. Chillcott). 3♂, 1♀, "Georgia" (Osten Sacken).

Indiana: Elkhart Co., ♂, Elkhart (C. W. Johnson). Noble Co., ♀, Wolf Lake, VII-14-1895. Tippecanoe Co., ♂, Lafayette, IX-8-1917 (J. M. Aldrich). ♀, "Ind.".

Kansas: Douglas Co., ♀, Lawrence, VI-6-1922 (C. H. Curran). Pottawatomie Co., ♀, VI-29-1958 (N. Marston). Reno Co., ♂, Sand Hills, Medora, VI-25-1923 (Clarence Bare). Riley Co., ♂, ♀, Manhattan, V-5 (R. H. Painter). ♀, "Kans." (S. W. Williston).

Maryland: Prince Georges Co., ♂, ♀, Beltsville, VII-6-1916 (F. R. Cole); ♀, Beltsville, VI-1-1917 (W. L. McAtee).

Massachusetts: ♀, "Mass." (Osten Sacken).

Michigan: Berrien Co., ♀, St. Joseph, VII-2-1942 (C. W. Sabrosky). Cheboygan Co., ♂, VII-24-1932 (Gertrude Grant); ♀, 1934 (Gertrude Grant); 2♀, VII-20-1935 (Milton Sanderson); ♀, Biological Station, VII-28-1930 (L. C. Stuart). Chippewa Co., ♀, Raco, VIII-26-1956 (R. H. Painter). Grand Traverse Co., ♀, Traverse City, VI-21-1937 (C. W. Sabrosky). Huron Co., ♀, Port Austin, VI-18-1922 (T. H. Hubbell). Leelanau Co., ♂, 6 mi. N. Traverse City (C. W. Sabrosky). Oceana Co., ♂, ♀, Hart, VII-14-1942 (C. W. Sabrosky). Saint Joseph Co., ♀, Constantine, IX-4; ♂, Nottawa, VIII-31-1933 (C. W.

Sabrosky). Washtenaw Co., 3♂, Ann Arbor, VII-22-25-1917 (E. G. Anderson); ♀, Ann Arbor, IX-11-1927 (N. K. Bigelow).

Minnesota: Ramsey Co., ♀, Fort Snelling, VII-28-1922 (A. A. Nichol).

Nebraska: Buffalo Co., ♀, Platte River,nr. Elm Creek, X-18-1956 (J. C. Downey).

New Hampshire: Grafton Co., ♂, Franconia (Mrs. A. T. Slosson).

New Jersey: Atlantic Co., ♂, ♀, Buena Vista, VI-11-1893 (C. W. Johnson). Burlington Co., ♂, ♀, VI-18, VIII-15-1921; ♀, Pemberton, IX-8-1907; 3♂, Riverton, V-20, VI-24, VIII-11-1906 (C. W. Johnson); ♂, Riverton, VI-26-1920 (R. H. Painter). Camden Co., 2♀, Clementon, VIII-24, 30-1908. Gloucester Co., ♂, ♀, North Woodbury, VI-13, VIII-1-1901; ♂, Westville, VIII-21-1892 (C. W. Johnson). Middlesex Co., 5♀, Milltown, VIII-22, IX-10-1910 (J. A. Grossbeck). Monmouth Co., ♂, Long Branch, VI-9-1913 (C. W. Johnson). Ocean Co., ♀, Manahawkin, IX-5-1910 (A. J. Weidt); ♀, Whiting, VIII-15-1920 (R. H. Painter). ♂, "Burrsville", VII-1-1917 (M. C. Van Duzee).

New York: Monroe Co., ♂, Rochester (G. Frank). Suffolk Co., 2♂, Coram, VIII-8-1920 (J. Bequaert); ♀, Orient, Long Island, IV-20-1932 (Roy Latham); ♀, Orient, VIII-1-1936 (Roy Latham); ♂, Wading River, VII-15-1930.

North Carolina: Macon Co., ♂, Highlands, VII-30-1957 (W. R. Richards).

Ohio: Hamilton Co., ♂, Cincinnati, V-30-1908 (J. S. Hine). Hocking Co., ♀, V-30-1923.

South Carolina: Allendale Co., 2♂, Fairfax, IV-23, 24-1932 (E. M. Howe).

Texas: Bexar Co., ♂, Helotes, VII-1-1917 (J. Bequaert). Brown Co., 6♂, 5♀, Brownwood, VI-22 to VIII-24-1921 (R. H. Painter); ♀, Brownwood, IX-4-1923 (R. H. Painter); ♂, Brownwood, IX-4-1957 (R. H. & E. M. Painter); ♀, Brownwood, VI-7 (R. H. Painter). Kimble Co., ♂, ♀, Junction, VIII-15 (R. H. Painter).

Real Co., 2♂, ♀, Frio Can., VII-19-1939 (R. H. Paintar). Travis Co., 2♂, Austin, VI-26-1921 (R. H. Painter); ♂, ♀, Austin, X-11-1922 (R. H. Painter). Wharton Co., 2♂, Wharton, VI-24-1917 (J. Bequaert).

Vermont: Rutland Co., ♂, Chittanden, VIII-1-15-1916.

Virginia: Fairfax Co., 2♂, ♀, Falls Church, VI-4, 11, VII-28 (N. Banks). 2♀, "Glancarlyn", VI-7.

Canada: Manitoba, ♂, ♀, Awema, VII-28, 31-1920 (N. Criddle, H. A. Robertson); ♂, ♀, Awema, VIII-31, IX-7-1921 (N. Criddle, P. Vrom). Ontario, ♂, Blackburn, VI-4-1939 (G. A. Hobbs); 2♂, ♀, Norway Point, Lake of Bays, VI-22-VII-2-1920 (J. McDunnogh); ♂, Point Pelee, VI-12-1925 (G. S. Walley); 2♂, 2♀, Point Pelee, VI-24-29-1927 (F. P. Ide). Quabec, 2♂, ♀, Abbotsford, VI-8-1936; ♂, Aylmar, VI-27-1924 (C. H. Curran). Saskatchewan, ♀, Roche Percee, VII-6-1927 (E. & S. Criddle).

Guatemala: ♀, Moca Guatalon, III-IV-1931 (J. Bequaert); ♂, Tiquisate, IX-5-1951 (R. H. Painter).

Honduras: 4♂, Puarto Castilla, IV-3-6-1926 (R. H. Painter).

Mexico: Morelos, ♀, 3 mi. No. Alpuyeka, VI-9-1959 (H. E. Evans). Oaxaca, ♂, Tehuantepec, VII-1-1936 (Hartwig and Oliver). San Luis Potosi, ♀, Xilitla, VII-13-1954. Vera Cruz, ♂, Nautla, VII-29-1948 (W. G. Downs).

Types. A. albofasciatus albofasciatus was originally described by Macquart in 1834 as Anthrax analis. In 1840, however, he acknowledged that analis Macquart was a junior synonym of analis Say (1823), and redescribed his species as albofasciatum. (In order to agree in gender with Anthrax, the masculine form, albofasciatus, must be used.) In both cases the species was described from "Georgia". Painter & Paintar (1962) state that they were

unable to find types of this species in either the Paris Museum or the Bigot collection. The type of antecedens Walker is in the British Museum (Natural History). Specimens of elbofasciatus from southeastern United States agree well with the description of the type made by Painter & Painter (1962).

Dates of Occurrence. Merch 16 (Highlands Co., Florida) to October 18 (Buffalo Co., Nebraska).

A. albofasciatus albofasciatus is the most variable subspecies in the albofasciatus group. All the color characteristics except those of the wings exhibit clines from southeast to north and west. Specimens from Florida are usually very dark with black scales and pile predominating while those from Texas and southeestern Canada are light with more white and yellow pile and gold scales. Specimens from eastern Mexico and Central America resemble Texes specimens most and Floride specimens the least. Fortunately there is only a small amount of veriation in the maculation of the wings and the genitalia which are the principal diegnostic characters.

In addition to the specimens listed above, one specimen in poor condition from Abaco Caya, Allans Cay, Bahama Islands, may belong to this subspecies. The wings,however, have a distinct spot at the base of cell M_1 end an edditional cloud on the m crossvein, and lack the infuscated area in cells 1A end 2A found in albofasciatum. An aberrent specimen from Brownwood, Texas (VI-22-1921, R. H. Painter, coll.) which is probebly albofasciatus has the pile on the prosternum rust-colored instead of black and some of the light scales on the abdomen rust-colored insteed of gold.

Eight specimens collected by the euthor near the mouth of Rist Canyon, near Bellvue, Larimer Co., Coloredo represent what is probably a small, isolated population of this subspecies. The specimens closely resemble

those from Texas end Kansas although one large female has e distinct spot at the base of cell M_1. The genitalia of one male were extracted and found to agree with those of specimens from the eastern United States.

A. albofasciatus albofasciatus is most closely related to elbofesciatus picea. The two subspecies are difficult to distinguish and distributional data must be relied upon to e large extent. They may be most readily separeted throughout the range of variation of both subspecies by the mele genitalia. In picea the tips of the gonocoxites are more than twice as long es wide and have coarse black setae at the apices while in albofasciatus they ere less then twice as long as wide and have finer setae, some of which may be yellow. Most specimens of albofasciatus also differ in having the spot at the base of cell M_1 reduced or absent. A. pauper differs from albofasciatus in heving the spot at the base of cell R_4 and the infuscated erea in cells 1A end 2A reduced or absent.

A. albofasciatus albofasciatus has been confused by some of the older authors with A. limatulus limatulus. The latter is usually larger, however, and has the infuscation of the wings indistinctly margined, fading gredually apically and posteriorly, whereas albofasciatus has the infuscation on the outer portion of the wings well-defined.

Anthrax albofasciatus picea Marston, n. ssp.

?Anthrax varia, Strickland, 1938, p. 195 (as "A. varia Fall.") (nec. Fabricius, 1794; misident.).

Diagnosis. Wings with sectorel crossvein absent; isolated spots present at the beses of cells R_4, M_1 and $2M_2$; infuscatcn filling one-half

or more of cell M; cells 1A and 2A with an indistinctly defined medial infuscated area (Plate V, Fig. 10). Prosternal tuft of pile mixed black and white; post-alar tuft of pile black with a few white hairs sometimes present. Fringe of pile on posterior margin of occiput black with light tips, sometimes lighter dorsally but without a distinct area of light pile behind the vertex. Light scales on femora gold; black scales on the posterior femora occupying from two-thirds to four-fifths of the anterior surface and up to one-third of the posterior surface. Tips of the gonocoxites about twice as long as broad, distinctly curved on both the inner and outer margins and separated medially by slightly more than the width of one lobe; apices with long black setae (Plate VI, Fig. 10). Distal segments of gonostyli ovate, beaked at the apex (Plate IV, Fig. 10).

Male. Integument mostly black, purplish-grey pollinose. Fore and middle tibiae and distel margins of the apical abdominal segments orange; posterior tibiae and genitalia red. Scales on face and occiput yellowish-white, on lower front gold, on upper front gold medially and black laterally. Setae black. Pile on posterior margin of occiput black with light tips.

Mesonotum with sparse gold, white and black scales not formed in well-defined bands; margins with linear, semi-erect, mixed white and gold scales. Pleurae with sparse gold scales; scales on coxae white. Pile on prosternum, pleurae and anterior margin of mesonotum mixed black and white; a few gold hairs present on the pleurae; post-alar tuft black. Scutellum with white scales on the posterior margin, laterally on the anterior margin and on the median line; remainder of anterior margin and disc covered with black scales; a few gold scales present between the black and white.

Wings hyalina with brown maculation; basal infuscation extanding into the basas of calls R and M, and to tha humeral crossvein in the costal call; subcostal call complately infuscatad. Maculation consisting of distinct spots at tha bases of calls R_4, M_1 and $2M_2$, aggregatas of spots extending from the r-m crossvein to vein R_1 and from the base of cell Cu_1 to the basa of call R_1; a poorly defined spot prasent in cell 1A and extending into cell 2A; apical infuscation in cell M extending halfway to the basa. Sectoral crossvein absent (Plate V, Fig. 10).

Famora with black scales prasent on tha apical four-fifths of the anterior margins, postarior femora also with black scales on tha apical one-third of the posterior surfaces, remaindar of femoral surfaces covered with gold scales. Fora and middla tibiae with black scales anteriorly, white scalas posteriorly; posterior tibiae with black scales.

First abdominal tergum with whita scalas laterally, gold scales medially; pile on lateral margins white with a few gold and black hairs posteriorly. Second abdominal tergum with a broad antarior band of black scales followed by a band of gold scalas; postarior margin with a medial spot of black scalas and a fringa of white scalas. Third tergum with an anterior band of black scales followed by a narrow band of gold scales which doas not extend entiraly to the lateral margins; posterior fringe of scales whita laterally, black madially, a few white scales present submedially. Fourth targum with an anterior band of black scales broadened laterally and narrowed medially, followed by a band of gold scales not extending to tha lateral margins; postarior margin with white scales laterally and black scalas medially, a few whita scalas present submedially. Fifth

tergum entirely covered with white scales except a medial crescent of mixed black and gold scales. Terga six and seven entirely covered with white scales with the exception of medial spots of black scales.

Male Genitalia. Distal lobes of the gonocoxites about twice as long as wide, slightly curved on both the inner and outer margins and separated medially by about one and one-half times the width of one lobe; apical setae black (Plate VI, Fig. 10). Distal segments of gonostyli ovate, usually about as broad as high, beaked at the apex; distal margin broadly rounded; proximal margin almost straight before the indentation below the beak; beak projecting vertically or sometimes somewhat horizontally (Plate IV, Fig. 10). Dorsal part of the apex of the intromittent organ straight, only slightly convex across the face and projecting proximally at a slight angle; medial and lateral proximal projections right-angled; distal face with two truncate lobes broadened at the apex just above the medial process above the aedeagus; medial process projecting only slightly from the plane of the dorsal part and with a single pair of teeth above the apex. Ventro-lateral parts of the intromittent organ coarctate on the ventral margins, rounded at the apex and projecting only slightly or not at all past the plane of the dorsal part (Plate II, Fig. 5).

Female. Similar to male. Spots on wings somewhat larger; infuscation extending almost to the base in cells R, M, 1A and 2A.

Variation. The fringe of pile on the posterior margin of the occiput may include a few white hairs behind the vertex. The pile on the prosternum may be predominantly black, white or yellow. The pigmentation of the wings may vary somewhat but cells R and M are always more than one-half infuscated.

The tarsi may be yellow, especially in smaller specimens, and the apices of the femora may also be yellow or reddish. The black scales on the posterior femora may occupy from one-half to all of the anterior surfaces and up to one-third of the posterior surfaces.

One specimen from Forest Grove, Oregon lacks the lobes on the distal face of the dorsal part of the intromittent organ as does albofasciatus albofasciatus; it also has the medial process above the aedeagus distinctly projecting, but otherwise it agrees with typical specimens of albofasciatus picea.

Body Length.

Male--Range: 6.7-8.0 mm; $\bar{x}$: 7.6 mm; s.d.: 0.61 mm; n: 3.

Female--Range: 6.1-8.6 mm; $\bar{x}$: 7.0 mm; s.d.: 0.84 mm; n: 14.

Wing Length.

Male--Range: 6.5-9.2 mm; $\bar{x}$: 7.6 mm; s.d.: 1.03 mm; n: 7.

Female--Range: 6.3-9.1 mm; $\bar{x}$: 7.6 mm; s.d.: 0.99 mm; n: 15.

Distribution. This species apparently occurs throughout Canada and Alaska in areas dominated by Spruce-Fir forests and it is found in the continental United States only where these forests occur in mountain ranges along the Canadian border (Map II).

Holotype. ♂, Whitehorse, Yukon Territory, Canada, VII-18-1949 (D. L. Watson).

Allotype. ♀, Reindeer Depot, Mackenzie Delta, Northwest Territories, Canada, VII-11-1948 (J. R. Vockeroth).

Paratypes. Montana: Glacier Co., ♂, Glacier Pk. Sta., VII-24 (J. M. Aldrich). Ravalli Co., ♀, Hamilton, VI-1-1952 (G. P. Holland).

Washington: Pierce Co., ♀, Sumner, VII-31-1952.

Canada: Alberta, ♀, Clymont, VI-25-1936 (E. H. Strickland); 3♀, McMurray, VI-25, VII-6-1953 (G. F. Ball). British Columbia, ♀, Ft. St. John, VII-29-1927 (P. N. Vroom). Manitoba, ♀, Aweme, VI-17-1922 (R. M. White). Northwest Territories, ♂, Norman Wells, Northwest Territories, VII-28-1959 (W. R. M. Mason); ♂, Reindeer Depot, Mackenzie Delta, VII-11-1948 (J. R. Vockeroth). Ontario, ♂, Burks Falls, VII-14-1926 (F. P. Ide); ♂, Low Bush, Lake Abitiba, VII-17-1925 (N. K. Bigelow); ♀, London, '96. Quebec, ♂, Aylmer, VII-13-1926 (C. B. Hutchings); ♂, ♀, Netashquan, VIII-10, 15-1929 (W. J. Brown); ♀, Thunder River, VIII-23-1930 (W. J. Brown). Saskatchewan, ♂, Indian Head, VII-1-1937 (A. R. Brooks). Yukon Territory, ♀, Marsh Lake, VII-10-1948 (Mason & Hughes).

Other Material Examined. New Hampshire: Grafton Co., ♂, Franconia (Mrs. A. T. Slosson).

Oregon: Polk Co., ♀, Bush's Pass, Selem, VII-7-1939 (G. F. Smith). Washington Co., ♂, Forest Grove, VII-12-1918.

Canade: Alberta, ♀, Waterton Lakes, VII-12-18-1923 (J. M. McDunnogh). Saskatchewan, ♀, Indian Heed, VII-1-1937 (A. R. Brooks).

Types. The holotype end allotype are in the Canedien National Collection. Paratypes may be found in the collections of the author, the University of Oregon, the American Museum of Natural History, the University of California, the U. S. Netional Museum, the Museum of Comperative Zoology, and in the Canadian Nationel Collection.

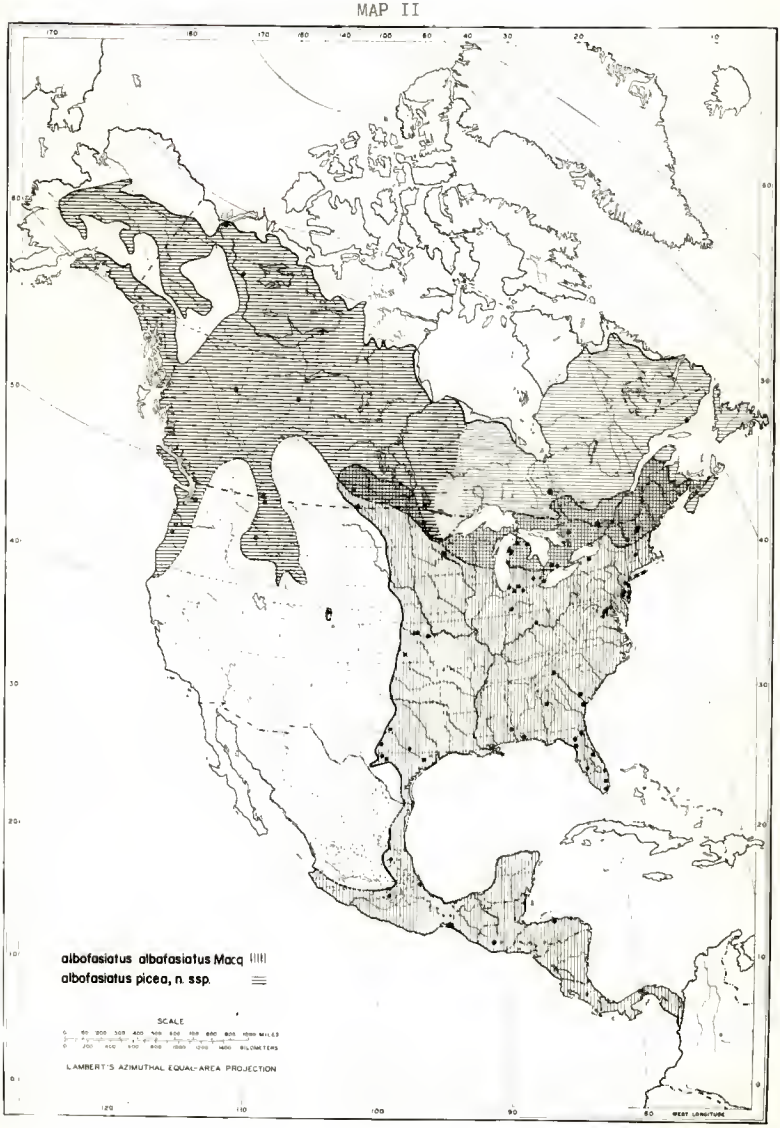
Dates of Occurrence. June 1 (Ravali Co., Montana) to August 23 (Thunder River, Quebec).

EXPLANATION OF MAP II

Anthrax albofasciatus albofasciatus Macquart, distribution (vertical lines).

Anthrax albofasciatus picea Marston, n. ssp., distribution (Horizontal lines).

MAP II


albofasiatus albafasiatus Macq
albofasiatus picea, n. ssp.
SCALE
LAMBERT'S AZIMUTHAL EQUAL-AREA PROJECTION
WEST LONGITUDE

A number of specimens which appear to be intermediates between albofasciatus picea and albofasciatus cascadensis have been found in the area where the two species overlap. These intermediates are discussed under cascadensis.

A. albofasciatus picea is difficult to distinguish from albofasciatus cascadensis and albofasciatus albofasciatus except on the basis of the male genitalia, and distributional data must be relied upon to a large extent. Usually picea has the infuscation of the wings heavier than cascadensis, cell M being nearly filled in both sexes of the former whereas the males and often the females of the latter have the central part of cell M hyaline. The males of picea may be readily distinguished from the males of cascadensis by the beaked apex of the distal lobes of the gonostyli and the shorter distal lobes of the gonocoxites. A. a. picea may be distinguished from a. albofasciatus throughout the range of both subspecies only by the male genitalia. In picea the tips of the gonocoxites are longer than wide and have long black setae at their apices whereas in albofasciatus the tips of the gonocoxites are little if any longer than wide and lack long, black setae. Specimens of albofasciatus from the northern United States differ from specimens of picea in having the spot at the base of cell M_1 reduced or absent.

Anthrax albofasciatus cascadensis Marston, n. ssp.

Argyramoeba limatulus, Osten Sacken, 1877, p. 243 (nec. Say, 1823, misident.).

Spogostylum varium, Cole & Lovett, 1921, p. 244 (nec. Fabricius, 1794; misident.).

?Anthrax varia, Maughan, 1935, p. 8; Strickland, 1938, p. 195 (as "A. varia Fall.") (nec. Fabricius, 1794; misident.).

Diagnosis. Wings with sectoral crossvein absent; isolated spots present at the bases of cells R_4, M_1 and $2M_2$; female with cell M mostly or entirely infuscated and with a large infuscated area in cells 1A and 2A; male often with e small infuscated area in cells 1A and 2A (Plate V, Fig. 11). Prosternal tuft of pile black or mixed black and white; post-alar tuft of pile black; fringe of pile on posterior margin of occiput black with light tips, not lighter behind the vertex. Light scales on femora varying from gold to yellowish-white; black scales on posterior femora occupying from one-third to ell of the anterior surface. Distal lobes of the gonocoxites narrow, distinctly curved on both the inner end outer margins and separated by more than twice the width of one lobe; apices covered with short, black setae (Plate VI, Fig. 11). Distal segments of gonostyli broad at the base, tapering gradually to e bluntly pointed apex, slightly bent outward and twisted proximally on the upper half (Plate IV, Fig. 11).

Male. Integument generally black, purple-grey pollinose; tibiae, proximal tersal segments and genitalia red; posterior margins of distal abdominal segments yellow. Scales on lower front, face and occiput white; on upper half of front black. Setae on head black. Posterior fringe of pile on occiput black, white-tipped, not lighter behind the vertex.

Anterior half of mesonotum with a medial and two sub-lateral stripes of black scales, and two narrow submedial bands of white scales; posterior

half entirely covered with black scales except two submedial white spots; margins of mesonotum with linear, semi-erect white scales. Pile on prosternum black; on pleurae and anterior margin of mesonotum mixed black and white; post-alar tuft black. Setae on pleurae black. Sternopleurae and coxae with white scales. Scutellum with white scales on the posterior margin, the lateral parts of the anterior margin and a small mediel spot posteriorly on the disc; remainder with black scales.

Wings hyaline with light brown maculation; basal infuscation extending into the bases of cells R, M, 1A and 2A, and past the humeral crossvein in the costal cell; subcostal cell entirely infuscated. Maculation consisting of isolated spots at the bases of cells R_4, M_1 and $2M_2$, elongated spots from the base of cell R_5 to vein R_1 and from the base of cell Cu_1 across the base of cell $1M_2$ to the base of cell R_1; an indistinct infuscated area present near the middle of cells 1A and 2A. Sectoral crossvein absent (Plate V, Fig. 11).

Femora with black scales on the anterior margins and yellowish-white scales on the posterior margins. Fore and middle tibiae with black scales anteriorly, white scales posteriorly; scales on posterior tibiae entirely black.

First abdominal tergum with black scales medially and white sceles laterally on the posterior margin; pile on the lateral margins mostly white with some black hairs posteriorly. Second and third abdominal terga with a band of black scales anteriorly followed by a narrow, incomplete band of yellowish-white scales; posterior margins with a band of black scales replaced laterally by white scales, and a marginal fringe of white scales

interrupted medially by black scales. Fourth tergum entirely covered with black scales except a few white ones on the lateral margin, in two submedial tufts on the posterior margin and in a small medial spot near the anterior margin. Fifth tergum entirely covered with white scales except a crescent-shaped medial spot of black scales Sixth and seventh terga with small spots of black scales medially and white scales laterally. Venter with sparse white scales.

Male Genitalia. Distal lobes of the gonocoxites narrow, broadly curved on both the inner and outer margins and separated medially by more than twice the width of one lobe; setae on the lobes short and black (Plate VI, Fig. 11). Distal segments of gonostyli long, broad and tapering gradually to a bluntly pointed apex; apex slightly twisted proximally (Plate IV, Fig. 11). Dorsal part of the apex of the intromittent organ slightly convex and nearly vertical; medial and lateral proximal projections bluntly pointed; a large rectangular membranous area present in the center with low, obtuse projections on either side; medial process above the aedeagus spatulate with a small tooth just above the apex. Ventro-lateral parts of the intromittent organ short and truncate (Plate II, Fig. 5).

Female. Similar to male. Pile on prosternum mixed black and white. Spot at the bases of cells R_3 and R_5 extending distally in cell R_1 to a point halfway between the r-m crossvein and tha base of cell R_4; spot in cells 1A and 2A larger; cell M almost totally infuscated. Black scales on femora less extensive, occupying only the apical three-fourths of the anterior surfaces of the fore and middle femora, and the apical one-half of the posterior femora. White scales less extensive on the apical abdominal segments.

Variation. The scales on the pleurae vary from yellow to white, the pile on the prosternum varies from entirely black to entirely white. The infuscated area in cells 1A and 2A varies in size and may be absent in some males. The color of the tibiae varies from yellow to red. The light colored scales on the femora may be white, yellow or gold. The black scales on the posterior femora may be restricted to the apices. On the abdomen there may be e few gold scales medially on the anterior terga.

Body Length.

Male--Range: 6.0-10.0 mm; $\bar{x}$: 7.8 mm; s.d.: 0.96 mm; n: 19.

Female--Range: 6.2-9.6 mm; $\bar{x}$: 7.9 mm; s.d.: 1.00 mm; n: 10.

Wing Length.

Male--Range: 6.2-10.3 mm; $\bar{x}$: 8.4 mm; s.d.: 0.92 mm; n: 19.

Female--Range: 6.3-10.1 mm; $\bar{x}$: 8.5 mm; s.d.: 1.24 mm; n: 10.

Distribution. This subspecies occurs in mountain forests from southern California north into southern British Columbie and south in the Rocky Mountains into northwestern Wyoming and north-central Utah. The lack of specimens from Colorado suggests that the subspecies has been unable to traverse the arid areas in southwestern Wyoming, western Coloredo and eestern Utah. The distribution of A. plesia is coincident with that of cascadensis except that the former occurs in the mountainous areas of Colorado. A. albofasciatus cascadensis is replaced by a. picea on the north and by a. daphne in the Southwest and in Colorado (Map III).

Holotype. ♂, Fremont National Forest, Klamath Co., Oregon, VI-18-1922 (E. C. Van Dyke).

Allotype. ♀, Truckee, Nevada Co., California, VI-21-1927 (E. P. Van Duzee).

Paratypes. California: El Dorado Co., ♂, China Flat, VI-28-1948 (C. Chan). Fresno Co., ♂, Bubbs Cr. Cn., Kings River, VII-8-1910 (E. C. Van Dyke). Lake Co., ♂, nr. Hobergs, VI-9-1932. Lassen Co., ♂, Bridge Cr. Camp, VII-9-1949 (P. D. Hurd); ♀, Spauldings, VI-27-1949 (F. Morishita). Los Angeles Co., ♂, Crystal Lake, VII-9-1942 (E. M. Evans); ♂, Tanbark Flat, VI-20-1956 (J. I. Stage). Mariposa Co., ♀, El Portal, V-15-1938 (Carl T. Sierra). Napa Co., ♂, Samuel Spr., V-22-1956 (E. I. Schlinger). Plumas Co., ♂, 4 mi. W. Quincy, VI-30-1949 (P. D. Hurd). Riverside Co., ♂, ♀, Banning, V-29-1928 (E. C. Van Dyke); 2♂, Riverside, IV-26, V-19-1933 (A. J. Basinger). San Bernadino Co., ♂, Camp Baldy Rd., VI-26-1956 (R. W. Bushing); 3♂, Mt. Home Cn., VI-8-1924 (J. M. Aldrich). Soiano Co., ♂, Green Valley, V-9-1953 (J. C. Hall). Shasta Co., ♀, 7 mi. NE Burney, IV-6-1959 (S. Areekul). Sonoma Co., ♀, IV-27-V-9 (Osten Sacken). Tulare Co., ♀, Giant Forest, VII-19-1928 (C. L. Fox). ♀, "California".

Idaho: Nez Perce Co., ♂, Waha, VI-18-1909 (J. M. Aldrich).

Oregon: Hood River Co., 3♂, Hood River, VI-7-16-1917 (F. R. Cole); ♂ Mt. Hood, VI-24-1925 (E. C. Van Dyke). Wasco Co., 2♂, Mosher, VI-11,14-1917 (F. R. Cole).

Utah: Cache Co., ♂, Logan, VI-22-1955 (G. L. Nielson).

Washington: Pierce Co., ♂, Ranier National Forest, Currant Flat, VI-21-1936 (S. E. Crumb). "Virden", ♀, VII-5-1932 (C. H. & D. Martin).

CANADA: British Columbia, ♀, Anderson Lake, D'Arcy, VI-17-1926 (J. McDunnough); ♀, Lillooet, VI-9-1918 (A. W. A. Phair); ♂, Oliver, Baldy Mtn., VII-24-1953 (J. E. H. Martin).

Other Material Examined. California: Lake Co., ♀, Upper Lake, VI-20-1940 (G. E. Bohart). Lassen Co., ♀, Bridge Cr. Camp, VII-9-1949 (D. Cox). Los Angales Co., ♂, Crystal Lake, VI-29-1950 (P. D. Hurd); ♀, Devils Basin, VII-12-1931 (E. O. Essig). Mariposa Co., ♂, El Portal, VI-18-1938 (E. D. Snyder). Monterrey Co., ♂, Arroyo Seco Camp, VI-6-1956 (R. M. Bohart). Napa Co., ♀, Sage Cyn., V-15-1951 (J. C. Hall). Nevada Co., ♀, Truckee, VI-21-1927 (E. P. Van Duzee). Riverside Co., ♀, Hemet Reservoir, San Jacinto Mtns., V-22-1939 (E. S. Ross); ♂, San Jacinto Mtns., VI-30-1933 (R. H. Beamer). Shasta Co., ♂, Shingleton, V-22-1941 (C. W. Anderson). Sierra Co., ♀, Independence Lake, VII-16-1958 (R. M. Bohart). Trinity Co., ♀, Carrville, VI-16-1934 (T. G. H. Aitken). Tuolumne Co., ♀, Strawberry, VII-7-1938 (W. H. Lange). ♂, ♀, "California".

Montana: Beaver Head Co., ♀, VII-10-1928. Gallatin Co., ♀, Gallatin Mts., VII-7-1914; ♀, VI-1-1924. Ravalli Co., ♀, Florence, VI-19-1912.

Oregon: Hood River Co., ♂, VI-6-1917 (F. R. Cole); ♀, Parkdale, VI-18-1917 (F. R. Cole). Klamath Co., ♀, Eagle Ridge, VI-24-1924 (C. L. Fox); ♂, Fremont Nat'l Forest, VI-18-1922 (E. C. Van Dyke). Malheur Co., ♀, V-3-1946.

Utah: ♂, Emigrant Canyon (Hall).

Washington: Pierce Co., ♀, Sumner, VII-31-1932.

CANADA: Alberta, 3♀, Waterton Lakes, VII-12-18-1923 (J. McDunnough); ♀, Waterton, VII-9-1923 (H. L. Seamans). British Columbia, ♀, Chase, VI-15-1921 (W. B. Anderson); ♀, Creston, VI-28-1924 (C. S. Lallamand); ♀, Karemeos, VII-12-1923 (C. B. Garrett); ♀, 4 mi. W. Princeton, VI-3-1957 (E. I. Schlinger).

Types. The holotype and allotype are in the collection of the California Academy of Sciences. Paratypes may be found in the collections of the author, Jack C. Hall, R. H. Painter, the University of California, the California Academy of Sciences, Oregon State University, Utah State University, the U. S. National Museum, the Museum of Comparative Zoology and in the Canadian National Collection.

Dates of Occurrence. April 6 (Shasta Co., California) to August 7 (Tuolumne Co., California).

Five males have been studied from northern California which are similar externally to cascadensis, but which have a distinct type of male genitalia.

These specimens have the tips of the gonocoxites like those of cascadensis but shorter and broader. The distal segments of the gonostyli are quite distinct, having the apex elongated, bluntly rounded and slightly curled outward. The apex of the intromittent organ is similar to cascadensis, but the medial proximal projection is horizontal, the projections on either side of the central, lightly sclerotized area are lobe-like and the medial process above the aedeagus projects distally and has several pairs of teeth above the apex. Externally, the variants are like cascadensis except that the pile on the prosternum is partly yellow, the area of black scales on the femora is much reduced and the spots on the wings are generally smaller.

A number of males have been examined which appear to be intermediates between albofasciatus cascadensis and albofasciatus picea, and between cascadensis and albofasciatus daphne. A number of females have been associated with the intermediate males, but they are very difficult to separate

from each other and from cascadensis. Intermediates of both sexes run to cascadensis in the key.

Eleven males which show intermediate characters between cascadensis and daphne are at hand from northeestern California and north-central and south-central Oregon where the two parent subspecies occur sympatrically. These intermediates have the distal lobes of the gonocoxites like those of cascadensis, but shorter and closer together. The distal segments of the gonostyli are like those of daphne but much wider at the base and blunt at the apex. The apex of the intromittent organ is similar to montanus but the central membranous area is smaller and the projections on either side of this area are lobe-like; the medial process above the aedeagus projects outward somewhat and has two to several pairs of teeth above the apex. Externally the intermediates are very much like daphne, but the wings are generally somewhat darker and the fringe of pile behind the occiput is not lighter behind the vertex.

Three males have been studied which show intermediate charecters between cascadensis and picea. The tips of the gonocoxites are like those of cascadensis but shorter. The distal segments of the gonostyli are like those of picea but the beak at the apex is less pronounced. The apex of the intromittent organ is like that of cascadensis but the medial lightly sclerotized area is smaller, the projections on either side of this area are lobe-like and the medial process above the aedeagus has a pair of broad, obtusely pointed projections above the apex instead of sharply angled projections. Externally the intermediates are very much like cascadensis. They differ in having fewer black scales on the legs, more white pile on the prosternum and less infuscation on the wings.

A. a. cascadensis differs from daphne in having the haire on the posterior margin entirely black, or when light haire are present behind the vertex, in having the anterior surface of the posterior femora partly covered with light scales. The females of cascadensis may be distinguished from the females of daphne by the presence of infuscation in cells 1A end 2A. The males may be distinguished by the ovate distal segments of the gonostyli in cascadensis es opposed to the awl-shaped segments in daphne. A. e. cascadensis is difficult to distinguish from e. picea and distributional data must be relied upon to a large extent. Usually picea has the infuscetion of the wings heavier than cascadensis, cell M being elmost completely derk in both sexes of the former whereas the males and often the females of the letter have the centrel part of cell M hyeline. The meles of picea mey be readily distinguished from the males of cascadensis by the beaked epex of the distal lobes of the gonostyli and the shorter distal lobes of the gonocoxites. A. varicolor varicolor differs from cascadensis in possessing a complete sectoral crossvein.

Anthrax albofasciatus daphne (Osten Sacken)

Argyramoeba limatulus, Osten Sacken, 1877, p. 213 (nec. Say, 1823; misident.).

Argyramoeba daphne Osten Sacken, 1886, p. 104; Kertesz, 1909, p. 62.

Spogostylum daphne (Osten Sacken), Aldrich, 1905, p. 222.

Anthrax daphne (Osten Sacken), Painter & Painter, 1962, p. 73.

Diagnosis. Wings with sectoral crossvein absent; isolated clouds present at the bases of cells R_4, M_1, R_3 and R_5, $2M_2$, Cu_1 and in cell R below the base of R_1; apical clouds sometimes reduced and occasionally lacking at the bese of cell M_1 (Plate V, Fig. 12). Prosternal tuft of pile mixed black and white; post-alar tuft of pile usually white. Fringe of pile on occiput lighter behind the vertex. Black scales usually covering almost the entire anterior surface of the posterior femora. Scales on the posterior tibiae usually dense and jet-black. Tips of gonocoxites broad and close together, only slightly curved on both the inner and outer mergins and separated by less than the width of one lobe (Plate VI, Fig. 12). Distal segments of gonostyli small, awl-shaped, quadrengular baselly, usually narrowing abruptly before the linear apex (Plate IV, Fig. 12).

Male. Integument generally black, grey or slightly blue-grey pollinose, tibiae and genitalia red. Face, lower front and occiput with yellowish-white scales; upper front with black sceles. Setae black. Fringe of pile on hind margin of occiput black with white tips, becoming yellow with white tips behind tha vertex.

Anterior half of mesonotum with a medial and two sublateral bands of black scales separated by two submedial bands of light scales which are

yellow medially and white laterally; posterior half of mesonotum covered with black scales except a long medial triangle of white scales and two sublateral triengles of yellow or white scales extending forward from tha posterior margin. Lateral margins of mesonotum usually with semi-erect, linear white scales; humeral calli sometimes with gold scales. Scales on pleurae yellow. Pile on prosternum black or mixed black and white; on pleurae and anterior margin of mesonotum mixed black and white with a few yellow hairs sometimaa present; post-alar tuft of pila usually white, sometimes black or mixed black and white. Scutallum with whita scales on the posterior margin, the lateral areas of the anterior margin and the mesal line; remaindar with black scalas.

Wings hyaline with light brown maculation; basal infuscation extending out to the bases of cella R, M, 1A and 2A, filling the costal cell to tha humeral crossvein and ell of the subcostal cell. Isolated clouds present at the beses of cells R_4, R_3 and R_5, M_1, $2M_2$, Cu_1, and in cell R below the base of R_1; spots sometimes reduced at the bases of cells R_4, M_1 and $2M_2$, occaaionally absent at the base of cell M_1. Sectoral crossvein absent (Plate V, Fig. 12).

Femora usually with black scales anteriorly and yellow or gold scalas posteriorly, the yellow scales occasionally occupying up to one-half of the anterior surfaces and the black acales sometimes covering the posterior femora entirely. Fore and middle tibiae with black scales anteriorly, yellow scales posteriorly; hind tibiae covered with dense, jat-black scalas, rarely with a few yellow scales proximally.

First abdominal tergum with white scales laterally and yellow scales medially on the posterior margin, pile on lateral margins white with a few black hairs sometimes present. Second abdominal tergum usually with a band of dark yellow scales anteriorly, sometimes reduced or absent, followed by a band of black scales which varies in width inversely with the size of the anterior band, and another band of dark yellow scales not extending to the lateral margins; posterior margin with two submedial and two lateral spots of white scales separated by spots of black scales. Third tergum with a band of dark yellow scales anteriorly followed by two submedial and two lateral patches of white scales separated by black scales on the posterior margin. Anterior portion of tergum four with a band of black scales separated medially by dark yellow scales, posterior margin with white scales except a small medial patch of black scales. Terga five, six and seven covered with white scales except small medial spots of mixed yellow and black scales. Venter with sparse white scales laterally and black scales medially, at least on the anterior segments.

Male Genitalia. Tips of gonocoxites broad, about two-thirds as wide as long, undulate on the outer margin, slightly curved on the inner margin and separated medially by less than the width of one lobe; setae on apices short and black (Plate VI, Fig. 12). Distal segments of gonostyli small, narrow, tapering slightly about two-thirds of the way to the apex, then usually narrowing abruptly or sometimes gradually curving on either margin to the linear tip (Plate IV, Fig. 12). Dorsal half of the apex of the intromittent organ short, broad and distinctly convex; medial proximal projection broad and truncate or acuminate at the tip; lateral proximal projections obtusely angled or not evident. Dorsal face with two short lobes which are usually broadened and truncate at the tips, but may be linear. Medial process above the aedeagus extending beyond dorsal part and with one to three pairs of teeth above the apex. Ventro-lateral parts of the intromittent

organ rounded at the apex and extending out to the tip of the medial process above the aedeagus (Plate II, Fig. 6).

Female. Similar to male. Spots on wings sometimes larger, spot at the bases of cells R_3 and R_5 sometimes extending to vein R_1; spot in cell R below the base of R_1 connected with the spot at the base of cell Cu_1.

Body Length.

Male--Range: 4.8-8.3 mm; $\bar{x}$: 6.6 mm; s.d.: 0.97 mm; n: 15.

Female--Range: 4.5-8.5 mm; $\bar{x}$: 7.0 mm; s.d.: 1.07 mm; n: 17.

Wing Length.

Male--Range: 4.9-8.8 mm; $\bar{x}$: 7.0 mm; s.d.: 0.98 mm; n: 15.

Female--Range: 4.8-9.1 mm; $\bar{x}$: 7.4 mm; s.d.: 1.17 mm; n: 17.

Distribution. A. albofasciatus daphne occurs in arid mountainous areas in the southwestern United States. It is allopatric to albofasciatus cascadensis on the north and west except in northern California and Oregon where the two occur sympatrically. In central California daphne seems to predominate on the eastern side of the Sierra Nevada mountains while cascadensis predominates on the western side. In Colorado, where cascadensis does not occur, daphne seems to have taken over the ecological niche normally occupied by cascadensis (Map III).

New Material Examined. Arizona: Apache Co., ♀, 39 mi. W. Eager, VI-20-1961 (R. H. & E. M. Painter). Gila Co., ♀, 5 mi. N. Winkleman, III-28-1961 (R. H. & E. M. Painter). Pima Co., 4♂, Baboquivari Mts., III-31-1937 (W. Benedict); ♂, 2♀, Elkhorn Ranch, Sabino Canyon, III-14-1961 (J. Bequaert); 2♂, Sabino Canyon, II-28-1961 (R. H. & E. M. Painter); 3♂, ♀, Sabino Canyon, III-12-1961 (R. H. & E. M. Painter); ♂, Sabino Canyon,

V-11-1961 (R. H. & E. M. Painter). Pinal Co., ♂, Ray, V-15-1954 (G. D. Butler); ♀, 5 mi. S. Rey, IV-5-1961 (R. H. & E. M. Painter). Santa Cruz Co., ♂, Nogales, IV-30-1953 (R. M. Bohart); ♂, ♀, 15 mi. NW Nogales, IV-27-1961 (R. H. & E. M. Painter).

Californie: Fresno Co., ♂, Lone Indian Lake, VIII-20-1949 (E. I. Schlinger); ♂, 2♀, Pioneer Basin, Sierra Nev. Mts., VIII-19-1956 (E. I. Schlinger); Sequoia Nat'l Park, VII-26-1930. Inyo Co., ♀, Diaz Lake, V-19-1937; 2♀, Mono Pass, VIII-13-1957 (D. D. Linsdele); 9♂, 4♀, Ruby Lake, VIII-13-1957 (D. D. Linsdele, J. Powell and C. D. MacNeill); 3♀, 3 mi. N. Westgard Pass, VI-26-1953 (J. W. MacSwain). Mono Co., ♂, Sonora Pass, VII-13-1957 (J. W. MacSwain); ♂, Sonora Peak, VIII-10-1957 (C. D. MacNeill). Nevada Co., ♂, Boca, VII-3-1954 (J. C. Downey). Placer Co., ♂, Carnelian Bay, VI-17-1958 (R. M. Bohart). Plumas Co., ♀, Meadow Valley, VI-21-24-1924 (E. C. Van Dyke); ♂, 2♀, Onion Velley, VII-7-1949 (R. C. Bechtel and E. I. Schlinger). Riverside Co., ♂, Pinon Flat, San Jacinto Mts., V-24-1939 (B. Brookman); ♂, Idyllwild, V-28-1939 (B. Brookman). San Diego Co., ♀, Borrego, IV-11-1952 (E. G. Linsley); Sierra Co., ♀, Gold Lake, VII-26-1921 (C. L. Fox). Siskyou Co., ♀, Castle Lake, VIII-29-1958 (J. Powell). Ventura Co., 2♂, ♀, Lockwood Vly., V-10-1959 (E. I. Schlinger).

Colorado: Archuleta Co., ♀, Pagosa Jct., VI-25. Boulder Co., ♀, Boulder, V-31-1929 (M. C. Van Duzee). Chaffee Co., ♀, Monarch Pass, VII-16-1948 (D. & C. H. Martin). Clear Creek Co., ♀, "Denver", (C. W. Johnson). Gunnison Co., ♂, Somerset, VII-4-1959 (R. H. and E. M. Painter). Hinsdale Co., ♂, ♀, VI-28-1937 (R. H. Beamer); ♀, Lake City, VI-29-1937 (C. L. Johnston). Huerfano Co., ♀, Spanish Peaks, VI-15. Lake Co., ♀, Tennessee Pass, VIII-6-8-1920. Mineral Co., 3♀, Creede, VIII-1914 (S. J. Hunter).

Park Co., ♂, ♀, Fairplay (W. L. Carpenter).

Nevada: Lyon Co., ♀, Dayton, V-30-1958 (T. R. Haig).

New Mexico: Lincoln Co., ♂, Ruidoso, VI-26-1940 (R. H. Beamer). McKinley Co., ♂, 18 mi. N. Gallup, VI-26-1931 (H. A. Scullen).

Oregon: Baker Co., ♂, Sparta, VII-3-1922 (E. C. Van Dyke). Harney Co., ♀, Pike Creek, Steens Mts., VI-23-1947 (F. Ellerton). Hood River Co., ♀, Parkdale, VI-18-1917 (F. R. Cole). Klamath Co., 2♀, Crater Lake, VII-17-1922 (E. C. Van Dyke); ♂, Lake of Woods, VIII-13-1935 (Geo. Ferguson).

Utah: Iron Co., 2♀, Cedar Breaks, VII-3-1940 (Gersh & Hook). Juab Co., ♂, Callao, VI-14. Salt Lake Co., ♀, 10 mi. E. Salt Lake City, VI-11-1952 (R. H. Beamer).

Wyoming: Uinta Co., ♀, Fort Bridger, VIII-7 (Osten Sacken).

Types. A. albofasciatus daphne was described by Osten Sacken (1886) from a series of twelve males and six females. Two males and one female of the cotype series are in the Museum of Comparative Zoology. Six males and four females are in the British Museum (Natural History). Painter & Painter (1962) state that a male was marked as lectotype in the British Museum.

Dates of Occurrence. February 28 (Pima Co., Arizona) to August 10 (Inyo Co., California).

A. albofasciatus daphne is most closely related to albofasciatus cascadensis. A number of intermediates have been studied from the area in northern California and Oregon where the two subspecies occur sympatrically. These intermediates are discussed under cascadensis.

A. a. daphne differs from a. cascadensis in having the occipital fringe of pile with a tuft of white hairs behind the vertex, or, if these hairs are absent, in having the anterior surface of the posterior femora almost completely covered with black scales. Daphne differs from A. plesia in having the prosternal tuft of pile mixed black and white instead of white and in having a spot at the base of cell R_3. It may be distinguished from A. vierecki by the absence of a sectoral crossvein.

Anthrax aureosquamosus aureosquamosus Marston, n. sp.

Diagnosis. Wings with no sectoral crossvein; basal infuscation and maculation dark brown, isolated spots present at the bases of cells R_4, M_1, $2M_2$ and on vein 2A extending into cells 1A and 2A (Plate V, Fig. 8). Prosternal pile white, post-alar tuft gold, black or mixed. Fringe of pile on posterior margin of occiput black with light tips above, merging to white with yellow bases below. First abdominal tergum with gold scales medially and a few white scales laterally on the posterior margin; second tergum with a narrow line of gold scales on the anterior margin. Black scales on the posterior femora restricted to the apices. Distal lobes of the gonocoxites about twice as long as wide, broadly curved on the outer margin with a distinct fold at the base, sharply curved on the inner margin and separated medially by about twice the width of one lobe; apical setae predominantly yellow (Plate VI, Fig. 7). Distal segments of gonostyli about twice as high as the width at the base, more or less rounded basally and with a squared apical portion (Plate IV, Fig. 14).

Male. Integument generally black, blue-grey pollinose; tibiae, proximal tarsal segments, posterior margins of the abdominal segments and genitalia reddish-orange. Scales on face and lower part of front white in the middle, yellow on the sides; upper part of front with two lateral spots of bleck scales and sparse yellow scales between; scales on occiput yellow along the eye margins greding to white posteriorly. Epistomal setae mixed black and gold, the former predominating. Fringe of pile on posterior margin of occiput black with white tips above, becoming yellow with white tips below.

Mesonotum with three indistinct, longitudinal stripes of oblanceolete black scales separated by two bands of mixed yellow and white scales, margins with curly white lanceolate sceles. Prosternal pile white; pile on pleurae white with some yellow hairs, on humeral calli and anterior margin of the mesonotum white with some black setae; post-alar tuft yellow. Fine setae on pleurae yellow. Cuneate end oblanceolate scales on the pleuree and coxae white. Macrochaetae on thorax bleck. Anterior margin of scutellum with curly oblanceolete scales; disc and posterior margin covered with elliptic gold scales laterelly end black scales medially.

Pigmentation of wings brown; basal infuscation extending out to the anal incision and the bases of cells 1A, R end M; costal and subcostel cells completely infusceted; isolated spots present at the bases of cells R_4, M_1 and $2M_2$, and on vein 2A halfway between the besal crossvein end the base of cell Cu_1; short trensverse bands extending from the r-m crossvein to vein R_1 and from the base of cell Cu_1 to the base of cell R_1. Sectorel crossvein absent (Plate V, Fig. 8).

Scales on fore femore mostly yellow, e few white scales present at the base and a patch of bleck scales present on the distal one-third of

the anterior margin; middle femora with white scales on the posterior side except at the apex, black scales anteriorly on the distal one-half and yellow scales elsewhere; hind femora covered with yellow scales except e few white scales basally and a small anterior patch of black scales at the apex. Fore and middle tibiae with black scales anteriorly and yellow scales posteriorly; hind tibiae entirely covered with black scales.

Pile on the lateral margins of the first abdominal tergum white; second tergum with a few cuneate black scales laterally. Hind margin of the first tergum with elliptic gold scales medially and two small lateral areas of cuneate white scales; second tergum with a narrow band of lanceolate gold scales anteriorly followed by a wide band of linear black scales interrupted medially by gold scales, and a band of elliptic gold scales; posterior margin with a median and two subleteral spots of black scales and two submedian and two lateral spots of cuneate yellow scales. Terga three, four and five mostly covered with elliptic gold scales; lateral spots of black scales present on the anterior margins and a mediel and two expanded sublateral spots of bleck scales present on the posterior margins. Terga six and seven with cuneate yellow scales laterally and black scales medially. Venter with elliptic yellow scales medially; small patches of cuneate white scales present laterally on the anterior sterna.

Male Genitalia. Distal lobes of the gonocoxites about twice as long as the width at the base, broadly curved on the outer margin with a distinct fold at the base, sharply curved on the inner margin and separated medially by about twice the width of one lobe; apical setae predominantly yellow, a few black hairs sometimes present (Plate VI, Fig. 7). Distal segments of gonostyli about twice as high as the width at the base, evenly curved on both

the distal and proximal margins before narrowing to the squared apical portion. Dorsal part of the epex of the intromittent organ bulbously convex with the laterel margins turned out as flanges, especially below; medial proximal projection short and obtusely pointed, lateral proximal projections bluntly pointed; mediel process above the aedeagus not projecting beyond the dorsal part and with e transverse flange ebove the sharply pointed apex. Ventro-lateral parts of the apex of the intromittent organ broedly rounded and projecting past the tip of the aedeagus (Plate II, Fig. 7).

Female. Similar to male. Spots on wings larger; spot on vein 2A extending ell the way across cell 1A; spot around the bases of cells R_{2+3} end R_5 extending in cell R_1 to a point below the tip of the subcosta. Light scales on femora and tibiae white rether than yellow. Gold scales on abdomen lighter, nearer yellow; bleck petches of sceles larger and distinct patches of cuneate white scales present on the posterior margins. Venter mostly covered with white scales, a few elliptic yellow scales present medially.

Variation. The relative emounts of black and gold or yellow scales on the abdomen is variable, but the pattern remains the same. The black scales on the hind femora may occupy up to one-fourth of the enterior surface and the emounts on the other femora vary proportionately. The post-alar tuft and the pile on the sides of the first abdominal segment mey have a few bleck hairs present.

Body Length.

Male--Range: 4.8-9.7 mm; $\bar{x}$: 7.6 mm; s.d.: 1.98 mm; n: 7.

Female--Range: 6.4-8.1 mm; $\bar{x}$: 7.2 mm; s.d.: 0.75 mm; n: 4.

Wing Length.

Male--Range: 5.8-10.0 mm; $\bar{x}$: 8.3 mm; s.d.: 1.96 mm; n: 7.

Female--Range: 7.5-9.2 mm; $\bar{x}$: 8.2 mm; s.d.: .75 mm; n: 5.

Distribution. A. aureosquamosus aureosquamosus occurs in coniferous forests from San Francisco and Lake Tahoe in California north into Washington and east and south into Utah. It is allopatric to aureosquamosus chaparralus in California (Map III).

Holotype. ♂, Carnelian Bay, Lake Tahoe, Placer Co., California, VII-8-1958 (R. M. Bohart).

Allotype. ♀, 4 mi. W. Quincy, Plumas Co., California, VI-30-1958 (P. D. Hurd).

Paratypes. California: Colusa Co., ♂, Arbukle, VIII-8-1956 (S. M. Fidel). Lake Co., ♀, Lake Pillsbury, VII-4-1948 (U. N. Lanham). Mendocino Co., ♀, Hopland, IX-4-1957 (W. W. Middlekauff). Plumas Co., ♀, 4 mi. W. Quincy, VI-25, VII-2-1949 (J. E. Gillaspy, P. D. Hurd). Santa Clara Co., ♂, Mt. Hamilton, VI-25-1937 (E. S. Ross).

Utah: Cache Co., ♂, Logan, VII-23-1956 (E. S. Ross). Salt Lake Co., ♂ Salt Lake City, VI-24-1922 (A. L. Lovett). Weber Co., ♀, Ogden, IX-4-1957.

Types. The holotype and allotype are in the collection of the University of California. Paratypes may be found in the collections of the author, Oregon State University, the University of California, Utah State University, the California Academy of Sciences and the Museum of Comparative Zoology.

Dates of Occurrence. June 24 (Salt Lake Co., Utah) to September 4 (Weber Co., Utah & Mendocino Co., California).

A. aureosquamosus aureosquamosus differs from A. varicolor in lacking a sectoral crossvein. It differs from A. albofasciatus cascadensis and albofasciatus daphne in that the prosternal pile is entirely white. There appear to be no good external characters for separating the females of A. aureosquamosus aureosquamosus from aureosquamosus chaparralus and distributional data must be relied upon. The males of the former differ from those of the latter in having the apex of the distal segments of the gonostyli narrow and truncate rather than with two low tubercles and a sharp distal projection.

Anthrax aureosquamosus chaparralus Marston, n. ssp.

?Argyramoeba varia, Coquillett, 1884, p. 95 (partim) (nec. Fabricius, 1794; misident.).

Diagnosis. Wings without a sectoral crossvein; basal infuscation and maculation dark brown, isolated spots present at the bases of cells R_4, M_1, and $2M_2$; a distinctive spot present on vein 2A extending into both cells 1A and 2A (Plate V, Fig. 8). Prosternal pile white, post-alar tuft gold, black or mixed. Fringe of pile on posterior margin of occiput black with light tips above, yellow with light tips below; a tuft of white hairs sometimes present behind the occiput. First abdominal tergum with gold scales medially; second tergum with a narrow anterior band of gold scales. Black scales on posterior femora restricted to the apex. Distal lobes of the gonocoxites about one and one-half times as long as wide with a fold at the base; outer margins broadly curved, inner margins slightly curved; lobes separated medially by about one and one-half times the width of one lobe; apical setae yellow proximally, black apically (Plate VI, Fig. 8). Distal

segments of the gonostyli quadrangular; apex with proximal and medial low, broad tubercles and a sharp distal projection (Plate IV, Fig. 13).

Male. Integument generally black, blue-grey pollinose; tibiae, proximal tarsal segments, posterior and lateral margins of abdominal terga, posterior margins of abdominal sterna and genitalia reddish-orange. Scales on face and front ovate-lanceolate and semi-recumbent, yellowish-white on the face and lower part of the front, black in lateral spots on middle of front, yellowish scales present above and between the spots of black scales. Occiput with sparse, yellowish-white, recumbent scales. Setae on front and lower half of face black, a few yellow setae laterally on face. Fringe of pile on posterior margin of occiput white behind the vertex, black on the upper half on either side of the vertex, yellow with white tips on the lower half.

Anterior half of mesonotum with a medial and two sublateral longitudinal bands of lanceolate black scales separated by bands of mixed light brown and white linear and lanceolate scales; posterior half with a medial band of lanceolate brown and white scales and submedial and subleteral bands of lanceolate black scales separated by a narrow line of light brown and white scales. Posterior and lateral margins of mesonotum with curly, semi-recumbent scales, white on posterior margin, mixed gold and white on lateral margins. Scutellum covered with lanceolate scales, mixed white and gold on the margins and in a narrow medial line, black on remainder of disc. Mesopleurae, sternopleurae and anterior half of pteropleurae covered with white pile, erect, linear white scales and black and gold setae; dorso-posterior half of sternopleurae with a patch of semi-recumbent, lanceolate white scales.

Pile on prosternum, propleurae, humeral calli and anterior margin of mesonotum white; propleurae with mixed black and gold setae; anterior margin of mesonotum and humeral calli with only black setae. Post-alar tuft of pile mixed gold and black. Coxae covered with lanceolate, semi-recumbent white scales and mixed black and gold setae.

Wings hyaline with brown maculation; basal infuscation extending out to humeral crossvein, extreme bases of cells R, M, 1A and anal incision; cell Sc completely infuscated. Isolated spots and bands present at the bases of cells R_3 and R_5, R_4, M_1, $1M_2$, extending from base of vein R_s to base of cell Cu_1 and on vein 2A halfway between its origin and apex. Sectoral crossvein absent (Plate V, Fig. 8).

Scales on legs lanceolate-ovate. Fore and middle femora covered with black scales on the apical half of the dorsal side; remainder covered with white scales except for a number of gold scales along the margin of the black, especially apically. Hind femora covered with white and yellowish-white scales except for some intermixed black scales dorsally at the apex. Fore and middle tibiae with black scales anteriorly and white scales posteriorly; hind tibiae with black scales.

Pile on lateral margins of first abdominal tergum white, gold and black setae intermixed posteriorly; second and third terga with some black pile and a few lanceolate, erect black scales laterally. Hind margin of first tergum with ovate-lanceolate scales, gold medially and submedially, white laterally. Second tergum with a narrow anterior band of linear gold scales followed by a broad band of linear black scales and a band of lanceolate yellowish-white scales; hind margin with a small medial spot and two

sub-lateral spots of linear black scales enclosed by larger sub-medial and lateral spots of ovste white scales. Third and fourth terga with broad anterior bands of yellowish-white to gold lanceolete scales; hind margin of third tergum with large mediel and subleteral spots of lanceolete black scales, and smell submedial end large lateral spots of ovate white scales; hind margin of fourth tergum with smell submedial spots of ovate white scales end e few gold scales laterally, the remainder being covered with lanceolate-ovate black scales. Fifth tergum with a short medial band of ovate gold scales anteriorly and e spot of lerger ovate-cuneate white scales posteriorly with e few bleck scales intermixed; spots of large lanceolate black scales present submedielly; leteral margins broadly covered with ovate-cuneete white scales. Sixth end seventh terga with small mediel, posterior spots of lanceolate-ovate black scales; remeinder covered with ovate-cuneate white sceles. Abdominal sterna covered with sparse, fine gold setee; leterel end posterior margins covered with sparse, ovate-cuneete white sceles, more numerous posteriorly.

Male Genitalie. Distel lobes of the gonocoxites about one and one-half times as long as wide with a fold et the base; outer margins broadly curved, inner mergins slightly curved; lobes separated medially by ebout one and one-half times the width of one lobe; apical setae yellow proximally, bleck distally (Plete VI, Fig. 8). Distal segments of the gonostyli oblong, ebout one and one-half times higher than the width at the base; distal margin broadly curved basally end slightly recurved to the apicel point, proximel margin broadly curved; apex with proximal and medial low, broad tubercles and a sharp distel projection (Plate IV, Fig. 13). Dorsal part of the apex

of the intromittent organ with e sharply projecting medial section and flattened leteral sections; medial and lateral proximal projections acute. Medial procass above the aedeagus small, with sherp dorsal and lateral angles. Ventro-leteral parts of the apex of the intromittent organ short, not extending beyond the medial process ebove the aedeagus, almost vertical epically (Plete II, Fig. 8).

Female. Similer to male. Setee on lower edge of front partielly gold; setae on lateral portions of fece gold. Infuscetion of wings more extensive; spot at the beses of cells R_3 and R_5 extending ecross cell R_1 and distally to a point even with the tip of the subcosta. Laterel margins of first tergum with only a few bleck setae present posteriorly. White scales less extensive on the sides of the posterior terga.

Variation. The post-alar tuft of pile varies from entirely black to entirely gold. The extent of the black scales on the femora varias slightly end there may be a few gold scales between the bleck and white scales. The relative number of gold and white scales on the abdomen is slightly varieble. The size of the spots on the wings is varieble.

Body Length.

Male--Range: 9.0-11.7 mm; $\bar{x}$: 10.5 mm; s.d.: 1.49 mm; n: 6.

Female--Range: 7.7-10.5 mm; $\bar{x}$: 9.0 mm; s.d.: 0.68 mm; n: 15.

Wing Length.

Male--Range: 10.0-12.8 mm; $\bar{x}$: 11.4 mm; s.d.: 1.29 mm; n: 6.

Famale--Renge: 9.4-11.8 mm; $\bar{x}$: 10.4 mm; s.d.: 0.75 mm; n: 15.

Distribution. A. aureosquamosus chaparrelus occurs in the cheparral area from the vicinity of Sen Francisco in California into the northern

part of Baja, California. It is allopatric to A. aureosquamosus aureosquamosus on the north.

Holotype. ♂, Sierra San Pedro Martir, 2 mi. W. Socorro, Baja California, Mexico, VI-4-1958 (J. Powell).

Allotype. ♀, Pauma Valley, San Diego Co., California, IV-13-1959 (E. I. Schlinger).

Paratypes. California: Los Angeles Co., ♀, Monrovia Canyon, VI-7-1931 (Chas. H. Martin); ♀, Tanbark Flat, VI-22-1950 (J. W. MacSwain); 2♀, Tanbark Flat, VI-21-1956 (R. M. Bohart; B. M. Bartosh); ♀, Westwood Hills, V-9-1940 (M. M. Barnes). Monterrey Co., ♂, Arroyo Seco Camp, V-11-1958 (R. M. Bohart). Riverside Co., ♂, Cranston Range Sta., nr. San Jacinto, V-31-1941 (E. C. Van Dyke); ♀, Elsinore, IV-21-1933 (A. C. Basinger); 2♀, Keen Camp, San Jacinto Mts., V-17-1939 (E. G. Linsley; E. S. Ross). San Bernadino Co., ♀, Redlands, 1913; ♀, Wildwood Canyon, VI-11-1958 (H. R. Moffitt); ♀, Yucaipa, VI-25-1952 (R. H. & L. D. Beamer, et al.). San Diego Co., ♀, nr. Buckman Sprs., V-7-1953 (F. X. Williams); ♀, Plum Canyon, Anza Desert St. Park, IV-4-1959 (E. I. Schlinger).

Other Material Examined. California: Los Angeles Co., ♂, ♀, Tanbark Flat, VI-19-1950 (J. C. Hall); ♂, IV-22-1939. Riverside Co., ♀, Gilman Hot Springs, V-30-1941 (E. C. Van Dyke). San Bernadino Co., ♂, Hills W. of Redlands, III-29-1923. Sonoma Co., ♂, (M. C. Van Duzee).

Types. The holotype and allotype are in the collection of the University of California. The paratypes are in the collections of the author, R. H. Painter, Jack C. Hall, Oregon State University, the University of California, the University of Kansas and the California Academy of Sciences.

Dates of Occurrence. March 29 (San Bernadino Co., California) to June 25 (San Bernadino Co., California).

Two specimens with a variant type of male genitalia have been studied from San Bernadino Co, and San Diego Co., California. The structures appear intermediate between those of aureosquamosus and chaparralus. The madial section of the dorsal part of the intromittent organ is bulbous and is separatad from the marginal flanges by a fold below. Tha medial proximal projection is obtusely pointed while the lateral proximal projections are bluntly produced. The ventro-lateral parts of the apex of the intermittent organ are large and project past the tip of the aedeagus in lateral view. Tha distal lobes of the gonocoxites are lika those of aureosquamosus, but shorter. The distal segments of the gonostyli are like those of chaparralus, but longer and narrower.

A. aureosquamosus chaparralus is practically identical externally to aureosquamosus aureosquamosus. Distribution data must be relied upon to separate the females of the two subspecies. The males of chaparralus, however, differ from those of aureosquamosus in having the apex of tha distal segments of the gonostyli with two low tuberclas and a sharp distal projection rather than having the apex narrow and truncate. Characters separating A. aureosquamosus from other closely related species are given under the nominate subspecies.

EXPLANATION OF MAP III

Upper Left.

Anthrax albofasciatus cascadensis Marston, n. ssp. distribution (horizontal lines).

Anthrax albofasciatus daphne (Osten Sacken), distribution (vertical lines).

Upper Right.

Anthrax aureosquamosus aureosquamosus Marston, n. ssp., distribution (vertical lines).

Anthrax aureosquamosus chaparralus Marston, n. ssp., distribution (horizontal lines).

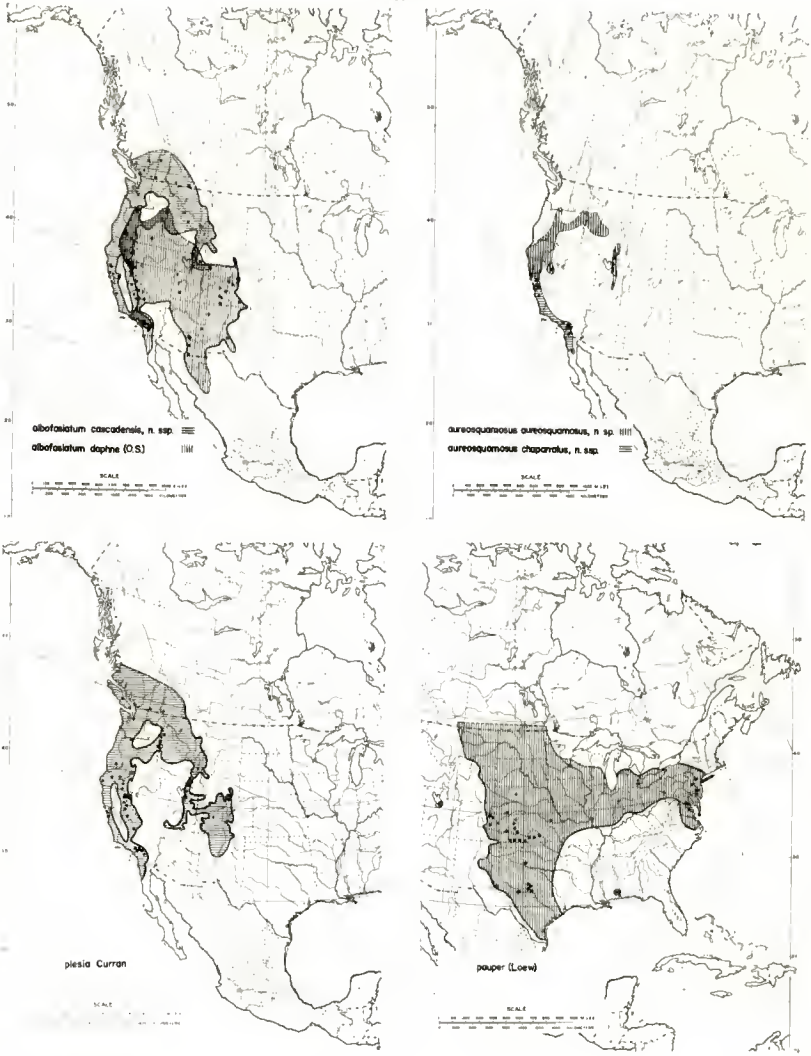
Lower Left.

Anthrax plesia Curran, distribution.

Lower Right.

Anthrax pauper (Loew), distribution.

MAP III


albofasiatum cascadense, n. ssp.
albofasiatum daphne (O.S.)
aureosquamosus aureosquamosus, n. sp.
aureosquamosus chaparalus, n. ssp.
plesia Curran
pauper (Loew)

Anthrax pauper (Loew)

Argyramoeba pauper Loew, 1869, p. 29; Osten Sacken, 1877, p. 243; Osten Secken, 1878, p. 90; Coquillett, 1894, p. 95; Kertesz, 1909, p. 66.

Spogostylum peuper (Loew), Aldrich, 1905, p. 223.

Anthrax pauper (Loew), Johnson, 1925, p. 108; Maughan, 1935, p. 33.

Spogostylum limatulus, var. pauper (Loew), Cole, Malloch & McAtee, 1924, p. 185.

Diagnosis. Sectoral crossvein absent; cell M_1 without a spot et the base; the spots at the bases of cells R_4 end $2M_2$ reduced to clouds or absent; cells 1A and 2A without a lerge mediel infuscated area (Plate V, Fig 13). Prosternal tuft of pile black, post-aler tuft white. Light scales on the femora gold, yellow or white; black scales covering from three-fourths of the enterior surfaces to all of the posterior femora. Distal lobes of the gonocoxites about twice es long as wide, slightly curved on the inner margins, moderately curved on the outer margins and separated medially by ebout one and one-half times the width of one lobe; apical setae black (Plate VI, Fig. 15). Distal segments of the gonostyli ovete, beaked at the epex; distal margin not greatly produced apically; beak in the same plane as the rest of the lobe (Plete IV, Fig. 15).

Male. Integument generally black, grey to blue-green pollinose; tibiae, genitalia and distal margins of apical abdominal segments red to yellow. Scales on lower front, face and occiput white to yellow; on upper front usually bleck although sometimes yellow medially. Setae bleck. Fringe of pile on posterior margins of occiput usually entirely black although there may be a few white hairs behind the vertex in some specimens.

Scales on the mesonotum usually mixed black, white and yellow or gold, although sometimes predominantly black or gold; linear, semi-erect scales on margins white or mixed gold and white. Scales on pleurae yellow, a few white scales sometimes present; on coxae white or mixed yellow and white. Prosternal tuft of pile black; pile on pleurae and anterior margin of mesonotum mixed black and white or black, yellow and white; post-alar tuft of pile white. Setae on pleurae black. Scutellum with white scales on the posterior margin and the lateral aspects of the anterior margin; disc usually covered with gold scales although there may be a medial patch of black scales.

Wings hyaline with brown or light brown maculation. Basal infuscation extending out to the bases of cells R, M and 2A, and out to the humeral crossvein in the costal cell; subcostal cell entirely pigmented. Maculation consisting of indistinct clouds at the bases of cells R_4 and $2M_2$ which may be absent, and aggregates of spots at the bases of cells R_3 and R_5, and extending from the base of cell R_1 across cell R and along the base of cell $1M_2$, to the base of cell Cu_1. Sectoral crossvein absent (Plate V, Fig. 13).

Fore and middle femora with black scales anteriorly and white or yellow scales posteriorly, a few light colored scales sometimes present basally on anterior margin. Scales on posterior femora entirely black, or black anteriorly and mixed black and yellow or black and white posteriorly. Fore and middle tibiae with black scales anteriorly and white scales posteriorly; scales on hind tibiae entirely black.

First abdominal tergum with white scales laterally and black or gold scales medially on posterior margin; lateral margins white pilose, with a

tuft of black hairs of variable size near posterior margin. Second tergum usually entirely covered with black scales except a medial transverse band of gold scales and two submedial and two sublateral spots of white scales on posterior margin; occasionally gold sceles may replace the black scales anteriorly as far back as the medial transvarse bend of gold scales or whita scales may extend over tha entire posterior margin. Third tergum with e crescent-shaped band of gold scales extending from posterior margin laterally to anterior margin medially; remainder of tergum usually covered with black scales with the exception of two submedial and two lateral spots of white scales on the posterior margin; occasionally the black scales may be largely replaced by gold scales. Fourth tergum usually with mixed black and gold or yellow scales laterally and anteriorly; posterior margin with a petch of black scales medially and with submedial and lateral spots of white scales, either the light or the dark scales may replece the other. Fifth, sixth and seventh terge with white scales laterally end gold or yellow scales medially, the gold or yellow scales most extensive on fifth tergum and reduced to a narrow line on seventh tergum. Venter usually sparsely covered with gold or yellow scales, occasionally with some black scales; a few white scales sometimes presant on posterior margins of posterior sterna and laterally on anterior sterna.

Mala Genitalia. Distal lobes of tha gonocoxites about one and ona-half times as long as wide, moderataly curved on the outar margins, slightly curved or straight on the inner margins and separated medially by about one and one-half times the width of one lobe; apical setae black and moderately

fine (Plate VI, Fig. 15). Distal segments of gonostyli ovate and with an apical beak; distal margin broadly curved, but not produced above beak; proximal margin moderately curved about two-thirds of way to apex; beak projecting vertically or up to 30 degrees proximally, not formed transversely to the segment although usually bent outward (Plate IV, Fig. 15). Dorsal part of apex of the intromittent organ reclining between 30 and 45 degrees, distinctly convex transversely and flat longitudinally; medial and lateral proximal projections acute; dorsal face with two short lobes which may be reduced to teeth. Medial process above aedeagus not projecting distally from plane of dorsal part, with two sharp teeth at the apex and usually with a pair of large acutely pointed teeth above the apex although these are rarely reduced or absent. Ventro-lateral parts of apex intromittent organ not produced apically (Plate II, Fig. 2).

Female. Similar to male. Infuscation of wings more extensive; the aggregate of spots at bases of cells R_3 and R_5 extending to vein R_1 and sometimes spreading along it proximally to the spot at base of cell and distally halfway to tip of subcosta. Cell 1A rarely with a slight medial infuscation. Body usually with more gold and less black scales; second tergum usually with the black scales mostly replaced by gold.

Body Length.

Male--Range: 4.6-7.9 mm; $\bar{x}$: 6.0 mm; s.d.: 0.98 mm; n: 13.

Female--Range: 4.5-8.4 mm; $\bar{x}$: 6.2 mm; s.d.: 1.16 mm; n: 16.

Wing Length.

Male--Range: 5.0-8.1 mm; $\bar{x}$: 6.6 mm; s.d.: 0.88 mm; n: 13.

Female--Range: 4.5-8.4 mm; $\bar{x}$: 6.4 mm; s.d.: 1.13 mm; n: 16.

Distribution. A. pauper inhabits the Great Plains and the northeastern section of the United States where it apparently is restricted to open sandy areas. Even though it appears to be closely related to albofasciatus, the fact that the two are sympatric over a part of their ranges and no intermediates have been recognized would indicate that they are separate species.

Two specimens from Washington Co., Alabama indicate that this species may range east from Texas along the Gulf Coast. No specimens were noted in an extensive collection from Florida, however. A male from Salt Lake Co., Utah indicates that the species may also range across southern Wyoming into the Great Basin. All of the specimens of A. pauper collected by the author have been found in open sandy areas. One female was observed ovipositing in holes and crevices in a sandy area near Manhattan, Kansas.

New Material Examined. Alabama: Washington Co., 2♀, Leroy, VI-11-1917 (J. Bequaert).

Colorado: Arapahoe Co., ♀, Peoria, VIII-13-1946 (R. H. Painter). Denver Co., ♂, Denver, VI-5-1899 (C. W. Johnson). El Paso Co., 3♀, VIII-19-1959 (N. Marston). Lincoln Co., 2♀, Boyero, VIII-16-1957 (N. Marston). Prowers Co., 2♀, V-29-1959 (N. Marston); 2♀, VIII-27-1959 (N. Marston); ♂, 2♀, Lamar, VI-4-11-1919. Yuma Co., ♂, ♀, VIII-8-1959 (N. Marston); ♀, Yuma, VII-20-1953 (R. R. Driesbach). ♂, "Col.".

Illinois: ♀, "Ill." (Osten Sacken).

Indiana: Tippecanoe Co., ♂, Lafayette, VII-23 (J. M. Aldrich).

Kansas: Clark Co., 2♂ (F. H. Snow); ♂, ♀, May, June (F. H. Snow); 3♂, VII-24-1933 (R. H. Painter). Finney Co., ♂, ♀, VII-22-1933 (R. H. Painter). Kiowa Co., 2♂, VII-17-1958 (R. H. Painter). Logan Co., ♀, VI-8-1950

(R. H. Painter). Meade Co., ♂, VII-23-1933 (R. H. Painter). Morton Co., ♂, 2♀, June, 1902 (F. H. Snow). Pratt Co., ♂, VII-19-1958 (R. H. Painter). Pottewatomie Co., ♂, ♀, VI-11-1939 (R. H. Painter); 2♂, 2♀, VI-29, VII-6-1958 (N. Marston). Reno Co., ♀, IX-22 (R. H. Painter); ♂, VII-19-1961 (R. H. Painter); ♀, Medora, VII-3-1938 (R. H. Painter); ♀, Medora, V-28-1959 (N. Marston). Scott Co., 3♂, VII-20-1933 (R. H. Painter); ♀, Scott Co. State Park, VI-14-1939 (D. A. Wilbur). Seward Co., ♀, VIII-18-1911 (F. X. Williams); ♂, 2♀, VI-29 (E. M. and R. H. Painter). Sumner Co., ♂, ♀, Wellington, IX-21-1935 (C. Sabrosky). Thomas Co., ♂, VIII-25-1940 (R. H. Peinter). ♂, "N. Ks.".

Maryland: Calvert Co., ♀, Chesapeake Beach, IX-8-1920 (J. M. Aldrich). Prince Georges Co., ♂, Beltsville, VI-2-1920 (C. T. Greene); 3♂, Beltsville, VI-9 (Nathan Banks); ♂, ♀, Beltsville, VII-6 (F. R. Cole); ♂, Bladensburg, VI-23-1916 (R. C. Shannon).

Massachusetts: Plymouth Co., ♂, Manomet.

Michigan: Wayne Co., ♀, Detroit, VII-7-1907 (A. W. Andrews).

Nebraska: Thomas Co., ♀, Halsey, VIII-22-1912 (J. T. Zimmer).

New Jersey: Burlington Co., ♂, Pemberton, VII-8-1907 (A. J. Weidt); ♂, Riverton, August. Camden Co., ♀, Camden, VI-30-1896; ♀, Clementon, VIII-9-1891 (C. W. Johnson). Gloucester Co., 2♂, 3♀, Westville, VII-12-VIII-23-1892 (C. W. Johnson); 2♂, ♀, Westville, VIII-21, 28-1892 (J. M. Aldrich); ♀, VIII-14-1892. Warren Co., ♀, Delaware Water Gap, VII-10 (C. W. Johnson); ♂, Cramer Hill, VI-10-1895; ♀, Lucastown, VI-27-1910. 3♀, "N. J.", VIII-16-1891 (D. W. Coquillett); 2♀, "N. J.", (D. W. Coquillett).

New Mexico: Lea Co., ♀, Jal, V-3-1961 (J. Bequaert).

New York: Nassau Co., ♂, Bayville, IX-6 (N. Banks). Richmond Co., 2♀, Staten Id., VII-2-1916 (J. Bequaert). Suffolk Co., ♂, Cold Spring Harbor, Long Island, VII-15-1931 (C. H. Curran); ♀, East Hempton, VIII-9-1933 (E. L. Ball); ♂, ♀, Gardiner's Island, VIII-17-23-1918; ♀, Orient, VII-12-18-1920 (J. Bequaert).

Oklahoma: Harmon Co., ♂, 7 mi. SW of Hollis, VI-20-1926 (T. H. Hubbell).

Pennsylvania: ♂, "Lehigh Gap", VI-30-1901 (C. W. Johnson).

Texas: Brown Co., ♂, 2♀, Brownwood, V-24-VIII-23-1921 (R. H. Painter). Comancha Co., 2♂, Hasse, IX-9-1958 (R. H. & E. M. Painter). Eastlend Co., ♂, Ranger, VII-18-1931 (R. H. Painter). Mills Co., ♂, 2♀, VII-20-1931 (R. H. Painter). Tom Green Co., ♂, ♀, San Angelo, VIII-29-1924 (R. H. Painter).

Utah: Salt Leke Co., ♂, Saltair, VII-12-1922 (E. P. Van Duzee).

Virginia: Northampton Co., 3♂, Cepe Charles, VIII-28-1931 (T. F. Winburn). Westmoreland Co., 2♀, Colonial Beech, VIII-1916 (F. R. Cole).

Wisconsin: Milwaukee Co., ♂, ♀, Milwaukee, VII-4-1901 (S. Graenicher).

Canada: Ontario, ♂, Jordan, VII-27-1919 (W. A. Ross).

Types. A. pauper was described by Loew (1861) from e male collected in Illinois. The type, now located in the Museum of Comparetive Zoology, is badly rubbed end molded.

A. pauper apparently is most closely releted to A. albofesciatus albofasciatus and A. plesia. It differs from albofasciatus in having the spot at the base of cell R_4 and the medial infuscated aree in cells 1A and 2A reduced or absent end in not having the distal margins of the distal segments of tha gonostyli produced ebove the apical beak. A. pauper differs from

plesia in having the prosternal tuft of pile black instead of white and in having the apices of the distal lobes of the gonocoxites of the male genitalia with black instead of yellow setae.

Dates of Occurrence. May 3 (Lea Co., New Mexico) to September 22 (Reno Co., Kansas).

Anthrax plesia Curran

?Argyramoeba limatulus, Osten Sacken, 1877, pp. 242, 243-244 (nec. Say, 1829) (partim).

Spogostylum pauper, Cole & Lovett, 1921, p. 244 (nec. Loew, 1869; misident.).

Anthrax plesia Curran, 1927, p. 84, Strickland, 1938, p.195.

Diagnosis. Wings with sectoral crossvein absent; cells R_4 and M_1 without spots at the bases; costal cell hyaline beyond the humeral crossvein (Plate V, Fig. 14). Fringe of pile on posterior margin of occiput black with light tips in the male; female with a tuft of white hairs behind the vertex; post-alar tuft of pile usually black; prosternal pile usually entirely white. Light colored scales on femora yellow in the male, white in the female. Distal lobes of the gonocoxites short, slightly curved on the inner margins, broadly curved on the outer margins and separated by less than the width of one lobe; apices covered with fine yellow setae (Plate VI, Fig. 16). Distal segments of gonostyli ovate with a short apical beak which is usually set transversely to the plane of the remainder of the lobe (Plate IV, Fig. 16).

Male. Integument generally black, blue-grey pollinose; genitalia and the apices of the abdominal sterna and apical terga orange; tibiae red. Scales on the face, lower front and occiput white, a few yellow scales

sometimes present; upper front with black scales. Setae on head black. Fringe of pile on posterior margin of occiput mostly black with light tips, a few white hairs sometimes present; a distinct tuft of white hairs rarely present behind the vertex.

Anterior portion of mesonotum with three longitudinal bands of linear or lanceolete black scales usually separated by bands of white scales; posterior half usually with a medial band and two sublateral spots of white scales seperated by black scales; the white scales often replaced by yellow scales and sometimes by black scales. Margins of mesonotum with long, curly, semi-recumbent white scales. Pleurae and coxae with sparse, curly, semi-recumbent linear white scales. Prosternal pile usually entirely white, sometimes with a few black hairs present; pleurae and anterior margin of mesonotum with mixed black and white pile; post-aler tuft of pile usually entirely black; white or mixed black and white in specimens from southern California. Fine setae on sternopleurae, mesopleurae and pteropleurae mostly black, a few gold setae sometimes present on the upper half of the sternopleurae. Macrochaetae on thorax black. Scutellum with curly, recumbent, linear and lanceolate white scales on the posterior margin, the lateral aspects of the anterior margin and the median line; disc covered with linear and lanceolate black scales and a line of yellow scales between the white and black.

Wings mostly hyaline; basal infuscation extending out to the humeral crossvein and the bases of cells R, M and 1A; subcostal cell entirely infuscated. Isolated spots present at the bases of cells R_3 and R_5, Cu_1, and in cell R below the base of R_1; sometimes an indistinct cloud at the base of cell $2M_2$. Sectoral crossvein absent (Plete V, Fig. 14).

Anterior femora with black scales anteriorly, bare posteriorly; yellow scales present at base and elong margins of black; black scales on middle femora covering from three-fourths to all of the anterior surfaces, remainder covered with yellow sceles; scales on hind femora varying from entirely black to yellow on the posterior surfaces and mixed black end yellow on the anterior surfaces. Scales on fore and middle tibiae sparse, black anteriorly, yellow posteriorly; scales on hind tibiae black.

First abdominal tergum with white pile laterally, often with a few bleck hairs posteriorly; scales on posterior edge white laterally, yellow medially. Second tergum with a broad band of linear black scales anteriorly followed by a band of lanceolate yellow scales sometimes interrupted medially with black scales; posterior mergin with four patches of lanceolete or cuneate white scales separated by three patches of black scales; a narrow band of yellow scales sometimes present on the anterior margin. Third tergum with the distribution of scales similar, but with the anterior black band nerrower. Fourth tergum completely covered with black scales except e small, crescent-shaped medial band of yellow scales and a few white scales on the posterior edge. Fifth tergum with e nerrow black band of scales anteriorly and a small medial patch of yellow scales on posterior margin surrounded by black scales; remainder completely covered with shining, cuneate white scales; sixth and seventh terga entirely covered with white scales except small medial patches of bleck scales on posterior margins. On many specimens the yellow scales may be partially or completely rubbed off making the basal tergites appear to be predominantly covered with black sceles.

Venter of abdomen with sparse, curly, linear or lanceolate white sceles; a few yellow scales sometimes present on the last two segments.

Male Genitalie. Distal lobes of the gonocoxites short and broad, slightly curved on inner margins, widely curved on outer margins and separated medially by less than the width of one lobe; setae on the lobes fine and entirely yellow (Plate VI, Fig. 16). Distal segments of gonostyli ovate, slightly longer than wide and with a distinct apical beak which is usually formed obliquely to the basal portion; beak sometimes in same plane in specimens from southern California. Dorsal part of the apex of the intromittent orgen flat below and convex dorsally, sometimes produced bulbously in specimens from southern California; medial proximal projection obtusely pointed, lateral proximal projections acutely rounded; apical fece with a short tooth on each side. Medial process above aedeagus with a bilobed process apically. Ventro-lateral parts of the apex of the intromittent organ evenly rounded apically and projecting past gonopore (Plate II, Fig. 1).

Female. Similar to male. Scales on anterior portion of occiput often yellowish; occipital fringe of pile lighter, with a distinct white patch behind the vertex. Spots on the wings slightly larger; spot surrounding the beses of cells R_3 and R_5 extending across cell R_1; spot et base of cell Cu_1 narrowly connected with one in cell R below base of R_1. Yellow scales on legs largely replaced by white scales except along mergins of the black scales in some specimens; bare areas on the posterior surfaces of the fore and middle femora in the males covered with white scales. Venter of abdomen with a few yellow scales medially on segments four through seven.

Body Length.

Male--Range: 3.9-8.1 mm; $\bar{x}$: 6.3 mm; s.d.: 1.12 mm; n: 14.

Female--Range: 6.3-7.7 mm; $\bar{x}$: 6.9 mm; s.d.: 0.36 mm; n: 14.

Wing Length.

Male--Range: 4.5-8.1; $\bar{x}$: 6.9 mm; s.d.: 0.94 mm; n: 14.

Female--Range: 6.6-7.9 mm; $\bar{x}$: 7.1 mm; s.d.: 0.38 mm; n: 14.

Distribution. A. plesia inhabits mountain forests from southern California north to British Columbia and south in the Rocky Mountains into Colorado.

New Material Examined. California: Alpine Co., 2♂, 4♀, Hope Valley, VII-9-18-1948 (W. K. Bauman, A. Bartel, P. D. Hurd, L. W. Quate, N. D. Waters). El Dorado Co., ♀, Kyburz, VII-10-1955 (H. R. Moffitt); 2♀, Strawberry Valley, VIII-15-1912 (E. C. Van Dyke). Humboldt Co., ♀, Honeydew, VI-20-1950 (J. N. Simons). Kern Co., ♀, Mil Potrero, VII-8-1959 (R. M. Bohart). Lassen Co., ♂, Blue Lake, VII-19-20-1947 (R. F. Leigh); ♂, Bridge Creek Camp, VII-9-1949 (J. E. Gillaspy); ♀, Summit Camp, VI-28-1949 (P. D. Hurd). Los Angeles Co., 2♂, 4♀, Monrovia Canyon, VII-6 to VIII-3-1930 (C. H. Martin, R. H. Painter); 3♀, Monrovia Canyon, VI-25 to VII-4-1931 (C. H. Martin); ♀, Tanbark Flat, VII-14-1956 (J. C. Hall); ♀, July (D. W. Coquillett). Mariposa Co., ♂, ♀, Yosemite, VI-11-13-1931. Nevada Co., ♂, ♀, Boca, VI-28-1954 (R. C. Blaylock, G. Schaefers); ♀, Boca, VI-11-1959 (R. M. Bohart); ♀, Truckee, VI-24-1954 (R. H. Goodwin). Plumas Co., ♀, Lake Almanor, VII-8-1949 (J. E. Gillaspy). Riverside Co., ♀, San Jacinto Mts., VII-30; ♂, Pinon Flat, San Jacinto Mts., V-18-1939 (E. X. Ross). San Bernadino Co., ♀, Big Bear Lake, VIII-24-1957 (E. I. Schlinger);

2♀, Cajon Jct., VI-24-VII-4-1958 (J. C. Hall); ♂, ♀, Mt. Home Cn., VI-8 to VII-1-1922; ♀, Phelan, V-22-1957 (E. I. Schlinger). Santa Cruz Co., 2♀, Soquel, VI-22-24-1950 (M. T. James). Siskyou Co., ♀, Ponderosa, VI-20-1954 (A. A. Grigarick). Trinity Co., ♂, Big Flat Coffee Creek, VI-21-1934 (T. H. H. Aitken). Tulare Co., ♀, Giant Forest, VII-28-1929 (R. H. Beamer); ♀, Sequoia Nat'l Park, VII-26-1930 (T. F. Winburn, R. H. Painter). Tuolumne Co., ♂, Pinecrest, VII-4-1947 (P. H. Arnaud, Jr.). 2♀, "Glen Martin", VIII-16-1920.

Colorado: Larimer Co., ♀, Little Beaver Creek, VII-23-1961 (N. Marston). Gunnison Co., ♂, Somerset, VII-4-1959 (R. H. Painter).

Idaho: Lake Co., ♂, ♀, Beak Lake, VII-9-1920. Latah Co., ♂, Boville, VII-17-1952 (M. T. James & Harry Davies). 2♂, L. Waha, VIII-8-1951 (M. T. James).

Nevada: Ormsby Co., ♂, Carson City, VI-26-1929 (E. P. Van Duzee); 2♀, Verdi, VI-25-1954 (G. Schaefers).

Oregon: Baker Co., ♀, Melhorn's Mill, Near Halfway, VII-4-1922 (W. J. Chamberlin); ♀, Wallow Mt's., VII-6-1922 (E. C. Van Dyke). Hood River Co., ♂, VI-2-1917 (F. R. Cole); ♂, Hood River, VI-8-1917 (F. R. Cole) 2♂, ♀, Hood River, VI-25-1917 (F. R. Cole). Jackson Co., ♀, Prospect, VII-20-1924 (C. L. Ferguson). Wallowa Co., ♂, Lake Wallowa State Park, VIII-18-1954 (M. T. H.&B. James).

Utah: Cache Co., ♂, Logan Canyon, VI-25-1949 (W. J. Hanson). Salt Lake Co., ♂, Saltair, VII-12-1922 (E. P. Van Duzee). Weber Co., ♀, Ogden, VII-25-1920.

Washington: Aslton Co., ♀, Field Springs State Park, VII-5-1957. King Co., ♀, Seattle, VII-4-1891 (C. W. Johnson). Whitman Co., ♀, Pullman, VIII-17-1955 (V. F. Newhouse). ♀, "Rattlesnake Grade", VII-18-1950 (R. B. Spurrier); ♂, "Virden", IX-4-1933 (Dorothy Martin); ♀, "West Wash." (H. K. Morrison).

Wyoming: Teton Co., ♀, Jackson, VII-13-20-1920.

CANADA: British Columbia, ♀, Campbell R., VIII-26-1950 (T. K. Bourns); ♀, Courtenay, VII-15-1935; ♀, Miracle Beach, nr. Oyster River, VI-11-1955 (J. R. McGillis); ♂, ♀, Orofino Mt., nr. Oliver, VI-15-1958 (H. & A. Howden); ♀, Robson, VII-16-1947 (H. R. Foxlee); ♀, Victoria, VI-24-1928 (W. Downes).

Types. A. plesia was described by Curran (1928) from a male and female collected at Lillooet, British Columbia. The type is in the Canadian National Collection at Ottawa, Ontario (No. 2415).

A. plesia is most closely related to pauper. It differs in having the prosternal pile white instead of black, and in having the post-alar tuft of pile black instead of white in all specimens except those from southern California. A. plesia also differs in having the setae on the distal lobes of the gonocoxites yellow instead of black and in having the beak of the distal segments of the gonostyli set transversely to the plane of the segment in all specimens except those from southern California. A. plesia may also be confused with albofasciatus daphne. Most specimens of daphne may be distinguished by the presence of clouds at the bases of cells R_4 and M_1 but a few males lack this character. In this case the males of daphne differ from plesia in having a distinct tuft of white hairs on the posterior margin of the occiput behind the vertex and in having the

distal segments of the gonostyli quadrangular basally with a styliform apex instead of ovate basally with a beaked apex.

Dates of Occurrence. May 18 (Riverside Co., California) to September 4 ("Virden", Washington).

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APPENDIX

EXPLANATION OF PLATE I

Fig. 1. Anthrax limatulus limatulus Say, lateral view of male genitalia.

Fig. 2. Anthrax limatulus fur (Osten Sacken), lateral view of male genitalia.

Fig. 3. Anthrax limatulus artemesia Marston, n. ssp., lateral view of male genitalia.

Fig. 4. Anthrax limatulus columbiensis Marston, n. ssp., lateral view of male genitalia.

Fig. 5. Anthrax limatulus vallicola Marston, n. ssp., lateral view of male genitalia.

Fig. 6. Anthrax limatulus larrea Marston, n. ssp., lateral view of male genitalia.

Fig. 7. Anthrax varicolor vierecki (Cresson), lateral view of male genitalia.

Fig. 8. Anthrax varicolor varicolor (Bigot), lateral view of male genitalia.

ABBREVIATIONS USED IN PLATE I

Fig. 1.

aae - Apex of aedeagus

bae - Base of aedeagus

bap - Basal apodeme of aedeagus

dai - Dorsal part of apex of intromittent organ

dgc - Distal lobe of gonocoxites

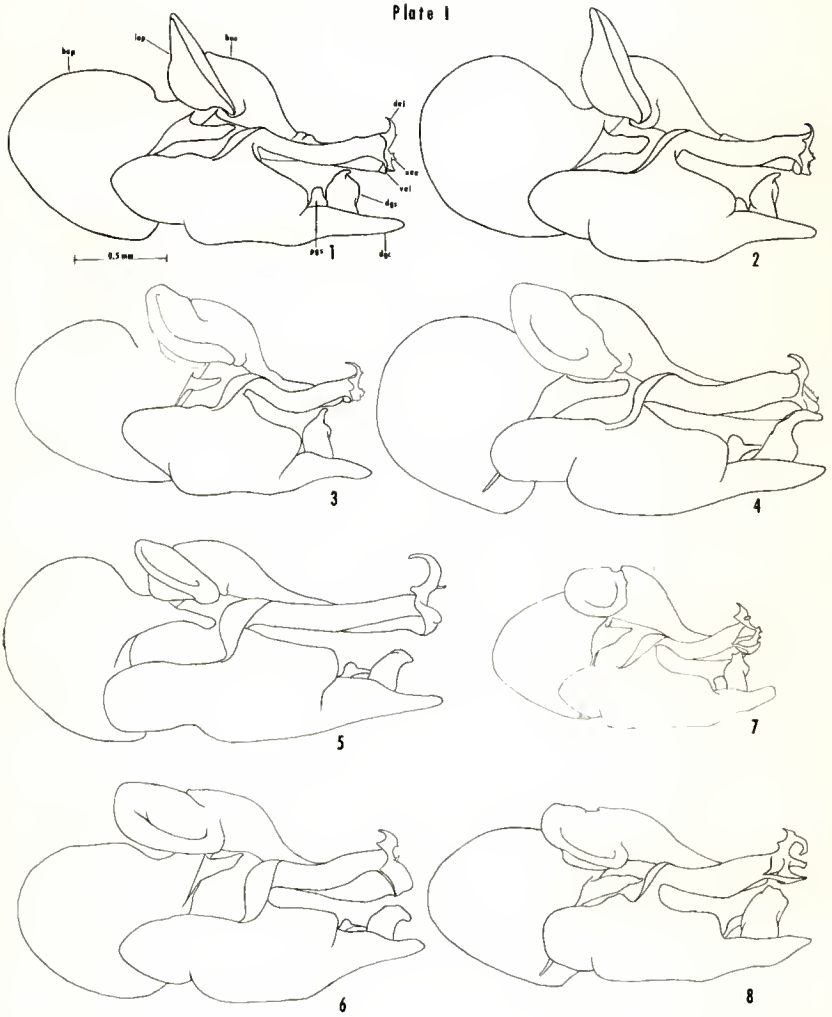
dgs - Distal segment of gonostylus

lap - Lateral apodeme of aedeagus

pgs - Proximal segment of gonostylus

vai - Ventro-lateral part of apex of intromittent organ

Plate I



EXPLANATION OF PLATE II

Fig. 1. Anthrax plasia Curran, lateral view of male genitalia.

Fig. 2. Anthrax pauper (Loew), lateral view of male genitalia.

Fig. 3. Anthrax albofasciatus albofasciatus Macquart, lateral view of male genitalia.

Fig. 4. Anthrax albofasciatus picea Marston, n. ssp., lateral view of male genitalia.

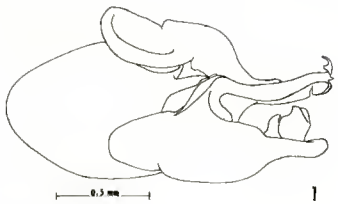
Fig. 5. Anthrax albofasciatus cascadensis Marston, n. ssp., lateral view of male genitalia.

Fig. 6. Anthrax albofasciatus daphne (Osten Sacken), lateral view of male genitalia.

Fig. 7. Anthrax aureosquamosus aureosquamosus Marston, n. sp., lateral view of male genitalia.

Fig. 8. Anthrax aureosquamosus chaparralus Marston, n. ssp., lateral view of male genitalia.

Plate II



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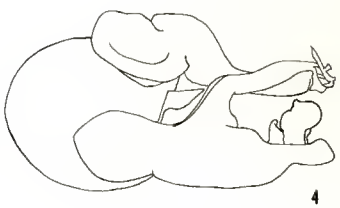

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EXPLANATION OF PLATE III

Fig. 1. Anthrax nidicola Cole, lateral view of male genitalia.

Fig. 2. Anthrax limatulus limatulus Say, dorsal view of right antenna.

Fig. 3. Anthrax limatulus fur (Osten Sacken), dorsal view of right antenna.

Fig. 4. Anthrax limatulus artemesia Marston, n. ssp., dorsal view of right antenna.

Fig. 5. Anthrax limatulus vallicola Marston, n. ssp., dorsal view of right antenna.

Fig. 6. Anthrax limatulus larrea Marston, n. ssp., dorsal view of right antenna.

Fig. 7. Anthrax limatulus columbiensis Marston, n. ssp., dorsal view of right antenna.

Fig. 8. Anthrax pauper (Loew), dorsal view of right antenna.

Fig. 9. Anthrax plesia Curran, dorsal view of right antenna.

Fig. 10. Anthrax nidicola Cole, dorsal view of right antenna.

Fig. 11. Anthrax varicolor varicolor (Bigot), dorsal view of right antenna.

Fig. 12. Anthrax varicolor vierecki (Cresson), dorsal view of right antenna.

Fig. 13. Anthrax albofasciatus albofasciatus Macquart, dorsal view of right antenna.

Fig. 14. Anthrax albofasciatus daphne (Osten Sacken), dorsal view of right antenna.

Fig. 15. Anthrax albofasciatus cascadensis Marston, n. ssp., dorsal view of right antenna.

Fig. 16. Anthrax albofasciatus picea Marston, n. ssp., dorsal view of right antenna.

Fig. 17. Anthrax aureosquamosus aureosquamosus Marston, n. sp., dorsal view of right antenna.

Fig. 18. Anthrax aureosquamosus chaparralus Marston, n. ssp., dorsal view of right antenna.

EXPLANATION OF PLATE III (concl.)

Fig. 19. *Anthrax limatulus fur* (Osten Sacken), lateral view of third instar larva.

a. Sagittal view of hypopharyngeal skeleton and mouth parts.

b. Dorsal view of hypopharyngeal skeleton and mouth parts.

Fig. 20. *Anthrax limatulus fur* (Osten Sacken), lateral view of first instar larva.

a. Lateral view of hypopharyngeal skeleton and mouth parts.

Fig. 21. *Anthrax limatulus limatulus* Say, lateral view of pupa.

ABBREVIATIONS USED IN PLATE III

Figs. 19, a, b.

amh - apical sclerite of mouth hook
ant - antenna
bmh - basal sclerite of mouth hook
csp - caudal spiracle
dhp - dorsal hypopharyngeal plate
lab - labrum
lhp - lateral hypopharyngeal plate
max - maxilla
tsp - thoracic spiracle

Figs. 20, a.

amh - apical sclerite of mouth hook
aps - abdominal pseudopod
bmh - basal sclerite of mouth hook
cds - caudal seta
hps - hypopharyngeal skeleton
max - maxilla
ths - thoracic seta

Fig. 21.

aft - anterior facial tubercle
atb - anal tubercle
ftb - frontal tubercle
pft - posterior facial tubercle

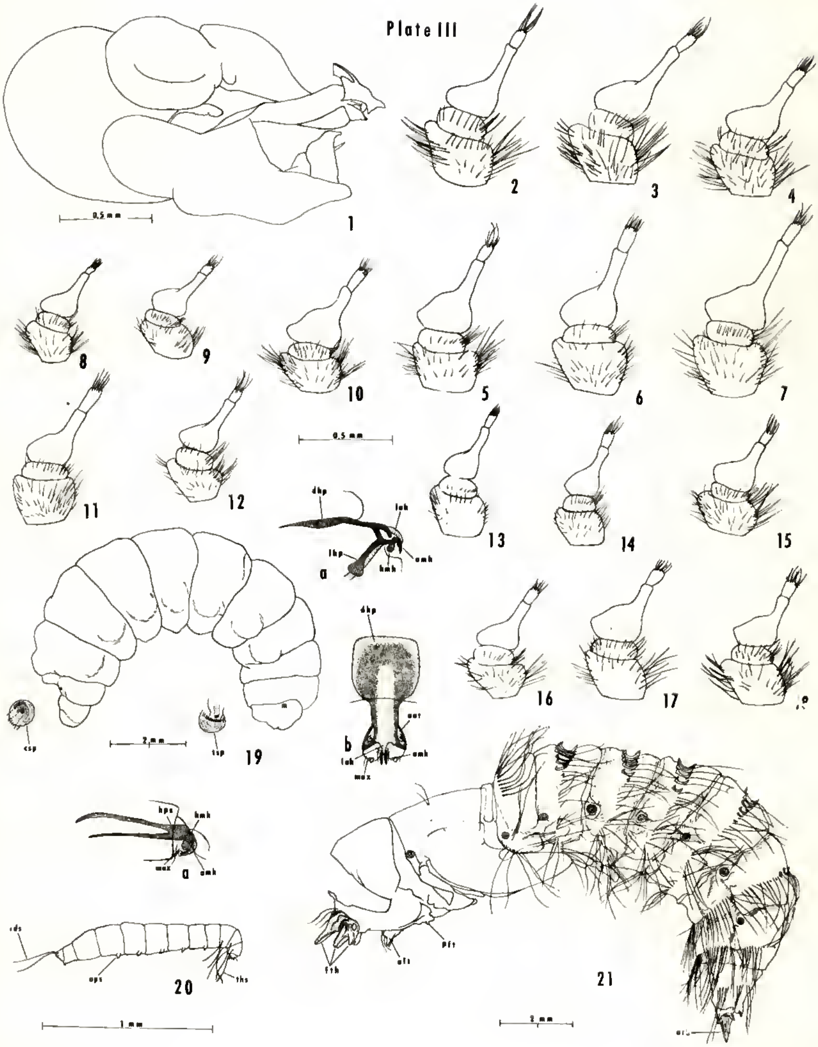
Plate III
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16
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2 mm
tsp
19
hps
hmh
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a
amh
rds
aps
20
ths
1 mm
fth
afl
pfl
21
2 mm

EXPLANATION OF PLATE IV

Fig. 1. Anthrax limatulus limatulus Say, ventro-lateral view of distal segment of right gonostylus.

Fig. 2. Anthrax limatulus fur (Osten Sacken), ventro-lateral view of distal segment of right gonostylus.

Fig. 3. Anthrax limatulus artemesia Marston, n. ssp., ventro-lateral view of distal segment of right gonostylus.

Fig. 4. Anthrax limatulus larrea Marston, n. ssp., ventro-lateral view of distal segment of right gonostylus.

Fig. 5. Anthrax limatulus vallicola Marston, n. ssp., ventro-lateral view of distal segment of right gonostylus.

Fig. 6. Anthrax nidicola Cole, ventro-lateral view of distal segment of right gonostylus.

Fig. 7. Anthrax varicolor varicolor (Bigot), ventro-lateral view of distal sagment of right gonostylus.

Fig. 8. Anthrax varicolor vierecki (Cresson), ventro-lateral view of distal segmant of right gonostylus.

Fig. 9. Anthrax albofasciatus albofasciatus Macquart, ventro-lateral view of distal segment of right gonostylus.

Fig. 10. Anthrax albofasciatus picea Marston, n. ssp., ventro-lataral view of distal segment of right gonostylus.

Fig. 11. Anthrax albofasciatus cascadensis Marston, n. ssp., ventro-lateral view of distal segment of right gonostylus.

Fig. 12. Anthrax albofasciatus daphne (Osten Sacken), ventro-lateral view of distal segmant of right gonostylus.

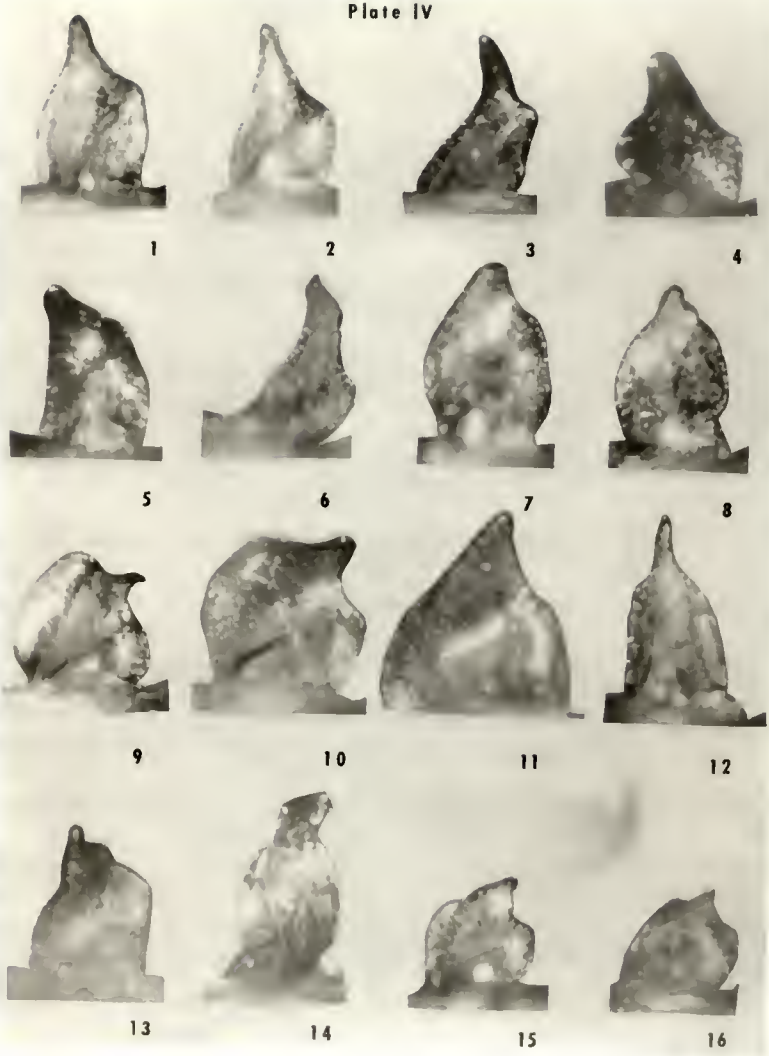
Fig. 13. Anthrax aureosquamosus chaparralus Marston, n. ssp., ventro-lateral view of distal sagment of right gonostylus.

Fig. 14. Anthrax aureosquamosus aureosquamosus Marston, n. sp., vantro-lateral view of distal segment of right gonostylus.

Fig. 15. Anthrax pauper (Loew), ventro-lateral view of distal sagment of gonostylus.

Fig. 16. Anthrax plesia Curran, ventro-lateral viaw of distal segment of gonostylus.

Plate IV



EXPLANATION OF PLATE V

Fig. 1. Anthrax limatulus limatulus Say, wing.

Fig. 2. Anthrax limatulus fur (Osten Sacken), wing.

Fig. 3. Anthrax limatulus artemesia Marston, n. ssp., wing.*

Fig. 4. Anthrax limatulus larrea Marston, n. ssp., wing.

Fig. 5. Anthrax varicolor varicolor (Bigot), wing.

Fig. 6. Anthrax varicolor vierecki (Cresson), wing.

Fig. 7. Anthrax nidicola Cole, wing.

Fig. 8. Anthrax aureosquamosus aureosquamosus Marston, n. sp., wing.**

Fig. 9. Anthrax albofasciatus albofescietus Macquart, wing.

Fig. 10. Anthrax albofasciatus picea Marston, n. ssp.

Fig. 11. Anthrax albofasciatus cascadensis Marston, n. ssp., wing.

Fig. 12. Anthrax albofasciatus daphne (Osten Sacken), wing.

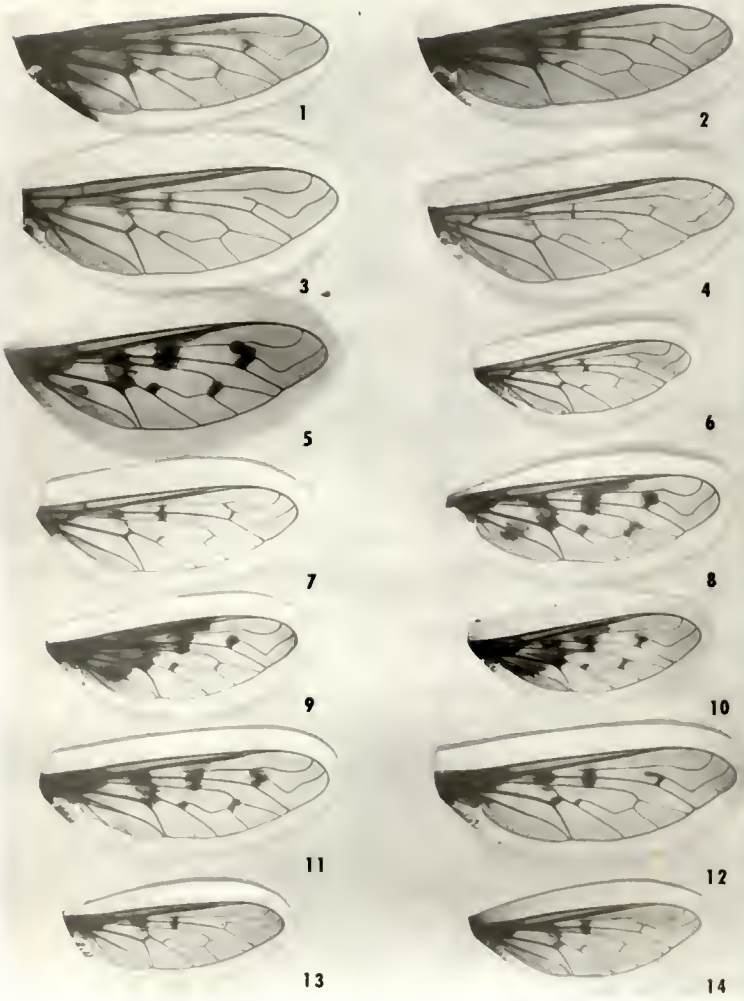
Fig. 13. Anthrax pauper (Loew), wing.

Fig. 14. Anthrax plesia Curran, wing

* The wings of Anthrax limatulus vallicola Marston and Anthrax limatulus columbiensis Marston, n. sspp. are similer in form to the wing of Anthrax limatulus artemesia.

** The wing of Anthrax aureosquamosus chaparralus Marston, n. ssp., is similar in form to the wing of Anthrax aureosquamosus aureosquamosus.

Plate V



EXPLANATION OF PLATE VI

Fig. 1. Anthrax limatulus limatulus Say, vantral view of distal lobes of gonocoxites.

Fig. 2. Anthrax limatulus fur (Osten Sacken), ventral view of distal lobes of gonocoxites.

Fig. 3. Anthrax limatulus artemesia Marston, n. ssp., ventral view of distal lobes of gonocoxites.

Fig. 4. Anthrax limatulus larrea Marston, n. ssp., ventral view of distal lobas of gonocoxites.

Fig. 5. Anthrax limatulus vallicola Marston, n. ssp., ventral view of distal lobas of gonocoxites.

Fig. 6. Anthrax nidicola Cola, ventral view of distal lobes of gonocoxitas.

Fig. 7. Anthrax auraosquamosus aureosquamosus Marston, n. sp., ventral viaw of distal lobes of gonocoxitas.

Fig. 8. Anthrax auraosquamosus chaparralus Marston, n. ssp., ventral view of distal lobes of gonocoxitas.

Fig. 9. Anthrax albofasciatus albofasciatus Macquart, ventral view of distal lobes of gonocoxites.

Fig. 10. Anthrax albofasciatus picea Marston, n. ssp., ventral view of distal lobes of gonocoxitas.

Fig. 11. Anthrax albofasciatus cascadensis Marston, n. ssp., ventral view of distal lobas of gonocoxites.

Fig. 12. Anthrax albofasciatus daphne (Osten Sacken), vantral view of distal lobes of gonocoxitas.

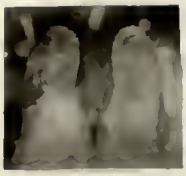
Fig. 13. Anthrax varicolor varicolor (Bigot), ventral view of distal lobas of gonocoxites.

Fig. 14. Anthrax varicolor vierecki (Cresson), vantral viaw of distal lobes of gonocoxites.

Fig. 15. Anthrax pauper (Loew), vantral view of distal lobas of gonocoxitas.

Fig. 16. Anthrax plesia Curran, vantral view of distal lobes of gonocoxitas.

Plate VI



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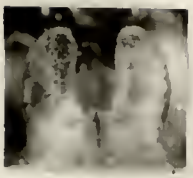

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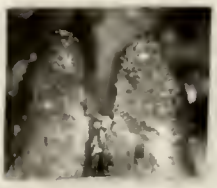

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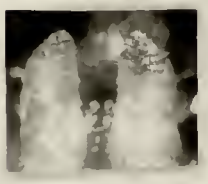

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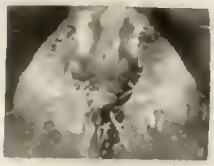

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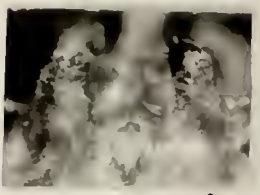

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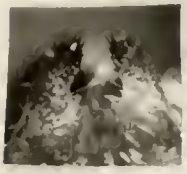

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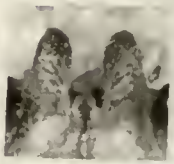

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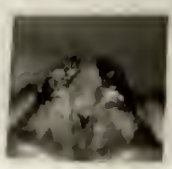

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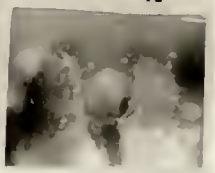

16

A MONOGRAPH OF THE NEARCTIC SPECIES OF THE ALBOFASCIATUS GROUP OF THE GENUS ANTHRAX SCOPOLI (DIPTERA:BOMBYLIIDAE)

by

NORMAN LEE MARSTON

B. S., Colorado State University, 1958

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Entomology

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Manhattan, Kansas

1962

The purposes of this study were (1) to clarify the relationships of the known species of the albofasciatus group of the genus Anthrax (Diptera: Bombyliidae) in North America, (2) to describe any previously unrecognized taxa, (3) to compila all of the available information on the biologies of the species and (4) to make a datailed study of the biology of Anthrax limatulus fur (Osten Sacken).

Specimens were borrowed from most of the major collections in the United States and Canada. Comparative studies of tha diagnostic characters were made in order to segregate the specimens into tha various taxa. Particular emphasis was givan to the externally visible characters of tha male genitalia since these structures were found to ba very characteristic for each taxon.

A nomenclatorial history of the generic name Anthrax was reviewed and a partial synonomy of the genus was compiled. Complete descriptions were made for the genus and tha albofasciatus group. A key was constructed to separata the Nearctic species and subspecies of this group.

Seventeen taxa of the albofasciatus group were found to occur in North America. Nine of these had been described previously as distinct species, Anthrax limatulus Say, A. albofasciatus Macquart, A. pauper (Loew), A. fur (Osten Sacken), A. daphne (Osten Sacken), A. varicolor (Bigot), A. vierecki (Cresson), A. plasia Curran and A. nidicola Cole. In this study, A. fur A. daphne and A. vierecki were lowered in rank to subspecies of A. limatulus, A, albofasciatus and A. varicolor, respectively. Of tha eight undescribed taxa, A. aureosquamosus was described as a new species and A. limatulus artemesia, A. l. larrea, A, l. vallicola, A. l. columbiensis, A. albofasciatus picea, A. a. cascadansis and A. aureosquamosus chaparralus wera described as new subspecies.

Descriptions and diagnoses were made for each species and subspecies along with drawings of the male genitalia and antennae, and photographs of the wings and the externally visible parts of the male genitalia. The synonomy for each taxon was compiled. Localities from which specimens were collected were listed and distribution maps were constructed for each taxon. Notes were added as to the disposition of the types.

A detailed study was made of the biology of Anthrax limatulus fur (O. S.). Observations were made on the oviposition behavior of the female and several specimens were reared from egg to adult in the laboratory. Descriptions were made of the first and third instar larvae of A. l. fur and of the pupae of A. l. limatulus Say and A. nidicola Cole. Notes were included on the biologies of other taxa where information was available.