

# THE BLOWFLIES OF NORTH AMERICA

BY

DAVID G. HALL

Bureau of Entomology and Plant Quarantine  
United States Department of Agriculture



THE THOMAS SAY FOUNDATION

1947

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WILLIS STANLEY BLATCHLEY

whose interest in the Thomas Say Foundation  
was demonstrated by a substantial gift.

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## INTRODUCTION

**B**LOWFLIES<sup>1</sup> are among the most familiar of insects. They are the bright bluebottle or greenbottle flies<sup>2</sup> of our childhood days. Most of us recall instances in which some of these two-winged insects figured prominently. Such flies have been known to man through the ages,<sup>3</sup> but in spite of the ubiquity of the group, it is only within comparatively recent years that fairly complete knowledge of the biologies of a few of the species has been gained.

Blowflies occur in almost every region of the world. Many species are abundant in the tropics throughout the year; others are numerous in the arctic during the short summer season.

This paper presents a systematic account of the species of Calliphoridae<sup>4</sup> now known to occur in North America<sup>5</sup>. There

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<sup>1</sup>The term "to blow" in the sense of depositing eggs is of considerable antiquity, and many examples of its use can be found, some dating back into the 16th century. For instance: Chapman, 1816, "Iliads of Homer," 16:23-29,

"I much fear, lest with blows of flies, his brass-inflicted wounds are fil'd." Or Shakespeare's, "to suffer the flesh-fly blow my mouth," "Tempest," Act 3, Sc. 1: or,

"Rather on Nilus mud,  
Lay me stark naked and let the water flies  
Blow me into abhorring"

"Anthony and Cleopatra," Act 3, Sc. 1;

or again his, "These summer flies have blowne me full of maggot ostentation," "Loves Labor Lost," Act 5, Sc. 2. Samuel Purchase, in his "A Theater of Political Insects," 1657, stated, "... as the blotches of the flies are nurished by the flesh wherein they are blowne . . .;" and Wagstaffe, in his "Vindication of King Charles the Martyr," 1692, said,

"... it is the nature of flies to be ever buzzing and blowing upon anything that is raw."

<sup>2</sup>It has not been possible to trace the derivation of the term "bottle fly." Melander (*in litt.*) states that "bot" is an old term for a maggot: hence "bottle" means a little maggot. A bluebottle fly literally is a blue fly that produces little maggots. The old Gaelic form is "boiteag," meaning maggot.

<sup>3</sup>Something of the habits of these flies was known during ancient times. The first published account of such habits appears to be that of Homer in his "Iliad." The actual date of these works has not been established definitely, but the first authoritative text is that by Aristarchus of Samothrace (150 B.C.). While there is no earlier written text, the poems are vastly older. In more recent times, Linnaeus (*Entomologia Faunae Suecae Descriptionibus* 3:470, 1789) stated, *Tres muscae consumunt cadaver equi aequae cito ac leo*, indicating that the great number of offspring produced by only a few individuals within a short time had been observed by him.

<sup>4</sup>Calliphora: from Greek Καλλι, a stem used in compounding words to denote beauty, and φερα, a bringing forth (from φέρειν).

<sup>5</sup>Here considered to comprise the mainland from the arctic to and including the Panama Canal Zone, together with the West Indies north of Jamaica.

are 83 species belonging in 27 genera recognized from this region. Of these, 15 species and 6 genera are described as new. The work has been prepared for the use of entomologists, public health officials, physicians, veterinarians, biologists, and students. The keys are designed to assist in the rapid determination of the species and, together with the detailed descriptions and the illustrations of the more significant morphological details, are diagnostic of all the known species from this area.

*Acknowledgements.* I find myself indebted to so many individuals for so great a variety of assistance, much of it indirect, that a complete acknowledgement of benefits received can scarcely be given. An attempt has been made to give a bibliography of sources of much of the published information included on biologies and habits, but it has not been possible to show them all. This information has been abstracted from papers of biologists all over the world, but especially from papers originating in the Division of Insects Affecting Man and Animals, Bureau of Entomology and Plant Quarantine, and I am grateful to the authors of these papers for their assistance.

This study is based principally upon collections in the United States National Museum and upon material personally reared and collected. All of the abundant forms were studied and reared in the field during the progress of the study and many of the species were reared from egg to adult upon numerous occasions. Other institutions furnishing considerable material are American Museum of Natural History, British Museum (Natural History), Colorado State College, Commonwealth Council for Scientific and Industrial Research, Canberra, F. C. T., Australia, Cornell University, Emory University, Field Museum of Natural History, Illinois Natural History Survey, Iowa State College, Iowa Wesleyan College, Massachusetts Agricultural College, Ohio State Museum, Ohio State University, Oregon State Agricultural College, University of Alberta (Canada), University of Idaho, University of Kansas, University of Washington, Utah State College, and the Division of Insects Affecting Man and Animals, Bureau of Entomology and Plant Quarantine. Valuable material from the collections of T. H. G. Aitken, W. W. Baker, A. J. Basinger, E. C. Cushing, Alexander Cuthbertson, R. H. Daggy, D. G. Denning, E. O. Engel, P. W. Fattig, E. F. Knipling, Wm. L. Jellison, M. C. Lane, David F. Miller, J. F. Neff, R. L. Post, M. P. Riedel, C. W. Sabrosky, F. M. Snyder, J. Wilcox, and James Zetek was also examined. Notwithstanding the large amount of material studied, doubtless a good many species remain to be discovered and the biologies and immature

stages of a majority of the species are unknown. Much of the area has not been entomologically explored. Collections from Central America and particularly the arctic have been meager.

I wish especially to express my indebtedness to the Division of Insects Affecting Man and Animals, Bureau of Entomology and Plant Quarantine, for information on biologies of certain economic species which was abstracted from their files, and to Mr. E. F. Knipling, of that Division, who furnished much information bearing upon affinities between certain species as shown in the immature stages. Series of reared specimens from egg masses secured from single females were received from Dr. E. W. Laake and other members of the same Division.

Information on type specimens including the identification of certain specimens was obtained through correspondence with R. H. Beamer, Kansas University; Max Beier, Naturhistorisches Museum, Vienna, Austria; C. H. Curran, American Museum of Natural History; Richard Dow, Boston Society of Natural History; E. O. Engel, Munich, Germany; M. J. Mackerras, Commonwealth Council for Scientific and Industrial Research, Canberra, F. C. T., Australia; Rene Malaise, Naturhistoriska Riksmuseum, Stockholm, Sweden; John Smart, British Museum (Natural History), London, England; E. Seguy, Paris Museum, Paris, France; and C. H. T. Townsend, Itaquaquecetuba, E. F. C. B., Sao Paulo, Brazil. Mr. R. C. Shannon contributed much of the data for the historical review of the classification of the family Calliphoridae. The constant helpful friendliness of Stacy W. Edwards of Kerrville, Texas, then a First Lieutenant in the Sanitary Corps, Army of the United States, who travelled with me throughout Central America and much of South America during 1942 and 1943 while making entomological surveys, made such surveys considerably more complete and certainly more enjoyable than had they been made alone. The engravings for two of the colored plates were furnished by M. S. Yeomans, State Entomologist for Georgia, and the excellence of all the color engravings is due to the skill of my friends in the Dixie Engraving Company, Savannah, Georgia.

To all these institutions and correspondents I wish gratefully to acknowledge my indebtedness.

#### HISTORY OF THE CLASSIFICATION OF THE CALLIPHORIDAE

A complete history of the final segregation of the family Calliphoridae can scarcely be presented here. Major advances in the taxonomy of this family are apparently correlated with the dis-

covery and application of new characters. Therefore, only an abbreviated review of the introduction of characters is given. Development of the classification divides somewhat naturally into three periods on the basis of the characters largely employed at the time. In the first period, characters of mouthparts, antennae, wings and color were the basis of the taxonomy; in the second period, principally characters of chaetotaxy; and in the third period, the more stable characters used in the previous period together with others of the genitalia, immature stages, and biology.

*First period.* Linnaeus (1757) divided all Diptera into 10 genera on the basis of differences he found in the mouthparts. Three of these (*Musca*, *Oestrus*, and *Conops*) when grouped together correspond roughly to the present suborder Cyclorrhapha. Each of these divisions contained calypterate species. The largest, *Musca*, also contained species of Syrphidae, Stratiomyidae and Bombyliidae. Linnaeus further divided his genus *Musca* into 5 groups on characters afforded by the arista. He was thus able to separate certain calliphorid and muscid species in which the arista is plumose from some tachinid and anthomyiid species in which it is bare.

Harris (1776) illustrated wing venation of flies known to him and divided Linnaeus' genus *Musca* into five "orders." The first of these included the Calliphoridae, Sarcophagidae, and Tachinidae.

Dumeril (1801) divided the order Diptera into 4 families on characters of the mouthparts. He placed the blowflies in what he termed "Sarcostomes," recognizing 21 genera. The Calliphoridae were included in the Muscidae. In 1806 he further extended his system, adding 1 more family and separating the "Chetoloxes" (which included the Tachinidae and the Muscidae) from "Aploceres" (which included Bibionidae, Stratiomyidae, etc.) on characters of mouthparts and the presence or absence of hairs on certain portions of the mouthparts. He separated the Muscidae (including Calliphoridae) from the Tachinidae on the basis of the plumose arista.

Meigen (1803) introduced the character of the size of the squama by separating certain genera of flies with abbreviated squamae (now considered Acalypteratae) from other genera with large squamae (now considered Calypteratae). He also made use of the character of the bend in the fourth vein to separate anthomyiid flies from other muscoid groups.

Latreille (1805) first subdivided the order Diptera on the basis of habits and immature stages as well as upon adult characters.

His first division was called "Tipulares" (renamed "*Nemocera*" by Latreille in 1817); and his second division (to which Macquart gave the name "*Brachycera*" in 1834) was divided into 12 families, one being the Muscidae. The Calliphoridae were included in the Muscidae. Latreille noted that the Muscidae and the Tipulidae have different types of pupae.

Fallen (1814-1820) noted the presence of oral vibrissae in the Calypteratae and their usual absence in the Acalypteratae.

Robineau-Desvoidy (1830 and 1863) may correctly be called the first specialist on the muscoid flies. He first used the character of the ptilinum, characters of head sclerites, bristles, simple proportion, and differences in venation, and he recognized the arista as having evolved from the fourth and terminal antennal segments of *Nemocera*. In his attempt to develop a natural classification he endeavored to make use of larval habits. He established many of the genera of Calliphoridae which are recognized at the present time. It is especially noteworthy that the work of Robineau-Desvoidy was apparently much ahead of his time, for it has been only within the past 40 years that an attempt has been made to credit him with his understanding of the natural relationships between the species of muscoid flies.

Meigen (1838) noted that a transverse mesonotal suture is present in calypterate flies and that such a suture is incomplete in acalypterate flies.

Characters in the mouthparts, wings, and antennae were chiefly used for classifying the major divisions of muscoid Diptera for nearly 100 years. These may have been satisfactory for the separation of genera and species in a limited area, but they certainly became of less value as new forms were discovered and described.

*Second period.* The discovery by Mik and Osten Sacken that the arrangement of bristles on muscoid flies was relatively constant within a species, and the resultant systematic use of such bristling for taxonomic purposes, ushered in the second historical period. The combination of characters of bristling with those previously introduced allows an arrangement of genera and species which is somewhat similar to that now in general usage.

Mik (1878) proposed the first system for classifying the bristles of the legs of muscoid flies. This system was amplified by Osten Sacken (1904), while Grimshaw (1905) later proposed an almost identical system, apparently independent of Mik and Osten Sacken.

Osten Sacken (1881 and 1884) first noted that the arrangement of bristles on the bodies of flies could be used as a means

of classification, and his system is used by most dipterists at the present time. Owing to their prominence, such bristles were often mentioned by earlier workers, especially Fallen, Robineau-Desvoidy, and more particularly Rondani. The latter introduced the term "macrochaeta" for larger bristles. Osten Sacken termed the system "chaetotaxy." He noted that calypterate flies have a row of bristles across the hypopleura and that acalypterate flies do not have such a row of bristles. This important discovery has been incorrectly attributed to Girschner.

Girschner (1893) offered a system of classification for the major grouping of muscoid flies which approaches the classification now in general use. His major divisions were based upon the character of the hypopleural bristles and his minor divisions upon other characters of chaetotaxy, supplemented by differences in abdominal tergites and sternites. He was the first to recognize the calliphorid flies as a distinct group, under the subfamily name of Calliphorinae. Various European dipterists still retain the subfamily status for the group.

Brauer and Bergenstamm (1889-1894) introduced numerous characters of the head such as the position of the vibrissae, the shape and position of the clypeus, and the shape of various sclerites, and they greatly extended the use of chaetotactic characters. These authors paid particular attention to the generic separation of calypterate flies and less attention to the natural relationships between genera and species. Some of the calliphorid species were included by them in sections of the Sarcophagidae and others were included with the Muscidae. Both these sections contained members of other families as well.

Hough (1899), the first to publish a comprehensive account of North American blowflies, used the system proposed by Girschner. He was the first to recognize the blowflies as a distinct family.

Villeneuve (1914, p. 256) discovered that the presence or absence of cilia on the posterior basal portion of the remigium would divide the Calliphoridae into two distinct groups. He called the group with bare remigium "C. nudiae," which would include the subfamilies Calliphorinae, Polleniinae, and part of the Mesembrinellinae of the present paper. The group with ciliate remigium he called "C. ciliae;" this would include the Chrysomyinae, Rhiniinae, and a few Mesembrinellinae.

*Third period.* The characters which most accurately define the calypterate flies and the family Calliphoridae have been discovered within the past 25 years, and these discoveries are, at least in part, coincident with the general employment of better optical equipment.



Malloch (1919) stated that most, if not all, of the calypterate flies have a longitudinal suture on the dorsum of the second antennal segment and that this suture, with minor exceptions, is absent in acalypterate species. In this paper Malloch also stated that the abdominal spiracles are located in the tergites in species of Calypteratae but are located in the membrane between the tergites and sternites in species of Acalypteratae. These characters have been found to hold with remarkably few exceptions, the most notable being pointed out by Malloch in a later paper (1925) when he erected the family Glossinidae for the species of *Glossina* (these have the abdominal spiracles located in the membrane, possibly owing to their pupiparous mode of reproduction). These two characters alone will usually separate nearly all the calypterate species from the acalypterate species. Malloch also introduced many other characters hitherto unnoticed, such as the pilosity or bareness of the propleura, postalar declivity, prosternum, and posterior surface of the hind coxa (1918); later still he introduced others such as the form of the reniform greater ampulla (1925) and the presence or absence of intrapostocular cilia (1935), which he used to separate doubtful Tachinidae from certain Calliphoridae. In the last mentioned paper Malloch placed *Silbomyia* in the Tachinidae, but most of the specimens which I have seen have intrapostocular cilia and the form of the male genitalia is conspicuously calliphorid. Because he introduced many such characters in the body of descriptions or in keys, the exact dates when some were first proposed are difficult to ascertain.

Baer (1921) introduced the character of the "infrascutellum" to distinguish the Tachinoidea from the Sarcophagoidea. The same character was independently employed by Malloch in 1925.

Shannon (1923 and 1926) again raised the blowflies to family status, and in the former paper separated this family from the Sarcophagidae by the presence of pile on the prosternum and propleura and a patch of setae on the metanotum below the squamae. These characters excluded the Polleniinae, but Shannon included these in Calliphoridae in his second paper by giving precedence to the character of the absence of hair on the posterior surface of the hind coxa, which is present on all the species of Sarcophagidae then known to him.

In another paper Shannon (1924) pointed out that the presence or absence of hypopleural bristles is closely correlated with the biologies of the major groups within the Calypteratae. He observed that groups lacking these bristles are mainly phytophagous in larval habits, while those groups which have hypop-

leural bristles are mainly parasitic or carnivorous. He noted exceptions to this generalization, but pointed out that most of the species with omnivorous larvae belong to the Muscidae, Calliphoridae, or Sarcophagidae, and that in each of these species sufficient characters are available to indicate a common ancestry. According to Shannon, the groups lacking hypopleural bristles are the more primitive in the two stipes, and it might be expected that they would have less fixed larval habits. He stated further that there are some omnivorous species of Sarcophagidae, but noted that most of the oestrid flies are obligatory parasites and that the relatively few instances of true parasitism on both invertebrate and vertebrate hosts among the anthomyiid species are of independent origin.

Townsend (1935 and 1937) gave the first synopsis of the generic and supergeneric relationships of the calliphorid flies for the entire world. His work gives due consideration to all the previously introduced characters and proposes others pertaining to head structure, chaetotaxy, and the internal reproductive organs of both sexes. Biologies and the immature stages were also taken into account. In his *Manual of Myiology* Townsend has given us the most extensive work yet published upon the entire calypterate series, and his knowledge of the group exceeds that of any previous student.

Since the genitalic structures of the various species of blowflies have been little used in supergeneric classification, a history of the use of genitalic characters as a means of specific differentiation has been omitted from the above discussion. The use of such parts as taxonomic characters is less than half a century old, but within the past 30 years an extensive literature has become available upon the specific differences of the genitalia of calypterate flies, particularly of the males.

Swammerdam (1752) was probably the first student to describe and illustrate the internal sexual structures of Diptera.<sup>6</sup> Reaumur (1738), Suckow (1828), Dufour (1848), and others also described and figured parts of the reproductive organs of certain species. Siebold (1838) described the reproductive organs of *Calliphora* and *Onesia*. Lowne (1890-1895) described the reproductive structures of *Calliphora* and introduced much of the terminology of parts which is now in general use. Bruel (1898) also published upon these structures in *Calliphora*. Townsend (1908, 1911, and 1914) published significant contributions to the knowledge of the female reproductive system. He

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<sup>6</sup>Swammerdam's "Bybel der Natuur" was not published until after his death, but was written previously to 1670.

was apparently the first to appreciate the taxonomic importance of the female genitalia of Diptera. Patton (1932-1939), together with certain of his students (E. C. Cushing and Chi Ho), has published extensively upon the external structures of the male and female genitalia of certain muscoid flies. His conclusions are that these parts are of considerably more importance in the ultimate classification of such flies than has hitherto been attributed to them.

With the sole exception of Townsend's papers on the female reproductive system, however, there has been little or no attempt to use the internal sexual organs as a means of indicating relationships of such flies.

Pandelle (1896) described the male genitalia of a number of Palaearctic calypterate species. He gave no illustrations and his descriptions of such parts were little used by later students. DuRoselle (1904) in Europe and Lahille (1907) in Argentina illustrated the male copulatory organs of several calypterate species, these illustrations being intended for use as an aid for the identification of the species involved. Boettcher (1912-1913) published a synopsis of the Palaearctic species of *Sarcophaga* and used the male genitalia as a means of specific determination. In this he was followed by Parker (1914) and Aldrich (1916) in North America. The use of the male genitalic structure as a means of specific determination in muscoid flies has become widespread since that time. Too often other available characters have not been used in descriptions, and the result has often been that females cannot be accurately associated with their males. Furthermore, the grouping value of such characters has not been considered. Many contributors have figured genitalia without any attempt to evaluate the characters and have neglected to describe other essential details of the species.

As new forms are discovered, characters previously introduced to separate larger groups of species become obscured. Thus, while Shannon endeavored to maintain the Calliphoridae as a distinct family, Aldrich indicated to the author (*in litt.*, 1926-1928) that, on the basis of the same characters used by Shannon, he regarded the Sarcophagidae and Calliphoridae to be but one family, the Calliphoridae. Malloch (1925) had already indicated that he considered the Sarcophagidae to be a subfamily of the Calliphoridae. Curran (1934) proposed the name Metopiidae for the combination known to Malloch and Aldrich as the Calliphoridae.

The furrowed dorsum of the second antennal segment, the presence of hypopleural bristles, the undivided metanotum, the

presence of intrapostocular cilia, and the general structures of the male and female external and internal genitalia will separate the family Calliphoridae from all other Diptera now known to the author. The species of Sarcophagidae lack intrapostocular cilia and the general structure of the genitalia of both sexes indicate little actual relationship between the two families. These characters hold for all North American calliphorid and sarcophagid species, and for all members of both families now known to the author.

### IMPORTANCE OF BLOWFLIES TO MAN

Blowflies have considerable effect upon the economy of man and are included among the insects of most importance to him. They may seriously affect the health of man and sometimes the health of his livestock. They also exert a distinct influence upon the abundance and welfare of wildlife due to their attacks upon animals and birds. Substantial sums are spent to alleviate certain conditions for which such flies are responsible and large expenditures are sometimes necessary for their control.

**TRANSMISSION OF DISEASES.** The omnivorous and promiscuous feeding habits of many species of the more abundant blowflies enable them to be potential vectors of a number of diseases of man. The disease-carrying propensities of these flies are often overlooked. With the sole exception of the common housefly, the importance of the nonbiting flies is frequently neglected entirely. Blowflies may transmit pathogenic organisms to man by one or more of several methods.

Feeding upon infected filth such as human excrement or sewage, blowflies may easily infect food intended for human consumption and they may thus become of considerable importance during epidemics of intestinal diseases such as typhoid or cholera. Microorganisms may be transferred mechanically from an infected source to human food upon the appendages, body, hairs or bristles of blowflies which have fed or congregated on infected materials. Flies which have fed upon infected materials may contaminate human food by the so-called "vomit-drop" or by depositing infected material on such food during defecation.

Blowflies may become vectors of certain diseases because of their breeding habits and may be of considerable importance during epidemics of such diseases as plague and anthrax. The larvae of most species of blowflies occur principally in carcasses; animals dying from infectious diseases are as readily blown as

those dying from other causes, and the adults of larvae originating from infected carcasses may be positive for the disease.

*Enteric Diseases.* A list of enteric infections spread by blowflies is nearly identical to that of the common housefly and is too extensive to be given here. In the slum districts of Pieping, China, Yao, Yuan, and Huie (1929) found the common blowflies (*Calliphora spp.* and *Lucilia spp.*) to carry over 3,500,000 bacteria per specimen. Even in the cleanest and most sanitized portions of that city each adult blowfly carried an average of nearly 2,000,000 such bacteria. From eight to ten times as many bacteria were found to occur inside such flies as on the outside. *Bacillus coli* and *B. dysenteriae* were the most important of the more abundant pathogenic forms found. By washing captured blowflies these investigators found *Entamoeba coli* and cysts of certain flagellates and ciliates. Examinations of the digestive tract of these flies revealed the presence of all of the above named organisms and *Endolimax nana* as well. Of particular significance was the fact that the death rate from gastrointestinal diseases in the areas concerned was roughly proportional to the number of blowflies captured. Trophozoites of *Entamoeba histolytica* may be cultivated from the vomit of blowflies from 5 to 17 minutes after infected substances are ingested, according to Pipkin (1942). He found that cysts of *histolytica* could be retained within the intestinal tract of such flies for from 86 to 258 minutes and that these could be deposited in a viable state in the defecation of the flies. Frye and Meleney (1932) found cysts of this amoeba in the intestinal tract of flies captured in three of twelve homes in which infected individuals resided. The vibrios of cholera (*Vibrio comma*) will survive in the intestinal tract of blowflies for 24 hours according to Gill and Lal (1931). These authors found that vibrios disappear from the body of the flies after about 4 hours but reappear on or about the fifth day at which time the fly is capable of infecting food by its feces. Apparently these flies are not only mechanical vectors but may be involved in biological transmission of the disease as well. Infected blowflies are able to contaminate food or water by the deposition of these vibrios for a period as long as 24 hours via vomit-drop methods. Meats, fish, and vegetables are favorite sources of food for these flies and when eaten uncooked, are potential sources of this disease.

The exact role held by various species of blowflies in the transmission of virus diseases such as poliomyelitis is not yet clear. Virus of poliomyelitis has been demonstrated in stools of infected persons. This virus has been found to be present also on

the surface or within the bodies of blowflies collected in the field during epidemics of the disease. No less than three groups of investigators made such recoveries from adult blowflies in 1941 and 1942. Sabin and Ward (1941-1942) found the virus to exist in 8 of 15 samples of blowflies captured in the vicinity of outbreaks of the disease in Georgia and Ohio. Trask et al (1940-1943) and Paul et al (1940-1943) found the virus to occur in 4 of 19 samples of blowflies collected within epidemic areas during and after the onset of nearby cases of poliomyelitis in Connecticut, Alabama, and eastern Canada. All of these positive samples contained specimens of *Phaenicia sericata* and *Phormia regina*. Some of the samples contained specimens of *Protophormia terrae-novae* as well as a few specimens of less abundant species. These species are not frequent visitors to human excrement, especially that in outdoor deep pit latrines. Where and how they originally obtained the virus is still an unsolved problem. Whether the virus multiplies on or within the bodies of blowflies or is merely carried accidentally is unknown. It is doubtful that they obtain the infection from the excrement of persons ill with poliomyelitis; houseflies in the same or in similar samples were not positive for the virus. It is possible that animal reservoirs of such diseases occur in nature. Animals die and normally become infected with blowfly larvae. Larvae and adults from infected animals would probably be positive for the virus. The promiscuous and omnivorous feeding habits of blowflies together with their habits of regurgitation and defecation on human foods would make the transmission of the virus to humans possible and a relatively simple matter. Anyone visiting markets can observe great numbers of these species feeding or congregating upon fruits such as peaches, grapes, and others, all of which are commonly consumed unwashed by humans. These factors in the origin and transmission of this disease have not been investigated.

*Non-enteric Diseases.* Larvae, pupae, and adults of blowflies reared from carcasses of rats which died of plague (*Pasteurella pestis*) were all positive for that organism according to Russo (1931). He found plague bacilli in the excrement of such flies. Larvae of blowflies fed upon meat infected with spores of anthrax (*Bacillus anthracis*) remained infective for that organism for several days after adults had emerged from their pupal cases according to Graham-Smith (1911). He cultivated the bacillus from the appendages and intestinal contents of the reared flies for more than 15 days after emergence as adults and these flies were found to be capable of infecting materials over which they

walked, fed, and upon which they deposited infected feces. Roberts (1934) found that larvae of *Phaenicia pallescens* would ingest eggs of *Ascaris*, that these eggs would survive pupal metamorphosis of the fly, and that such eggs are passed with the fecal droppings of the adult. These data are supported by the findings of Pipkin (1942-1943).

Serological evidence leads Shope (1936-1938) to consider that "the virus of swine influenza is a surviving prototype of the agent responsible for the great human pandemic of 1918." If this is true, hogs and earthworms may serve as the source of future epidemics. He suggested that there might be a saprophytic transformation of the virus in either the swine lungworm, a fairly common parasite in the bronchioles of hogs, or in the earthworm, the alternate host of this nematode.

Earthworms may prove to be the animal reservoir of both swine and human influenza. The swine lungworm may be the vector of influenza to hogs and the clusterfly (*Pollenia rudis*) the vector to man. This blowfly is an important insect parasite of earthworms, and it sometimes occurs in tremendous numbers in human habitations during fall and winter months. These factors in the origin and transmission of human influenza have not been investigated.

The following organisms have been recovered from adults of common blowflies, Tuberculosis (*Mycobacterium tuberculosis*), Tularemia (*Pasteurella tularensis*), Undulant Fever (*Brucella abortus*), and various species of trypanosomes and Leishmanias. They may be vectors of eye diseases such as acute conjunctivitis and/or of skin diseases such as yaws.

MYIASIS. Laake stated that "Myiasis is the term used when referring to the presence of and the resulting disturbance caused by fly larvae living parasitically on the tissues of man and other animals." Myiasis may be classified anatomically according to the portion of the body affected, for instance, cutaneous or subcutaneous, cavity or wound, intestinal, nasal, aural, rectal, ophthalmic, etc.

Flies may be placed conveniently in several categories according to the time of the occurrence of their larvae in wounds. The condition of a wound is somewhat indicative of the species of blowfly larvae which may infest it.

Primary Flies cause *Specific Myiasis*. Larvae of such flies are obligate tissue parasites. They initiate wounds in man and animals, are able to infest areas of unbroken skin, and may infest already existing lesions.

Secondary Flies cause *Semi-Specific Myiasis*. Larvae of such

flies do not cause lesions in man and animals. Gravid females of this group usually deposit their eggs upon decaying flesh. They may be attracted to wounds which already exist and they may deposit eggs sometimes on morbid tissue. The larvae then live in and extend such lesions.

Tertiary Flies may cause *Accidental Myiasis*. Larvae of such flies are found only in very advanced cases of cutaneous myiasis. Gravid females of this group normally deposit their eggs in decaying organic material and their larvae are of relatively rare occurrence in wounds.

Old pustular suppurating lesions may contain many species of secondary or tertiary blowflies in the maggot stage. These maggots may be calliphorine, chrysomyine, sarcophagine, or even species of *Musca*, *Muscina*, or *Stomoxys*. Many of these species may be beneficial in wounds because lesions of the suppurative type seem to heal rapidly due to the presence of saprophagous larvae. This phenomenon may be attributed in part to secretions of urea, ammonium carbonate, and allantoin by the larvae, to mechanical effects which apparently promote growth of granulating tissue, to the stimulation of secretions within the wound which destroy large numbers of bacteria and inhibit their growth, and to the removal of dead tissues from the lesion which makes conditions less favorable for the development and increase of pathogenic organisms.

*Subcutaneous Myiasis*. Several species of blowflies are responsible for subcutaneous myiasis in North America. One such species (*Callitroga americana* Cushing and Patton) causes the death of a number of persons each year. Borgstrom (1938) reported over 55 cases of human myiasis in southeastern United States during 1935. Cushing and Patton (1933) reported 8 percent mortality in 179 cases of myiasis caused by this species which were studied by them. During the summers of 1934 and 1935 we of the Bureau of Entomology and Plant Quarantine laboratories in Georgia saw a large number of human cases of nasal, auricular, ocular, and cutaneous myiasis, all of which were due to the larvae of *americana*.

This species causes innumerable cases of myiasis in livestock and the death of large numbers of domestic and wild animals almost every year in southern North America. The most acute of all insect problems concerning livestock in southern North America is due to this blowfly.

Myiasis cases produced by larvae of *americana* are often extremely destructive and may lead to death unless prompt corrective measures are applied. Apparently the destruction of



tissue alone is not responsible for the extent of the injury to the person or animal so affected. Borgstrom (1938, p. 396) stated "The severe effects must be due either to metabolic or toxic products of the larvae formed during their activity in the wound." Exudates from infested wounds contain practically no leucocytes and such wounds never show signs of pus formation. Although bacteria are consistently associated with myiasis lesions, when such bacteria are inoculated in pure culture into other wounds they fail to produce pyogenic infections. In two instances in which staphylococci were inoculated with *americana* larvae into wounds they produced an accumulation of pus which disappeared within two or three days. Borgstrom's observations suggest that the leucopenia found in screwworm cases may be due to the destruction of leucocytes by the presence of larvae in such wounds. Wounds infected with *americana* larvae invariably develop a pure culture of a single species of bacterium, *Proteus chandleri* Borgstrom (1938). In no instance has any other organism been found in the lesion from 24 to 48 hours after the introduction of *americana* larvae into a wound.

Wounds with a pH of from 6.9 to 7.3 are most attractive to feeding and ovipositing adult blowflies. Wounds with an acid reaction heal quickly and are not so attractive. Wounds which produce a watery discharge are exceedingly attractive to gravid blowflies for a considerable period of time.

Prior to 1933 subcutaneous myiasis in the southern part of North America was mostly attributed to *Callitroga macellaria* (F.) and control measures advocated were based in part upon the biology of that species. Actually *macellaria* is secondary in wounds and the larvae occur principally in decaying meats. The usual cause of screwworm injury and subcutaneous myiasis in southern North America is *Callitroga americana*, a species previously confused with *macellaria*. Most discussions of screwworm flies in the economic literature apply to *americana*.

The impression generally prevails that screwworm outbreaks are of only recent occurrence in North America and that such outbreaks date from the serious situation in the southern United States during 1933-1935. As a matter of fact screwworm flies have been rather well known in the Middle West for many years and an account written in 1882 describes nasal myiasis in the human so typically that it is repeated here in part. This account is from a letter addressed to C. V. Riley by Fred Humbert, M. D., Alton, Illinois.

"A farmer's wife, 35 years of age, was attacked on Monday, Sept. 27, 1875, with a headache and a flushed face. From this

time the pains in the region of the frontal cavity at the base of the nose and below the eye extending to the right ear increased. At times the pain was more severe than at others but it never entirely left. This pain was described as preventing hearing and breathing and so excruciating that at intervals day and night her cries could be heard at a great distance from the house. Tuesday evening blood mucus began to run from the right nostril which was somewhat swollen, the swelling extending by Friday over the whole front side of her face. On this day, the fifth of the complaint, four large maggots dropped out of the right nostril. When I was first called to the patient, Monday, October 4, only the right lip and nostril were swollen, the acrid discharge having somewhat blistered the lip below. After each discharge, maggots dropped from the nostril, until the twelfth day, 140 or more maggots having escaped. The majority of the maggots were three-fourths of an inch in length, there being only a few which seemed a line or two shorter; they were of a yellow hue, conical shape, and having attached to one end, two horn-like hooks. On Monday, September 18, 1882, I saw a patient in the same neighborhood suffering from the same malady. At that time, 280 maggots had been discharged and at the close of the illness, over 300. There was a swelling on each side of the nose with a small opening to each. I lanced these openings and more maggots came out."

*Intestinal Myiasis.* Blowfly larvae may be the cause of intestinal myiasis in man. Such cases are most often caused by tertiary flies and may usually be considered accidental. Larvae may hatch from eggs deposited by gravid females on meats or other foods intended for human consumption. Hoeppli and Watt (1933) working with species of *Chrysomya* and *Lucilia*, and Desoil and Delhaye (1922) working with species of *Calliphora* noted that larvae of these genera were able to live in the human intestinal tract. According to Herms (1939) the presence of such larvae in the human intestinal tract is usually accompanied by dizziness and nausea followed by more or less abdominal pain. He stated that "diarrhea with discharge of blood may occur as the result of injury to the intestinal mucosa by the larvae," and "living and dead larvae are expelled with either the vomit or stool or both." Herms and Gilbert (1933) reported upon a case of intestinal myiasis from which species of *Calliphora*, *Phaenicia*, and *Sarcophaga* were reared. Because of the peculiar recurrence of violent symptoms and the expulsion in vomit and stool of broods of very young larvae along with fully grown larvae they concluded that Parker (1922) might have been cor-

rect in his assumption that blowfly larvae could multiply by paedogenesis although Keilin (1924), after conducting careful and extended experiments, concluded that paedogenesis does not occur in *Calliphora*.

**EFFECT OF BLOWFLIES ON WILDLIFE.** Certain species of blowflies are parasitic upon birds and others upon animals. *Apaulina metallica* is found in large numbers in nests of the bank swallow and Stoner (1936) stated that the bloodsucking parasitic larvae of this blowfly were the most injurious external parasites of the bank swallow in New York State. There are many references in the literature upon the effects of *Callitroga americana* and other blowflies upon game animals. No North American mammal, large or small, is exempt from myiasis caused by the larvae of this species. *Pollenia rudis* and species of the genus *Onesia* are obligate parasites of earthworms and the economic effect of such species is difficult to ascertain.

**FINANCIAL LOSS.** In the southern part of the United States one species of blowfly (*americana*) causes a loss of from 4 to 10 millions of dollars each year in the state of Texas (Bishopp, 1934). According to Belschner (1937) the sheep blowfly (*Phaenicia cuprina* Wiedemann) costs Australia nearly 20 millions of dollars annually. He states that "with the single exception of drought, the sheep blowfly is probably the biggest problem with which each Merino sheep breeder has to contend."

The advent of the automobile and the moving of stables and dairies into the country has caused a great reduction in the abundance of houseflies and stableflies in urban centers. Such flies are now of relatively minor importance in larger cities except in the vicinities of zoological parks, riding academies and markets. The reduction in the number of these flies is largely attributable to the excellence of modern systems of municipal sanitation and public health supervision. But the number of blowflies in urban centers has not been decreased in the same proportion.

It has been estimated by Hyslop (1938, p. 48) that 26 millions of dollars are spent each year in the United States for the control of flies. This total included only sums spent for screen wire and sprays. The public does not differentiate between different species of flies. These 26 millions of dollars worth of wire screening and sprays are purchased for the purpose of keeping all sorts of insects from buildings. A considerable proportion of this amount is spent obviously for the purpose of keeping blowflies from homes, stores, and packing establishments.

The discarding of maggot-infested meats in packing industries

and retail outlets causes an annual financial loss to the meat industries as well as to the purchaser. Sums spent upon screw-worm remedies such as benzol and pine tar oil have not been estimated. Expenditures upon traps, fly papers, and other similar devices for use in blowfly plague alleviation are unknown. The cost of the labor alone to install and supervise such devices must be high.

No exact total of monetary loss occasioned by blowflies can be ascertained. It is apparent that the annual loss caused by such flies is much greater than has been recognized generally.

### CONTROL OF BLOWFLIES

The methods to be followed for the control of blowflies are more or less dependent upon the species involved, and a knowledge of their habits and biologies is needful for exact procedure. However, the following general recommendations may be made.

**BLOWFLY CONTROL BY SANITATION.** The practice of thorough sanitation in urban or rural areas is necessary to combat plagues of blowflies. These practices will also serve to mitigate plagues of other household flies as well. The odors of cooking foods, such as cabbage or cauliflower, may attract flies from considerable distances, and these flies may then remain in the vicinity to feed upon improperly handled garbage or about filthy garbage containers. Garbage containing meat scraps or meat products may be a constant source of blowflies during summer months if placed on open dumps. The proper disposal of meat and meat scraps by slaughter houses, butcher shops, or markets is a matter which should receive the constant attention of public-health authorities.

*Protection of human foods.* Foods intended for human consumption should be protected from blowflies. Meat of any sort, whether fresh, cooked, cured, or dried, is especially attractive to them. Dried fish hanging in market places, particularly in tropical areas, may become literally covered with swarms of feeding blowflies. The slaughtering of animals and the distribution of meat before daylight in tropical countries is a commendable practice, but the manner in which such meat is afterward exposed in open markets and bazaars is deplorable. This very common procedure renders such meat accessible to every blowfly in the entire street or market place. Cold meats or other foods left unprotected in kitchens or dining rooms where blowflies may have access to them become potential sources of various diseases transmitted by these flies. Even fruits and vegetables

intended to be consumed unwashed and raw must be protected from blowflies in open stores and market places.

*Garbage disposal.* Cell-type sanitary fills may be used for garbage disposal, or garbage may be incinerated or buried. Under any circumstances the method used for garbage disposal must reduce odors, and the remains must not be left attractive to blowflies.

*Excrement.* Human excrement must never be exposed to congregating or feeding blowflies. This is a matter of extreme public health importance in situations where such flies may later have access to foods intended for human consumption. In cities and towns, modern systems of disposal are usually available. In areas where such systems are not present, it is necessary for other arrangements to be made. Away from access to proper toilet facilities an individual may use a small hole dug in the ground with a stick, and cover the feces with earth. Small military units in bivouac areas for 1 week or less may provide a straddle trench approximately 1 foot wide, 4 feet long, and 2 feet deep, for each 25 men. Sufficient earth should be replaced over the material by each user of the trench to prohibit feeding by blowflies. The thorough spraying of the trench and immediate surrounding area with a 5-percent DDT solution will largely prevent fecal contamination of human foods by flies attracted to such latrines. The trench must be completely covered with earth upon closing the camp. Semipermanent or permanent camps call for the digging of deep-pit latrines to be covered by box-type sanitary privies. Such boxes should be treated with 5-percent DDT oil solution on a weekly basis. Paradichlorobenzene crystals should be scattered in dry, deep, pits at the rate of 2 ounces per hole twice each week.

Construction jobs should be provided with latrines at every point where laborers may be working. These latrines must be inspected regularly to see that they are maintained in proper sanitary condition. Under no circumstance should the open ground be used as a latrine. Privies may be built on skids and placed over pits 3 or 4 feet deep on work projects which may last longer than 1 week. These movable privies, treated with DDT as a residual, may be transferred once or twice each week to new locations over newly dug pits. The transfer is easily made by means of bulldozer equipment which may then push and pack earth into the old pit with a minimum of time and effort. Blowflies will not frequent darkened pits unless the contents are definitely malodorous. The constant moving of temporary privies over new pits and the filling of the old pits is an excellent and

economical method of reducing the hazard of fecal-borne epidemics on construction jobs.

Sewage-treatment plants sometimes attract blowflies by their odors and the flies so attracted may feed upon partly or poorly digested sludge. Modern and properly administered treatment plants are not a breeding source of such flies.

*Disposal of dead animals.* Many species of blowflies breed in bodies of dead animals. Dead stock on ranches or dead men on battlefields are sources of great swarms of these flies. The control of blowflies under such circumstances depend on proper poisoning with sodium arsenite or carcass disposal. Large carcasses will produce the greater numbers of blowflies, other things being equal, but the common practice of throwing bodies of small animals upon manure heaps, into weed patches, or behind barns will result in the development of considerable numbers of these flies. Bodies of very small animals such as rats, mice, or birds may produce many blowflies during various stages of carcass decay and at certain seasons of the year. Rodent-control units often prove to be very successful in killing great numbers of rats or other rodents by baiting and fumigating but few such units make an attempt to incinerate or otherwise dispose of resulting dead animals. These may cause the spread of epidemics of plague or other rodent-borne diseases such as typhus. Burial of animals is a satisfactory means of disposal if the body is buried sufficiently deep to prohibit access to the carcass by ovipositing blowflies. Incineration of animals is considered more satisfactory if carried to completion. Any animal suspected of having died from an infectious disease should be burned. Under any circumstance, burning, burying, or treatment by sodium arsenite or benzene hexachloride spray, must be accomplished as soon as the dead man or animal is found. Dead men on battlefields are usually buried. Large carcasses of animals are most easily burned in a trench dug as long as the animal, slightly narrower than the width of the animal's body and from 12 to 18 inches in depth. Less physical effort is required to dig such a trench beside the animal than to drag the carcass to the trench. When the trench has been dug and filled with wood, the carcass is rolled over on it, and the wood is fired at the windward end of the trench. An incinerator prepared in this manner will satisfactorily dispose of a medium-sized carcass within a few hours. Any remains may be buried in the trench when it is refilled.

**CONTROL OF ADULT BLOWFLIES.** Blowflies sometimes occur in considerable numbers in well-cared-for areas, and a reduction in their abundance may be desirable. This is

often particularly true in Army posts, camps, or stations where every attempt is made to keep the reservation sanitary but where flies are being attracted from outside sources. There are several methods for reducing the abundance of blowflies. The treatment of outside walls and surfaces, particularly garbage areas, transfer points and street gutters with a 2.5-percent DDT in a wettable powder spray preparation at 15 to 30 day intervals is highly desirable.

*Blowfly traps.* Fly traps are of some value in catching blowflies that are attracted to clean, sanitary areas from outside sources or the few flies that always escape even the most thorough methods adopted for their destruction. Traps are of no primary value in the control of flies.

Although many different models and types of traps have been devised, most of them operate on similar principles. Blowflies are positively phototropic and they usually fly toward a light upon entering a darkened area. The principle upon which all successful blowfly traps operate is to induce flies to enter a bait chamber by means of an attractant. They then fly upward toward light through a passage with a large opening and a small exit into a cage from which there is little opportunity to escape. As a result of extensive experimentation, it has been found by F. C. Bishopp and E. W. Laake, that the most effective, economical, and easily operated of all fly traps is the conical type recommended in United States Department of Agriculture Farmers' Bulletin 734 (rev. 1937), pp. 3-5 and fig. 1. Most other traps based upon the bait-light principle catch only a minor fraction as many flies as are caught in this trap.

Blowflies are attracted in greatest numbers to decaying meats or meat products. Odors from such baits are obnoxious and may not be desirable about dwellings or stores. Usually the stronger the odor of the bait, the greater the drawing power. The larger the bait, the more blowflies it will usually attract to a trap, and, other things being equal, small quantities of rotting meat attract only small numbers of blowflies. When the bait has reached a certain stage in its decay its value as an attractant is gradually lost, and new bait must be prepared. A bait which is exceptionally effective for blowflies is composed of the mucous membranes that form the intestinal linings of hogs and cattle. This substance, called "gutslime," is obtainable from packing establishments where sausage casings are prepared. Meat of any kind, or entire carcasses of small animals with the intestines exposed, will make satisfactory baits. It is best to place such decaying meat in water in the bait pans during warm, dry weather. Some mag-

gots may complete their growth and escape from the bait pans unless 1 teaspoonful of nicotine sulfate is added to each gallon of water used in the preparation of the bait. This will not reduce the attractiveness of the bait, and it will check the breeding of blowflies in the bait pan. A less odorous bait which will attract considerable numbers of blowflies is composed of one-fourth pound of dried whole egg stirred into 1 gallon of water. This bait will be more efficient if it is stirred frequently and kept alkaline by the weekly addition of 1 teaspoonful of sodium bicarbonate in each gallon of water. Milk, or casein and water, to which over-ripe bananas have been added makes a rather effective attractant for use about dwellings or stores.

The container which holds the bait in fly traps is a very important factor. Small or deep containers do not allow the bait to produce the odors attractive to flies in sufficient strength and the resulting catches are proportionately small. The bait pan most suitable for use in the trap recommended is approximately 4 inches deep and from 14 to 18 inches in diameter. It should be about 4 inches less in diameter than the diameter of the base of the cone. Such a bait container will hold a considerable quantity of bait and water and calls for relatively infrequent bait renewal during hot weather. Bait pans should be kept well filled and they should be washed at frequent intervals.

Traps should be set upon platforms about 2 feet square and high enough to protect the bait from animals. The trap should be set where blowflies naturally congregate. During cool weather such flies will be found most frequently in sunny locations near buildings and protected from the wind. During hot, dry weather a better location may be in partly or wholly shaded places. A poorly situated trap will catch only a small part of the number that might have been caught in the same trap in a better location only a short distance away.

Under ordinary circumstances traps should be emptied once each week. Dead flies piled high against the cone inside the trap will reduce the light which attracts the flies upward from the bait chamber, and the catching power of the trap will be materially reduced. To kill the flies in the trap before removing them the entire trap may be given a residual treatment of DDT, the trap may be placed in hot water, the flies may be killed with one of the numerous fly sprays, or they may be killed by dumping them from the trap into an open fire. During summer months it is not necessary to kill flies that are caught, for the majority die very rapidly within the traps, especially when the traps have been treated with DDT. To empty a trap in hot weather, the



trap is inverted and the dead flies shaken down. The living flies will go upward and the lid, now on the bottom, is removed and the dead flies shaken out. The lid is replaced and the trap returned to its normal position without the loss of many live flies.

*Accessory methods and devices.* Thorough screening and sealing of all cracks and other openings through which flies might enter living, messing, and other quarters are, of course, a necessity in keeping flies out of such places. This is particularly true of rooms where food is being handled. Poisons, sticky fly papers or wires, and other similar devices are of no particular benefit in reducing the numbers of blowflies. Blowflies inside buildings may be killed by the use of one of the many commercial 5-percent DDT-pyrethrum fly sprays or with one of the aerosols containing DDT and pyrethrum. It must be remarked in this connection that blowflies are more difficult to kill with such sprays than are many other kinds of flies. It is usually advisable to sweep up those that fall to the floor and dispose of them properly.

Gutters and sidewalks about market places may be treated with a 2.5 percent, water dispersible DDT spray at 15-day intervals with a resulting remarkable decrease of blowflies about such places.

The residual treatment of inside walls of food-handling establishments with DDT is not, however, desirable. Flies affected by DDT residual treatments do not die until they have staggered, stumbled and bumbled about, often into food.

*Large-scale control methods.* Dead men on battlefields and excrement in latrines produced various species of blowflies in numbers beyond human comprehension on Pacific Islands during World War II. This was particularly true in the Marianas during July, August, and early September in 1944. The use of DDT, eight ounces in one gallon of fuel oil, distributed at the rate of two quarts per acre from C-47 type aircraft by the Pacific Division Air Transport Command, for the control of a critical dengue epidemic on Saipan in September, 1944, brought the blowfly situation to a spectacular conclusion. The success of fly control programs in the Pacific by this organization was based upon a full understanding of fly biology and habits. DDT is an effective fly adulticide but is of little value as a larvicide. To obtain a reduction in a blowfly population over a long period of time, it is necessary to apply the insecticide at 7-day intervals for the period of time required by the immature stages to become adults, the stage of the flies affected. This period is approximately 21 days in the tropics during peak breeding activity. The area covered was always as great as could be economically

included, whole islands where possible, for fly control in limited areas cannot possibly last for long periods of time. In no single instance did this type of control program fail to reduce blowfly populations to a near vanishing point for from six months to a year or more. I reported upon the first of these great control operations in 1945 under the title "Aerial DDT, Emergency Measure for Control of Mosquito-borne Epidemics."

The residual treatment of inside walls of food-handling establishments with DDT is not, however, desirable. Flies affected by DDT residual treatments do not die until they have staggered, stumbled, and bumbled about, often into food.

**MYIASIS CONTROL (Human).** Infestation of human beings by larvae of blowflies may be prevented by personal hygiene, by sleeping during the day behind screens or under nets, by full screening of hospitals, and by the complete protection of individuals with wounds or nasal catarrh.

Early diagnosis and treatment of maggot infestations is of the utmost importance. Deep-seated infestations such as those in natural body openings may not be noticed for some time. Early indications are pain, local swelling, or sensations of burrowing or crawling. The presence of bloody discharges is often a diagnostic feature.

Maggots should be removed by a competent physician promptly upon their discovery, for they may do much damage to human tissues within a very short time. In infestations of natural orifices, ether, chloroform, or benzol may be introduced on a pledget of cotton so that the larvae will be forced to breathe the fumes. Such an application will kill or stupefy the maggots, after which they may be removed easily with blunt-tipped forceps. A second or third application of the anesthetic for 2 or 3 minutes may prove necessary for the removal of all larvae. Upon the removal of all maggots, antiseptics should be applied to the wounds to prevent infection.

**MYIASIS CONTROL (Animal).** Infestation of animals by screwworms or other myiasis-producing flies can be prevented. Sores, cuts, or bruises on stock in pasture should be carefully watched for maggot infestation. To prevent unnecessary injuries in yards or stalls, nails, projecting boards, and snags should be removed. Overcrowding, trampling, and rough handling of animals shipped in cars or trucks should be avoided. The shearing of sheep and goats should be carefully done, and cuts should be treated every day or two until they are healed. Operations such as branding, castrating, or dehorning, and the birth of animals should be planned, if possible, for the cold

months of the year when blowflies are not abundant. If these precautions cannot be taken, the animals concerned should be placed in screened hospital stalls or confined in a small hospital pasture, where they can be kept under observation until their wounds are healed.

The Bureau of Entomology and Plant Quarantine of the U. S. Department of Agriculture recommends either one of two materials for the treatment of myiasis cases in stock. The first, consisting of benzol to kill larvae and pine-tar oil to repel ovipositing female blowflies, has been used by stockmen for many years with excellent results. The second, and preferable one, called "Formula 62," is not designed to repel the flies but to kill the larvae in the wound and to prevent reinfestation by destroying any young larvae that hatch subsequently.

The benzol-pine tar oil treatment is given as follows: Benzol (90 percent) is applied to infested wounds by means of a rubber bulb syringe, and, after a few minutes, more benzol is applied and a cotton plug is inserted in the opening of the wound. Several minutes later the maggots will be either dead or stupefied, and the cotton plug and larvae may be removed with blunt-tipped forceps. Upon the removal of all maggots, blood and serous fluids may be cleaned from around the wound. If the animal is to be turned out where it may be reinfested, the wound must be protected from ovipositing blowflies, and this may be accomplished by an application of pine-tar oil (dehydrated, acid-free, specific gravity 1.065). The animal should be inspected every day and new applications of pine-tar oil made until the wound has completely healed.

Formula 62 is prepared according to the following prescription :

Diphenylamine (technical grade) . . . .	3½ parts by wt.
Benzol (C. P.) . . . . .	3½ parts by wt.
Turkey red oil (pH 10 or neutral) . . . .	1 part by wt.
Lamp black . . . . .	2 parts by wt.

The diphenylamine is dissolved in the benzol, preferably by allowing the mixture of these two materials to stand for 12 to 24 hours. Turkey red oil is added and the mixture thoroughly shaken. Lamp black is gradually stirred in and the mixing continued until a consistency of molasses has been reached. The mixture is best applied to screwworm wounds by means of a 1-inch paint brush.

Precautions that should be observed in the preparation, storage, and use of this screwworm remedy are as follows: (1) As benzol is a highly inflammable liquid, lighted cigarettes, cigars, or open

flames should be extinguished during the preparation or use of the remedy. (2) As benzol is a highly volatile liquid, and will evaporate quickly, it should not be left in an open container. When not in use it should be kept in a tightly closed container in a cool place. If the preparation becomes too thick through loss of benzol by evaporation, additional benzol may be stirred in to bring the mixture back to its original consistency. (3) Infested wounds near eyes of animals should be treated with care, for the preparation is irritating to the eyes. When an excessive amount of the mixture gets into an eye of an animal being treated, the eye should be washed immediately with plain water. (4) Other substances, such as oils or greases, may destroy the efficiency of the preparation and should never be added to the formula.

Animals being treated for screwworm infestation must be inspected every few days and additional quantities of Formula 62 applied until the wound is entirely healed.

**CONTROL OF OTHER BLOWFLIES.** The cluster fly is a parasite of earthworms. It occurs in dwellings only during winter months, coming in late in the autumn in search of hibernation quarters. Usually it enters homes by crawling up outside walls and into attics or upstairs bedrooms through cracks about window casings or between the side walls and roof. Such entrance into houses may be prevented by sealing these openings. A thorough application of one of the various fly sprays, particularly one containing DDT, in attics, closets, and upstairs bedrooms during late October or early November will alleviate this cluster fly plague.

Control of the various species of *Apaulina* is an exceedingly difficult task. It has been suggested that pupae of these flies, which may be found in nests of birds, should be destroyed as soon as nestlings have left; but this is nearly impossible when these parasites are abundant, and the procedure would obviously be costly.

### METHODS OF COLLECTING BLOWFLIES

Adult blowfly collections may be made during most of the year in North America, at least from southern Canada southward. During warm periods of the winter, species which hibernate in the adult stage may be collected in favorable situations, but the best collecting for almost all the species is accomplished during the breeding season.

In general, blowfly collecting may be divided into three different types: general collecting, trapping, and breeding or rearing. The last two methods are most productive.

*General collecting.* General collecting with a hand net is often rather nonproductive unless one has a previous knowledge of some of the habits of blowflies. Since many of the species are carrion-breeding forms any type of carrion should yield specimens, particularly when decomposition is not too far advanced. Fresh excrement of carnivores, soured but not rotten fruit, and melons during certain stages of decay are often favorable attractants. Many calliphorids may be collected upon foliage in sunlight with a hand net, particularly between the hours of 8:00 and 11:00 in the morning. After that time, during the heat of the day, adult flies are too active to be caught in numbers by this method. Male specimens seem to predominate in collections made upon foliage, where they appear to congregate while feeding upon honeydew or seeking moisture. Parasitic species are not often collected in a hand net unless a breeding area is located. Species of *Apaulina*, for instance, may be abundant during the height of their breeding season where bank or cliff swallows are nesting. *Callitroga americana* may be collected about the wounds of warm-blooded animals.

*Trapping.* Methods of trapping carrion-breeding blowflies have occupied much time, thought, and effort in this country, in southern Africa, and in Australia. Traps have been used not only in determining the status of certain species in various localities but also in the control of economic forms. Traps large enough to hold entire carcasses dragged into them by horses have been designed for the control of one species; some have concrete bases. Other traps employ a wind-power apparatus which continually stirs baits composed of carcasses and water. Such traps catch enormous numbers of blowflies which are attracted to carrion. One small wire screen trap, such as indicated in figure I, will usually supply more specimens of the common blowfly species than may be desired for taxonomic purposes and, if used at intervals over a period of a year or two, will yield almost all the carrion-breeding species of the locality. Such a trap may be constructed according to plans given by Bishopp (1916), or may be purchased. Beef or hog liver, or the carcass of some available small animal, is the usual bait placed in the open container below the funnel of the trap. Water sufficient to cover the meat is then added. Slight alterations in the bait will attract a different series of blowflies. For example, freshly exposed carrion attracts species of *Phaenicia* predominantly. Baits several days old attract species of *Callitroga*, and baits still a few days older, *Calliphora* and *Cynomyopsis* during the periods of the year when species of these two genera are abundant. *Sar-*

*cophaga* species are commonly attracted to baits which are very old and strong. Even in the Lucilini there is a strongly marked difference in preference for baits of different ages, *Phaenicia sericata* and *pallescens* preferring baits slightly older than *Lucilia illustris* and *BufoLucilia silvarum*.

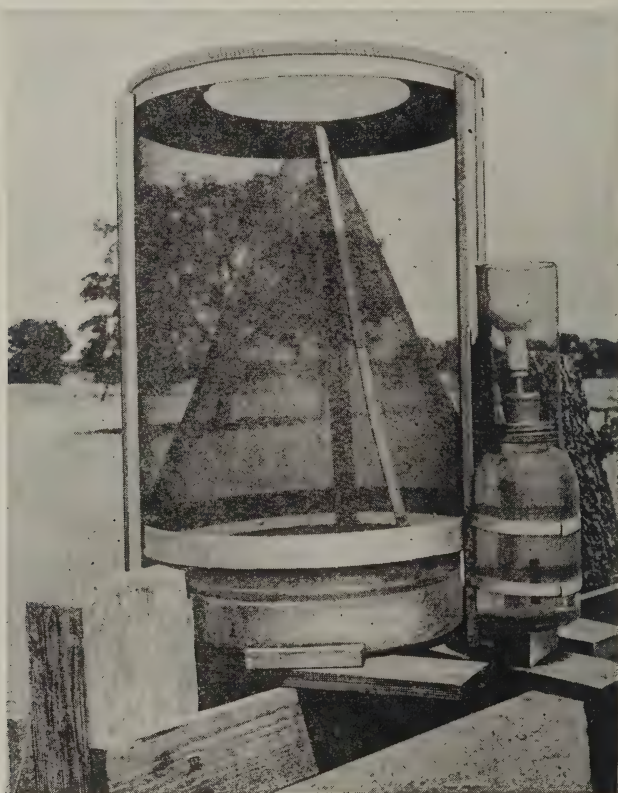


FIG. I. Standard conical type blowfly trap. Designed by Bishopp and Laake, this trap has been found to be the most effective type for making collections of blowflies. Menard, Tex., August 23, 1929.

*Rearing.* Few dipterous insects are more easily reared in numbers than many species of calliphorid flies. Most of the carrion-breeding forms can be reared continuously with a minimum of effort in either artificial or natural light, and they may be inbred for years without apparent weakening of the strain. Miller (1940) has inbred *Phormia regina* and *Phaenicia*

*sericata* for over 200 generations in 10 years. He observed that "these cultures have lost nothing in vigor and are well adapted to laboratory rearing and uses."

Female flies are brought to the laboratory in small glass vials with cotton plugs and transferred to incubation cages. Those caught in the open have usually copulated and will deposit fertile eggs.

The most convenient cage is made from a pint-size ice cream container with the center of the removable top replaced by a wire or cloth screen. Such cages are inexpensive, light, easily replaced, and convenient to handle.

Adult flies must always have an ample quantity of fresh water. They may be fed upon small bits of banana and yeast; in fact, it has been found that they will live longer on this food than on any other. The ovaries of female blowflies will not develop if there is an absence of protein in their diet; this is readily supplied by placing small quantities of ground beef in their cages.

Eggs will usually be deposited upon the under side of the ground beef. According to Lennox (1939), the percentages of eggs of *Phaenicia cuprina* hatching upon alkaline media are invariably higher than those hatching upon acid media. Blown meat should be removed daily and placed upon several inches of slightly moistened, clean sand in another ice cream container. This container should be equipped with a regular top since mature larvae migrate and may escape through wire or cloth netting.

Ground beef is a satisfactory larval food for the carcass-breeding species; fat beef, owing to its high acid content, becomes rancid and is not favorable. Mackerras and Freney (1933) stated that an alkaline reaction was apparently favorable to the development of blowfly larvae, while an acid reaction was comparatively unfavorable. Lennox (1939) also found "that the rate at which the medium is liquefied by larval growth is more rapid the higher the pH value," and that the pH range of food media at which *Phaenicia cuprina* developed satisfactorily was wide, between pH 4 and 9. He found that the final reaction of the medium was apparently little influenced by the initial pH value. In all cultures in which the number of full-grown larvae was not less than 20 per 10 gms. of medium, the ultimate pH value was always between pH 7 and 8.

It has been demonstrated within the past few years that saprophagous species of blowflies can be reared upon a sterile artificial medium. This is important to laboratories in hospitals where certain blowfly larvae are reared for surgical use. Lennox

(1939), in experimenting with various media for the rearing of blowflies (particularly *Phaenicia cuprina*), found the following formula to produce full-grown larvae, under sterile conditions, in the same time as beef liver.

Agar solution (one and one-half percent) . . . . .	93.0
Yeast (dried bakers') . . . . .	6.7
Sodium chloride . . . . .	.3

The addition of fresh egg white instead of agar solution produced larvae in about 24 hours less time.

A method of rearing larvae of *Callitroga americana*, an obligatory parasite on warm-blood animals, which have never been found to complete their growth normally on cold-blood animals, carcasses, or other nonliving media, has been developed by Melvin and Bushland (1936 and 1940). Their most recent formula for this medium is as follows:

Water . . . . .	1 liter
Formalin (39 percent formaldehyde) . . . . .	6 cc.
Beef (finely ground muscle tissue) . . . . .	1 kg.
Blood, beef (citrated at the rate of 3 gm. per liter) . . . . .	500 cc.

"The ingredients are thoroughly mixed in the order given in a No. 2 galvanized tub approximately 15 inches in height by 2 feet in diameter. The rearing tub is kept in a warm room (temperature range, 85 to 100 degrees F.). Newly hatched larvae are placed on the medium and begin to feed immediately. They are allowed to feed for three days and are then transferred to a tub of fresh medium where they feed for three or four days more before completing larval growth. During the first three days, several thousand larvae may be grown in one rearing tub but during the second three days, about 2,000 larvae will exhaust the food supply of a fresh tub."

These authors state that the formula given does not need to be followed strictly for satisfactory results but that the amount of formalin is important, for bacterial decomposition renders the medium unsuitable for larval development. The volume can be regulated according to the number of larvae being reared, it being important only that, regardless of the size of the container, the medium should fill it to the depth of approximately 1 inch.

Warmth, moisture, shelter, and aëration are essential physical conditions for larval development of carrion-breeding species of calliphorid flies.



The larvae mature in from 3 to 4 days in warm weather and then migrate from the food. They will enter the sand to pupate if it is not too moist or too dry. The food should be removed when all the larvae have left it, and the wire or cloth screen top may be placed on the cage when all the larvae have pupated. The sand in the cage should not be allowed to become dry; with a little experience one learns to judge the amount of water to be added daily.

The pupal period varies with the species and also with the season of the year. Many of the species overwinter as mature larvae. In some instances a few days in an ice box and a gradual warming will hasten pupation. With favorable temperatures delayed pupation is usually the result of the sand's being too dry or too moist.

Certain calliphorid species cannot be reared in this way. *Pollenia rudis* and species of *Onesia* which are parasitic upon earthworms may be reared according to the technique of Keilin (1915) or Decoursey (1927). Since *Apaulina* larvae suck avian blood, the rearing of such species is a difficult procedure and each different species group may require different methods.

Many of the species have never been reared and few facts are known concerning their biologies. The above procedure is satisfactory, however, for the majority of the species which have saprophagous habits in the larval stage.

### PRESERVATION OF SPECIMENS

Emerging adults should be fed upon granulated sugar and banana for at least 24 hours before being killed and pinned. This procedure is necessary to fill out and harden the body wall and to allow sufficient time for the color to develop fully. The empty pupal case should be placed upon the pin just below the adult specimen.

In order to obtain specimens of the different instars, some larvae should be preserved upon hatching from the egg, others 24 to 48 hours later, and still others when they start to migrate from the food source. Selected specimens should be killed by immersion in boiling water. I prefer to preserve muscoid larvae in a solution prepared according to the following formula:

Alcohol, 90 percent .....	85 cc.
Formalin, 40 percent .....	10 cc.
Glycerine .....	5 cc.

Specimens preserved in this solution retain their shape and color indefinitely and, after perforation with a fine needle, may

be boiled in caustic potash solutions when cleared parts are needed.

If sufficient time is available larval specimens may be dropped alive into a warm Hetherington's Solution which must be made fresh every few days. This solution is made according to the following formula:

Absolute alcohol .....	60 cc.
Chloroform .....	45 cc.
Glacial acetic acid .....	15 cc.
Phenol crystals .....	30 cc.

Specimens are left in this solution for about 24 hours, then transferred into a solution composed of 50 percent Hetherington's Solution and 50 percent oil of wintergreen for an hour or two, and finally into oil of wintergreen for a period of 24 hours. This procedure gives an almost transparent larva in nearly natural shape, with all the sclerotized parts in their natural locations and in nearly perfect view.

Both the buccopharyngeal mechanism and the spiracles are seen to best advantage by transmitted light. Such parts may be dissected from the larva and placed upon a microscope slide in balsam. It is necessary to pass specimens preserved in 70 percent alcohol solutions through the alcohol and xylol series before placing them in balsam, but specimens in oil of wintergreen may be transferred directly to balsam. In the latter instances better specimens are obtained if a few drops of oil of wintergreen are added to the balsam.

Detail in sclerotized areas may sometimes be studied best when stained. Such areas do not stain very well, but a saturated solution of picric acid in absolute alcohol combined with a saturated solution of safranin in absolute alcohol will give satisfactory results in about 24 hours. Destaining may be accomplished in xylol if necessary. The advantage of this stain is mainly in the fact that it is not necessary to retrace steps from Hetherington's Solution to weaker alcohols or water, then back to absolute alcohol and xylol.

### EXPLANATION OF TERMS

Only a few of the terms used in this study require explanation. Most of them have been used in the taxonomic literature of Diptera or are in the taxonomic literature of other zoological forms, and such terms are explained in detail in most glossaries. Some of those employed here, however, are either new or have been used infrequently; these are explained below.

Intrapostocular cilia are minute setae placed in a more or less well-defined row immediately behind the rear margin of the eye and in front of the first row of postocular cilia. This is a new term. The small setae are often difficult to discern and can be seen to best advantage only under high magnification and with good illumination. The row is most obvious in *Callitroga* and *Paralucilia*, less so in *Onesia*, *Acrophaga*, and *Melanodexia*.

Proportional and dimensional characters were made with the aid of a cross-line disc placed between the lenses of the ocular in the binocular microscope. (The measurements given in this paper were secured with medium high power, and the same magnification was used throughout.)

Measurements are given in micrometer units instead of in millimeters. These measurements were secured by averaging the actual measurements in a series of specimens. The figures therefore represent relative and not actual lengths and widths. They are to be used as a basis of comparison between parts of the same specimen or as a basis of comparison between different species. Obviously, actual measurements of parts in individual specimens are of only minor importance. Extremes may be of great value in the future when series of specimens of the same species have been reared or collected, but for several of the species only single specimens have been available.

Proportional measurements in specimens of the same species remain nearly constant. Those given may vary only as much as one-half unit in one direction or the other. Where greater differences occur in series considered to be a single species, the instances are discussed in the text. In several cases where the character seems to lose its specific value, it is possible that more than one species exists in the series, or that the species is heterozygous for the character. There is the possibility that too many forms will be recognized as distinct species when reliance is placed on differences in measurements, but usually other characters have been discovered to support the conclusions based on such measurements.

Characters of this sort may be confusing at first to students not familiar with them, but a little practice will show that such differences may be as easily observed as others. It has been found that they may be trusted to show real specific distinctions more accurately than many other characters.

Ten specimens of each sex were measured when this number was available, including the largest and smallest individuals, specimens from the extremes of the distribution, and several of average size.

Measurements of the height and length of the head are taken in profile view. The length of the head at the antenna is the average length in micrometer units from the visible posterior margin of the head (most often visible just behind the postocular cilia) to the antennal base. The length of the head at the vibrissa is the average length in micrometer units from the lower rear margin of the metacephalon to the vibrissal angle. The height is the average distance in micrometer units from the lowest margin of the head to the upper ocelli. The eye height is the distance in micrometer units from the lowest point to the uppermost margin.

The buccal height in relation to the eye height is obtained by dividing the number of micrometer units in the height of the eye into the number of micrometer units in the height of the bucca (distance from the lower margin of the head to the lower eye margin).

The width of the front at the vertex in relation to the head width is the fraction obtained by dividing the number of micrometer units between the eyes across the inner vertical bristles by the number of micrometer units in the entire head width. The width of the front at the narrowest portion and at the lunule are obtained similarly.

The width of the parafaciale is the distance from the margin of the eye to the slight angle where the parafaciale widens to meet the frontale, just above the first antennal segment and nearly at the lunule. The width between the vibrissae is the distance between the bases of the largest bristles.

The costal margin of the wing is divided into a series of sections by the terminations of the longitudinal veins, and the relative proportions of these sections to one another are expressed by the average number of micrometer units in each section. In the Mesembrinellinae the character is of great value, but in the Luciliini and Calliphorini it is not so useful because of variation in specimens of what appear to be the same species. However, such figures do aid in indicating the positions of certain wing veins.

The terminology applied to the leg bristles in this paper is that now in common use by students of the taxonomy of the Anthomyiidae. When rows of bristles occur regularly upon a certain leg surface, or when a constant number of bristles has been found in certain positions throughout the species of a genus, then this fact is noted in the generic description. When the number of bristles or the position of certain bristles upon a given leg surface has been found to vary from one species to

another, such variation has been considered to be of possible specific value and such differences have been noted in the specific descriptions.

## VARIATION

The general impression seems to prevail among students of Diptera that few characters of color and chaetotaxy are sufficiently constant to be useful in the recognition of the different species of Calliphoridae. This feeling, however, is apparently based upon cursory examinations of series of specimens supposed to represent a single species but exhibiting very different metallic colorings, the mass of synonymy published in catalogs, and, at least in part, upon published papers dealing with "variation" in *Lucilia* and *Calliphora*. That variation occurs in characters employed in this paper to distinguish between species of Calliphoridae cannot be doubted; but careful study of an immense mass of material has demonstrated that certain characters, ordinarily ignored as too variable, are definitely usable.

Usually adults of Diptera acquire normal color within a few hours after emergence; but in many Calliphoridae the typical coloring may not develop for 24 hours, especially in humid weather. In some of the species of *Phaenicia* the typical coloring may take on a bronzy hue after 2 or 3 days, and this change may become even more pronounced later. Such changes are most obvious when green or blue is the predominant color. Specimens may change in color even after they have been killed, although such changes are slight in the case of deep blue or yellowish species, provided the specimens are fully developed when killed.

It is true that some variation exists in the chaetotaxy of muscoid flies (See Townsend, 1914, p 112). It seems only necessary to state here that most of the characters used were selected from those proved to be relatively constant in long series of specimens reared from egg masses deposited by single females, which, in some cases, were from second- and third-generation rearings. When such series were not available, characters were chosen that had been found to vary little in long series of closely related species.

It has been known for many years that large individuals of a species have more strongly developed bristles and hairs than do small individuals of the same species. In many cases weak bristles tend to become hairlike (or are rarely absent) and may be overlooked unless searched for carefully. The actual position of certain bristles may vary slightly in some specimens of a

reared series, but this happens rarely and does not seriously interfere with the use of the bristle arrangement as a distinguishing character.

In a number of reared series of several species obtained from widely separated sources in the United States, reduction and duplication of bristles occurred in the dorsocentral or acrostichal series in slightly less than 5 percent of the individuals. Duplication occurred nearly twice as often as reduction. Such variation occurred on one side or the other, rarely on both sides in the same specimen. This matter is discussed more fully under sections dealing with *Phormia regina* and *Phaenicia sericata*.

In cases where variation seems to be significant, this fact has been noted in the description of the species; characters showing too wide variation have not been used in the taxonomic treatment of the species concerned. Only a few species have been separated upon characters of chaetotaxy alone, although it would have been possible to do so in many instances.

Just how much reliance may be placed on the position of bristles on the legs is questionable at the present time. A given number may remain constant in a single species, but the actual position of one or more of these may differ slightly among specimens which otherwise appear identical. Whether these differences are specific cannot be ascertained now, and such characters have not been employed in the separation of species.

As a rule, several characters have been given in the keys for the separation of each species. Usually one or two of the key characters pertain to chaetotaxy and one or more to proportional measurements of certain parts. Finally, a supplementary color character is often given. Although it is felt that any one of the characters will usually separate the species concerned satisfactorily, all characters mentioned should be fully considered before arriving at a definite conclusion as to the identity of a specimen.

In several supposedly cosmopolitan species small differences can be noted among Australian, African, and North American specimens, but such differences are minute and may possibly be of no real significance. They can be distinguished in a long series but not always in individual specimens, so I have not attempted to differentiate between these forms. For example, the *Phaenicia sericata* of Europe and North America appear to have slightly different average frontal widths. *Protophormia terrae-novae* from Europe agrees with the Alaskan *terrae-novae* treated here, but specimens of this species from the southern part of its distribution appear to have slightly different buccal and eye-height

proportions. *Pollenia rudis* also varies widely in eye size, but I am unable to find characters for separating distinct segregates.

### TECHNIQUE

Since the male genitalia are diagnostic in many species, it is usually necessary to relax dried specimens in order to observe and study the various parts. Internal structures are seen to best advantage in fresh material placed in proper fixing and killing solutions. The following technique applies only to the external sclerotized structures of the male and female. Relaxing of such specimens may be accomplished in several ways, but the method which I find most satisfactory requires merely a deep glass evaporating dish, a piece of cork, and a towel or two. The dried specimens are pinned to the cork, which is then placed in the evaporating dish; the towels are saturated with water, folded, and then placed over the top of the dish. Even the oldest and driest of specimens may be fully relaxed in from 24 to 48 hours. When the specimens dry, they usually retain all the color and pollinosity existing before treatment. There is little or no opportunity for specimens to become moldy during relaxing because both the dish and the towels may be sterilized frequently and the cork can be changed as desired.

In nearly 120,000 male specimens relaxed in this way, only a very small percentage became damaged and these because of stain due to the presence of grease. This grease was removed with varying success by placing such specimens in ether or chloroform for a day or two. Under this treatment they usually regained their former appearance.

In certain instances when a hurried identification of a dry male specimen is desired one of two methods may be employed to relax the genitalia. Ammonia water may be applied to the tip of the abdomen with a camel's-hair brush at 10-minute intervals until the parts have softened; this will usually allow the genital parts to be removed, often without damage to the rest of the specimen. The hazard to the wings and legs, however, is great, and the abdomen is sometimes broken during the process. If a specimen is of no particular value, the abdomen may be removed completely and placed in boiling water until the parts have relaxed. In some cases such abdomens can be dried in alcohol and ether, then glued back in place upon the specimen.

In order to pull the male genitalia into view without breaking the specimen or spoiling it during the process of extraction, a set routine has been developed. The relaxed specimen is removed from the relaxing jar and gently but firmly held be-

tween the thumb and forefinger of the left hand with the head of the fly toward the palm of the hand and the legs upward. The hands are then placed on the microscope stage, backs down, with the middle fingers placed firmly together. The dissecting needle is held like a pencil in the right hand (see Fig. II). This method assures steadiness and a minimum of damage to specimens. Middle or high magnification is desirable. Dissecting needles most suitable for this work are made by forcing a slightly hooked minuten nadeln or No. 00 steel insect pin into a suitable handle. Sealing wax will usually hold the pin in place permanently.

The needle is gently thrust between the genitalia and the edge of the fifth sternite. The hook is then slightly turned toward

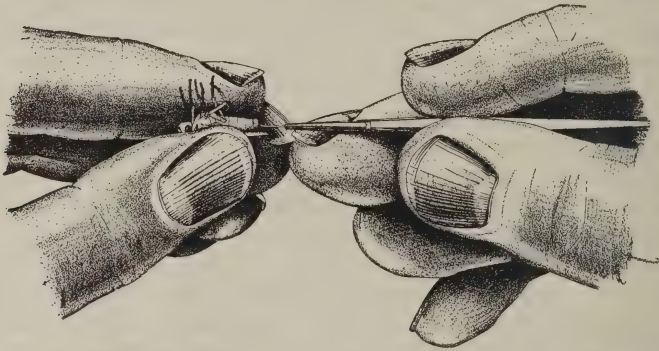


FIG. II. Method of holding specimen and position of hands during dissection of the genital segments of the male.

the genital capsule and carefully retracted in an attempt to break the muscle attachments between the genitalia and the terminal portions of the abdomen. This action should be performed several times on each side until the entire genitalia appear loose but still remain intact with the tip of the abdomen. The needle is next hooked to the tips of the inner forceps and by gentle retraction the parts are rolled outward into view. If complete dissection is necessary, attachments are finally severed with the needle. If not, the dissection is complete as soon as the parts are fully exposed.

The genitalia to be fully dissected are placed in a small crucible containing 10 percent potassium hydroxide and carefully brought almost to the boiling point. A quick inspection under the binocular microscope will show the progress of clearing. The clearing should not be carried too far, for certain internal fea-



tures can then be seen only with difficulty. After being cleared, the genitalia should be washed for 10 minutes in water. Complete dissection is accomplished under glycerine in a watch glass under a high power of the binocular microscope.

Several methods of storing such dissections have been used. The one preferred involves small glass vials, glycerine, and small corks. The glycerine is placed in the bottom of the vial, the dissected specimen is immersed in the glycerine, and the cork (the tip of which is covered with balsam) seals the preparation. Balsam and glycerine apparently do not mix and vials corked in this way for a number of years have remained in excellent condition. The vial is subsequently placed on the pin with the specimen; thus the adult, the labels, and the vial enclosing the genitalia may be kept together on a single pin in the collection.

Various other methods of preparation have been used, such as slide or point mountings, but such mounts either discolor, are partly obscured, or must be stored separately.

### SYNONYMY

Much of the synonymy given is that proposed by the late J. M. Aldrich, who examined type specimens of many North American species in European museums. In some instances his new synonymy was left only in note form. Synonymy in the *Luciliini* is that given by Aubertin in 1933.

I have studied most of the types of North American calliphorid flies in North American museums but have examined only a few which are in European museums. The keys to the *Chrysomyini* were sent to all European museums in which type specimens of North American species are deposited and these type specimens were run through the keys by competent dipterists. In some respects this course was not entirely satisfactory, but it was the only way in which the identity of many of the old types could be determined.

A considerable part of the synonymy given by Bezzi in the 1907 Palaeartic Catalog of Diptera is not repeated for species supposedly occurring in both North America and in the Palaeartic Region. In many points this work has been found to be erroneous and only type examination will clarify such synonymy.

### CLASSIFICATION

The purpose of the key to larger groups in this work is to define the family Calliphoridae. No attempt is made to show actual affinities of calypterate or acalypterate flies other than those of the calliphorid stem.

As stated by other authors, the genotype of *Musca* is *vomitorea* Linnaeus by designation of Latreille (1810, p. 444). There is no question that the designation was a valid one under the Rules. When the economic importance of the common housefly became recognized early in the present century, Townsend designated *domestica* Linnaeus as genotype of *Promusca*, realizing that *vomitorea* and *domestica* are but distantly related. But the name *Musca domestica* had become of world-wide interest within a period of about 20 years, and, in order to preserve this well-publicized combination, the International Commission on Zoological Nomenclature suspended the Rules for the acceptance of *domestica* as genotype of *Musca* (Opinion 82), notwithstanding the fact that *vomitorea* stood as genotype for *Musca* for well over 100 years. In accordance with the ruling of the Commission, *vomitorea* is therefore accepted as the genotype of *Calliphora*.

The species included here under the subfamilies Mesembrinellinae and Rhiniinae are aberrant in the Calliphoridae. They have been placed with *Pollenia* and others in a separate family recently, but *Pollenia* shows affinities to *Calliphora* which are not possessed by *Mesembrinella* or *Rhinia*. Both are treated in the traditional sense because of the similarity of the genitalia. More information on their biology and immature stages may eventually indicate more clearly their true relationships.

The affinities of Phormiini and the *Phormia*-like species are not yet entirely clear. These species seem to be more closely related to the Calliphorini than to the Chrysomyini, but no very definite evidence to support this conclusion was found. On the contrary, characters of the larvae and the ciliate remigium lead me to place them with the Chrysomyinae.

# KEY TO MAJOR TAXONOMIC UNITS OF NORTH AMERICAN MUSCOID AND CALLIPHORID FLIES

1. Second antennal segment without a laterodorsal longitudinal seam; thorax without a complete transverse suture on dorsum anterior to wings; abdominal spiracles 1 to 5 located in membrane (except in Chloropidae and Ephydriidae); lower calypter normally undeveloped; posthumeral bristles absent; postalar callosity normally undeveloped; anterior orbits usually separated above from laterovertical plates or latter alone are developed and bear fronto-orbital bristles (if frontoorbital bristles are located on orbits, the lower bristles are closer to eye margin than upper); subcostal vein often incomplete or imperfect; fourth vein usually straight.....Acalypteratae.

Second antennal segment with a complete laterodorsal longitudinal seam; thorax normally with a complete transverse suture on dorsum anterior to wings; abdominal spiracles 2 to 5 located in tergites (except in Glossinidae); lower calypter usually large; posthumeral bristles usually present; postalar callosity usually developed; anterior orbits not separated above from laterovertical plates and bearing a row of converging frontoorbital bristles which are more distant from eye margin toward lunule than toward vertex; subcostal vein always distinct and ending in costal vein.....Calypteratae....2

2. Hypopleuron usually without hairs or bristles below metathoracic spiracle; pteropleuron usually without vestiture; when three sternopleural bristles present, these usually arranged 1 + 2; ventral abdominal membrane more or less exposed, usually distinct; fourth longitudinal vein straight or but slightly curved, and usually extending to wing margin behind wing apex.....Anthomyiaria.

Hypopleuron usually with hairs or bristles in one or more rows below the metathoracic spiracle; pteropleuron usually pilose or setose; when three sternopleural bristles present, these usually arranged 2 + 1; ventral abdominal membrane usually hidden; fourth longitudinal vein curving or bending forward, most often narrowing the apical cell .....Oestromuscaria. 3

3. Metanotum strongly biconvex, the postscutellum well-defined; edges of sternites usually overlapped and at least partially hidden by margins of tergites; abdomen often with discal bristles. Larva parasitic upon immature stages of insects or warbles or bots in mammals; posterior spiracle always with a definite "button" . . . . Oestroidea and Tachinoidea.

Metanotum not biconvex, the postscutellum absent or weakly developed (if more or less prominent, the metathoracic spiracular covering is not in two parts but covers the entire lower portion, leaving a small opening in the middle above); first sternite overlapping lateral margins of tergites; abdomen rarely with discal macrochaetae. Larva saprophagous, parasitic upon insects or animals; posterior spiracles with or without a button. . . . . 4.

4. Hypopleuron with weak hair not arranged in rows, or bare, the pteropleuron either pilose or bare (if both bare, then fourth vein with rounded angle or evanescent). Larva saprophagous; posterior spiracular openings short, radially arranged, sinuous, or bent (if more or less parallel, then with each opening pointed at inner end); rarely with distinct fusiform pads on lateral margins of segments . . . . . Muscoidea.

Hypopleuron setose, with one or more rows of bristles below metathoracic spiracle; pteropleuron setose; fourth vein usually with a definite angle or bend. Larva saprophagous or parasitic upon other animals; posterior spiracular apertures elongate, usually slender and subparallel; margins of posterior depression with tubercles or processes, three laterally on upper margin, and generally four on lower margin . . . . . Sarcophagoidea. 5

5. Intrapostocular cilia always absent; usually four notopleural bristles; spiracle 8 of abdomen sclerotized and located anterodorsally to outer forceps in membrane\*; propleuron and prosternum usually bare (if pilose, then never with long and thick-set pile or hair); arista plumose, pubescent or bare, the apex always bare, the plumosity rarely long or extending beyond the basal four-fifths; abdomen usually grey or black tessellated, sometimes ornamented with golden pollen (metallic green or blue in several Neotropical genera); greater ampulla usually knob-

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\*According to Patton (1934).

like and round. Larva with dorsal cornua of cephaloskeleton divided or incised; spiracles in deep depression (except in Sarothromyinae); peritreme usually open, the "button" indistinct or absent. . . . . Sarcophagidae.

Intrapostocular cilia present (except in Rhiniinae and occasionally in *Melanodexia* and *Onesia*); only two notopleural bristles developed (rarely with an adventitious weakened third); spiracle 8 of abdomen absent; propleuron and prosternum pilose (except in Polleniinae); arista with plumosity usually long and extending nearly to apex; abdomen usually metallic blue, green, bronze, or black; greater ampulla reniform. Larva with dorsal cornua not divided or incised; spiracles not in deep depression; peritreme usually closed, the button usually distinct and in peritreme (except in Chrysomyinae) . . . . Calliphoridae. 6

6. Metanotum with small but distinct postscutellum; metathoracic spiracle ovate and very large, the opening on the dorsal margin; bucea narrow, hardly one-fifth eye height; fourth vein with a broad sinuous curve toward costal margin; female without sclerotized and membranous ovipositor, the larva developed within well-defined uterus. Larva with sclerotized area on ventral surface of third segment . . . . . Mesembrinellinae, p. 60.

Metanotum without postscutellum; metathoracic spiracle not as described; bucea distinctly higher in comparison with eye height; fourth vein usually with a distinct angle; female with sclerotized and membranous ovipositor, the larva not developed within a well-defined uterus. Larva without sclerotized area on ventral surface of third segment . . . . . 7

7. Remigium ciliate above . . . . . 8  
 Remigium bare above . . . . . 9

8. Occipital orbits very narrow; intrapostocular cilia inconspicuous or absent; greater ampulla either bare or but faintly pubescent; lower calypter always bare on upper surface, rounded at apex, the lateral margin nearly straight. Third-instar larva with spiracular "button" within closed peritreme which extends between each slitlike aperture; dorsal cornua of cephaloskeleton having the appearance of being divided . . . . . Rhiniinae, p. 89.

- Occipital orbits wide, the intrapostocular cilia very distinct; greater ampulla often pilose or setose; lower calypter truncate posteriorly, slightly to considerably concave on the lateral margin, and on the upper surface always pilose at base, as in Phormiini, to setose on the disc as in Chrysomyini (bare in *Hemilucilia* and *Chloroprocta*). Third instar larva with spiracular "button" not within closed peritreme which does not separate each slit-like aperture; cephaloskeleton not appearing divided ..... Chrysomyinae, p. 95.
9. Prosternum and propleuron setulose or pilose; vestiture of parafaciale not reaching lower eye margin; thorax without crinkly hair. Third-instar larva with closed, strongly sclerotized, peritreme ..... Calliphorinae, p. 202.
- Prosternum and propleuron bare; parafacials setose to lower eye margin; thorax with crinkly hair. Third instar larva with weakly sclerotized closed peritreme.... Polleniinae, p. 340.

## FAMILY CALLIPHORIDAE

Although most of the diagnostic characters of calliphorid flies known to me are employed in the preceding key, a summary of characters which all such flies have in common is given here.

**MALE AND FEMALE CHARACTERS HELD IN COMMON.** Head usually, and often considerably wider than high, sometimes wider in female than in male; clypeus flush to deeply impressed, and most often half as wide as long but sometimes either wider or narrower; faciale usually slightly bowed; vibrissae usually strong; proboscis rarely exceeding head height, usually one-half to two thirds as long; labella large; cheek grooves deep; palpi filiform, cylindric, or clavate, sometimes flattened, rarely short; antenna with first segment erect and usually flush with frons in profile, second segment two to four times as long as first, with a few strong setae dorsally, and with a laterodorsal longitudinal seam, third segment two to eight times as long as second, the lateral margins more or less parallel, the apex rather rounded; arista considerably longer than third antennal segment, penultimate segment of arista short and often somewhat bulbous, apical segment slightly thickened at base only, then gradually tapering toward apex, usually with long hairs which are sometimes less numerous and shorter below, rarely pectinate,\* pubescent or bare; vertex narrower in male than in female; ocelli three; ocellar triangle often slightly raised; genoorbital bristles absent; intrapostocular cilia present except in Rhiniinae and occasional specimens of *Onesia* and *Melanodexiini*.

Thorax with metanotum not divided except in Mesembrinelinae in which the postscutellum is slightly raised; greater ampulla raised, reniform; lesser ampulla swollen and differentiated from rim of postparapteron; hypopleuron with a well-defined row of bristles; intrahypopleural bristles undifferentiated; pteropleuron usually setose on posterior half or slightly more; pteropleural bristles in a well-defined tuft, none long; mesopleuron bare on about anterior fifth; mesopleural bristles in a well-defined row; notopleuron setose; notopleural bristles usually two, rarely an adventitious third one between these; intrasterno-

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\*Williston (1908) defined the term "pectinate" as follows: The arista is said to be *pectinated* if the hairs are fewer, stronger, and confined to one side.

pleural row of bristles undifferentiated; lateral postscutellar plates setose.

Wing with fourth vein angularly or roundly bending toward wing apex; third costal section nearly as long as fifth and sixth together; anterior cross vein usually oblique, near the middle of the second section of the fourth vein; posterior cross vein sinuate to doubly arcuate, rarely almost straight, considerably beyond middle of third section of fourth vein; last section of fifth vein rarely more than one-third as long as preceding section; first and fifth veins bare, third with setulae toward base; sixth vein never extending to wing margin; seventh vein usually short and straight; lower squamal lobe considerably larger than upper, both lobes of medium to large size.

Legs rarely short, usually of medium length, never greatly modified; fore femur with dorsal, posterodorsal and posteroventral row of bristles; fore tibia with anterodorsal row of small setae; middle femur with posteroventral row of bristles and with from one to several anterior bristles near middle; hind femur with anterodorsal and anteroventral rows of bristles; tarsi usually as long as corresponding tibiae, rarely modified or ornamented; claws and pulvillae usually as long as preceding tarsal segment.

Abdomen either broad, round ovate, or oblong oval, and usually more elongate in male than in female; sternites exposed and usually overlapping tergites, first usually wider than second; ventral membrane rarely narrowly exposed (widely exposed in Mesembrinellinae); spiracles in tergites; eighth spiracle absent.

Genital segments of female in form of extensile ovipositor and usually concealed in fourth abdominal segment (except in Mesembrinellinae).

Genital segments of male small to large, often ventral, but sometimes terminal to fourth abdominal segment.

**MORPHOLOGY OF ABDOMEN AND GENITALIA.** The genitalia of the calliphorid flies are of the same general structure almost throughout the family and, with the exception of those of the females of species of Mesembrinellinae, may be used for family distinctions. In this they differ considerably from those of the many species of Sarcophagidae in which there is so much diversity of form, position, and ornamentation of the various parts. The genitalic structures of the calliphorid flies are somewhat difficult to use as a means of specific differentiation. While specific differences usually exist, they are not obvious. Since the structure of the genitalia is so similar almost throughout the family, it seems unnecessary to describe it for each



genus and species.<sup>1</sup> Instead, a generalized description of the parts is offered below. The terminology employed is that proposed by Lowne (1890-1895) unless otherwise noted.

*Abdomen.* The abdomen, as the term is used in taxonomic literature of the muscoid flies, is composed of the first five segments, the first tergite being fused with the second (indicated mainly by the presence of its spiracle), so that the abdomen is apparently four-segmented dorsally. The sclerite formed by the fusion of the first and second abdominal tergites has always been called the first in taxonomic literature and I adhere to this practice. The first sternite is large and may be seen without difficulty, the second to the fourth sternites are usually smaller and narrower, and the fifth and last obvious sternite often large and deeply emarginate. Each apparent tergite, except the first, bears a pair of spiracles, one on each side. These five segments comprise what has been termed the "abdomen." The remaining segments, with their appendages, have been referred to frequently as the "postabdomen."

*Genital segments of male.* In the male, the sixth tergite is nearly fused with, and often considered a part of, the following segment. It is a narrow ribbonlike sclerite, and usually bears one or two rows of strong marginal bristles.

The homologies of the remaining tergites and sternites are uncertain. What is herein termed *first genital segment* (GS I) is the first large dorsal sclerite behind the fifth tergite. This segment bears a spiracle on each side, and has often been considered the combined seventh and eighth tergites, but Crampton (1936, 1941) shows it to be a composite segment composed of sternites seven and eight. Another spiracle anterolaterally in the tergite is possibly the sixth. According to Patton (1934) the species of Calliphoridae lack a sclerotized eighth abdominal spiracle. The next large dorsal sclerite is called *second genital segment* (GS II). Schröder (1927) considers the segment to be composed of circumvested sternites because of the looping of certain internal sexual parts over the rectum and Crampton (ibid.) concurs in this opinion. By others this segment is considered to be the ninth tergite. It is the actual genital segment.

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<sup>1</sup>For further information on these parts, see Lowne (1890-1895), Brül, (1897, p. 511-618), Schröder (1927), Townsend (1934), and Graham-Smith (1939).

Comparisons of the internal anatomy of these flies are mainly from the published works of Townsend (1934-1937) for *Pollenia*, *Callitroga*, *Proto-phormia*, *Calliphora*, *Lucilia*, *Phaenicia*, and *Cynomyopsis*; Keilin (1915) for *Pollenia*; Dufour (1844-45) for *Rhyncomyia* and *Stomorphina*; Lowne (1890-1895) for *Calliphora*; Siebold (1838) for *Onesia*; Graham-Smith (1939) for *Calliphora*.

Within the segments lie the genitalia proper, the whole complex of structures beyond the fifth abdominal segment being termed the *terminalia*. It has also been called the postabdomen, hypopygium (which term should actually be applied only to the anal plate), genitalia and many other terms. In the present paper the parts composing the terminalia are referred to as the *genital segments* (Fig. III).

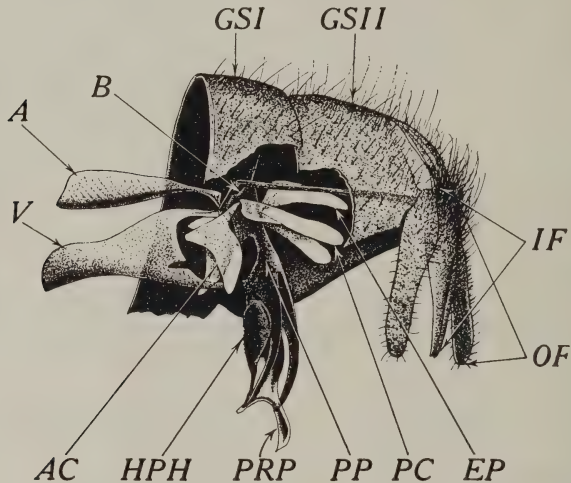


FIG. III. *Calliphora vicina* Robineau-Desvoidy. Male genital segments, sclerotic morphology.

A.	Apodeme.	IF.	Inner foreeps.
AC.	Anterior gonapophysis.	OF.	Outer foreeps.
B.	Phallobase.	PC.	Posterior gonapophysis.
EP.	Epiphallus.	PP.	Paraphallus.
GSI.	First genital segment.	PRP.	Praeputium.
GSII.	Second genital segment.	V.	Vinculum.
HPH.	Hypophallus.		

When genitalia are exposed to view, the most obvious internal appendage is the *phallosome* (P), which is a sclerotic and membranous tube, the various sclerotized areas of which apparently do not change materially in position, and within which lies the apical portion of the ejaculatory duct. The phallosome may be divided into three rather distinct portions: the phallobase (B); the middle portion, or paraphallus (PP); and the apical or terminal portion, or praeputium (PRP).

The *phallobase* is short and heavily sclerotized and bears posteriorly a single long thinly-sclerotized process, the epiphallus

(EP), the lower surface of which is smooth. The *paraphallus*, composed of membrane and sclerotized areas, has a pair of stout, curved, ventral struts which end distally in outwardly directed barbs or spurs. On the distal section of the upper wall is a heavily-pigmented sclerotized area, the *hypophallus* (HPH), which is partially covered in most instances with short spines, from which strong lateral processes, *cornua*, project distally, more or less parallel, and close to the barbed processes of the paraphalli. In a median line, a single process projects distally and another proximally to support the membrane. The *praeputium* is strengthened on the dorsal surface by the median distal process of the hypophallus and laterally by projections of the cornua. This apical section terminates in a small, funnel-like expansion at the base of which the ejaculatory duct opens. The phallosome is attached basally to the apodeme by means of a short, narrow, sclerotized ribbon.

The aedeagal *apodeme* (A) is a strongly sclerotized, more or less curved rod which is often nearly as long as the phallosome. It is longitudinally depressed posteriorly and strongly concave from side to side. The anterior surface possesses a median longitudinal carina or ridge which divides near the basal end, each branch terminating in a cup-like depression. The apical end is free, but the basal end is attached to the base of the phallosome.

The *vinculum* (V) is a sclerite divided into two parts. The apical section is an elongate, somewhat sclerotized plate with the tip free; the basal section is attached to the genital segments. The body is a broader and more heavily sclerotized plate which articulates upon each side with the "quadrilateral plate" (Graham-Smith, 1939), but lateral to the articulation a strongly sclerotized prong passes ventrally and posteriorly to form a bent lateral process. The lateral process articulates with the anterior end of a rod, which is an anteriorly directed prolongation from the outer forceps. Aside from general habitus, some of these parts have not been found to be of particular value in the specific determination of the flies concerned and, because they obscure more important details, have been omitted from the illustrations of such parts.

The *quadrilateral plate* is a median structure, concave on its lower surface, which articulates with the body of the vinculum and is fused with the anterior gonapophyses. It has usually been omitted from the illustrations.

The gonapophyses are a pair of sclerotized, plate-like structures which lie laterad of the quadrilateral plate. The *anterior*

*gonapophysis* (AC) (here called the anterior clasper) has a wide base which is fused to the under surface of the quadrilateral plate. The ventral edge is often ornamented. The *posterior gonapophysis* (PC) (here called the posterior clasper) is usually a stout, elongate plate which is often heavily sclerotized at the base but less so apically. The ventral surface may also be ornamented. The shape and ornamentation of these parts are sometimes of specific importance, but the perspective from which the plates are viewed often distorts these characters.

The *inner forceps* (IF) and the *outer forceps* (OF) are the hindmost genital appendages. The inner forceps lie on each side of the anal opening or slightly below it. These articulate at their bases with the outer side of an inner distal process of the second genital segment. Just anterior to these are the outer forceps, which articulate basally on the outer side with an inner distal process of the second genital segment and also with the inner forceps at their bases. Basally and anteriorly, these forceps articulate with the posterior end of the basal plate of the outer forceps which unites the forceps and the vinculum. Both the inner and outer forceps afford characters which are often visible in some degree without special preparation. The inner forceps may appear hook-like in profile, the outer forceps wider and more pad-like.

*Internal sexual organs of male.* The internal sexual organs of the male blowfly (Fig. IV) consist of a pair of testes (T), one on each side in the posterior portion of the fourth abdominal segment, their ducts (VE) (vasa efferentia), a pair of vehicular glands (VG) (paragonia), an unpaired vas deferens (VD), an ejaculatory sac (ES), and the ejaculatory duct.

In the various species of Calliphoridae the *testes* are usually pyriform, often with an hour-glass constriction at the lower third (which apparently acts as a pump), surrounded by an envelope of fat cells, and extending into a short vas deferens. The vehicular or accessory glands open by means of a very short duct and accompany the distal ends of the vasa efferentia into the vas deferens. The latter usually tapers gradually for about half its length into a tube of more or less uniform diameter which opens into the ejaculatory sac or bulb, from which the thin and extensile ejaculatory duct passes to the terminal portion of the phallosome.

The testes in *Pollenia* (Polleniinae) are long subpyriform and taper distally. In *Rhyncomyia* (Rhiniinae) they are fusiform in thick hoods of tissue. In *Callitroga* (Chrysomyinae) males have testes that are more or less elongate and also in tissue hoods,

while in *Calliphorinae* most of the known species have testes which are more or less elongate, rather constricted on the distal third, and are enveloped in tissue hoods of varying thicknesses.

The *vasa efferentia* in *Pollenia* are about one-third as long as the length of the testes, while in *Rhyncomyia* they are short. In *Callitroga* they are a little longer than the testes, but in *Phormia*, *Protophormia*, and *Apaulina* they are nearly twice as long as the testes and taper to the insertion. In *Cynomyopsis* and *Lucilia* the *vasa efferentia* are very long and slender. In the former they are about half again as long as the testes, while in *Lucilia* they are more slender on the terminal one-third to one-half.

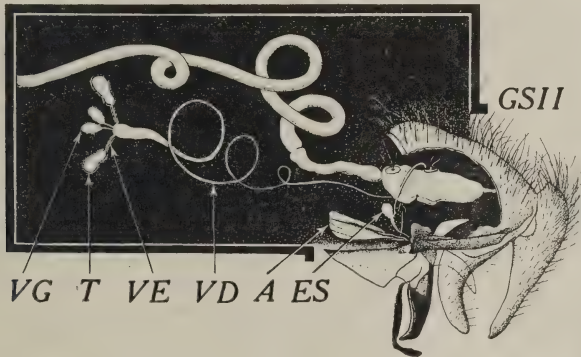


FIG. IV. *Huascaromusca bicolor* (Fabricius). Internal reproductive system of male.

- |                      |                      |
|----------------------|----------------------|
| A. Apodeme.          | VD. Vas deferens.    |
| ES. Ejaculatory sac. | VE. Vasa efferentia. |
| T. Testes.           | VG. Vehicular gland. |

The *vehicular glands* are oval to elliptic in *Rhyncomyia*, gut-like in *Callitroga*. In *Phormia*, *Protophormia* and *Apaulina* they are curled and from one-fourth to one-half longer than the testes. In *Calliphora* they are gut-like and more or less swollen basally. In *Cynomyopsis* they are about one-fourth longer than the testes and in *Lucilia* they are about two-thirds longer than the testes.

The *vas deferens* in *Pollenia* is but little longer than the glands. In *Rhyncomyia* it is slender. In *Callitroga* it is longer than the *vasa efferentia* and somewhat stouter. In *Phormia*, *Protophormia*, and *Apaulina* it is twice as long as the testes and tapered to the insertion in the oval ejaculatory bulb. In *Calliphora* it is not

long and is widest at its commencement, appearing more or less swollen at the head. In *Cynomyopsis* it is about one-third longer than the testes and rather stout, while in *Lucilia* the basal fourth is enlarged, the dilation tapered toward each end.

The *ejaculatory sac* in *Callitroga* is usually as wide as or wider than the testes. In *Calliphora* it is rounded to oval, and in *Lucilia* it is very large, flattened, and ovate. The apodeme within the ejaculatory bulb varies considerably in size, shape, and sculpture. I do not find it to be of any great importance in the specific separation of these flies. It is generally more or less similar throughout the species known to me, in *Calliphora* being more or less typical of the entire stem.

*Genital segments of female.* Except in Mesembrinellinae (the anatomy of which is described on page 61) the postabdominal portion, or ovipositor, is composed of a series of small sclerotized tergites and sternites surrounded by large areas of membrane, the terminal segment of which is equipped with four cerci. The ovipositor is capable of considerable extension and is totally unlike the heavily sclerotized postabdominal segments found in the females of typical sarcophagid species.

*Internal sexual organs of the female.* The internal sexual organs of reproduction in the female blowfly (Fig. V) as typified by *Calliphora* consist of paired ovaries (O) and short ovarian ducts (OD) which lead from them, these uniting to form a common oviduct (CO), two long accessory glands (AG), three spermathecae (S), and a membranous and sclerotized uterovagina (UV). The internal sexual structures of onesine flies are unknown to me, but these species are said to be larviparous and, if so, they can scarcely have the type of sexual structures described here. The structures in Mesembrinellinae are so modified that they are described in the subfamily characteristics on page 62.

*Ovaries* of typical sexually mature blowflies may nearly fill the posterior half or more of the abdominal cavity. Each ovary is oval, more or less concave on the dorsal and median surfaces and convex on the ventral and lateral surfaces, and is enclosed in a thin membrane. In *Calliphora vicina*, a large species, an ovary measures about 3.5 mm. in length, 0.3 mm. in transverse diameter, and 1.5 mm. in thickness. An ovary consists of a group of tapering, cylindric units which are termed "ovarioles," and these are further divided into egg chambers, the foremost of which is smallest and most rudimentary. In *Pollenia* an ovary is composed of many ovarioles; in *Rhyncomyia*, of only 10 to 12, each about 1.5 mm. in length. In *Callitroga* the ovaries are composed of from 70 to 100 ovarioles each, as are those of *Phormia*

and *Protophormia*. The ovaries of *Calliphora* consist of up to 300 ovarioles each; of *Cynomyopsis*, about 60; of *Cynomya*, 50 to 75; of *Cyanus*, 75 to 100; and of *Lucilia* and *Phaenicia*, about 100.

The ovarian ducts typically commence as funnel-shaped extensions of the ovarian capsule and unite on a median line to form a common oviduct. In *Phormia* these are somewhat elong-

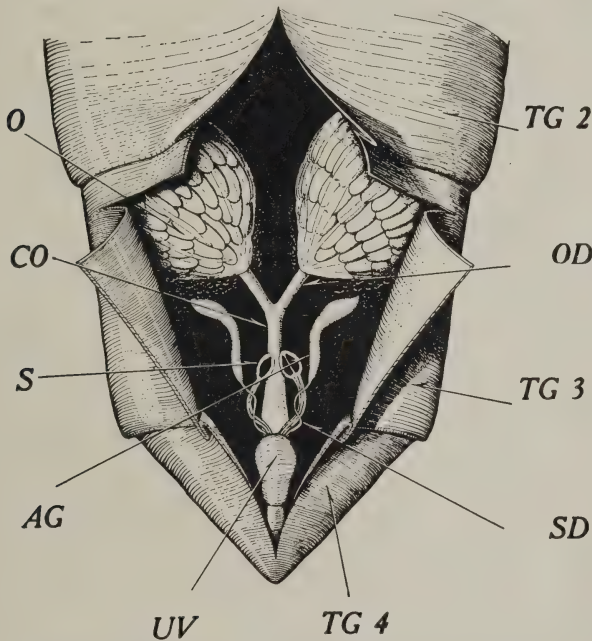


FIG. V. *Calliphora vomitoria* (Linnaeus). Internal reproductive system of female.

AG. Accessory gland.  
CO. Common oviduct.  
O. Ovary

OD. Ovarian duct.  
S. Spermatheca.  
SD. Spermathecal duct.  
UV. Uterovagina.

ate; in *Rhyncomyia* they are short. In *Lucilia* they are nearly one-half as long as the common oviduct.

The *common oviduct* is extremely extensile, averaging about 2 mm. in length in the retracted ovipositor of *Calliphora vicina*, or considerably more than that length when the ovipositor is extended. This passes posteriorly just ventral to the rectum as far as the posterior portion of the rectal pouch, where it bends abruptly to pass into a "preuterus," then into the uterovaginal

tube. In *Rhyncomyia* the common oviduct is short while in *Phormia* it is somewhat elongate. In *Cynomyopsis* it is nearly twice as long as a single egg. In *Melanodexia* it is as long as the preuterus.

The *spermathecae* are small, three in number, and lie dorsad of the common oviduct, usually two more or less united on the right, and one on the left side. They are united to the uterovagina by long, thin, spermathecal ducts, one to each spermatheca. In Rhiniinae (*Rhyncomyia*) these ducts are long and slender. In Chrysomyinae they are short in *Callitroga* but as long as the spermathecae in *Protophormia*. In Calliphorinae two are united in *Calliphora*, but this is not so in *Cynomyopsis* and *Cyanus*. In the latter two genera they are elongate, subcylindric, in thin tissue hoods, their ducts nearly as stout as the spermathecae, and nearly three times as long. In *Lucilia* and *Melanodexia* they are enclosed in thick hoods, and two are in a double head and have their ducts united; in *Lucilia* the latter are curled in the middle, while in *Melanodexia* they are straight, and in both they are nearly as long as the common oviduct.

The *uterovagina* is usually a wide, horizontally directed canal into which the "sacculus" (of Lowne) passes. The anterior two-thirds is often called the uterus; and the posterior one-third, the lining of which is entirely sclerotized, is often termed the "vagina." Except in the Mesembrinellinae, there is no typical "uterus" in the calliphorid flies so far as I know, although it has been stated that females of *Onesia* have a double-sac type of uterus. In *Pollenia* and *Melanodexia* the uterovagina bears a pair of elongate, oval vesicles behind the origin of the spermathecae, and each of these contains a strong, curved, sclerotized rod; this is not so sharply pointed in the latter as in the former. In the Calliphorinae, Rhiniinae, and Chrysomyinae the uterovagina is simple and regular.

The *accessory glands* are two elongate cavities surrounded by a thick, transparent, medially united, sclerotized capsule, and these open on the dorsal wall of the preuterus which forms a large tuberosity. In *Rhyncomyia* they are elongate and club-like. In *Callitroga*, *Phormia*, and *Apaulina* they are swollen at the free end, and in the latter genus they are six times as long the spermathecae. In *Calliphora* they are elongate, often swollen terminally; in *Cynomyopsis* they are longer than the common oviduct and a little stouter than the spermathecal ducts except at the broadened tips. In *Melanodexia* they are half again longer than the common oviduct, convoluted, their ducts almost as long as the glands.



Internal sexual structures of the females of the Sarcophagidae differ from those of the Calliphoridae in having a heart-shaped, or cordate, uterus. This is short and has two dorsal sacs, or pouches, developed laterally from the anteroventral walls. These two sacs and the uterovagina together form the uterus. The uterus contains eggs until the enclosed embryo has developed to the fully formed maggot ready for deposition. On the basis of the female internal sexual organs, the sarcophagid flies divide into at least three major groups: (1) the typical Sarcophaginae, as noted above; (2) the Miltogramminae, which have a thick, short-set V-shaped uterus, the arms of which are anterior productions of the lateroventral walls; and (3) the melanophorid genera, some of which do not have an incubating uterus but a uterovagina capable of incubating but a single egg, and others which have the more typical double-sac type of uterus.

EGG. The oviparous species of Calliphoridae have from small to large, macrotype, more or less cylindrical, reticulate or longitudinally fluted to rather striate eggs. Eggs of *Pollenia* are of medium size; *Rhinia* eggs are small to medium. Those of *Calliphora* are large, elongate, more or less cylindric, reticulate, and with a micropyle anteriorly, from which a shallow, dorsal groove extends almost to the posterior end. In *Callitroga* the species have large eggs which are elongate and ovicylindric; the dorsum is marked by a well-defined groove. In *Cynomyopsis* and *Cyaanus* the eggs are feebly striate longitudinally.

OVIPOSITION. Blowfly females of typically saprophagous species usually deposit their eggs upon carrion. They will, however, deposit upon a wide range of fresh and decaying types of refuse when carrion is not present. Products of bacterial action are not essential attractants. Eggs of oviparous species are apparently deposited in much the same manner. Typically, they are deposited one at a time in rapid succession on or near food sources. The females extend the telescopic terminal parts of their abdomens and push the eggs down, one after another. The eggs slip into place, often completely filling a crevice, sometimes becoming arranged in fan-shaped masses. Under exceptional circumstances one or more eggs may hatch in the uterovagina and these may be deposited as active larvae. Eggs soon dry upon being exposed to air, and they then stick to each other and to blown surfaces. When dry they have a more or less waxy appearance and are difficult to wet with aqueous solutions. Females often deposit composite masses of eggs and numerous females depositing in the same localities near an attractive location may produce aggregate masses of thousands of eggs of one or more species.

Clean healthy animals are rarely attacked by blowflies. Moore (1937, p. 227) suggested that some abnormal attractant must be present on fleece of sheep to attract ovipositing females. He considered such attractants to be possibly the remains of urine and feces on the wool, foot-rot, wool-rot, discharging wounds, or dips grossly contaminated with urine or feces.

Temperature and humidity are important factors in the development and growth of ovaries. High humidity is apparently favorable and low humidity is not. Evans (1935b) considered humidity to exert little effect upon oviposition at temperatures of 10° to 35° C., but low humidity to be unfavorable at 40° C.

**LARVA.** The larvae of blowfly species have the posterior spiracles nearly flush with the rim of the anal area and the dorsal cornua is entire. The larvae of Sarcophagidae have the posterior spiracles within a deep depression and the dorsal cornua is incised or divided. However, the larva of *Sarothromyia femoralis* (Schiner), a widespread Neotropical sarcophagid, does not have the typical deep posterior depression, and the larva of *Stomoxys lunata* (Fabricius), a blowfly species occurring in Bermuda, misleadingly has the dorsal cornua with a longitudinal clarified area which sometimes appears as a division.

The usual custom of describing the three obvious larval instars attained by two moults is followed in this paper. Apparently, however, there is another larval instar which is usually overlooked. Fraenkel (1938) stated "The cuticle of the third instar becomes the puparium by a process of contraction, darkening, and hardening, which is generally called pupation. The third moult is the prepupal moult, by which the puparium becomes separated from the hypodermis; the fourth moult is the pupal moult, which separates off the thin sheath—from the now-completed pupa; and by the fifth moult the emerging adult frees itself from the pupal cuticle."

The three obvious instars of blowfly larvae may be easily recognized by characters found in the posterior spiracles. First-instar larvae have little or no indication of peritreme surrounding the posterior spiracles and the two ovate apertures in each spiracle are nearly or actually united basally. Such larvae are also metapneustic. Differentiating characters in this instar are difficult to discern and formal descriptions of the stage are usually omitted. Second-instar larvae are amphipneustic as are third-instar larvae, the anterior spiracles found laterally at the base of the second segment, have circular openings radiating fanlike from main trunks. The peritreme surrounding each posterior spiracle is more definite than in the previous instar although it is

often indistinct about the "button" area. The two oval apertures are distinctly separated. Third-instar larvae have each posterior spiracle with three slitlike, nearly parallel apertures, the peritreme is distinct, and the "button," if present, is obvious.

The cephaloskeleton (pls. 33B, 34H, or 43D) which lies within the first to third segments, is divided into paired sclerotized articulated segments. The labial sclerite (*lsc*) is that portion of the cephaloskeleton which is curved or hooked ventrally and acts as a tooth or mandible. Immediately below is the minute dentate sclerite (*dsc*). An unpaired accessory sclerite (*alsc*) lies between the paired labial sclerites in some species; this is present in the Calliphorini, not in the Luciliini. Articulating with and posterior to the labial sclerite is the hypostomal sclerite (*hsc*) which in turn articulates with the pharyngeal sclerite. Immediately below the hypostomal sclerite is a small infrahypostomal sclerite (*ihsc*). The pharyngeal sclerite is winged and is the hindmost as well as the largest of the sclerites composing the buccopharyngeal apparatus. This is divided into an upper and lower wing which are termed dorsal (*dc*) and ventral (*vc*) cornua; the anterodorsal prolongation is termed the dorsopharyngeal sclerite (*dphsc*) or dorsal arch; a ribbonlike parastomal (*pssc*) or suprahypostomal sclerite extends dorsally over the hypostomal sclerite.

The posterior cavity (pl. 34G, *pc*) has three pairs of tubercles on the dorsal margin; these are termed inner (*i*), median (*m*), and outer (*o*) pairs. The lower border is provided with three or four pairs of tubercles and these are designated in the same way. The anal protuberance (pl. 34G, *ap*) has two prominent tubercles between which lies the anal opening.

The posterior spiracles lie within the so-called posterior cavity, and each is partially (pl. 34D) or completely (pl. 42D) surrounded by sclerotized peritreme (*p*) in the third instar. The scar produced by the casting of the external portion of the spiracle in the previous instar is called the "button" (*b*), and this may or may not be evident. The "button" is obvious within the peritreme in the Calliphorinae, not in the Chrysomyinae. The position of the two or three more or less oval and nearly parallel slitlike apertures yields characters of considerable significance, but the ornamentation within the slits is of apparently no taxonomic value. The so-called "sun-ray" structures, or peristigmatic glands (of Keilin, 1915), have usually been omitted in the illustrations.

**LARVAL HABITS.** The larvae of most blowfly species are saprophagous and are usually found feeding upon decomposing substances, most often flesh. Decomposing flesh, however, is not

necessary for their development, and they occasionally occur in mixed garbage and other kinds of refuse. Although they develop normally in decomposing media, they are often injured by excessive putrefaction. Thus, upon emerging from the egg, the larva feeds for a short time upon the surface of the food in the vicinity of the egg mass, then it bores into the comparatively fresh food within, preferring that to the putrid decomposing material outside. Wounds in which such species occur are usually old, pustular, and suppurative. With only few exceptions they have a tendency to feed outside a myiasis wound if the wound is in a long-fleece animal.

Larvae of blowflies are extremely sensitive to light and react negatively to it. The response becomes more marked with age. Ellsworth (1933) found that larvae of *sericata* were protected from overstimulation by light through the retraction of the entire photoreceptor organ and the infolding of the chitinous collar.

The effects of temperature and humidity upon larval development of several species were studied by Bishopp (1915), Herms (1928), Smit (1928), and Wardle (1930). Larvae of *sericata* become active when carcass temperature reaches 50° to 55° F., according to Deonier (1940), and it is possible that the larvae of most species react similarly.

Hydrogen ion concentration in the digestive tract of larvae of blowflies was studied by Hobson (1931) and Waterhouse (1940). These authors found the pH to be 7.0 in the crop, 6.5 in the anterior portion of the midgut, 3.0-3.5 in the middle portion of the midgut, 7.5-8.3 in the posterior portion of the midgut, and 8.0-8.5 in the hindgut. The latter author found these pH values to be essentially similar in all species studied.

**DIAPAUSE.** When fully developed, blowfly larvae leave their food and enter the prepupal stage. According to Mellanby (1938, p. 392) "The prepupa is externally indistinguishable from a larva, but it does not feed and it possesses other physiological properties." After several days of favorable conditions, the larva becomes rounded and the skin becomes hardened to form the puparium. Under unfavorable circumstances, such as low temperature or lack of sufficient moisture, they are able to suspend pupation and may remain active for months without further apparent development. This cessation of development is called "diapause." The diapause presumably ends when the prepupa has acquired sufficient water to overcome any effects of desiccation and is stimulated to pupation by suitable temperature.

**PUPATION.** Fraenkel (1935) stated "Proofs have been established for the action of a hormone inducing pupation in the blowfly. This hormone is secreted from 16 hours before pupation at 20° C. The hormone producing organ is either the ganglion, or in its immediate neighborhood. After the hormone has already been discharged, pupation can be successfully accomplished without the cooperation of the nervous centers (ganglia)."

**PUPARIUM.** The puparium is the sclerotized, more or less shrunken, cast skin of the third-instar larva. It therefore possesses the major external characters of that instar and has been described for only a few of the species. The depth in the soil at which pupation occurs may be characteristic of species within a genus, and this information is regularly given when known.

**ADULT HABITS.** The adult blowfly usually emerges from the puparium in the morning. The metallic species are first grayish brown in color, then various metallic shades, and after a few hours are typically colored. Some of the species gradually change in color from yellow gray to bronzy green over a period of 3 to 4 days.

Most of the species differ markedly from each other in adult habits. Some of these differences are so obvious that one can identify certain species in nature by flight habits or other essential peculiarities. Some of these differences are discussed in the text under species headings.

Individual blowflies may live for a considerable time in captivity. Salt (1932) secured sterile eggs from a female of *sericata* 91 days old and he reported upon another female which lived for 104 days. He found the average length of life in *sericata* to be 56.6 days in the female, 41.0 days in the male.

Limited larval food supply and delayed pupation will cause variation in the size of adult blowflies. Delayed pupation will also result in the production of "monsters" manifest in wings that will not fold, lack of muscular coordination, or atrophy of abdomen or appendages. Individuals of this kind often emerge from puparia subjected to low temperatures and high humidities. Such individuals die within a day or two.

## SUBFAMILY MESEMBRINELLINAE

The flies which belong to this subfamily differ considerably from typical Calliphoridae. They are mostly testaceous with metallic-colored abdomens, and are the largest of the North American calliphorid flies.

Little is known concerning the biology of any of the species which belong here. Both males and females are more or less crepuscular and are never found in bright sunlight. During periods of bright sunlight adults retreat into the darkest portions of the jungle. In early morning and late afternoon, or when the sun is concealed by clouds, they may be collected in open areas in the forest. Both sexes may be collected commonly on decaying fruits, feces of birds and animals, juices of vegetation, fermenting substances, and other decaying substances. They rarely fly more than a few feet above the jungle floor. Males often congregate on low foliage near sources of attractive food. Females may be collected either on foods or as they fly slowly through the shadowed jungle. The adults of these species are among the most abundant of all flies in American tropical rain forests and in behavior they are unlike any of the other calliphorine flies I have ever collected.

All specimens belonging to the subfamily Mesembrinellinae possess the following characters in common.

**MALE AND FEMALE.** Head wider than high, length at antenna and at vibrissa half or less greatest width; length at oral margin and at vibrissa nearly equal; epistoma gently warped forward from clypeal plane and nearly or quite as wide as clypeus; metacephalon not apparent and the lower posterior margin of head rounded in profile; bucca comparatively narrow when compared with eye height; eye large, elongate-oval, set nearly straight in head, bare; inner vertical bristles strong, decussate; postvertical bristles weak, proclinate; interfrontal bristles present in female, absent in male; ocellar bristles large, proclinate; postocellar bristles weak, proclinate; clypeus sunken, shallow; facial carina absent or not apparent; parafaciale bare; faciale slightly concave in profile, the edge rounded, low; vibrissa slightly above oral margin, with a second elongate bristle slightly below this, and often with a third and a fourth bristle at or near juncture of the lower anterior margin of head with the lower margin of the epistoma; proboscis about two-thirds head height; haustellum nearly five-eighths length of proboscis, stout, sparsely setose; palpus clavate, thickened apically; antennal base at

or near middle of eye with head in profile; bases approximate; third segment of antenna reaching nearly to vibrissa; arista nearly twice as long as third segment, penultimate segment short, terminal segment elongate, thickened only at base and uniformly tapering to apex, with long ciliation above and below; back of head flat or but slightly rounded in profile.

Thorax with propleuron bare; presupraalar bristle one; notopleural bristles two; prosternum narrowed posteriorly, widening anteriorly, setose; postalar declivity with tuft of hair in center; sclerites at wing-base with only preepaulet setose; tympanic pit bare; greater ampulla slightly reniform posteriorly; postalar bristles two, one weak; postdorsocentral bristles three; intrapostalar, intrapostsupraalar and intrapostsutural bristles absent; postintraalar bristles two; postsupraalar bristles three; spiracles large; scutellum with under surface finely setose, the setae short, and with one discal and one apical bristle.

Legs elongate and slender; hind coxa setose posteriorly; fore tibia with one posterior bristle near apical third; middle tibia with one anterodorsal bristle near apical third and one ventral bristle near apical third; hind tibia with one anteroventral bristle near apical fourth and two posterodorsal bristles toward base.

Wing without costal spine; subcostal sclerite with fine pubescence; remigium bare below (ciliate posteriorly above in *Mesembolia*); only third vein with setae; bend in fourth vein widely rounded; anterior cross vein at or near middle of second section of fourth vein; upper squamal lobe small, bare, rounded; lower squamal lobe of medium size, ovate, bare.

Abdomen with tergites not overlapping sternites, the ventral membrane usually widely exposed in both sexes; first and second segments without dorsal bristles; fourth segment often with discal and usually with strong marginal bristles.

Genital segments of male large, terminal, globose, and obvious in repose; of female, not in form of extensile ovipositor.

#### MORPHOLOGY OF INTERNAL SEXUAL STRUCTURES.

It has been stated previously that the Mesembrinellinae are aberrant in the Calliphoridae. The reproductive habits, the structures of the internal organs of reproduction, and certain details of external morphology in the female are not as in typical blowflies. However, these flies are treated here as a subfamily of Calliphoridae because the male genital structure is very similar to that found in typical Calliphoridae, and the adult fly possesses most of the characters considered calliphorine.

Female Mesembrinellinae produce second-instar larvae and the female reproductive system (Fig. VI) is modified for this purpose. It appears somewhat different from the type found in *Calliphora*, but most of the parts are homologous. The postabdominal segments (pl. 10, A) are modified to allow for the deposition of large larvae and there is no telescopic sclerotized and membranous ovipositor. Tergites 1 to 5 are as in *Calliphora*; sternites 1 to 5 are very small and the ventral membrane is obvious.

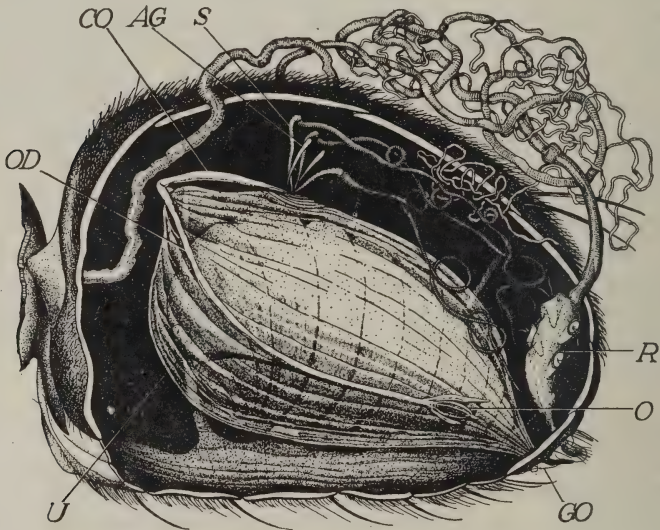


FIG. VI. *Huascaromusca bicolor* (Fabricius). Internal reproductive system of female.

AG. Accessory gland.  
CO. Common oviduct.  
GO. Genital opening.  
O. Ovary.

OD. Ovarian duct.  
R. Rectum.  
S. Spermatheca.  
U. Uterus.

Tergites 6 and 7 are united and have two pairs of spiracles; tergite 8 is strongly sclerotized; tergite 9 is less strongly sclerotized and has a marginal row of macrochaetae; this is the last obvious abdominal tergite. The anus is located above a strongly-sclerotized, flattened plate which appears similar to, and possibly is, a sternite, and between a pair of terminal paraprocts; the genital opening is located immediately below and is surrounded by membrane capable of considerable distention.

The uterus is of the simple, sac-like, incubating type, composed of thin white membrane capable of remarkable distention;



it incubates a single egg at one time, retaining the developing larva well into the second instar. There is no chitinous vagina. The nulliparous uterus is very small and lies just ventrad of the rectum in the sixth and seventh segments. The developing larva within the uterus has the oral hooks near the anteroventral uterine wall and its posterior spiracles at the genital opening. The ducts of the spermathecae and accessory glands open into the center of a thickened membranous area on the anterodorsal third of the uterus. This thickened area extends anteriorly into the common oviduct, which divides into the lateral oviducts, these beginning in the ovaries which are composed of only three or four ovarioles each. One ovariole usually develops during the period when a larva is developing within the uterus. The spermathecae are three in number, two on the right side and one on the left. These are in the form of long, sclerotized, tubular coils which are enclosed in thick tissue hoods. Their less sclerotized ducts are about as long as the accessory glands. The membranous accessory glands are two in number and are relatively short.

The ovarian egg is sometimes 2 mm. in length and 0.75 mm. in diameter. Only one egg develops at one time and it continues to grow while it moves from the ovaries through the ducts and hatches in the uterus.

The fully developed first-instar larva occupies almost the entire posterior half of the abdominal cavity, the anterior half of which is filled with air-sacs. The common oviduct extends to the foremost portion of the uterus and the lateral oviducts then extend to the ovaries located posteriorly on the ventrolateral surfaces of the uterus. The spermathecae and accessory glands, portions of the digestive tract, rectum, and Malpighian tubules, with numerous tracheal branches, are imbedded in fat body and tissue in the hindmost portion of the abdominal cavity. There is no evidence of placental development nor is there evidence of parental feeding, although Townsend (1934) stated, "The larva is apparently enveloped in a placenta trachealis." Weber (1933, p. 534) stated that the food of such larvae is supplied within the egg. I was unable to find secretory glands and it seems doubtful that sufficient food material is supplied by this means to yield larvae of the size produced by *Huascaromusca bicolor* (10-12 mm.) or by *H. facialis* (12-14 mm.).

The external and internal genital structures of male mesembrinelline flies (Fig. IV) are similar in general appearance to those of the typical calliphorine flies. The ejaculatory bulb and its apodeme are proportionately larger than in *Calliphora vom-*

*toria*; the vas deferens is elongate and narrowed apically, the anterior sixth is thickened. The hourglass-shaped testes and the egg-shaped vehicular glands are very small; the latter are about half as large as the former, and, with the vasa efferentia, are enclosed in tissue hoods. The vasa efferentia are about as long as the testes.

Giglio-Tos (1893) designated *Musca quadrilineata* Fabricius as genotype of his genus *Mesembrinella*. His *quadrilineata* was a misidentification. Aldrich (1922) redescribed the *quadrilineata* of Giglio-Tos (nec Fabricius) as *Mesembolia bellardiana*. Townsend (1931), considering *Mesembrinella* to apply to *quadrilineata* Giglio-Tos, not Fabricius, proposed *Eumesembrinella*, naming *quadrilineata* Fabricius as genotype. Most of the species treated by Aldrich (1922) under the name of *Mesembrinella* belong in the genus *Huascaromusca* Townsend, which has (*cruciata* Townsend) = *xanthorrhina* Bigot as genotype. Townsend saw Giglio-Tos' and Fabricius' type specimens and Aldrich saw the Fabrician type.

*Mesembrinella* and *Mesembolia* do not occur in North America so far as I know.

#### KEY TO GENERA AND SPECIES OF NORTH AMERICAN MESEMBRINELLINAE

1. Posthumeral and preacrostichal bristles present.....2  
     Posthumeral and preacrostichal bristles absent .....  
         ..... *Promesembrinella semiflava* (Ald.), p. 65
2. Two preintraalar bristles present .....3  
     Presutural intraalar bristles absent .....5
3. Sixth section of costa less than one half as long as preceding section; width of parafaciale opposite lunule 0.30 or less of distance between vibrissae .....4  
     Sixth section of costa more than one-half as long as preceding section; width of parafaciale opposite lunule 0.40 of distance between vibrissae.....  
         ..... *Huascaromusca umbrosa* (Ald.), p. 82
4. Front of male 0.07—0.08 of head width, with a small proclinate fronto-orbital bristle nearly opposite foremost ocellus; female with only one proclinate fronto-orbital bristle. ....  
         ..... *Huascaromusca abaca*, new species, p. 68

- Front of male 0.02—0.023 of head width, without fronto-orbital bristles; female with two or three proclinate frontoorbital bristles.....  
 .....*Huascaromusca bicolor* (Fabr.), p. 69
5. Fourth abdominal segment with a row of strong discal bristles ..... 6  
 Fourth abdominal segment with only marginal bristles... 8
6. Femora, pleura, and abdomen blue-green to blackish... 7  
 Femora, pleura and base of abdomen yellow orange.....  
 .....*Huascaromusca tibialis* (Ald.), p. 81
7. Two to three rows of postocular cilia; only one lateral scutellar bristle; thoracic spiracles with orange hair....  
 ..... *Huascaromusca uniseta* (Ald.), p. 84  
 Only one row of postocular cilia; with two lateral scutellar bristles; thoracic spiracles with dark brown hair  
 ..... *Huascaromusca xanthorrhina* (Big.), p. 86
8. Faciale low, rounded, and setose only at vibrissae..... 9  
 Faciale high, sharp, and setose to middle .....  
 ..... *Huascaromusca facialis* (Ald.), p. 72
9. Legs, pleura, and base of abdomen largely orange or brown ..... 10  
 Legs, pleura, and base of abdomen blue green .....  
 ..... *Huascaromusca spicata* (Ald.), p. 79
10. Only one preacrostichal bristle .....  
 ..... *Huascaromusca formosa* (Ald.), p. 77  
 Two preacrostichal bristles.....  
 ..... *Huascaromusca flavicrura* (Ald.), p. 75

### PROMESEMBRINELLA, NEW GENUS

*Male and female.* Head length at antenna greater than at vibrissa, causing frontal profile to appear protuberant at antennal base and the parafaciale to be considerably narrower below than toward lunule; faciale low and rounded; clypeus short and wide. Thorax with posthumeral and preacrostichal bristles absent. Wing low and rather narrow. Female without frontoorbital bristles.

*Genotype, Mesembrinella semiflava* Aldrich.

This genus differs from other genera in the subfamily by lacking posthumeral and preacrostichal bristles. It differs from *Huascaromusca* in head proportion as well.

*Promesembrinella semiflava* (Aldrich), new combination

*Mesembrinella semiflava* Aldrich, U. S. Natl. Mus., Proc. 66(18) : 14-15, 1925. (Type, male from La Suiza de Turrialba, Costa Rica, No. 26799, U. S. National Museum.)

A yellowish to brown species with faintly infuscated wing, front, antenna, palpus, and legs orange, the dorsum of thorax and the third and fourth abdominal segments metallic blue.

*Male.* Head width at greatest 14.0; length at antenna 6.2 and at vibrissa 5.2; eye height 11.0; head height 12.0; clypeus with length fully twice width, orange, rather silvery pollinose; epistoma but very slightly warped forward from clypeal plane; bucca 0.10 of eye height, orange, golden pollinose, with a few scattered black hairs, some pale hairs before the metacephalic suture; frontale totally obliterated at narrowest portion of front, orange anteriorly; frons at narrowest (about two units below the foremost ocellus) 0.03 of head width, 0.10 at vertex, and 0.20 at lunule, orange in ground color anteriorly, dark brown to black posteriorly, golden pollinose, without fine hair outside frontal rows of bristles; vertex dark brown to black, brown pollinose; frontal row of bristles vestigial posteriorly, fading out at narrowest portion of front and composed of about five bristles, only the anterior ones strong; parafaciale golden pollinose over orange ground color, 1.2 in width opposite lunule, narrowing to about 0.6 below; faciale low, rounded, broad, with only a few small black setae above the vibrissae; vibrissae at oral margin, set 3.6 apart; antenna orange, third segment three times as long as second and reaching almost to the vibrissae; arista orange brown, darker apically, the ciliation dark brown; palpus orange, 3.5 in length; back of head dark brown to black above; metacephalon orange, the former silvery pollinose, with one row of postocular cilia and with orange colored hair.

Thorax orange, dorsum dark brown to bluish black metallic, with some white pollen which is particularly noticeable anteriorly, and with two dorsal, longitudinal, shining black stripes outside the dorsocentral rows of bristles which extend posteriorly to the scutellar suture, and with less distinct and narrower stripes outside the acrostichal rows of bristles, which do not extend beyond the suture; pleura slightly silvery, with orange hair; propleuron slightly silvery, with fine orange hair; propleural bristles two; sternopleural bristles two, both strong;

sternopleuron with an additional bristle set on the posterior margin of the sclerite and ventrad of hindmost sternopleural bristle (this bristle has not hitherto been noted and may be termed the "poststernopleural bristle"); mesospiracular bristles two, these set farther posterior than normal; postacrostichal bristles two; thoracic spiracles with orange hair, the meta-thoracic spiracle without black hair ventrally; sclerites at wing base orange; smaller ampulla brown; scutellum with one lateral bristle, the under surface with fine orange hair; postscutellar plates orange pilose.

Legs with coxae, trochanters and femora orange, tibiae and tarsi dark orange brown, darker apically; middle tibia with an elongate anterodorsal bristle near middle, two posterior bristles, one near the basal third and one near apical third, and one posterodorsal bristle near middle; hind tibia with two anterodorsal bristles, one near basal third and the other near middle, one anteroventral bristle near the apical third, and two posterodorsal bristles, one near basal fourth, the other much longer, near the apical third.

Wing hyaline, brownish; basicosta and subcostal sclerite orange, the latter orange pubescent; costal sections 2 to 6 in the proportions 100:85:128:85:6; third vein with one to three basal setulae; squamal lobes brownish.

Abdomen with first and second segments yellow to orange, the hind margin of the former narrowly metallic purplish, the posterior fifth of latter deep purple, the band considerably wider laterally, both segments with a single lateral bristle; third segment slightly orange laterally and basally, posteriorly metallic purple, and with long erect marginal bristles; fourth segment entirely dark metallic purple, with long erect discal bristles in a row at middle of segment, and with a weaker row of marginal bristles; ventrally, mostly yellowish or orange with orange pile; all sternites orange to orange brown with orange pile; fifth sternite as illustrated (pl. 10, C).

Genital segments dark orange brown to blackish brown, with fine erect black hairs. Internal anatomical features and posterior view of forceps (pl. 10, B and D), as illustrated.

*Female.* Head height 12.0; eye height 10.0; bucca 0.08 of eye height; length of head at antenna 7.0, and at vibrissa 6.0, width 15.0; width of front at narrowest (at vertex) 0.17 of head width, the margins narrowly diverging anteriorly to within 1.5 of the lunule, then suddenly diverging to 0.27 of head width at lunule; frontal row of bristles extending posteriorly only about half the distance from the lunule to the foremost ocellus, weaker

posteriorly, and consisting of five or six bristles; parafrontale with a few dark setae outside the frontal row of bristles; frontale with nearly parallel margins, red orange anteriorly, darker posteriorly, and wider than parafrontale; third antennal segment 3.4 times as long as second; parafaciale 1.6 in width opposite lunule; vibrissae set 4.4 apart; palpus 4.0 in length, orange. Wing (pl. 8, A) with costal sections 2 to 6 in the proportion 110:90:150:80:14. Otherwise like male except for normal sexual differences.

*Length.* 9-10 mm.

Originally described from three males and two females collected from February 23-28 to March 16, by Pablo Schild. (A. L. Melander's collection.)

*P. nigrifrons* (Bigot) has the eyes in the male contiguous for a short distance rather than distinctly separated; the costal margin in both sexes is heavily infuscated beyond the second costal section, and there are three dark stripes on the dorsum of the thorax separating four pollinose stripes. This species is Neotropical and specimens are at hand from Brazil, Ecuador, and Peru.

### HUASCAROMUSCA TOWNSEND

*Huascaromusca* Townsend, Insecutor Inscitiae Menstruus 6:155, 1918. Genotype. (*Huascaromusca cruciata* Townsend) = *Somomyia xanthorrhina* Bigot. (Monobasic.)

*Male and female.* Head (pl. 1, A) length at antenna and at vibrissa equal or the length at antenna only slightly greater than length at vibrissa; front in female usually with parallel margins, narrow in male; clypeus about as long as wide; parafaciale usually narrowed above. Thorax with posthumeral and preacrostichal bristles. Wing long but not particularly narrowed as in *Mesembrinella* and *Promesembrinella*.

### *Huascaromusca abaca*, new species

A yellowish to blackish-brown species with hyaline wings, the head, appendages, and base of abdomen yellow. This species is usually determined under the name *bicolor*, to which species it is closely related. The two are almost identical in superficial appearance.

*Male.* As in *bicolor* except head with small proclinate fronto-orbital bristles which are nearly opposite the anterior ocellus, no weak accessory ocellar bristles; width of front at narrowest 0.07 to 0.08 of full head width; vibrissa only slightly above the oral margin.

Thorax blackish brown, darker on dorsum; sternopleuron with pale hair only; mesothoracic spiracle without dark hair on the lower margin.

Abdomen with first segment yellow, the posterior margin narrowly purplish black; second segment yellow, the posterior margin widely purplish black in center on dorsum, more narrowly so laterally; third and fourth segments deep metallic purplish or greenish black.

Genital segments (pl. 10 E and F) orange with black setae.

*Female*. Similar to male, with the usual normal sexual differences, and differing from the female of *bicolor* in having but one proclinate frontoorbital bristle.

*Length*. 9-11 mm.

*Type*. Male, No. 53112, in the U. S. National Museum.

*Type locality*. Barro Colorado Island, Canal Zone, Panama.

Thirteen specimens including the holotype were collected in fruit fly traps during August and September 1936 by James Zetek; 13 additional specimens were collected during January 1929 by C. H. Curran in the same locality; 2 specimens are in the collection from Higuito, San Mateo, Costa Rica, collected by Pablo Schild. The species is not uncommon in the tropical rain forests of both east and west coasts of Guatemala and Nicaragua during the month of May.

*Huascaromusca bicolor* (Fabricius), new combination

*Musca bicolor* Fabricius, Systema Antliatorum, p. 291, 1805; Wiedemann, Aussereuropäische zweiflügelige Insekten, vol. 2, p. 392, 1830. (Type, female from South America, in Copenhagen, Denmark.)

*Calliphora socors* Walker, Roy. Ent. Soc. London, Trans. (n. ser.) 5:311, 1858. (Type, female from Mexico, in the British Museum.)

*Leptoda bicolor* (Wiedemann), Brauer and Bergenstamm, Zweiflügler des Kaiserlichen Museums zu Wien, vol. 6, no. 3, p. 132, 1893.

*Mesembrinella bicolor* Giglio-Tos, Mus. di Zool. ed Anat. Comp. R. Torino, Bol. 8(147):4, 1893; R. Acad. Sci. Torino Mem. (2)45:11, 1895; Surcouf, Paris Mus. d'Hist. Nat. Nouvelle Arch. (5)6:70, 1919 (in part).

*Mesembrinella aeneiventris* Van der Wulp, Biologia Centrali-Americana, Insecta, Diptera, vol. 2, p. 301, 1896. (Cotypes, [both sexes] from Mexico, in the British Museum.)

*Ochromyia bicolor* (Fabricius) Sureouf, Paris Mus. d'Hist. Nat. Nouvelle Arch. (5)6:70, 1919 (in part).

*Mesembrinella bicolor* (Fabricius) Aldrich, U. S. Natl. Mus. Proc. 62:13, 1922; Engel, Konowia 10(2):135, 1931; Townsend, Rev. de Ent. 1:69, 1931.

A yellowish brown species with faintly infuscated wings, orange head, antennae, palpi and legs, the abdomen metallic bluish to purple except at base.

*Male.* Head width 16.0; length at antenna 7.7, and at vibrissa 7.4; eye height 11.8; head height 13.8; bucca 13.5 of eye height, orange, with scattered black hair, no pale hairs before the metacephalic suture, and thinly silvery yellow pollinose; frontale fully 0.60 frontal width, orange; frons narrow, at narrowest 0.02-0.03 of head width, 12.6 at vertex and 0.20 at antennal base, orange, yellowish-silvery pollinose, bare; frontal row of bristles composed of 9 or 10 bristles, only the anterior ones strong, the rows diverging as they follow the margin of the frontale; inner vertical bristles strong, decussate; ocellar bristles long and strong, with a pair of accessory ocellar bristles immediately behind the posterior ocelli, these about two-thirds as long as the normal pair; vertex orange, pollinose; clypeus orange, yellowish-white pollinose; parafaciale 1.2 in width opposite lunule, orange, bare; faciale rounded, somewhat concave in profile, bristled only slightly above vibrissae; vibrissae 0.8 above oral margin and separated by 3.8, with a strong bristle just below at the lower anterior margin; proboscis orange; palpus orange, 4.1 in length; antenna bright orange, third segment 2.4 times as long as second; arista orange at base, brown apically, the ciliation brown; postorbital brown, silvery pollinose; back of head dark brown above, orange below, yellowish silvery pollinose, postvertex orange red, one row of postocular cilia and with scattered yellowish hair.

Thorax yellow orange to orange brown, dorsum rather reddish brown with whitish pollen in certain lights and with indistinct shining longitudinal stripes; humerus yellow to yellow orange, with scattered tawny and black hair, and with three humeral bristles; preintraalar bristles three, the foremost one weak; presutural supraalar bristle one; preacrostichal bristles two, strong; predorsocentral bristles two, strong; propleural bristles one or two; mesospiracular bristle rather distant from suture; sternopleuron with scattered black hair above, pale hair below; sternopleural bristles three; hypopleural bristles arranged in a wide "V", sclerites at wing base orange; postacrostichal bristles two; both mesothoracic and metathoracic spiracles with orange



hair, the latter with fine long black hairs ventrally; scutellum concolorous with dorsum, the under surface with yellow pile; lateral bristles two large and two weak; postscutellar plates with long tawny hair.

Legs with femora orange, tibiae and tarsi dark orange brown; middle tibia with two posterior bristles, one near basal third and one near apical third, and one posterodorsal bristle near apical third; hind tibia with two anterodorsal bristles, one near basal fourth and one near middle.

Wing (pl. 8, B) hyaline, slightly tinged with orange brown, especially along the costal margin and basally; basicosta orange; subcostal sclerite orange, with orange pubescence; costal sections 2 to 6 in the proportions 100:84:123:66:16; third vein with only one or two basal setulae; upper squamal lobe hyaline, orange brown apically; lower squamal lobe orange brown.

Abdomen with first segment yellowish to orange, the posterior margin purplish; second segment purple over orange ground color; third and fourth segments shining purple over brown, the third with a marginal row of strong, erect bristles, the fourth with a marginal row of rather weak bristles; abdomen usually more orange ventrally than dorsally; fifth sternite (pl. 11, B), as illustrated.

Genital segments large; first segment dark metallic, with black setae; second segment orange, with black setae. Internal anatomical details (pl. 11, A, B, and C), as illustrated.

*Female.* Head width 16.3; length at antenna 7.7, and at vibrissa 7.5; eye height 11.0; head height 12.8; bucca 0.12 of eye height; frontale 0.60 of frontal width at lunule, wider posteriorly; proclinate frontoorbital bristles two or three; frontal row of bristles consisting of five large and three or four small bristles, the rows not divergent anteriorly, extending to the base of the second antennal segment; front with nearly parallel margins from vertex to within 1.5 units of the lunule, 0.27 of head width at vertex, 0.30 at antennal base, with a few pale hairs outside the frontal rows; parafaciale 1.7 in width opposite lunule; vibrissae set 4.0 apart; palpus 4.6 in length; third antennal segment 2.5 times as long as second. Wing with costal sections 2 to 6 in the proportions 100:95:140:70:19. Otherwise similar to male except for normal sexual differences.

There is considerable variation in the number of bristles in certain series in this species. The acrostichal series may have two or three bristles anterior to the suture, and two, three or four posterior to the suture. There may be either two or three sternopleural bristles, usually three. A first impression of a long

series of this species is that more than a single species may be represented, but the differences are apparently not of specific significance.

*Length.* 9-12 mm.

*Distribution.* Neotropical: North as far as Cozumel, Quintana Roo Province, Yucatan, Mexico, and south as far as Paraguay. This species is the most abundant of the genus in the tropical rain forests of Central America and may be collected during every season of the year. No specimens were collected at elevations over 500 feet. They are most numerous in the dense tropical rain forests along coastal sections.

*Biology, habits, and immature stages.* *Egg:* Large macrotype, 2.5 mm. long, 0.75 mm. in diameter, smooth, membranous, without apparent sculpture. The egg is withheld in the uterus until hatched and it is apparently enclosed in a membranous covering.

*Larva.* First instar: Length 3.0-8.0 mm. Nearly white, translucent, smooth, segmentation not apparent in newly hatched larva but obvious in more mature larva. Metapneustic; posterior spiracles (pl. 32, C) large, each with two well-defined, nearly horizontal, ovate apertures; newly hatched larva with posterior spiracles located dorsally in weak depression nearly one-third the distance toward the cephalic segment normal in situation in more mature specimens. Cephaloskeleton (pl. 32, A and B) with pharyngeal sclerites weakly developed but labial sclerites remarkably well-developed, divided, heavily sclerotized, weakly curved, spatulate.

The developing larva protrudes into open air through the genital opening of the female; many female specimens have been examined with the larva so exposed.

*Huascaromusca facialis* (Aldrich), new combination

*Mesembrinella facialis* Aldrich, U. S. Natl. Mus. Proc. 62(11):17, 1922. (Type, female from Costa Rica, No. 25248, U. S. National Museum.)

A yellowish brown species with the fourth abdominal segment nearly black.

This species differs in some respects from other species included in the genus *Huascaromusca*, but too few species have been seen to judge the significance of these differences. The genotype has the tympanic ridge clearly bare, but this may be only a specific character in the genus.

*Female.* Head width 16.4; length at antenna and at vibrissa 6.5; eye height 11.0; epistoma strongly warped forward from clypeal plane; clypeus deeply sunken but wide; head height

13.0; bucca 0.21 of eye height, dull orange with thin whitish pollen and with both dark and pale hairs before the metacephalic suture; frontale almost twice as wide as parafrontale anteriorly and nearly four times as wide posteriorly, orange red; front with nearly parallel margins, at vertex, 0.23 of head width, 0.26 at lunule, reddish orange in ground color, and thinly silvery-yellow pollinose, with a few dark hairs outside the frontal rows of bristles; these rows consisting each of about five bristles and extending posteriorly only about one-third the distance from the lunule to the foremost ocellus; parafaciale reddish orange, covered with silvery-yellowish pollen, 1.6 in width opposite lunule; faciale with dark, thick-set, short bristles which ascend nearly half the distance from the vibrissa to the antennal base; vibrissae only slightly above the oral margin and set 4.0 apart; antenna yellow to yellow orange, third segment 3.5 times as long as second; arista orange at base, darker apically, with brown ciliation which is darker toward apex; palpus orange, 4.0 in length; back of head dark brown, postorbital with thin silvery pollen, one row of postocular cilia and with scattered yellow hair.

Thorax yellowish to brownish, darker on dorsum, with thin whitish pollen which, when viewed from behind, extends in three dorsal longitudinal stripes; preacrostichal bristles two, the hindmost set 2.5 before the suture; hindmost predorsocentral bristle 2.0 before the suture; dorsum, dorsal margin of sternopleuron, and posterior margin of mesopleuron with fine black hair, but elsewhere with fine orange hair; postacrostichal bristles in prescutellars only; sternopleural bristles three; sclerites at wing base yellow to orange; spiracles with yellow hair, the metathoracic spiracle with several long black hairs on the posterior margin; tympanic ridge wide and strongly setose, the setae black; scutellum concolorous with dorsum, under surface laterally with pale hair, with black hair in center, lateral bristles two, with a weaker bristle just anterior to basal; postscutellar plates with long pale hair.

Legs varying from yellow basally to brown apically; coxae with soft yellow pile; middle tibia with anterodorsal bristle near middle and ventral bristle near apical third.

Wing (pl. 8, C) hyaline, clouded with brown, and strongly yellowish brown along the costal border; subcostal sclerite and basicosta orange, the former with soft, fine, orange pubescence; costal sections 2 to 6 in the proportions 110:84:140:50:20; anterior cross vein very short; squamal lobes brown, with a nap of very short fine pile above.

Abdomen colored like thorax, shining, the posterior margin of

each segment darker; third segment with posterior margin dark metallic purple and with strong marginal bristles; fourth segment with dark brown pollen in certain lights and with a marginal row of bristles; sternites light brown but darker toward fifth, each with long and strong erect black marginal bristles and with several scattered discal bristles.

*Male.* Head height 18.0; width 22.0; length at antenna 11.0 and at vibrissa 9.4; eye height 15.0; bucca 0.16 head height; frons at vertex 0.08 of head width, only a narrow line at narrowest, but widening to 0.26 at lunule; frontal row consisting of about seven bristles, the rows diverging anteriorly with the frontale, and obsolete at the narrowest portion of frons; parafrontale narrow, bare; parafaciale 1.6 in width opposite lunule, narrower below; vibrissae placed 5.0 apart; palpus 6.2 in length. Wing with costal sections 2 to 6 in the proportions 120:120:150:54:32. Otherwise like female except for normal sexual differences; details of genital segments (pl. 11, D and E) as illustrated.

*Length.* 14 mm.

*Distribution.* Coastal eastern Central America north as far as Belize, British Honduras, south as far as Panama, and inland as far as Flores, northeastern Guatemala.

The female description is based upon the holotype, and the male description upon a male specimen selected from a series trapped in Panama.

A series of *facialis* was collected during August and September, 1936, in fruitfly traps on Barro Colorado, Canal Zone, Panama, by James Zetek. Several of the specimens of this series were gravid upon capture and had large larvae of apparently the second instar partially protruding from their abdomens. These larvae varied from 7 to 9 mm. in length.

*Larva.* Length 3-14 mm. Translucent pearly white in early hours, the segmental lines distinct but with little or no indications of spinose bands of more mature specimens, the pigmented and spinose areas becoming more apparent with development and causing the specimen to appear banded. Cephalic segment (pl. 32 D) large, with three or four horizontal oral grooves and with sclerotized pigmented areas laterodorsally toward posterior margins, these gradually extending around the entire posterior margin; second segment in early hours of development with an area of minute single-pointed spines on anteroventral and lateral margins, these becoming more definite, the spines larger and more pigmented as specimen matures; posterior half or more dorsally and posterior third or more posterolaterally pigmented black; third segment posterolaterally toward middle with pig-

mented areas and toward anterior ventral third with pigmented sclerotized plate; sixth to eleventh segments each posterodorsally and posteroventrally with narrow spinose bands, strong anterior spinose bands posteroventrally, the individual spines long and black in more mature specimens; ventral pad on the eleventh segment with weak spines in younger specimens, but strong, black and hooklike in more mature specimens; spines around posterior cavity long and hairlike; anal protuberance and ventral view of posterior portion (pl. 32, F and G), as illustrated. Posterior cavity shallow, the ventral margin with six weak tubercles, the dorsal margin with eight tubercles. Metapneustic; posterior spiracles (pl. 32, H) in early part of instar each with two slitlike apertures, these partially joined ventrally; in more mature specimens the plates separated by one-fourth the width of one plate, each plate more or less heart-shaped and with two distinct slitlike, nearly horizontal apertures; peritreme very weak and hardly apparent dorsally but strong around the button area. Cephaloskeleton (pl. 32, E) weakly developed in very young larvae but more heavily sclerotized and pigmented in more mature specimens; labial sclerites divided at tips but united basally, elongate and strongly hooked; hypostomal sclerite very short; pharyngeal sclerite weakly pigmented, the dorsal cornua short, weakly sclerotized except at dorsopharyngeal area, the ventral cornua without longitudinal grooves or furrows, elongate, weakly sclerotized; no accessory sclerites.

It was impossible to determine whether one or two instars are included in the above description. All the larvae at hand are metapneustic, a condition usually considered indicative of first-instar development. The smallest larvae are 3 mm. in length, the largest larvae fully 14 mm. It is difficult to understand how sclerotized parts of a single instar could attain the extremes exhibited by these larvae. It may be that the larva of this species is deposited nearly ready for molting into the third instar and the free larval stage is therefore a very short one; perhaps this is a necessity in the tropics.

*Huascaromusca flavicrura* (Aldrich), new combination

*Mesembrinella flavicrura* Aldrich, U. S. Natl. Mus. Proc. 66(18): 16, 1925. (Type, male from La Suiza de Turrialba, Costa Rica, in A. L. Melander's Collection.)

A blue-black species with orange head and appendages.

*Male.* Head width 13.6; length at antenna 6.4, and at vibrissa 6.0; eye height 10.0; head height 12.0; bucca 0.12 of eye height, orange, with golden pollen, and with only black hair before the

metacephalic suture; frontale yellow orange anteriorly; frons at narrowest only 0.01 of head width, 0.08 at vertex, and 0.18 at lunule, orange in ground color, covered with golden pollen anteriorly, brownish posteriorly, and with only a few weak hairs outside the frontal rows of bristles; frontal row of bristles not extending posteriorly beyond narrowest part of frontale, consisting of about eight bristles, only the anterior ones strong; ocellar triangle with strong proclinate accessory ocellar bristles immediately behind posterior ocelli; vertex brown, brownish pollinose; parafaciale orange, golden pollinose, 1.0 in width opposite lunule, slightly narrower below; faciale with only a few dark setae above the oral margin; vibrissae set 3.4 apart; palpus orange, 3.0 in length; antenna with third segment 2.5 times as long as second; arista orange brown at base, darker apically, and with dark brown ciliation; postorbital brown, silvery pollinose; back of head dark brown, gray pollinose, with one row of postocular cilia and with tawny hair; metacephalon orange.

Thorax faintly silvery and without distinct stripes; humerus orange, laterally with tawny hair; humeral bristles three; most of fine thoracic hair dark; lower and anterior pleura orange brown; propleural bristles two; mesospiracular bristles three, both sets of bristles placed rather posteriorly among long pale tawny hair; sternopleural bristles two; preacrostichal bristles two, the hindmost placed slightly anterior to hindmost predorsocentral bristle which is set 2.0 before the suture; preintraalar bristle one, the posterior one absent; posterior half of pteropleuron with long fine tawny hair; postacrostichal bristles two; sclerites at wing base brown to black; tympanic ridge with several brown hairs; postalar declivity with a tuft of brown hair toward center; spiracles with orange hair, the metathoracic spiracle with a few dark hairs ventrally and posteriorly; scutellum with lateral bristles two, only the basal one strong; under surface with black hair in center and yellow hair laterally; postscutellar plates yellow setose.

Legs with orange coxae, these with yellow pile; femora orange, apically orange brown; tibiae and tarsi dark orange brown; bristling as in *bicolor* except femoral hairs longer and in more continuous series.

Wing (pl. 8, D) hyaline, anteriorly brownish; basicosta yellow; subcostal sclerite brownish with brownish pubescence; costal sections 2 to 6 in the proportions 90:60:110:80:10; squamal lobes mostly hyaline, the upper lobe with lateral portion of rim brown, the lower lobe with inner portion brown.

Abdomen bluish purple, the first segment orange except at the posterior margin, where it is narrowly dark on dorsum and more widely dark laterally; second segment slightly yellow basally on sides; first and second segments each with one lateral bristle; third segment dark metallic purplish, with a marginal row of strong erect bristles; fourth segment with a marginal row of weaker bristles.

Genital segments orange brown, of medium size, and with erect black hair. Internal anatomical features (pl. 12, A and B) as illustrated.

*Female.* Head width 13.4; height 11.2; eye height 9.1; bucca 0.20 of eye height; length at antenna 6.5, and at vibrissa 6.3; parafaciale 1.4 in width opposite lunule; distance between vibrissae 3.4; front at narrowest (at vertex) 0.22 of head width, 0.29 at lunule, the margins but slightly divergent, anteriorly brown with brownish pollen toward vertex; third segment of antenna 2.6 times as long as second; palpus 3.3 in length. Thorax with whitish dorsal longitudinal stripes outside acrostichal rows of bristles, these extending slightly beyond suture. Wing with costal sections 2 to 6 in the proportion 95:70:120:100:13. Otherwise similar to male except for normal sexual differences.

*Length.* 7.0-8.5 mm.

The type series, collected from February 8 to July 26, 1923, by Pablo Schild, are the only specimens known to me. Three paratypes, one male and two females, are in the National Museum. The above descriptions are based upon these specimens.

*Huascarmusca formosa* (Aldrich), new combination

*Mesembrinella formosa* Aldrich, Wash. Ent. Soc. Proc. 34:25, 1932. (Type, male from Santa Emilia, Pochuta, Guatemala, in the collection of J. Bequaert of Harvard University.)

An orange and brown species which has the apical portion of the abdomen metallic blue.

This species differs from *flavicurva*, which is apparently the most closely related described species, by having but one pre-acrostichal bristle, the antennae partially blackish, the epistoma not prominent, the pleura and tibiae more yellowish, and the front of the female considerably wider in comparison to the head width.

*Male.* Not seen. Described by Aldrich as having eyes nearly contiguous, front at narrowest only half as wide as anterior ocellus; parafaciale and postorbit with silvery-white pollen which is nearly imperceptible on bucca with the yellow ground color

showing through; parafaciale at narrowest not so wide as the third antennal segment.

*Female.* Head width 15.3; height 12.0; eye height 10.0; length at antenna 6.9, and at vibrissa 7.2; bucca 0.12 of eye height, orange, with thin whitish pollen and with black hair, a few pale hairs below and posteriorly; front orange red anteriorly, brownish black posteriorly, silvery yellow pollinose, 0.27 of head width at vertex, the margins gradually diverging anteriorly, then flaring to one-third of head width at lunule; six large frontal bristles anteriorly, four weaker frontal bristles posteriorly, with a few weak hairs outside the frontal rows; frontale orange anteriorly, graduating toward dark brown on the posterior two-thirds, occupying considerably more than one-half the frontal width; vertex dark brown, silvery to brown pollinose; parafaciale orange, covered with silvery yellow pollen, 1.7 in width opposite lunule and narrowing very slightly below; faciale rather rounded, but high from clypeal plane, and with some black setae above vibrissae which ascend about one-fourth the distance to the antennal base; vibrissae slightly above the oral margin and set 3.8 apart; antenna orange, third segment dark brown on the dorsal half or more and 2.6 times as long as second; arista brown, with long brown ciliation; palpus yellow, 4.1 in length; back of head black, postvertex dark brown and mostly shining, but with some gray pollen, with one row of postocular cilia and with scattered tawny hair; metacephalon orange.

Thorax dark brown with silvery or silvery yellowish pollen, leaving a shining middorsal longitudinal stripe extending to scutellar suture, and with another stripe outside the dorsocentral row of bristles which does not extend quite so far; fine thoracic hair mostly dark; pleura orange to brownish with thin pollen; humerus orange to orange brown, with pale hair laterally and ventrally and with three bristles; propleural bristle one, among long fine pale hair; mesospiracular bristles two or three, usually only one strong, these also surrounded with long fine pale hair; sternopleuron with considerable pale hair ventrally and on the posterior margin; sternopleural bristles two; pteropleuron with posterior half covered with pale hair; preacrostichal bristle one, placed 2.8 before the suture; hindmost predorsocentral bristle placed 1.6 before the suture; preintraalar bristles one; postacrostichal bristle one; sclerites at wing base yellowish brown; lesser ampulla black; postalar declivity in center and tympanic ridge with a few pale hairs; thoracic spiracles with pale yellow hair, the metathoracic spiracle with long tawny hair on ventral margin; scutellum concolorous with dorsum, the under surface



with pale hair, lateral bristle one; postscutellar plates with long fine pale hair.

Legs yellow to orange at coxae, the color graduating through orange to dark brown toward tarsi; coxae with fine yellow hair; chaetotaxy as in *bicolor*.

Wing (pl. 8, E) brownish along all veins and yellowish anteriorly and basally; basicosta yellow orange; subcostal sclerite orange brown with long brown setae; costal segments 2 to 6 in the proportions 100:110:143:68:10; squamal lobes hyaline and brownish, the upper lobe with brown rim, the lower lobe brown on the inner third.

Abdomen with first segment orange at base, metallic blue over brown ground color on the posterior margin; second, third, and fourth segments brown, metallic bluish, with thin, shifting, silvery pollen; no lateral bristles on first or second segments, third with strong erect marginal row, fourth with a marginal row of weaker bristles.

*Length.* 8.2-9.4 mm.

Three paratype females of this species are in the National Museum (No. 43882) and three are in J. Bequaert's collection.

*Huascaromusca spicata* (Aldrich), new combination

*Mesembrinella spicata* Aldrich, U. S. Natl. Mus. Proc. 66(18):13, 1925. (Type, male from La Suiza de Turrialba, Costa Rica, No. 26796, U. S. National Museum.)

A blue- or purplish-black species with brown legs, hyaline wings; the face, clypeus, palpi, and antennae orange.

The genital structures of the male of this species are unique in the subfamily. The external structure of the abdomen (pl. 12, C and E) and postabdominal segments are reminiscent of certain sarcophagid species, particularly *Sarcophaga argentea* Tns. and *S. importuna* Wlk.

*Male.* Head width 12.8; length at antenna 6.4 and at vibrissa 6.0; eye height 10.0; head height 12.0; epistoma orange; bucca orange with golden pollen, 0.16 of eye height, with black and golden hair, frontale as wide as parafrontale, orange anteriorly, orange brown posteriorly; frontal row of bristles consisting of about 11 bristles, large and strong anteriorly only, weak and hair-like toward the narrowest part of the front; front at narrowest, 0.10 of head width, 0.15 at vertex, and 0.23 at lunule, orange anteriorly, brownish posteriorly, with golden pollen and with a few dark hairs outside the frontal rows; vertex dark brown with brown pollen; ocellar triangle with a pair of acces-

sory ocellar bristles located rather far behind the posterior ocelli; faciale sharply defined, with black setae ascending nearly one-third the distance to the antennal base; parafaciale orange, with golden pollen, 1.4 in width opposite lunule and slightly narrower below; vibrissae set 3.8 apart; antenna bright orange, third segment 3.5 times as long as second, and rather wide throughout; palpus orange, 4.0 in length; back of head black, silvery pollinose, with one row of postocular cilia and with abundant yellow hair; metacephalon orange with silvery pollen.

Thorax blue black, the pleura rather brownish, with thin whitish pollen, and with three longitudinal stripes on dorsum; humerus with three bristles, laterally with fine yellowish hair; preacrostichal bristles two, the hindmost set 2.2 before the suture; hindmost predorsocentral bristle set 1.5 before the suture, preintraalar bristle one; postacrostichal bristles two; fine hair on thorax black except anteriorly on sternopleuron and posteriorly on pteropleuron; sternopleural bristles two; mesospiracular bristles three or four arranged nearly in a row; prosternum with black setae except posteriorly where the hair is pale; sclerites at wing base dark brown to black, the greater ampulla with fine silvery pubescence; postalar declivity with black hair in center; tympanic ridge nearly bare; spiracles with brown hair, metathoracic spiracle with long black hair on ventral margin; scutellum with fine dark orange to brown hair on under surface, lateral bristles two, a third weaker lateral bristle just anterior to basal bristle; postscutellar plates with dark brown setae.

Legs brown, the color graduating to brownish black apically; coxae with pale hair; chaetotaxy as in *bicolor*.

Wing (pl. 8, F) hyaline, rather brownish anteriorly and basally, and infuscated at anterior cross vein; basicosta and subcostal sclerite dark brown, the former with silvery pubescence, the latter with dark brown pubescence; costal sections 2 to 6 in the proportions 90:60:105:80:12; squamal lobes rather milky white basally, rims dark brown with dark brown ciliation.

Abdomen metallic purple over dark brown ground, with faint silvery pollen and rather erect dense short black hair, and each segment with a marginal row of bristles; sternites progressively wider and shorter toward fifth which is very short and wide (pl. 12, D).

Genital segments large, black, shining, with abundant black hair; inner forceps with inner margins not divergent, their bases posteriorly united and swollen into a hump, this divided into two arms extending posteriorly toward anus and bearing

striking, black, converging hair-tufts which touch on the median line. Internal features as illustrated (pl. 12, E and F).

*Female.* Unknown.

*Length.* 8.3 mm.

*Huascaronusca tibialis* (Aldrich), new combination

*Mesembrinella tibialis* Aldrich, U. S. Natl. Mus. Proc. 62(11):16, 1922. (Type, male from Porto Bello, Panama, No. 25247, U. S. National Museum.)

An orange-brown species with the dorsum of the thorax brown, dorsum of abdomen except at base metallic blue, and the tibiae and tarsi dark brown.

*Male.* Head height 12.4; width 15.4; eye height 11.0; length at antenna 7.0, and at vibrissa 6.0; bucca 0.12 of eye height, deep orange, mostly shining, and with both black and orange hair; frontale orange brown; parafrontale orange; eyes contiguous for a short distance; front at vertex 0.10 of head width, 0.18 at lunule; frontal row of bristles not continuing posteriorly beyond the narrowest portion of front and composed of about five bristles, only the anterior ones strong; a few weak dark hairs on parafrontale outside frontal row; parafaciale 0.8 in width opposite lunule, narrower below; faciale low, rounded, with a few black hairs above the vibrissa; vertex brown, brown pollinose; ocellar triangle with weak postocellar bristles behind posterior ocelli; vibrissae slightly above oral margin and set 4.0 apart; antenna deep orange, third segment 2.5 times as long as second; palpus orange, 4.0 in length; metacephalon orange; back of head black, grayish yellow pollinose, with one row of postocular cilia and tawny hair.

Thorax deep orange, dorsum orange brown with brown pollen, with a shining middorsal stripe and a lateral stripe outside the dorsocentral row of bristles, neither of which extends to the scutellar suture; fine thoracic hair mostly black; humerus orange, with two bristles, and with fine black hair; sternopleural bristles two; preacrostichal bristle one, this placed 2.7 before the suture; hindmost predorsocentral bristle placed 1.6 before the suture; postacrostichal bristle one; sclerites at wing base orange to orange brown; lesser ampulla dark brown; propleural bristle one; mesospiracular bristle one; spiracles with orange hair, the metathoracic spiracle with fine long black hairs on the ventral margin; scutellum deep brown, rather metallic purple in certain lights, under surface with dark hair, lateral bristles two; post-scutellar plates with black setae.

Legs with coxae, femora and pulvilli orange, the femora

darker apically; tibiae and tarsi dark brown; coxae with some fine orange hair; bristling as in *bicolor*.

Wing (pl. 8, G) brownish, orange basally, basicosta and subcostal sclerite orange brown, the latter with orange pubescence; costal sections 2 to 6 in the proportions 90:70:100:80:10; squamal lobes orange brown, rims brown with tawny ciliation.

Abdomen with first segment orange at base, the posterior third dark metallic purple on dorsum, with one lateral bristle; second segment with only ventral margins of tergite orange, the posterior third shining purple, with one lateral bristle; third segment with posterior two-fifths shining purple and with two rows of strong erect marginal bristles; fourth segment brownish pollinose over purple ground color, with a row of strong discal bristles and a row of weaker marginal bristles.

Genital segments large, globose, dark brown, with black hair. Internal morphological features (pl. 13, A and B) as illustrated.

*Female.* Unknown.

*Length.* 8.7 mm.

The holotype, which was collected March 18, 1911, by Busck, is the only specimen known to me.

*Huascaromusca umbrosa* (Aldrich), new combination

*Mesembrinella bicolor* Van der Wulp (nec Giglio-Tos), *Biologia Centrali-Americana*, Insecta, Diptera, vol. 2, p. 301, 1896. (Two females, Mexico, in the British Museum.)

*Mesembrinella umbrosa* Aldrich, U. S. Natl. Mus. Proc. 62(11): 12, 1922. (Type, male from Costa Rica, No. 25246, in the U. S. National Museum.)

A rather uniformly dark brown species with the abdomen metallic blue over a brown ground color except at the base.

This is the largest of the calliphorid species known to me. It is one of the most strikingly colored species of *Mesembrinellinae*.

*Male.* Head width 21.0; length at antenna and at vibrissa 9.8; eye height 17.8; bucca 0.11 of eye height, deep orange with yellow pollen, and with only black hairs; frontale deep orange, not as wide as parafaciale at the lunule, and obliterated at the narrowest portion of front; frontal row of bristles extending anteriorly only to the antennal base and not further than the narrowest portion of front, consisting of eight or nine bristles, the anterior ones strong; vertex dark brown and dark brown pollinose; front at narrowest 0.01 of head width, 0.11 at vertex, and 0.24 at lunule, orange, golden pollinose, and practically bare of fine hairs; inner vertical and ocellar bristles weak but elongate;

parafaciale orange, with golden pollen, 1.8 in width opposite lunule and but little narrower below; faciale with short orange brown setae for about one-third the distance from the vibrissa to the antennal base; vibrissae slightly above the oral margin and set 4.4 apart; antenna orange to orange brown, third segment twice as long as second and reaching four-fifths the distance to the vibrissa; palpus orange, 3.5 in length; arista orange brown at base, darker apically, the ciliation dark brown; back of head dark brown to black, silvery yellowish pollinose, the postorbital silvery, with one row of postocular cilia and with yellowish hair.

Thorax with dorsum dark brown anteriorly and laterally, with brown pollen, and with indistinct longitudinal stripes on dorsum; pleura with golden brown pollen; humerus with three humeral bristles, and black hair dorsally, golden hair laterally; preacrostichal bristles two or three, if three, then the foremost weak, the posterior one set 4.0 before the suture; hindmost predorsocentral bristle set 2.4 before the suture; preintraalar bristles two or three, if three, then the foremost weak and often out of line with the normal series; postacrostichal bristle one; sternopleural bristles three; dorsum, posterior and dorsal margins of mesopleuron, and upper half of sternopleuron with fine black hair, elsewhere the fine hair is tawny to golden; pteropleural tuft of hair orange; sclerites at wing base orange except lesser ampulla which is black; tympanic ridge with fine orange hair; prosternum with orange hair; thoracic spiracles with orange hair, the metathoracic spiracle with long fine orange hair on the ventral margin; under surface of scutellum with abundant short orange hair, basal lateral bristle strong and with a lesser lateral bristle anterior to it, discal bristle set rather posteriorly from normal position.

Legs deep orange, darker apically; coxae and trochanters with fine orange hair; chaetotaxy as in *bicolor*.

Wing brown basally and yellowish anteriorly, strongly infuscated along the veins but the cells paler toward center; basicosta and subcostal sclerite orange brown, the latter with some long fine orange brown hair; costal sections 2 to 6 in the proportions 140:160:140:70:44; upper squamal lobe brown with dark brown rim, the lower lobe orange brown with brown pubescence.

Abdomen orange brown with metallic bluish to purple reflections except at base, mostly shining, but with golden to golden brown pollen basally and ventrally in certain lights; first and second segments without lateral bristles, third and fourth seg-

ments each with a marginal row of weak bristles; fifth sternite with a V-shaped incision and with black hair.

Genital segments comparatively small, dark brown, with black hair, lying almost parallel with sternites. Internal features as illustrated (pl. 13, C, D, and E).

*Female.* Head height 17.4; eye height 13.6; bucca 0.22 of eye height; length at vibrissa and at antennal base 10.0; width 21.0; frontale orange to red orange, occupying three-fifths of frontal space, the margins nearly parallel; frontal row consisting of about 12 bristles, only the anterior 4 or 5 large; front at narrowest (at vertex) 0.26 of head width, the margins nearly parallel or but slightly divergent, these flaring outward anteriorly to 0.32 of head width at lunule, with a few brownish hairs outside the frontal rows; third antennal segment twice as long as second; vibrissae set 4.6 apart; parafaciale 2.6 in width opposite lunule; palpus 6.0 in length; vertex orange brown, golden brown pollinose. Wing (pl. 8, H) with costal sections 2 to 6 in the proportions 145:160:180:80:45. Otherwise similar to male except for normal sexual differences.

*Length.* 13-15 mm.

*Distribution.* Neotropical: Costa Rica, south to northern South America.

As pointed out by Aldrich (1922), some specimens placed under this name have fulvous hairs on the pleura, coxae, femora, and tibiae.

*Huascaromusca uniseta* (Aldrich), new combination

*Mesembrinella uniseta* Aldrich, U. S. Natl. Mus. Proc. 66(18):13-14, 1925. (Type, male from La Suiza de Turrialba, Costa Rica, No. 26797, U. S. National Museum.)

A blue-black species with dark brown to black legs, hyaline wings; the face, anterior portion of bucca, palpi, and thoracic spiracles bright orange.

*Male.* Head width 12.8; length at antenna 7.0 and at vibrissa 6.0; eye height 10.0; head height 10.8; bucca orange anteriorly, black posteriorly, 0.10 of eye height, with dark hair only; frontale red orange on anterior third, black at vertex, and twice as wide as parafrontale at narrowest; frontal row of bristles extending anteriorly to nearly opposite base of second antennal segment but not extending posteriorly beyond the narrowest portion of the front, consisting of about six bristles; parafrontale black, silvery pollinose, bare; front at narrowest 0.14 of head width, 0.19 at vertex, and 0.25 at lunule; vertex black, slightly silvery, parafaciale orange, golden pollinose, 1.2 in width oppo-

site lunule and narrowing below; clypeus red orange, silvery pollinose; vibrissae only slightly above the oral margin and set 3.6 apart; faciale rather flattened, with only a few short setae above vibrissa; antenna orange, third segment three times as long as second; arista orange at base, dark brown to black apically, with black ciliation nearly to apex; back of head black, silvery pollinose, with two or three rows of postocular cilia and with yellow-orange hair which is particularly noticeable below.

Thorax indistinctly striped, with thin whitish pollen that is visible from a posterior view mainly; all lesser thoracic hair black; preacrostichal bristles two, the posterior one 2.4 before the suture; hindmost predorsocentral bristle 2.2 before the suture; postacrostichal bristles two; sternopleural bristles three; prosternum with black setae laterally and yellow hair in middle; sclerites at wing base dark brown to black; thoracic spiracles with orange hair, the metathoracic spiracle with long black hairs on the ventral margin; under surface of scutellum with brown hair laterally, and with one lateral bristle and a weak bristle just anterior to it; postscutellar plates with black setae.

Legs as in *bicolor* except with longer hair, this more abundant on the middle and hind femora, particularly on the anteroventral and posteroventral surfaces.

Wing (pl 8, I) hyaline, slightly infuscated basally and at cross veins; basicosta and subcostal sclerite orange brown, the latter darker and with brown pubescence; costal sections 2 to 6 in the proportions 80:60:100:84:12; squamal lobes orange brown to brown, the rims darker.

Abdomen blue black with purple reflections, whitish pollinose anteriorly and ventrally in certain lights; first and second segments each with one lateral bristle; third segment with a marginal row of long strong erect bristles; fourth segment with a distal row of from four to six bristles, and with a marginal row of weaker bristles; sternites black, fifth as illustrated (pl. 14, B).

Genital segments large, black, shining, with black hair. Internal features (pl. 14, A and C) as illustrated.

*Female.* Head height 10.4; width 13.0; eye height 9.0; bucca 0.20 of eye height; length at antenna 7.4 and at vibrissa 6.0; parafaciale 1.6 opposite lunule; distance between vibrissae 3.6; frontal 2.0 times as wide as parafrontale anteriorly and wider toward vertex, orange red on anterior half, black posteriorly; frontal row of bristles not extending posteriorly beyond middle, composed of about four bristles; only one proclinate and one reclinate frontoorbital bristle; front at vertex 0.25 of head width, the margins nearly parallel to within one unit of lunule, then

diverging to 0.32 of head width. Wing with costal sections 2 to 6 in the proportions 90:70:100:100:12. Abdomen with several elongate bristles on each sternite. Otherwise like male except for normal sexual differences.

*Length.* 8.0-8.5 mm.

Only the six males and four females of the type series, which were collected February 22 to March 29, and September 5 to October 1, 1923, by Pablo Schild, are known to me. These were originally from the collection of A. L. Melander.

*Huascaromusca xanthorrhina* (Bigot), new combination

*Calliphora xanthorrhina* Bigot, Soc. Ent. de France Bull. CLXXX, 1887. (Type, male from Mexico, in the Collin Collection at Newmarket, England).

*Somomyia xanthorrhina* Bigot, Soc. Zool. de France Bull. 12: 602, 1887. (Same description of same material above).

*Mesembrinella chrysochea* Brauer (Moritz Ms.), Akad. der Wiss. Wien, Math.-Nat. Kl. Sitzber. (1) 106(1):596, 1895. (Specimens from Venezuela, in Vienna). New synonymy.

*Huascaromusca cruciata* Townsend, Insector Inscitiae Menstruus 6:166, 1918; Aldrich, U. S. Natl. Mus. Proc. 62 (1): 15, 1922. (Type, female from Peru, No. 53745, U. S. National Museum). New synonymy.

*Mesembrinella bequaerti* Séguy, Encyc. Ent. (B II) Dipt. 2:195, 1926. (Type, female from Peru, in Paris). New synonymy.

*Mesembrinella decrepita* Séguy, Encyc. Ent. (B II) Dipt. 2: 195, 1926. (Type, male from Colombia, in Paris). New Synonymy.

A blue-black species with hyaline wings and orange front, antennae, and palpi.

*Female.* Head width 12.8; length at antenna and at vibrissa 6.5; eye height 8.8; head height 11.0; bucca 0.23 of eye height, orange, shining, with scattered black hair, no pale hairs before the metacephalic suture; frontale 0.60 of frontal width at lunule, orange anteriorly, brown to black posteriorly; front at narrowest (at vertex), 0.22 of head width, the margins nearly parallel anteriorly to within 2.0 units of lunule, then widening to 0.31 of head width at antennal base, with yellow pollen over orange ground color, and with some hairs in rows extending anteriorly to foremost frontal bristle; frontal rows of bristles extending to the base of the second antennal segment and not or but little divergent anteriorly, each row consisting of five or



six bristles; vertex subpollinose, black; clypeus golden over reddish ground color; parafaciale 1.5 in width opposite lunule, orange, yellowish silvery pollinose; vibrissae 0.6 above oral margin and set 3.3 apart; palpus orange, 4.5 in length; antenna orange, third segment two and one-half times as long as second and reaching four-fifths the distance to the vibrissae; arista brown, ciliation brown; back of head silvery over black ground color, the postorbits orange pollinose, with one row of postocular cilia and with yellowish hair.

Thorax black with thin whitish pollen anteriorly and on pleura, with indistinct shining longitudinal stripes on dorsum which do not extend to suture; pleura lightly silvery; humerus concolorous, and with three bristles, all strong; propleural bristles two or three; preacrostichal bristles two, the hindmost placed 2.6 before the suture; hindmost predorsocentral bristle placed 1.6 before the suture; sternopleuron black setose; sternopleural bristles three; mesopleuron on posterior four-fifths, hypopleuron on posterior fourth, pteropleuron on posterior half and prosternum entirely, with black setae; sclerites at wing base black; postacrostichal bristles two; mesopiracular bristles three or four, almost in a tuft; thoracic spiracles with dark-brown hair; scutellum concolorous with dorsum, the under surface generally with yellowish-brown hair, lateral bristles two, the basal one strong.

Legs brown to black; coxae without fine pale hair; middle femur with one anterior bristle near middle, about four anteroventral bristles basally and four to six ventral bristles basally; middle tibia with one posterior bristle near basal fourth and usually one posterodorsal bristle near apical third (one specimen has one bristle near basal fourth on this surface on one side); hind tibia with two elongate anterodorsal bristles, one near basal third and one near middle; claws and pulvilli a little shorter than last tarsal segment.

Wing (pl.8, J) hyaline, brown basally; costal sections 2 to 6 in the proportions 95:75:135:86:18; third vein with two or three basal setulae; subcostal sclerite and basicosta dark brown; fourth vein entering costa 1.0 before wing apex; both squamal lobes brown especially on posterior margins, the lower lobe with a fringe of dark brown hair.

Abdomen black with purplish reflections and silvery pollinose in certain lights especially ventrally; third segment with a marginal row of strong bristles; fourth segment with strong erect discal bristles in a partial row, and with a marginal row of weaker bristles.

*Male.* Not seen.

*Length.* 8-9 mm.

*Distribution.* Neotropical: Southern Mexico southward to Peru.

*Remarks.* Shortly after the appearance of the description of Townsend's *cruciata* in 1918, Collin wrote to Aldrich suggesting that *xanthorrhina* Bigot might be an older name for the species, and that Townsend's description of *cruciata* exactly fitted the type of Bigot's *xanthorrhina*. Aldrich hesitated to adopt the name of *xanthorrhina* for this species because of the difference in the localities given. But in 1929 he compared specimens of the Peruvian *cruciata* with the two Bigot types of *xanthorrhina* from Mexico and concluded that they were the same.

Aldrich saw the types of *bequaerti* Séguy and *decrepita* Séguy in Paris in 1929, indicating in his notes that they were this species.

It is interesting to note that no males of this species have been in collections seen by me. Notwithstanding the fact that I made extensive collections through Central and South American countries, no specimens of this species were ever found. It is possible that some of the specimens included in this paper under another name may prove to be males of *xanthorrhina*. Aldrich's identification of the type of *decrepita* Séguy as this species would appear to indicate that the male is essentially like the female.

Brauer mentioned the manuscript name *Mesembrinella chrysorhea* Moritz in his 1895 paper, the specimens being from Venezuela. The name was never published by Moritz, and Brauer must assume the responsibility for the name since his was the first published description of the species.

## SUBFAMILY RHINIINAE

Members of the Rhiniinae lack intrapostocular cilia, have very narrow occipital orbits, and most of the species have the epistoma protuberant. Since only one species is known to occur in the Western Hemisphere, no attempt has been made to give a synopsis of the characters for the subfamily, for those noted in the key will apparently suffice.

### GENUS *STOMORHINA* RONDANI

*Idia* Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol 5. p. 9, 1826. (Preoccupied). *Genotype*. (*Idia fasciata* Meigen) = *Musca lunata* Fabricius. (Designation of Brauer and Bergenstamm).

*Stomorhina* Rondani, Diptera Italicae Prodromus, vol. 4, p. 9, 1861 (change of name for *Idia* Meigen, preoccupied); Brauer and Bergenstamm, Zweiflügler des Kaiserlichen Museums zu Wien, vol. 4, no. 1, p. 186, 1889; *ibid.*, vol. 6, no. 3, p. 89, 1893; Townsend, Indian Mus. Rec. 14:191, 1917; Senior-White, Indian Mus. Rec. 27:92, 1925; Malloch, Ann. and Mag. Nat. Hist. (9) 18:499, 1926; Linn. Soc. N. S. Wales, Proc. 52:329, 1927; Curran, Amer. Mus. Nat. Hist. Bull. 52:375, 1928; Amer. Mus. Novitates 506:15, 1931; Bequaert, Amer. Mus. Novitates 539:3, 1932; Townsend, Manual of Myiology, vol. 2, p. 154, 1935; *ibid.*, vol. 5, p. 108, 1937.

*Stomorrhina* Rondani, Diptera Italicae Prodromus, vol. 5, p. 226, 1862.

*Stomorrhyna* Rye, Zool. Rec. 12:275, 1875.

*Stomorrhina* Scudder, Nomenclator Zoologicus, Sup. List, p. 319, 1882.

*Stomathorrhina* Bezzi, Ztschr. f. syst. Hym. Dipt. 6:53, 1906.

*Stomatorrhina* Bezzi, Ztschr. f. syst. Hym. Dipt. 6:144, 1906.

*Stomatorrhinia* Malloch, Linn. Soc. N. S. Wales Proc. 52:329, 1927.

*Male and female*. Head (pl. 1, B) width about one-sixth greater than head height; length at antenna less than at vibrissa in male, nearly equal in female; oral margin strongly produced,

the epistoma as long as clypeus, greatly produced, erectly porrect, and strongly warped forward from the clypeal plane; metacephalon flat; bucca high; eye long-ovate, the longitudinal axis nearly parallel with posterior margin of head; frontale in male obsolete at narrowest portion, in female slightly narrower than parafrontale, striate; eyes in male nearly contiguous, in female separated by nearly one-third head width, with a few scattered hairs on the parafrontale outside the frontal row of bristles; frontal rows of bristles extending anteriorly to the middle of the third antennal segment and widely divergent; inner vertical bristles straight; outer vertical bristles absent in male but present in female; postvertical bristles absent; frontoorbital bristles absent in both sexes, the female with a row of short setae in place of these; ocellar bristles minute; postocellar bristles proclinate; clypeus wide, nearly flush with facial profile; facial carina short, wide, high, and with a median furrow separating antennal bases; parafaciale of uniform width, setose on the upper two-thirds; faciale rounded, strongly bowed, with only a few bristles above vibrissae, haustellum half head height; palpus two-thirds length of head at vibrissa, thin, strongly flattened and clavate; antennal base below eye-middle when head is viewed in profile; third segment of antenna about twice as long as second and reaching nearly four-fifths the distance to the vibrissa; arista with short penultimate segment, long pectinate above for slightly more than half the distance to the apex; back of head flat or dished in profile, without intrapostocular cilia; occipital orbits very narrow.

Thorax with two humeral bristles; propleuron bare; preintraalar, predorsocentral and preacrostichal bristles not differentiated; posthumeral bristle absent; presupraalar bristle one; sternopleural bristles two; prosternum flat, of medium size, narrow, pilose; postalar declivity bare; tympanic pit bare; postalar bristles two; postaerostichal and postdorsocentral bristles in prescutellars only; postintraalar bristle one; postsupraalar bristles two; scutellum without discal bristles, lateral bristles two, no apical bristles.

Legs with anterior coxa finely pilose, posterior coxa bare posteriorly; fore femur with posterodorsal and posteroventral rows of bristles, the posterior surface with considerable hair but no rows of bristles; fore tibia with a few short anterodorsal bristles toward middle, one of which near the apical third is stronger than others, and with one strong posterior bristle near apical third; middle femur with one strong anterior bristle near middle, and with anteroventral and posteroventral rows of bristles.

tles which are strong only basally; hind femur with anterodorsal, anteroventral, and posteroventral rows of bristles, the latter row strong only basally; hind tibia with an anterodorsal row of bristles, two or three of which are stronger than others in the series, one anteroventral bristle near apical fourth, and three posterodorsal bristles, one near basal third, one near middle, and one near apical third; male tarsi slightly flattened ventrally; female front tarsi flattened and widened; claws and pulvilli as long as preceding tarsal segment.

Wing without costal spine; remigium posteriorly with long cilia above, bare below; third vein with two or three basal setulae; fourth vein with apical section or fold, the angle rounded and bent obtusely toward apex; apical cell clearly open; anterior cross vein beyond middle of second section of fourth vein, oblique; posterior cross vein arcuate; last section of fifth vein from 0.12 to 0.15 as long as preceding section; seventh vein straight; upper squamal lobe bare, small, rounded; lower squamal lobe large, ovate, bare.

Abdomen without discal or median marginal bristles; third and fourth segments each with a marginal row of short recumbent bristles; first and second sternites of male covered by margins of tergites; female third and fourth sternites but narrowly exposed; fifth sternite of male cleft.

Male genital segments of medium size, first segment rather globose; second segment large, rather flattened.

Larva with "button" in peritreme, posterior spiracles with oval apertures, and stigmal field outlined by elongate tubercles.

#### *Stomorphina lunata* (Fabricius)

*Musca lunata* Fabricius, Systema Antliatorum, p. 292, 1805. (Type, male from Madeira, in Copenhagen).

*Idia fasciata* Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 5, p. 9, 1826; Brauer and Bergenstamm, Zweiflügler des Kaiserlichen Museums zu Wien, vol 7, no. 4, .p. 22, 1894. (Type, France, apparently lost).

*Idia lunata* (Fabricius). Wiedeman, Aussereuropäische zweiflügelige Insekten, vol. 2, p. 351, 1830; Loew, Stettin. Ent. Ztg. 5 (1) :18-20, 1844; Schiner, Reise der Novara, Diptera, p. 309, 1868; Fauna Austriaca, Die Fliegen, vol. 1, p. 579, 1862; Pandellé, Rev. de Ent. 15:148-149, 1896.

*Idia cinerea* Robineau-Desvoidy, Essai sur les Myodaires, vol. 2, p. 422, 1830. (Type, Isles de la mer d'Africa, in Paris).

*Idia rostrata* Robineau-Desvoidy, Essai sur les Myodaires, vol. 2, p. 421, 1830; Wiedemann, Aussereuropäische zweiflügelige Insekten, vol. 2, p. 352, 1830; Villeneuve, Revue Zool. Africaine, vol. 3, no. 3, p. 435, 1914. (Type, Isle de France, in Paris).

*Stomorhyna maculata* Rondani, Soc. Ital. di Sci. Nat. Atti 8:288, 1865. (Type, Europe, apparently lost.)

*Stomorhina lunata* (Fabricius), Bezzi, Katalog der Paläarktischen Dipteren, vol. 3, p. 523, 1907; Villeneuve, Revue Zool. Africaine, vol. 3, no. 3, p. 435, 1914; Townsend, Indian Mus. Rec. 13:192, 1917; Senior-White, India Dept. Agr. Mem. Ent. Ser. 8 (4):43, 1923; Spolia Zeylanica 13:109, 1924; Indian Mus. Rec. 27:93, 1925; Suster, Jassy Univ. Ann. Aci. 16 (1-2):222, 1930; Townsend, Ann. and Mag. Nat. Hist. (10) 8:372, 1931; Manual of Myiology, vol. 2, p. 154, 1935; Frey, Finska Vetensk. Soc. Comm. Biol. 6 (1):139, 1937; Townsend, Manual of Myiology, vol. 5, p. 108, 1937; Senior-White, Fauna of British India, Diptera, vol. 6, p. 191, 1940.

This species is the only known North American calliphorid fly with a pectinate arista.

*Male.* Head height 11.0; width 13.0; length at antenna and at vibrissa 6.0; eye height 7.5; bucca 0.40 eye height, with abundant medium-length yellow hair or pile, much of which is pale before the metacephalic suture, black, thickly covered on the posterior three-fourths with yellowish-white pollen; frontale red brown; frons nearly obsolete at narrowest, at vertex 0.15 of head width, 0.26 at lunule, thinly greyish pollinose over black ground color; vertex shining black, clypeus black, silvery pollinose; parafaciale 1.0 in width opposite lunule, black, thinly silvery pollinose; vibrissae 1.4 above the oral margin and separated by 3.0; palpus black; antennal segments brown to black; back of head black, with two rows of postocular cilia and abundant yellowish-white hair.

Thorax olivaceous green, thinly whitish or silvery pollinose, dorsally with thin erect black pile and suggestions of darker longitudinal stripes which extend to the apex of the scutellum; a black area at base of each bristle, giving the whole a punctate appearance; pleura slightly silvery or yellowish pollinose, with considerable yellowish and whitish pile; mesopleuron with black pile on posterior four-fifths; sternopleuron whitish pollinose anteriorly, with a tuft of long whitish pile; pteropleuron with white to yellowish pile on posterior half; prosternum with long whitish to yellowish pile at center; sclerites at wing base black,

the greater ampulla with thin tawny pile; mesospiracle with white hair; under surface of scutellum with fine white pile.

Legs black, silvery pollinose; anterior coxa with white pile.

Wing hyaline; subcostal sclerite with white pubescence; basicoxa black; squamal lobes white, the upper hyaline on apical half.

Abdomen brownish black, slightly olivaceous green, silvery pollinose in certain lights and shining in others; black at bases of setae; first segment black on dorsum, second to fourth segments each with large yellowish lateral spots; ventrally mostly yellowish.

Genital segments black, shining, with scattered black hair. Internal anatomical features (pl. 14, D, E, and F) as illustrated.

*Female.* Head height 10.0; width 12.0; length at antenna 5.0, and at vibrissa 6.0; eye height 6.4; bucca 0.53 of eye height; width of front at vertex 0.30 of head width, 0.40 at lunule; parafaciale 1.6 in width opposite lunule; third segment of antenna slightly more than twice as long as second. Otherwise similar to male except for normal sexual differences.

*Length.* 6-7 mm.

*Distribution.* Holarctic: Southern Europe, northern Africa, southern Asia, North America.

The species evidently occurs in North America only on the island of Bermuda. Although I collected on many of the islands in the Caribbean over different seasons, especially in the Bahama group, no specimens were ever seen. One specimen which was collected in September 1922 is in the American Museum of Natural History. Dr. Curran informs me that the species is not rare in Bermuda.

*Biology, habits and immature stages.* Portschinsky (1894, pp. 120-121) reared *lunata* as a parasite of egg pods of certain species of Palearctic Acrididae. Senior-White (1923) confirmed this observation in India. Williams (1933, p. 473) reported that *lunata* was the chief natural enemy of locusts in Kenya, Africa, and Cuthbertson (1933) found up to 95 percent of the locust egg pods in Rhodesia, South Africa, were preyed upon by this species. It thus appears quite certain that *lunata* departs from the general saprophagous habit of the Calliphoridae in being predaceous in the egg capsules of certain locusts. As many as 50 eggs of *lunata* have been found in a single egg capsule of the host. According to Potgieter (1929), the flies are very active at the time of oviposition by the host and as soon as one of the latter withdraws its abdomen from the ground, the female flies rush to the spot and deposit eggs in the still fluid covering of the egg mass.

Oviposition may also take place in partially hatched egg capsules. Larvae have been noted to migrate from one egg capsule to another to complete feeding. Usually 2 or 3 puparia are found in a single capsule, but the number may be as high as 12.

The species is not exclusively predaceous upon locust egg masses. Cuthbertson (1935) reared *lunata* from larvae which he found in soil beneath dung heaps infested with termites, also from larvae associated with dead and dying termites in the broken down fungus beds of a termite nest.

The following descriptions of immature stages are based upon collections of *lunata* forwarded to me by Mr. Cuthbertson; the notes upon the stages are from his 1935 paper.

*Egg.* About 1.5 mm. in length, 0.30 in diameter; with a finely reticulated pattern.

The incubation period is from 18 to 24 hours during summer conditions.

*Larva.* First instar: Length 1.5-1.75 mm. Metapneustic. Posterior spiracles more or less heart-shaped, each with two ovate apertures which appear united; peritreme and "button" indistinct. Cephaloskeleton weakly sclerotized.

This stage lasts only 14 to 24 hours under favorable circumstances.

Second instar: Length 3.5-6.0 mm. Anterior spiracles each with 6 or 7 circular openings. Posterior spiracles each with two oval apertures, peritreme distinct, the "button" enclosed in almost imperceptible peritreme. No indication of spinose rings or bands on any segment. Cephaloskeleton (pl. 33, B) strongly sclerotized, the upper cornua with appearance of being divided into two sections, these being united by a non-pigmented area. Anal area (pl. 33, D) large, surrounded by 8 elongate tubercles.

During January and February in South Africa, this instar requires 36 to 48 hours for development.

Third instar: Length 5-14 mm. As in previous instar but sclerotized areas heavier and more deeply pigmented. Posterior spiracles with three oval apertures (pl. 33, A) and cephaloskeleton (pl. 33, C) as illustrated.

The third instar requires 2 to 3 days to complete development under favorable conditions.

*Puparium.* Length 7-7.5 mm. Dark brown, with most of the external characters of the mature larva.

The pupal stage lasts for 10 to 16 days during the summer months in South Africa.

The entire life cycle appears to cover less than 30 days under ideal conditions.



## SUBFAMILY CHRYSOMYINAE

The "screwworm" species, the "black blowflies" of authors, and the "nestling screwworms" of this country belong to this subfamily. Biologies, habits, and immature stages of only a few of the species are known.

All the species belonging to the Chrysomyinae have the remigium ciliate posteriorly at the base. The subfamily may be divided into two tribes upon superficial examination. The species of Chrysomyini have blue or green metallic bodies, bright orange heads, reddish or black legs, and most of them have dark longitudinal stripes on the dorsum of the thorax. The species of Phormiini are dull olivaceous-green or bluish-green species with black heads and legs.

Flies of the tribe Chrysomyini are the abundant blowflies of the tropics of North and South America. None of the species of the tribe Phormiini apparently occur much farther south than Mexico City. Almost every rotting animal and vegetable substance in any locality has its fauna of one or more of the various species which belong to the tribe Chrysomyini. Not even the abundant housefly, *Musca domestica* L., is more numerous in the market places in the American Tropics, and only in the immediate vicinity of stables and corrals are blowflies outnumbered by any other flies.

The North American representatives of Chrysomyinae have the following characters in common.

*Male and female.* Head width greater than height; front narrower in male than in female; inner vertical bristles present; postvertical bristles weak, reclinate frontoorbital bristles usually, and proclinate frontoorbital bristles usually absent in male, but one or two proclinate and one reclinate frontoorbital bristles usually present in female; ocellar bristles proclinate in male, proclinate to divaricate in female; facial carina absent or very slightly developed; proboscis two-thirds to three-fourths head height; haustellum one-third to one-half head height, setose; labellum of moderate size; antennal base at or but slightly below middle of eye in profile, the bases either approximated or but slightly separated; arista with the terminal segment elongate, slightly thickened at base, and gradually tapering to apex, plumose above and below two-thirds to four-fifths the distance from base to apex.

Thorax with propleuron strongly pilose; propleural bristle strong; notopleural bristles usually two; pteropleuron bare on

anterior half, the bristles in a short tuft; greater ampulla strongly reniform posteriorly; intrapostsupraalar bristles absent; scutellum usually without apical bristles.

Legs of medium length; fore tibia with several short anterodorsal bristles; middle femur with a posteroventral row or partial row of bristles; middle tibia with one ventral bristle; hind tibia with a dorsal bristle near apex; tarsi with claws and pulvilli as long as or just slightly shorter than last tarsal segment.

Wing without costal spine; remigium ciliate above posteriorly at base; only third vein setulose; anterior cross vein at or near middle of second section of fourth vein; posterior cross vein sinuate to doubly arcuate; fifth vein with last section one-fifth to one-sixth the length of preceding section; sixth vein usually short.

Abdomen with ventral membrane exposed in female; discal and median marginal bristles absent on intermediate segments.

Male genital segments small, nearly ventral and often almost hidden.

*Larva.* Second instar with oral hooks enlarged near tips. Posterior spiracle of third instar with incomplete ring or peritreme, the "button" absent or poorly defined and situated in the gap of peritreme.

**KEY TO GENERA AND SPECIES OF NORTH AMERICAN CHRYSOMYINAE**

- meso- and pleuro-chaetae - 1-2-3-4-5-6-7-8-9-10-11-12-13-14-15-16-17-18-19-20-21-22-23-24-25-26-27-28-29-30-31-32-33-34-35-36-37-38-39-40-41-42-43-44-45-46-47-48-49-50-51-52-53-54-55-56-57-58-59-60-61-62-63-64-65-66-67-68-69-70-71-72-73-74-75-76-77-78-79-80-81-82-83-84-85-86-87-88-89-90-91-92-93-94-95-96-97-98-99-100*
1. Hind coxa pilose posteriorly; one presupraalar bristle. Larva without definite "button" in postspiracular plate. . . . . *lower part of face inflated* . . . . . Chrysomyini 2  
 Hind coxa without fine hair or pile posteriorly; two presupraalar bristles (except in *Phormia*). Larva with definite "button" in postspiracular plate. . . . . Phormiini. 13
  2. *Parafaciale* bare; preintraalar bristles two; predorsocentral bristles two or three; back of head concave in profile; sternopleural bristles, except occasionally, two; postdorsocentral bristles three or four, only the prescutellar large . . . . . 3  
 Parafaciale setose; preintraalar bristles and predorsocentral bristles absent; back of head in profile protuberant, flattened, or but slightly concave; sternopleural bristles three; postdorsocentral bristles two or three. . . . . 8

3. Epistoma short, nearly as wide as clypeus; vibrissa but slightly above oral margin; postocellar bristles absent; posterior thoracic spiracle neither elongate-ovate nor transverse ..... 4  
 Epistoma long, either slightly or considerably narrower than width of clypeus; vibrissa distinctly above oral margin; postocellar bristles present; posterior thoracic spiracle large, elongate-ovate, transverse ..... 5
4. Legs and base of abdomen always, and humerus and anterior pleura usually, yellow to yellow orange or orange brown. (Neotropical) .....  
 ..... *Hemilucilia segmentaria* (Fabricius), p. 107  
 Legs, base of abdomen, humerus, and anterior pleura brown to black with greenish overcast. (Neotropical) .....  
 ..... *Hemilucilia flavifacies* (Engel), p. 106
5. Posthumeral bristle present; intrapostsutural bristle present; postintraalar bristle one; intrapostalar bristle present; remigium below posteriorly at base with several fine hairs; lower squamal lobe pilose above ..... 6  
*present* →  
 Posthumeral bristle absent; intrapostsutural bristles absent; postintraalar bristles two; intrapostalar bristles absent; remigium below usually bare posteriorly at base; lower squamal lobe bare above ..... 7
6. Thorax almost entirely shining or with two indistinct dark longitudinal stripes on dorsum; bucca brown with tawny hair; anterior thoracic spiracle with brown hair (Neotropical) ..... *Myiolucilia fulvinota* (Bigot), p. 112  
 Thorax slightly silvery pollinose and with three distinct dark longitudinal stripes on dorsum; bucca orange with golden colored hair; anterior thoracic spiracle with yellow hair (Neotropical) *Myiolucilia lyrcea* (Walker), p. 113
7. Squamal lobes white to yellow orange; legs usually yellow orange to orange brown (Neotropical) .....  
 ..... *Chloroprocta fuscianipennis* (Macquart), p. 117  
 Squamal lobes infuscated especially on the apical half; legs usually dark brown to black (Neotropical) .....  
 ..... *Chloroprocta idioidea* (Robineau-Desvoidy), p. 119
8. Palpus short filiform; epistoma elongate, distinctly narrower than clypeus; front of male at narrowest 0.05 or more of head width, of female, 0.28 or more of head width; intrapostalar bristle absent. Third-instar larva without accessory oral sclerite ..... 9

- Palpus elongate clavate; epistoma elongate but not much narrower than clypeus; front of male nearly obliterated at narrowest, 0.34 of head width in female; intrapostalar bristles present. Third-instar larva with well-defined accessory oral sclerite ..... 12
9. Parafrontale with light hair anteriorly outside frontal row of bristles; male basicostal scale and legs yellow orange or orange brown and phallosome nearly straight; female occiput brown to black, and with one or two proclinate frontoorbital bristles ..... 10
- Parafrontale with dark hair anteriorly outside frontal row of bristles; male basicostal scale and legs usually black, phallosome bent ventrally and enlarged apically, the anterior gonapophysis deeply notched apically; female with occiput usually reddish orange to brown and rarely with proclinate frontoorbital bristles, (Nearctic and Neotropical) .....  
..... *Callitroga americana* (Cushing and Patton), p. 125
10. Fourth abdominal segment strongly pollinose laterally; male without frontoorbital or outer vertical bristles and anterior gonapophysis without well-developed basal accessory sclerite ..... 11
- Fourth abdominal segment nearly shining and with only a trace of pollen laterally; male with one reclinate frontoorbital bristle opposite middle of ocellar triangle, with strong outer vertical bristles, and phallosome elongate, the apex narrow and reduced in size. (Neotropical) .....  
..... *Callitroga minima* (Shannon), p. 148
11. Thorax usually bright metallic yellow to blue green, a mid-dorsal longitudinal stripe not extending over scutellum; female usually with two proclinate frontoorbital bristles; male phallosome of but moderate length, the apex well-developed. (Nearctic and Neotropical) .....  
..... *Callitroga macellaria* (Fabricius), p. 138
- Thorax usually metallic dark blue to black, a mid-dorsal longitudinal stripe extending over scutellum; female with one proclinate frontoorbital bristle; male phallosome heavily sclerotized apically and projecting into well-defined hooks, the posterior gonapophysis large, elongate, and but weakly hooked anteriorly. (Neotropical) .....  
..... *Callitroga aldrichi* (Del Ponte), p. 123
12. Squamal lobes dark brown, almost black (Nearctic) .....  
..... *Paralucilia wheeleri* (Hough), p. 153

- Squamal lobes white, rarely orange or orange brown. (Neotropical) . . . . . *Paralucilia fulvipes* (Macquart), p. 157
13. Mesonotum conspicuously flattened on disc; eyes in male distinctly separated (except in several species of *Apaulina*); mesothoracic spiracle with dark hair (dark orange brown in *Apaulina hirudo*) . . . . . 14  
 Mesonotum convex; eyes in male very narrowly separated or contiguous; mesothoracic spiracle with bright orange hair (Holarctic) . . . . . *Phormia regina* (Meigen), p. 161
14. Mesothoracic spiracle small, the propleural area not reduced; head not conspicuously elongate; cilia of arista long; apical cell open; hindmost preintraalar bristle present . . 15  
 Mesothoracic spiracle much enlarged, the size of the propleural area reduced; head elongate; cilia of arista very short; apical cell closed in wing margin; hindmost preintraalar bristle absent (Holarctic) . . . . .  
 . . . . . *Boreëllus atriceps* (Zetterstedt), p. 170
15. Preacrostichal bristles present, elongate; lower margin of head convex; head at vibrissa shorter than or as long as its length at antenna; upper squamal lobe without black setae above; three postintraalar bristles present; preintra-postalar bristle present . . . . . 16  
 Preacrostichal bristles absent or vestigial; lower margin of head straight; length of head at vibrissa greater than at antenna; upper squamal lobe black setose above; two or three postintraalar bristles present; preintra-postalar bristle absent. (Holarctic) . . . . .  
 . . *Protophormia terrae-novae* (Robineau-Desvoidy), p. 174
16. Front wide in both sexes, in male at narrowest 0.14 or more of head width, in female 0.28 or more; parafaciale opposite lunule wider than distance between vibrissae . . . 17  
 Front in both sexes narrower, rarely exceeding 0.11 of head width in male, 0.26 of head width in female; parafaciale opposite lunule usually narrower than distance between vibrissae . . . . . 19
17. Fore tibia with one posterior bristle; scutellum without apical bristles but with normal subapical bristles; outer forceps of male fully one-third to one-half as wide as long . . . . . 18  
 Fore tibia with two posterior bristles; scutellum with apical bristles; outer forceps of male hardly one-fourth as wide as long (Nearctic) . . . . .  
 . . . . . *Apaulina sapphira*, new species, p. 200

18. Front at narrowest 0.14 of head width in male, 0.28 in female; parafaciale opposite lunule slightly narrower than distance between vibrissae in proportion 2.0:2.2 in male, and only slightly wider in female, 2.0:1.9 (Nearctic) . . . . .  
*Apaulina basingeri*, new species, p. 190
- Front at narrowest 0.15 of head width in male, 0.30 in female; parafaciale opposite lunule wider than distance between vibrissae in proportion of 2.4:1.8 in male, 3.6:3.2 in female (Nearctic) . . . . .  
*Apaulina avium* (Shannon and Dobroseky), p. 186
19. Reclinate fronto-orbital bristles present in female; front at narrowest considerably wider than 0.05 of head width in male (except in *aenea* which has orange brown squamae), and wider than 0.20 in female; parafaciale opposite lunule in male narrower than half the distance between vibrissae . . . . . 20
- Reclinate fronto-orbital bristles absent in female; front at narrowest 0.05 of head width in male, 0.20 in female; parafaciale opposite lunule about half as wide as distance between vibrissae in male, in proportion 1.2:1.6 in female (Nearctic) . . . . .  
*Apaulina hirudo* (Shannon and Dobroseky), p. 192
20. Squamal lobes tinged with orange or brown . . . . . 21  
 Squamal lobes clearly white . . . . . 23
21. Squamal lobes brown in male but yellowish or orange in female; width of parafaciale opposite lunule less than distance between vibrissae in the proportion 1.2-1.5:2 in male, 1.6:2 or nearly equal in female; front at narrowest 0.06 of head width in male, 0.24 in female; male body color metallic blue but female body color aeneous or cupreous green . . . . . 22
- Squamal lobes infusate in both sexes; parafaciale opposite lunule less in width than distance between vibrissae in the proportion 1.8:2.0 in male, 1.6:1.8 in female; front at narrowest 0.07 of head width in male, 0.27 in female; body color metallic blue in both sexes. (Nearctic) . . . . .  
*Apaulina hesperia* (Shannon and Dobroseky), p. 192
22. Male with parafaciale opposite lunule and distance between vibrissae in the proportion 1.2:2.0; female body color bright aeneous green with silvery pollen, the fourth abdominal segment cupreous with whitish pollen, the squamal lobes strongly tinged with orange; middle femur with

one or two (usually only one) anteroventral bristles near base. (Nearctic).....

.....*Apaulina aenea* (Shannon and Dobrosecy), p. 185

Male with parafaciale opposite lunule and distance between vibrissae in the proportion 1.5:2.2; female body color blackish cupreous with thin whitish pollen, the squamae lightly tinged with yellow, the third abdominal segment sometimes and the fourth segment always highly polished cupreous; middle femur with two or three (usually two) anterodorsal bristles toward base. (Nearctic).....

.....*Apaulina cuprina*, new species, p. 191

23. Front at narrowest less than 0.09 of head width in male, 0.27 in female; parafaciale opposite lunule less in width than distance between vibrissae in *metallica*, equal in *sialia*.....24

Front at narrowest 0.10 or more of head width in male, 0.28 in female; parafaciale opposite lunule equal in width to distance between vibrissae. (Nearctic).....

.....*Apaulina hirundo* (Shannon and Dobrosecy), p. 196

24. Head length at antenna and at vibrissa approximately equal in both sexes; distance between vibrissae greater than width of parafaciale opposite lunule in proportion 1.4:2.4 in male, 1.7:2.0 in female; body color of male metallic blue, fourth abdominal segment of female bright metallic cupreous. (Nearctic).....

.....*Apaulina metallica* (Townsend), p. 196

Head length at antenna greater than at vibrissa in approximate proportion 7.0:6.5; distance between vibrissa and width of parafaciale opposite lunule nearly equal; body color metallic blue in both sexes. (Nearctic).....

.....*Apaulina sialia* (Shannon and Dobrosecy), p. 201

#### KEY TO KNOWN LARVAE OF CHRYSOMYINAE<sup>1</sup>

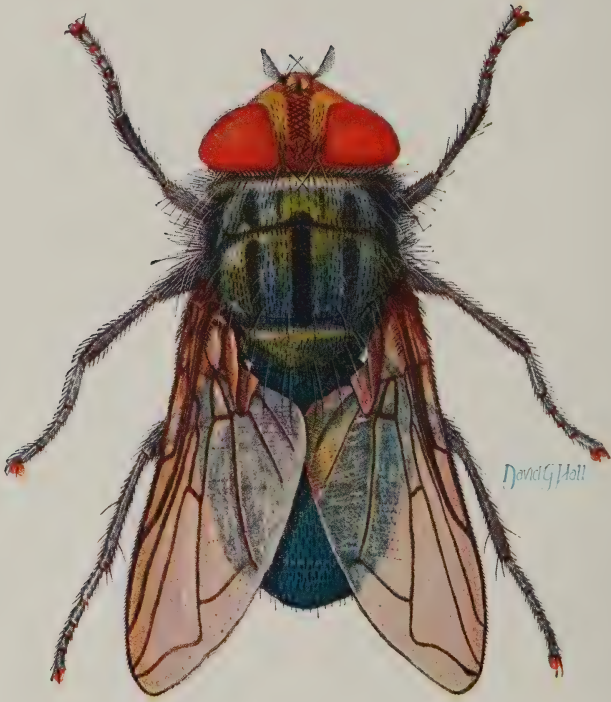
1. Second and third instar (cf. *Callitroga americana*) without dorsal spines on posterior margin of segment 11; without definite "button" in posterior spiracle.....Chrysomyini. 2
- Second and third instar with dorsal spines on posterior margin of segment 11; with definite "button" in posterior spiracle.....Phormiini. 5

<sup>1</sup>Adapted in part from Knipling (1936, 1939, 1940), and Laake *et al.* (1936).

2. Second and third instars with spines on anal protuberance arranged in V-shaped group; dorsal spines on segments 8-10 ..... 3  
 Second and third instars with spines on anal protuberances not arranged in V-shaped group; dorsal spines absent on segments 8-10.....  
 ..... *Chloroprocta fuscianipennis* (Macquart), p. 119
3. Second and third instars with tracheal trunks leading from posterior spiracles not pigmented.....4  
 Second and third instars with tracheal trunks leading from posterior spiracles pigmented, dark brown to black ....  
 .... *Callitroga americana* (Cushing and Patton), p. 132
4. Second instar with ratio of distance between inner tubercles on upper margin of posterior cavity and distance between inner and median tubercles on each side approximately 1.5:1.0. Third instar with accessory oral sclerite absent.....*Callitroga macellaria* (Fabricius), p. 144  
 Second instar with ratio of distances between tubercles mentioned above approximately 1.1:1.0. Third instar with accessory oral sclerite present.....  
 ..... *Paralucilia wheeleri* (Hough), p. 155
5. Second instar with dorsal spines present on posterior margin of segment 10. Third instar with larger tubercles on upper margin of posterior cavity distinctly longer than one-half the width of one posterior spiracle; dorsal spines present on posterior margin of segment 10 ..... 6  
 Second instar with dorsal spines absent on posterior margin of segment 10. Third instar with length of larger tubercles on upper margin of posterior cavity less than one-half the width of one posterior spiracle; dorsal spines absent on posterior margin of segment 10.....  
 ..... *Phormia regina* (Meigen), p. 166
6. Cephalic segment small, nearly bare, rounded, second segment flattened, and with numerous marginal rows of minute spines which are longer toward margin.....  
 ..... *Apaulina avium* (Shannon and Dobrosky), p. 188  
 Cephalic segment as in *Phormia*, second segment not flattened, and without numerous rows of minute spines as described .....  
 .. *Protophormia terrae-novae* (Robineau-Desvoidy), p. 177







CHRYSOMYINI

Color Plate I.—*Callitroga americana* (Cushing and Patton).  
Adult female, dorsal view, X 10.

## TRIBE CHRYSOMYINI

## (The screwworm flies)

The species placed in this tribe (color plate I) have fine pile posteriorly on the hind coxae, and have but one presupraalar bristle on the thorax. None of the larvae of these species has a well-defined "button" in the posterior spiracle.

The names *Chrysomya* Robineau-Desvoidy, *Mya* Rondani, *Somomya* Rondani, *Compsomyia* Rondani, and *Pycnosoma* Brauer and Bergenstamm have been used in the taxonomic and economic literature of North America. It is therefore considered necessary to review a part of the taxonomic history of *Chrysomya* and other names that have been confused with it in this country, for the genus *Chrysomya* does not occur in the Western Hemisphere.

Robineau-Desvoidy (1830, p. 444) proposed the generic name *Chrysomya* without designating a genotype. Rondani (1863, p. 27) included *Musca marginalis* Wiedemann (1830) in *Chrysomya* and designated it as genotype. Bezzi (1907, p. 544) stated that *Chrysomya regalis* Robineau-Desvoidy, an originally included species, was a synonym of *Musca marginalis* Wiedemann. Coquillett (1910, p. 523) accepted (*marginalis*) = *regalis* as genotype of *Chrysomya*. Townsend (1916, p. 6) drew the same conclusion.

Rondani (1850, p. 175) proposed the generic name of *Mya* for a group of similar species, but this name was preoccupied. In 1856 (p. 90) he proposed (*Musca vomitoria* Fabricius) = *vomitoria* Linnaeus as the genotype; *Mya* is thus an isogenotypic synonym of *Calliphora* Robineau-Desvoidy. Coquillett (1910, p. 571) designated *Musca segmentaria* Fabricius as genotype for *Mya*, but this designation cannot be considered valid because of the prior selection of *vomitoria* by Rondani.

Rondani (1861, p. 9) proposed the name of *Somomya* for the segregate which he had previously described under the name of *Mya*. In 1910 (p. 606) Coquillett erroneously designated *Musca segmentaria* Fabricius as genotype of *Somomya*, but *Somomya* is an isogenotypic synonym of *Calliphora*; its genotype is *Musca vomitoria* Linnaeus.

Rondani (1875, p. 425) proposed the generic name *Compsomyia* for several European and Asiatic species, without designating a genotype. Brauer and Bergenstamm (1894, p. 12) selected *Musca macellaria* Fabricius as genotype for *Compsomyia*, but Villeneuve (1914, p. 256) and Townsend (1915, p. 646) showed that this species is unavailable as genotype and the latter author

showed that *macellaria* is not congeneric with any European or Asiatic species. Coquillett (1910, p. 526) designated *Musca dux* Escholtz as genotype for *Compsomyia*.

Brauer and Bergenstamm (1894, p. 12) erected the genus *Pycnosoma* for the reception of *Musca marginalis* Wiedemann. This name is a synonym of *Chrysomya* through synonymy of the genotypes. According to Bezzi (1907, p. 543), *Paracompsomyia* Hough is also a synonym of *Chrysomya*.

### HEMILUCILIA BRAUER

*Hemilucilia* Brauer, Akad. der Wiss. Wien. Math-Nat. Kl. Sitzber. (1) 104:598, 1895; Surcouf, Paris Mus. d'Hist. Nat. Nouvelle Arch. (5) 6:54, 1919; Aldrich, U. S. Natl. Mus. Proc. 62 (11) :6, 1922; Séguy, Paris Mus. d'Hist. Nat. Bul. 31:440, 1925; Townsend, Rev. Mus. Paul. 15:213, 1926; Shannon, Wash. Ent. Soc. Proc. 28 (6) :125, 1926; Curran, Amer. Mus. Nat. Hist. Bull. 66:473, 1934; Townsend, Manual of Myiology, vol. 2, p. 163, 1934; Cushing and Hall, Wash. Ent. Soc. Proc. 39 (7) :196, 1937; Townsend, Manual of Myiology, vol. 5, p. 128, 1937. *Genotype*. *Musca segmentaria* Fabricius. Monotypic.

*Male and female*. Head (pl. 1, C) with short epistoma which is nearly as wide as clypeus and warped forward into horizontal plane but not strongly curved downward after the warp; metacephalon rather flattened in profile; eye large and slightly oblique; frontale almost obsolete 2.0 units anterior of foremost ocellus; parafrontale nearly obsolete toward middle and posteriorly; frontal rows of bristles obsolete at narrowest portion of frontale but extending anteriorly to the base of the second antennal segment and moderately diverging as they follow the margins of the frontale; outer vertical bristles absent in male; postvertical bristles weak, proclinate; female with one reclinate and two proclinate fronto-orbital bristles; ocellar bristles of moderate size, proclinate in male, divaricate in female which also has two or three lesser accessory ocellar bristles posteriorly; clypeus almost twice as long as wide, sunken, deep, narrow, rather box-like; facial carina absent; parafaciale narrowed above; faciale rather rounded, steep, with small setae in three or four rows which ascend nearly three-fourths the distance to the antennal base; vibrissa only slightly above the oral margin; proboscis 10.0 in length; haustellum 5.0; palpus long clavate; antennal base near eye middle when head is viewed in profile, antennae with bases approximated; arista with long plumosity above and

below to apex; back of head concave above, slightly rounded below with head in profile, and with one row of postocular cilia.

Thorax with humeral bristles three or four, weak to moderately strong; preintraalar bristles two, the posterior one of which is placed about 1.0 before the suture; posthumeral bristle present; preacrostichal bristles absent or vestigial; predorsocentral bristles four, two weak and two strong, the posterior bristle placed 1.0 before the suture; presupraalar bristle one; mesopleural bristles about six, strong; sternopleural bristles two; prosternum large, wider anteriorly than posteriorly, pilose; postalar declivity setose in center; hypopleural bristles about seven; postdorsocentral bristles four, only prescutellars strong; postalar bristles two; postacrostichal bristles two, only the prescutellar strong; intrapostsutural bristles present; postintraalar bristles two, intrapostsupraalar bristles absent; intrapostalar bristle differentiated; mesospiraacular bristles long; mesothoracic and methathoracic spiracles large, the latter ovate; scutellum with one discal bristle (sometimes one weaker discal bristle laterally), and three lateral bristles, the intermediate one of which is weak.

Legs with hair and short pile on coxae; anterior tibia with about three anterodorsal bristles, these evenly spaced from basal fifth to middle, and with one posteroventral bristle near apical fourth; middle femur with one anterior bristle near middle, one anteroventral bristle near basal sixth, three posteroventral bristles, these evenly spaced from base to basal third, and with several apical bristles ranging from posterior to posterodorsal surface; middle tibia with one anterodorsal bristle near apical third, two posterior bristles, one near basal fourth and one near apical third, and one posterodorsal bristle near apical fourth; hind femur with unevenly-spaced anteroventral row of bristles, about three near basal third, one near middle, and two or three near apical third, and one posteroventral bristle near basal fourth; hind tibia with three anterodorsal bristles, one near basal third, one near middle, and one near apical fourth, two anteroventral bristles, one near middle and one near apical third; claws and pulvilli small.

Wing with subcostal sclerite strongly setose anteriorly and apically; fourth vein without apical section or fold, the angle rounded and rather obtuse; apical cell clearly open and ending 0.8 before the wing tip; anterior cross vein 1.0 beyond the middle of the second section of the third vein and strongly oblique; posterior cross vein doubly arcuate; last section of fifth vein one-fifth as long as preceding section; upper squamal lobe small,

long, pilose on upper basal surface; lower squamal lobe of moderate size, ovate, bare.

Abdomen with discal bristles only in scattered erect hair on fourth segment; second, third and fourth segments each with a marginal row of weak short recumbent bristles; female with ventral membrane widely exposed.

Male genital segments slightly flattened and situated ventrally when in repose; first segment large, globose; second segment of moderate size and rather flattened.

*Hemilucilia flavifacies* (Engel), new combination

*Strongyloneura flavifacies* Engel, Konowia 10:138, 1931. (Type, female from "Nord-Chiquitos," Bolivia, in the collection of Dr. E. O. Engel, Stuttgart).

*Hemilucilia fuscianipennis* Aldrich (nec Macquart), U. S. Natl. Mus. Proc. 62 (11):7, 1922; Shannon, Wash. Ent. Soc. Proc. 28 (6):126, 1926; Curran, Amer. Mus. Nat. Hist. Bull. 66:473, 1934; Cushing and Hall, Wash. Ent. Soc. Proc. 39 (7):196, 1937.

This species is usually determined as *Hemilucilia fuscianipennis* (Macquart) but is not that species. Dr. Engel's name is apparently the correct name for this well-known and abundant tropical species.

Brown species with metallic yellow-green body, orange to orange-brown appendages and mottled wings.

*Male.* Similar in most respects to *segmentaria* but head with eight or nine frontal bristles, the rows becoming obsolete about half way to the ocellar triangle, the upper bristles very short and hairlike; front at lunule 0.24 of head width and 0.12 at vertex; upper posterior margin of vertex more convex; third antennal segment about five times as long as second.

Thorax bright yellow green but appearing metallic bluish in certain lights, the humerus, postalar callosity, anterior part of mesopleuron greenish or bluish black; greater ampulla and lesser ampulla dark brown with a greenish luster; mesothoracic spiracle with whitish hair; metathoracic spiracle with dark brown hair.

Wing (pl. 8, K) with remigium basally below without cilia.

Legs orange brown, the color increasingly darker apically.

Genital segments (pl. 15 A, B, C and D) as illustrated.

*Female.* Similar to male except for wide front, which is black almost to lunule, where the color abruptly changes to bright orange yellow and for normal sexual differences.

*Length.* 7-9 mm.

*Distribution.* Neotropical: Quintana Roo, Yucatan, Mexico, to Paraguay and Brazil. The species is not uncommon along the coastal sections of eastern Central America.

*Biology.* Adults of this species are commonly attracted to meat-baited traps. They occur with considerable frequency in open areas in tropical rain forest country where they appear to have the habits of *Callitroga macellaria*. Specimens may be collected upon dead animals along roads or on low shrubbery in the immediate vicinity of such animals. The immature stages are undescribed.

### *Hemilucilia segmentaria* (Fabricius)

*Musca segmentaria* Fabricius, Systema Antliatorum, p. 292, 1805; Wiedemann, Aussereuropäische zweiflügelige Insekten, vol. 2, p. 401, 1830. (Type, female from South America, in Copenhagen).

*Calliphora femorata* Walker, Roy. Ent. Soc., London, Trans. (n. ser.). 5:310, 1858. (Type, female from Mexico in the British Museum; now with thoracic characters obliterated).

*Lucilia nubipennis* Rondani, Truqui Studi ent. 1:77, 1848. (Type, in Florence or lost; sex not stated).

*Mya semidiaphana* Rondani, Nuovi Ann. Sci. Nat. Bologna (3)2:177, 1850; Coquillett, U. S. Natl. Mus. Proc. 37(1719): 571, 1910. (Type, in Florence or lost; sex not stated.)

*Lucilia segmentaria* (Fabricius) Brauer and Bergenstamm, Zweiflügler des Kaiserlichen Museums zu Wien, vol. 5, no. 2, p. 116, 1891.

*Chrysomyia segmentaria* (Fabricius) Hough, Kans. Univ. Quart. 9:204, 1900.

*Somomyia segmentaria* (Fabricius) Malloch, Ann. and Mag. Nat. Hist. (9)17:504, 1926.

*Hemilucilia segmentaria* (Fabricius) Brauer, Akad. der Wiss. Wien, Math.-Nat. Kl. Sitzber. (1)104:598, 1895; Aldrich, U. S. Natl. Mus. Proc. 62(11):6, 1922; Shannon, Wash. Ent. Soc. Proc. 28(6):125, 1926; Townsend, Rev. de Ent. 1:71, 1931; Curran, Amer. Mus. Nat. Hist. Bull. 66:473, 1934.

An orange brown species with metallic yellow-green humeri, sometimes overcast with blue, the head, humerus, base of abdomen, and appendages orange to orange brown, the wings with dark areas.

*Male.* Head width 17.5; length at antenna and vibrissa 7.2; length at oral margin 7.5; eye height 12.6; head height 15.5; bucca 0.21 eye height, thinly golden pollinose, with abundant medium length golden hair, the anterodorsal margin with an area of dark hair; frontale orange to orange brown, smooth; front at vertex 0.10 of head width, 0.28 at lunule, silvery yellow pollinose, with a few dark hairs in a single row extending to the foremost frontal bristle; frontal bristles about 11; vertex brownish black, subpollinose; clypeus yellowish golden; parafaciale 1.0 in width opposite lunule, golden pollinose; faciale with minute yellowish setae; vibrissae separated by 2.6; palpus yellow orange, 3.2 in length; antenna yellow orange, third segment five times as long as second and reaching 0.85 the distance to the vibrissa; back of head brownish above, orange below, with sparse yellowish hair, below with longer orange hair.

Thorax metallic yellow green to bluish black with darker dorsal longitudinal stripes, little or no pollinosity except immediately behind head on dorsum which is thinly whitish in certain lights; pleura mostly orange, shining or but slightly silvery; humerus yellow orange; propleuron whitish pollinose; mesopleuron with yellow pile except on anterior fifth; sternopleuron with scattered long yellow hair except anteriorly; hypopleuron with yellow hairs; pteropleuron and prosternum with scattered yellow hair, the former only on posterior half; postalar declivity with tuft of long yellow hair in center; sclerites at wing base yellow orange; tympanic pit yellow pilose on outer rim; greater ampulla yellow with fine yellowish white pile; lesser ampulla black; postalar callus orange brown to black; mesothoracic spiracles with orange hair; halteres yellow orange; scutellum concolorous with dorsum, the under surface laterally with fine yellowish pile; lateral postscutellar plates with pale yellow pilosity.

Wing (pl. 9, A) hyaline with infuscated pattern as illustrated; costal sections 2 to 6 in the proportion 92.5:57:120:45:10; subcostal sclerite orange; remigium below basally with fine pale hair; third vein setulose 0.35 the distance to the cross vein; upper squamal lobe tinged with pale brown; lower squamal lobe yellow brown to orange.

Abdomen metallic green to bluish with thin silvery pollen, first segment yellow orange basally, greenish blue on posterior margin; second, third, and fourth segments greenish blue; with yellow hair on light portions and below on sternites, elsewhere with black hair.

Genital segments with scattered black hair, the first segment



black, second segment orange brown, both shining; internal anatomical features (pl. 15, E and F) as illustrated.

*Female.* Head (pl. 1, C) height 16.0; head length at antenna 7.0 and at vibrissa 7.5; parafaciale 1.2 in width opposite lunule; distance between vibrissae 2.6; eye height 11.0; bucca 0.30 eye height; third segment of antenna six times as long as second; palpus 4.2 in length; head width 18.4; front at vertex 0.27 of head width, 0.21 at narrowest (1.5 units anterior to foremost ocellus) and 0.27 at lunule, the frontal margins converging anteriorly; frontale bright red orange 0.68 of front just anterior to ocellar triangle and narrowing to 0.50 of front immediately posterior to lunule; inner vertical bristles decussate; outer vertical bristles divaricate; frontal rows of bristles following the margins of the frontale, diverging anteriorly and reaching to about the middle of the second antennal segment, each row consisting of about 12 bristles; vertex black; area posterior to ocellar triangle orange red; back of head blackish brown with one row of postocular cilia and with orange hair. Thorax anteriorly yellow orange on pleura, elsewhere as on dorsum. Abdomen with bristles in marginal rows, less elongate and more recumbent than in male. Otherwise similar to male except for normal sexual differences.

*Length.* 8-10 mm.

*Distribution.* Neotropical: Cozumel, Quintana Roo Province, Yucatan, Mexico, to northern Chile; most abundant in Venezuela and the Guianas.

*Biology.* Adults of this species are commonly collected in meat-baited traps, and in nature they appear to act very similar to *Callitroga macellaria*. They occur most frequently in open areas near dense rain forests where they feed on rotting substances, particularly well-decayed carcasses of animals. The immature stages are unknown.

Hough (1900, p. 204) considered *Chrysomya hyacinthina* Robineau-Desvoidy to be a synonym of this species but this is an error as is indicated elsewhere.

### MYIOLUCILIA, NEW GENUS

*Paralucilia* Townsend (nec Brauer and Bergenstamm), Insector Inscitiae Menstruus 4:11, 1916; Rev. de Ent. 1:70, 1931; Manual of Myiology, vol. 2, p. 163, 1935; *ibid.*, vol. 5, p. 129, 1937; Aldrich, U. S. Natl. Mus. Proc. 66(18):17, 1925; Ent. Soc. Amer. Ann. 18:456-457, 1925.

Medium-sized blue and black species with shining bright blue-

metallic reflections, dull orange and brown heads, orange-brown antennae and black legs.

*Male and female.* Head (pl. 1, D) height usually less than width in proportion of 12:16 in female, 14:16 in male; length at antenna half head height, length at vibrissa somewhat greater; epistoma short, nearly as wide as clypeus, warped forward from clypeal plane and then not warped strongly downward; metacephalon rather flattened and but slightly produced posteriorly in profile; eye large, ovate in both sexes but upper and lower arcs equal in female, the upper arc much less than lower arc in male; front obliterated in male at narrowest portion, the eyes nearly contiguous; frontal rows of bristles obsolete posterior to narrowest portion of front, moderately diverging anteriorly as they follow the margins of the frontale, and extending anteriorly to the base of the second antennal segment; inner vertical bristles decussate; outer vertical bristles absent in male; postvertical bristles weak, proclinate; fronto-orbital bristles absent in male, one strong reclinate and two weak proclinate in female; clypeus a little wider than one-fourth the length, deeply sunken, narrow; parafaciale narrowed above, bare; faciale rounded, steep, with two or three rows of short black setae which ascend nearly four-fifths the distance to the antennal base; vibrissa strong, above oral margin by 1.0; proboscis three-fourths of head height; palpus one-half as long as proboscis, clavate, the tip flattened; base of antenna slightly below eye middle when head is viewed in profile; antennal bases distinctly separated by a short and inconspicuous carina; third antennal segment reaching four-fifths the distance to the vibrissa; arista with plumosity, which is long above and short below, extending almost to apex; back of head in male concave above in profile, less obviously so in female, both sexes with one row of postocular cilia.

Thorax with humeral bristles three, rarely four, strong; propleural bristles usually one, but sometimes two; preintraalar bristles two, the presutural bristle present; posthumeral bristle present; preacrostichal bristles absent or vestigial; predorso-central bristles two or three, weak, the posterior one placed 1.0 before suture; presupraalar bristle one; sternopleural bristles usually three but sometimes only two; hypopleural bristles arranged in wide "V" along the posterior and dorsal margins of sclerite; prosternum large, wide; postalar declivity in center and anteriorly with hair tuft; prepaulet setose; tympanic pit thickly setose; tympanic ridge with a few short setulae; greater ampulla pilose or setose; postalar bristles two; postsupraalar bristles three; postacrostichal bristles one or two, only the prescutellar

one large; postdorsocentral bristles four or five, usually strong only in prescutellars; intrapostsutural bristle present; postintraalar bristle one; intrapostalar bristle present; mesothoracic bristle one, long; mesothoracic spiracle large, oval; metathoracic spiracle as long as squamopleuron, transverse; scutellum with three discal bristles, one of these rather subapical, and with three strong lateral bristles.

Legs with fine hair on coxae; anterior tibia with about six short black dorsal bristles and with one posteroventral bristle near apical third; middle femur with one anterior bristle near middle and about six long ventral bristles in a row which extends from base to near middle; middle tibia with one anterodorsal bristle near apical third, one ventral bristle near apical third, one posterodorsal bristle near apical third; hind femur with posterodorsal row of long, thin bristles which are set closely together, and with a posteroventral row of bristles which are not set closely together, the two apical bristles longest and strongest; hind tibia with one dorsal bristle near apex, about five anterodorsal bristles in a row which extends from base to near middle, one anterodorsal bristle near apical fourth, two anteroventral bristles near middle, and one posterodorsal bristle near apical third; tarsi brownish to black, claws and pulvilli short.

Wing with subcostal sclerite setose on anterior edge; remigium below with several fine hairs at base; third vein setulose about one-fifth the distance to the cross vein; fourth vein without apical section or fold; seventh vein long, curved; lower squamal lobe short, subovate, narrowed posteriorly, pilose on anterior half or more of upper surface.

Abdomen without discal bristles but fourth segment with erect and scattered hair; no median marginal bristles; male with row of rather long and erect marginal bristles on second, third, and fourth segments, these bristles short and recumbent in female; ventral membrane narrowly exposed.

Male genital segments rather large, first segment large, without marginal row of bristles posteriorly; second segment smaller and rather flattened.

*Genotype.* *Musca lyrcea* Walker.

A further discussion of this genus will be found on page 152 under the heading of *Paralucilia* Brauer and Bergenstamm. It will suffice here to state that Townsend (1916) recognized the fact that Brauer and Bergenstamm had at least two species in a mixed series before them when they described the genus *Paralucilia*, designating *Calliphora fulvipes* Macquart as genotype. Since this designation must stand for *Paralucilia* according to

the Rules of the International Code, it is necessary to give the second segregate a new generic name.

*Myiolucilia fulvinota* (Bigot), new combination

*Somomyia fulvinota* Bigot, Soc. Ent. de France Ann. (5)7:251, 1877. (Type, female from Mexico, in the British Museum.)

*Paralucilia fulvipes* (Macquart) Brauer and Bergenstamm, Zweiflügler des Kaiserlichen Museums zu Wien, vol. 5, no. 2, p. 430, 1891 (in part).

*Chrysomyia desvoidyi* Hough, Kans. Univ. Quart. 9:208, 1900. (Type, male from Chapada, Brazil, in the American Museum of Natural History.) New synonymy.

*Paralucilia braueri* Townsend, Insecutor Inscitiae Menstruus 4:11, 1916; Rev. de Ent. 1:70, 1931; Manual of Myiology, vol. 2, p. 163, 1934; Manual of Myiology, vol. 5, p. 129, 1937. (Type, female from Chile, in Vienna.) New synonymy.

Similar to *lyrcea* Walker, but with the dorsum of the thorax somewhat shining or with two faint longitudinal, middorsal stripes; mesothoracic spiracle with brown hair; bucca brown, thinly whitish yellow pollinose, with tawny whitish hair. Internal morphological features of male genitalia (pl. 16, A) as illustrated.

*Distribution.* Neotropical: Mexico southward to Brazil. Although the species seems to be generally distributed, it is abundant only from the southern portion of Central America toward Ecuador and the Guianas.

*Biology.* In nature, the habits of the adults of *fulvinota* are very similar to those of *Callitroga macellaria*. They are attracted to carrion and both sexes may be easily trapped with a decaying-meat bait. The immature stages are unknown.

Mr. Smart informs me that Walker's type specimen shows little or no indication of longitudinal striping on the dorsum of the thorax, but that is not unusual in this species. The illumination must be very favorable or the stripes are not apparent.

Aldrich indicated in his notes and also in correspondence with Aubertin that he considered *fulvinota* a synonym of *Paralucilia callipes* (Bigot). This is an error. The latter name is a synonym of *Myiolucilia lyrcea* (Walker), a prior name for the species commonly known in North America as *Paralucilia desvoidyi* (Hough).

Hough's type of *desvoidyi* and a series of about 30 specimens collected in British Guiana are in the American Museum of Natural History. The bodies of these are shining blue. The

bodies of most of the specimens in the U. S. National Museum are more metallic greenish. Two specimens, marked "? types," from the Chapada, Brazil, type series of Hough at the Field Museum in Chicago and two cotypes in the University of Kansas collection are like the series in the National Collection.

*Myiolucilia lyrcea* (Walker), new combination

*Musca lyrcea* Walker, List of the Specimens of Dipterous Insects in the Collection of the British Museum, vol. 4, p. 873, 1849. Type, male from Montevideo, Uruguay, in the British Museum.)

*Musca verena* Walker, List of the Specimens of Dipterous Insects in the Collection of the British Museum, vol. 4, p. 877, 1849. (Type, female from Venezuela, in the British Museum.)  
New synonymy.

*Musca caruca* Walker, List of the Specimens of Dipterous Insects in the Collection of the British Museum, vol. 4, p. 877, 1849. (Type, female from Chile, in the British Museum.) New synonymy.

*Musca gamelia* Walker, List of the Specimens of Dipterous Insects in the Collection of the British Museum, vol. 4, p. 878, 1849. (Type, male from Montevideo, Uruguay, in the British Museum.) New synonymy.

*Somomyia callipes* Bigot, Soc. Ent. de France Ann. (5)7:249, 1877. (Type, male from Mexico, in the British Museum.)  
New synonymy.

*Male.* Head width at greatest 15.8; length at antenna 6.5, and at vibrissa 7.1; eye height 10.4; head height 13.7; bucca orange, 0.28 eye height, thinly golden pollinose, with abundant medium-length whitish-yellow to golden hair, and with some dark hair anteriorly and above; frontalia obliterated at middle, widening toward lunule, orange red; front almost obliterated, consisting of merely a faint line beginning 1.5 to 2.0 units below anterior ocellus and continuing for 2.0 units, at vertex 0.11 of head width, 0.16 at lunule, brown to black with golden pollinosity, and with some small setae in rows extending to foremost frontal bristles; frontal bristles about eight to nine; vertex subpollinose, black; ocellar bristles of moderate size, proclinate; clypeus golden; vibrissae separated by 2.2; haustellum with whitish setae; palpus 3.8, orange; antenna orange, third segment 3.8 times as long as second; arista orange at base, black at tip, with dark brown plumosity; back of head black, dark brown above

occiput, and with a number of medium-length whitish-yellow hairs which become longer below.

Thorax dark metallic bluish green to black, with thin whitish pollen anteriorly, and with three faint, blackish longitudinal stripes on dorsum which do not extend posteriorly beyond the scutellar suture; pleura lightly silvery anteriorly; humerus concolorous; propleuron yellow pilose; mesopleuron with scattered black setae on posterior four-fifths; sternopleuron with scattered dark hair above and tawny below; hypopleuron with brownish pile on posterior four-fifths; pteropleuron with thick-set pile on posterior three-fourths; postalar declivity anteriorly and in center with dark hair; preparapton dark brown; preepaulet black; squamal process brown; postparapton brown to black, its rim brown; greater ampulla brown, with short brown recumbent pile; postalar callus concolorous; mesothoracic spiracle with yellowish-white hair; metathoracic spiracle dark brown, with several long brown hairs on anterior and ventral margins; halteres orange; scutellum concolorous, the under surface laterally with tuft of whitish-yellow pile toward base; lateral post-scutellar plate with dark-brown setae.

Legs dark brown to black; coxae thinly whitish pollinose with whitish hair.

Wing (pl. 9, B) hyaline, infuscated (sometimes nearly black) toward base; costal sections 2 to 6 in the proportions 80:58:100:30:10; subcostal sclerite orange brown; remigium basally below with a few fine hairs; third vein setose one-fifth the distance to the cross vein; fourth vein with a rounded angle which is first bent toward anterior margin of wing at nearly 90 degrees, then toward wing apex, and ending 1.0 before the apex; upper squamal lobe hyaline on inner half, infuscated on outer half; lower squamal lobe infuscated.

Abdomen usually shining dark metallic bluish green with purple reflections but sometimes greenish with thin whitish pollen in certain lights; first tergite shining black; second, third, and fourth tergites with shining purplish hind margins; all tergites below strongly whitish pollinose and with soft pale hair; first and second sternites with long whitish pile; third and fourth sternites with dark hair; fifth sternite as illustrated.

Genital segments black, shining, with black scattered setae. Internal features (pl. 16, B, C, and D) as illustrated.

*Female.* Head (pl. 1, D) width 16.0; length at antenna and at vibrissa 6.5; eye height 9.7; head height 12.8; bucca 0.45 of eye height; frontale 0.5 width of front, orange to orange brown; front at narrowest (about 1.0 above lunule) 0.25 head width,

0.27 at vertex, 0.28 at lunule; frontal rows of bristles following the margins of the frontale, each row consisting of about 12 bristles; parafaciale 1.3 in width opposite lunule; vibrissae separated by 2.4; palpus 4.0 in length; third antennal segment four times as long as second; otherwise similar to male except for normal sexual differences.

*Length.* 8.0-9.5 mm.

*Distribution.* Neotropical: Carmen, Campeche, Mexico, southward to Chile. It is apparently a grassland species which is most abundant at elevations of from 500 to 1500 feet. Not many specimens have been collected and the species is possibly rather localized in distribution. Most of the specimens I have seen were collected in the vicinity of Merida, Mexico, in Panama, or Bolivia.

*Biology.* Adults of both sexes are attracted to carcasses and they may be trapped in meat-baited traps. In nature, the habits of this species are similar to those of *Callitroga macellaria*. The immature stages are unknown.

#### CHLOROPROCTA VAN DER WULP

*Chloroprocta* Van der Wulp, *Biologia Centrali-Americana*, Insects, Diptera, vol. 2, p. 296, 1896; Williston, *Manual of North American Diptera*, p. 342, 1908; Aldrich, *U. S. Natl. Mus. Proc.* 62(11):7, 1922; Shannon, *Wash. Ent. Soc. Proc.* 28(6):126, 1926; Townsend, *Rev. Mus. Paul.* 15:213, 1926; *Manual of Myiology*, vol. 2, p. 163, 1934; *ibid.*, vol. 5, p. 123, 1937; Cushing and Hall, *Wash. Ent. Soc. Proc.* 39(7):197, 1937. *Genotype.* (*Chloroprocta semiviridis* Van der Wulp) = *Lucilia fuscanipennis* Macquart. (Monobasic.)

Small dull dark brown species with metallic greenish reflections, orange head, antennae and palpi, and dark brown wings.

*Male and female.* Head (pl. 2, A) width greater than height in proportion 7:6; length at antenna slightly more than half head height; length at epistoma slightly greater than length at antenna; epistoma elongate, distinctly narrower than clypeus and warped forward from clypeal plane; metacephalon rounded in profile and very slightly produced; bucca produced downward; eye large, ovate, nearly contiguous above and the upper facets enlarged in male, widely separated in female; frontal rows of bristles extending anteriorly to middle of second antennal segment and diverging with margins of frontale; inner vertical bristles decussate, strong; postvertical bristles proclinate, moderately strong; frontoorbital bristles absent in male, two small

proclinate and one small reclinate in female; vertex small; ocellar bristles proclinate, weak in male, nearly divaricate in female; postocellar bristles proclinate, weak; clypeus twice as long as wide, deeply sunken, narrow; facial carina absent; parafaciale narrowed above, bare; faciale rounded and with two or three rows of very short black setae which ascend almost two-thirds the distance to the antennal base; vibrissa slightly above the oral margin; proboscis about half head height; palpus cylindrical and clubbed at tip in male, clavate in female; antenna at or but slightly below eye middle when head is viewed in profile, the bases approximated; third segment reaching fully four-fifths the distance to vibrissa; arista long plumose above, shorter below for four-fifths the distance to the apex; back of head concave above and rounded below in profile, with one row of postocular cilia.

Thorax with three humeral bristles of medium size; propleural bristles strong; preintraalar bristles two, weak, the middle bristle absent; preacrostichal bristles absent or vestigial; predorsocentral bristles two, weak; posthumeral bristle absent; presupraalar bristle one, strong; sternopleural bristles two; hypopleural bristles usually arranged in "V" along posterior and dorsal margin of the sclerite; pteropleuron bare on anterior half, thickly covered with black setae on posterior half; prosternum large, wide, setose; postalar declivity with tuft of setae in center; tympanic pit setose; postacrostichal row represented by one large prescutellar bristle; postdorsocentral bristles strong only in prescutellars but sometimes with three or four in the row, all weak; intrapostsutural bristle absent; postintraalar bristles two; intrapostsupraalar bristles absent; intrapostalar bristles absent; mesospiracular bristle one, large; thoracic spiracles large, ovate; scutellum with one large and often with two or three smaller discal bristles, one sometimes simulating subapical bristle; lateral bristles three, strong.

Coxae with thin pile, the hind coxae sometimes almost bare posteriorly; anterior femur with a partial posteroventral row of bristles which extends from the middle to the apex; anterior tibia with about three dorsal bristles, one near basal third, one near middle, and one near apical third, and with one posteroventral bristle between middle and apical third; middle femur with one anterior bristle near middle, one long anteroventral bristle near basal sixth, three long posteroventral bristles basally, and a close-set row of smaller posteroventral bristles extending from near middle to apex; middle tibia with one anterodorsal bristle near apical third, one ventral bristle near apical third, two posterior bristles, one near basal third and one near apical third,



and one posterodorsal bristle near apical third; hind femur with dorsal and posterodorsal rows of bristles which are long basally and apically, about three ventral bristles basally, and with long scattered hairs which are not in rows posterodorsally; hind tibia with one dorsal bristle near apex, usually four anterodorsal bristles, one near basal fourth, two near middle, and one near apical fourth, two anteroventral bristles, one near middle and one near apical third, and one posterodorsal bristle near apical third; claws and pulvilli not as long as last tarsal segment.

Wing with subcostal sclerite setose; only third vein setulose; fourth vein without apical section or fold, the angle rounded and bent obtusely toward apex; apical cell open and ending before apex by a narrow margin; anterior cross vein slightly before middle of second section of fourth vein, oblique; posterior cross vein double arcuate; last section of fifth vein one-fifth as long as preceding section; seventh vein long, curved; upper squamal lobe small, bare, rounded; lower squamal lobe large, bare, ovate.

Abdomen with tergites overlapping sternites in male, ventral membrane narrowly exposed in female; third and fourth segments each with a marginal row of weak and recumbent bristles.

Male genital segments small, almost hidden; first segment slightly larger than second and with several weak but erect bristles on posterior margin.

*Chloroprocta fuscanipennis* (Macquart), new combination

*Lucilia fuscanipennis* Macquart, Diptères exotiques, sup. 4, no. 2, p. 223, 1851. (Type, male from Bahia, Brazil, in Paris.)

*Chloroprocta semiviridis* Van der Wulp, Biologia Centrali-Americana, Insecta, Diptera, vol. 2, p. 296, 1896; Aldrich, U. S. Natl. Mus. Proc. 62(11):7, 1922; Shannon, Wash. Ent. Soc. Proc. 28(6):126, 1926; Townsend, Rev. de Ent. 1:71, 1931; Manual of Myiology, vol. 2, p. 163, 1935; *ibid.*, vol. 5, p. 123, 1937; Cushing and Hall, Wash. Ent. Soc. Proc. 39(7):197, 1937; Knippling, Ent. Soc. Amer. Ann. 32(2):366, 1939. (Type, male from northern Yucatan, Mexico, in the British Museum.) New synonymy.

*Male.* Head width 14.7; length at antenna 6.7 and at vibrissa 6.9; length at oral margin 7.0; eye height 11.0; head height 12.9; bucca 0.13 eye height, orange in ground color, heavily golden pollinose, with scattered medium-length dark hair on upper and anterior three-fourths, with golden hair below and posteriorly; frontale anteriorly one-half frontal width, orange red, striate; front but a thin line for nearly 3.0 below ocelli, but widening to

0.11 of head width at vertex and 0.20 at lunule, with moderate golden pollinosity and with some setae outside the frontal rows of bristles which extend anterior to the foremost frontal bristle; frontal rows of bristles extending to about the middle of the second antennal segment and obsolete or vestigial near middle of front, each row consisting of about 7 to 9 bristles; vertex subpollinose, brown; clypeus yellowish; parafaciale 0.8 in width opposite lunule, orange in ground color, golden pollinose; palpus 3.9, orange; antenna yellow orange, third segment three times as long as second; arista yellow, black at tip, plumose, the hairs dark; back of head dark brown above, orange below, and with abundant yellowish hairs of medium length.

Thorax dull metallic greenish blue over brownish to black ground color, with thin whitish pollen anteriorly and with indistinct fuscous longitudinal stripes which do not extend posteriorly over the scutellum; pleura lightly silvery; humerus concolorous; propleuron whitish pilose; mesopleuron black setose except on anterior one-fourth; hypopleuron with only a few hairs above and posteriorly; pteropleuron with black setae on posterior half; prosternum with scattered yellow setae; postalar declivity in center with black setae; preparapton yellow orange; preepaulet, squamal process, postparapton and its rim, brown; greater ampulla dark brown with fine decumbent pile; mesothoracic spiracle whitish; metathoracic spiracle orange; lateral postscutellar plate with black setae; under surface of scutellum with fine brown setae.

Legs orange brown; coxae yellow orange with some yellow pile; tarsi reddish brown; claws black, pulvilli brown.

Wing (pl. 9, C) infuscated; costal sections 2 to 6 in the proportion 70:50:100:40:8; third vein setulose one-third the distance to the cross vein; squamal lobes tinged with yellow orange.

Abdomen brownish in ground color, metallic greenish blue with thin whitish pollen; first segment yellowish orange at base below; with a narrow shining longitudinal middorsal stripe extending from the first to fourth segment, least apparent on third; fourth segment with erect discal hairs.

Genital segments brownish with a slight bluish green luster; both segments with scattered black setae. Internal features (pl. 17, A, B, C, and D) as illustrated.

*Female.* Head (pl. 2, A) height 10.0; eye less elongate and more ovate than in male and bucca higher in proportion to eye height; front at narrowest (1.5 units above lunule) 0.24 head width, 0.29 at vertex, and 0.30 at lunule; frontal row of bristles extending anteriorly to antennal base; parafaciale 1.4 in width

opposite lunule; vibrissae set 2.0 apart. Otherwise similar to male except for normal sexual differences.

*Length.* 5-6 mm.

*Distribution.* Nearctic and Neotropical: Southern Texas through Central America to Brazil. Although not exactly coastal in distribution, the majority of specimens I have seen or collected have been from along the Gulf of Mexico (Port Lavaca, Texas; Tampico, Vera Cruz, Carmen, Cozumel and Chetumal, Mexico), the coastal sections of the Caribbean (Puerto Barrios, Guatemala, Gold Fields, Nicaragua and LaGuaira, Venezuela), and inland in British Guiana and Dutch Guiana. No specimens were collected by me in the mountains of Central America, or along the Pacific coast of Central or South America.

*Biology.* Little is known of the immature stages or biology of this species. The anal area (pl. 33, E) of the puparium is as illustrated. Adults of both sexes are attracted to carrion and they may be easily trapped in meat-baited traps. In nature, adults act very similarly to those of *Callitroga macellaria* and they may be captured on low foliage in the vicinity of dead animals. Knipling reared larvae on hamburger at Edinburg, Texas, March 29 to April 14, 1937 (Bish. No. 27206). The larval characters given in the key are from Knipling (1939).

### *Chloroprocta idioidea* (Robineau-Desvoidy)

*Chrysomya idioidea* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 445, 1830. (Type, female from Brazil, in Paris).

?*Chloroprocta* sp. Van der Wulp, Biologia Centrali-Americana, Insects, Diptera, vol. 2, p. 296, 1896. (Two males and one female from northern Yucatan, Mexico, in the British Museum.)

Similar in both sexes to *fuscanipennis*, but differing from that species in having the squamal lobes infuscated especially on the apical half, and in having the legs dark brown to black. Seemingly, *idioidea* is smaller and the wings appear to be more deeply brownish.

*Length.* 5.5 mm.

*Distribution.* Neotropical: Quintana Roo, Yucatan, Mexico, to northern South America. The species is either uncommon or extremely local in distribution, although I have collected specimens from Chetumal, Quintana Roo Province, Yucatan, Mexico; Flores and San Jose, Guatemala; Costa Rica; Panama; Colom-

bia; west of Maracaibo, Venezuela; British Guiana; Dutch Guiana; and Paraguay.

*Biology.* Males and females are attracted to carcasses and they may be collected in meat-baited traps. The immature stages are unknown.

### CALLITROGA BRAUER

*Callitroga* Brauer, Akad. der Wiss. Wien, Math.-Nat. Kl. Denkschr. (1)47:74, 1883; Brauer and Bergenstamm, Zweiflügler des Kaiserlichen Museums zu Wien, vol. 6, no. 3, p. 106, 1893; Townsend, Wash. Acad. Sci. Jour. 5:645, 1915; Insecutor Insectiae Menstruus 4:6, 1916; Johnson, Amer. Mus. Nat. Hist. Bull. 41:439, 1919; Stiles and Hassall, U. S. Pub. Health Serv. Hyg. Lab. Bull. 150:330, 1928. Genotype. *Musca macellaria* Fabricius (By present designation).

*Compsomyia* Brauer and Bergenstamm (nec Rondani), Zweiflügler des Kaiserlichen Museums zu Wien, vol. 7, no. 4, p. 12, 1894; Brauer, Akad. der Wiss. Wien, Math.-Nat. Kl. Sitzber. (1) 108:2, 1899 (in part).

*Cochliomyia* Townsend, Wash. Acad. Sci. Jour. 5:646, 1915; Rev. Mus. Paul. 15:213, 1926; Manual of Myiology, vol. 2, p. 165, 1935; *ibid.*, vol. 5, 125, 1937; Shannon, Insecutor Insectiae Menstruus 11:106, 1923; Aldrich, U. S. Natl. Mus. Proc. 66(18):17, 1925; Shannon, Wash. Ent. Soc. Proc. 28 (6):124, 1926; Shannon and Del Ponte, Inst. Bact. [Argentina], Rev. 4 (5):568, 1926; Aubertin and Buxton, Ann. Trop. Med and Parasitol., 28 (3):245, 254, 1934; Cushing and Hall, Wash. Ent. Soc. Proc. 39 (7):196, 1937. Genotype. *Musca macellaria* Fabricius. (By original designation.)

*Paralucilia* Coquillett (nec Brauer and Bergenstamm), U. S. Natl. Mus. Proc. 37 (1719):584, 1910.

Small to medium-sized dull-metallic or bright green and greenish-blue species which have orange heads, dark longitudinal stripes on the dorsum of the thorax, yellow-orange to orange-brown antennae and palpi, the latter short and filiform, the legs orange red to black, and the wings hyaline.

*Male and female.* Head (pl. 2, B) width slightly to considerably greater than height; length at vibrissa greater than at antenna; epistoma elongate, considerably narrower than clypeus, warped forward from clypeal plane, then projecting downward after the warp; eye of moderate size, ovate, the facets

of nearly equal size; frontale in male nearly obliterated below ocelli, then widening toward lunule; parafrontale with numerous hairs which extend from vertex to parafaciale outside frontal row; frontal rows of bristles but slightly divergent anteriorly in female and only moderately so in male; inner vertical bristle present in both sexes; postvertical bristle present; frontoorbital bristles absent in male, usually two proclinate and one reclinate (rarely one or both entirely absent) in female; ocellar bristles of moderate size, proclinate in male, nearly divaricate in female; clypeus deeply sunken and narrow; facial carina short, narrow, low, separating antennae by a very narrow margin; parafaciale below one-half as wide as clypeus, narrowed above, and with medium-length hairs which are scattered generally near eye; faciale sharp, steep; vibrissa strong, well above oral margin; proboscis three-fourths head height; haustellum nearly half head height; palpus short and filiform; antennal bases slightly below eye middle when head is viewed in profile, narrowly separated by the short and narrow carina; third segment of antenna elongate, from three to four times as long as second, and reaching about four-fifths the distance to the vibrissa; arista thickened slightly at base, plumose on about the basal four-fifths, the hairs long above, shorter below.

Thorax with humeral bristles one strong and two or three weaker; propleural bristle strong; preacrostichal bristles absent or vestigial; presupraalar bristles one strong, and often with a weaker one anteriorly; sternopleural bristles three, the middle or lower bristle often very weak but rarely absent; hypopleuron bare of fine hair except on posterior margin; prosternum of moderate size, wide, pilose; postalar declivity thickly pilose in center and anteriorly; tympanic pit with a few long hairs; post-supraalar bristles three; postacrostichal bristles two, only pre-scutellars strong; intrapostsutural and intrapostsupraalar bristles absent; mesopiracular bristle long; mesothoracic spiracle small; scutellum with three strong lateral bristles, the under surface laterally pilose, without apical bristles; lateral post-scutellar plates with fine hairs.

Legs with fine pile on coxae; fore tibia with one posteroventral bristle between middle and apical third; middle femur with a short row of long posteroventral bristles toward base, one posterior bristle and one posterodorsal bristle near apex; middle tibia with two anteroventral bristles, one near basal third and one near apical third, one ventral bristle slightly beyond middle and two posteroventral bristles, one near basal third and one near apical third; hind femur with anterodorsal row of short,

closely set bristles, a short row of anteroventral bristles toward apex, and a partial row of long posteroventral bristles toward base; hind tibia with a dorsal subapical bristle, two anteroventral bristles toward middle, and two posterodorsal bristles toward middle; claws and pulvilli small.

Wing hyaline; remigium below with a few setulae at base; only third vein setulose; fourth vein bent toward anterior margin of wing at 90 degrees, the angle slightly rounded; apical cell open; anterior cross vein strongly oblique and at or but slightly beyond middle of second section of fourth vein; posterior cross vein doubly arcuate; last section of fifth vein one-fifth as long as preceding section; seventh vein short and curved; lower squamal lobe ovate, wide behind, pilose above in depression and anteriorly.

Abdomen with ventral membrane narrowly exposed in female; no discal or median marginal bristles on intermediate segments; third and fourth segments each with weak and recumbent bristles in marginal row.

Genital segments large, globose, the first rather flattened.

The generic name *Callitroga* is validated by Brauer (1883) by citation in specific synonymy. The genotype must be selected from one of the three names originally associated with it, namely *Calliphora anthropophaga* Lesbini, Weyenbergh and Conil, *Compsomyia macellaria* (Fabricius) and *Lucilia hominivorax* Coquerel. The only information pertinent to this problem is that presented by Brauer (1883). This is as follows: "*Calliphora anthropophaga* Lesbini, Weyenbergh et Conil. 'Myiasis' Act. Acad. Nat. Buenos Aires, T.III. Entr. 2. 41-98. Arch. d. Zool. experimental. T.9. 289 (Conil) Ann. d. Scien. naturell. 6, ser. T. X. Nr. 4 = *Compsomyia* (Rond. 1875) *macellaria* F. conf. *Lucilia hominivorax* Coq. (*Lucilia* O. S., *Callitroga* Sch., *Musca* olim.) E. Lynch Arribalzaga, Anales de la Sociedad cientifica argentina. Tome X. p. 70-84."

Under Article 25, as interpreted by Opinions 1, 4, and 53 of the International Commission, *Callitroga* is validated although merely cited in synonymy. Townsend (1915) considered it invalid but later admitted its validity. It must be noted that since Brauer, in the publication cited, deals with species and not with genera as such, the synonymy cannot be regarded as generic. In other words, it cannot be considered that *Callitroga* is here synonymized with *Calliphora*, *Compsomyia*, *Lucilia*, or *Musca*, but that the species which Brauer here calls *Compsomyia* (F.), with its synonyms *Calliphora anthropophaga* Con., and *Lucilia*

*hominivorax* Coquerel, was placed by Schiner (in MS) in the genus *Callitroga*.

In view of this, Townsend's action in designating *Musca dux* Escholtz, the type of *Compsomyia*, as type of *Callitroga* cannot be accepted. Brauer was dealing, not with the genus *Compsomyia*, but with a single species, *macellaria* (F.), and two supposed synonyms, *anthropophaga* and *hominivorax*. The specific synonymy given does not restrict the genotype to *Musca macellaria* F., and all three names, and these alone, are available for genotype designation.

*Musca macellaria* Fabricius is hereby designated genotype of *Callitroga* Brauer.

***Callitroga aldrichi* (Del Ponte), new combination**

*Cochliomyia aldrichi* Del Ponte, Rev. de Ent. 8 (3-4) :274, 1938.  
(Type, male from San Salvador, West Indies, No. 53114, U. S. National Museum).

*Cochliomyia laniaria* Aldrich (nec Wiedemann), U. S. Natl. Mus. Proc. 66(18) :18, 1925; Shannon, Wash. Ent. Soc. Proc. 28 (6) :124, 1926; Curran, Scient. Survey Porto Rico and Virgin Islands, vol. 11, pt. 1, p. 92, 1928; Cushing and Hall, Wash. Ent. Soc. Proc. 39 (7) :196, 1937.

Wiedemann's name was first given as *taniaria* (1830, p. 406) but this may have been a typographical error for Wiedemann later changed the name to *laniaria* (p. 683). As stated by Aldrich, Wiedemann, in mentioning that this name had been given to a certain fasciate variety of *macellaria* in Count Hoffmann-segg's collection, added that the specimens under this name were not otherwise different from *macellaria*. Aside from stating that *laniaria* differs from *macellaria* in possessing white dorsal abdominal pollinose spots or interrupted cross bands, the note seems to indicate that *macellaria* has similar fasciate markings.

Wiedemann's species was described from Brazilian specimens and Del Ponte, surmising that Aldrich's *laniaria* was different from Wiedemann's, gave Aldrich's segregate a new name.

A small grayish-black species with faint metallic reflections, orange bucca and antennae, three wide black longitudinal dorsal stripes on thorax extending to apex of scutellum, and with fourth abdominal segment cupreous.

*Male.* Similar to *macellaria* but head height 10.2; width 10.8; length at antenna 5.0 and at vibrissa 5.3; eye height 8.3; bucca

0.22 eye height, shining orange, with whitish-yellow hairs below and posteriorly, but with dark hairs on upper anterior area; front at vertex 0.13 of head width, 0.06 at narrowest (1.5 anterior to foremost ocellus), and 0.29 at lunule, black with dense yellowish-silvery pollen, and with numerous whitish hairs outside the frontal row; vertex subpollinose, black, with considerable black hair; frontale very narrow below ocellar triangle but gradually widening to lunule, usually black but sometimes orange brown; postocellar bristles minute; frontal row of bristles following the margin of the frontale and extending anteriorly almost to the middle of the second antennal segment, consisting of 13 or 14 bristles, these shorter and hairlike posteriorly but apparent nearly to ocellar triangle; antenna with first and second segment orange brown; third segment three times as long as second and dark orange brown; faciale with several rows of short black setae which ascend nearly four-fifths the distance to the antennal base; vibrissae set 1.6 apart; parafaciale 1.0 wide opposite lunule, orange red to black, with whitish pollen, and bare on lower third, the upper two-thirds with short yellowish hair along the eye margin and toward antennal base; back of head blackish, with scattered yellowish hair which becomes longer and more abundant below.

Thorax black, metallic bluish, with thin whitish pollen, and with three wide longitudinal stripes on dorsum which extend to scutellar apex, the intermediate lighter stripes strongly metallic bluish in certain lights; bristles anterior to suture small, but two or three predorsocentral bristles apparently larger than surrounding hairs; preintraalar bristle one, strong; mesopleuron with scattered erect black hair except anteriorly; sternopleuron with scattered whitish hair which is especially abundant and long below; postscutellar plates with black setae; mesothoracic spiracle with white hair.

Legs black, with considerable soft whitish hair; middle femur without anterior bristles; middle tibia with one anterodorsal bristle and one posterodorsal bristle near apical third; hind tibia with two well-defined anterodorsal bristles, one near middle and one near apical fourth.

Wing infuscated basally; costal sections 2 to 6 in the proportions 61:38:77:28:7.4; third vein setulose one-fourth the distance from base to cross vein; subcostal sclerite and basicosta yellow, the former setose; upper squamal lobe hyaline, white; lower squama tinged with pale yellow to brown.

Abdomen dull blackish aeneous with metallic purple and crepus reflections and with very slight pollinosity except for



small lateral spots on segments 2 to 4 which show quite heavy whitish pollen in certain lights especially on lateral margins of tergites; a middorsal longitudinal stripe beginning at the anterior margin of the second segment and continuing to a point a little beyond the base of the fourth segment, posterior third of third segment shining, coppery aeneous; fourth segment reddish coppery-aeneous.

Genital segments with first segment coppery aeneous, second orange brown to black, both with long scattered black erect hair; forceps orange brown. Internal features (pl. 17, E and F) as illustrated.

*Female.* Similar to male except head height 10.0; length at antenna 4.7 and at vibrissa 5.3; eye height 7.5; bucca 0.25 eye height; head width 12.0; front at vertex 0.29 head width, 0.34 at lunule, the margins very slightly curving inward from vertex to four-fifths the distance to lunule where front is narrowest; frontal rows of bristles narrowly converging anteriorly; fronto-orbital bristles one reclinate and one or two very weak proclinate; parafaciale 1.2 in width opposite lunule; vibrissae set 1.7 apart; palpus 2.3 in length; back of head blackish above and yellow orange below. Legs with one long anterior bristle near middle on middle femur.

*Length.* 5.5-7.0 mm.

*Distribution.* Nearctic and Neotropical: Key West, Fla.; West Indies; Bermuda, Bahamas, Cuba, San Salvador, Puerto Rico, Virgin Islands.

*Lucilia taeniaria* Thomson (nec Wiedemann, var. b of *macellaria*) (1869, p. 544) is the same as *Paralucilia fulvipes* (Macquart).

*Biology.* Male and female specimens may be collected frequently while they feed upon fresh horse manure which is apparently very attractive to them. On the Island of Nassau, Bahamas, during May, 1943, many specimens were taken in meat-baited traps. Males may be collected on low foliage near leaking water faucets and females on or near carrion, particularly dead fish and mollusks on ocean beaches. The immature stages are unknown.

***Callitroga americana* (Cushing and Patton), new combination  
(The screwworm fly)**

*Cochliomyia americana* Cushing and Patton, Ann. Trop. Med. and Parasitol. 27 (4):539, 1933; Laake, Cushing and Parish, U. S. Dept. Agr., Bur. Ent. & P. Q., Tech. Bull. 500:1-4, 1936; Cushing and Hall, Ent. Soc. Wash. Proc.

- 39 (7):196, 1937. (Type, male from Texas, No. 53115, U. S. National Museum.)
- ?*Chrysomya alia* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 447, 1830. Type, from Brazil, in Paris).
- \*?*Chrysomya affinis* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 445, 1830. (Type, from Brazil, in Paris.)
- ?*Chrysomya therminieri* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 446, 1830. (Type, from Carolina, in Paris).
- \*?*Chrysomya caerulescens* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 447, 1830. (Type, from Carolina, in Paris).
- \*?*Chrysomya plaei* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 448, 1830. (Type, from Antilles, in a ruined condition, in Paris).
- ?*Lucilia hominivorax* Coquerel, Ent. Soc. de France Ann. (3) 6:173, 1858; *ibid.* 7:233, 1859; Laboulbene, Ent. Soc. de France Bull. (4) 8:xxxvi, 1868; Aubertin and Buxton, Ann. Trop. Med. and Parasitol, 28 (3): 245-254, 1934; Townsend, Rev. de Ent. 6:485, 1936; Del Ponte, Rev. de Ent. 8 (3-4):273-275, 1938. (Type, from Guiana, South America, in Paris).
- ?*Calliphora infesta* Philippi, Ztschr. f. d. ges. Naturw. 17 (6): 513-514, 1861; Ann. Univ. Chile 1:729, 1861. (Type, apparently lost).
- ?*Calliphora anthropophaga* Conil, in Lesbini, Weyenbergh and Conil, Acad. Nac. de Cien. Exactas Buenos Aires, Actas 3: 43-98, 1878; Acad. Nat. Cien. Arg. Rep. Bol. 3 (4):296-325, 1881. (Type, apparently lost).
- Somomyia fulvobarbata* Bigot, Soc. Zool. de France Bull 12: 598, 1887. (Type, male from Mexico, in the British Museum).
- Compsomyia homicida* Brauer, Akad. der Wiss. Wien, Math-Nat. Kl. Sitzber. (1) 108:525, 1899. (Type, male from Cayenne, in the British Museum).
- Compsomyia macellaria* (Fabricius) Austen, Ann. and Mag. Nat. Hist. (6) 18:238, 1896; Townsend, Calif. Acad. Sci. Proc. (2) 4:619, 1895.
- Chrysomyia macellaria* (Fabricius) Lynch-Arribalzaga, Soc. Cient. Argentina An. 7:253, 1879; Murtfeldt, Insect Life

4:200, 1893; Riley and Howard, *Insect Life* 6:56, 1896; Ward, *West. Med. Rev.* 12 (12):483-485, 1907; Johnson, *Psyche* 15:60, 1908; Lahille, *Bol. Dir. Gen. Ganad. Min. Agric. Buenos Aires*, 1915.

*Cochliomyia macellaria* (Fabricius) Shannon and Del Ponte, *Inst. Bact. [Argentina]*, *Rev.* 4 (5):566, 1926; Aguirre, *Soc. Argentina Patag. Reg. Norte Tucuman*, 7 *Reun.*, 2:797, 1931; Reed, *Chile Nat. Hist. Rev.* 36:143, 1932; Bequaert, *Carnegie Inst. Wash.*, *Pub.* 431:565, 1933; Del Ponte, *Soc. Biol. Montevideo Arch.*, *sup.* 5:1299-1301, 1930.

It has been very difficult to decide upon the correct name for this important species of blowfly. The name that may ultimately be used is possibly one of the five proposed by Robineau-Desvoidy which are questioned. According to Séguy, who had been provided with a copy of the key presented in this paper, the type specimens of those species run to *americana*, two definitely so, three questionably, but since the genitalia of these types were not inspected, the specimens may not have been correctly identified. The type of *Lucilia hominivorax* was run by Séguy to *Hemilucilia flavifacies* Engel in the same key; but the biology of the species, as given by Coquerel, seems to indicate a species of *Callitroga* and, since other authors have placed the name here, I leave it in the above list with a query. The only name fully available at the present time for this species is *fulvobarbata* Bigot, but this is not accepted here because it appears almost certain that earlier names will be found available. M. Séguy informs me that the type specimens of the species marked with an asterisk are in poor condition but that they may be questionably determined as this species.

The biological information given in the references included above under the name *macellaria* (F.) seems to indicate that *americana* is the species under consideration. It has been virtually impossible to straighten out all references in the economic entomological and medical literature dealing with North American screwworms although an attempt has been made to do so. Specimens of flies reared from maggots collected in connection with cases of subcutaneous myiasis in which the clinical history indicates "unclean," "cattarrhal," or "pustular" lesions, would seem to suggest that some other species of blowfly was involved, for *americana* does not normally occur under such conditions. Cases of subcutaneous myiasis in northeastern North America are usually caused by larvae of *Wohlfahrtia vigil* (Walker) and those in northwestern North America by *Wohlfahrtia opaca*

(Coquillett). *Callitroga americana* is not known to occur in these areas.

It was pointed out a good many years ago that several species of blowflies were confused in studies upon screwworm infestations in the Americas. Lahille (1915) correctly diagnosed the situation and showed that two species were involved in the confusion, one being clearly saprophagous, the other a species of identical superficial appearance, the one responsible for myiasis of man and animals. He showed how these species might be separated by the use of characters which he found in the male genitalia.

This species differs most obviously from *macellaria* in having the anterior portion of the parafrontale clothed with black hair instead of pale yellowish hair. It is also deeper blue and less greenish in color, it is generally larger and more heavily built, and the male genital structures are distinctly different.

*Male.* Head length at antenna 7.1 and at vibrissa 8.0, this difference being largely due to the posterior production of the metacephalon; head height 13.8; width 16.0; eye height 9.8; bucca 0.37 of eye height and bright shining orange with but a trace of golden pollen and with abundant golden-orange hair; frontale narrow just anterior to foremost ocellus but plainly discernible and widening to about one-half the width of the front at the lunule, orange brown anteriorly, black posteriorly; front at vertex 0.11 of head width, 0.06 at narrowest (just anterior to foremost ocellus) and 0.31 at lunule, with heavy golden pollen, and with abundant scattered short black hair outside the frontal row of bristles which extends almost to the base of the antenna where the short hairs of the parafaciale are golden; frontal row of bristles following the margin of the frontale, extending anteriorly to about the middle of the second antennal segment, and consisting of about 12 or 14 bristles; postvertical bristles weak, decussate; facial carina less apparent than in *macellaria*, practically vestigial, separating the antennal bases by a distinct but narrow space; parafaciale 1.6 in width opposite lunule, not so markedly narrowed above, with heavy golden pollen over bright orange ground color, and with numerous golden-orange hairs of medium length which are most abundant near eye; faciale with several rows of short black setae which ascend about three-fourths the distance to the antennal base; vibrissae separated by 2.2; antenna with third segment 3.2 times as long as second; back of head with abundant golden-orange hairs of medium length which become longer below.

Thorax much as in *macellaria* but considerably stouter, es-

pecially at the humeri; black middorsal longitudinal stripe extending anteriorly only slightly beyond suture; coloring tending toward bluish or purplish black instead of bluish green; predorsocentral bristles weak but usually present (three may be counted in some specimens); preintraalar bristles two, the anterior bristle stronger, the posterior bristle often weak and hairlike or occasionally absent; presupraalar bristle one, strong; pleura with mostly black hairs except for a small area of tawny hairs on posterior margin of sternopleuron and another immediately surrounding the mesopleural row of bristles; prosternum with scattered black hair; postalar declivity with a definite tuft of black and tawny hairs near middle; scutellum with one large and usually one smaller discal bristle, but sometimes with three or four smaller discals beside these, the under surface with black hair laterally; lateral postscutellar plates with black setae.

Legs black, sometimes brownish black, and often with bluish green luster; anterior coxa with a few whitish hairs toward base; anterior femur with dorsal and posteroventral rows of bristles and with long scattered hairs posteriorly; anterior tibia with five to seven dorsal bristles; middle tibia with one anterodorsal bristle near apical third; hind femur with anterodorsal and anteroventral rows of bristles with an incomplete row basally on ventral surface; hind tibia with anterodorsal row of short closely-set black setae.

Wing considerably infuscated toward base and with wing veins dark brown to black; costal sections 2 to 6 in the proportions 91:68:109:31:8.6; subcostal sclerite orange brown, darker at base, and with some rather short but distinct setae basally on anterior margin; basicostal scale dark brown to black; upper squamal lobe hyaline, brownish on outer portion; lower squamal lobe usually white, but orange brown in a few specimens.

Abdomen deep bluish black with purple luster, with pollen which appears silvery whitish in certain lights, the first segment mostly shining; a shining middorsal longitudinal stripe extending from a wide base on the anterior margin of the second segment, rapidly narrowing posteriorly to a narrow line on the fourth segment; ventral margins of tergites with heavy whitish pollen; fourth segment with rather erect scattered discal hairs.

Genital segments strongly metallic greenish over a black ground color, mostly shining; first segment with a rather well-defined row of marginal bristles. Internal features (pl. 17, G, H, and I) as illustrated.

*Female.* (Color plate I). Head (pl. 2, C) length at antenna 7.1 and at vibrissa 7.6; width 15.9; height 13.5; eye height 9.5; bucca 0.36 of eye height; front at vertex 0.27 of head width, 0.38 at lunule; frontale with nearly parallel margins, slightly widening toward lunule and narrowing toward ocellar triangle, with several scattered interfrontal setulae which are not paired or consistently placed, bright reddish orange anteriorly, red orange to brownish from vertex to occiput; normally without proclinate fronto-orbital bristles; third segment of antenna 3.7 times as long as second. Abdomen colored as in male and differing most obviously from that of *macellaria* in lacking bright silvery-pollinose spots laterodorsally on the fourth segment. Otherwise similar to male except for normal sexual differences.

*Length.* 8-10 mm.

The coloration of this species depends somewhat upon ecological conditions. Tropical specimens are often noticeably smaller, more brilliantly orange yellow and metallic bluish, with legs tending toward deep brown, and wings more deeply brownish. Specimens from the United States, especially from the Middle West, are definitely more metallic bluish black and the legs are shining greenish black. The usual variations in the color of such specimens are in the basicostal scale, the occiput, the subcostal sclerite, and the legs. Investigations by Melvin in Texas indicate that the intensity of the color of these parts may be determined by temperature. Under normal conditions in nature a large majority of specimens of this species can be separated from *macellaria* by the color of the legs, basicostal scale, and occiput. There are, however, so many constant characters by which to differentiate the species that it should not be necessary to refer to those which are known to be variable.

*Distribution.* Nearctic and Neotropical: United States southward to southern Brazil and northern Chile.

This semitropical species occurs throughout the southern part of North America. Its range sometimes extends northward to central California in the West and to northern Iowa and Indiana in the East. It has not been collected northeast of South Carolina. It occurs in south Florida and south Texas during the entire year.

Specimens of *americana* are often found in collections identified as *Paralucilia fulvipes* (Macquart) or *Chrysomyia wheeleri* Hough. Small specimens may sometimes be found under the name *Cochliomyia macellaria* (Fabricius). The specimens discussed as *Compsomyia macellaria* (F.) by Townsend (1895, p. 619) and later determined as *Compsomyiops fulvipes* (Macq.) by Aldrich, are *americana*.

*Biology, habits, and immature stages.* *Callitroga americana* larvae are found in nature only in wounds of man or animals and never in decaying meats. It is not saprophagous. Except



FIG. VII. *Callitroga americana* female ovipositing on wound on goat. Note the shingle-like arrangement of egg clusters.

in very rare instances, adults of *americana* have not been captured in hand nets and have been obtained in numbers only by rearing the species to the adult stage.

*Eggs.* Egg masses (Fig. VII) are usually deposited on or near edges, or on dry surfaces, of wounds, occasionally on scab or

dry tissues and rarely on moist surfaces. The egg mass consists of from 10 to 393 eggs and is oval, shinglelike, and usually tightly glued to the surface of the wound, although it may not have the characteristic flat shinglelike appearance when attached to wool or hair near a wound.

Individual eggs (pl. 33, F and G) are approximately 1.04 mm. in length and 0.22 mm. in diameter; reticulated, glistening white or slightly tinged with cream color, rounded posteriorly, somewhat flattened anteriorly, with a dorsal ridge or seam extending from anterior end almost to posterior end, dividing at anterior end and extending ventrally around micropyle in a broad band, giving the appearance of a circular cap.

Under natural conditions the duration of the incubation period ranges from 11 to about 21 hours. Eggs deposited on wounds probably are subjected to a more or less constant temperature. It has been observed that eggs of *americana* which were exposed to temperatures near 30° F. were killed.

*Larva*<sup>1</sup>. First-instar: Elongate, more or less cylindric in shape, with 12 apparent segments, tapering anteriorly from sixth segment; the last three segments slightly tapering posteriorly; length and width at time of hatching 1.2 mm. and 0.23 mm., respectively; fully developed first-instar larvae an average of 3.6 mm. in length and 0.57 mm. in width at widest point. Armed with large dark single-pointed recurved spines arranged in more or less irregular rows near margin of segments; spines in anterior rows largest, larger spines measuring approximately 20 microns in length. Segments 2 to 9 each completely encircled with a band of spines at anterior margin; segment 11 without spines on dorsum, laterally reduced to two or three rows of small, more lightly pigmented spines; segment 12 with spines confined to ventral and ventrolateral surfaces; segments 6 to 12 ventrally each with the band of spines wider and transversely divided by a narrowed spineless area; each segment posteriorly devoid of spines except for two or three rows of small spines on ventral surface of each of segments 5 to 12; segments 5 to 10 laterally each with fusiform areas which are provided with a group of spines. Twelfth segment depressed behind, with the two posterior spiracles located dorsally in the depression; each spiracle comprised of two small broadly oval apertures, each of which is encircled by a delicately sclerotized ring, from which finger-like projections extend toward the center of the opening; frequently the two openings are so closely joined at the inner ven-

<sup>1</sup>This description, modified, is that by Knipling (*Laake et al*, 1936, pp. 5-12).



tral border as to appear bilobed; peritreme (easily distinguished in later instars) not apparent; anal protuberance, located ventrally on last segment, with two conical fleshy projections, the anal tubercles; a group of spines situated anteriorly and posteriorly on anal protuberance; two or three rows of spines also present between anal protuberance and lower margin of posterior cavity; tubercles bordering posterior cavity poorly defined. Cephaloskeleton (pl. 34, A) consisting of a pair of large pharyngeal sclerites, composed of paired dorsal and ventral cornua and a rather short anterodorsal projection; pharyngeal sclerites apparently not joined anterodorsally as in later instars; ventral portion of pharyngeal sclerites extending anteriorly and joining the hypostomal sclerites, which in turn articulate with a ventral basal portion of the labial sclerites; parastomal sclerites paired, slender, extending anteriorly from pharyngeal sclerites just above hypostomal sclerites; labial sclerites paired, small elongate, bearing a group of about six small hooklets; above and between labial sclerites the unpaired supralabial sclerite which is present only in first-instar larvae; length of cephaloskeleton from tip of labial sclerites to posterior extremity of dorsal cornua ranging from 0.24-0.27 mm. (average of 10 specimens 0.26 mm., average width at widest point 0.27 mm.).

Second-instar: More robust than previous instar, length and width of newly molted specimens approximately 3.5 and 0.6 mm., respectively; fully developed second-instar larvae from 6.3 to 7.4 mm. in length and approximately 1.5 mm. in width. Heavily armed with large dark spines, the larger ones measuring approximately 55 microns in length, each with one to three points, more often with one or two; segments 2 to 9 each completely encircled anteriorly with spinose bands; segment 10 with band generally interrupted by a narrow space on dorsum; segment 11 with bands reduced to two or three rows of smaller spines laterally, these never completely encircling segment; segment 12 with spines confined to ventral and ventrolateral surfaces; ventral and lateral fusiform areas as in first instar; segment 11 completely encircled posteriorly by a spinose band of about three rows of smaller anteriorly recurved spines; segment 10 with irregular ventral and lateral rows, and a few scattered spines which may extend to the dorsal surface but not arranged to form a complete band; sometimes a few scattered lateral spines on segments 9 and 8 and a few ventrally on segments 7 and 6. Anterior spiracles paired, small, fan-shaped, one situated on each side near base of segment 2, generally with seven to nine fingerlike processes or branches; posterior

spiracles (pl. 34, C) paired, small, each with two slits partly surrounded by a ring or peritreme which is incomplete ventrad of slitlike openings, narrowed, and lightly pigmented dorsally; greatest diameter of spiracular plates 0.134-0.168 mm. (average about 0.15); main tracheal trunks provided with dark pigment, the pigmented portion extending approximately one-half the length of segment 12. Posterior cavity more depressed than in first instar; upper border provided with three pairs of rather low, broadly rounded, fleshy processes; inner and outer pairs poorly defined; on lower border of cavity the median pair somewhat the largest and the outer pair larger than the inner pair which are poorly defined; relative positions similar to those of third instar; anal protuberances rather small, with two prominent anal tubercles; spines on anal protuberance similar to those in third instar. Cephaloskeleton (pl. 34, B) with two prominent labial sclerites, each with a more or less rectangular basal portion; and with two long broadly curved labial sclerites; pharyngeal sclerites produced anterodorsally and connected by the dorsopharyngeal sclerites; length of cephaloskeleton from 0.67-0.688 mm. (average of 10, 0.67 mm.).

Third instar: Rather robust, tapering toward cephalic segment from sixth segment and slightly tapering toward posterior end on last three segments; length from 6.4-17.0 mm., and width from 1.6-3.5 mm.; fully matured larva (pl. 34, E) usually 15-16 mm. in length; newly molted larva creamy white in color; mature larva with slightly reddish tinge. Heavily armed with large one- to three-pointed, more often one- or two-pointed, spines (*sp*); anterior margins of each of segments 2 to 9 completely encircled with a band of spines arranged in irregular rows, those in anterior rows largest; segment 10 with anterior band of spines somewhat narrowed and usually interrupted on dorsum as in second instar; segment 11 with anterior band never completely encircling segment and spines laterally smaller and greatly reduced in numbers; segment 12 with spines restricted to ventral and ventrolateral surfaces; posterior margin of segment 11 provided with a loose band of two or three rows of anteriorly curved spines; segment 10 with spines ventrally and ventrolaterally, a few scattered ones laterally and dorsolaterally; segments 7 to 9 each with spines at posterior margin reduced to one or two rows and confined to ventral surfaces. Anterior spiracles (*asp*) each provided with from 6 to 11, usually 7 to 9, fingerlike branches (average of 120 spiracles, 8.3 branches per spiracle); posterior spiracles (pl. 34, D) large, each with a prominent dark-pigmented peritreme (*p*) which apparently does not completely

surround the three more or less oval slitlike apertures; greatest diameter of spiracular plate from 0.39-0.46 mm. (average of 10, 0.43 mm.); the two main tracheal trunks darkly pigmented, the pigmented portion extending anteriorly to tenth or ninth segment. Upper border of posterior cavity (pl. 34, G, *pc*) bearing three pairs of low broadly rounded tubercles; inner (*i*) and outer (*o*) pairs approximately equal; median (*m*) pair greatly reduced and closely approximated to outer tubercle; lower border of cavity provided with similar tubercles, median pair largest and outer pair larger than inner pair; an additional pair of small tubercles situated medially near lower margin of posterior cavity; anal protuberances (*ap*) comparatively small, with two prominent conical anal tubercles; rather prominent spines located anteriorly and posteriorly on anal protuberance; short rows of three to four minute spines situated on lower portion on depressed area and on lower margin of posterior cavity. Cephaloskeleton (pl. 34, H) essentially as in second instar but the parts larger and rather different in appearance in mature larva; a narrow pigmented strip arising at anterodorsal margin of pharyngeal sclerites and extending posteriorly (this is not visible in younger third-instar larva but appears as the larva matures); entire cephaloskeleton from 1.40-1.56 mm. (average of 10, 1.49 mm.).

When the larvae penetrate tissues, they assume a characteristic head-downward position in the wound, with the posterior spiracles usually exposed to the outside air. Larvae of this species are obviously gregarious, rarely move about in the wound (pl. 34, F) when once embedded in the flesh, and cause a typical pocketlike (fig. VIII) injury. They may feed from 99.5 to 198 hours according to experiments conducted by Cushing, in Laake et al. (1936, p. 16), at Sonora, Tex. He found that the majority of mature larvae leave the wound between the hours of 9 a.m. to 2 p.m. When fully developed they drop to the ground and pupate in the soil. Travis, Knipling, and Brody (1940) showed that larvae of *americana* begin to migrate from a carcass immediately after the death of the animal, practically all of them leaving within 48 hours. They found that 69 percent of such migrating larvae pupated under the carcass and that none migrated further than 2 feet.

*Puparium.* Of typical calliphorid shape and appearance, averaging approximately 10.2 mm. in length and 4.3 mm. in diameter, dark brown in color, otherwise with the external characters of the mature larva.

The pupal stage of *americana* was found by Laake et al. (1936,

p. 19) to vary in Texas from about 7 days during midsummer to about 54 days during winter. Travis, Knipling, and Brody (1940) conducted detailed experiments upon the depth in the soil at which *americana* larvae pupated. They found that in nature all puparia of this species are found within the top 1½ inches of the soil, the majority within ½ inch of the surface. They also noted that larvae tended to pupate in clumps of vegetation if such were present, that pupation was slightly deeper



FIG. VIII. *Callitroga americana* myiasis wound in steer initiated by acid-branding operation. Note the deep pocket-type wounds. Savannah, Ga., May 12, 1935.

where the vegetation was more sparse, that larvae migrated farther where there was no vegetation than when the vegetation was dense, and that pupation occurred somewhat deeper in moist soil in the laboratory than in the field. Sixty-six percent of the puparia were found in a vertical position, 30 percent at an angle between vertical and horizontal positions, and 4 percent in a horizontal position.

*Adult.* The adult usually emerges from the puparium between the hours of 4 to 7 a.m. The preoviposition period is from 5 to

10 days. A female may deposit as many as 300 eggs in from 4 to 6 minutes, and a total of as many as 2,853 eggs. In captivity one female was kept alive for 65 days when fed upon meat, sugar water, and bananas and exposed to an average room temperature of about 80° F. (H. O. Schroeder and C. N. Smith, at Washington, D. C.), but the species probably does not live this long in nature.

Adults of *americana* do not seem to be as active as some of the other species of blowflies. In cages they apparently prefer to remain motionless. In nature they have been observed feeding upon wounds, fresh manure, and fresh meat. It is obvious that they are strong fliers. Parish (1937, p. 743) found female flies capable of flying 9 miles. Gravid females are most frequently attracted to wounds from 2 to 10 days old, according to Knipling and Travis (1937). Oviposition does not occur at temperatures of less than 65° F. Short exposures to a minimum temperature of 24° F. will not kill adult females in nature, although continued low temperature will apparently kill all adults. The average life cycle at Dallas, Tex., during September and October is 24 days, according to Laake et al. (1936, p. 21).

According to the same authors (1936) *americana* occurs in nature with *macellaria* in the ratio of 1:590, as determined in a study on the attraction to fresh infested and uninfested necrotic wounds in cattle at Menard, Tex. In standard meat-baited traps these authors determined that one specimen of *americana* occurred to 2,427 specimens of *macellaria*.

Evidence secured by various agencies indicates that *americana* is a primary obligatory parasite which initiates most of the cases of external or subdermal myiasis of man or other animals in North America. Necrotic lesions are subject to continuous attack and the species has been obtained in pure culture from nearly 80 percent of all cases of cutaneous myiasis in Texas, according to Laake et al. (1936). Specimens of *americana* have never been bred from carcasses of animals in nature so far as I know except in instances wherein larvae occurred in the animal before it died, and in nature females have not been observed to oviposit on wounds other than those of living warm-blooded animals. It is the only North American calliphorid known to be entirely parasitic upon mammals. An animal which has become infested with larvae of *americana* usually dies unless treated.

*Callitroga macellaria* (Fabricius)  
(The secondary screwworm fly)

*Musca macellaria* Fabricius, Systema Entomologiae, p. 776, 1775; Entomologia Systematica, vol. 4, p. 319, 1794; Systema Antliatorum, p. 292, 1805; Olivier, Encyclopédie méthodique. Dictionnaire des Insectes, vol. 8 p. 14, 1811; Wiedemann, Aussereuropäische zweiflügelige Insekten, vol. 2, p. 405, 1830. (Type, female from West Indies, in Copenhagen.)

*Chrysomya viridula* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 445, 1830. (Type, from Brazil, in Paris.) New synonymy.

?*Chrysomya tibialis* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 446, 1830. (Type, from Jamaica, in Paris or lost.) New synonymy.

?*Chrysomya decora* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 448, 1830. (Type from Antilles, in Paris or lost.)

*Chrysomya hyacinthina* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 450, 1830; Hough, Kans. Univ. Quart. 9:204, 1900. (Type, from middle America, in Paris.) New synonymy.

*Lucilia durvillei* Macquart, Diptères exotiques, vol. 2, no. 3, p. 299, 1843. (Type, from Payta, Peru, in Paris.) New synonymy.

*Lucilia macellaria* (Fabricius) Macquart, Diptères exotiques, vol. 2, no. 3, p. 304, 1843; Bigot, Sagra's Histoire Physique, Politique et Naturelle de l'Ile de Cuba, p. 820, 1857.

*Lucilia vittata* Macquart, Diptères exotiques, vol. 2, no. 3, p. 298, 1843. (Type, from Nouvelle-Hollande, in Paris.) New synonymy.

*Musca certima* Walker, List of the Specimens of Dipterous Insects in the Collection of the British Museum, vol. 4, p. 873, 1849. (Type, female from Florida, in the British Museum.)

*Musca phauda* Walker, List of the Specimens of Dipterous Insects in the Collection of the British Museum, vol. 4, p. 896, 1849. (Type, a teneral male specimen from the Galapagos Islands, in the British Museum.)

*Mya alia* Rondani, Nuovi Ann. Sci. Nat. Bologna, 7-8:13, 1850.

?*Lucilia rubrifrons* Macquart, Diptères exotiques, sup. 4, no. 2,

p. 223, 1851. (Type, female from Buenos Aires, in Paris or lost.)

?*Lucilia tibialis* Macquart, Diptères exotiques, sup. 4, no. 2, p. 215, 1851. (Type, male from Rio de Janeiro, Brazil, in Paris or lost.)

*Musca fasciata* Walker, Diptera Saundersiana, vol. 1, p. 337, 1856. (Type, female in poor condition from Brazil, in the British Museum.) New synonymy.

?*Musca turbida* Walker, Diptera Saundersiana, vol. 1, p. 336, 1856. (Type, from Jamaica, in the British Museum, or lost.) New synonymy.

?*Lucilia curvipes* Thomson, Eugenes Resa, vol. 6, no. 2, p. 544, 1868. (Type, female from Rio de Janeiro, Brazil, in Stockholm or lost.) New synonymy.

*Lucilia picicrus* Thomson, Eugenes Resa, vol. 6, no. 2, p. 543, 1869. (Type, female from Panama, in Stockholm.) New synonymy.

*Lucilia porticola* Thomson, Eugenes Resa, vol. 6, no. 2, p. 544, 1869. (Type, female from "Callao," in Stockholm.)

*Lucilia quadrisignata* Thomson, Eugenes Resa, vol. 6, no. 2, p. 544, 1869. (Type, male from Galapagos, in Stockholm.)

*Somomyia aztequina* Bigot, Soc. Ent. de France Ann. (5)7:252, 1877; Giglio-Tos, Ditteri del Messico, vol. 4, p. 5, 1894 (*Chrysoomyia*); Brauer, Akad. der Wiss. Wien, Math.-Nat. Kl. Sitzber. (1)108:523, 1899 (*Compsomyia*). (Type, male from Mexico, in the British Museum.)

*Somomyia flavigena* Bigot, Soc. Ent. de France Ann. (5)7:249, 1877; Brauer, Akad. der Wiss. Wien, Math.-Nat. Kl. Sitzber. (1)108:522, 1899 (*Compsomyia*). (Type, female from Mexico, in the British Museum.)

*Somomyia iridicolor* Bigot, Soc. Ent. de France Bull. CLXXXI, 1887; Soc. Zool. de France Bull. 12:599, 1887. (Type, male from Central America, in the British Museum.) New synonymy.

*Callitroga macellaria* (Fabricius) Brauer, Akad. der Wiss. Wien, Math.-Nat. Kl. Denkschr. (1)47:74, 1883.

*Chrysoomyia lynchi* Lahille, Bol. Dir. Gen. Ganad., Min. Agric. Buenos Aires, 1915.

*Compsomyia macellaria* (Fabricius) Lynch, Soc. Cient. Argentina An. 10:70-84, 1880; Van der Wulp, Tijdschr. v. Ent.

25:38, 1882; Blanchard, Soc. Ent. de France Ann. 65:654-668, 1896; Austen, Ann. and Mag. Nat. Hist. (6)18:238, 1896; Meaden, Trinidad Field Naturalists' Club Jour. 2:279, 1895.

*Chrysomyia macellaria* (Fabricius) Giglio-Tos, Ditteri del Messico, vol. 4, p. 5, 1894; Osborn, U. S. Dept. Agr., Div. Ent. Bull. (n. s.) 5:123-133, 1896; Hough, Zool. Bull. 2(6):283, 1899; Banks, U. S. Dept. Agr., Bur. Ent. Tech. Bull. 22:19, 1912; Bezzi, Philippine Jour. Sci. 12:130, 1917; Parman, Jour. Econ. Ent. 13(4):341, 1920; Bishopp and Laake, Jour. Agr. Res. 21(10):729-766, 1921; Cole, Calif. Acad. Sci. Proc. (4)12(25):470, 1923; Townsend, M. T., Ent. Soc. Amer. Ann. 21:127, 1928; Engel, Konowia 10(2):138, 1931.

*Cochliomyia macellaria* (Fabricius) Townsend, Wash. Acad. Sci. Jour. 5:646, 1915; Aldrich, U. S. Nat. Mus. Proc. 66(18):17, 1925; Cole, Calif. Acad. Sci. Proc. (4)16(14):489, 1927; Shannon and Del Ponte, Inst. Bact. [Argentina], Rev. 4(5):566, 1926; Bequaert, Rice-Harvard Exp. to Amazon, p. 238, 1926; West, in Leonard, Mem. 101, Cornell Univ., p. 826, 1928; Curran, N. Y. Acad. Sci. 11(1):92, 1928; Dunn, Amer. Jour. Trop. Med. 9:502, 1929; Townsend, Rev. de Ent. 1:70, 1931; Felt, Jour. Econ. Ent. 24:1288, 1931; Cushing and Patton, Ann. Trop. Med. and Parasitol. 27:539, 1933; Aubertin and Buxton, Ann. Trop. Med. and Parasitol. 28(3):245-254, 1934; Townsend, Manual of Myiology, vol. 2, p. 163, 1935; *ibid.*, vol. 5, p. 125, 1937; Cushing and Hall, Wash. Ent. Soc. Proc. 39(7):196, 1937; Del Ponte, Rev. de Ent. 8(3-4):275, 1938.

A green-bodied species with orange head, reddish legs, and hyaline wings, the thorax with black longitudinal stripes on the dorsum.

*Male.* Head with length at antenna less than at vibrissa in proportion of 5.7:6.3; head height 11.2; head width 12.8; eye height 8.4; bucca 0.25 of eye height, golden, with abundant pale orange to yellowish hair of medium length, and shining or with a trace of golden pollen; frontale nearly obliterated just anterior to foremost ocellus and widening toward lunule where it occupies about half the frontal width, orange-brown, slightly striate; front at vertex 0.11 of head width, 0.05 at narrowest and 0.29 at lunule, with coarse golden pollen on a blackish ground, and with short yellowish to white hairs outside the frontal rows extending downward on almost the entire parafaciale; frontal



row of bristles not very well-defined above, extending anteriorly to the base of the first antennal segment and consisting of 13 or 14 bristles, the rows moderately diverging as they follow the inner margin of the frontale; vertex subpollinose, black; clypeus golden; facial carina narrowly but distinctly separating antennal bases; parafaciale one-half clypeal width near middle, 1.2 wide opposite lunule, narrowed above, with golden pollen; faciale with a row of short black hairs which ascend about halfway to the antennal base; vibrissae above oral margin by 1.75 and separated by 1.7; palpus 1.6 in length, yellow orange, with black setae; antenna with first and second segments orange, third segment 2.8 times as long as second, yellow orange to orange brown; back of head with abundant whitish yellow medium-length hairs which become longer below.

Thorax bluish green and metallic black, with purplish luster, with pollen which appears whitish silvery in certain lights, conspicuously so anteriorly, and with three black longitudinal stripes on dorsum which do not extend beyond scutellar suture; pleura shining or lightly silvery; propleuron with whitish pile; no bristles on dorsum anterior to suture except one or two presupraalars; if two, then the anterior one usually weak; mesopleuron with uniformly scattered whitish hair on posterior margins; sternopleuron with well distributed whitish hair on posterior three-fourths; hypopleuron bare except on posterior margin; pteropleuron with uniformly distributed black hair on posterior half; prosternum with scattered white hairs; postalar wall with tuft of black setae; preaparteron orange brown, with fine whitish decumbent pile; preapulet black, setose; tympanic pit with several long white hairs; sclerites at wing base black; greater ampulla with a green luster and with short fine decumbent whitish pile; only prescutellar bristles of the postacrostichal series strong; shorter pair often immediately before these; postdorsocentral bristles two, only the prescutellar strong; mesothoracic spiracle rather large, its flap with whitish yellow hair; metathoracic spiracle small, with dark brown hair; halteres orange; lateral postsutellar plates with fine whitish hairs; under surface of scutellum laterally with fine whitish pile.

Legs orange brown to dark brown; coxae orange brown to black with a greenish-metallic luster; anterior femur usually dark reddish brown basally; anterior tibia usually orange red and with about four short bristles dorsally; middle femur usually dark reddish brown and with from one to three bristles anteriorly near middle, middle tibia usually orange red, with one ventral bristle near middle and two posteroventral bristles;

hind femur usually orange reddish or brown; hind tibia usually orange red to brown and with a row of short fine anterodorsal setae; tarsi orange brown, sometimes nearly black; claws black; pulvilli whitish.

Wing slightly tinged with orange brown toward base and with wing veins usually orange brown to dark brown; costal sections 2 to 6 in the proportions 78:56:96:30:6.6; subcostal sclerite orange, setose; basicostal scale orange brown; remigium bare basally below; third vein setulose about one-third the distance to the cross vein; fourth vein usually without but sometimes with a very short apical spur or fold; apical cell open and ending before apex of wing by one and one-half times the length of sixth costal section; upper squamal lobe hyaline white; lower squamal lobe with long white hairs anteriorly and in the depression, and usually white, rarely brownish, or occasionally yellowish.

Abdomen bluish green, sometimes purplish, rarely metallic yellow green or bronze; hind margins of segments with purple reflections and rather shining; with a narrow shining middorsal longitudinal stripe, the pattern more or less fixed; with silvery whitish pollen; fourth segment laterally and edges of tergites ventrally strongly pollinose.

First genital segment black, with metallic greenish luster and occasionally silvery pollinose, with scattered setae, and without a defined marginal row of bristles; second segment smaller, dark orange brown to black, with scattered setae. Internal features (pl. 18, A and B) as illustrated.

*Female.* Head (pl. 2, B) length at vibrissa greater than at antenna in proportion of 5.5:6.7; width, 13.9; height, 10.8; eye height 8.0; bucca 0.30 of eye height; front at vertex 0.28 of head width, 0.38 at lunule, gradually widening from the narrowest part (at vertex) toward the lunule; frontale 0.56 of frontal width at vertex and narrowing to 0.41 of frontal width toward the lunule, with numerous scattered interfrontal setae; frontal bristles not shorter posteriorly; outer vertical bristles divaricate and almost as long as inner; frontoorbital bristles one reclinate and usually two proclinate; ocellar bristles almost divaricate, and often followed by several shorter divaricate bristles; third segment of antenna 2.9 times as long as second; palpus 2.3 in length; back of head bulging and slightly flattened, but less so than in male. Abdomen laterally on fourth segment with well-defined silvery pollinose areas which are visible from above. Wing with basicostal scale yellow orange to orange brown. Otherwise similar to male except for normal sexual differences.

*Length.* 6-9 mm.

*Distribution.* Widely distributed in the Nearctic and Neotropical regions, from southern Canada throughout the United States, Mexico, the West Indies, Central America, and South America southward to Chile and Argentina.

Certain variations in coloration occur. Northern specimens often have considerably less orange-red color than southern specimens, while specimens from southern states or from the tropics are rather greenish in certain lights when freshly collected. Adults from relaxing jars are usually more metallic blue to purple than adults in nature. The typical coloring of the legs is yellow orange to red orange, never black. It is possible to produce most of these variations in *macellaria* by varying humidity and temperature during the immature stages.

Aldrich indicated that the three specimens of this species which are in the museum at Copenhagen are probably not the Fabrician types, but these specimens were accepted as types by Townsend. Both Aldrich and Townsend agreed that they represent the species now known under this name.

Synonymy of *macellaria* by older authors cannot be accepted without question and relatively few names previously listed as synonyms have been found actually to refer to this species. Some of the names listed above as synonyms of *macellaria* were so identified from type specimens in European museums by Aldrich in 1929, but the synonymy may not be correct in all cases, for Aldrich was not aware at that time of the existence of *americana*; he often identified the latter species under the name of *Paralucilia fulvipes* (Macquart).

*Biology, habits and immature stages.* *Egg.* Deposited in a yellowish, rounded, loosely cemented, irregularly flattened mass, the average number in a single mass being from 40 to 250 eggs (maximum observed, 1,228). The individual egg is approximately 1 mm. in length and 0.2 mm. in diameter, smooth, glistening whitish, rounded at posterior end and somewhat flattened at anterior end, with a narrow dorsal longitudinal band or seam, the narrowness of which causes the cap to appear small.

When live animals are blown by this species, the egg masses are usually deposited among wool or hair in irregularly arranged patches and loosely or not at all attached to the skin. Such egg masses may be composite depositions from several females, and a suitable location near an attractive wound may contain thousands of *macellaria* eggs.

The incubation period is approximately half that required for *americana*. Melvin (1934) found almost 33 hours were required for incubation at 64° F. and that few eggs hatched at tempera-

tures much below this; less than a 10 percent hatch occurred at 59° F. At 104° F. incubation was completed in 6.73 hours, but no hatch was obtained at 109° F. The optimum temperature for the hatching of eggs of this species appears to be at about 89° F., at which temperature it requires 8.13 hours to complete incubation.

*Larva*.<sup>\*</sup> First instar: Size and general form similar to those of *americana*. Spines small and brownish in color, all spines with a single point, the larger spines approximately 6 microns in length. Last segment slightly depressed behind. Posterior spiracles similar to those of *americana*. Tubercles bordering posterior cavity poorly defined. Cephaloskeleton (pl. 35, A) differing significantly from that of *americana*, the pharyngeal sclerites each with a prominent anterodorsal projection and joined at anterior extremity, the parastomal sclerite broader and the labial sclerites greatly different in structure, these consisting of a pair of irregular elongate sclerites with a large number of small hooklets closely grouped at anterior extremity; the cephaloskeleton considerably larger than in *americana*, the length ranging from 0.33—0.34 mm. (average of 10, 0.336 mm.; average width at widest point, 0.125 mm.).

Second instar: Slightly less robust than in *americana*. Spines small, length of larger spines approximately 20 microns; spines in anterior rows of each band generally with two and occasionally with three points, those in posterior portion of band more often with one point. Anterior margins of each of segments 2 to 9 completely encircled with spines, segment 10 with band interrupted on dorsum and segments 11 and 12 with spines restricted to ventral and ventrolateral regions; dorsal and lateral spines wanting posteriorly on margins of all segments, while in *americana* the posterior margins of segments 11 and 10 are armed with several lateral and dorsal rows of spines. Anterior spiracles more often with 9 or 10 branches. Posterior spiracles (pl. 35, C) more lightly pigmented and smaller than those of *americana* (average greatest diameter approximately 0.12 mm.); tracheal trunks leading from posterior spiracles not pigmented. Tubercles on border of posterior cavity larger and more conspicuous than in *americana*, the general appearance of last segment essentially as in third instar. Cephaloskeleton (pl. 35, B) with labial sclerites comparatively short and not so broadly curved as in *americana*; length of cephaloskeleton from 0.73-0.80 mm., average width approximately 0.3 mm.

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<sup>\*</sup>This description is a modification of Knippling's, in Laake et al. (1936, pp. 12-13).

Third instar (pl. 35, D): Far less robust and slightly smaller than *americana*. Spines (*sp*) comparatively small, with one to three points but more often with two. Anterior margins of each of segments 2 to 9 completely encircled with bands of spines arranged in more regular rows than in *americana*; segment 10 with band interrupted on dorsum, and segments 11 and 12 with spinous area restricted to ventral and ventrolateral regions; spines wanting on posterior margin of all segments, except for one or two rows of small spines on center of segments 7 to 12. Anterior spiracles (*asp*) short with rather short branches, the number of branches varying from 8 to 12, usually 9 to 11 (average of

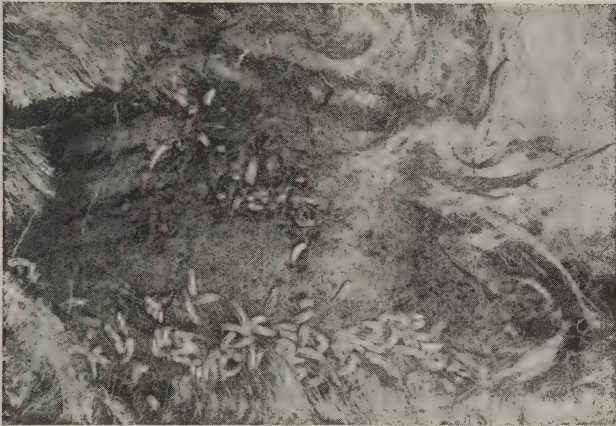


FIG. IX. *Callitroga macellaria* larvae on sheep. Note the "honey-comb" type of lesions in bare area which are caused by feeding larvae, and the migrating larvae in the wool. The original wound is located on the upper edge of this bare area. Valdosta, Ga., September 12, 1935.

120 spiracles, 9.81 branches per spiracle). Posterior spiracles (pl. 35, E, *psp*, and F) smaller and more rounded than in *americana*, greatest diameter of spiracles 0.342-0.370 mm. (average of 10, 0.356 mm.); tracheal trunks leading from posterior spiracles not pigmented. Posterior cavity (pl. 35, E, *pc*) outlined with conspicuous conical tubercles, the inner (*i*) and outer pairs on upper margin equal in size, the median (*m*) pair smaller; on lower margin, the outer pair slightly larger and the inner pair smaller than the median tubercles; an additional pair of small tubercles situated medially near lower margin of posterior cavity; anal protuberance (*ap*) large, with two pigmented, conical, anal tubercles (*at*); spines on anal protuberance in a more or

less V-shaped group extending upward on outer side; border of posterior cavity armed with numerous rows of three or four spines. Cephaloskeleton (pl. 35, G) with labial sclerites smaller than in *americana*; pharynx with longitudinal ridges, whereas in *americana* it is smooth; pharyngeal sclerites large with dorsal cornua slightly elevated; pigmented strip of varying extent just above dorsal cornua in more mature third-instar larvae; length of cephaloskeleton from 1.43-1.63 mm. (average of 10, 1.56 mm.).

As the eggs hatch, in myiasis cases, the emerging larvae begin to feed upon necrotic tissue, migrating considerably from one place to another. They have no definite type of attack in carcasses. They are active when internal temperatures of the carcass reach 41-50° F., according to Deonier (1940). In wounds larvae of this species do not form the typical pocketlike injury characteristic of *americana*, but often migrate into the wool or hair (Fig. IX) about the wound. On long-fleeced sheep the larvae have a tendency to feed outside the wound in the wool; in short-haired animals they tend to feed in the wound. They attain maturity in from 6 to 20 days, then migrate from the carcass or drop from the wound and then burrow into the soil or crawl into shelter to pupate.

*Puparium.* Similar to that of *americana* but not quite so large and not so barrel-shaped. It averages about 7.6 mm. in length and 2.8 mm. in diameter and has the external characters of the mature larva. Melvin, in Laake et al. (1936), found that *macellaria* larvae pupated in about 1.35 inches of clay soil, 1.41 inches of heavy black soil, and 1.76 inches of sand, and that 5 inches was the maximum depth at which pupation occurred. He found the length of the pupal stage to be approximately half that of *americana* under conditions in which the pupae of both were exposed to the influence of outside weather factors.

*Adult.* The preoviposition period in *macellaria* is from 3 to 18 days according to Bishopp (1917, p. 325). Females oviposit principally upon carrion, occasionally upon live animals. One female may deposit as many as eight egg masses, the period between depositions ranging from one to seven days. The average interval seems to be from two to four days. Gravid females will deposit enormous numbers of egg masses upon a single carcass; Babcock and Bennett (1921, p. 5) stated, "One will often see a mass of eggs half as large as a man's fist where many screw-worm flies have been depositing." Part of such a mass might have been composed of eggs deposited by other calliphorids, for example, *Phormia regina* or species of *Phaenicia*; but in southwest Texas, where these observations were made, most of the

eggs making up such masses found during summer months had probably been deposited by *macellaria*.

The total developmental period varies from 9 to 39 days, according to Bishopp, (1915, p. 326), depending upon the temperature and humidity.

The numbers of adult *macellaria* usually increase from early spring until frost although a normal decrease in their abundance usually occurs during midsummer when the weather is hot and dry. Rainy periods are apparently productive of the greatest abundance, for a warm humid atmosphere is best suited to the rapid development of the species. The number of these flies is limited mainly by weather conditions and by available carcasses. Bishopp (1917) judged by rather careful estimation that one carcass might produce upwards of a million flies of this species.

This species occurs in southern Florida and southern Texas during the entire year. In South Carolina during the winter of 1931 adults were collected throughout the winter in the neighborhood of the Charleston city dumps. Deonier (1940) observed copulating and ovipositing adults in Texas when atmospheric temperatures were 58° F. and he reported the minimum temperature for activity for adults to be from 50-60° F. Bishopp (1915, pp. 325-326) stated that from 10 to 14 broods are produced in southern Texas. The species seldom becomes abundant in northern United States. It is apparently killed by early frosts. In the extreme northern part of its range it appears about June 1-15 in Ohio along the southern shore of Lake Erie. It is not abundant in the northern Middle West but most common there seems to have its peak population of *macellaria* during the month of August. The species practically disappears in Ohio by late September, although a few individuals may be found as late as November first.

The average life of the adults is comparatively short, ranging from two to six weeks. In nature they feed upon a variety of foods, ranging from garbage refuse to the nectar of certain flowers<sup>1</sup>. Much of the life of this species is spent about carrion; vegetation surrounding a carcass may swarm with thousands of adult *macellaria*. The obvious predilection for decaying meat exhibited by this species has played a conspicuous part in attempts to control it.

Bishopp and Laake (1921, p. 765) found that adults of *macellaria* would migrate as far as 8 miles in 24 hours and 10 miles

<sup>1</sup>Wild parsnip (*Pastinaca sativa*); also flowers which give off an odor resembling that of carrion, i.e. *Aristolochia* spp.

in less than 48 hours; they observed a maximum migration of 15.1 miles.

*Economic importance.* As already stated, *macellaria* is a "secondary" myiasis-producing species of minor importance. Only twelve cases of myiasis caused by *macellaria* were reported in 1936 from the southern United States by Knipling and Rainwater (1937). *Sarcophaga plinthopyga* Wied. occurs more frequently in pure cultures in cases of myiasis in southwest Texas than *macellaria*, and *Phormia regina* is of more importance in the southeast.

According to Knipling and Travis (1937, p. 733), the larvae apparently kill infested animals, but the species is not of particular importance in areas where *americana* is not present except under certain conditions where soiled wool or other factors render sheep susceptible to severe maggot infestation.

*Callitroga macellaria* is frequently involved in the blowing of meats in shops and homes and, when abundant, is of considerable economic importance in abattoirs. It is the common fly about the market places in the American tropics.

#### *Callitroga minima* (Shannon), new combination

*Cochliomyia minima* Shannon, Wash. Ent. Soc. Proc. 28 (6): 124, 1926; Cushing and Hall, Wash. Ent. Soc. Proc. 39 (7): 196, 1937. (Type, male from San Francisco Mountains, Santo Domingo, West Indies, No. 28886, U. S. National Museum).

A small species with the same general appearance of *macellaria*, but the fourth abdominal tergite cupreous.

*Male.* Similar to *macellaria* but head height 9.0; width 11.1; length at antenna 4.6 and at vibrissa 4.8; eye height 6.8; bucca 0.26 of eye height, with dark hair above which becomes yellowish below and toward the metacephalic suture; eye larger than normal for the genus, the facets on inner and upper margins slightly larger than those laterally and below; frontale black, approximately 0.5 frontal width at narrowest; front at vertex 0.16 of head width, 0.07 at narrowest (slightly anterior to anterior ocellus) and 0.25 at antennal base, blackish, with silvery pollen which is slightly tinged with yellow, and with pale hairs outside the frontal row, these continuing anteriorly on the parafaciale; frontal row of bristles, about 11 in number, becoming vestigial toward occiput, the rows diverging anteriorly as they follow the frontale, and extending to the base of the second antennal segment; reclinate frontoorbital bristle one; vertex with dull black



pollen, and with considerable short black hair; back of head blackish with thin yellowish silvery pollen and with considerable whitish hair; parafaciale greatly narrowed above, blackened on upper half, with silvery to yellowish-silvery pollen, and bare on lower half; clypeus about one and one half times as long as broad; epistoma not so strongly narrowed from clypeus but strongly warped forward, then briefly downward toward oral margin; antenna orange brown, third segment dull brownish, four times as long as second; palpus 2.0 in length.

Thorax blackish with metallic blue-green luster, with considerable dull fuscous and silvery pollen, and with three wide, dorsal, longitudinal stripes which do not extend beyond the scutellar suture; predorsocentral bristles two, the anterior bristle weak; preintraalar bristles with the middle one of the series absent and the anterior bristle weak; presupraalar bristle one, stronger than other presutural bristles; posthumeral bristle weak; intrapostalar bristle a little longer and stronger than surrounding hairs; mesopleuron with scattered short black hairs except on anterior fourth; squamopleuron with short fine decumbent brownish pile; lateral postscutellar plates with dark hair.

Legs dark brown; midtibia with one anterodorsal bristle near apical third; coxae and basal sections of femora with soft whitish hairs.

Wing hyaline, not strongly brownish basally; costal sections 2 to 6 in the proportions 60:40:80:28:6; basicosta and subcostal sclerite orange, the latter setose; anterior cross vein slightly beyond middle of second section of fourth vein; bend in fourth vein rounded and without apical spur or fold; upper squamal lobe hyaline, brownish on apical fifth; lower squamal lobe hyaline at base but strongly infuscated on apical three-fifths or more.

Abdomen colored as thorax, mostly shining but with thin whitish pollen especially laterally and along edges of tergites in certain lights; fourth segment bright aeneous with metallic bronze, gold, and yellow green.

Second genital segment orange yellow. Internal anatomical features (pl. 18, C, D, and E) as illustrated.

*Female.* Head height 7.4; length of head at antenna 4.0 and at vibrissa 4.4; eye height 5.6; bucca 0.29 of eye height; parafaciale opposite lunule 1.2 in width; distance between vibrissae 1.4; head width 9.4; front at narrowest (at vertex) 0.31 of head width, 0.36 at antennal base; palpus 2.5 in length. Otherwise similar to male except for normal sexual differences.

*Length.* 5.5-8.5 mm.

*Distribution.* Neotropical: Evidently limited to the West Indies.

This species may be uncommon or extremely local in distribution. The type series was collected during September 1905 by August Busck. In addition I have seen 15 specimens from Cuba in the American Museum of Natural History which were collected in May and September.

The extremely long phallosome is diagnostic of the male, and a small accessory sclerite connecting the posterior paramere with the base of the phallosome is a character not seen in other species of *Callitroga*. The aeneous metallic luster of the fourth abdominal tergite of the female is also diagnostic of the species.

*Biology.* Adults appear to have habits similar to those of *aldrichi* and *macellaria*. In the vicinity of LaFe and Guiane, western Cuba, both sexes were trapped with meat-baited traps. Males apparently have a predilection for fresh horse manure. The immature stages are unknown.

#### PARALUCILIA BRAUER AND BERGENSTAMM

*Paralucilia* Brauer and Bergenstamm, Zweiflügler des Kaiserlichen Museums zu Wien, vol. 5, no. 2, p. 87, 1891; *ibid.*, vol. 6, no. 3, p. 92, 1893; Brauer, Akad. der Wiss. Wien, Math.-Nat. Kl. Sitzber. (1) 107:469, 1898; Townsend, Insector Inscitiae Menstruus 4:11, 1916; Aldrich, U. S. Natl. Mus. Proc. 66 (18):17, 1925; Ent. Soc. Amer. Ann. 18:456-457, 1925; Shannon and Del Ponte, Inst. Bact. [Argentina], Rev. 4 (5):566, 1926; Townsend, Rev. de Ent. 1:70, 1931; Curran, Amer. Mus. Nat. Hist. Bull. 66:472, 1934. Genotype. *Calliphora fulvipes* Macquart. (Monobasic).

*Compsomyiops* Townsend, Insector Inscitiae Menstruus 6:153, 1918; Shannon, Insector Inscitiae Menstruus 11:106, 1923; Townsend, Rev. Mus. Paul. 15:213, 1926; Rev. de Ent. 1:70, 1931; Manual of Myiology, vol. 2, p. 163, 1935; *ibid.*, vol. 5, p. 127, 1937; Cushing and Hall, Wash. Ent. Soc. Proc. 39 (7):197, 1937. Genotype. *Calliphora fulvipes* Macquart. (By original designation).

A species with the general coloring and appearance of species of *Callitroga* but usually larger and with elongate palpi.

*Male and female.* Head (pl. 2, D and E) width always considerably greater than height; length at antenna somewhat less than length at vibrissa; oral margin slightly protuberant; epistoma warped forward from clypeal plane and then downward and squarely cut off at oral margin; metacephalon produced pos-

teriorly and slightly downward; eye of medium size, elongate oval, set nearly straight in head; front very narrow in male, wide in female; with long and abundant hairs, not arranged in rows, situated outside of frontal row of bristles and extending anteriorly to the middle of the parafaciale; frontal bristles vestigial posteriorly in male; outer vertical bristles absent in male, present in female; frontoorbital bristles absent in male, one reclinate in female; ocellar bristles proclinate in male, almost exactly divaricate in female; clypeus about one and one-half times as long as wide, deeply concave; facial carina absent; parafaciale narrowed above, with numerous scattered hairs which are mainly near eye; faciale slightly convex in profile, with short black setae in several rows which extend nearly to antennal base; vibrissa above oral margin; palpus elongate clavate; antennal base somewhat below eye-middle when head is viewed in profile, the bases approximated; third segment of antenna reaching fully two-thirds the distance to the vibrissa; arista elongate, slightly thickened at base, and with long plumosity above, shorter below, for about four-fifths the distance to the apex; back of head, especially in male, flat or slightly concave in profile, with one row of postocular cilia.

Thorax with two humeral bristles; propleural bristles strong; preintraalar and preacrostichal bristles absent; predorsocentral bristles usually absent but sometimes the usual presutural a little larger than surrounding hairs; presupraalar bristle one; sternopleural bristles three; hypopleuron setose on posterior and dorsal margins; pteropleuron bare on anterior half; prosternum flat, large, narrow behind and widening rapidly anteriorly, setose; postalar declivity setose in center and anteriorly; tympanic pit with several long hairs; postacrostichal bristles two, and postdorsocentral bristles two or three, only the prescutellars strong; intrapostsutural, postintraalar and intrapostsupraalar bristles absent; intrapostalar bristles differentiated; mesospiraacular bristles one strong and two weak; metathoracic spiracle with long hair on anterior margin; scutellum with one discal bristle, under surface with fine hair; lateral postscutellar plates setose.

Legs without fine pile on coxae but posterior coxa setose posteriorly; claws and pulvilli short; fore tibia with about five or six short black dorsal bristles and with one strong posteroventral bristle near apical third; middle femur with a long, well-defined row of posteroventral bristles; middle tibia with one anterodorsal bristle near apical fourth, one ventral bristle near apical fourth, one or two posterior bristles, sometimes one near middle and always one at apical third, and one or two posterodorsal

bristles, one always at apical third, and one sometimes near middle; hind femur with complete posteroventral and posterodorsal rows of bristles, and a partial basal anteroventral row of bristles; hind tibia with one dorsal bristle apically, about three anterodorsal bristles distributed from base to near middle, two anteroventral bristles near middle, and two posterodorsal bristles near middle.

Wing hyaline; subcostal sclerite setose on anterior apical margin; remigium bare at base below; only third vein setulose above; fourth vein without apical section or fold; anterior cross vein at middle of second section of fourth vein; posterior cross vein gently sinuate; last section of fifth vein one-fifth as long as preceding section; seventh vein long, curved; upper squamal lobe of medium size, pilose on lower basal section, the posterior margin rounded; lower squamal lobe large, ovate, widened posteriorly, pilose on depression and anteriorly above.

Abdomen with ventral membrane usually narrowly exposed; no discal or median marginal bristles on intermediate segments; second and third segments each with a marginal row of weak decumbent bristles; fourth segment with a marginal row of longer and more erect bristles.

Genital segments with first segment large, narrow, globose, and without a row of marginal bristles; second segment small, rather flattened.

The problem of the genotype selection for *Paralucilia* Brauer and Bergenstamm must be settled on the basis of the short original description of the genus: "Bei *Lucilia* bildet eine n. G. *Musca* (*Calliph.*) *fulvipes* (Blanch. S.). Dritte Ader nur basal gedornt. *Paralucilia* n. Chile." In this reference the "(Blanch. S.)" refers to Blanchard and Schiner. The species *fulvipes* Macquart appeared in publications of each of these writers previous to the publication of *Paralucilia*. In using the names of Blanchard and Schiner rather than that of Macquart, it is possible that Brauer and Bergenstamm attached no particular significance to association of the original author's name with the specific name. However, there is no evidence within the original reference to indicate that they were restricting their concept of the genus *Paralucilia* to certain specimens determined by Blanchard and Schiner or that they were excluding *Calliphora fulvipes* Macquart; and there is no doubt that *Musca* (*Calliph.*) *fulvipes* (Blanch. S.) is nomenclatorially the same as *Calliphora fulvipes* Macquart. This being the case, the identity of the material before Brauer and Bergenstamm when they described *Paralucilia* has no bearing on the nomenclatorial problem.

Townsend's conclusions differ materially from the above. He considers the Brauer and Bergenstamm generic description to refer to a specific female in the Schiner collection, which was misidentified as *Calliphora fulvipes* but which belongs in the genus *Myiolucilia*.

***Paralucilia wheeleri* (Hough), new combination**

*Chrysomyia wheeleri* Hough, Zool. Bull. 2 (6):284, 1899; Townsend, Insector Inscitiae Menstruus 6 (7-9):154, 1918. (Type, male from Monterey, Calif., No. 53120, U. S. National Museum).

*Paralucilia affinis* Shannon (nec Robineau-Desvoidy) (in part), Wash. Ent. Soc. Proc. 28 (6):127, 1926.

*Somomyia callipes* Aubertin and Buxton (nec Bigot), (in part), Ann. Trop. Med. and Parasitol. 28 (3):246, 1934.

This North American species has long been confused with *fulvipes*. It may be easily separated from that species, however, by its dark squamal lobes and its considerably larger size; it is the largest of the North American chrysomyine flies.

A large blue-green-bodied, red-legged species with the general aspect of *Callitroga americana*, but the palpi elongate and the squamae dark brown.

*Male*. Head width 16.9; length at antenna 7.7, at vibrissa 8.6, and at oral margin 8.8; eye height 10.1; head height 14.2; bucca 0.36 eye height, orange, rather shining or with thin golden pollen, and with abundant yellow hair; frontale orange red, nearly obsolete for 2.0 below foremost ocellus but gradually widening anteriorly; front at narrowest 0.02 of head width, 0.13 at vertex and 0.23 at lunule, black, with thick silvery gray pollen; frontal rows of bristles nearly vestigial posteriorly, but extending anteriorly almost to middle of the second antennal segment, diverging with the margins of the frontale, and each row consisting of 10 or 11 bristles; vertex subpollinose, black, with considerable erect black hair; ocellar bristles of medium size; clypeus golden; parafaciale black above, orange below, with silvery pollen along eyes; vibrissae above oral margin by 1.2 and separated by 2.2; palpus orange, 2.8 to 4.6 in length; antenna with third segment 4.1 times as long as second, orange red to brown; arista orange in middle, black at base and tip, back of head black above, orange below, and with abundant yellowish hairs which are longer on metacephalon.

Thorax bluish green to black with metallic green luster, and with three black longitudinal stripes which do not extend upon

the scutellum, the intermediate blue-green stripes strongly whitish in certain lights; pleura lightly silvery; propleuron with black pile; notopleuron strongly setose, the setae long; mesopleuron with black setae; sternopleuron with black hair but with a few pale hairs on the posterior margin; hypopleuron with black hair on posterior margin and yellow hair on dorsal margin; pteropleuron with thickset yellow hairs posteriorly; postalar wall in center and posteriorly with tuft of black setae; preparapton yellow, with fine, white, decumbent pile; prepaulet black, tympanic pit with black hairs; sclerites at wing base black; greater ampulla black, with fine, white, decumbent pile; mesothoracic spiracle with yellowish white hair and metathoracic spiracle with brownish white hair, the latter with long black hairs on the anterior margin; lateral postscutellar plates with black setae; under surface of scutellum with fine black hair.

Legs black and orange; coxae black, fore femur black basally and orange red apically, fore tibia reddish brown to brown at base and orange red apically; hind femur orange brown at base and orange red apically; hind tibia orange red to brown; tarsi orange brown to black; claws black, pulvilli brown.

Wing (pl. 9, D) infuscated at base; costal sections 2 to 6 in the proportion 91:62:98:32:9; subcostal sclerite orange at base, brown apically, third vein setulose one-fourth the distance to the cross vein; fourth vein with angle at 90 degrees, then gradually curving toward wing tip and ending before apex by 1.0; squamal lobes brownish to black.

Abdomen metallic bluish with green and black luster, and with thin pollen which appears silvery in some lights; second and third tergites with a shining, longitudinal, middorsal stripe which extends from a widened base on the anterior portion of second segment to a very narrow line posteriorly on third segment; ventral margins of all tergites with whitish pollen; fourth segment with scattered weak erect hair; fifth sternite (pl. 19, C) as illustrated.

First genital segment black, metallic green, shining, with scattered setae; second segment black, shining, with scattered setae. Internal anatomical features (pl. 19, A, B, and D) as illustrated.

*Female.* Head (pl. 2, D and E) height 13.3; length at antenna 6.9 and at vibrissa 8.4; eye height 8.8; bucca 0.51 of eye height; parafaciale opposite lunule 2.3 in width; distance between vibrissae 2.3; front at vertex 0.34 of head width and 0.41 at antennal base, the margins obviously bent outwards below ocellar triangle and curving inward again anteriorly; frontale orange red with numerous, scattered, short, black hairs, es-

pecially on the margin of ocellar triangle (which is longer than in other North American chrysomyine flies), wide at ocellar triangle but still wider just anterior to foremost ocellus, then narrowing to narrowest point at lunule; head width 17.0; eye more oval than in male.

*Length.* 9-11 mm.

*Distribution.* Nearctic: The species occurs rather commonly from southern Mexico to the state of Washington and as far east as Colorado and western Texas. It is most abundant in the far Southwest in high altitudes, especially in forested areas, but during the winter months specimens may be collected on the Pacific Coast in considerable numbers at low altitudes. It is a relatively abundant species during the summer in the mountain ranges of New Mexico, Arizona and California. It occurs in the southern portions of the San Jacinto Mountain Range in southern California during the winter, but only in high altitudes in the summer season. It was not found by the author on the Coachella Desert or in Imperial Valley in California, although specimens were collected in an arid section east of Yuma, Ariz., in November 1930. In southwest Texas specimens may be collected during the winter, being most abundant in April.

Specimens of this species are often found in collections under the name *Cochliomyia macellaria*. Many of the specimens of *Callitroga americana* found in the National Museum collection had been determined as *Chrysomyia wheeleri*. Superficially, *americana* and *wheeleri* appear similar, since they are of about the same size and of much the same coloring.

*Biology, habits and immature stages.* *Paralucilia wheeleri* is saprophagous like *Callitroga macellaria* and is of little economic importance. Larvae may be found breeding in carcasses, or occasionally in myiasis wounds, of animals throughout its range of distribution, and generally occur with larvae of *Callitroga*, *Phormia*, or *Lucilia*. Breeding takes place under favorable temperature conditions in late fall or early spring but is probably continuous throughout much of the year in favorable situations in southern latitudes.

*Egg.* Macrotype, large, hatching in from 20 to 24 hours under favorable temperature conditions. According to Deonier and Knipling (1940), a single egg mass may contain 350 to 500 eggs.

*Larva.* Of typical calliphorine shape and habitus. With a mean temperature of 69.5° F. the larva matures in approximately five days. Deonier and Knipling (1940) state that this period is increased with a decrease of temperature; at 58.5° F., for instance, 10 days are required to complete development. Mod-

erately cool weather is apparently favorable for development, but the larvae will not mature under continued low temperatures.

First instar<sup>1</sup>: Length 2.5-3.9 mm. Complete spinose bands on each of segments 2 to 9; segment 10 without or with only a few spines on dorsum, on segments 11 and 12 these restricted to ventral or ventrolateral surfaces; spines on posterior margin of segments restricted to a single row each on venter of segments 7 to 12. All spines light to dark brown, each with a single point, the larger spines 6 microns in length. Three small tubercles above and three small ones below posterior cavity. Posterior spiracles each with two slits appearing confluent below and not surrounded by peritreme. Amphipneustic. Cephaloskeleton (pl. 36, B) as illustrated.

Second instar: Length 4.0-9.5 mm. Spinose bands and distribution of spines essentially as in previous instar, but each spine with one to three points, usually with two; a V-shaped group of spines located on anal protuberance similar to that in *Callitroga macellaria*. Tubercles located as in previous instar. Posterior spiracles each with two slits surrounded by incomplete peritreme. Anterior spiracles each with about 12 branches. Cephaloskeleton (pl. 36, C) as illustrated.

Third instar: Mature larva (pl. 36, A) 8.5-17.0 mm. in length. Segments 2 to 9 each provided with complete spinose bands at anterior margin; segment 10 with band incomplete on dorsum; segment 11 with band generally restricted to ventral and ventrolateral surfaces; posterior margin of all segments without spines on dorsum. Anterior spiracles with about 12 branches each. Posterior spiracles (pl. 36, E) relatively large and provided with a broad peritreme, the greatest diameter of one spiracle averaging 0.37 mm.; tubercles three on upper, and three on lower, margin of posterior cavity; inner and outer pairs on upper margin approximately equal in size, the median pair somewhat smaller; inner pair separated by less than two-thirds the distance between inner and outer tubercles on each side; outer tubercles on lower margin larger than median, and inner tubercle greatly reduced. Anal area (pl. 36, F) with two prominent tubercles, the spines of which are arranged in a V-shaped group. Cephaloskeleton (pl. 36, D) approximately 1.6 mm. in length, resembling that found in *Cochliomyia* but possessing an accessory oral sclerite not found in closely related genera.

*Prepupa.* This stage is 3 to 7 days in duration at a mean air

<sup>1</sup>Adapted from Deonier and Knipling (1940). Many of the biological notes on *wheeleri* were abstracted from this paper.



temperature of 69.9° F. In periods of cooler weather the stage may be prolonged to 15 days.

*Puparium.* The puparium of *wheeleri*, as in all calliphorid species, has most of the external characters of the mature larva. The pupation period covers 8 to 14 days at a mean air temperature of 72.2° F., but may be prolonged to 49 days or perhaps longer, depending upon weather conditions.

*Adult.* Both sexes of *wheeleri* may be collected in carcass-baited traps; as many as 3,072 were collected by this means in Arizona during the latter part of March, 1938 by C. C. Deonier (Deonier and Knipling, 1940), who found that captured gravid females deposited readily on lean meat. He also collected gravid females in nature upon a dog carcass. The specimens which I have collected were attracted to myiasis wounds, to carcasses, or upon foliage where the adults apparently sun themselves during the early morning hours.

#### *Paralucilia fulvipes* (Macquart)

*Calliphora fulvipes* Macquart, Diptères exotiques, vol. 2, no. 3, p. 289, 1843; Blanchard, in Gay, Historia física y política de Chile, vol. 7, pp. 434-435, 1852; Schiner, Reise der Novara, Diptera, p. 309, 1868. (Type, male from Chile, in Paris or lost).

?*Calliphora rufipes* Macquart, Diptères exotiques, vol. 2, no. 3, p. 286, 1843. (?Type, male from America, in the Paris Museum).

?*Calliphora violacea* Macquart, Diptères exotiques, vol. 2, no. 3, p. 285, 1843; Brauer, Akad. der Wiss. Wien, Math.-Nat. Kl. Sitzber. (1) 108:522, 1899. (*Paralucilia*). (?Type, from America, in the Paris Museum).

?*Lucilia cyanicolor* Rondani, Nuovi Ann. Sci. Nat. Bologna (3) 2:178, 1850. Change of name for *Calliphora violacea* Macquart, preoccupied.

*Calliphora tibialis* Macquart, Diptères exotiques, vol. 4, no. 2, p. 215, 1851. (Type, male from Rio de Janeiro, Brazil, in the Paris Museum.) New synonymy.

*Lucilia taeniaria* Thomson, Eugénies Resa, vol. 6, no. 2, p. 544, 1869. (Type, female from Buenos Aires, Argentina, in Stockholm.) New synonymy.

*Paralucilia fulvipes* apparently does not occur in the North American fauna, but, since *fulvipes* and *wheeleri* have been confused under one name for many years by all authors except Townsend, it has been necessary to obtain considerable informa-

tion in regard to the synonymy of *fulvipes* as well as of *wheeleri*. This information is therefore included. Although the range of distribution of these species may well overlap in Central America, I collected no specimens of *fulvipes* there in almost a year of intensive collecting.

*Male and female.* Squamal lobes usually white, rarely orange or brownish; often smaller than *wheeleri* and more metallic greenish in color. *Paralucilia fulvipes* and *wheeleri* are very much alike but these characters will apparently separate them satisfactorily. Male genital segments with internal features (pl. 19, E, F, G, and H) as illustrated.

*Length.* 8-10 mm.

*Distribution.* Neotropical: Argentina to Venezuela and Colombia.

The type specimens of this species are apparently lost. They are not in any of the European museums with which I have been in correspondence; nor did Aldrich or Townsend find them. There seems little question, however, that the name is properly applied.

The name *Chrysoomyia affinis* Robineau-Desvoidy was applied to *fulvipes* by Shannon in 1926. He did not distinguish between *fulvipes* and *wheeleri*. The type specimen of *affinis* is *Callitroga macellaria* (F.) according to Aldrich who examined it in the Paris Museum in 1929, and M. Séguy tells me that it is a species of *Callitroga*, questionably *americana*. *Calliphora peruviana* Robineau-Desvoidy was listed by Shannon in 1926 as a synonym of *fulvipes*. Aldrich stated that one specimen of each sex of this species is in the Paris Museum, that they are in too poor condition to permit positive specific identity, but that they are *Calliphora*. A homotype of *peruviana* by Macquart is also in the Paris Museum, and M. Séguy tells me that this specimen is *Callitroga macellaria*. *Lucilia durvillei* Macquart, listed by Shannon as a synonym of *fulvipes*, is also a synonym of *macellaria*. *Calliphora annulipes* Philippi, often listed as a synonym of *fulvipes*, is unknown to me. The description appears to apply to *fulvipes*.

The original description of *Calliphora rufipes* by Macquart gives the type locality as "Java," so the specimen under this name in the Paris Museum labeled "Amerique" may not be the type. The original description of *Calliphora violacea* Macquart gave the type locality as "Africa." Brauer transferred the name to *Paralucilia*, a genus which apparently does not occur in Africa. Séguy told me that the supposed type is a female in poor condition labeled "Amerique," and that it is a specimen





PHORMIINI

Color plate II.—*Phormia regina* (Meigen). Adult female, dorsal view, X 10.

of *Paralucilia fulvipes*. I have not seen specimens of *fulvipes* from Mexico. In view of this situation, the placement of Macquart's name as a synonym of *fulvipes* must be questioned. The name being preoccupied, *cyanicolor* was proposed by Rondani to replace it. Aldrich saw the supposed type of *Calliphora tibialis* Macquart in the Paris Museum and he considered it to be a specimen of *Callitroga macellaria* (F.) but, according to Séguy, it is *fulvipes*.

Blanchard's and Macquart's *fulvipes* were identical. The latter author described the Gay dipterous material. Schiner stated that he had a Macquart type of *fulvipes* in his collection; others were sent to him and at least three males from Chile were determined by comparison with the Macquart type. This is the series upon which *Paralucilia* was based.

*Biology.* The habits and immature stages of this species are similar to those of *Paralucilia wheeleri*. Adults collected near Cochabamba, Bolivia, during June, 1943, had habits indistinguishable from those of *wheeleri*.

### TRIBE PHORMIINI

#### (Black blowflies)

The tribe Phormiini includes black and dark blue or olivaceous green flies (Color plate II) which differ from the species belonging to the Chrysomyini as follows: The posterior coxa is bare posteriorly; most of the species have two presupracalar bristles; and the larvae of members of this tribe have a definite "button" in the postspiracular plate.

### PHORMIA ROBINEAU-DESVOIDY

*Phormia* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 465, 1830; Soc. Ent. de France Bull., p. V, 1849; Histoire Naturelle des Diptères des Environs de Paris, vol. 2, p. 845, 1863; Hough, Ent. News 10:66, 1899; Zool. Bull. 2(6):288, 1899; Hendel, Wien. Ent. Ztg. 20:29, 1901; Aldrich, Wien. Ent. Ztg. 20:68, 1901; Bezzi, Katalog der Paläarktischen Dipteren, vol. 3, p. 530, 1907; Townsend, Smithsn. Misc. Collect. 51:123, 1908; Villeneuve, Wien. Ent. Ztg. 30:84, 1911; Rodhain and Bequaert, Bull. Sci. de la France et Belg. (7) 49(3):243, 1916; Malloch, Canadian Arctic Expedition Rpt., vol. 3, p. 59e, 1919; Engel, Ztschr. f. Wiss. Insektenbiol. 15(10-12):255-257, 1920; Shannon, Insecutor Insectiae Menstruus 11:107, 1923; Séguy, Encycl. Ent. (A) 9:169, 1928; Lundbeck, Diptera Danica, vol. 7, p. 138, 1927;

Patton and Cushing, *Ann. Trop. Med. and Parasitol.* 28(3):305-314, 1934; Townsend, *Manual of Myiology*, vol. 2, p. 171, 1935; *ibid.*, vol. 5, p. 163, 1937. Genotype, *Musca regina* Meigen by designation of Robineau-Desvoidy.

*Calliphora (Phormia)* Pandellé, *Rev. de Ent.* 15:213, 1896 (in part).

*Euphormia* Townsend, *U. S. Natl. Mus. Proc.* 56(2301):542, 1919; Rohdendorf, *Ent. Mitt.* 13:282, 1924. (Isogenotypic with *Phormia*.)

*Male and female.* Head (pl. 3, A and B) with length of antenna and at vibrissa nearly equal; bucca almost one-third eye height; parafaciale narrowed above and hirsute; faciale bristled about half the distance to antennal base with three or four rows of short setae; front of male narrow and widening anteriorly, with parallel margins in female; outer vertical and frontoorbital bristles absent in male; palpus clavate; arista with long plumosity above and below for nearly three-fourths its length; back of head concave above in profile, evenly rounded below; intra-ocular cilia absent above, a few laterally and below.

Thorax with disc of mesonotum convex; humeral bristles five; propleuron strongly pilose in center; propleural bristles three or four; preintraalar bristles two, the presutural present; preacrostichal bristles three or four; posthumeral bristles usually one (sometimes two); postintraalar bristles two; preintrapostalar bristle absent; notopleural bristles two large, one medium, (rarely a still smaller fourth); sternopleural bristles two or three (usually three); prosternum laterally setose; preparapteron and greater ampulla with fine, short, decumbent pubescence; post-acrostichal bristles two; postdorsocentral bristles four or five; mesothoracic spiracle elongate-oval; metathoracic spiracle triangularly ovate, the anterior edge with long hairs; scutellum with one or two (usually two) discal bristles, three to five lateral bristles, only the basal and angular ones strong, apical bristles absent, and under surface pilose in center.

Legs with fore femur without anteroventral row of bristles; tarsi as long as tibiae; claws and pulvilli as long as last tarsal segment.

Wing with subcostal sclerite bare; remigium below at base with some long ciliae; only third vein setulose; fourth vein bent toward wing apex at 85-degree angle; apical cell widely open; anterior cross vein beyond middle of second section of fourth vein in proportion of 5.0:4.5; posterior cross vein oblique and not strongly arcuate; last section of fifth vein about one-fifth as long as preceding section; upper squamal lobe bare, rounded;

lower squamal lobe large, apically rounded, the inner margin more rounded than outer, bare.

Abdomen with scutellar depression extending nearly four-fifths the distance toward posterior margin of the first segment; all tergites with fine short hairs; intermediate segments without discal or median marginal bristles; third segment with a row of longer marginal hairs.

Genital segments of male generally retracted and hidden, more or less globose, the first segment without a marginal row of bristles.

*Phormia regina* (Meigen)

(The black blowfly)

*Musca regina* Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 5, p. 58, 1826; *ibid.*, vol. 7, p. 292, 1838; Schiner, Fauna Austriaca, Die Fliegen, vol. 1, p. 589, 1862. (*Lucilia*). (Type, probably from Europe, apparently lost.)

*Musca thalassina* Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 5, p. 54, 1826; Macquart, Histoire Naturelle des Insectes Diptères, vol. 2, p. 254, 1835. (Type, female, in Paris.)

*Phormia philadelphica* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 466, 1830; Histoire Naturelle des Diptères des Environs de Paris, vol. 2, p. 848, 1863. (Type, male from Philadelphia, in Paris.)

*Phormia fulvifacies* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 467, 1830. (Type, in Paris or lost.)

*Phormia mollis* Walker, List of the Dipterous Insects in the Collection of the British Museum, vol. 4, p. 892, 1849. (Type, a headless specimen from St. Martins Falls, Albany River, Hudson Bay, in the British Museum.)

*Musca proxima* Walker, Insecta Saundersiana, vol. 1, p. 241, 1856. (Type, from California, in the British Museum.)  
New synonymy.

*Lucilia stigmatalis* Thomson, Eugenes Resa, vol. 6, no. 2, p. 544, 1869. (Type, female from California, in Stockholm.)  
New synonymy.

*Lucilia rufipalpis* Jaenicke, Senckenb. naturf. Gesell. Abhandl. 6:340, 1867; Hough, Zool. Bull. 2(6):288, 1899. (Type, from Illinois, in the British Museum.)

- Lucilia nigrina* Bigot, Ent. Soc. de France Ann. (5)5:247, 1877; Brauer, Akad. der Wiss. Wien, Math.-Nat. Kl. Sitzber. (1)108:523, 1899 (*Calliphora*); Aubertin, Linn. Soc. London Jour., Zool. 38:429, 1933. Type, from Illinois, in the British Museum.)
- Somomyia rupicola* Bigot, Soc. Zool. de France Bull. 12:603, 1887; Soc. Ent. de France Ann. 7:clxxx, 1887; Aubertin, Linn. Soc. London Jour., Zool. 38:431, 1933. (Type, male and female from Rocky Mountains, in the Bigot Collection, Newmarket, England.)
- Somomyia rufigena* Bigot, Ent. Soc. de France Bull. 7:clxxxi, 1887; Soc. Zool. de France Bull. 12:598, 1887; Hough, Zool. Bull. 2:288, 1899; Brauer, Akad. der Wiss. Wien, Math.-Nat. Kl. Sitzber. (1)108:521, 1899. (Type, male from Rocky Mountains, in the Bigot Collection, Newmarket, England.)
- Lucilia infuscata* Townsend, (in part), Smithsn. Misc. Collect. 51:123, 1908.
- Phormia regina* (Meigen). Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 466, 1830; Histoire Naturelle des Diptères des Environs de Paris, vol. 2, p. 847, 1863; Hough, Zool. Bull. 2(6):288, 1899; Townsend, U. S. Natl. Mus. Proc. 56(2301):542, 1919 (*Euphormia*); Engel, Ztschr. f. Wiss. Insektenbiol. 15(10-12):257, 1920; Mueller, Arch. f. Naturgesch. 88A(1-3):69, 1922; Shannon, Wash. Ent. Soc. Proc. 28(6):128, 1926; Séguy, Encycl. Ent. (A) 9:169, 1928; Wainwright, Roy. Ent. Soc., London, Trans. 76:237, 1928; Séguy, Encycl. Ent. (BII.) Dipt. 5:78, 1929; Patton and Cushing, Ann. Trop. Med. and Parasitol. 28(3):307, 1934; Townsend, Manual of Myiology, vol. 2, p. 171, 1935; *ibid.*, vol. 5, p. 163, 1937.

A slender, olivaceous or lustrous green and black species, the anterior spiracle with orange hair.

*Male.* Head (pl. 3, A and B) length at antenna 5.5, and at vibrissa 5.6; eye height 8.7; head height 11.5; bucca 0.30 of eye height, with abundant black hair; frontale 0.5 frontal width; front at narrowest 0.01 head width, 0.17 at vertex and 0.21 at lunule; with gray pollen, with some scattered hairs outside frontal bristles extending to about the middle of the parafaciale; frontal rows of bristles extending anteriorly to about the base of the second antennal segment, and but moderately divergent, each row consisting of about 14 bristles which are short and hairlike posteriorly; inner vertical bristles long, thin, decussate; ocellar triangle with numerous long erect black hairs posteriorly;



parafaciale with gray pollen and with hair of medium length scattered above; palpus 3.0 in length, yellow orange; third antennal segment three times as long as second, yellow orange to brown; arista black, with long black plumosity; back of head black, silvery, with two rows of postocular cilia and abundant short whitish hairs.

Thorax black with metallic bluish-green luster, with thin silvery pollen anteriorly just behind head and with darker black longitudinal stripes on dorsum extending slightly beyond suture; pleura mostly shining; humeral bristles of moderate length; propleuron with whitish-yellow hairs; propleural bristles moderately strong; preacrostichal bristles weak to strong, the hindmost one placed anterior to suture by 1.5; postacrostichal and postdorso-central bristles differentiated mainly in the precutellars; mesothoracic spiracle with bright orange hair; metathoracic spiracle with dark yellowish brown hair, the anterior edge with black hair; scutellum with minute subapical discal bristles which simulate apicals, and the under surface with fine, short, scattered, whitish hairs.

Legs black, shining; fore tibia with a complete dorsal row of bristles and without a posterodorsal row; middle femur with two anterior bristles near middle, one anteroventral bristle at basal fourth, without long hair ventrally, and with four anterodorsal bristles toward basal third; middle tibia with two posterior bristles, one at basal fourth, one near middle, and one posterodorsal bristle near middle; hind femur with complete anterodorsal and anteroventral rows of bristles and three long ventral basal bristles; hind tibia with incomplete anterodorsal row of bristles, the row better defined and the bristles set closer together toward base, two anteroventral bristles, one near middle, the other near apical fourth, and three posterodorsal bristles, one near basal fourth, one near middle, and one near apical fourth.

Wing (pl. 9, E) hyaline, slightly infuscated toward base; costal sections 2 to 6 in the proportion 80:60:95-100:30:8; subcostal sclerite orange brown to black; remigium basally below with fine orange-colored pile and with some black cilia; third vein setulose almost one-half the distance to cross vein; fourth vein usually without, but sometimes with, a very short fold at bend; upper squamal lobe usually hyaline but sometimes yellowish white; lower squamal lobe yellowish white.

Abdomen slightly olivaceous or bluish green to black, shining.

Genital segments greenish black, with scattered erect black hairs. Internal anatomical features (pl. 19, I and J) as illustrated.

*Female.* Head length at vibrissa and at antenna 6.5; head width 14.0; eye height 8.25; head height 11.0; frontale 0.30 frontal width, with numerous interfrontal bristles; bucca 0.33 eye height; front at vertex 0.31 head width, slightly wider near middle and 0.41 at lunule; outer vertical bristles two-thirds as long as inner; fronto-orbital bristles two, moderate in size, proclinate. Otherwise similar to male except for normal sexual differences.

*Length.* 6-11 mm.

There is considerable variation in certain characters of *Phormia regina*, even in series of reared specimens. Specimens from the southern limits of the known distribution have smaller eyes than specimens from the northern limits, which results, of course, in a variation in the buccal and eye height proportion. Southern specimens have the buccal height 0.16 to 0.20 the eye height. Some specimens, particularly females, have the length of the head at the vibrissa slightly greater than the length of the head at the antennal base.

Viable puparia of an inbred strain of this species were kindly forwarded to me by Dr. David F. Miller, Department of Zoology and Entomology, Ohio State University, Columbus, Ohio, who has continued the strain through more than 200 generations in 10 years. The original parent stock consisted of one male and one female collected during 1930 in Washington, D. C.

Variation in head proportions has been reduced by inbreeding in this strain, but variation in several bristle series has persisted and is identical with such variation in specimens found in nature.

In nature, adults of *regina* usually have three sternopleural bristles on each side; there is one large bristle posteriorly and one large and one small bristle anteriorly, the latter of these two being situated slightly below and caudad to the former. Occasionally, specimens are collected which have three sternopleural bristles on one side and two on the other or have only two sternopleural bristles on each side. The observed variation per 100 specimens collected in nature is: Three on each side, 47 percent; three one one side and two on the other, 37 percent; two on each side, 16 percent. This variation agrees with that found in the inbred strain. Invariably, the missing bristle is the small anteroventral one. The usual number of discal scutellar bristles in field-collected specimens of *regina* is two on each side; one occurs almost anterior to the strong apical marginal bristle and the other, a weaker bristle, is usually situated anterolaterally. Sometimes specimens collected in nature have

but one discal bristle on each side; more commonly, two bristles occur on one side and only one on the other. The observed variation per 100 specimens collected in nature is: Two on each side, 52 percent; two on one side and only one on the other, 36 percent; one on each side, 12 percent. This variation, again, agrees with that found in Dr. Miller's inbred strain. Invariably the weaker lateral discal bristle is the one that is absent. The variation in these two characters does not appear to be correlated with sexual differences or with each other. Only one specimen in nearly 500 has been found that had at the same time only two sternopleural bristles and only one discal scutellar bristle.

*Distribution.* Holarctic: Commonly found during the spring and fall throughout the United States, and occurring as far south as Mexico City, Mexico, at high altitudes. It is abundant during the spring months in the southern states. Australian: Oahu, Hawaiian Islands, at 1000 or more feet elevation.

Aldrich found in the Paris Museum in 1929 a specimen of *regina* labeled *Chrysomyia philadelphica* Macquart. He indicated in his notes that this specimen might be Meigen's type of *regina*.

There are two species in the cotype series of *Somomyia rufigena* Bigot. Hough synonymized the name with *Phormia regina* (Meigen), but did not examine the type series. Brauer pointed out that one species should be referred to a new genus near *Myio-trixa*. Aldrich, in 1929, found one species to be *Myiophasia metallica* Townsend, the other *Phormia regina*. I select the male specimen of *Phormia regina* from the Rocky Mountains as the lectotype of *Somomyia rufigena* Bigot.

*Biology, habits and immature stages.* Eggs 1.5 mm. long, elongate, elliptic, tapering slightly toward one extremity; macrotype, large whitish (resembling those of *Callitroga americana* in coloration); usually deposited in agglutinated masses of varying number among hair or in wool. The egg masses are sometimes found in or near edges of wounds in animals and, in such instances, they resemble the egg masses of *americana*.

Melvin (1934) found that, at a constant temperature of 59° F., it required nearly 52 hours for eggs of this species to hatch, while at 104° F., only 8.7 hours were required. He also found that none of the eggs hatched at 109° F. The optimum temperature for the incubation of eggs appears to be approximately 99° F., at which temperature 8.13 hours are required to complete incubation.

The embryology of the eggs of *Phormia regina* has been studied by Miss Mary Auten (1934, pp. 481-506).

*Larva.* First instar<sup>1</sup>: Length 2-3 mm., diameter 0.3 mm. Tapering slightly to the anterior segments, which taper sharply, the segmentation distinct, each body segment marked with a series of transverse bands of short dark chitinous points. Cephaloskeleton (pl. 37, A) very characteristic in this stage, the labial sclerites slender, nearly rectilinear, and at the anterior extremity with paired stomal plates, each of which has six minute teeth; hypostomal sclerite with a long rectilinear anterior process, the main part a broad dorsoventral bar of chitin produced posteriorly at both the dorsal and ventral angles as a tapering and relatively narrow process; dorsal sclerite slender, strongly looped and uniting the two lateral pharyngeal plates. Metapneustic; posterior spiracles each with one well-developed, narrowly oval orifice and a rudimentary second.

Second instar: Length 3.5-6.0 mm., diameter, 1.0-2.0 mm. General characteristics about as in previous instar but spinose bands not so apparent. Cephaloskeleton (pl. 37, B) with labial sclerites moderately heavy, somewhat decurved and irregular, united by a broad dorsal process; pharyngeal sclerite a broad dorsoventral plate with a curved process on anterodorsal angle, and another longer one on posteroventral angle, the dorsal cornua rather broad and elongate. Structure of anterior spiracle rather indistinct but with 10 or 11 circular orifices; posterior spiracles (pl. 37, D) each with two distinct ovate slitlike apertures.

Third instar: Length 9-17 mm., diameter 3-4 mm. Typically muscoid in habitus, creamy translucent white, yellowing with maturity. Segments 3-9 anteriorly with complete spinose bands, segment 10 with band weak dorsally; segment 2 dorsoanteriorly with spines; all segments except cephalic one with ventral spinose bands; segments 11 and 12 without dorsal spines; segments 8-11 posteroventrally with weak bands of single-pointed spines. Spines on anterior segments small; spines wedge- or dome-shaped with from one to four pointed (usually two sharp points), and pigmented only on tips. Anterior spiracles each with 10-11 rounded, radially arranged orifices; posterior spiracles (pl. 37, E) each with three subparallel, slitlike apertures, the peritreme incomplete, the "button" hardly apparent. Anal area with spiracles located in depression somewhat deeper than typical for calliphorid larvae, distinctly cup-shaped; dorsally with six nearly equidistant, low tubercles, median tubercles separated by a distance approximately one and one-half times the diameter of a spiracular plate, outer tubercles largest; ventrally with six

<sup>1</sup>Adapted from Felt (1913).

tubercles, outer and median largest, inner tubercles situated ventrally and out of line with median and outer, which are closest together. Anal protuberance large, the tubercles widely separated; below and between tubercles with spinose areas. Cephaloskeleton (pl. 37, C) with labial sclerite stout, heavily sclerotized, strongly decurved; hypostomal sclerite short, irregular; pharyngeal sclerite with a pigmented process on anterodorsal angle, another less obvious at posteroventral angle; ventral longitudinal grooves apparent.

The total larval stage ranges from 4 to 15 days, according to Bishopp (1917).

The larvae of *regina* are normally saprophagous and may be found in great numbers in carcasses of animals. They also occur in abundance in the paunch contents of slaughtered cattle, especially if some blood is mixed with these. On the open range, especially during the fall and winter, carcasses of large animals are responsible for the development of the vast majority of these flies. Paine (1912) found the larvae breeding in great numbers in the city garbage in Massachusetts, as did Walton in New Mexico (1915).

In cases of myiasis the larvae of *regina* sometimes cause a bloody discharge, which seems to indicate that a certain amount of destruction of tissue may take place. In such instances the wounds sometimes superficially resemble those produced by *Callitroga americana*.

*Puparium.* Length 9.0-9.5 mm., diameter 3-4 mm.; color light brown to almost black. The anterior extremity narrowly rounded and somewhat constricted subapically; each segment with a double transverse band of sclerotized points; posterior extremity contracted subapically and easily recognized by the submedian spiracles located in a somewhat ill-defined depression margined with irregular short, broad, sclerotized tubercles.

According to Bishopp (1915, p. 323), the pupal stage is 3 to 13 days in duration in the vicinity of Dallas, Texas. The total developmental period covers 10 to 25 days.

*Adult.* The adults of *regina* may be found during the entire year but are most abundant during the spring and fall months.

This species is typically a cold-weather blowfly, occurring most abundantly during early spring months. Carcasses found in nature during the winter season in southern United States, where the species breeds during much of the entire year, literally swarm with maggots of *regina*. The species becomes less abundant with the approach of hot weather, and it constitutes only

a very small percentage of the total blowfly population during the summer months except at high altitudes and in northern areas. Adults may be collected rather frequently in early fall months, and they hibernate when temperatures drop too low for adult activity. Hibernating adults may be found in numbers in tunnels of various wood-boring insects. A few adults may be collected upon the sunny side of buildings on warm days during winter months. Females will not oviposit at this season of the year.

The preoviposition period ranges from 7 to 17 days, according to Bishopp (1915, p. 327).

Adults of *Phormia regina* will migrate as far as 11 miles in less than 48 hours, according to Bishopp and Laake (1921, p. 765). Spermatogenesis and fertility of *regina* were studied by Cowan (1932), and its olfactory responses by McIndoo (1933).

*Economic importance.* *Phormia regina* is a well-adapted facultative saprophagous species capable of causing wound myiasis and serious injuries to man and domestic animals under certain environmental conditions. It appears to be of especial importance where soiled wool, or other factors not necessarily associated with wounds, render sheep or other animals particularly susceptible to its attack. It is also found commonly in wounds caused by castration and dehorning, such wounds occurring most frequently from November to March in southern states and during early spring or late fall in the Middle West. Parish and Laake (1935) state that during the spring months this species constituted 67 percent of all adults reared from larvae which developed in wounds of domestic animals in the Menard area of Texas. They concluded that it is of more importance than *Callitroga americana* until as late in the season as May 14. Knipling and Rainwater (1937) found *regina* to be the most important "secondary" myiasis-producing blowfly in southeastern United States.

Larvae of *regina* have been used in postoperative surgery, and methods for the rearing of sterile maggots of this species are given by Haub and Miller (1932) and Robinson (1933).

When fresh blood is present in abattoirs, *regina* often becomes extremely abundant and annoying.

### BOREELLUS ALDRICH AND SHANNON

*Boreëllus* Aldrich and Shannon, Insecutor Inscitiae Menstruus. 11:107, 1923; Enderlein, Gesell. f. naturf. Freunde Sitzber. 4-7:245, 1935; Townsend, Rev. de Ent. 1:71, 1931; Manual of Myiology, vol. 5, p. 139, 1937. Genotype, (*Boreëllus aris-*

*tatus* Aldrich and Shannon) = *Phormia caerulea* Malloch (1919), preoccupied, = *Sarcophaga atriceps* Zetterstedt. (Monobasic).

*Mallochomyia* Townsend, *Insecutor Inscitiae* Menstruus 14:25, 1926. Genotype, (*Mallochomyia johanseni* Townsend) = *Sarcophaga atriceps* Zetterstedt. (Monobasic).

*Male and female.* Head (pl. 3, C and D) elongate, with length at vibrissa greater than at antenna; parafaciale narrowed above and hirsute; faciale concave in profile, and bristled about five-sixths the distance to the antennal base; palpus elongate, clavate; third antennal segment about twice as long as second; arista with short plumosity above and below about three-fourths the distance to the apex; back of head bulging.

Thorax with mesonotum conspicuously flattened on disc; humeral bristles three, rarely a fourth present; propleuron narrowed due to enlargement of mesothoracic spiracle, strongly setose; propleural bristles two; preintraalar bristle one, the presutural absent; predorsocentral bristles two; notopleural bristles two; pteropleuron bare on hind margin but with a tuft of thick-set hair postmediodorsally; prosternum setose; postacrostichal bristle one; postdorsocentral bristles four; postintraalar bristles two; no preintrapostalar bristle; prothoracic spiracle much enlarged, long-ovate; mesothoracic spiracle slightly enlarged; the anterior margin without long hair; scutellum with one discal bristle, two lateral bristles and usually a long weak third bristle between these, apical bristles absent, under surface of scutellum with scattered hair.

Legs with anterior femur without anteroventral row of bristles; tarsi as long as tibiae; claws and pulvilli as long as last tarsal segment in male, a little shorter in female.

Wing with subcostal sclerite with fine long hairs; remigium basally below with some cilia; only third vein setulose above; fourth vein without apical section or fold at angle and bending gently toward wing tip at almost 45 degrees; apical cell closed in wing margin, the third vein curved posteriorly to meet fourth vein in costa; anterior cross vein before middle of second section of fourth vein in proportion 4.0:4.5; posterior cross vein gently doubly arcuate; last section of fifth vein about one-seventh preceding section; upper squamal lobe with dark setae on upper side, rounded posteriorly and the inside apical margin truncate; lower squamal lobe rather large, ovate, pilose on margin.

Abdomen with scutellar depression extending about one-half the distance toward posterior margin of first segment; all tergites with rather long erect hair and with several long lateral

marginal bristles; third segment with a marginal row of about 16 to 18 long thin bristles; fourth segment with abundant, long, erect, scattered hairs; first sternite longer than broad, each successive sternite smaller.

This is the most distinctive genus in the tribe Phormiini. The head is elongate, the apical cell is closed in the wing margin, and the arista is pubescent.

### *Boreëllus atriceps* (Zetterstedt)

*Sarcophaga atriceps* Zetterstedt, Diptera Scandinaviae, vol. 4, p. 1311, 1845; Bonsdorff, Finlands Tvavingade Insecter, vol. 2, p. 143, 1866; Holmgren, Ent. Tidskr. 4:165, 1883. (Type, female from Mullsjo, Sweden, in Lund).

*Phormia boganidae* Erichson, Middendorff's Reise in den Äussersten Norden und Osten Siberiens 1843-44, vol. 2, no. 1, p. 67, 1851; Rohdendorf, Ent. Mitt. 13 (6):283, 1924; Villeneuve, Soc. Ent. de Belg. Bull. et Ann. 70:42, 1930. (Type male in Zoological Museum of the Russian Academy of Science). New synonymy.

*Melinda atriceps* (Zetterstedt). Hendel, Wien. Ent. Ztg., 20:33, 1901.

*Onesia (Sarcophaga) atriceps* (Zetterstedt). Becker, Mem. Imp. Acad. Sci. St. Petersburg (8) 18 (10):5, 1907.

*Onesia atriceps* (Zetterstedt). Frey, Acad. Sci. Russ. Mem. 29 (10):3-5, 1915.

*Phormia caerulea* Malloch, Canadian Arctic Expedition Rpt., vol. 3, p. 59c, 1919. (Type, male from Bernard Harbour, Northwest Territories, in Canadian National Collection).

*Boreëllus aristatus* Aldrich and Shannon, Insecutor Inscitiae Menstruus 11:107, 1923. (New name for *caerulea* Malloch, preoccupied).

*Mallochomyia johanseni* Townsend, Insecutor Inscitiae Menstruus 14:25, 1926. (New name for *caerulea* Malloch, preoccupied).

*Phormia atriceps* (Zetterstedt), Collin, Ann. and Mag. Nat. Hist. 16:335, 1925; Ann. and Mag. Nat. Hist. (10) 7:78, 1931.

*Boreëllus atriceps* (Zetterstedt), Aldrich, Brooklyn Ent. Soc. Bul. 22:22, 1927; Johnson, Psyche 36 (2):141, 1929; McDunnough, Nat. Mus. Canada Bull. 53:119, 1928; Villeneuve, Soc. Ent. de Belg. Bull. et Ann. 70:42, 1930; Townsend, Rev. de Ent. 1:71, 1931; Enderlein, Gesell. f. naturf. Freunde



Sitzber. 4-7:245, 1925; Townsend, Manual of Myiology, vol. 5, p. 166, 1935.

A dark blue to bluish-black species with lustrous blue black abdomen, black head and appendages, and hyaline wings.

*Male.* Head (pl.3, C and D) with eye height 5.7; head height 8.4; length at antenna 6.1 and at vibrissa 6.9; bucca 0.44 of eye height, with long abundant black hair; front at narrowest 0.26 of head width, 0.40 at vertex and at lunule, mostly shining black but some thin gray pollen anteriorly, and with some long black thin hairs outside frontal bristles which are especially abundant on vertex and extend anteriorly to slightly above middle of parafaciale; faciale bristled about four-fifths the distance to the antennal base; frontal row of bristles consisting of from 10 to 12 long thin erect bristles which extend anteriorly to middle of the second antennal segment, the rows only moderately diverging anteriorly; inner vertical bristles long, hairlike, decussate; parafaciale narrowed above, with very thin pollen; palpus yellow orange, 4.0 in length; third antennal segment 2.2 times as long as second, brown to black; arista black, with short black plumosity for three-fourths its length; back of head with one well-defined and four to six ill-defined rows of postocular cilia and with abundant elongate black hair.

Thorax blue black with purple and green luster, with silvery pollen, and with darker dull black longitudinal stripes on prothorax which do not extend beyond scutellar suture; pleura shining, with thin gray pollen below; propleuron with dark hair; predorsocentral bristles long and erect, the hindmost posterior bristle placed 1.0 before suture; prosternum with scattered black setae; preparapton and greater ampulla with fine short decumbent white pubescence; postacrostichal bristles long and hairlike, only the preputellar strong; postdorsocentral bristles three strong, the second weak and sometimes absent but the row spaced for four; prothoracic and metathoracic spiracles with dark brown hair; scutellum with lateroapical discal bristle, under surface with fine brown hair.

Legs black, mostly shining; middle tibia with irregularly placed dorsal row of bristles and with a row of posterodorsal bristles; middle femur with two anterior bristles near middle, an irregular anteroventral row and a ventral row extending from base to near middle; middle tibia with four anterodorsal bristles, one near basal fourth, two near middle and one near apical fourth, two posterior bristles, one near basal fourth, the other near middle, and four posterodorsal bristles, two near basal fourth short and fine, and two near middle longer and stouter;

hind femur with anterodorsal and anteroventral rows and a partial ventral row on apical half; hind tibia with anterodorsal row extending from base to apical third, two anteroventral bristles near middle and a series of posterodorsal bristles, the basal ones set close together.

Wing (pl. 9, F) hyaline, slightly infuscated basally and anteriorly; costal sections 2 to 6 in the proportion 75:52:105:41:0; subcostal sclerite orange brown to black, with dark brown pile basally, and with long black hairs; third vein setulose from 0.25 to 0.35 the distance to the anterior cross vein; upper and lower squamal lobes with dark brown pile, brown.

Abdomen bluish black, rarely greenish and sometimes slightly purplish in certain lights, shining; all tergites with erect black hair; fifth sternite (pl. 20, D) as illustrated.

Genital segments similar to those of *Phormia regina*. Internal anatomical features (pl. 20, A, B, and C) as illustrated.

*Female*. Head width 11.7; length at antenna 6.7, and at vibrissa 7.5; eye height 5.8; head height 9.0; bucca 0.30 eye height; front at narrowest 0.46 head width, 0.46 at vertex and 0.52 at lunule; outer vertical bristles long and thin; fronto-orbital bristles two, long, thin, proclinate or almost divaricate; ocellar bristles slightly divaricate. Otherwise similar to male except for normal sexual differences.

*Length*. 6.5-8.5 mm.

*Distribution*. Holarctic: North of the Arctic Circle. From published reports and from specimens which have been seen during this study, *Boreëllus atriceps* (Zetterstedt) is evidently widely distributed in the northern part of the Holarctic Region. It is not commonly collected.

The above description was prepared from the following specimens: Three cotype specimens of *Boreëllus aristatus*, one male and two females (in poor condition) from Bernard Harbour, Northwest Territories, Canada (Canadian Arctic Expedition), May 1915 and 1916, and one male, Sigmia, Baffin Land, Aug. 2, 1897 (Schuchert and White), in the U. S. National Museum; one paratype male of *Phormia caerulea* from the type locality, one female, Umanak, Greenland, June 1, 1914 (M. C. Tanquary), one female, Nettiing Lake, Baffin Land, June 25, 1925 (J. D. Soper), and one male and one female, Greenland, in the American Museum of Natural History.

The first North American record of *atriceps* is that by Malloch (1919), who redescribed it under the preoccupied name *Phormia caerulea* from specimens collected at Bernard Harbour, Northwest Territories. Aldrich and Shannon (1923) proposed *aristatus*

as a new name for the species because of the preoccupation and selected it as the genotype of their new genus *Boreëllus*. Their specimens were Malloch's paratypes. Townsend (1926) proposed the name *Mallochomyia johanseni* for the same purpose. Townsend (1931, p. 71) gave the correct binomial after seeing the type of *atriceps*.

Collin (1925) distinguished between this species and *Phormia groenlandica* (Zetterstedt) and stated that the two were undoubtedly congeneric. The latter is a synonym of *Protophormia terrae-novae* (R.-D.). Villeneuve (1930, p. 42) indicated that the description given by Rohdendorf (1924) for *Phormia boganidae* Erichson exactly matches that for *Phormia atriceps* (Zetterstedt) and assumed that the species was synonymous with *Phormia terrae-novae*.

*Biology, habits, and immature stages.* Collin (1925) reports upon specimens reared from a dead fox in Greenland. It is saprophagous like *Phormia regina* (Mg.) and *Protophormia terrae-novae* (R.-D.). Larvae were collected from a walrus head during July at Dundas Harbor, Devon Island, Baffin Land, by A. J. Duval and C. O. Handley, U. S. Department of Interior. Pupae and adults from these, as well as larvae, were forwarded to the Bureau of Entomology and Plant Quarantine for identification too late for larval descriptions to be included in this work.

### PROTOPHORMIA TOWNSEND

*Protophormia* Townsend, Smithsn. Misc. Collect. 51(1803):123, 1908; Shannon, Wash. Ent. Soc. Proc. 28(6):119, 1926; Townsend, Manual of Myiology, vol. 5, p. 166, 1937. Genotype. *Phormia terrae-novae* Robineau-Desvoidy. (Monobasic.)

*Male and female.* Head (pl. 4, A and B) with length at vibrissa greater than at antenna; parafaciale narrowed and with minute scattered hairs above; faciale bristled for about three-fourths the distance toward antennal base; palpus long, clavate; third antennal segment about twice length of second; arista with long plumosity above and shorter plumosity below, for about two-thirds its length; back of head evenly rounded.

Thorax with disc of mesonotum conspicuously flattened; humeral bristles four; preintraalar bristles two or three; preacrostichal bristles absent or vestigial; predorsocentral bristles two, sometimes a weak third anterior to normal row; notopleural bristles two, sometimes a weak third between them; prosternum setose; prepapateron and greater ampulla with fine short de-

cumbent pubescence; postacrostichal bristles weak; postdorso-central bristles four to six, usually five; postintraalar bristles two or three; preintrapostalar bristle absent; mesothoracic spiracle long ovate; metathoracic spiracle triangularly ovate and normal, the anterior margin setulose; scutellum with one discal bristle, four lateral bristles and no apical bristles, the under surface with scattered hairs.

Legs with fore femur with anteroventral row of bristles; tarsi as long as tibia; claws and pulvilli as long as last tarsal segment.

Subcostal sclerite with long setae its full length; remigium setose basally below; only third vein setulose above; fourth vein bent at 90 degrees toward wing apex; apical cell widely open; anterior cross vein beyond middle of second section of fourth vein in proportion 5:4; posterior cross vein gently doubly arcuate; last section of fifth vein one-sixth as long as preceding section; upper squamal lobe pilose below and rounded; lower squamal lobe large, ovate, and bare.

Abdomen with scutellar depression extending about two-thirds the distance toward the posterior margin; intermediate segments without dorsal bristles; third segment with a marginal row of longer hairlike bristles; fourth segment with considerable long erect hair on dorsum; first sternite large, each successive sternite smaller.

Genital segments in general as described in *Phormia*.

#### *Protophormia terrae-novae* (Robineau-Desvoidy)

*Phormia terrae-novae* Robineau-Desvoidy. Essai sur les Myodaires, vol. 2, p. 467, 1830; Hough, Zool. Bull. (6):289, 1899; Hendel, Wien. Ent. Ztg. 20:30, 1901; Parker, Ent. News 28:281, 1917; Aldrich, Psyche 25:33, 1918; Parker, Ent. News 29(4):144, 1918; Malloch, Canadian Arctic Expedition Rpt., vol. 3, p. 59c, 1919; Weiss and Dickerman, N. Y. Ent. Soc. Jour. 29:144, 1921; Villeneuve, Soc. Ent. de Belg. Bull. et Ann. 68:148, 1928; Tao, Amer. Jour. Hyg. 7:752, 1927; Lundbeck, Diptera Danica, Vol. 7, p. 139, 1927; Roberts, Ent. Soc. Amer. Ann. 23:791, 1930; Patton and Cushing, Ann. Trop. Med. and Parasitol. 28(3):307, 1934. (Type from North America, in Paris or lost.)

*Musca groenlandica* Zetterstedt, Insecta Lapponica, p. 657, 1838; Diptera Scandinaviae, vol. 4, p. 1330, 1845. Bonsdorff, Finlanda Tvavingade Insekter, vol. 2, p. 149, 1866; Staeger, Naturhist. Tidsskr. (2)1:363, 1845; (*Calliphora*); Holmgren, Svenska Vetensk. Akad. Öfversigt af . . . Forhandl.

29(6):101, 1872; Verrall, Ent. Monthly Mag. 18:152, 1881; Strobl, Naturw. Ver. f. Steiermark, Mitt. 30:70, 1893; Pandellé, Rev. de Ent. 15:215, 1896; Riedel, Allg. Ztschr. f. Ent. 6:152, 1901; Neilsen, Meddelelser om Grønland, vol. 43, no. 2, p. 46, 1917. (Type, male and female from Westrobothnia, Lapland, apparently lost.)

*Lucilia terrae novae* Macquart, Diptères exotiques, sup. 4(2):224, 1851. (Type, female from Terre-Neuve, in Paris.) New synonymy.

*Phormia nigripalpus* Robineau-Desvoidy, Histoire Naturelle Diptères des Environs de Paris, vol. 2, p. 846, 1863. (Type, female from France, in Paris.) New synonymy.

*Pollenia groenlandica* (Zetterstedt). Rondani, Dipterologiae Italicae Prodromus, vol. 5, p. 194, 1862.

*Protophormia terrae-novae* (Robineau-Desvoidy). Townsend, Smithsn. Misc. Collect. 51:123, 1908; Shannon, Wash. Ent. Soc. Proc. 28(6):128, 1926; Townsend, Manual of Myiology, vol. 2, p. 168, 1935; *ibid.*, vol. 5, p. 166, 1937.

*Phormia groenlandica* (Zetterstedt). Engel, Ztschr. f. Wiss. Insektenbiol. 15(10-12):255, 1920; Mueller, Zool.-Bot. Gesell. Wien. Verhandl. 73:75, 1923; Arch. f. Naturgesch. 88:69, 1922; Collin, Ann. and Mag. Nat. Hist. (10)7(37):78, 1931; Collin, Ann. and Mag. Nat. Hist. (9)16(93):335, 1925.

*Phormia caerulea* Robineau-Desvoidy Bezzi, Katalog der Paläarktischen Dipteren, vol. 3, p. 530, 1907; Frey, Acad. Sci. Russ. Mem. 29(10):3-6, 19, 1915; Wainwright, Roy. Ent. Soc., London, Trans. 76:237, 1928; Böving, Wash. Ent. Soc. Proc. 27(2):32, 1925.

*Protocalliphora terrae-novae* (Robineau-Desvoidy). Séguy, Encycl. Ent. (A) 9:168, 1928.

A dark blue species with greenish-blue abdomen and black legs.

*Male.* Head (pl. 4, A and B) with eye height 8.2, head height 10.7; length at antenna 6.6 and at vibrissa 7.1; bucca 0.24 of eye height, buccal hairs black, abundant, long; frontale 0.4 of frontal width; front at narrowest 0.13 head width, 0.21 at vertex and 0.29 at antennal base, with thin gray pollen and some scattered hair outside frontal bristles which extend anteriorly to about the middle of the parafaciale; faciale bristled three-fourths the distance to the antennal base; frontal rows of bristles extending anteriorly to the base of the second antennal segment and narrowly diverging, each consisting of about 12 bristles which are hairlike posteriorly; inner vertical bristles long, decussate;

parafaciale with gray pollen; faciale with three or four rows of setae; palpus 4.0 in length, yellow orange; third antennal segment orange brown to black, 2.2 times as long as second; arista black, with black plumosity; back of head with one well-defined row of postocular cilia and three or four scattered rows, and with sparse whitish hairs of medium length.

Thorax blue green lustrous black, without pollinosity, and with darker dull black longitudinal stripes on dorsal prothorax which extend but slightly beyond suture; pleura shining; propleuron with dark hair in center; hindmost predorsocentral bristles placed 1.0 before suture; postacrostichal bristles and postdorsocentral bristles with only prescutellars strong; mesothoracic spiracle with some long black setae; scutellum with the under surface with very fine white hair and only the basal and angular lateral bristles strong.

Legs black and shining; fore tibia with a complete dorsal row of bristles; middle femur with three or four anterior bristles near middle, a row of short fine anteroventral bristles on apical half, one long thin ventral bristle near middle, and scattered fine posteroventral bristles, usually one slightly before middle, one slightly beyond middle and often one near basal third (a pre-apical bristle might be considered to belong in the row), one posterior bristle near apical fourth, and two posterodorsal bristles, one near basal fourth and one slightly beyond middle; hind femur with scattered dorsal, anterodorsal, and anterior bristles, complete anteroventral and ventral rows, and with scattered posteroventral bristles; hind tibia with a complete antero-dorsal row, with three anteroventral bristles, the first near middle, the third near apical fourth, and with two posterodorsal bristles near middle.

Wing (pl. 9, G) hyaline, slightly infuscated basally; costal sections 2 to 6 in the proportion 60:53:108:41:47; subcostal sclerite brownish black; third vein setulose for 0.40 the distance toward the anterior cross vein; fourth vein usually without but sometimes with a very short fold at angle; upper squamal lobe brown, with black setae below; lower squamal lobe brown.

Abdomen shining, dark bluish green to black tending toward dark greenish blue or purplish in certain lights.

Genital segments with internal anatomical features (pl. 20, E and F) as illustrated.

*Female.* Bucca 0.33 eye height; frontale 0.6 frontal width; front at narrowest 0.37 head width, 0.37 at vertex and 0.44 at antennal base; outer vertical bristles two-thirds as long as inner; frontoorbital bristles two of medium size, both proclinate; ocellar

bristles divaricate. Otherwise similar to male except for normal sexual differences.

*Length.* 6.5-12.5 mm.

*Distribution.* Holarctic: This species occurs in considerable numbers in northern Europe, Asia, Alaska, and Canada. It occurs less abundantly in the United States but has been collected as far south as central Texas and northern Georgia. In the western part of the United States the species may be collected at high altitudes during the summer.

The inner and outer forceps of the species vary somewhat in length, but are usually about equal. Northern specimens are usually darker, more purplish and show less tendency toward yellow orange on the antennal segments and at the vibrissal angle than do southern specimens, but reared material from a single egg mass shows both types of coloration. Northern specimens may be more distinctly bristly, and these bristles are apparently more erect and hairlike. Several specimens have been seen in which the remigium on one side lacks cilia below.

Bezzi (1907) accepted the name *caerulea* Robineau-Desvoidy (1830) as having precedence over *terrae-novae*, which is described further on the same page. There appears to be no justification for this action. Robineau-Desvoidy (1849, p. 4) stated that his *caerulea* and *regina* were male and female of *dispar* Dufour (1845), which is a synonym of *azurea* Fallen (1816), although that conclusion has not been supported by later investigations.

There are no apparent differences between numerous specimens which have been determined as *Phormia groenlandica* (Zetterstedt) by various authors and the species considered here as *Protophormia terraenovae* (Robineau-Desvoidy).

*Biology, habits, and immature stages.* Egg as in *Phormia* but larger and more elongate, slightly curved, the chorion longitudinally fluted.

*Larva.*<sup>1</sup> First instar: Dorsopharyngeal sclerites broad; hypostomal sclerite with anterior portions bent sharply dorsally; dorsal and ventral prolongations longer than in *Phormia*; labial sclerite composed of one median hook with two short rods and groups of tooth-like structures basally. Complete anterior spinose bands on segments 2-9; annulus incomplete on tenth, absent dorsally on eleventh, and restricted to ventral region on part of lateral surface; narrow posterior ventral bands present on segments 6-11, the last with a few dorsal spinose rows; lateral fusiform areas on segments 6-10. Spines not heavily sclerotized; dome- and wedge-shaped. No tubercles on posterior end.

<sup>1</sup>Adapted from Tao (1927).

Second instar: Cephaloskeleton more heavily sclerotized, and the dorsal and ventral cornua closer together than in *Phormia*, with two labial sclerites. Anterior spiracles each with 10 to 12 branches. Posterior spiracles each with two ovate apertures, the plates broader transversely than longitudinally, closer together than in *Phormia*. Six tubercles on upper and four on lower portions. Segments 2-11 with complete anterior spinose bands; posterior bands on segments 10 and 11; posterior bands ventrally on segments 6-9. Lateral fusiform areas on segments 5-8. Spines almost all wedge-shaped, with two or three points, and arranged in short rows.

Third instar: As in second and third instars of *Phormia regina* except as noted. Posterior spiracles (pl. 37, F) as illustrated.

*Puparium*. With external characters of mature larva.

This saprophagous species is seemingly the northern counterpart of *Phormia regina*, which is not abundant north of the Canadian Border. It is an early spring species in the United States, although occasional specimens may be collected in the summer months. I have collected *terrae-novae* in considerable numbers on flowers of wild parsnip during early July in northern Michigan, but never in southern Ohio. It occurs in Utah from March 27 to June 29 at altitudes of 4,000 to 6,000 feet, being most abundant there during the last week in May; but specimens may be collected in high altitudes as far south as southern California during June, and it is not uncommon in Colorado above 7,000 feet during July and August. During July *terrae-novae* is a very abundant species in the subarctic region especially in southern Alaska, Greenland, and in the vicinity of Hudson Bay, Canada.

*Economic importance*. In Alaska *terrae-novae* is the common blowfly during the summer season; it acts much the same as *Phormia regina* in Texas. In western North America, where it sometimes attacks soiled wool of sheep, it is the "black blowfly" of various authors. In Alaska, Hadwen and Palmer (1922) stated that larvae attack living reindeer and often kill the animal. In the northern Middlewest it is often found to be the cause of myiasis in dehorned cattle and in docked lambs during early spring months. In Scotland it is found in the role of a "primary" blowfly in cases of myiasis in sheep during the early part of the season; it sometimes occurs along with *Phaenicia sericata* according to MacLeod (1937). Larvae of *terrae-novae* have been reported as parasites of nestling birds in Europe by Séguy (1929), but not in North America.



## APAULINA, NEW GENUS

(Bird nest screwworm flies)

*Protocalliphora* Hough, Ent. News 10:66, 1899 (in part); Bezzi, Parasitol. 14:32, 1922; Shannon, Insecutor Inscitiae Menstruus 11:107, 1923; Shannon and Dobroseky, Wash. Acad. Sci. Jour. 14:249, 1924; Dobroseky, Biol. Bull. 48(4):275, 1925; Shannon, Wash. Ent. Soc. Proc. 28(6):128, 1926; Séguy, Encycl. Ent. (A) 9:161, 1928; Encycl. Ent. (BII.) Dipt. 5:63, 1929; Townsend, Manual of Myiology, vol. 2, p. 168, 1935; *ibid.*, vol. 5, p. 166, 1937.

*Phormia* (*Protocalliphora*). Villeneuve, Soc. Ent. de Belg. Bull. et Ann. 68:148, 1928; Konowia 10:72-73, 1931 (in part).

The genus *Protocalliphora* Hough does not occur in North America. North American bird parasites previously included by various authors in this genus should be referred to *Apaulina* since they differ from species of the Palearctic genus *Protocalliphora* by the characters given in following key.

1. Middle of postalar declivity without tuft of hair or setae; tympanic membrane or pit bare; scutellum without apical bristles (except in *sapphira*); remigium without cilia basally below; fore tibia usually with one posterior bristle. . . . . *Apaulina*, new genus.

Middle of postalar declivity with tuft of hair in middle; tympanic membrane or pit setose; scutellum with apical bristles; remigium basally below with cilia; fore tibia with two posterior bristles. . . . . *Protocalliphora* Hough.

In addition to the above characters, species of *Apaulina* appear to be considerably smaller and with heavier silver pollen than the species of *Protocalliphora*.

*Male and female.* Head (pl. 4, C) wider than high; length at oral margin and at vibrissa approximately equal; metacephalogenly rounded in profile, and only slightly produced behind; bucca less than one-third eye height and with numerous setae; front narrowed on middle in male, wider and the margins nearly parallel in female, facial carina absent; parafaciale hirsute in middle above; faciale with two or three rows of ascending bristles; vibrissae above oral margin by 0.4 to 0.75, somewhat approximated and slightly closing epistoma which is gently warped forward from the clypeal plane; palpus clavate; antennal bases at or near eye-middle when head is viewed in profile, bases approximated; arista with penultimate segment as long as

diameter, thickened only at base and uniformly tapering to apex, with long plumosity for fully three-fourths its length; back of head evenly rounded; slightly concave above occiput especially in male, with one well-defined and several ill-defined rows of postocular cilia.

Thorax with preacrostichal bristles strong; posthumeral bristles present; notopleural bristles two; sternopleural bristles three, the lower anterior bristle always weak but very rarely absent; hypopleuron bare on anterior half or more; prosternum narrow, laterally setose; postalar declivity bare; squamopleuron, ampullae and preparapteron covered with fine short decumbent pile; postintraalar bristles three; preintrapostalar bristle present; postsupraalar bristles three; mesothoracic spiracle elongate-oval and of moderate size; metathoracic spiracle angularly rounded and of moderate size; scutellum with subbasal and apical lateral bristles long and strong and usually with three lesser lateral bristles, subapical discal bristles present, apical bristles absent (except in *sapphira*).

Legs with hind coxa bare posteriorly; fore tibia with one posterior bristle at or near apical third (except in *sapphira*); fore femur with dorsal, posterodorsal and posteroventral rows of bristles; middle femur with two or three short anterior bristles near middle and with one long thin anteroventral bristle near basal fourth; hind tibia with posterodorsal row of bristles.

Wing (pl. 9, H) with subcostal sclerite setose; remigium basally below bare; third vein setose at base; fourth vein bent angularly toward wing apex; apical cell open and ending considerably before wing apex; anterior cross vein oblique and at or near middle of second segment of fourth vein; posterior cross vein doubly arcuate; last section of fifth vein one-fourth to one-fifth as long as preceding section; upper squamal lobe small, rounded apically, bare of black hair; lower squamal lobe large, elongate-oval, convex on inside margin, rounded apically, bare.

Abdomen without discal or median marginal bristles; the third and fourth segments each with a marginal row of bristles.

Genital segments of male globose, black, setose, the first without a marginal row of bristles.

*Genotype.* *Protocalliphora avium* Shannon and Dobrosky (1924).

Several North American authors have published notes upon the habits of North American species of *Apaulina* under the name *Protocalliphora chrysorrhoea* (Meigen). Hendel (1901a, p. 210) indicated that Meigen's description applies to a different genus from Schiner's and that Meigen's species might be an

*Onesia*. The accuracy of the determinations by these authors cannot now be established. It is probable that Banks (1912) had *sialia*. Many of Walton's specimens reported upon in 1915 have not been located, but those that are in the National Museum are *sialia* and *hirudo*.

The species of *Apaulina* are well distributed throughout the northern part of the United States and southern Canada. At least one species occurs in Alaska; but no species of *Apaulina* has been noted south of Virginia. In response to a request for such information several southern ornithologists have stated that they have never observed nests of birds infested with species of *Apaulina*. In addition Mr. H. J. Reinhard, Entomologist, Texas Agricultural Experiment Station, informs me that there are no southern specimens of *Apaulina* in either his collection or that of the Texas Experiment Station. It would appear that some of these parasites should occur considerably further south in the United States than the present records indicate; many of the species of birds in the following list nest as far south as Arkansas. For instance, the yellow-breasted chat, which may appear as early as April 10 in northwestern Arkansas, nests frequently in that area.

It is obvious that the forms of *Apaulina* are very closely related taxonomically and biologically. Some of the species are so close that they can be separated only with considerable difficulty. Different species are often reared from a single nest and such series may not always indicate a proper association of the sexes if different but closely related species are involved. Our knowledge of the taxonomy of the entire group is especially restricted by the lack of specimens from known strains. The present study has been made from series of specimens reared from nests of birds or from specimens collected in the field in hand nets, and it is impossible to know the range of variation within a single species or whether diversity considered of specific value in this study is genetic or caused by ecological conditions.

The first segregations made in this study were based principally upon the differences in the male genitalia; differences in head structure were then correlated with these. Additional specific differences were found in chaetotaxy in several instances, or, finally, color differences were utilized as supplementary characters for the separation of the species.

There are apparently three species groups of *Apaulina* in North America. The first includes *avium*, *basingeri*, and perhaps *sapphira* which apparently belongs here on head structure although the genital structure is similar to that found in *metal-*

*lica*; it is aberrant in either group. The second group includes only *hirudo*, which lacks reclinate fronto-orbital bristles in the female and has different habits in the larval stages. The third group includes *metallica* and its allies, these differing from each other in minor head proportions and in coloration. The true interpretation of the American species may have been shown by Shannon when he divided the forms into three species and grouped the rest of the segregates around these as varieties and subspecies. It is possible, however, that there are many more than three species and that the groups mentioned should have subgeneric rank.

*Biology, habits, and immature stages.* Since the habits of all the species are more or less similar, all available notes are briefly summarized here.

Members of both *Apaulina* and *Protocalliphora* are obligatory, bloodsucking parasites upon nestling birds. Eggs are deposited singly or in small masses in new nests. The larvae are nocturnal in habit and are apparently intermittent feeders. The larval period is from 10 to 13 days. When the larvae mature, they either pupate within the debris in the bottom of the nest or drop to the ground and pupate in the soil. The method of hibernation is not known. According to Dobrosky (1925) the species probably overwinter as adults; they may be similar to *Phormia* in this respect.

Certain types of bird nests seem to be preferred by females of *Apaulina*, those of passerine birds apparently being most attractive. Mason (1936) was able to show quantitative figures proving the tree swallow to be the preferred host in New England and the blue bird the second choice. He suggested that these preferences were due to differences in nest construction. There seems to be no question that hole-nesting species suffer greatly from these parasites and that nests built upon the ground or in the open rarely contain specimens of *Apaulina*. This explains, at least in part, the large percentage of hole-nesting species in the following host list. It is usually necessary to observe nestlings within nests in order to secure records of parasitism of those species which build in trees or in shrubbery.

*Apaulina metallica* was found in large numbers in nests of *Riparia riparia riparia* in New York State by Dayton Stoner (1936). He stated that the larva of this fly is the most injurious external parasite of the bank swallow in this region. The larvae seemed to confine their activities largely or entirely to young birds in nests, particularly in late June and throughout July. Their occurrence appeared to vary considerably, and to be

dependent upon local, seasonal, or possibly other conditions. As many as 77 larvae were found upon one nestling. These were well distributed over the young birds, prevalent particularly in auricular openings, on rumps or on wings. Such parasitized nestlings often had the bases of the tail feathers matted with excrement and had blood oozing from wounds made by the mouthparts of the larvae. The soles of the feet and the skin between the bases of the toes seemed to be especially vulnerable. As many as three larvae were taken from the external ear opening of one bird; two engorged larvae were taken from the external nasal passage of another bird. Stoner discovered that these larvae might be found upon fledgling bank swallows throughout the day. The feeding larvae were not easily detached and the birds evidently made no effort to remove larvae from themselves or from each other.

Opinions regarding effects of *Apaulina* larvae upon birds differ considerably. Appreciable injury to nestlings does not always result from attacks by these parasites according to McAtee (1929), Thomas (1939), and Sargent (1938). But they are considered to be a serious menace to fledglings by Plath (1919), Johnson (1929), and Mason (1926). Important intangible effects were noted by Mr. Edward S. Thomas in a letter, dated January 9, 1940, who contends that the larvae of *Apaulina* might be a contributing factor to nest desertion and that they may weaken some nestlings to an extent that their chances of survival might be seriously affected after leaving their nests.

Mason (1936) pointed out that in New England there is a coincidental emergence of both *Apaulina* and its pupal parasite *Mormoniella* about the middle of June.

The following species of birds<sup>1</sup> have been reported to be hosts of various species of *Apaulina*.<sup>2</sup>

- Accipiter cooperi* (Bon.), Cooper's Hawk
- Asio wilsonianus* (Less.), Long-eared Owl
- Bombycilla cedrorum* Vieill., Cedar Waxwing

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<sup>1</sup>This list indicates that almost every family of Passeriformes is affected by species of *Apaulina*, and it is probable that almost every species will be found to be similarly affected. It will be observed that the nests of the species concerned are of considerably diverse habitat, in a wide range of climate, and of very different nest construction. It will also be seen that although many of the species of other orders are parasitized, the number may be limited, at least in part, by the construction of the nest.

<sup>2</sup>These records have been secured from the literature and the specific name of the parasite and the data secured from the rearing have been omitted. There appears to be little, if any, host specificity, and it is probable that any of the species of *Apaulina* will attack any of the above hosts within its own range of distribution.

*Buteo borealis borealis* (Gmel.), Red-tailed Hawk  
*Buteo lineatus lineatus* (Gmel.), Red-shouldered Hawk  
*Buteo swainsoni* Bon., Swainson's Hawk  
*Carpodacus mexicanus frontalis* (Say), Common House Finch  
*Carpodacus purpureus californicus* Baird, California Purple

## Finch

*Corvus brachyrhynchos brachyrhynchos* Brehm, Eastern Crow  
*Dendroica aestiva brewsteri* Grinn., California Yellow Warbler  
*Dendroica caerulescens caerulescens* (Gmel.), Black-throated

## Blue Warbler

*Dendroica discolor discolor* (Vieill.), Northern Prairie Warbler

*Dumetella carolinensis* (L.), Catbird

*Helmitheros vermivorus* (Gmel.), Worm-eating Warbler

*Hirundo erythrogaster* Boddaert, Barn Swallow

*Hylocichla ustulata ustulata* (Nutt.), Russet-back Thrush

*Icteria virens virens* (L.), Yellow-breasted Chat

*Iridoprocne bicolor* (Vieill.), Tree Swallow

*Lanius ludovicianus gambeli* Ridge., California Shrike

*Melospiza melodia melodia* (Wil.), Eastern Song Sparrow

*Melospiza melodia beata* Bangs, Mississippi Song Sparrow

*Melospiza medodia morphna* Ober., Rusty Song Sparrow

*Melospiza georgiana* (Lath.), Swamp Sparrow

*Mimus polyglottos leucopterus* (Vig.), Western Mocking Bird

*Myiarchus crinitus boreus* Bangs, Northern Crested Flycatcher

*Otocoris alpestris occidentalis* McCall, Montezuma Horned

## Lark

*Passer domesticus domesticus* (L.), English Sparrow

*Passerina cyanea* (L.), Indigo Bunting

*Penthestes atricapillus atricapillus* (L.), Black-capped Chickadee

*Petrochelidon albifrons albifrons* (Raf.), Northern Cliff Swallow

*Pica pica hudsonia* (Sab.), American Magpie

*Pipilo maculatus oregonus* Bell, Oregon Towhee

*Pipilo fuscus crissalis* (Vig.), California Brown Towhee

*Piranga erythromelas* Vieill., Scarlet Tanager

*Progne subis subis* (L.), Purple Martin

*Psaltriparus minimus minimus* (Tns.), Coast Bush-Tit

*Richmondia cardinalis cardinalis* (L.), Eastern Cardinal

*Riparia riparia riparia* (L.), Bank Swallow

*Sayornis saya saya* (Bon.), Say's Phoebe

*Sialia sialis sialis* (L.), Bluebird

*Spinus psaltria hesperophilus* (Ober.), Greenbacked Goldfinch

- Spinus tristis salicamans* Grinn., Willow Goldfinch  
*Spizella arborea arborea* (Wilson), Eastern Tree Sparrow  
*Spizella passerina passerina* (Bech.), Eastern Chipping Sparrow  
*Sturnus vulgaris vulgaris* L., Starling  
*Thryothorus ludovicianus ludovicianus* (Lath.), Carolina Wren  
*Toxostoma rufum* (L.), Brown Thrasher  
*Troglodytes aedon aedon* Vieill., Eastern House Wren  
*Turdus migratorius propinquus* Ridg., Western Robin  
*Tyrannus vociferans* Swain., Cassin's Kingbird  
*Zenaidura macroura marginella* (Wood.), Western Mourning Dove  
*Zonotrichia albicollis* (Gmel.), White-throated Sparrow  
*Zonotrichia leucophrys leucophrys* (Forst.), White-crowned Sparrow  
*Zonotrichia leucophrys nuttalli* Ridg., Nuttall's Sparrow

The names used above are as given in "Check List of North American Birds," American Ornithologists' Union, Lancaster, Pa., Ed. 4, 1931, and further checked by Dr. Herbert Friedmann, Curator of Birds, United States National Museum.

***Apaulina aenea* (Shannon and Dobrosky), new combination**

*Protocalliphora splendida* variety *aenea* Shannon and Dobrosky, Wash. Acad. Sci. Jour. 14:251-252, 1924; Curran, Ontario Ent. Soc. Ann. Rpt. 55:101, 1924; Johnson, Boston Soc. Nat. Hist. Occas. Papers 7(15):216, 1925. (Type, female from Franconia, N. H., No. 26860, U. S. National Museum.)

Body of female bright aeneous green and the squamal lobes orange brown in both sexes.

*Male.* Head height 10.5; head width 13.7; length at antenna and at vibrissa 7.0; eye height 8.8; front at narrowest 0.06 head width, 0.13 at vertex and 0.32 at lunule; parafaciale opposite lunule narrower than width between vibrissae in proportion of 1.2:2.0; bucca 0.23 eye height; squama infuscated, particularly on rim. Similar to male of *metallica* in coloration, chaetotaxy, and male genitalia.

*Female.* Head height 9.5; head width 13.0; length at antenna and at vibrissa 6.5; eye height 7.8; front at narrowest (at vertex) 0.24 head width, 0.41 at lunule; parafaciale narrower than width between vibrissae in proportion of 1.6:2.0; bucca approximately 0.23 eye height; squama yellowish white to orange. Body bright

yellow green with bronze luster and covered with whitish pruinosity. Otherwise similar to female of *metallica*.

*Distribution.* Nearctic: Widespread from central California to British Columbia and eastward to New England but evidently not abundant anywhere.

In addition to the original type series, there are four specimens of *aenea* in the National Museum collection reared from nests of the swallow *Petrochelidon albifrons albifrons*, during August and September 1937, Kamloops, British Columbia (G. J. Spencer), and four specimens reared from a sparrow fledgling, July 2, 1936, Hamilton, Mont. (C. B. Philip).

***Apaulina avium* (Shannon and Dobrosky), new combination**

*Protocalliphora avium* Shannon and Dobrosky, Wash. Acad. Sci. Jour. 14:250, 1924; West, in Leonard, Mem. 101, Cornell Univ., p. 827, 1928; Jellison and Philip, Canad. Ent. 65(1): 26-31, 1933. (Type, male from Ithaca, N. Y., No. 26856, U. S. National Museum.)

*Protocalliphora avium* var. *asiovora* Shannon and Dobrosky, Wash. Acad. Sci. Jour. 14:250, 1924. (Type, male from McElroy Lake, Wash., No. 26858, U. S. National Museum.)  
New synonymy.

Parafrontale wide in both sexes; the outer forceps of the male half as wide as long.

*Male.* Head length at vibrissa 8.0 and at antenna 9.0; eye height 9.25; head height 12.5; head width 15.0; bucca 0.27 of eye height and with abundant rather short and stubby black hair; frontale black, 0.60 frontal width; front at narrowest 0.15 head width, 0.23 at vertex and 0.40 at lunule, black, with light yellow to golden pollen, and with several rows of small setae outside frontal row of bristles which descend to below the middle of the second antennal segment, none near eye margin; frontal bristles about 12, these shorter and more hairlike toward vertex, the rows slightly divergent and extending anteriorly almost to the base of the second antennal segment; parafaciale about 0.46 clypeal width and widening above, opposite lunule wider than distance between vibrissae in proportion of 3.6:3.2, black, with thin silvery yellowish pollen and with scattered setae above; faciale bristled one-half the distance to antennal base with two rows of short stout setae; palpus 3.5 in length, yellowish orange; second antennal segment orange red; third antennal segment 1.6 times as long as second, dark orange



brown; back of head with one well-defined and three or four ill-defined rows of postocular cilia and with considerable scattered whitish yellow hair.

Thorax blue black, metallic purplish and blue green, with thin gray pollen which is particularly noticeable immediately behind head on dorsum, and with three to five black stripes, the middle stripe extending to the apex of the scutellum; pleura with thin silver pollen; propleuron with long tawny hair; preintraalar bristles with hindmost one placed anterior to suture by 0.5; preacrostichal bristles three, the hindmost placed 0.5 before suture; predorsocentral bristles four, the hindmost placed 1.0 before suture; postacrostichal bristles four, long and strong, often with fifth bristle between first and second and the row spaced for six; postdorsocentral bristles with row spaced for four bristles but the second often weak and sometimes absent; mesothoracic spiracle with dark yellow or tawny hair; metathoracic spiracle with dark yellow hair, the anterior edge with or without long black hair; scutellum with one discal bristle and one subapical discal bristle and with scattered short white hair below.

Legs black, middle femur with one anteroventral bristle at basal fifth, and a posteroventral row extending from base to apical fourth; middle tibia with one subapical dorsal bristle, three anterodorsal bristles, one at basal fourth, one near middle, and one near apical fourth, one ventral bristle near apical third, two posterior bristles, one near basal third and one near apical third, sometimes a third bristle in this series slightly basad of these, and with two posterodorsal bristles near basal third; hind femur with one dorsal subapical bristle and with anterodorsal, anteroventral and posteroventral rows of bristles; hind tibia with anterodorsal row of long and strong bristles, one dorsal subapical bristle, four anteroventral bristles in a row on apical half, and a row of four posterodorsal bristles.

Wing hyaline, somewhat brownish basally and toward costa; costal sections 2 to 6 in the proportion 90:52:127:37:9; subcostal sclerite dark orange brown to black, with black setae; third vein setulose two-fifths the distance to cross vein; fourth vein with a short fold or section at the right-angled bend, the vein then gently curving toward wing apex; anterior cross vein at or near middle of second section of third vein; posterior cross vein gently doubly arcuate; upper and lower squamal lobes white.

Abdomen colored as in *metallica*; scutellar depression extending about three-fourths the distance to the hind margin of first tergite; fourth segment with scattered erect bristles of medium

length; first sternite large, following sternites successively smaller. Fifth sternite (pl. 21, B) as illustrated.

Genital segments with internal anatomical features (pl. 21, A and C) as illustrated.

*Female.* Head height 11.5; eye height 7.6; head width 15.5; length at antenna 8.0 and at vibrissa 7.0; bucca 0.34 eye height; front at narrowest (at vertex) 0.30 head width, 0.42 at lunule; frontale approximately 0.70 frontal width, and usually with interfrontal bristles; parafrontale and parafaciale usually with dull bronzy golden pollen; outer vertical bristles about two-thirds as long as inner ones; frontoorbital bristles two proclinate and one reclinate; parafaciale at middle one-half as wide as clypeus and wider than distance between vibrissae in proportion 2.4:1.8 opposite lunule. Abdomen usually with heavier white pollen than in male. Otherwise similar to male except for normal sexual differences.

*Length.* 6-10 mm.

*Distribution.* Nearctic: Northern United States and southern Canada; apparently most abundant in the northeastern Great Plains region.

No differences have been found to support the distinctness of the variety *avium asiovora* Shannon and Dobrosky, which was based upon one male from the state of Washington in the U. S. National Museum. As stated by Shannon, this variety is darker in color than the typical *avium*, the basicosta is lighter in color, the mesonotal hairs are longer, and the outer forceps are somewhat truncate apically. A long series of specimens from Montana exhibit characters intermediate between the typical *avium* and its supposed variety *asiovora*. Northwestern and northern specimens of most calliphorids often are darker in color, the orange parts therefore appearing lighter by contrast. The hair of northern specimens is often longer, thinner, and more erect. In spite of these apparent differences I hesitate to use the varietal name until additional material has been examined.

*Biology, habits, and immature stages.* Eggs are deposited in small masses in newly constructed nests of passerine birds. The individual egg is apparently undescribed.

*Larva.* Third instar: Length 10-15 mm., greatest diameter 3-5 mm., of typical blowfly larva habitus, creamy white to slightly brownish in color, usually with an internal reddish tinge when first collected due to presence of avian blood. Each segment with integument covered with numerous minute single-pointed spines, these longer on anterior segments and especially abundant and longer along segmental margins; first segment

rounded, nearly bare and without trace of oral grooves; second segment flattened, with the spines arranged in rows and increasing in length toward margin. Cephaloskeleton (pl. 38, B) heavily sclerotized and pigmented; labial sclerites small, strongly curved, nearly triangular; hypostomal sclerites slightly longer than hooks, broad, strong; parastomal sclerite broad, shortened; ventral cornua broad, short, without longitudinal rows on ventral margin; dorsal cornua long and strong. Respiratory system with anterior spiracles each with seven or eight apertures in fan-shaped arrangement; posterior spiracles (pl. 38, A) each with three well-defined, nearly parallel apertures, the innermost aperture set slightly apart from other two, "button" nearly transparent but still distinct, peritreme nearly indistinct ventrally but well defined dorsally, ovate below but nearly round above. Anal segment subtruncate, the spiracles in a shallow cup-shaped mid-dorsal cavity which is margined by six low bare anal protuberances, these distinctly marked by encircling rows of minute spines.

*Pupa.* With most of the external characters of the mature larva; 7-10 mm. in length and 3.5-4 mm. in diameter; of typical calliphorid habitus.

According to Dobroseky (1925), the larva of *avium* was described and illustrated under the name *Protocalliphora azurea* (Fallen) by Coutant (1915), who collected larvae from nests of *Corvus brachyrhynchos brachyrhynchos* Brehm (Eastern Crow), at Ithaca, N. Y. Coutant states that these larvae were intermittent feeders on the blood of this host and that such larvae may be found crawling about through the feathers of nestling birds. He was not able to rear such larvae to maturity by feeding them upon solid flesh, either fresh or decayed.

Jellison and Philip (1933) stated that every occupied nest of magpie and crow examined by them in the Bitterroot Valley, southwestern Montana, contained *avium* larvae, as many as 373 larvae being taken from a single magpie nest. These larvae were confined to the fibrous mass of rootlets and stems which line such nests and to the accumulation of very dry scaly duff that had sifted through this mass to the tight mud-plastered floor. The larvae were not found on or near the fledglings, but bright red blotches of undigested blood showed plainly in the foregut. Larvae were dissected and stained smears of gut contents showed nucleated erythrocytes of avian blood. The pupal period of 983 reared specimens was found to average 11.02 days at room temperature (approximately 24° C.) during May and June. Jellison and Philip said "The nests of magpies and crows appear to offer

an optimum type of habitat for *Protocalliphora avium*, and it is possible that these birds are the usual hosts, while in nests of smaller, beneficial species, the parasites may be injurious and even fatal to nestling birds as reported in the literature. Certainly, the magpie nestlings observed by us appear healthy and of good flesh, with only minute lacerations on the breast to indicate feeding by the generous infestations of maggots present."

The pupal parasites *Muscidifurax raptor* Girault and Sanders, *Mormoniella vitripennis* (Walker), and *Morodora armata* Gahan have been reported as having been reared from *avium*, the latter species being originally described as supposedly from this host.

#### *Apaulina basingeri*, new species

The head and genitalia of the male of this species shows it to be closely related to *avium*, from which it differs in having the front and parafaciale narrower.

*Male.* Head height 10.6; length at antenna and at vibrissa 7.2; eye height 7.8; front at narrowest 0.14 head width, 0.17 at vertex and 0.36 at lunule; head width 13.5; parafaciale opposite lunule and distance between vibrissae in the proportion 2.0:2.2; parafrontale and parafaciale black with dull gray pollen; basal segments of antenna orange; coloration and chaetotaxy as in *avium*. Genital segments with internal features (pl. 21, D) as illustrated.

*Female.* Head height 10.0; length at antenna and at vibrissa 7.0; eye height 7.5; front at narrowest (at vertex) 0.28 head width, 0.40 at lunule; head width 13.5; parafaciale opposite lunule and distance between vibrissae in the proportion 2.0:1.9; parafrontale and parafaciale either with dull silvery or brassy pollen. Otherwise similar to male except for normal sexual differences.

*Length.* 7-9.5 mm.

*Type.* Male, No. 54929, U. S. National Museum.

*Type locality.* San Diego, Calif.

The type series consists of the following specimens: Three males, including the holotype, June 28, 1917, San Diego, Calif. (J. M. Aldrich); four males, June 4, 1936, Temecula, Calif., two females, from nest of house finch, July 1936, Anaheim, Calif., one male, September 20, 1934, Corona, Calif., two males, May 18, 1934, Forest Home, Calif., and one female, May 4, 1934, Riverside, Calif. (A. J. Basinger); two males and three females, from nest of mourning dove, June 10, 1938, Le Grande, Calif. (J. A. Neff); one male, July 4, 1929, San Diego, Calif., one male,

July 22, 1935, Sargent, Calif., one male, June 24, 1935, Lockwood, Calif., and three males, July 6, 1929, Laguna, Calif. (R. H. and Jack Beamer).

*Apaulina cuprina*, new species

The male of *cuprina* is similar to the male of *metallica* in coloring and in the genitalia, but it differs from that species, by having the squamal lobes infusate, and in head proportions. The female of *cuprina* has the fourth abdominal segment similar to that of *metallica* except that it is highly polished.

*Male.* Head height 10.3; length at antenna and at vibrissa 6.8; eye height 8.3; front at narrowest 0.06 head width, 0.15 at vertex and 0.30 at lunule; head width 13.8; parafaciale opposite lunule and distance between vibrissae in the proportion 1.5:2.2; parafaciale and parafrontale black, with thin gray (sometimes brassy) pollen; coloration and chaetotaxy as in *metallica*, but the squamal lobes infusate, the rims strongly so. Genital segments with internal features as in *metallica*.

*Female.* Head height 9.1; length at antenna 6.8 and at vibrissa 6.4; eye height 7.5; front at narrowest (at vertex) 0.26 head width, 0.37 at lunule; head width 12.9; width of parafaciale opposite lunule and distance between vibrissae in the proportion 1.8:1.9; middle femur with two or three (more often two) anteroventral bristles toward base; body color and chaetotaxy as in *metallica* but the third abdominal segment often, and the fourth segment always, highly polished, and the squamal lobes are tinged with yellow or orange. Otherwise as in male except for normal sexual differences.

*Length.* 6-9 mm.

*Type.* Male, No. 54930, U. S. National Museum.

*Type locality.* Riverside, Calif.

The type series consists of the following 23 male and 35 female specimens: 28 females and 17 males, reared from House Finch, Goldfinch, and Phoebe nests, May and June, 1936, Riverside, Calif. (A. J. Basinger); 5 males and 3 females from the nest of a wild canary, June 1935, Ravalli County, Mont. (W. L. Jellison); 1 male, Mt. Moscow, Idaho, July 1, 1932, (J. M. Aldrich); 2 females, "Ex nest of western robin," Seattle, Wash., (O. E. Plath); 1 female, Mt. Hood, Ore., July 29, 1921, (A. L. Melander); 1 female, Marys Peak, Oregon (A. L. Lovett).

This species has usually been determined as *splendida* or *metallica*, especially in western states. Part of the series of specimens upon which Plath (1919) reported are this species. It

is probable that many of the reports of *splendida*, *metallica*, or *aenea* from western states are *cuprina*.

*Apaulina hesperia* (Shannon and Dobroscky), new combination

*Protocalliphora hesperia* Shannon and Dobroscky, Wash. Acad. Sci. Jour. 14:251-252, 1924. (Type, male from Ainsworth, British Columbia, No. 26861, U. S. National Museum).

This species appears to be closely related to *metallica* as indicated by Shannon. The general form of the male genitalia is similar to that of *metallica*, but the outer forceps are wider and the inner forceps seem to be more heavily sclerotized. Other differences are noted in the description and key.

*Male*. Head width 14.0; head height 11.2; length at antenna and at vibrissa 6.5; eye height 8.7; bucca 0.24 eye height; front at narrowest 0.7 of head width, 0.14 at vertex and 0.35 at lunule; parafaciale opposite lunule less in width than distance between vibrissae in proportion 0.8:2.0; squamal lobes infuscated; coloration and chaetotaxy mainly as in *metallica*. Male genital segments (pl. 21, E and F) as illustrated.

*Female*. Head width 12.5; head height 9.7; length at antenna 7.0 and at vibrissa 6.2; eye height 7.0; bucca 0.26 eye height; front at narrowest (at vertex) 0.27 head width, 0.40 at lunule; parafaciale opposite lunule less in width than in distance between vibrissae in proportion 1.6:1.8; coloration as in female of *sialia*. Otherwise similar to male except for normal sexual differences.

*Distribution*. Neartic: Northwestern United States and western Canada.

In addition to the type series, I have seen one male, reared from a puparium collected in a nest of *Petrochelidon albifrons albifrons* (Raf.) (Northern Cliff Swallow), September 3, 1936, at Kamloops, British Columbia, by G. J. Spencer, and a long series of both sexes collected from nests of Goldfinch and Phoebe, May and June, 1936, in southern California, by A. J. Basinger.

*Apaulina hirudo* (Shannon and Dobroscky), new combination

*Protocalliphora hirudo* Shannon and Dobroscky, Wash. Acad. Sci. Jour. 14:252, 1924. (Type, male reared from warbler's nest in Colorado, No. 26862, U. S. National Museum).

?*Protocalliphora hirudo* var. *cuprea* Shannon and Dobroscky, Wash. Acad. Sci. Jour. 14:253, 1924; Johnson, Bull. N. E. Birdbanding Assoc. 1:53, 1925; Boston Soc. Nat. Hist. Oec. Papers 7(15):216, 1925; Bull. N. E. Birdbanding As-

soc. 5:30, 1929; Ent. Soc. Amer. Ann. 22:133, 1929; Boston Soc. Nat. Hist. Bull. 59:21, 1931. (Type, female from Puget Sound, Wash., reared from *Turdus migratorius propinquus* (Western Robin), No. 26863, U. S. National Museum).

?*Protocalliphora hirudo* var. *parva* Shannon and Dobrosky, Wash. Acad. Sci. Jour. 14:253, 1924. (Type, male from Colorado, No. 26864, U. S. National Museum.)

A small species with habitus and general color of *metallica* but with different head proportions and reclinate frontoorbital bristles absent in the female.

*Male.* Head width at greatest 11.2; length at antenna and at vibrissa 6.0; eye height 7.5; head height 9.0; bucca 0.21 eye height, with thin gray pollen; frontale extremely narrow, obliterated at narrowest, but one-half frontal width at lunule; front at narrowest 0.05 of head width, 0.12 at vertex and 0.33 at lunule, with thin yellow-golden to bronze-colored pollen, and with some scattered setae extending anteriorly to tip of second antennal segment; frontal bristles about 12, thin and hairlike near middle and nearly obsolete posteriorly, the rows extending anteriorly to the base of the second antennal segment, and moderately divergent anteriorly as they follow the margins of the frontale; vertex shining black; parafaciale opposite lunule 0.20 clypeal width, 0.5 the distance between vibrissae; faciale bristled one-third the distance to antennal base with two or three rows of setae; vibrissae above oral margin by 0.4 and separated by 2.0; palpus orange yellow; second antennal segment brown to black; third segment one and three-fourths times as long as second, reaching four-fifths the distance to the vibrissa, reddish brown; back of head with one well-defined and two or three ill-defined rows of postocular cilia and with abundant whitish-yellow hairs.

Thorax greenish metallic blue to lustrous black, with thin whitish pollen which is especially noticeable immediately behind head on dorsum, and with darker black longitudinal lines extending slightly posterior to suture; propleuron with yellowish brown hairs; preintraalar bristles four, the posterior bristle placed 0.60 before the suture; preacrostichal bristles three strong, with a smaller fourth often present, the hindmost bristle placed before the suture by 1.0; predorsocentral bristles three, and usually with a weaker fourth, the hindmost bristle placed anterior to suture by 1.0; notopleural bristles two, sometimes with a weaker third; selerites at wing base with whitish pubescence; postacrostichal bristles four, all strong; mesothoracic spiracle a little smaller than normal in *Apaulina*, with orange to brown hair; metathoracic spiracle with orange to orange brown hair; post-

dorsocentral bristles four, sometimes only three apparent with the second weak (rarely with two or three adventitious bristles in the row but the row always spaced for four); under surface of scutellum with fine whitish yellow setae.

Legs black, middle femur with three bristles near middle anteriorly, and four or five basal ventral bristles in row; middle tibia with two anterodorsal bristles near middle, one ventral bristle near apical fourth; two posterior bristles, one near basal fourth and the other near apical fourth, and one posterodorsal bristle near apical third; hind femur with anterodorsal, anteroventral and posteroventral rows, and with one dorsal subapical bristle; hind tibia with bristles of irregular size, anterodorsal row usually represented by two longer bristles, posterodorsal row with about five bristles, anteroventral row apically with about three bristles, and one dorsal subapical bristle.

Wing hyaline, lightly infuscated basally and anteriorly; costal sections 2 to 6 in the proportion 70:40:90:30:2; basicostal scale bright orange; third vein setulose from one-third to one-half the distance to the cross vein; fourth vein with or without an extremely short fold or stump at the angle, bent at about 45 degrees toward apex of wing; posterior cross vein only slightly doubly arcuate; last section of fifth vein one-fifth preceding section; upper and lower squamal lobes infuscated.

Abdomen metallic bluish green to black, with thin silver pollen; scutellar depression extending four-fifths the distance to the hind margin of first tergite; third and fourth tergites each with a row of weak marginal bristles; first sternite longer than broad, each successive sternite shorter and narrower.

Genital segments about as described in *Apaulina metallica*. Internal features (pl. 21, G) as illustrated.

*Length.* 6-8 mm.

*Distribution.* Nearctic: Colorado and New Mexico.

The type male and the allotype female were reared from puparia collected in a warbler's nest in Colorado (M. A. Palmer); one paratype male was reared from a maggot collected in a sparrow or goldfinch nest in Colorado (W. W. Arnold); two males and two females were reared from larvae found as subcutaneous parasites of a horned lark nestling at Koehler, N. Mex. (Webster No. 7707, W. R. Walton).

Walton (1915), in discussing a collection of *Apaulina* (among which was this species), stated, "This fly was reared from a fledgling of horned lark (*Otocaris alpestris*) by Mr. Wildermuth, June 11. The larvae were contained in purulent sores on the



sides of the body near the legs and on the neck. The bird, although weak and emaciated, was able to flutter away after the maggots were removed. It was first discovered by John R. Sandige.”

The variety *hirudo cuprea* was described by Shannon and Dobrosky from a female which differed from the typical form in being yellow green with metallic bronze luster, and covered with whitish pollen, about as in *aenea*. I find no other differences. Perhaps male specimens might show distinctions; but, until such specimens have been found and differences noted, it seems best to synonymize the name with *hirudo*. Johnson (1925, 1929, and 1931) reported the rearing of two maggots of this variety from the neck of a sparrow at Middleboro, Mass., but I have seen no eastern specimens of *hirudo*.

The variety *hirudo parva* was described by Shannon and Dobrosky from one male and one female. The female lacks the middle and hind legs and the abdomen, and the male head and part of the thorax have become lost; neither, therefore, is suitable for further description. Except for the lack of a weak third notopleural bristle, the subspecies *hirudo parva* fits the description given for *hirudo* by Shannon and Dobrosky. However, since so many important parts of the two specimens are lacking, I am not able to draw definite conclusions. The specimens are very small, due possibly to insufficient larval food, and bristle development is often considerably reduced under such conditions. The squamae are infused with orange brown. The type locality given for *hirudo parva* is Kansas, but this is an error. Dr. L. L. Adams originally received these specimens from S. W. Williston, who collected the material at Greeley, Colo. Adams sent the material to Aldrich and he passed it on to Shannon.

Two specimens, one male and one female, reared from larvae collected under the skin of nestling yellow warblers, at Fort Collins, Colo. (Mrs. S. H. Fry), pupated June 28, 1911, and emerged as adults July 10, 1911. The male differs slightly in head proportions and the female in color, but in all other characters these specimens agree with the typical form.

The three varieties were separated by Shannon and Dobrosky by means of the following characters.

1. General color dark, with rather heavy pruinosity..... 2  
General color bronze.. *hirudo cuprea* (Shannon & Dobrosky)
2. Squama darkened... *hirudo hirudo* (Shannon & Dobrosky).  
Squama white..... *hirudo parva* (Shannon & Dobrosky).

***Apaulina hirundo* (Shannon and Dobrosky), new combination**

*Protocalliphora splendida* var. *hirundo* Shannon and Dobrosky, Wash. Acad. Sci. Jour. 14:251-252, 1924. (Type, male from Stratford, Wash., No. 26859, U. S. National Museum).

*Male.* Head width 13.0; head height 10.2; eye height 9.0; length at antenna 6.6 and at vibrissa 6.1; bucca 0.19 eye height; parafaciale opposite lunule as wide as distance between vibrissae in proportion 1.6:1.6; front at narrowest 0.10 head width, 0.19 at vertex and 0.34 at lunule; with coloration and chaetotaxy of *sialia* and *metallica*. Male genital segments with internal features (pl. 22, A and B) as illustrated.

*Female.* Head width 13.0; head height 10.0; eye height 7.7; length at antenna 6.6 and at vibrissa 6.2; parafaciale opposite lunule as wide as distance between vibrissae in proportion 2:2; front at vertex (which is narrowest) 0.28 head width, 0.38 at lunule; coloration of *sialia*. Otherwise as in male except for the normal sexual characteristics.

*Distribution.* Nearectic: Washington and British Columbia.

The type series, comprising three males and five females, was collected from a nest of *Petrochelidon albifrons albifrons* (Raf.) (Northern Cliff Swallow), on July 4, 1920, by R. C. Shannon, who found many of the nests examined to contain dead young birds. Five specimens were reared from larvae collected in a nest of the same host on August 16, 1937, at Kamloops, British Columbia, by G. J. Spencer.

***Apaulina metallica* (Townsend), new combination**

?*Calliphora splendida* Macquart, Diptères exotiques, sup. 1, p. 196, 1846; Harbeck, Ent. News 18:216, 1908. (Type, female from Galveston, Tex., apparently lost).

*Phormia metallica* Townsend, Ent. Soc. Amer. Ann. 12:376, 1919. (Type, female from Fredonia, N. H., in U. S. National Museum).

*Protocalliphora metallica* (Townsend) Bezzi, Parasitol. 14:33, 1922; Shannon, Insecutor Inscitiae Menstruus 11:107, 1923.

*Protocalliphora splendida* (Macquart) Shannon and Dobrosky, Wash. Acad. Sci. Jour. 14:252, 1924; Johnson, Boston Soc. Nat. Hist. Occas. Papers, 7(15):216, 1925; Bull. N. E. Birdbanding Assoc. 1:53, 1925; Séguy, Enc. Ent. Dipt. 2:86, 1925; Woods, Bull. N. E. Birdbanding Assoc. 2:12, 1926; Johnson, Bull. N. E. Birdbanding Assoc. 3:2, 1927; Lloyd, Canad. Field Nat. 12:3, 1927; West, in Leonard, Mem. 101,

Cornell Univ., p. 826, 1928; McAtee, Wash. Ent. Soc. Proc. 31 (6):107-111, 1929; Johnson, Ent. Soc. Amer. Ann. 22: 133, 1929; Johnson, Boston Soc. Nat. Hist. Bull. 59:23, 1931; Whitehead, Jour. Econ. Ent. 26:293, 1933; Johnson, Bird-banding 3:26, 1932.

*Male.* Head (pl. 4, C) length at vibrissa and at antenna 7.0; eye height 8.7; head height, 12.0; head width 14.5; bucca 0.24 eye height, buccal hairs black, abundant, of moderate length; frontale 0.72 frontal width; front at vertex 0.13 head width, 0.07 at narrowest and 0.33 at lunule, with dull silvery or lead-colored pollen and a considerable number of scattered setae to below the middle of parafaciale; frontal bristles about 10, those toward vertex considerably weaker, the rows extending anteriorly only to base of second antennal segment and gradually diverging; parafaciale one-third clypeal width, of about equal width above and below, black, with slightly yellowish silvery pollen, and with scattered setae above but none immediately near eye; faciale bristled nearly halfway to antennal base with two or three rows of short setae; palpus 3.4 in length, yellow orange; third antennal segment 1.5 times as long as second, dark brown to black; arista with long cilia above and shorter cilia below, the plumosity extending four-fifths the distance to the apex; back of head with one well-defined row and two or three ill-defined rows of postocular cilia, and with abundant scattered whitish-yellow hair.

Thorax blue black with metallic bluish-green areas in some lights, with thin gray pollen (except immediately behind head on pronotum where it is densely white or silvery), and with three to five black stripes which extend to slightly beyond suture; pleura lightly dusted with silvery pollen; propleuron with black or brownish-black setulae; preintraalar bristles three, the hindmost placed closer to the suture than the hindmost presupraalar bristle; preacrostichal bristles three, strong, the posterior bristle placed before the suture by 0.5; predorsocentral bristles three or four, the foremost weak and sometimes absent, the posterior bristle placed before the suture by 1.4; notopleural bristles two; preparapтерon and greater ampulla with white pubescence; postacrostichal bristles four, strong; postdorsocentral bristles four, the second weak, sometimes absent; mesothoracic spiracle small, with yellow-brown hair; the anterior margin with or without long hair; scutellum with fine short white hair below.

Legs black, middle femur with two anterior bristles near middle, one or two (more often one) strong anteroventral bristles at basal fourth, and with a row of long thin posteroventral

bristles, these shorter and more closely set apically; middle tibia with four anterodorsal bristles, three toward middle and basally and one on apical half, this one the strongest, and with two posterior bristles, one near middle, the other on apical half; hind femur with complete rows of bristles on anterodorsal and anteroventral surfaces, a partial posteroventral row of bristles toward base, and one dorsal apical and one posterodorsal subapical bristle; hind tibia with complete anterodorsal and posterodorsal rows of bristles and three anteroventral bristles near middle and apically.

Wing (pl. 9, H) hyaline, lightly infuscated toward base; costal sections 2 to 6 in the proportion 81:42:92:40:7; subcostal sclerite orange to brown, with fine short white pubescence at base, setose apically; remigium bare posteriorly below; third vein setose one-half the distance to the anterior cross vein; fourth vein angled at about 80 degrees and then curving toward apex of wing; anterior cross vein at middle of second section of fourth vein; posterior cross vein doubly arcuate; last section of fifth vein one-fourth preceding section; upper and lower squamal lobes white.

Abdomen blue black with reddish violet reflections, with thin gray pollen; scutellar depression extending four-fifths the distance toward the posterior margin of the first segment; third and fourth tergites each with a marginal row of bristles; fourth tergite with numerous long setae; first sternite about as long as broad; each successive sternite narrower. Fifth sternite (pl. 22, D) as illustrated.

Genital segments about as in *Phormia regina*. Internal features (pl. 22, C and E) as illustrated.

*Female.* Head length at vibrissa and at antenna 6.5; eye height 8.2; head height 10.0; head width 14.0; bucca 0.22 eye height; frontale bare and 0.62 frontal width; front at vertex (narrowest) 0.27 head width and 0.34 at lunule; parafrontale and parafaciale with silvery pollen, definitely tinged with brown, a darker brown or silvery-brown spot opposite lunule; parafaciale 0.30 clypeal width; a row of small setae outside frontal row; vertex subpollinose; frontal rows strongly divergent anteriorly; outer vertical bristle about two-thirds as long as inner; fronto-orbital bristles two proclinate and one reclinate. Fourth abdominal segment bronze or metallic bronze in color; entire abdomen more heavily pollinose and tending more toward bluish green than in male. Otherwise similar to male except for normal sexual differences.

*Length.* 7-9 mm.

Female specimens of *cuprina* which have the squamae only slightly tinged with yellow will run to *metallica* in the key, but females of *metallica* have the anteroventral surface of the middle femur with one or two (usually only one) bristles toward the base.

*Distribution.* Nearctic: Most abundant in northeastern United States but occurring rarely as far south as Virginia and even more rarely as far west as California; not common.

As noted by Townsend in 1919, Coquillett identified this form as *Calliphora splendida* Macquart. He was followed in this by Aldrich and Shannon, who used the combination *Protocalliphora splendida* (Macquart). Macquart's species, said to be from Galveston, Tex., was described as being 5 lines (10 mm.) long, with the thorax and scutellum black, the abdomen greenish blue with tip golden, the basal antennal segments short and fuscous, and the wing fuscous on the costal border. An unsuccessful attempt was made to locate the type of *Calliphora splendida* Macquart. So far as can be ascertained, species of *Apaulina* do not occur in Texas and specimens rarely approach 10 mm. in length. Masquart's description of *splendida* does not accurately cover the species known under the name of *splendida* in North America and because of this the name *metallica* Townsend is used for this form. It would not be surprising to find the Macquart type an entirely different species for, aside from the golden fourth abdominal segment, the description will fit many of the larger species discussed in this paper.

*Biology, habits, and immature stages.* *Larva.* Third instar: Length 8-12 mm., greatest diameter 2.5-4.0 mm. Translucent pearly white; freshly fed larvae with reddish tinge, migrating larvae brownish. Cephalic segment nearly bare; second segment (pl. 38, D) with a fringe of elongate and narrowed setae on posterior margin; each successive segment with numerous spinose bands of minute single-pointed setae, these least numerous at segmental lines. Posterior spiracles above median line (pl. 38, C) in the weak posterior depression, small, separated by a distance equal to two or three times the greatest diameter of one spiracle; anterior spiracle with eight or nine radially-arranged apertures. Cephaloskeleton (pl. 38, E) with small labial sclerites which are not strongly curved ventrally; hypostomal sclerite strongly sclerotized; parastomal sclerite rather short and thick; pharyngeal sclerite strongly sclerotized; no longitudinal ridges or grooves on ventral cornua.

The third-instar larva of *metallica* differs from that described for *avium* chiefly in that body spines are smaller, the rows of

spines on the second segment are set more closely together, and the individual spines in these rows are longer and more hairlike.

Whitehead (1933) collected 121 puparia of this species from a nest of purple martins in Quebec; the chalcidoid parasite *Mormoniella vitripennis* (Walker) was reared from 92.74 percent of them.

### *Apaulina sapphira*, new species

This interesting little species differs from the typical *Apaulina* in having two posterior bristles on the front tibia and in having apical bristles on the scutellum. These characters are found in *Protocalliphora*, but not in other species of *Apaulina*. In other respects its affinities are definitely with *Apaulina*. The proportions of the head are similar in many respects to those in *avium*, but the parafaciale is considerably narrower.

*Male*. Head height 9.0; length at antenna and at vibrissa 6.0; eye height 6.5; bucca 0.33 eye height; front at narrowest 0.15 head width, 0.21 at vertex and 0.43 at lunule; head width 11.4; parafaciale opposite lunule and distance between vibrissae in proportion 1.8:1.8; parafrontale with golden pollen; entire head black, vertex shining; antenna black, second segment orange red at apex, third segment only a little longer than second; palpus orange brown.

Thorax metallic blue black; propleuron with a few distinct black hairs; predorsocentral bristles three, strong in presutural bristles only; scutellum with one discal bristle and with minute apical bristles.

Legs with fore tibia with two posterior bristles, one near middle and one near apical third; middle tibia with three posterior and three posterodorsal bristles.

Wing hyaline.

Abdomen bright metallic blue green with purple reflections, with whitish pollen, this changing under shifting illumination; with a mid-dorsal longitudinal shining stripe.

Genital segments apparently similar to those of *hesperia*, the outer forceps being about four times as long as broad.

*Female*. Head height 8.5; length at antenna and at vibrissa 6.0; eye height 6.4; bucca 0.31 the eye height; head width 11.0; front at narrowest (vertex) 0.30 head width, 0.43 at lunule; parafaciale opposite lunule equal in width to distance between vibrissae. Otherwise similar to male except for normal sexual differences.

*Length*. 7.5 mm.

*Type*. Male, No. 53264, U. S. National Museum.

*Type locality* Naknek Lake, Alaska.

One male and two females (paratypes) were collected at Savonoski, Naknek Lake, Alaska, August 1, 1919 (J. S. Hine). These three specimens were included in *sialia* by Shannon (1924, p. 252).

***Apaulina sialia* (Shannon and Dobroscky), new combination**

*Protocalliphora splendida* variety *sialia* Shannon and Dobroscky, Wash. Acad. Sci. Jour. 14:251, 1924; Johnson, Boston Soc. Nat. Hist. Occas. Papers 7 (15):216, 1925; West in Leonard, Mem. 101, Cornell Univ., p. 827, 1938; Johnson, Psyche 34:33, 1927; Ent. Soc. Amer. Ann. 22:132, 1929; Birdbanding 1:169, 1930; Birdbanding 3:26-28, 1932; McAttee, Wash. Ent. Soc. Proc. 31 (6):105, 1929. (Type and type locality not stated).

*Male.* Head width 13.8; head height 11.0; length at antenna 7.0 and at vibrissa 6.5; eye height 9.0; bucca approximately 0.20 eye height; front at narrowest 0.08 head width, 0.16 at vertex and 0.31 at antennal base; parafaciale opposite lunule and distance between vibrissae equal, 1.7:1.7; propleural hair often yellowish brown, legs with three posterodorsal bristles on middle tibia as in *avium*, but with two anterodorsal bristles, one near middle, the other near apical fourth, two posterior bristles, and two posterodorsal bristles. Otherwise apparently similar to *metallica*. Genital segments (pl. 22, F) as illustrated.

*Female.* Head width 14.0; head height 10.5; length at antenna 7.5 and at vibrissa 6.5; eye height 7.5; bucca 0.30 eye height; front at narrowest (vertex) 0.26 head width and 0.40 at lunule; parafaciale opposite lunule equal in width to distance between vibrissae, 1.8:1.8. Body coloration differing from typical *metallica* in having abdomen completely dark bluish black, the apical segment not bronzy metallic. Otherwise similar to male except for usual sexual differences.

*Length.* 6-8.5 mm.

*Distribution.* Nearctic: North of Virginia in the United States to southern Canada, apparently most abundant in the north-eastern sections of the United States.

This species is found in many collections determined as *Protocalliphora splendida* (Macquart) or *Phormia chrysorrhoea* (Meigen). The male genitalia show it to be closely related to *metallica*. The female is easily separated from *metallica* on the basis of color differences, but the male is separated from *metallica* and *aenea* only with considerable difficulty.

## SUBFAMILY CALLIPHORINAE

The typical bluebottle and greenbottle flies belong to this subfamily. All the species have the prosternum and the propleuron setulose, the parafaciale bare on the lower third or more, and are without crinkly hair on the thorax. The presence or absence of pile on the upper surface of the lower squamal lobe divides the subfamily into the tribes Luciliini and Calliphorini in North America. While the two tribes appear to be very dissimilar upon superficial examination, and certain authors have accorded each subfamily rank, well-defined characters to separate them have not been found. Characters supporting supergeneric differentiation are often difficult to find and such groups become less distinct as additional material is studied. It is possible, however, to indicate the relationships among the several genera in the Calliphorinae by the following tribal characterizations: The Luciliini includes small to average-sized, somewhat shining bronzy green (color plate III) or blue-green to purple species. The tribe Calliphorini includes small to large species with pollinose thoraces and shining to pollinose metallic greenish to bluish abdomens (color plate IV). Most of the species belonging to this subfamily are saprophagous, although a few are parasitic upon toads or earthworms, and several others may be found as tertiary blowflies in cases of myiasis.

It must be remarked here that representatives of this subfamily are not abundant in the tropics. Not only are there few species but those that may be found there are not particularly abundant. Of all of the species included herein, only a few of the species of *Phaenicia*, one of the genus *Calliphora*, and *Cynomyopsis cadaverina* (R.-D.) apparently occur in Central America. Of the last two species, these apparently occur with frequency only in the Mexican highlands. I did not see them in the mountains of Guatemala, Honduras, or Nicaragua.

The North American representatives of this subfamily possess the following characters in common.

*Male and female.* Head width greater than head height; epistoma warped forward from clypeal plane; bucca usually high in relation to eye height; vibrissae at or but slightly above the oral margin and well separated; faciale convex in profile; eye ovate and set more or less obliquely in head; outer vertical bristles (cf. *Eucalliphora*) and proclinate frontoorbital bristles usually absent in male; parafaciale bare on lower fifth or more; postocellar and postvertical bristles weak and proclinate; front-



ale longitudinally striate; arista with long cilia above and below, the tip often bare.

Thorax without long crinkly hair; propleuron setose; notopleural bristles two; mesopleuron bare on anterior fourth; sternopleuron bare on anterior fifth; prosternum setose; pteropleuron bare on anterior half or slightly less; intrapostsutural and intrapostsupraalar bristles absent; scutellum without apical bristles.

Legs of moderate length; hind coxa bare posteriorly.

Wing with remigium bare above and below; only third vein setulose and this only at base; fourth vein ending in costal margin considerably below wing apex; apical cell clearly open; upper squamal lobe rounded, small, bare; lower squamal lobe large, posterior margin often wide.

Abdomen oviconical to ovate, often considerably more conical in male than in female.

*Larva.* Second instar with labial sclerite enlarged toward tip. Third instar with posterior spiracle with complete peritreme or ring in which there is a distinct "button."

#### KEY TO SPECIES OF NORTH AMERICAN CALLIPHORINAE

1. Lower squamal lobe bare above; parafaciale usually entirely bare; parasquamal tuft present; arista usually with cilia almost to apex. Larva without accessory oral sclerite between labial sclerites. . . . . (Luciliini, p. 211) 2
- Lower squamal lobe pilose above; parafaciale usually partially setose; parasquamal tuft absent; arista with or without cilia apically. Larva with accessory oral sclerite between labial sclerites. . . . . (Calliphorini, p. 271) 15
2. Vibrissa above oral margin; arista with penultimate segment short, the cilia long above and below; preintraalar bristles three; back of head in male flattened or concave in profile. . . . . 3
- Vibrissa at oral margin; arista with penultimate segment from one and a half to two times as long as its diameter and with rather short cilia above and below; preintraalar bristles two; back of head in male rounded in profile (Alaska) *Francilia alaskensis* Shannon, p. 213
3. Subcostal sclerite with only short soft pubescence; ocellar triangle not reaching halfway to lunule in female. . . . 4
- Subcostal sclerite with wiry bristles; ocellar triangle large, reaching halfway to lunule in female (Holaretic). . . . .  
*Lucilia illustris* (Meigen), p. 224

*base of scapula*

4. Length of head at antenna and at vibrissa more than half head height; second abdominal segment with long and erect median marginal bristles..... 5  
 Length of head at antenna and at vibrissa less than half head height; second abdominal segment without median marginal bristles..... 6
5. Two postacrostichal bristles; front at narrowest 0.14 of head width in male, 0.35 in female. (Nearctic).....  
 .....*Bufolucilia elongata* (Shannon), p. 216  
 Three postacrostichal bristles; front at narrowest 0.08 of head width in male, 0.31 in female, (Holarctic).....  
 .....*Bufolucilia silvarum* (Meigen), p. 219
6. Three postacrostichal bristles ..... 7  
 Two postacrostichal bristles..... 9
7. Male with but one ocellar bristle and front rarely exceeding 0.12 of head width; bucca in both sexes greater than 0.25 eye height, metasternum setose, and body color light or dark blue green..... 8  
 Male with two proclinate ocellar bristles, the posterior bristle weak; front at narrowest 0.18 of head width in male; bucca in both sexes about 0.25 eye height, metasternum bare, and body color aeneous or yellowish green. (Nearctic) *Phaenicia pallescens* (Shannon), p. 247
8. Male with front at narrowest 0.11 of head width, parafaciale opposite lunule 0.66 of width between vibrissae, bucca 0.34 of eye height; female with frontal margins nearly parallel, front 0.34 of head width; bucca 0.38 of eye height. (Holarctic).....  
 .....*Phaenicia sericata* (Meigen), p. 259  
 Male with front at narrowest 0.05 of head width, parafaciale opposite lunule 0.33 of distance between vibrissae, and bucca 0.28 of eye height; female with front 0.32 of head width at vertex, the frontal margins narrowing anteriorly so that front is but 0.31 of head width slightly above lunule, and the bucca but 0.27 of eye height. (Nearctic) *Phaenicia thatuna* (Shannon), p. 269
9. One row of postocular cilia; second abdominal segment with a weak row of marginal bristles.....10  
 Two or more rows of black postocular cilia; second abdominal segment without a row of marginal bristles. (Nearctic) *Phaenicia mexicana* (Macquart), p. 243

10. Male with eyes obviously separated, front at vertex at least 0.13 of head width, eye facets not enlarged; female with bucca 0.25 eye height or more, parafaciale opposite lunule less than 0.40 the distance between vibrissae; color in both sexes bright green, blue green or olivaceous green. . . . . 11  
 Male with eyes narrowly contiguous and front at vertex but 0.10 of head width, the eye facets enlarged dorsally; female with bucca 0.30 of eye height, parafaciale opposite lunule 0.40 the distance between vibrissae; color in both sexes deep blue to red violet, the third and fourth abdominal segments shining. (Neotropical) . . . . . *Phaenicia purpurescens* (Walker), p. 254
11. Male with one reclinate frontoorbital bristle slightly anterior to foremost ocellus; female with black hair anteriorly on parafrontale outside frontal row of bristles. 12  
 Male without frontoorbital bristles; female with pale hair anteriorly on parafrontal outside frontal row of bristles . . . . . 13
12. Length of head at antenna and at vibrissa nearly equal; male with parafaciale opposite lunule 0.7 in width; female with bucca 0.25 of eye height and margins of front converging anteriorly; legs black in both sexes. (Nearctic) . . . . . *Phaenicia caeruleiviridis* (Macquart), p. 232  
 Length of head at antenna less than at vibrissa; male with parafaciale opposite lunule 1.2 in width; female with bucca less than 0.25 eye height and frontal margins not converging anteriorly; legs orange brown in both sexes. (Neotropical) *Phaenicia problematica* (Johnson), p. 253
13. Parafaciale orange to orange brown in ground color; male with front very narrow, 0.03 to 0.04 of head width; female with parafaciale opposite lunule not more than 0.46 distance between vibrissae. . . . . 14  
 Parafaciale black in ground color; male with front at narrowest 0.10 of head width; female with parafaciale opposite lunule 0.61 of distance between vibrissae. (Nearctic and Neotropical) . . . . . *Phaenicia cluvia* (Walker), p. 236
14. Bucca with black hair, no pale hairs before the metacephalic suture; middle tibia with two posterior bristles and one posterodorsal bristle. (Neotropical and Nearctic) . . . . . *Phaenicia eximia* (Wiedemann), p. 239

- Bucca with dark hair dorsally and anteriorly, pale yellowish brown hair anteriorly and posteriorly; middle tibia usually without posterior bristles and two or three posterodorsal bristles. (Neotropical).....  
 ..... *Phaenicia rica* (Shannon), p. 257
15. Faciale with strong ascending bristles; accessory ocellar bristles present .....16  
 Faciale without strong ascending bristles; accessory ocellar bristles absent.....17
16. Front at narrowest 0.21 of head width in male, 0.38 in female (Nearctic) . . *Eucalliphora lilaea* (Walker), p. 284  
 Front at narrowest 0.18 of head width in male, 0.32 in female (Nearctic) *Eucalliphora arta*, new species, p. 287
17. Scutellum with four or more strong lateral bristles; arista usually with long cilia almost to apex.....18  
 Scutellum with three strong lateral bristles; arista usually ciliate only three-fourths the distance to the apex..25
18. Hindmost preintraalar bristle present.....19  
 Hindmost preintraalar bristle absent (Holarctic).....  
 ..... *Aldrichina grahmi* (Aldrich), p. 290
19. Three postintraalar bristles .....20  
 Two postintraalar bristles .....21
20. Bucca reddish and 0.44 of eye height; front of male 0.13 of head width; parafaciale opposite lunule in female 0.89 of distance between vibrissae. (Nearctic).....  
 ..... *Calliphora coloradensis* Hough, p. 294
- gene* ← Bucca black and 0.32 of eye height; front of male 0.05 of head width; parafaciale opposite lunule in female 0.52 of distance between vibrissae. (Nearctic).....  
 ..... *Calliphora livida*, new species, p. 296
21. Bucca entirely black; basicosta black; male with front at narrowest from 0.04 to 0.06 of head width.....22  
 Bucca reddish on anterior half or more; basicosta often yellow to yellow orange; male with front at narrowest 0.09 to 0.10 of head width. (Holarctic).....  
 ..... *Calliphora vicina* Robineau-Desvoidy, p. 307
22. Cheek grooves yellow to orange red.....23  
 Cheek grooves black (Nearctic).....  
 ..... *Calliphora mortica* Shannon, p. 299

23. Base of wing not strongly darkened; rims of squamal lobes whitish; male genital segments of moderate size.....24  
 Base of wing strongly blackish; rims of squamal lobes dark brown to black; male genital segments large and globose (Neotropical).....  
 ..... *Calliphora peruviana* Robineau-Desvoidy, p. 301
24. Bucca 0.37 of eye height in male, 0.54 in female, black, with hair mostly black; length of head at antenna 0.87 that at vibrissa in both sexes; middle tibia usually with two posterior bristles. (Nearctic).....  
 ..... *Calliphora terrae-novae* Macquart, p. 303  
 Bucca 0.47 of eye height in male, 0.65 in female, black, with mostly reddish-orange hair which is most abundant posteriorly; length of head at antenna and at vibrissa nearly equal in male, but antennal length 0.94 of the vibrissal length in female; middle tibia usually with three posterior bristles. (Holartic).....  
 ..... *Calliphora vomitoria* (Linnaeus), p. 313
25. Abdomen clearly pollinose; second abdominal segment usually with row of strong, erect marginal bristles; lower squamal lobe rounded on posterior margin.....26  
 Abdomen somewhat shining, often without trace of pollen; second abdominal segment without, or with a weak, appressed marginal row of bristles; lower squamal lobe rather wide and truncate posteriorly.....33
26. Epistoma nearly as wide as clypeus; fourth vein with a distinct angle beyond bend; fifth sternite of male large, produced ventrally in profile; male genital segments large, the second segment nearly twice as long as wide .....27  
 Epistoma well narrowed from the clypeal width; fourth vein nearly straight beyond bend; fifth sternite of male small, not produced ventrally; male genital segments rather small, the second segment hardly longer than wide .....32
27. Parafaciale orange in ground color on lower half or more..28  
 Parafaciale entirely black in ground color.....29
28. Hindmost preintraalar bristles absent. (Nearctic).....  
 ..... *Acronesia abina*, new species, p. 274  
 Hindmost preintraalar bristles present. (Nearctic).....  
 ..... *Acronesia anana*, new species, p. 278

29. Squamal lobes white.....30  
 Squamal lobes brown .....31
30. Second abdominal tergite with a marginal row of strong bristles; third tergite with strong discal bristles. (Nearctic).....*Acronesia collini*, new species, p. 279  
 Second abdominal tergite with a marginal row of strong bristles; third tergite without strong discal bristles. (Nearctic).....*Acronesia popoffana* (Townsend), p. 280
31. Middle tibia with three anterodorsal bristles; hind tibia with two anteroventral bristles; back of head with mostly black hair (Nearctic).....  
 .....*Acronesia aldrichia* (Shannon), p. 277  
 Middle tibia with one or two anterodorsal bristles, usually with but one; hind tibia with one anteroventral bristle; back of head with mostly light hair except for one or two rows of postocular cilia (Nearctic).....  
 .....*Acronesia alaskensis* (Shannon), p. 275
32. Two preacrostichal bristles; male with two posterior bristles on fore tibia (Nearctic).....  
 .....*Onesia bisetosa*, new species, p. 322  
 One preacrostichal bristle; male with but one posterior bristle on fore tibia. (Nearctic).....  
 .....*Onesia townsendi*, new species, p. 324
33. Faciofrontal profile strongly protuberant, the parafacio-eye angle strong; male with reclinate frontoorbital bristle opposite ocellar bristles; one or three postacrostichal bristles.....34  
 Faciofrontal profile not protuberant, the parafacio-eye angle not strong; male without reclinate frontoorbital bristles; two postacrostichal bristles (Nearctic).....  
 .....*Cynomyopsis cadaverina* (Robineau-Desvoidy), p. 326
34. Hindmost preintraalar bristle absent; one postacrostichal bristle; male with second genital segment much longer than the first and with a ventral bristle on the middle tibia .....35  
 Hindmost preintraalar bristle present; three postacrostichal bristles; male with second genital segment hardly longer than the first and without ventral bristles on the middle tibia. (Nearctic).....  
 .....*Cyanus elongata* (Hough), p. 332

35. Eye short; bucca 0.42 of eye height in male, 0.50 in female; width of parafaciale opposite lunule less than 0.70 the distance between vibrissae; frontal width at vertex in male about 0.80 greater than at narrowest where it is but 0.18 of head width. (Holartic).....  
 ..... *Cynomya mortuorum* (Linnaeus), p. 337
- Eye elongate; bucca 0.35 of eye height or less in both sexes; width of parafaciale opposite lunule greater than 0.80 the distance between vibrissae; frontal width at vertex in male only about 0.60 greater than at narrowest where it is approximately 0.23 of head width (Nearctic)  
 ..... *Cynomya hirta* Hough, p. 339

KEY TO KNOWN THIRD-INSTAR LARVAE OF  
 CALLIPHORINAE\*

1. Accessory oral sclerite absent.....Luciliini 2  
 Accessory oral sclerite present.....Calliphorini 8
2. Pharynx without pigmented area below posterior extremity of ventral cornua..... 3  
 Pharynx with a prominent pigmented area below the posterior extremity of the ventral cornua.....  
 ..... *Lucilia illustris* (Meigen), p. 228
3. Dorsum of segment 11 posteriorly spinose..... 4  
 Dorsum of segment 11 posteriorly bare.....  
 ..... *Phaenicia eximia* (Wiedemann), p. 243
4. Median pair of tubercles on upper border of stigmal field distinctly smaller than outer pair..... 5  
 Median pair of tubercles on upper border of stigmal field equal to or but slightly smaller than outer pair (anterior half of segment 12 smooth on dorsum and dorsolateral surface of segment 11 devoid of spines) (Cf. *caerulei-viridis*) ..... *Phaenicia mexicana* (Macquart), p. 246
5. Inner tubercles on upper margin of posterior cavity separated by a distance approximately equal to the distance between the inner and outer tubercles..... 6  
 Inner tubercles on the upper margin of posterior cavity separated by a distance approximately equal to the distance between the inner and median tubercles.....  
 ..... *Phaenicia sericata* (Meigen), p. 265

\*Most of the following key to the larvae of Luciliini and the larval descriptions are modified from those of Knipling (1936).

6. Tubercles bordering stigmal field not prominent; inward projection of peritreme between outer and middle slits of posterior spiracles absent or at least not prominent; anterior spiracles generally with from 5 to 7 branches. . . 7  
 Tubercles bordering stigmal field large; the spiracular plate heavily pigmented, large, and with a prominent inward projection between the outer and middle slits; anterior spiracles generally with from 7 to 10 branches. . . . . *Phaenicia caeruleiviridis* (Macquart), p. 235
7. Posterior margin of segments 9 and 10 without dorsal spines and the posterior margin of segment 11 with three or four irregular rows of dorsal spines; peritreme between outer and median spiracular slits not projecting inward. . . . . *Phaenicia pallescens* (Shannon), p. 251  
 Posterior margins of segments 9 to 12 completely encircled with spines, and segment 11 with six to eight rows of dorsal spines on posterior margin; peritreme between outer and median spiracular slits projecting inward. . . . . *BufoLucilia silvarum* (Meigen), p. 222
8. Labial sclerite with width of basal portion and length of entire sclerite subequal, the apical tooth-like portion short . . . . . 9  
 Labial sclerite longer than broad, the apical tooth-like portion usually much longer than the entire width of basal portion. . . . . 10
9. Labial sclerite with length of basal portion less than length of apical tooth-like portion. . . . .  
 . . . . . *Cyanus elongata* (Hough), p. 333  
 Labial sclerite with length of apical tooth-like portion as long or only slightly longer than length of basal portion . . . . . *Eucalliphora lilaea* (Walker), p. 286
10. Segment 9 bare anterodorsally. . . . . 11  
 Segments 2 to 9 spinose anterodorsally. . . . . 12
11. Spines small and lightly pigmented; tubercles on both dorsal and ventral margins of anal area nearly equidistant; anal protuberance with only a few lightly pigmented spines *Calliphora coloradensis* Hough, p. 296  
 Spines large and deeply pigmented; median and inner tubercles on dorsal surface and median and outer tubercles on ventral surface of anal area approximated; anal protuberance with numerous pigmented spines. . . . . *Calliphora livida* Hall, p. 299







LUCILIINI

Color plate III.—*Phaenicia sericata* (Meigen). Adult female, dorsal view, X 10.

12. Segment 9 with complete posterior band of spines; anterior spiracles each with 8 (7-9) rounded orifices.....13  
 Segment 9 bare posterodorsally; anterior spiracles each with 10 (10-11) rounded orifices.....  
 ..... *Calliphora terrae-novae* Macquart, p. 305
13. Labial sclerite with tooth-like apical portion longer than greatest width of basal portion.....  
 ..... *Calliphora vicina* Robineau-Desvoidy, p. 310
- Labial sclerite with tooth-like apical portion as long as greatest width of basal portion.....  
*Cynomyopsis cadaverina* (Robineau-Desvoidy), p. 329

### TRIBE LUCILIINI

#### (*The greenbottle flies*)

All species which belong to this tribe (color plate III) have the lower squamal lobe bare above, a parasquamal tuft of setae, and the arista usually plumose to the tip; their larvae lack an accessory oral sclerite between the labial sclerites.

*Male and female.* Head with epistoma elongate, nearly as wide as the clypeus, and warped forward from clypeal plane; metacephalon not or but very slightly protuberant posteriorly in profile; female with two proclinate and one reclinate fronto-orbital bristles; clypeus approximately twice as long as wide; parafaciale usually entirely bare; arista usually with cilia nearly to tip.

Thorax with propleural bristles one to three; preacrostichal bristles two; predorsocentral bristles three; presupraalar bristle one; posthumeral bristle present; sternopleural bristles three; parasquamal tuft present; postalar bristles two with a weaker third medianly to the posterior bristle; postdorsocentral bristles three; mesothoracic bristles either one or two; scutellum with discal bristle one and lateral bristles four.

Legs with fore tibia with one posterior bristle slightly beyond middle; middle tibia with one ventral or anteroventral bristle near middle and two posterior bristles, one near basal third and one near apical third; hind tibia with an anterodorsal row of short bristles, several of which may be longer and stronger than others in the row; tarsi of medium length; claws about two-thirds as long as the last tarsal segment, the pulvilli slightly shorter than the claws.

Wing with anterior cross vein oblique; posterior cross vein sinuate to doubly arcuate; last section of fifth vein from 0.15

to 0.20 the length of the preceding section; lower squamal lobe bare.

### FRANCILIA SHANNON

*Francilia* Shannon, Insector Insectiae Menstruus 12:73, 1924; Wash. Ent. Soc. Proc. 28(6):129, 1926; Townsend, Rev. de Ent. 1:72, 1931; Manual of Myiology, vol. 2, p. 171, 1935; *ibid.*, vol. 5, p. 149, 1937. Genotype. *Francilia alaskensis* Shannon. (Monobasic.)

*Male and female.* Head (pl. 4, D) longer at vibrissa than at antenna, the metacephalon, which is somewhat longer than in *Phaenicia*, sufficiently produced posteriorly to cause the head to appear more or less square in profile; parafaciale bare, wide above and below; ocellar triangle longer than in either *Lucilia* or *Phaenicia*; vibrissa at oral margin; elypeus twice as long as wide, shallow, concave in profile; facial carina distinct between basal antennal segments, very narrow opposite first segment and widening opposite second, then widening and flattening toward middle of third segment where it practically disappears; palpus long-clavate; faciale almost straight and nearly vertical in profile, slightly convex toward vibrissa, and with several rows of short setae above vibrissa which ascend about one-third the distance to the antennal base; proboscis two-thirds head height; haustellum two-thirds as long as proboscis; antennal bases slightly separated by the narrow carina; first and second segments short, third segment considerably wider than normal in Luciliini; arista with penultimate segment one and one-half to two and one-half times as long as diameter, the terminal segment thickened for about one-half its length, then gradually tapering to apex, with short cilia above and below for about two-thirds its length; back of head rounded.

Thorax with four humeral bristles triangularly arranged, three laterally in a row and one medianly; propleuron thinly setose in middle toward the anterior margin; propleural bristles three, one strong and two weak; preintraalar bristles two, the hindmost absent; preacrostichal bristles two; prosternum flat, setose, narrow posteriorly but strongly widening and bulging anteriorly; postalar declivity setose in center; tympanic pit bare in center but with upper expansion and ridge setose; post-acrostichal bristles three; postsupraalar bristles three; meso-spiracular bristle strong; spiracles smaller than in other species of Luciliini; scutellum with under surface laterally with setae.

Legs as described for the genus *Phaenicia*.

Wing with doubled costal spine; fourth vein with nearly

rounded angle; anterior cross vein slightly basad of middle of second section of fourth vein and oblique; posterior cross vein doubly arcuate; last section of fifth vein one-seventh as long as preceding section.

Abdomen with second segment with a row of long and recumbent marginal bristles; third segment with long and suberect marginal bristles; fourth segment with considerable erect hair and a marginal row of bristles; ventral membrane narrowly exposed in female; sternites wider than long, the fifth sternite of male long and obvious in profile, somewhat resembling that found in *Phaenicia pallescens*.

Male genital segments small but prominent, with long and erect setae.

#### *Francilia alaskensis* Shannon

*Francilia alaskensis* Shannon, Insecutor Inscitiae Menstruus 12: 73, 1924; Townsend, Rev. de Ent. 1:72, 1931; Manual of Myiology, vol. 2, p. 171, 1935; *ibid.*, vol. 5, p. 149, 1937. (Type, male from Old Crow, Alaska, No. 26690, U. S. National Museum).

*Lucilia alaskensis* (Shannon). Shannon, Wash. Ent. Soc. Proc. 28 (6):129, 1926; Aubertin, Linn. Soc. London, Jour., Zool., 38 (260):398, 1933.

A medium-sized blue-green species with black legs and hyaline wings which has the vibrissa at the oral margin and the penultimate segment of the arista elongate.

*Male*. Head width 10.4; length at antenna 5.6 and at vibrissa 6.6; oral margin slightly protruding beyond vibrissal angle in profile; eye height 6.7; head height 8.5; bucca 0.26 of eye height, black, with thin gray pollen and with scattered black hair; frontale dark reddish brown at lunule, black posteriorly, striate, 0.6 as wide as front; front at narrowest 0.13 of head width, 0.27 at vertex and 0.27 at lunule, with bright whitish-silvery pollen over black ground color, and with a few minute black hairs outside frontal row of bristles; frontal bristles about 10, the rows extending to about the middle of the second antennal segment and diverging as they follow the margins of the frontale; vertex black, subpollinose, grayish in some lights; accessory ocellar bristles behind and between posterior ocelli; clypus black, with silvery pollen; parafaciale 1.2 in width opposite lunule, black, covered with bright whitish silvery pollen; vibrissae set 2.3 apart; haustellum black, with black setae; palpus 3.7 in length, dark yellow brown to black, with black setae; antenna black, third

segment slightly orange brown basally, 3.4 times as long as second; arista with black ciliation; back of head black, with thin silvery pollen, with three or four rows of postocular cilia, the first row composed of longer cilia; below with only black hair.

Thorax shining metallic blue green with bronze and purple reflections, very thinly silvery on pleura, dorsum from anterior view with dark stripes laterad of acrostichal row of bristles which extend slightly beyond suture; humerus concolorous and longer than in *Lucilia* or *Phaenicia*; propleuron with white pollen and with thin dark setae; hindmost preacrostichal bristle and hindmost predorsocentral bristle placed 1.8 and 0.8, respectively, before the suture; hypopleuron bare on anterior three-fourths; pteropleuron with black setae on posterior half; prosternum with black setae laterally; postalar declivity with a few short black setae in center; sclerites at wing base dark brown or black; postalar callus concolorous and with dark brown hair.

Legs black or slightly brownish; middle femur with one anterior bristle near middle, about four longer anteroventral and posteroventral bristles; middle tibia with one ventral bristle near middle, and one posterodorsal bristle near middle; hind tibia with an anterodorsal row of about six or eight bristles, two or three of which are stronger than the others in the series, one or two anteroventral bristles slightly beyond middle, and two or three posterodorsal bristles, one near middle and one near apical third always present, one near the basal fourth either present or absent.

Wing (pl. 9, I) hyaline, only slightly brownish basally; basicoستا dark brown; subcostal sclerite dark orange brown, darker apically, with fine dark brown recumbent pile; costal segments 2 to 6 in the proportion 55:39:85:38:7; third vein setose from three-fourths to four-fifths the distance from base to cross vein; squamal lobes infuscated, white, the inner posterior margin of the lower lobe brown.

Abdomen colored like thorax, with thin whitish pollen in certain lights; first segment black; second segment with a shining middorsal longitudinal stripe which extends from anterior to posterior margins.

Genital segments black, slightly metallic greenish, and with long black setae, the first segment without a marginal row of bristles. Internal anatomical features as illustrated (pl. 23, A, B, and C).

*Female.* Head (pl. 4 D) height 9.0; eye height 6.6; bucca 0.36 of eye height; length at antenna 6.0 and at vibrissa 6.8; parafacial opposite lunule 1.4 in width; distance between vibrissae 2.8;

head width 12.0; front at narrowest (which is about 1.5 above lunule) 0.36 of head width, 0.38 at vertex and 0.38 at lunule; third segment of antenna 5.4 times as long as second and very wide from base to apex. Wing with costal sections 2 to 6 in the proportion 80:50:110:40:8. Abdomen with marginal row of bristles on second segment strongly recumbent, those on third and fourth segments more erect. Otherwise similar to male except for normal sexual differences.

*Length.* 7-8 mm.

The holotype male and one paratype male are from Old Crow, Alaska. A female from Camp 334, Alaska Engineering Commission, collected by Aldrich on July 12, 1921, one female from Mt. McKinley National Park, Alaska (without other data), one female from Savonoski, Naknek Lake, Alaska, July, collected by J. S. Hine, now in the Ohio State Museum, and three females from near Churchill, Manitoba, Aug. 5-6, 1937, collected by R. H. Dagg, are presumably the same species.

*Biology, habits, and immature stages.* Unknown.

#### BUFOLUCILIA TOWNSEND

*Bufolucilia* Townsend, U. S. Natl. Mus. Proc. 56(2301):542, 1919; Rohdendorf, Ent. Mitt. 17(5):336, 1928; Townsend, Manual of Myiology, vol. 2, p. 172, 1935; *ibid.*, vol. 5, p. 140, 1937. Genotype. *Lucilia bufonivora* Moniez (Monobasic).

*Xerophilophaga* Enderlein, Deut. Ent. Gesell. Mitt. 4 (8): 120, 1933. Genotype. (*Onesia lucilioides* Van der Wulp) = *Lucilia silvarum* (Meigen).

*Male and female.* Head (pl. 5, A) with elongate epistoma narrowing slightly in male, as wide as clypeus in female, and a little warped forward from clypeal plane in both sexes; frontale as wide as parafrontale in male but one and one-half times as wide as parafrontale at vertex in female; frontal margins only slightly divergent anteriorly in female; parafaciale bare and of nearly equal width throughout; faciale slightly convex in profile; third segment of antenna reaching four-fifths the distance to the oral margin; back of head in profile flattened in male, slightly rounded in female; palpus clavate or nearly subfiliform; antennal base at eye middle when head is viewed in profile; arista with long cilia about and below for two-thirds its length.

Thorax with preintraalar bristles three; prosternum narrow; tympanic pit with tuft of setae; metasternum setose; postintraalar bristles two; intrapostalar bristle weak but present; mesothoracic spiracle small.

Legs with posteroventral row of bristles on middle femur, these longer and more closely set apically.

Wing (pl. 9, J) with minute costal spine; posterior cross vein sinuate.

Abdomen with two to four strong erect median marginal bristles on second segment; third and fourth segments each with a row of strong erect marginal bristles.

*Bufolucilia elongata* (Shannon), new combination

*Lucilia elongata* Shannon, Insecutor Inscitiae Menstruus 12: 76, 1924. (Type, female from Mt. Constitution, Orcas Island, Wash., No. 26688, U. S. National Museum).

*Lucilia bufonivora* Moniez, Aubertin, Linn. Soc. London Jour., Zool. 38 (260):419, 1933 (in part).

This species has been generally listed as a synonym of the Palearctic species *bufonivora* Moniez, but this is an error. *Bufolucilia bufonivora* has the front of the male at the narrowest 0.09 of the head width, while the front at the narrowest in *elongata* is 0.14 of the head width; in the female, the front at the vertex in *bufonivora* is 0.29 of the head width, while in *elongata* it is 0.35. Both *silvarum* and *bufonivora*, as determined by Villeneuve, Séguy, and Townsend, have three postacrostichal bristles while *elongata* has but two. Aubertin (1933) pointed out that the latter character is not entirely reliable in *silvarum* and *bufonivora* "as the chaetotaxy is rather variable in each species."

A blue-green species with strong median marginal bristles on the second abdominal segment and with two postacrostichal bristles.

*Male.* Head width 11.5; length at antenna 5.6 and at vibrissa 5.8; eye height 7.0; head height 9.0; bucca black, 0.29 of eye height, with scattered black hair and with silvery gray pollen; frontale as wide as parafrontale at lunule and narrowing posteriorly, dark reddish brown anteriorly and black posteriorly near ocellar triangle; front at narrowest (1.0 before foremost ocellus) 0.14 of head width, 0.20 at vertex and 0.30 at lunule, with bright silvery pollen; parafrontale with a single row of minute black hairs outside frontal row of bristles which extends slightly anterior to foremost frontal bristle; frontal bristles about 12, the rows extending to about the base of the second antennal segment and diverging considerably anteriorly as they follow the margins of the widening frontale; vertex black, subpollinose; ocellar bristles strong, proclinate; clypeus yellowish



toward epistoma, black above, with silvery pollen, about one and one-half times as long as wide; facial carina slightly developed between basal segments of antennae; parafaciale 1.1 in width opposite lunule and only slightly wider below, with bright silvery gray pollen; faciale with several rows of short black setae which ascend about one-fourth the distance to the antennal base; vibrissae placed 0.8 above the oral margin and set 2.3 apart; palpus 3.7 in length, brown; third segment of antenna three times as long as second and reaching four-fifths the distance to the vibrissa; arista with black cilia; back of head dorsally slightly flattened, rounded below, black, with thin silvery pollen around occiput, with three or four rows of postocular cilia and black hair.

Thorax shining metallic blue green with bronze colored reflections, somewhat purplish in certain lights, with only thin silvery pollen except on pleura, with indication of longitudinal stripes lateral to acrostichal row of bristles which do not extend posteriorly much further than suture; humeral bristles three strong and one weak, the latter placed between and slightly anterior to the two median bristles; propleural bristles two, strong; preintraalar bristles three; preacrostichal bristles two, the hindmost placed 2.2 before the suture; predorsocentral bristles three, hindmost placed 1.2 before the suture; presupraalar bristle one; prosternum of medium size, widening slightly anteriorly, with black setae laterally; sclerites at wing base dark brown to black; greater ampulla dark brown, brown pubescent; postacrostichal bristles two; mesospiracular bristles two; thoracic spiracles smaller than in most species of *Luciliini* and with dark brown hair; scutellum with under surface laterally with black hair, one discal bristle placed about one-third the length of the scutellum before the apical lateral bristles, and four lateral bristles.

Legs black; fore tibia with posteroventral bristle near apical third; middle femur with two or three anteroventral bristles near middle and about four posteroventral bristles near middle; middle tibia with one ventral bristle and one posterodorsal bristle near apical third; hind tibia with a series of about four anterodorsal bristles basally, two anteroventral bristles set close together at apical third, and two posterodorsal bristles, one near basal fourth and one near apical fourth.

Wing hyaline tinged with brown basally; basicosta dark brown to black; subcostal sclerite brown to black with brown pubescence; costal spine weak but discernible; costal sections 2 to 6 in the proportion 65:35:90:30:9; third vein setulose about 0.55 the distance to the cross vein; fourth vein with second and third sec-

tions in proportion 65:80; apical cross vein almost straight; last section of fifth vein one-fifth as long as preceding section; upper squamal lobe of medium size, white, slightly orange posteriorly; lower squamal lobe widened posteriorly, whitish at base and orange brown apically, especially on inner margin.

Abdomen colored like thorax, nearly entirely shining; first segment black or but faintly metallic; second segment with faint suggestion of polished middorsal spot anteriorly, and with a marginal row of strong erect bristles, the middle pair or two much longer and stronger than those next in row; third and fourth segments with numerous erect black hairs; all sternites of nearly equal width and with rather long black bristles. Fifth sternite with numerous long black bristles.

Genital segments larger than in *Lucilia* or *Phaenicia*, black, shining, with numerous long black setae. Lateral view of forceps (pl. 23, D) as illustrated.

*Female.* Head width 12.4; length at antenna and at vibrissa 6.6; eye height 7.4; head height 10.0; epistoma elongate, narrowing but slightly, almost as wide as clypeus; bucca 0.32 of eye height; frontale as wide as parafrontale at lunule but widening to one and one-half times width of parafrontale at anterior ocellus; front at narrowest (at vertex) 0.35 of head width, the margins almost parallel to about 1.5 above the lunule where the front is only slightly wider, then diverging more widely to 0.44 of head width at lunule; frontal bristles seven or eight, nearly all strong; outer vertical bristles one-half as long as inner vertical bristles; ocellar bristles nearly divaricate; third antennal segment 3.2 times as long as second; parafaciale 1.8 in width opposite lunule; vibrissae set 2.8 apart; palpus 4.0 in length; back of head rounded and not at all flattened. Legs with an additional posterodorsal bristle on hind tibia, this placed just before middle. Otherwise similar to male except for normal sexual differences.

*Length.* 6-9 mm.

Shannon described *elongata* from a single female specimen. There are now two male specimens in the National Museum collection which are presumably this species. One specimen is from Pullman, Wash., June 2, 1907 (collector unknown), and the other from Bellfountain, Ore., May 27, 1922 (A. L. Lovett). The above description of the male was drawn from the Oregon specimen.

*Biology, habits, and immature stages.* Unknown.

*Bufolucilia silvarum* (Meigen)

*Musca silvarum* Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 5, p. 53, 1826.

*Lucilia silvarum* (Meigen). Zetterstedt, Diptera Scandinaviae, vol. 4, p. 1318, 1845; Moniez, Bull. Biol. de la France et Belg., 8:25, 1876; *ibid.*, 9:67, 1878; Bezzi, Katalog der Paläarktischen Dipteren, vol. 3, p. 541, 1907; Townsend, Smithsn. Inst. Misc. Collect. 51:120, 1908; Tothill, Ent. Soc. Amer. Ann. 6:252, 1913; Mueller, Arch. f. Naturgesch. 88A(1-3):57, 1922; Zool.-Bot. Gesell. Wien, Verhandl. 73:55, 1923; Shannon, Insecutor Inscitiae Menstruus 12:75, 1924; Richards, Roy. Ent. Soc., London, Trans. 74(2):256, 1926; Lundbeck, Diptera Danica, vol. 7, p. 143, 1927; Wainwright, Roy. Ent. Soc., London, Trans. 76:238, 1928; Stewart, N. Y. Ent. Soc. Jour. 38:45, 1930; Roberts, Ent. Soc. Amer. Ann. 23:790, 1930; Aubertin, Linn. Soc. London Jour. Zool. 28:418, 1933; Balzac, Soc. Ent. de France Bull. 42(12):181, 1937. (Type, female from Germany, apparently lost.)

?*Lucilia brunica* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 459, 1830. (Type, from North America, apparently lost).

*Lucilia nigripalpis* Townsend, Smithsn. Inst. Misc. Collect. 51:120, 1908. (Type, female from Ohio, No. 10888, U. S. National Museum.)

*Lucilia sylvarum* (Meigen). Schiner, Fauna Austriaca, Die Fliegen, vol. 1, p. 591, 1862; Hough, Zool. Bull. 2 (6):287, 1899.

*Calliphora silvarum* (Meigen). Pandellé, Rev. de Ent. 15:219, 1896.

*Onesia lucilioides* Van der Wulp, Biologia Centrali-Americana, Insecta, Diptera, Vol. 2, p. 288, 1896; Enderlein, Deut. Ent. Gesell. Mitt. 4 (8):120, 1933 (*Xerophilophaga*). (Type, from Mexico City, Mexico, in British Museum.)

*Bufolucilia silvarum* (Meigen) Townsend, U. S. Natl. Proc. 56 (2301):542, 1919.

Similar to *elongata* but with three postacrostichal bristles.

*Male.* Head (pl. 5, A) width 11.2; length at antenna 5.1 and at vibrissa 5.9; eye height 7.2; head height 9.1; bucca 0.27 eye height and considerably produced forward; frontalia mostly black, sometimes brownish toward lunule; front at narrowest 0.08 of head width, 0.16 at vertex, and 0.24 at lunule, with heavy

silvery pollen and with a few scattered minute black setae outside frontal row; ocellar triangle with a number of erect black proclinate hairs; clypeus black, with heavy silvery pollen toward lunule; parafaciale opposite lunule 0.9 in width, somewhat wider below; faciale rather strongly convex in profile; vibrissae 1.0 above oral margin and 2.2 apart; palpus 3.2 in length, dark brown to black; antennae slightly separated at base by low narrow carina, broadening immediately below first antennal segment and extending to about middle of clypeus but decreasing in height toward epistoma; antenna dark brown to black, third segment 2.9 times as long as second; arista black, with long black cilia for three-fourths its length; back of head with some light hairs, particularly below on metacephalon.

Thorax colored as in *elongata*; propleural bristles in tuft; post-acrostichal bristles three, strong; scutellum similar to that of *elongata*, but under surface with black setae laterally nearly to middle.

Legs with middle tibia usually with two posterodorsal bristles.

Wing (pl. 9, J) with subcostal sclerite dark brown, black apically; basicosta black; costal sections 2 to 6 in the proportion 62:39:86:30:8; third vein setulose from 0.3 to 0.6 the distance to the cross vein; upper squamal lobe white, often orange to brownish on rim; lower squamal lobe white basally, darkening to brown apically.

Abdomen colored like thorax, second segment with an obvious dark shining spot anteriorly on the middorsum, and usually with a pair of long erect median marginal bristles but often with several pairs, the closest lateral bristles small and inconspicuous, the median bristles more noticeable by contrast.

Genital segments black, greenish metallic on dorsum, each segment with long black erect bristles. Internal anatomical features (pl. 23, E and F) as illustrated.

*Female* as in female of *elongata* except head width 11.6; height 8.6; length at antenna 5.2 and at vibrissa 5.9; bucca 0.27 of eye height; frontale red orange at lunule but darker posteriorly; front at narrowest (slightly above lunule) 0.31 head width, 0.32 at vertex and 0.33 at lunule; third antennal segment 3.2 times as long as second; parafaciale 1.3 in width opposite lunule; vibrissae set 2.4 apart; palpus 2.4 in length. Wing with costal sections 2 to 6 in the proportion 66:40:86:34:9; squamal lobes light in color, usually more orange than brownish. Otherwise similar to male except for normal sexual differences.

*Length.* 5-8 mm.

*Distribution.* Holarctic. Europe; Asia; North Africa; North

America: Southern Canada to as far south as District of Columbia and northern Virginia, Arkansas, Oklahoma, Colorado, and California.

The original spelling of the specific name was emended to *silvarum* by Schiner (1862), and this spelling has been commonly used.

The small carina described for *silvarum* is more apparent than that in *elongata* and it separates the antennal bases more obviously. It is similar to the carina of *bufonivora*, but the antennal bases are not separated so far in the latter species.

Heim de Balzac (1937, pp. 181-182) stated that *silvarum* and *bufonivora* differ only in small details of chaetotaxy and in slight modification of the genital apparatus of the males. He considered *silvarum* to be a saprophage and *bufonivora* to be a parasite. Both species, however, are clearly parasitic upon toads and frogs.

*Biology, immature stages, and habits.* The biologies of the several species of *BufoLucilia* are not well-known. While a considerable number of interesting facts about the species have been published, the whole story is not yet available. Moniez (1876 and 1878) first noted parasitism in the toad, and Balzac (1937, pp. 181-182) and Brumpt (1934, pp. 120-126) published upon certain phases of the parasitism and biology of *bufonivora* in Europe. The latter author was able to obtain eggs of this species only upon live toads; he concluded that it was a true parasite of toads and that females of *bufonivora* were not attracted to any other type of food. He reared it from egg to egg upon this host. He found the species to have three generations each year in France, the diapause to be dependent upon climatic conditions. The diapause in *bufonivora* was studied by Cousin (1933), who stated that the species had but two generations each year, the second instar being followed by the diapause. Stadler (1930) discussed the parasitism of *silvarum* in *Bufo vulgaris*, and illustrated, by photographs, the effect upon the host by larvae of this species. Full discussions of the known habits together with good bibliographies may be found in Kryger (1921) and Brumpt (1934.)

Wardle (1930) stated that *silvarum* will oviposit during late afternoon when the intensity of light is low and when atmospheric temperatures may also be low.

It cannot always be ascertained whether records of parasitism of toads and frogs as reported from the Palaearctic Region are based upon *silvarum* or *bufonivora*, because some authors have not distinguished between the two species. Such parasitism is supposedly of rather common occurrence in Europe.

*Bufolucilia silvarum* has been reared from frogs in North America in only one instance so far as I know; Mr. W. B. Cartwright, of the Bureau of Entomology and Plant Quarantine, kindly furnished me with the following record. In November, frogs (*Rana catesbeiana*, eastern bullfrog introduced into California) were found on the moist banks of a slough of the Mokelumne River, south of Franklin, California, infested with maggots of this species. Of 59 frogs examined, 22 had apparently been killed by these larvae, 11 living frogs had both eyes infested, and 15 living frogs had one eye infested. The larvae were milling around in a mass in the orbits of the eyes but had not penetrated the eye balls. Some larvae were observed to migrate from one eye to the other. Thirty-two larvae were found in an eye of one frog. Those reared emerged as adults late in February or early in March.

*Larva.* First instar: Spines distinct, heavily pigmented; complete band of spines at anterior border of segments 1 to 9; segment 10 usually without spines dorsally; posterior border of segments 9-12 completely encircled with spines; segment 9 with band narrowed to one or two dorsal rows; spines restricted to lateral and ventral surface on segment 8; border of stigmal field provided with long brownish hairlike spines. Tubercles of last segment as in *illustris*. Cephaloskeleton (pl. 39, A) with parts rather well-developed, the principal distinguishing feature being the broad pharyngeal arch, which is much broader than in other species.

Second instar: Segments 2 to 9 each provided with a complete band at anterior border, spines present on lateral surface of segment 10, but absent on dorsal surface; posterior border of segments 9-12 with a complete band, narrowed to one or two irregular dorsal rows on segment 9. Relative position of tubercles on stigmal field as in third instar, broad at base and somewhat pointed at tip. Pharyngeal sclerite (pl. 39, B) rather lightly pigmented, labial sclerites rather narrow and the dorsal posterior prolongation of basal portion narrower than in all other species except *pallescens*; shape of dorsal cornua about intermediate between that of *illustris* and *caeruleiviridis*. Anterior spiracles with five to seven branches, more often with six.

Third instar: Spines encircling body at anterior border of segments 2-9; on segment 10 several rows of spines extending almost to dorsal surface, and on segment 11 two or three irregular broken rows of spines present laterally; posterior border of segments 9-12 with complete band of spines; segment 11 with six to eight irregular rows dorsally, segments 9 and 10 with

about three and four rows respectively; segment 8 sometimes with a single irregular dorsal row but this usually absent for a short space; segment 12 very finely scabrous over entire dorsal surface, this area being smooth in the other species except *illustris*, which usually has a small, irregular, smooth area. Tubercles outlining stigmal field smaller and less conspicuous than in other species except *pallescens*, median pair on upper and inner pair on lower border of stigmal field less than half as large as others; tubercles on anal protuberance low, broadly rounded at tip. Posterior spiracles (pl. 39, D) rather small; peritreme wide and irregular, inner projections usually absent but there may be a short, pointed, pigmented projection between middle and lower slits. Cephaloskeleton (pl. 39, C) with dorsal and ventral cornua close together. Anterior spiracles with small short branches, the part external to cuticle approximately half the length of spiracular chamber; the number of branches in 52 spiracles from two series of larvae examined ranging from 5 to 7 (8 with 5 branches, 23 with 6, and 21 with 7.)

*Adult.* *BufoLucilia silvarum* is not a common species in North America, but it may be found in woods and pasture land during midsummer. It is an active fly and occurs upon foilage in early morning or late afternoon. Adults are not often attracted to decaying meats in traps and are rarely collected upon decaying substances. Parker (1918) trapped but a single individual in a privy vault trap at Laurel, Mont.

The species may be collected from April to September in southern Ohio, becoming most abundant during June and July. In northern Virginia specimens have been taken during the last week in March and until October. In central California adults may be found as early as February.

#### LUCILIA ROBINEAU-DESVOIDY

*Lucilia* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 452, 1830; Macquart, Soc. Sci. Arts Lille Mem. 1833 (— 1834) :162; Schiner, Fauna Austriaca, Die Fliegen, vol. 1, p. 589, 1862; Brauer and Bergenstamm, Zweiflügler des Kaiserlichen Museums zu Wien, vol. 4, no. 1, p. 89, 1899; *ibid.*, vol. 6, no. 3, p. 92, 1893; Hough, Ent. News 10:66, 1899; Zool. Bull. 2:287, 1899; Williston, Manual of North American Diptera, p. 343, 1908; Townsend, Smithsn. Misc. Collect. 51:118, 1908; Tothill, Ent. Soc. Amer. Ann. 6:241, 1913; Townsend, Ent. News 25:111, 1914; Shannon, Insecutor Insectiae Menstruus 11:107, 1923; *ibid.* 12:72, 1924; Bezzi, Bull. Ent. Res. 17:236, 1927; Curran, Amer. Mus. Nat. Hist. Bull.

52:368, 1928; Patton, Philippine Jour. Sci. 27:402, 1925; Malloch, Ann. and Mag. Nat. Hist. (9) 17:503, 1926; Linn. Soc. N. S. Wales, Proc. 52:320, 1927; Senior-White, Indian Mus. Rec. 28:130, 1926; Richards, Roy. Soc., London, Trans. 74 (2):255, 1926; Townsend, Rev. Mus. Paul. 15:224, 1926; Lundbeck, Diptera Danica, vol. 7, p. 140, 1927; Rohdendorf, Ent. Mitt. 17 (4):336-338, 1928; Wainwright, Roy. Ent. Soc., London, Trans. 76:237, 1928; Séguy, Encycl. Ent. (A) 9:145, 1928; Aubertin, Linn. Soc. London Jour., Zool. 38:389-436, 1933; Patton and Cushing, Ann. Trop. Med. and Parasitol., 28 (1):107-121, 1934; Séguy, Encycl. Ent. (B. II) Dipt. 8:134, 1935; Townsend, Manual of Myiology, vol. 2, p. 172, 1935; *ibid.*, vol. 5, p. 151, 1937. Genotype. *Musca caesar* Linnaeus by designation of Macquart (Insectes Diptères du Nord de la France, vol. 5, p. 162, 1833).

*Male and female.* Head (pl. 5, B) slightly longer at vibrissa than at antenna; oral margin protruding a little beyond vibrissal angle when viewed in profile; inner eye facets of male slightly enlarged; front of male very narrow, wide in female; ocellar triangle large in female, reaching nearly halfway to lunule; parafaciale narrowed above; clypeus moderately sunken; faciale slightly convex in profile especially toward vibrissa; antennal bases very slightly separated by a small and narrow carina; third segment of antenna reaching about five-sixths the distance to the vibrissa which is above the oral margin; arista with long cilia above and below nearly to apex; back of head flat or slightly concave above in profile, especially in male.

Thorax with humeral bristles three; preintraalar bristles three; postalar declivity setose, postalar bristles two strong, with a weaker third bristle medianly beside the hindmost one; post-acrostichal bristles two; prosternum of medium size, wider anteriorly, setose; intrapostalar bristle weak but present.

Wing with subcostal sclerite with some short wiry bristles; posterior cross vein doubly arcuate; lower squamal lobe nearly as wide as long.

Abdomen with marginal bristles only on third and fourth segments; ventral membrane narrowly exposed in female.

#### *Lucilia illustris* (Meigen)

*Musca illustris* Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 5, p. 54, 1826. (Type, from Germany, apparently lost.)



- Musca parvula* Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 5, p. 55, 1826. (Type, Europe, ? in Paris Museum.)
- Musca equestris* Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 5, p. 57, 1826. (Type, Europe, ? in Paris Museum.)
- ?*Lucilia lepida* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 453, 1830. (Type, France, in Paris or lost.)
- ?*Lucilia consobrina* Macquart, Diptères exotiques, sup. 3, p. 217, 1848. (Type, male, "Amerique septentrionale," apparently lost.)
- ?*Lucilia fraterna* Macquart, Diptères exotiques, sup. 3, p. 217, 1848. (Type, female from "Amerique septentrionale;" apparently lost.)
- Musca muralis* Walker, List of the Dipterous Insects in the Collection of the British Museum, vol. 4, p. 888, 1849. (Type, Saint Martin's Falls, Hudson's Bay, Albany River, in the British Museum.)
- Calliphora simulatrix* Pandelle, Rev. de Ent. 15:218, 1896. (Type, France, in Paris Museum.)
- ?*Lucilia infuscata* Townsend (?in part), Smithsn. Misc. Collect. 51:123, 1908; Tothill, Ent. Soc. Amer. Ann. 6:254, 1913; Townsend, Ent. News 25:112, 1914; Shannon, Insecutor Inscitiae Menstruus 12:73, 1924.
- ?*Lucilia purpurea* Townsend (? in part), Smithsn. Misc. Collect. 51:122, 1908; Tothill, Ent. Soc. Amer. Ann. 6:254, 1913; Shannon, Insecutor Inscitiae Menstruus 12:73, 1924.
- Lucilia caesar* of North American authors, nec Linnaeus, Townsend, Psyche, 1:468, 1893; Hough, Zool. Bull. 2(6):288, 1899; Kans. Univ. Quart. 9:203, 1900; Van der Wulp, Biologia Centrali-Americana, Insecta, Diptera, vol. 2, p. 297, 1896; Howard, Wash. Acad. Sci. Proc. 2:563, 1900; Coquillett, Wash. Acad. Sci. Proc. 2:440, 1900; Morgan, U. S. Dept. Agr. Div. Ent. Bull. 30:25, 1901; Townsend, Smithsn. Misc. Collect. 51:121, 1908; Herms, Jour. Expt. Zool. 10:167, 1911; Tothill, Ent. Soc. Amer. Ann. 6:248, 1913; Whiting, Ent. Soc. Amer. Ann. 6:257, 1913; Parker, Mont. State Bd. Ent. Bien. Rpt. 44, 1914; Ent. News 27:281, 1917; Ent. News 29(4):144, 1918; Bishopp, Jour. Econ. Ent. 10:273, 1917; Cole and Lovett, Calif. Acad. Sci. Proc. (4)11(15):1921; Shannon, Insecutor Inscitiae Menstruus 12:75, 1924; Strickland and Roy, Parasitol. 17:168, 1925; Essig, Insects

of Western North America, p. 587, 1926; Richards, Roy. Ent. Soc., London, Trans. 74(2):256, 1926; Townsend, M. M., Ent. Soc. Amer. Ann. 21:124, 1928; Roberts, Ent. Soc. Amer. Ann. 23:790, 1930; Curran, Amer. Mus. Nat. Hist. Bull. 61:89, 1930; Kingseote, Ontario Ent. Soc. Ann. Rpt. 62:92, 1931; Aubertin, Linn. Soc. London Jour., Zool. 38:400, 1933.

*Lucilia illustris* (Meigen) Aubertin, Linn. Soc. London Jour., Zool. 38:402, 1933.

*Lucilia caesar* (L.) as determined by Villeneuve, Lundbeck, Stein, Aubertin, Richards, Riedel, Engel, and other European dipterists, apparently does not occur in North America, but since it occurs in eastern Asia, as well as in Europe, it might perhaps be expected in collections from Alaska or western Canada. The *Lucilia caesar* of North American authors is usually *Lucilia illustris* (Meigen). Coquillett determined a number of species of both *Phaenicia* and *Lucilia* as *caesar*, as did other North American dipterists early in the present century, and many of the early references to either *caesar* or to *illustris* may be inaccurate.

Because *caesar* may occur in North America, the following key is presented to separate *illustris* and *caesar*.

1. Male with frontale obvious throughout and almost as wide as parafrontale at lunule, with epistoma slightly narrowing and vibrissae set 2.3 apart; both sexes with hindmost preacrostichal bristles usually placed 2.8 before the suture; female with front at narrowest 0.32 of head width, 0.35 at lunule and vibrissae set 2.6 apart.....  
.....*Lucilia illustris* (Meigen).

Male with frontale obsolete at narrowest portion of parafrontale, the eyes nearly contiguous for a short distance, epistoma nearly as wide as clypeus and the vibrissae set 2.8 apart; both sexes with hindmost preacrostichal bristles placed 2.6 before the suture; female with front at narrowest 0.31 of head width, 0.34 at lunule, and vibrissae set 0.30 apart  
.....*Lucilia caesar* (Linnaeus).

A blue-green species with strong wiry bristles on the subcostal sclerite.

*Male.* Head (pl.5,B) width 11.9; length at antenna 5.2 and at vibrissa 5.6; oral margin considerably protruding beyond vibrissal angle in profile; eye height 7.6; head height 9.8; epistoma orange; metacephalon produced slightly posteriorly and

obvious in profile; bucca 0.32 eye height, black, moderately grayish pollinose, with numerous black hairs, no pale hairs before the metacephalic suture; frontale obvious throughout but very narrow at narrowest portion of front, dark brown, widening to twice width of parafrontale at lunule; front at narrowest 0.05 head width, 0.16 at vertex and 0.24 at lunule, black, with silvery white pollen, and with a few scattered minute black hairs outside frontal row; frontal bristles about 13, the rows extending anteriorly to about the middle of the second antennal segment and moderately diverging as they follow the margins of the frontale; vertex shining silvery over dark brown ground; parafaciale opposite lunule 0.9 in width, wider below, with silvery pollen; faciale with several rows of short black setae which ascend nearly halfway to antennal base; vibrissae 0.6 above oral margin and placed 2.3 apart; palpus orange, 3.3 in length; antenna with first segment black, second usually orange apically, third 3.3 times as long as second and dark brown to black; arista dark brown to black, with long dark cilia; back of head black, with silvery pollen below, with three or four rows of postocular cilia and black hair, some pale hair on the metacephalon.

Thorax metallic blue green with bronze and purple reflections, with thin silvery pollen on dorsum between humeri in certain lights and on pleura, with a darker dorsal longitudinal stripe laterally to acrostichal row, this extending posteriorly to just beyond suture; propleuron with black setae; hindmost preacrostichal and predorsocentral bristles placed 2.8 and 1.2, respectively, before the suture; hypopleuron with black setae; prosternum laterally with brown setae; postalar declivity with a few black setae in tuft near middle; sclerites at wing-base dark brown to black; spiracles with dark brown to black hair; lateral postscutellar plates with black setae; under surface of scutellum bare in center.

Legs black; middle tibia with one anterodorsal bristle near middle, two posterior bristles, one near basal fourth and one near apical third, and one posterodorsal bristle near middle; hind tibia with two anteroventral bristles near or slightly beyond middle, and two posterodorsal bristles, one near basal fourth and one near apical fourth.

Wing hyaline, brownish basally; costal spine absent; basicoستا dark brown to black; subcostal sclerite dark brown to black, with numerous black wiry bristles; costal sections 2 to 6 in the proportion 70:45:90:35:8; third vein setulose from one-half to two-thirds the distance to the cross vein; fourth vein with rounded angle; apical cross vein nearly straight; anterior cross

vein near middle of second section of fourth vein; upper squamal lobe white at base, brown apically; lower squamal lobe brown.

Abdomen colored like thorax, thinly whitish in certain lights especially on venter; first segment metallic and dark brown; second segment with a faint indication of a middorsal spot on the anterior margin and with a marginal row of fine and hardly apparent bristles, these longer laterally; third segment with long erect marginal bristles; fourth segment with long erect scattered hairs and a marginal row of bristles. Fifth sternite (fig.98,B) as illustrated.

Genital segments black metallic, of medium size, apparent in profile with abdomen in repose, and with scattered erect black setae. Internal anatomical features (pl.23,G and H) as illustrated.

*Female.* Head height 10.2; eye height 7.3; head width 13.0; bucca 0.37 of eye height; length of head at antenna 5.9 and at vibrissa 6.3; parafaciale opposite lunule 1.4 in width; vibrissae set 2.6 apart; front at narrowest 0.32 of head width, only slightly wider at vertex and 0.35 at lunule, the margins almost parallel anteriorly to about 1.5 above lunule; third antennal segment 3.8 times as long as second; palpus 3.7 in length. Wing with costal sections 2 to 6 in the proportion 76:50:94:38:10. Otherwise similar to male except for normal sexual differences.

An extra lateral scutellar bristle often occurs on one side (rarely on both sides) between the basal and the median lateral bristle. Northern specimens seem to develop such adventitious bristles more often than specimens from the southern part of the species range. The normal number of lateral bristles in *Lucilia* is three.

*Length.* 6-9 mm.

*Distribution.* Holarctic. In North America from southern Canada to northern Mexico; common in the middlewestern part of the United States.

*Biology, habits, and immature stages.* *Egg.* Wardle (1930, p. 561) stated that *Lucilia illustris* seems to be less sensitive to light than *Phaenicia sericata* and that it will oviposit when the sky is overcast. Eggs are often deposited upon decaying meats, and during the summer in the middlewestern United States carcasses of animals are usually blown by this species in competition with *Phaenicia sericata*.

*Larva.* First instar: Distribution of spines rather difficult to determine owing to lack of pigmentation on some of the segments; segments 2-9 each bordered anteriorly with a complete band of spines; segment 8 with spines lighter in color on lateral

and dorsal surfaces; segment 9 with spines almost colorless; number of rows of spines reduced to one or two on segment 9; segment 10 with several rows of light-colored spines laterally which may extend to laterodorsal surface but do not join to form a complete band; posterior border of segment 11 with two or three rows of rather dark spines dorsally; on segment 10 the spines narrowed to one or two rows of lighter spines; dorsal surface of segment 9 with or without one or two irregular rows of almost colorless spines at posterior border; border of posterior cavity with small pigmented hairlike spines. Tubercles on segment 12 with inner pair on upper border separated by a distance approximately equal to distance between inner and outer tubercles; median pair on upper border and inner pair on lower border inconspicuous. Cephalopharyngeal sclerite (pl.39, E) comparatively strong and heavily pigmented; dorsal and ventral cornua approximately equal in length and width; anterior projection of pharyngeal sclerite rather short and joined by a narrow dorsal arch; hatching spine well-developed.

Second instar: Segments 2 to 9 each having anterior border provided with a complete band of spines; dorsal spines absent on segment 10 but one or two rows sometimes extending well up on laterodorsal surface; posterior border of segments 9-12 each with complete band of spines, reduced on segment 9 to one or two irregular rows; segment 8 with spines restricted to ventral and lateral surfaces. Tubercles on upper border of last segment broadly rounded and in relative size similar to those of third instar; inner pair on lower border approximately one-third as large as the median and outer pair; distance between inner tubercles on upper border as great or greater than distance between inner and outer ones. Cephaloskeleton (pl. 39, F) with dorsal cornua of almost uniform width to posterior end where it sharply tapers to a point; dorsal posterior projection of basal portion of labial sclerites broad and bluntly rounded. Anterior spiracles with six to eight branches.

Third instar: Spinous bands encircling body at anterior margins of segments 2-9; segment 10 with band of spines generally incomplete dorsally for a short space; segment 11 with spines above venter restricted to one or two irregular dorsal rows; posterior border of segment 11 with five or six irregular rows of spines on dorsum; segment 10 usually with one or two irregular dorsal rows, sometimes incomplete; dorsal spines generally absent on segment 9 and those anterior to it. Conical tubercles or fleshy protuberances outlining stigmal field rather large and prominent; inner and outer pairs on upper border nearly equal

and about twice as large as the median, the two inner tubercles separated by a distance greater than the distance between the inner and median tubercles and approximately equal to distance between inner and outer ones (as in *mexicana*); outer and median pairs on lower border large, approximately equal in size and much larger than inner pair; inner pair on lower lip smaller than outer pair on upper border; tubercles on anal protuberance slightly shorter and less pointed than the two outer pairs on lower border of stigmal field; segment 12 generally smooth to finely scabrous on dorsal surface. Posterior spiracles (pl.39,H) comparatively large, heavily pigmented, and with usual form; peritreme prominent, with well-developed inward projection between outer and middle slits. Cephaloskeleton (pl.39,G) large and heavily pigmented; dorsal cornua broad and widely separated from ventral cornua; at posterior end and below ventral cornua with a pigmented porous area, possibly representing a more heavily pigmented portion of the pharynx which is not conspicuous in other species of Luciliini here described; labial sclerites pointed slightly upward and curved downward. Anterior spiracles with comparatively large prominent branches; external portion equal to or only slightly longer than stigmal chamber (pigmented portion of trunk); anterior spiracles generally with 6 to 8 branches. Of 80 spiracles, 5 had 5 branches, 23 had 6, 20 had 7, 22 had 8, and only 2 had 9.

*Puparium.* According to Bishopp (1915) the pupal stage lasts from 5 to 16 days in Texas during fairly warm weather. During periods of fairly high temperatures in Texas he found that the larval period lasted from 2 to 5 days and that the puparia were formed from 3 to 12 days after the hatching of the eggs. During periods of low temperatures, however, the third larval stage was sometimes extended to several weeks.

*Adult.* In the Middle West *illustris* appears on the first warm days of spring, although a few adults may be collected in favorable situations during protracted warm periods in midwinter. Wardle (1930) stated that this species formed 24 percent of the total blowfly population in Minnesota during July, August, and September in 1927. Overwintering of *illustris* is supposedly in the larval or the pupal stage, although the appearance of adults during midwinter may indicate hibernation in that stage under certain conditions. The preoviposition period is from 6 to 20 days, according to Bishopp (1915); the flying range of the species was tentatively fixed at 3.5 miles by Bishopp and Laake (1921).

It seems that *illustris* is an open woodland and meadow species.

Adults may be collected in large numbers upon flowers of wild parsnips in Ohio during July. They are attracted to fresh human excrement sometimes, but most frequently to freshly exposed meat and are one of the most abundant green flies on freshly killed animals. The larvae are found most frequently in carrion.

Kingscote (1932) reports that larvae of this species often kill young foxes in two or three days by causing subdermal myiasis, but it is probable that another species may be concerned.

### PHAENICIA ROBINEAU-DESVOIDY

*Phaenicia* Robineau-Desvoidy, Histoire Naturelle des Diptères des Environs de Paris, vol. 2, p. 750, 1863; Bezzi, Katalog der Paläarktischen Dipteren, vol. 3, p. 539, 1907; Coquillett, U. S. Natl. Mus. Proc. 37:563, 1910; Townsend, Insecutor Inscitiae Menstruus 4:8, 1916; Malloch, Linn. Soc. N. S. Wales, Proc. 52:321, 1927; Rohdendorf, Ent. Mitt. 17 (4):336, 1928; Aubertin, Linn. Soc. London Jour. Zool. 38:392, 1933; Townsend, Manual of Myiology, vol. 5, p. 162, 1937. Genotype. (*Phaenicia concinna* Robineau-Desvoidy) = *Musca sericata* Meigen. By designation of Townsend (1916).

All the known species of *Phaenicia* in North America have the following characters in common.

*Male and female.* Head (pl.5,C) with epistoma warped a little forward from clypeal plane and nearly as wide as clypeus; meta-cephalon short and only slightly produced behind; inner vertical bristles decussate or reclinate; ocellar triangle hardly reaching one-third the distance to the lunule; clypeus well-depressed, slightly concave; facial carina absent or apparent only in a short narrow low keel between the first antennal segments; faciale slightly convex in profile and usually bristled only at vibrissa; vibrissae above oral margin and well-separated; proboscis two-thirds to three-fourths head height; palpus clavate; antennae inserted at or slightly below eye middle when head is viewed in profile, their bases approximated; arista with penultimate segment short, terminal segment elongate, with long cilia above and below nearly to apex; back of head flat or slightly depressed.

Thorax usually with three humeral bristles and a weaker fourth bristle anterior to these; propleural bristle strong; pre-intraalar bristles three, the foremost bristle usually weak; prosternum large, wide, setose; postalar declivity setose; preparap-

teron with fine pile; tympanic pit setose; greater ampulla pubescent; scutellar bridge setose; squamopleuron pilose; post-supraalar bristles three; postintraalar bristles two; intrapostalar bristle minute but rarely absent; mesothoracic bristle strong, mesothoracic and metathoracic spiracles not enlarged.

Wing (pl.9,K) without costal spine; subcostal sclerite without setae.

Abdomen without discal or median marginal bristles on intermediate segments; second segment with marginal row of recumbent bristles; third and fourth segments each with a more erect and stronger marginal row of bristles.

The genus *Phaenicia* differs most obviously from *Lucilia* in the character of the ocellar triangle and in the subcostal sclerite.

*Phaenicia caeruleiviridis* (Macquart), new combination

*Lucilia caeruleiviridis* Macquart, Diptères exotiques, sup. 5, p. 133, 1855; Brauer, Akad. der Wiss. Wien, Math.-Nat. Kl. Sitzber. (1) 108:522, 1899; Aubertin, Linn. Soc. London Jour., Zool. 38:421, 1933. (Type, female from Baltimore, Md., in the Bigot collection, British Museum.)

*Lucilia australis* Townsend, Smithsn. Misc. Collect. 51:122, 1908; Tothill, Ent. Soc. Amer. Ann. 6:254, 1913; Shannon, Insecutor Inscitiae Menstruus 12:79, 1924; Curran, Amer. Mus. Nat. Hist., Bull. 61:89, 1930. (Type, female, from Tennessee, No. 10894, U. S. National Museum.)

*Lucilia oculata* Townsend, Smithsn. Misc. Collect. 51:123, 1908; Tothill, Ent. Soc. Amer. Ann. 6:255, 1913. (Type, female, from Kentucky, No. 10896, U. S. National Museum.)

A brilliant blue-green species with the third and fourth abdominal segments highly polished.

*Male.* Head width 13.0; length at antenna and at vibrissa 5.6; eye height 8.7; head height 11.1; epistoma shorter and wider than in *sericata*; metacephalon hardly apparent in profile; bucca 0.25 of eye height, deep mahogany to black in color, with thin dull gray pollen, and with black setae; frontale very narrow for nearly 3.0 starting about 1.0 anterior to foremost ocellus, reddish brown and almost 0.35 of width of front at lunule; front at narrowest (2.0 below foremost ocellus) 0.03 of head width, 0.14 at vertex and 0.18 at lunule, with dull silvery pollen, bare except for a single row of minute dark setae just outside frontal row; frontal row consisting of eight or nine bristles, those posteriorly at narrowest part of front very weak, the rows extending anteriorly to lunule and diverging as they follow the margins of



the frontale; a reclinate fronto-orbital bristle present (located about 0.30 anterolaterad of foremost ocellus); vertex black, with thin silvery pollen; clypeus orange red to brown, lighter in color toward epistoma, and with silvery pollen; parafaciale dark reddish brown to black, with dull silvery pollen, 0.7 in width opposite lunule; faciale reddish brown, nearly straight in profile, with short black setae which ascend about 0.30 the distance toward the antennal base; vibrissae 1.0 above the oral margin and set 2.4 apart; length of proboscis 9; haustellum 5.5; palpus orange, 3.3 in length; antenna with first segment dark brown to black, second segment reddish brown, lighter at apex, third segment 4.1 times as long as second, orange to orange brown at base, darker apically; arista with long black cilia for four-fifths its length; back of head black, with whitish pollen around occiput and below, with one row of black postocular cilia and numerous pale hairs which are particularly noticeable on metacephalon.

Thorax metallic blue green with purple and bronze colored reflections, mostly shining but with very thin whitish pollen in certain lights, this mainly apparent on pleura; humeral bristles three; propleuron with tawny pile; hindmost predorsocentral and hindmost preacrostichal bristles placed 0.8 and 1.4, respectively, before the suture; prosternum with brown setae; postacrostichal bristles two; lateral postscutellar plates with black setae.

Legs dark brown to black, the femora often greenish metallic; coxae with only black hair; middle femur with one anterior bristle near middle, about four anteroventral bristles toward base, and from three to five posteroventral bristles from middle to base; middle tibia with one ventral bristle and one postero-dorsal bristle near apical third; hind femur with anterodorsal and anteroventral rows of bristles and with three to five ventral bristles from middle to base; hind tibia with an anterodorsal row of very short bristles among which two or three are conspicuous, one anteroventral bristle at apical third (4 of 23 specimens examined with two, this additional bristle placed toward middle), and with two posterodorsal bristles, one near basal third and one near apical third.

Wing hyaline, slightly brownish anteriorly and darker basally; basicosta yellow to orange brown; subcostal sclerite yellow orange, to orange, with fine short decumbent orange pile; veins orange to orange brown; costal segments 2 to 6 in the proportion 62:42:87:34:9; upper squamal lobe white or rather yellowish; lower squamal lobe white basally, light orange to brownish apically.

Abdomen mostly shining metallic blue green; first segment blackish; second segment with faint indication of polished mid-dorsal spot on anterior margin and with a marginal row of recumbent bristles the middle pair of which may be slightly longer than the others (not to be confused with median marginal bristles); third segment highly polished apically and with a well-developed marginal row of bristles; fourth segment highly polished and with scattered black hairs.

Genital segments black, often slightly metallic greenish on dorsum, small, with scattered erect black hair. Internal anatomical features (pl.24,A,B, and C) as illustrated.

*Female.* Head width 14.7; length at antenna and at vibrissa 6.0; eye height 9.0; head height 11.4; bucca 0.25 of eye height; frontale widest at foremost ocellus, gradually narrowing to lunule where it is nearly twice as wide as one parafrontale, black posteriorly and orange brown anteriorly; front at narrowest (about 1.0 above lunule) 0.25 of head width, 0.29 at vertex and 0.28 at antennal base, with some minute tawny-colored setae outside frontal row, the foremost of which is sometimes slightly anterior to foremost frontal bristle; frontal bristles about seven, all strong; parafaciale opposite lunule 1.2 in width; vibrissae set 2.7 apart; palpus 3.7 in length; antenna with third segment 4.4 times as long as second; vertex and back of head black, with thin whitish pollen and usually slightly metallic bluish-green. Wing with squamal lobes white. Otherwise similar to male except for normal sexual differences.

*Length.* 6-9 mm.

*Distribution.* Nearctic: Common in southeastern United States, particularly from Maryland to Florida, and north to Michigan and Wisconsin; less abundant west of the Mississippi River.

Tothill (1913, pp. 254-255) identified the male of *Lucilia oculata* Townsend as *Lucilia caesar* (Linnaeus) and the female as *Lucilia pilatei* Hough. He identified the female of *Lucilia australis* Townsend as *Lucilia pilatei* and the male as *caesar*. The types of Townsend's two species are *caeruleiviridis* as I determine the species. *Lucilia caesar* of North American authors has usually been *Lucilia illustris*.

Aubertin (1933) stated that the type of *caeruleiviridis* in Newmarket is a female, but Macquart indicated that his specimen was a male.

*Biology, immature stages, and habits.* *Egg.* Melvin (1934) found that eggs of this species did not hatch at temperatures of less than 79° F., and at this temperature 11.05 hours were re-

quired to complete the incubation period. No hatch occurred at temperatures greater than 99° F., and at this temperature 7.75 hours were required to complete the incubation period.

*Larva.* First instar: Distribution and appearance of spines as in *silvarum*.

Second instar: Distribution of spines as in *silvarum*. Tubercles on border of stigmal field rather large, median pair on upper border not much smaller than outer; inner pair on lower border more than one-half as large as outer and median pairs; distance between inner tubercles on upper border distinctly less than distance between inner and outer ones but greater than distance from inner to median tubercles. Cephaloskeleton (pl.40,A) with dorsal cornua tapering to posterior end; labial sclerites rather short and broad.

Third instar: Segments 2-9 each with a complete band of spines at anterior margin; segment 10 with the spines extending well up to laterodorsal surface but not joining; spines rather variable at posterior border of segments; segments 10 and 11 with spines dorsally, six to eight rows usually present on dorsal surface of segment 11; segment 12 generally smooth on dorsal surface; segment 9 with the lateral spines sometimes joined by a single irregular row to form a complete band. Tubercles outlining stigmal field very large and prominent, the outer and inner pairs on upper border approximately equal and less than twice as large as median; distance between inner and intermediate tubercles not so great as distance from inner to outer ones; the two outer pairs on lower border larger than those on anal protuberances and usually larger than larger pair on upper border of stigmal field. Button area of spiracular plates (pl.40, C) rather well-developed, with a cylindrical pigmented inward projection below which is visible only when mounted plates are examined; peritreme well-developed, inward projection of peritreme between inner and middle slit prominent; spiracles, in general, heavily pigmented as in *illustris*, especially at the border and around slits, degree of pigmentation however varying considerably with age of specimen. Cephaloskeleton (pl.40,B) similar to that of *silvarum* and *mexicana* but ventral cornua produced posteriorly beyond hump to a greater extent than in these two species; labial sclerites curved slightly upward, then downward.

Anterior spiracles with number of branches ranging from 6 to 10 (In one series of 62 spiracles, Knipling (1936) found that 4 spiracles had 6 branches, 16 had 7, 21 had 8, 18 had 9 and 3 had 10; while in another series of 24 spiracles, 1 spiracle had 7

branches, 5 had 8, 8 had 9, 9 had 10. Thus in one series there was a predominance of 7-, 8-, and 9-branched spiracles, with only a few 9- and 10-branched ones; in the other series, 8-, 9-, and 10-branched spiracles predominated, only a few having 7 branches). These branches are small, short, and the length of the external portion is approximately equal to that of the spiracular chamber.

*Adult.* Davis (1928) gave a note upon the oviposition by females of this species upon a thin and emaciated kitten in Virginia. The eggs were deposited in the fur, particularly near the tail. So far as Davis could ascertain, the animal was weak and ill for want of food but was not wounded. McAtee (1929) reported that he reared this species from a nest of starlings in Virginia. Donohoe (1937) stated that *Phaenicia caeruleiviridis* is of considerable importance in the northern part of the Sacramento Valley, Calif., in areas where the drying of certain fruits is carried on commercially.

*Phaenicia caeruleiviridis* is a common species in the woods and fields, where it may sometimes be collected upon human excrement. It does not seem to be abundant about houses, but may be collected in large numbers in traps baited with decaying meats when such traps are placed in urban areas. It appears about May 10 each year in the vicinity of Washington, D. C.

#### *Phaenicia cluvia* (Walker), new combination

*Musca cluvia* Walker, List of the Specimens of Dipterous Insects in the Collection of the British Museum, vol. 4, p. 885, 1849. (Type, from the West Indies, in the British Museum.)

*Lucilia pilatei* Hough, Zool. Bull. 2 (6):287, 1899; Townsend, Smithsn. Misc. Collect. 51:122, 1908; Tothill, Ent. Soc. Amer. Ann. 6:254, 1913; Johnson, Amer. Mus. Nat. Hist. Bull. 32:76, 1913; West, in Leonard, Mem. 101, Cornell Univ., page 828, 1928. (Type, male, Tifton, Ga., in the Field Museum.)

*Lucilia cluvia* (Walker). Aubertin, Linn. Soc. London Jour., Zool. 38:418, 1933.

A species with the general habitus of *caeruleiviridis*.

*Male.* Head width 10.9; length at antenna 4.7 and at vibrissa 5.1; eye height 7.4; head height 9.3; epistoma short but wide, warped abruptly forward almost to vibrissal profile just below vibrissa; metacephalon hardly apparent in profile; bucca 0.22 eye height, with thin silvery pollen over reddish brown ground

color anteriorly, brownish black posteriorly, and with scattered dark hair anterodorsally, yellowish or tawny hair below and posteriorly; frontale half frontal width, orange brown anteriorly, black posteriorly; frontal row of bristles consisting of 12 to 14 bristles, these strong anteriorly, weak posteriorly, the rows diverging anteriorly with margins of frontale and reaching to base of second antennal segment, the foremost bristle most divergent; inner vertical bristle strong, cruciate; clypeus with yellowish silvery pollen over orange-red to brownish ground color; front orange brown to black, with silvery pollen and with a few pale hairs outside frontal row, at narrowest 0.10 of head width, 0.18 at vertex and 0.29 at antennal base; faciale yellow orange to orange red, nearly straight in profile, with three or four rows of short stubby black setae ascending one-fourth the distance to the antennal base; parafaciale opposite lunule 0.9, dark brown to black in ground color, with silvery pollen; vibrissae only 0.5 to 0.7 above oral margin and set 2.0 apart; proboscis a little over half head height, haustellum half length of proboscis; palpus yellow orange, 3.0 in length; antennae set rather far apart at base, first segment dark brown to black, second orange to orange brown, third usually darker than second except at base and four times as long, reaching 0.85 the distance toward the vibrissa; arista orange to orange brown at base, black on apical half, with long black cilia for four fifths its length; back of head black, with silvery pollen especially around occiput, with one row of postocular cilia and with numerous pale yellowish hairs which are particularly abundant below occiput.

Thorax bright metallic blue green with coppery-colored reflections, mostly shining but with silvery pollen anterodorsally and on lower pleura in certain lights from anterodorsal aspect with bronze-colored dorsal longitudinal stripe just laterad of acrostichal row not extending posterior to suture, and with a suggestion of a stripe laterad of dorsocentral row just posterior to suture; humeral bristles three; propleuron with tawny setae; hindmost preintraalar bristle 0.6 before suture; preacrostichal bristles two, the hindmost placed 2.0 before suture; dorsocentral bristles three, the hindmost placed 1.2 before suture; prosternum with tawny-colored setae; postalar declivity with a few dark hairs near center; postacrostichal bristles two; scutellum as in *sericata*.

Legs brownish black; hind coxa bare posteriorly but elsewhere with fine tawny-colored hairs; hind trochanter with tawny-colored hairs; fore tibia with three, sometimes four, short stubby

bristles on dorsal surface, one near basal third, one near middle, and usually one between apical third and fourth; middle femur with one anterior bristle near middle, three or four anteroventral bristles toward base, and with four posteroventral bristles toward base; middle tibia with one anterodorsal bristle at apical third, one ventral bristle near apical third, two posterior bristles, one near basal third and one near apical third, and one postero-dorsal bristle near apical third; hind tibia with from one to three anterodorsal bristles, always one at basal third, usually one at or near middle, and rarely with one near basal sixth, with one anteroventral bristle at or near apical third, and with two postero-dorsal bristles, one near basal fourth and one near apical third.

Wing hyaline, yellowish toward base, with yellow orange to orange brown veins; basicosta yellow orange to orange brown; subcostal sclerite with golden pubescence; costal sections 2 to 6 in the proportion 56:31:73:27:8; lower squama lightly yellowish to yellowish brown.

Abdomen brilliant shining metallic blue green, with thin silvery pollen on venter; first segment black on dorsum; second segment with a purplish or black middorsal spot on anterior margin, the hind margin purplish or black, and with recumbent marginal bristles; third segment often with hind margin narrowly purplish or black and with a marginal row of erect bristles; basal sternites usually with considerable fine tawny-colored hair; fifth sternite brownish, divided, the arms rounded apically.

Genital segments brownish, metallic dorsally, internal anatomical structures (pl. 24, D and E) as illustrated.

*Female.* Head height 10.9; length of head at antenna 5.1 and at vibrissa 5.4; parafaciale 1.3 in width opposite lunule, vibrissae set 2.1 apart; head width 12.3; eye height 7.8; bucca 0.21 of eye height; front at narrowest (about 1.0 above lunule) 0.28 of head width, 0.29 at vertex and 0.34 at antennal base; frontale one-half frontal width at ocellar triangle and narrowing anteriorly, black at vertex, orange to orange brown at lunule; frontal row of bristles only very slightly diverging anteriorly as they follow the frontale, each row consisting of eight or nine bristles; outer vertical bristle 0.65 as long as inner and divaricate; frontoorbital bristles two proclinate and one reclinate, the foremost proclinate bristle usually considerably larger than the following bristle; ocellar bristles almost exactly divaricate and with a lesser pair of ocellar bristles immediately behind and between posterior ocelli, these also nearly divaricate. Otherwise similar to male except for normal sexual differences.

*Length.* 6-8 mm.

*Distribution.* Neartic and Neotropical: Cuba and Puerto Rico, north to North Carolina and west to southern Mississippi. The species occurs in Florida in late summer and in the northern limits of its range during October. It is present throughout the year in the West Indies and on some of the Florida Keys.

*Phaenicia cluvia* was reported from the state of New York by Leonard (1928, p. 828), but no specimens of the species from north of Virginia have been seen during the course of these studies.

Aubertin (1933, p. 418) placed Johnson's species *Lucilia problematica* questionably as a synonym of *cluvia*, but *problematica* is a valid species and is so treated elsewhere in this paper.

*Biology.* The habits of the adults of this species are exactly similar to those of *caeruleiviridis*, from which *cluvia* is difficult to distinguish in the field. Many specimens of both sexes may be collected in the vicinity of Miami, Florida, during August and September, where they congregate on fallen fruits and decaying materials. The species is attracted to carcasses and many specimens may be trapped in meat-baited traps. The immature stages are undescribed.

*Phaenicia eximia* (Wiedemann), new combination

*Musca eximia* Wiedemann, Zool. Mag. 1 (3):53, 1819; Ausser-europäische zweiflügelige Insekten, vol. 2, p. 399, 1830; Aubertin, Linn. Soc. London Jour., Zool. 38:423, 1933 (*Lucilia*). (Type, female from Brazil, in Vienna.)

*Musca ochricornis* Wiedemann (in part), Ausser-europäische zweiflügelige Insekten, vol. 2, p. 408, 1830. (Type, female from Brazil, in Vienna.)

*Lucilia eximia* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 456, 1830, = *Orthellia lauta* (Wied.) (Type, in Paris Museum.)

*Lucilia ruficornis* Macquart, Diptères exotiques, sup. 1, p. 198, 1846; Schiner, Reise der Novara, Diptera, p. 304, 1868; Roeder, Stett. Ent. Ztg. 46:347, 1885; Williston, Roy. Ent. Soc. London, Trans. 1896:367; Wolcott, Puerto Rico Dept. Agr. Jour. 7:225, 1923. (Type, male and female, from Colombia, apparently lost.)

*Lucilia punctipennis* Macquart, Diptères exotiques, sup. 3, p. 216, 1848. (Type, from Brazil, in the Bigot Collection, Newmarket, England.)

- Musca insularis* Walker, Insecta Saundersiana, vol. 1, p. 340, 1856. (Type, from West Indies, in the British Museum.)
- Somomyia amazona* Bigot, Soc. Ent. de France Ann. (5) 7:255, 1877. (Type, in the Bigot Collection, Newmarket, England.)
- Somomyia mutabilis* Bigot, Soc. Ent. de France Ann. (5) 7:248, 1877. (Type, Mexico, in the Bigot Collection, Newmarket, England.)
- Somomyia orenoquina* Bigot, Soc. Ent. de France Ann. (5) 7:253, 1877. (Type, from Brazil, in the Bigot Collection, Newmarket, England.)
- Somomyia pueblensis* Bigot, Soc. Ent. de France Ann. (5) 7:250, 1877; Brauer, Akad. der Wiss. Wien, Math.-Nat. Kl. Sitzber. (1) 108:522, 1899 (*Lucilia*). (Type, in the Bigot Collection, Newmarket, England.)
- Somomyia sylphida* Bigot, Soc. Ent. de France Ann. (5) 7:45, 1877; Brauer, Akad. der Wiss. Wien, Math.-Nat. Kl. Sitzber. (1) 108:523, 1899 (*Lucilia*); Tothill, Ent. Soc. Amer. Ann. 6:256, 1913. (Type, New Orleans, La., in the Bigot Collection, Newmarket, England.)
- Lucilia hirtiforceps* Shannon, Wash. Ent. Soc. Proc. 28 (6):133, 1926; Curran, Scient. Survey Porto Rico and Virgin Islands, vol. 11, pt. 1, p. 93, 1928; Roberts, Ecology 14 (3):309, 1933. (Type, male [with female in cop.] from Canal Zone, Panama, No. 28892, in U. S. National Museum.)

A blue-green species with the abdomen highly polished.

*Male*. Head length at antenna 4.9 and at vibrissa 5.4; height 10.8; width 12.3; eye height 8.5; bucca 0.23 of eye height, orange to orange brown in ground color, covered with coarse yellowish to golden pollen, and with scattered dark hair, no pale hairs before the metacephalic suture; metacephalon slightly protuberant posteriorly; frontale dark reddish brown, obliterated for at least 1.0 unit below anterior ocellus but wider than either parafrontale at lunule; front at narrowest 0.04 of head width, 0.13 at vertex and 0.22 at lunule, with silvery to yellowish pollen, and with a few short pale hairs outside frontal bristles which extend anteriorly to foremost frontal bristle; frontal rows of bristles extending anteriorly to about the base of the second antennal segment and diverging as they follow the margins of the frontale, each row consisting of about 10 bristles which are long anteriorly and weak or nearly vestigial posteriorly; vertex subpollinose, dark brown to black; clypeus with thin yellowish silvery pollen over yellow orange to orange ground color; epistoma often with



weak setae between vibrissae; parafaciale opposite lunule 0.7 in width, much wider below, and with thin yellowish silvery pollen over orange brown ground color; faciale nearly straight in profile and with several rows of short black setae which ascend about one-third the distance to the antennal base; vibrissae 0.5 above the oral margin and set 2.3 apart; proboscis 6.0 in length, haustellum 3.0; palpus yellow to orange, 3.5 in length; antenna with first and second segments orange brown to brown, third segment 3.8 times as long as second, reaching 0.85 of the distance to the vibrissae; arista brown and with long black cilia for 0.85 its length; back of head black, with yellowish white pollen around the occiput, with one row of postocular cilia and considerable whitish yellow hair, especially below on metacephalon.

Thorax shining metallic blue green, sometimes strongly blue with greenish reflections, and often with bronze-colored reflections in certain lights, usually with very thin whitish pollen anteriorly and on pleura; humeral bristles three; preacrostichal and predorsocentral bristles two, the posterior one in each row placed 2.8 and 1.4, respectively, before the suture; preintraalar bristles two or three, the foremost sometimes absent; presupralar bristle one; propleuron and prosternum with tawny hair; postalar declivity with a small tuft of black setae near middle; selerites at wing base dark brown to black; postacrostichal bristles two; lateral postscutellar plates with black setae.

Legs brown to brownish black; anterior femur and tibia as in *sericata*; middle femur with one anterior bristle near middle, about three anteroventral bristles, one at basal fourth, one at basal third and one at middle, and about four posteroventral bristles toward base; middle tibia with one anterodorsal bristle near apical third, two posterior bristles, one near basal third and one near apical third, and two posterodorsal bristles, one near basal third and one near apical third (1 of 10 specimens without basal bristle); posterior femur with anterodorsal and anteroventral rows of bristles (anteroventral row usually with bristles at base and apex considerably longer than those near middle), and with about three posteroventral bristles toward base; posterior tibia with an anterodorsal row of short fine bristles (usually two or three of these longer), usually two anteroventral bristles, one at about basal third and one between middle and apical third (1 of 10 specimens without basal bristle), and with two posterodorsal bristles, one near basal fourth and one near apical third.

Wing hyaline, brownish anteriorly, considerably so at base;

veins dark brown; basicosta brown to brownish black; subcostal sclerite yellow brown basally, darker apically, with fine short brown pile; costal sections 2 to 6 in the proportion 64:47:89:37:11; upper squamal lobe white at base and brown on margin; lower squamal lobe brown.

Abdomen shining metallic blue green or sometimes rather bluish with green reflections, the hind margin of the segments often purplish or black, and with only a trace of thin silvery pollen ventrally; first segment black; second with a slightly darkened area on anterior middorsal margin, and with a marginal row of rather weak recumbent bristles; third segment highly polished, particularly on posterior dorsal half, and with a marginal row of erect bristles; fourth segment entirely shining and highly polished; all segments ventrally with rather long black hair.

Genital segments black, very slightly greenish, small, with scattered black setae. Internal anatomical features (pl. 24, F, G, and H) as illustrated.

*Female.* Head height 10.9; eye height 8.6; bucca 0.22 of eye height; length at antenna 5.4 and at vibrissa 5.8; parafaciale opposite lunule 1.2 in width; vibrissae set 2.6 apart; head width 13.2; frontale black posteriorly, reddish brown at lunule, and narrowing toward lunule where it is a little wider than either parafrontal; front at narrowest (about 1.0 unit above lunule) 0.24 of head width, 0.29 at vertex and 0.29 at lunule; frontal row of bristles consisting of about six bristles nearly equal in size; outer vertical bristles divaricate and about three-fifths as long as inner vertical bristles; frontoorbital bristles two, proclinate (the anterior one the larger) and one reclinate; ocellar bristles almost exactly divaricate, and with a posterior pair of lesser divaricate ocellar bristles behind and between the posterior ocelli; vertex black, somewhat shining, and usually greenish in certain lights; epistoma rarely with weak setae between vibrissae; palpus 3.6 in length; third segment of antenna 3.8 times as long as second and usually more orange than in male. Thorax with slightly more whitish pollen than in male. Wing more yellowish or yellowish brown at base, squamal lobes white, orange on rims. Abdomen highly polished on last two segments, particularly on dorsum. Otherwise like male except for normal sexual difference.

*Length.* 6-8 mm.

Reared and teneral specimens of *eximia* are often bronzy green instead of the typical steel blue green. Specimens are frequently seen which are almost entirely blue with only suggestions of

green, and these often tend toward purplish in certain lights. The cause of such color differences is not fully understood, but they are not of apparent taxonomic significance. Male specimens of typical color often turn bluish in a relaxing jar.

*Distribution.* Neotropical and Nearctic: South and Central America, and extending northward to Port Lavaca and Uvalde, Texas.

*Biology.* Adults of both sexes may be collected throughout Central America on materials of decay. It is the common green bottlefly of the market places of Guatemala, Honduras, Nicaragua, Panama, Venezuela, and the Guianas. Specimens may be collected upon rotting fruits and garbage as well as upon carcasses and they are commonly attracted to meat-baited traps. Although other species of the genus are uncommon in the tropics this species apparently occurs at nearly all altitudes and in nearly all situations from the tropical rain forests along coastal regions to pine flats in the mountains of Guatemala. Larvae have been recovered and adults have been reared from rotting fruits in Panama, and from decaying meat in Puerto Rico (Jan. 6, 1936, Dozier). Lopez (1938) reared specimens from epithelial detritus on the feet of a fowl infested with *Cnemidocoptes mutans* Robin.

Roberts (1933) found that *eximia* often occurred in trees in the vicinity of Uvalde, Texas.

#### *Phaenicia mexicana* (Macquart), new combination

*Lucilia mexicana* Macquart, Diptères exotiques, vol. 2, no. 3, p. 300, 1843; Aubertin, Linn. Soc. London Jour., Zool. 38:422, 1933. (Type, male from Mexico, in the British Museum.)

*Lucilia unicolor* Townsend, Smithsn. Misc. Collect. 51:121, 1908; Shannon, Insector Insectiæ Menstruus 12:78, 1924; Wash. Ent. Soc. Proc. 28 (6):133, 1926; Roberts, Ent. Soc. Amer. Ann. 23:790, 1930; Ecology, 13 (3):309, 1933. (Type, female from New Mexico, No. 10892, U. S. National Museum.)

*Lucilia infuscata* Townsend, Smithsn. Misc. Collect. 51:123, 1908. (Type, male from New Mexico, No. 10895, U. S. National Museum.)

*Lucilia caesar* Tothill (nec Linnaeus), in part, Ent. Soc. Amer. Ann. 6:248, 1913.

Townsend described *Lucilia infuscata* from nine males and six females from Massachusetts, New Hampshire, Ohio, New

Mexico, Arizona, and British Columbia. Only the male holotype is now in the National Museum and apparently it is *mexicana*. *Lucilia unicolor* was described by Townsend from five females collected in New Mexico, Mexico, and British Columbia. Only the female holotype is now in the National Museum, and apparently it is also *mexicana*. *Lucilia mexicana* does not seem to have the distribution noted for *infuscata*, and it is concluded that the two series of type specimens included more than one species. Roberts (1930) states that one specimen of *mexicana* was collected in a trap at Ames, Iowa, on October 29; the distribution, therefore, may be considerably wider than indicated.

A species which is very similar to *caeruleiviridis*, but has two or more rows of postocular cilia.

*Male.* Head width 13.2; height 11.0; length at antenna 5.4 and at vibrissa 5.9; eye height 9.4; bucca 0.31 of eye height, orange brown to dark brown, with thin silvery pollen and with dark hair, no pale hair before the metacephalic suture; frontale reddish brown at lunule and darker brown toward ocellar triangle; very narrow at the narrowest part but as wide as parafrontale at lunule; front at narrowest 0.05 of head width, 0.14 at vertex and 0.23 at lunule, dark brown to black and with bright silvery pollen, and with a few scattered dark setae on parafrontale; frontal rows of bristles considerably divergent anteriorly as they follow the frontale and extend almost to the base of the second antennal segment, each row consisting of about 14 bristles which are strong anteriorly but weak at the narrowest portion of the frontale; a reclinate frontoorbital bristle slightly anterior to and opposite foremost ocellus; parafaciale opposite lunule 0.9 in width and considerably wider below, with bright silvery pollen over orange-brown ground color; faciale orange brown to dark brown, with a row of short fine setae which extend less than one-third the distance to the antennal base; vibrissae placed 0.6 above oral margin and 2.4 apart; palpus 3.4 in length; antenna with first and second segments dark brown, the latter orange at apex, third segment orange at base and gradually darkening to dark brown apically; arista brown with long brown cilia; back of head black with whitish pollen around occiput, with two rows of postocular cilia and numerous pale hairs which are most apparent on the orange colored metacephalon.

Thorax metallic blue green with purplish reflections, mostly shining, but with thin whitish pollen in certain lights especially on dorsum anteriorly between humeri and on pleura; propleuron with black setae; basal sclerites at wing base dark brown to

black; hindmost preacrostichal and predorsocentral bristles 2.6 and 1.2, respectively, before suture; postacrostichal bristles two.

Legs usually black but sometimes brownish on femora and tibiae.

Wing hyaline, faintly brownish anteriorly and toward base; basicosta dark brown to black; subcostal sclerite orange brown basally, darker brown apically, with fine decumbent brown pile; costal sections 2 to 6 in the proportion 73:50:90:39:9; second and third sections of fourth vein in proportion 74:67; third vein setulose nearly one-half the distance to the cross vein; squamal lobes white at base, the lower lobe brown apically.

Abdomen colored like thorax, first segment dark purplish; second segment with only a suggestion of marginal row of bristles; third segment with marginal row of strong bristles; fourth segment with scattered erect bristles.

Genital segments brown to black, slightly greenish dorsally, with scattered erect black hairs. Anatomical features (pl. 24, I) as illustrated.

*Female.* Head width 15.5; height 12.0; eye height 8.6; length at antenna and at vibrissa 6.4; bucca 0.33 of eye height; frontale narrowed anteriorly, orange red to brown; frontal rows of bristles consisting of about seven each, the rows strongly divergent anteriorly; vertex black, slightly silvery; parafrontale at narrowest 0.29 of head width, only slightly wider at vertex and 0.32 at lunule, silvery, with a row of minute setulae near eye which extend anteriorly to nearly opposite foremost frontal bristle; parafaciale opposite lunule 1.7 in width; vibrissae set 3.0 apart; antenna with third segment 4.7 times as long as second; palpus 3.9 in length. Wing with costal sections 2 to 6 in the proportion 81:57:112:45:11; both upper and lower squamal lobes white. Otherwise similar to male except for normal sexual differences.

*Length.* 6-9 mm.

*Distribution.* Nearctic and Neotropical: As far south as Brazil and as far north as Arizona, New Mexico, and Texas.

*Biology, habits, and immature stages.* Incubation period: Melvin (1934) found that incubation of eggs of this species did not occur at temperatures below 75° F., and at this temperature 14.03 hours were required for the eggs to hatch. No hatching occurred at temperatures higher than 99° F., and at this temperature 8.12 hours were necessary for complete incubation. The optimum temperature for the incubation appeared to be at about 94° F., at which temperature development was completed in 7.77 hours.

*Larva.* First instar: Spines heavily pigmented as in *caeruleiviridis* and *silvarum*; segments 1 to 8 each with a complete band of spines at anterior border; segments 10 and 11 provided with posterior border of spines on dorsal surface; segment 9 with bands of spines at both anterior and posterior margins narrowly interrupted. Tubercles on last segment and cephaloskeleton similar to those of *illustris*.

Second instar: Spines forming a complete band at anterior border of each of segments 2-8 and extending almost to dorsal surface on segment 9; segments 11 and 12 each usually with complete band on posterior border (sometimes restricted to ventral, lateral, and dorsolateral surfaces). Relative distribution of tubercles on last segment as in third instar. Tubercles broadly rounded at tip, the median pair on upper border and inner pair on lower border only slightly smaller than the others. Cephaloskeleton (pl. 40, E) similar to that of *caeruleiviridis* but labial sclerites more slender, the basal portion with a longer posterodorsal projection. Anterior spiracles with six to eight branches.

Third instar: Distribution of spines variable; anterior margin of each of segments 2-8 generally completely encircled with spines (in some specimens the complete band may extend to segment 9, while in others it may extend only to segment 7); posterior margin of segment 11 generally provided with three to four dorsal rows of spines, but spines sometimes absent at posterior margin of all but segment 12. Tubercles (pl. 40, G) outlining stigmal field rather prominent; inner pair on upper border equal to or only slightly larger than the other two pairs which are nearly equal in size; on lower border, outer and intermediate pairs large, the inner pair comparatively large (in other species the inner tubercles on lower border are always distinctly smaller). Posterior spiracles (pl. 40, D) with peritreme narrow and not heavily pigmented; a rather long narrow inward projection of peritreme between inner and lower spiracular apertures. Pharyngeal sclerites (pl. 40, F) similar to those of *caeruleiviridis* but with shorter ventral cornua. Anterior spiracles in one series with 5 to 8 branches (in a total of 24 spiracles, 1 had 5 branches, 7 had 6, 12 had 7, and 4 had 8); in another, with 6 to 11 branches (total of 84 spiracles distributed 3, 28, 33, 15, 4 and 1); size of lobes and form of spiracles as in *sericata*.

Most of the series in the National Museum collection are from Brewster County, Reagan Wells, Dallas, and Uvalde, Tex. It is not an abundant species in North America except in the

Southwest. In Menard Co., Tex., Parish and Cushing (1939b) found adults to occur throughout the year, but most abundantly about the first of June and again about the first of August. It was the most abundant species of *Phaenicia* in this area. Specimens from Arizona were collected at an elevation of 5,300 feet. Notwithstanding the fact that *mexicana* occurs throughout Central America, it is not an abundant species south of Mexico City and Campeche in Mexico. Only a few specimens were collected at Tapachula or Ixtapee in southern Mexico, and none in any of the other Central or South American countries.

*Phaenicia pallescens* (Shannon), new combination

*Lucilia pallescens* Shannon, Insector Inseitiae Menstruus 12:78, 1924; Wash. Ent. Soc. Proc. 28(6):131, 1926. (Type, male from Wilmington, N. C., No. 26689, in U. S. National Museum.)

*Phaenicia argyrocephala* Malloch (nec Macquart), Ann. and Mag. Nat. Hist. (9)17:506, 1926.

*Lucilia cuprina* Shannon (nec Wiedemann), Wash. Ent. Soc. Proc. 28:131, 1926; Malloch, Linn. Soc. N. S. Wales, Proc. 52:321, 1927; Bezzi, Bull. Ent. Res. 17:238, 1926.

*Phaenicia pallescens* (Shannon) has been considered to be a synonym of *Lucilia argyrocephala* of South Africa or of *Lucilia cuprina* of Asia and Australia. All three names have erroneously been treated as synonyms by some authors; but Oriental, African, and Australian specimens identified as *Phaenicia cuprina* differ from typical specimens of *Phaenicia pallescens* of North America in having the front at the narrowest not so wide in comparison with the head width, the bucca proportionately higher in comparison with the eye height, the lateral margins of the parafrenale in the female narrow from the vertex toward the lunule, and narrowest about 1.5 to 2.0 above the lunule.

Because of the apparent biological differences between the Australian *cuprina* and the species that has been known as *cuprina* in North America, series of larvae were sent to Mr. E. F. Knippling, Division of Insects Affecting Man and Animals, Bureau of Entomology and Plant Quarantine, and reared adults were forwarded to me by Mr. I. M. Mackerras of Canberra, Australia.

Patton (1920) had reported that the anterior spiracles of the oriental larvae of *cuprina* were comprised of from six to eight branches, Fuller (1932, p. 83) had described the anterior spiracles of third-instar larvae of the Australian form as having

seven or eight branches, and Knipling (1936) found this number to be from four to six in the North American form.

Mr. Knipling sent to me the following summary of his examinations: "A comparison of the immature stages of the Australian *cuprina* and the American species known under that name indicates close relationship. However, recognized American species possess no greater larval difference than these that differentiate these two forms. On the basis of the taxonomic differences discussed in this report (anterior spiracles, tubercles, and spines) it is concluded that the Australian and American forms are distinctly different. Whether or not the observed differences are of specific or varietal significance can be judged better by considering the larval differences in conjunction with adult differences."

*Phaenicia cuprina* (Wied.) is the most important blowfly in Australia. Approximately 90 percent of all "strikes" of sheep in Australia are due to this species according to Mackerras and Fuller (1937). The species is said to cause a loss of several millions of dollars each year to stock-breeders in that country. It is practically the only species to initiate "strike" in sheep in the Canberra District during the warmer months, and its distribution extends well into the drier sections of Australia. It reaches its greatest abundance in the tropical and arid parts of Australia during the spring and autumn months according to Mackerras, who considers the species an introduced one into the country. Fuller (1932) found the larva of *cuprina* to differ from that of *sericata* in having the posterior spiracles rounded, smaller, the peritreme thicker and wider, and the slits shorter and wider.

In South Africa the form usually considered under the name of *cuprina* is of little or no real economic significance so far as published records indicate. Lewis (1933) reported upon a number of myiasis cases in sheep; both this species and *Muscina stabulans* were reared from one of these cases. Rearing of the latter species, in cases of myiasis, indicates that the wound was an old and suppurating one. Cuthbertson (1933) stated that this form is common everywhere in Cape Colony, South Africa, and that it is considered a nuisance in butcher shops and about abattoirs. It appears that the African form resembles *pallescens* of North America in biology and habits.

It has generally been considered that *Phaenicia pallescens*, *cuprina* and *sericata* are closely related. While several characters of chaetotaxy place the species together, *sericata* is very distinct. According to Heim de Balzac (1937), Villeneuve is inclined to



regard *cuprina* (including *pallescens*) as a parasitic race of *sericata* slightly modified from the true form by its parasitic mode of life. It may be true that such habits tend to modify anatomy and account for differences between Australian specimens of *cuprina* which have been reared from cases of strike in sheep and the North American *pallescens* which is of no economic importance, but the differences between the *cuprina-pallescens* and *sericata* groups are so sharp and clear-cut that there should be no reason to confuse them.

A cupreous green species similar in general habitus to older and smaller individuals of *sericata* but with the metasternum bare.

*Male.* Head height 9.1; eye height 7.2; bucca 0.23 of eye height; length at antenna 5.2 and at vibrissa 5.3; epistoma elongate and nearly as wide as clypeus but shorter and flatter than in *sericata*, the facial profile more arcuate; metacephalon hardly apparent in profile; bucca reddish brown in ground color, with rather thin bright silvery pollen and with numerous short black hairs; frontale about 0.43 of frontal width, reddish brown anteriorly, often black or brownish black particularly posteriorly; front at narrowest 0.28 of head width, 0.18 at vertex and 0.31 at lunule; head width 11.0; parafaciale opposite lunule 1.3 in width; vibrissae set 1.9 apart and placed 0.75 above oral margin; parafrontale with bright silvery to yellowish silvery pollen, with a few scattered dark hairs outside the frontal row, these not extending anteriorly to the foremost frontal bristle and most numerous at vertex; frontal row of bristles consisting of about seven or eight bristles which are rather short and hairlike posteriorly; a pair of well-developed divaricate accessory ocellar bristles immediately behind and between posterior ocelli; vertex subpollinose, slightly silvery over brownish black ground color; faciale bristly only at or but slightly above vibrissa; proboscis about one-half head height, haustellum about one-fourth head height; palpus 3.0 in length; antennal segments usually black but often orange to orange brown; third segment three times as long as second; back of head black, usually metallic greenish, with two rows of postocular cilia and with pale hairs, the latter most apparent on postoral margin and above toward occiput.

Thorax pale yellow green with a metallic cupreous luster especially in certain lights, with several metallic cupreous longitudinal stripes on dorsum which are difficult to distinguish unless viewed anterodorsally, one outside acrostichal row extending from anterior margin to slightly beyond suture, and another outside dorsocentral row extending from suture toward scutellum,

neither of which extend to scutellum, with thin whitish pollen which is most apparent in certain lights just behind head on dorsum and on pleura; humeral bristles three strong with usually one smaller bristle anterior to and between inner and middle bristles; hindmost preacrostichal and predorsocentral bristles placed 1.0 and 2.2, respectively, before suture; postalar declivity with only a few weak hairs; metasternum bare.

Legs as in *sericata* except middle tibia usually with one anterior bristle near middle (this sometimes absent) and usually with but two or three anteroventral bristles toward base; middle tibia usually with but one posterodorsal bristle near middle; hind tibia usually without anteroventral bristles (if present, reduced in size).

Wing hyaline, yellowish basally and all veins yellowish; basicosta whitish yellow; costal sections 2 to 6 in the proportion 64:38:79:31:7; anterior cross vein slightly basad of middle of second section of fourth vein.

Abdomen usually cupreous greenish, with whitish pollen in certain lights especially on venter; first segment dark, only slightly metallic greenish; second with darkened shining mid-dorsal longitudinal stripe beginning at anterior margin and widening posteriorly, often extending upon anterior portion of third segment. Fifth sternite (pl. 24, M) strongly produced posteriorly and ventrally, giving the abdomen a ventrally-curved habitus.

Genital segments shining black, setose, large, globose, considerably hidden dorsally by posterior margin of fourth abdominal segment and ventrally by the elongate arms of fifth sternite. Internal anatomical features (pl. 24, J, K and L) as illustrated.

*Female.* Head height 9.4; eye height 6.8; bucca 0.26 of eye height; length of head at antenna and at vibrissa 5.5; parafaciale opposite lunule 1.8 in width; vibrissae set 2.1 apart; head width 12.0; front at vertex 0.40 of head width, at narrowest (only slightly posterior to lunule) 0.39, and at lunule 0.42; front with nearly parallel margins or these slightly narrowing anteriorly; frontale slightly wider than parafrontale and narrower anteriorly, reddish orange anteriorly and black posteriorly; vertex cupreous greenish over black or brown; parafaciale and parafrontale often considerably yellowish; third segment of antenna 2.6 times as long as second. Wing with costal segments 4 and 5 longer than in *sericata*. Abdomen with much more conspicuously whitish pollen especially on venter.

*Length.* 5.0-8.5 mm.

*Distribution.* Nearctic: Southern United States.

*Biology, immature stages, and habits. Egg.* The eggs are deposited in batches of approximately 100 on carcasses, especially in or near crevices about the natural openings.

Melvin (1934) found that eggs of *pallescens* failed to hatch at temperatures below 74° or above 104° F. At the lower limit 15.06 hours were required to complete incubation and at the upper limit 8.91 hours. He also found the optimum temperature to be apparently about 99° F., at which development was completed in 7.72 hours.

*Larva.* First instar: Spines almost without pigment, their distribution difficult to determine; segments 2-7 each with complete band of spines at anterior border; posterior border of segment 11 with two to three dorsal rows of heavily pigmented spines, but these apparently absent on dorsal surface of each of segments anterior to segment 11. Tubercles on segment 12 small; in same relative position as in later instars. Cephaloskeleton (pl. 41, A) very small and weakly developed; labial sclerites not prominent and hatching spine short; pharyngeal sclerites narrow, ventral cornua narrow and tapering to sharp point; anterodorsal projection of pharyngeal sclerites long, approximately two-thirds as long as dorsal cornua.

Second instar: Spines small and colorless to light brown; segments 2-7 each with a complete anterior band of spines; segment 8 with spines usually absent or very small and lightly pigmented on dorsal surface; posterior border of segment 11 with several dorsal rows of spines; segment 10 without dorsal spines. Tubercles on border of stigmal field small, relative position as in third instar. Cephaloskeleton (pl. 41, B) distinct and easily distinguished from those of other species, the most striking difference being in the appearance of the labial sclerites; entire length from tip of labial sclerites to tip of dorsal cornua 500-550 microns (in other species this length is at least 600 microns and sometimes it is greater than 700 microns). Anterior spiracles with four to six widely separated branches, more often with five.

Third instar: Spines not prominent, lightly pigmented; segments 2-8 each completely encircled with spines at anterior border; segment 9 generally with one or two irregular and broken dorsal rows, but these may be absent for a short space; spines restricted to ventral and lateral surfaces on segment 10; segment 11 posteriorly with three to four dorsal rows of spines; segment 10 without dorsal spines; distribution of spines as in *sericata*

but spines smaller, less pigmented, and seemingly less variable in distribution; segment 12 smooth on dorsal surface except posteriorly. Tubercles around stigmal field not nearly so prominent and much smaller than in *sericata*; outer pair on upper border distinctly larger than inner tubercles and more than twice as large as median ones; inner pair on lower border less than one-half as large as the other two pairs; relative position of tubercles similar to that in *illustris*; tubercles in anal protuberance about twice as large as the larger ones on the lower border of the stigmal field. Posterior spiracles (pl. 41, D) small and broad, usually broader than long; apertures short; peritreme without inner projections. Cephaloskeleton (pl. 41, C) small, approximately 1.0 mm. in length, this being considerably smaller than in other species; pharyngeal sclerites comparatively short and broad. Anterior spiracles with five to six branches (in 6♂ spiracles 40 had 5 branches, 24 had 6); portion of anterior spiracle external to cuticle approximately one-half as long as internal pigmented trunk.

Like all the species of *Phaenicia* in North America, *pallescens* is a typical saprophage. If the larvae are fed decaying meat the species may be easily reared from egg to adult in the laboratory. The larval stage lasts about 72 hours under favorable temperature conditions. The prepupal stage of *pallescens* lasts but a relatively few hours during the warmer periods of the year. The pupal stage may be as short as 6 or 7 days during the summer months, but emergence may be delayed for several weeks or even longer in cold weather.

*Adult.* *Phaenicia pallescens* is essentially a southern species. While *sericata* and *pallescens* may often occur together, the former is found most abundantly in cooler climates, the latter throughout the southeastern part of the United States, particularly in the more humid areas. The adults are most numerous in market sections of cities where they may be easily collected upon decaying produce. In the vicinity of Washington, D. C., adults usually appear about the first week of June and remain abundant until about the first of September, although a few lingering specimens may be collected as late as November first. In southern Florida, especially in the vicinity of Miami, *pallescens* is extremely abundant during the spring and summer months. Both sexes may be collected in numbers upon rotting fallen fruits and it is the abundant species of *Phaenicia* in meat-baited traps.

*Phaenicia problematica* (Johnson), new combination

*Lucilia problematica* Johnson, Ent. Soc. Amer. Ann. 6(4) :448, 1913. (Type, male from Bermuda, West Indies, No. 40793, U. S. National Museum.)

A small black-bodied species with orange-colored appendages.

*Male.* Head height 11.0; length at antenna 5.2 and at vibrissa 5.8; eye height 8.2; bucca 0.29 eye height, dull mahogany brown with scattered black hair and thin gray pollen; head width 12.4; front at narrowest 0.02 of head width, 0.19 at lunule and 0.14 at vertex, dark brown to black, with whitish pollen and with a few very small black hairs outside frontal row; vertex subpollinose, thinly silvery; parafaciale 1.2 in width opposite lunule, dark brown to black, with much silvery pollen, bare; faciale orange to red orange, slightly convex in profile, with a row of short black setae which ascend slightly less than 0.30 the distance from the vibrissa to the antennal base; vibrissae 0.4 above the oral margin and set 2.8 apart; frontale dark mahogany red, almost obliterated at narrowest portion of front; frontal row of bristles consisting of about nine bristles, those toward the narrowest part of the front hairlike, none present toward vertex; antenna with first and second segments orange, third segment 3.6 times as long as second and darker orange in color; arista with long dark brown cilia for four-fifths its length; palpus 3.6 in length; back of head black, with only thin silvery pollen, with one row of postocular cilia and with pale hair, especially on the metacephalon.

Thorax black with metallic olivaceous green luster, bronzy reflections, and thin silvery pollen which is noticeable especially on pleura; humeral bristles three; propleuron with tawny hair; prosternum with pale hair; hindmost preacrostichal and pre-dorsocentral bristles placed 1.8 and 0.8, respectively, before the suture; lateral postscutellar plate with black setae; postacrostichal bristles two; sclerites at wing-base orange except greater ampulla which is dark orange brown, lesser ampulla black and preepaulet dark brown.

Legs orange brown; middle femur with one anterior bristle near middle, two anteroventral bristles, one near basal third and one near middle; middle tibia with one ventral bristle near middle, one anterodorsal bristle near middle, and two posterior bristles, one near basal fourth and one near middle; hind tibia with one anteroventral bristle and two posterodorsal bristles

Wing hyaline, yellowish, veins yellowish; basicosta and subcostal sclerite bright orange, the latter with fine orange pile;

costal sections 2 to 6 in the proportion 60:46:95:40:8; third vein setulose about one-fourth the distance to the cross vein; second and third sections of fourth vein in proportion 75:65; both upper and lower squamal lobes orange brown, the former paler.

Abdomen colored like thorax; second segment with marginal bristles, the median pair or two rather erect, but not considered typical median marginal pairs; third segment with long marginal bristles; fourth segment with long scattered erect bristles.

Genital segments dark brown, rather large, with scattered erect black hairs, mostly shining, and with only faint traces of metallic luster. Anatomical features (pl. 25, A and B) as illustrated.

*Length.* 7 mm.

*Distribution.* West Indies, and uncommon.

*Biology, habits, and immature stages.* Unknown.

This species was synonymized with *Lucilia cluvia* by Aubertin (1933); it was not treated by Shannon (1926) in his synopsis of American Calliphoridae. It is colored very differently from any known North American species. In fact, its particular type of coloring is approached only by *Lucilia graphita* Shannon, described from the Hawaiian Islands, which is almost entirely black.

Johnson described the holotype of *problematica* as being a male specimen collected in Bermuda on June 30, 1905, by Professor Kincaid. This specimen is now in the National Museum collection erroneously marked "Cotype."

#### *Phaenicia purpurescens* (Walker), new combination

*Musca purpurescens* Walker, Linn. Soc. London, Trans. 17:355, 1837; Aubertin, Linn. Soc. London Jour., Zool. 38:426, 1933 (*Lucilia*). (Type, from Santa Catharina, Brazil, in the British Museum.)

*Lucilia brunnicornis* Macquart, Diptères exotiques, vol. 2, no. 3, p. 299, 1843. (Type, female from Mexico, in Paris.)

*Lucilia violacea* Macquart, Diptères exotiques, sup. 2, p. 99, 1847. (Type, male from Mexico, in Bigot Collection, Newmarket, England.)

*Somomyia pallidibasis* Bigot, Ent. Soc. de France Ann. (5)7:247, 1877. (Type, female from Mexico, in Bigot Collection, Newmarket, England.)

?*Lucilia praescia* Giglio-Tos, Mus. di Zool. ed Anat. Comp. R. Univ. Torino, Bol. 8(147):4, 1893. (Type, from Tampico, Mexico, in Torino or lost.)

*Lucilia ocularis* Shannon, Wash. Ent. Soc. Proc. 28(6):132, 1926. (Type, male from Costa Rica, No. 28890, U. S. National Museum.)

A large shining purplish or purplish-green species, the males of which have the anterodorsal eye facets enlarged.

*Male.* Head height 13.3; eye height 10.6; length at antenna 6.2 and at vibrissa 6.4; width 15.4; bucca 0.25 eye height, brown to black, with very thin gray pollen, and with scattered black hairs, posteriorly and below with light hairs; eye with enlarged facets anterodorsally; frontale orange brown, wider than parafrontale at lunule and greatly reduced posteriorly; front dark brown to black, almost obliterated at narrowest, only a thin line apparent between the eyes for a short space about 1.0 anterior to foremost ocellus, 0.10 of head width at vertex and 0.16 at lunule, with dull silvery pollen, and with only a few hairs outside the frontal row; frontal rows of bristles diverging anteriorly as they follow the margins of the frontale, each row consisting of about eight bristles, the foremost placed almost opposite the base of the second antennal segment, the bristles shorter posteriorly and vestigial or absent toward the narrowest portion of front; clypeus dark brown toward epistoma; parafaciale much narrowed above, 0.7 in width opposite second antennal segment, mostly red orange to brown, with thin silvery pollen, bare; faciale red orange to brown, nearly straight in profile, and with a row of short black setae which ascend nearly one-half the distance to the antennal base; vibrissae 0.8 above the oral margin and set 3.0 apart; palpus 4.0; antenna orange to brown, first segment always lighter apically, third segment 4.2 times as long as second, and usually lighter at base; arista orange to orange brown, lighter basally, the cilia long, light in color toward base and darker apically; back of head black, with whitish pollen except above, metacephalon orange, one row of postocular cilia and considerable pale hair which is most apparent below.

Thorax dark blue with greenish to almost entirely reddish purple luster, mostly shining but with thin whitish pollen in certain lights especially anteriorly on dorsum and on pleura; humeral bristles three; propleuron with tawny hair; hindmost preacrostichal and predorsocentral bristles placed 3.0 and 1.2, respectively, before suture; prosternum with both dark and pale

hair; postacrostichal bristles two; thoracic spiracles enlarged, brown.

Legs brown to black; middle femur with one anterior bristle near middle; middle tibia with one posterodorsal bristle; hind tibia with two posterodorsal bristles.

Wing hyaline, brownish anteriorly and basally; basicosta brown; subcostal sclerite orange brown, darker apically and with short fine decumbent brownish pile; costal sections 2 to 6 in the proportion 82:58:115:42:12; second and third sections of fourth vein in proportion of 8:9; third vein setose only at base; upper squamal lobe more or less hyaline, brown; lower squamal lobe infuscated, nearly black.

Abdomen colored like thorax and with thin whitish pollen ventrally; first segment usually black, often with slight greenish luster; second segment without dorsal shining spot anteriorly and with a marginal row of rather weak recumbent bristles; third segment considerably polished and with a marginal row of strong upright bristles; fourth segment highly polished.

Genital segments black, small, with scattered erect setae. Anatomical features (pl. 25, C and D) as illustrated.

*Female.* Head height 13.5; eye height 9.6; length at antenna and at vibrissa 6.3; bucca 0.30 of eye height; head width 15.4; eye with normal sized facets; parafaciale opposite lunule 1.3 in width; vibrissae set 3.3 apart; front at narrowest (about 1.0 above lunule) 0.26 of head width, 0.29 at vertex and 0.30 at lunule, black, with only a few dark hairs outside frontal row, and with heavy whitish pollen, often slightly yellowish toward vertex; frontale black, slightly reddish at lunule; frontal rows of bristles nearly parallel or converging only slightly anteriorly except in the foremost one or two bristles, each row consisting of about eight bristles; vertex black, subpollinose, often greenish or purplish. Abdomen with first segment rather strongly metallic. Otherwise like male except for normal sexual differences.

*Length.* 7-9 mm.

Most specimens are a deep reddish purple in color and easily recognized as this species. Some specimens, however, are blue green with only purple reflections, and they cannot be distinguished from *eximia* by color differences alone.

*Distribution.* Neotropical: Southern Mexico, through Central America and South America to Argentina.

*Biology, immature stages, and habits.* Although the species is well-distributed, it is apparently uncommon or extremely localized where it does occur. Considerable effort was expended in an attempt to collect and study this species in the field, but no



specimens were ever seen in nearly a year's collecting. The immature stages are unknown.

Aubertin (1933, p. 427) stated that all the specimens identified as *Calliphora praescia* G. T. by Van der Wulp in *Biologia Centrali-Americana* are *purpurescens*.

Macquart mentioned the enlarged eye-facets in the male in his description of *Lucilia violacea*; his earlier (1843) *Lucilia violacea* is another species.

### *Phaenicia rica* (Shannon), new combination

*Lucilia rica* Shannon, Wash. Ent. Soc. Proc. 28(6):132, 1926; Curran, N. Y. Acad. Sci. 11(1):93, 1928; Aubertin, Linn. Soc. London Jour., Zool. 38:424, 1933. (Type, male from Antigua, West Indies, No. 29145, U. S. National Museum.)

?*Lucilia azurea* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 455, 1830. (Type, in Paris.)

?*Somomyia semiviolacea* Bigot, Soc. Ent. de France Ann. (5)7:46, 1877; Brauer, Akad. der Wiss. Wien, Math.-Nat. Kl. Sitzber. (1)108:523, 1899. (Type, female, in very bad condition, from Puerto Rico, in the British Museum.)

?*Somomyia soulouquina* Bigot, Soc. Ent. de France (5)7:47, 1877. (Type, female, in very bad condition, from Haiti, in the British Museum.)

As indicated by Aubertin (1933), *Somomyia soulouquina* Bigot and *Somomyia semiviolacea* Bigot, both of which were described from the West Indies, might be older names for this species. Brauer (1899) stated that the "inner facets are larger" in the type of *semiviolacea*. Aldrich noted in 1929 that both types are females in a poor state of preservation, and that it was doubtful if either could be accurately determined. Aubertin (1933) indicated that *Lucilia azurea* Robineau-Desvoidy might also be an earlier name for *rica*, but that the label on the specimen is "Saint-Severe, (Lanes)." She concluded that the specimen was of a South American species approximating *rica* and not "common" as indicated by Robineau-Desvoidy. Because of the indefiniteness of the locality she did not use the name.

A medium-sized greenish-blue species with the habitus of *eximia*.

*Male*. Head width 11.4; length at antenna 4.6 and at vibrissa 5.0; epistoma orange, on level with vibrissa in profile, rather short, as wide as clypeus, and warped forward from clypeal plane; eye height 8.0; head height 10.2; bucca 0.25 of eye height,

orange brown in ground color, with dark brown hair anteriorly but with tawny to orange hair posteriorly, and with thin yellowish white pollen; frontale dark brown, hardly apparent at narrowest portion of front but as wide as parafrontale at lunule; front at narrowest 0.03 of head width, 0.13 at vertex and 0.21 at lunule, black in ground color, with silvery pollen tinged with yellowish, and with a few fine whitish hairs outside frontal row; frontal rows of bristles obsolete at narrowest part of front, not continuing toward vertex, extending anteriorly only to lunule, and moderately diverging as they follow the margin of the frontale, each row consisting of about seven bristles; postvertical and postocellar bristles yellow, weak and proclinate; clypeus brown, with thin silvery pollen; faciale orange to red orange or brown, straight in profile except as it curves forward at vibrissa, and with a row of short black setae which ascend about one-third the distance to the antennal base; vertex black, with faint brown pollinosity; only minute carina present; parafaciale opposite lunule 0.6 in width, almost as wide below, reddish brown in ground color, and with silvery pollen which appears yellowish in certain lights because of the ground color; vibrissae very slightly above the oral margin and set 2.4 apart; palpus orange, 3.4 in length, and slightly protruding beyond oral margin in profile; antenna with first segment brown, second and third segments orange basally, darker apically, the latter 4.6 times as long as second and reaching six-sevenths the distance to the vibrissae; arista slightly thickened at base, orange to brown, with long brown cilia above and below for four-fifths its length; back of head black, with silvery pollen around occiput, with one row of postocular cilia and with numerous pale hairs, especially below.

Thorax dark blue green with purple reflections, and with silvery pollen on dorsum especially between humeri and on pleura, and with faint indications of darker longitudinal stripe outside acrostichal row which extends only slightly beyond suture; humerus with mostly yellow setae; postintraalar bristles two; postacrostichal bristles two; postsupraalar bristles three; hindmost preacrostichal and predorsocentral bristles placed 1.8 and 0.8, respectively, before the suture; pleura with considerable pale hair; under surface of scutellum with pale hair laterally; lateral postscutellar plates with black setae; postalar declivity with pale and brown hair anteriorly and at middle; sclerites at wing-bases brown to black.

Legs black, often slightly brownish; coxae with considerable pale hair; middle tibia without posterior bristles; otherwise like *sericata*.

Wing hyaline, brownish anteriorly toward base; basicosta orange brown; subcostal sclerite yellow to yellow orange with fine soft orange pile; costal sections 2 to 6 in the proportion 46:38:80:34:10; third vein setulose from one-third to one-half the distance to the cross vein; mouth of apical cell more widely open than normal; apical cross vein very slightly curved; upper squamal lobe hyaline, brownish apically, rim brown; lower squamal lobe white basally, brown apically.

Abdomen colored like thorax, basally with whitish pollen in certain lights; first segment black; second segment purple on posterior third and with a marginal row of bristles; third and fourth segments shining, mostly purplish, each with a marginal row of strong erect bristles; basal sternites with considerable short pale hair.

Genital segments brown to brownish black, with black hair. Anatomical features (pl. 25, E) as illustrated.

*Female.* Head height 11.3; eye height 8.7; bucca 0.25 eye height; length at antenna 5.6 and at vibrissa 6.0; head height 13.7; front at narrowest (slightly above lunule) 0.26 of head width, 0.27 at vertex and at lunule; palpus 4.0 in length; third antennal segment 3.9 times as long as second; frontale orange brown at lunule, black posteriorly, twice as wide as parafrontale at ocellar triangle but only slightly wider at lunule; postvertical and postocellar bristles black; parafrontale with silvery pollen over dark brown ground; parafaciale opposite lunule 1.3 in width and slightly wider below; with silvery pollen over orange to orange-brown ground; vibrissae set 2.8 apart. Wing with basicosta more orange in color than in male; costal sections 2 to 6 in the proportion 70:46:95:43:12; upper and lower squamal lobes whitish basally, orange to brownish apically.

*Length.* 6.5-8.0 mm.

*Distribution.* Neotropical: West Indies.

*Biology, habits, and immature stages.* Unknown. Although many of the islands of the West Indies were visited and considerable collecting was done on some of them, this species was never encountered. It may be distinctly seasonal, or very local in distribution.

### *Phaenicia sericata* (Meigen)

*Musca sericata* Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 5, p. 53, 1826. (Type, from Germany, apparently lost; but may be in either Paris or Halle.)

- Musca nobilis* Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 5, p. 56, 1826; Linall, Insect Life 5(1):36-37, 1892 (translation); Hough, Ent. News 10:66, 1899; Tothill, Ent. Soc. Amer. Ann. 6:256, 1913. (Type, from Europe, apparently lost; but possibly in Paris.)
- Chrysomya capensis* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 451, 1830. (Type, from Africa, in Paris.)
- Musca pruinosa* Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 7, p. 294, 1830; Villeneuve, Deut. ent. Ztschr. p. 313, 1910 (*Lucilia*). (Type, female, type locality not stated, in Paris.)
- Lucilia basalis* Macquart, Diptères exotiques, vol. 2, no. 3, p. 305, 1843; Séguy, Encycl. Ent. (BII.) Dipt. 2:93, 1925. (Type, male from America, in Paris.)
- Lucilia flavipennis* Macquart, Diptères exotiques, vol. 2, no. 3, p. 296, 1843. (Type, male from Ceylon, in Paris.)
- Musca lagyra* Walker, List of the Specimens of the Dipterous Insects in the Collections of the British Museum, vol. 4, p. 885, 1849. (Type, from Fayal, in the British Museum.)
- ?*Lucilia latifrons* Schiner, Fauna Austriaca, Die Fliegen, Diptera, vol. 1, p. 590, 1862. (Type, sex and type locality not stated but probably Austria, possibly in Vienna.)
- ?*Lucilia sayi* Jaenicke, Senckenb. naturf. Gesell. Abhandl. 6:375, 1867; Schiner, Fauna Austriaca, Die Fliegen, vol. 1, p. 590, 1862; Brauer and Bergenstamm, Zweiflügler des Kaiserlichen Museums zu Wien, vol. 6, no. 3, p. 122, 1893. (Type, from Illinois, in the British Museum.)
- ?*Lucilia sericata* var. *latifrons* Schiner, Strobl, Wien. ent. Zeitg. 12:104, 1893.
- Lucilia giraulti* Townsend, Smithsn. Misc. Collect. 51:121, 1908; Tothill, Ent. Soc. Amer. Ann. 6:253, 1913; Shannon, Insector Inscitiae Menstruus 12:73, 1924. (Type, male from Paris, Tex., No. 10890, U. S. National Museum.)
- Lucilia barberi* Townsend, Smithsn. Misc. Collect. 51:121, 1908; Tothill, Ent. Soc. Amer. Ann. 6:253, 1913; Shannon, Insector Inscitiae Menstruus 12:73, 1924. (Type, male from Williams, Ariz., No. 10891, U. S. National Museum.)
- Lucilia frontalis* Aubertin, Linn. Soc. London Jour., Zool. 38:411, 1933; Brauer and Bergenstamm, Zweiflügler des Kaiserlichen Museums zu Wien, vol. 5, no. 2, p. 116, 1891 (nomen nudum). (Type, from Egypt, in Vienna.)

*Lucilia sericata* (Meigen), Townsend, Smithsn. Misc. Collect. 51:120, 1908; Bezzi, Soc. Ent. Ital. Bol. 39:85, 1908; Portici Lab. Zool. Gen. e. Agr. Bol. 6:81, 1912; *ibid.*, 8:295, 1914; Whiting, Ent. Soc. Amer. Ann. 6:257, 1913; Johnston, Queensland Agri. Jour. 1922:273; Shannon, Insecutor Insectariae Menstruus 12:77, 1924; Patton, Philippine Jour. Sci. 27:403, 1925; Richards, Roy. Ent. Soc., London, Trans. 74(2):256, 1926; Essig, Insects of Western North America, p. 587, 1926; Senior-White, Indian Mus. Rec. 28:131, 1926; Lundbeck, Diptera Danica, Vol. 7, p. 145, 1927; Bezzi, Bull. Ent. Res. 17:238, 1926; Wainwright, Roy. Ent. Soc., London, Trans. 76:238, 1928; Brannon, Jour. Parasitol. 20(3):190-194, 1934; Miller, Cawthron Inst. Sci. Res. Monog. No. 2, p. 54, 1939; Senior-White, Fauna of British India, Diptera, vol. 6, p. 54, 1940.

*Phaenicia sericata* (Meigen), Malloch, Ann. and Mag. Nat. Hist. (9) 17:506, 1926; Linn. Soc. N. S. Wales, Proc. 52:321, 1927; Bezzi, Bul. Ent. Res. 17:238, 1926; Townsend, Manual of Myiology, vol. 2, p. 172, 1935; *ibid.*, vol. 5, p. 162, 1937.

Although the type locality given for *Lucilia basalis* Macquart is America, Séguy and Aubertin state that the label on the supposed type specimen indicates that it is from Mogador.

The type of *Lucilia giraulti* Townsend is a male lacking the abdomen and one wing and can no longer be identified with absolute assurance, but the remains of the specimen indicate that it falls into the group of species to which *sericata* belongs. The rest of the type series is no longer in the National Museum collection. Since this name has customarily been placed as a synonym of *sericata*, I leave it here. *Lucilia barberi* Townsend, represented in the National Museum collection by a single male specimen, is apparently a synonym of *sericata*.

A yellow-green to aeneous- or cupreous-green species (Color plate III) with whitish pruinescence, with three postacrostichal bristles and with setose metasternum.

*Male.* Head (pl. 5, C) width 13.2; length at antenna 5.7 and at vibrissa 6.2; height 10.5; length at oral margin slightly greater than at vibrissa; eye height 7.9; epistoma elongate, only slightly warped forward from clypeal plane and nearly as wide as clypeus; bucca 0.34 eye height, black, with abundant short- to medium-length black hair, no pale hair before the suture, and with moderately heavy gray pollen; frontale approximately three-fifths frontal width, orange red anteriorly, black posteriorly; front at narrowest 0.11 of head width, 0.19 at vertex

and 0.32 at lunule, with rather heavy gray pollen, and with some scattered short black setae outside frontal row which extend to just anterior to foremost frontal bristle; frontal rows of bristles extending to about base of second antennal segment and narrowly diverging anteriorly as they follow the margin of frontale, each row consisting of about eight or nine bristles; inner vertical bristle strong, decussate or reclinate; frontoorbital bristles absent; vertex subpollinose, black; ocellar triangle black, often metallic green; clypeus about twice as long as wide, silvery; parafaciale opposite lunule 1.4 in width, as wide below, silvery; vibrissae above oral margin by 1.4 and separated by 2.1; proboscis 9.0 in length; haustellum 0.33 head height; palpus orange, 3.6 in length; antennae with bases approximated, brownish black, third segment 3.2 times as long as second and reaching four-fifths the distance to the vibrissae; arista elongate, black, with long black cilia above and below almost to apex; back of head black with greenish overcast and whitish pollen, with three rows of postocular cilia and with abundant medium-length black hair.

Thorax metallic yellow green, slightly bluish in certain lights, rarely purplish, with very thin whitish pollen or shining, and without dorsal longitudinal stripes; pleura shining or with a trace of whitish pollen; humeral bristles three strong, with a weaker fourth anterior to these; propleuron with abundant black setae in center; preintraalar bristles three, the foremost usually weak, the hindmost bristle placed anterior to suture by 0.5; preacrostichal bristles two strong, the hindmost bristle placed anterior to suture by 1.5; predorsocentral bristles three strong, the hindmost bristle placed anterior to suture by 2.5; sternopleuron with black setae except on anterior fifth; pteropleuron with anterior half brown, posterior half metallic green; prosternum laterally with black setae; postalar declivity anteriorly with scattered black setae; preparapteron brown, with short fine decumbent white pile; hypopleuron setose on posterior half; preepaulet black; tympanic pit with tuft of long black setae; squamal process brown; postparapteron brown to black; greater ampulla black, with short fine decumbent brownish pile; scutellar bridge with long black setae; squamopleuron with soft short tawny pile; postacrostichal bristles three strong; mesothoracic spiracle and metathoracic spiracle with dark brown hair; halteres orange brown; scutellum with under surface laterally with fine brownish-black setae and discal bristles located laterally and posteriorly; lateral postscutellar plate with black setae.

Legs black, anterior femur often greenish metallic; anterior tibia with one posteroventral bristle near apical third; middle

femur often greenish, with two short anterior bristles near middle, an anteroventral row of bristles extending from base to about middle, and a posteroventral row of much longer bristles which extends from the base to near apical third; middle tibia with one anterodorsal bristle near apical fourth, one ventral bristle near apical five-eighths, two shorter posterior bristles, one near basal three-eighths and one near apical five-eighths, and with two posterodorsal bristles of about the same size near the same locations; hind femur with a partial posteroventral row of bristles extending from base to near middle; hind tibia with anterodorsal row of bristles which are short basally and longer apically, two anteroventral bristles, one near middle and one near apical third, and with a posterodorsal row of bristles, only three being long, one near base, one near basal fourth, and one near apical fourth; tarsi black, normal; claws and pulvilli black, former about two-thirds longer than latter.

Wing (pl. 9, K) hyaline, usually rather yellowish at base; basicosta whitish yellow; costal sections 2 to 6 in the proportion 76:49:89:38:6.9; subcostal sclerite yellow orange with yellow orange pubescence; third vein setulose three-fifths the distance to the cross-vein; fourth vein without apical section or fold, the angle rather rounded and entering costal margin 2.0 before apex; anterior cross vein at middle of second section of fourth vein; posterior cross vein sinuate; last section of fifth vein one-fifth the length of preceding section; upper and lower squamal lobes white, the lower wide behind.

Abdomen metallic yellow green, often shining or with thin silvery pollen especially below; first segment usually black; second segment with a narrow middorsal black spot on anterior margin; second segment with short marginal row of bristles.

Genital segments small, black, shining, globose, with scattered setae, the first without marginal rows of bristles. Internal anatomical features (pl. 25, F and G) as illustrated.

*Female.* Head length 12.6; length at antenna 5.4 and at vibrissa 5.8; length at oral margin 6.0; eye height 6.5; bucca 0.38 eye height; head height 9.5; front widening only a little anteriorly, the frontal rows slightly converging anteriorly as they follow the narrowing frontale; front at narrowest (at vertex) 9.38 of head width, and 0.41 at lunule, with bright silvery pollen; outer vertical bristles about two-thirds as long as inner; fronto-orbital bristles two proclinate and one reclinate; ocellar bristles almost exactly divaricate, and with another smaller pair just behind the posterior ocelli; vertex with silvery pollen; parafaciale opposite lunule 1.8 in width; distance between vibrissae 2.2;

third segment of antenna three times as long as second. Wing with costal sections 2 to 6 in the proportion 65:43:78:33:4. Abdomen with considerably more whitish pollen laterally and ventrally in certain lights than in male. Otherwise similar to male except for normal sexual differences.

*Length.* 6.0-9.5 mm.

The difference in the number of postacrostichal bristles is one of the major characters distinguishing the *sericata-pallescens* group from a larger group composed of *caeruleiviridis*, *mexicana*, *cluvia*, and others. Consideration of this bristle series alone will permit placement of most specimens into their proper grouping. But several previous authors have questioned the value of the difference because of variation noted in the number of bristles on each side. For instance, the majority of specimens of *sericata* and *pallescens* have three postacrostichal bristles on each side, but some have three on one side and four on the other, and a few have four on each side. Because of such observations reared series of several of the species were obtained from different parts of the United States and these were studied and compared with each other.

While the typical number of postacrostichal bristles in both *sericata* and *pallescens* is three on each side, some specimens have four on one or both sides. The additional bristle is usually a weak one in advance of the regular series but it is sometimes as large as the normal bristle following it. If the following normal bristle is absent, (it is missing in six out of 100 specimens) this causes the row to have the normal number of three bristles but the row is spaced for four. Of a total of 608 specimens reared from egg masses obtained from isolated females, 259 males and 239 females of *sericata* (82 percent) had the typical number of three postacrostichal bristles on each side, 28 males and 62 females (14 percent) had three postacrostichal bristles on one side and four on the other, while 3 males and 16 females (3 percent) had four postacrostichal bristles on each side. One male had two postacrostichal bristles on one side but three on the other. The series of reared *pallescens* showed nearly identical percentages of variation in the postacrostichal series. An inbred strain of *sericata* showed wider variation than F<sub>1</sub> generation series from Menard and Dallas, Texas.

Two postacrostichal bristles normally occur on each side in *caeruleiviridis* and *mexicana*. Specimens of the former species in the F<sub>2</sub> generation, specimens of the latter species in the F<sub>1</sub> generation, and numerous specimens of both species collected in nature exhibited no variation in this number.



If any conclusions can be drawn from this preliminary survey, the figures seem to indicate that females develop supernumerary bristles in the acrostichal series more frequently than do males, that specimens of *sericata* and *pallescens* rarely, if ever, occur with only two postacrostichal bristles on each side, and that these two species can be separated from *caeruleiviridis*, *mexicana*, and probably most of the species which have only two postacrostichal bristles on each side by this sole difference.

*Distribution.* It is often stated that *sericata* is cosmopolitan in distribution but this is doubtful. No specimens were collected in Central and South America in 1942 and 1943, nor on any islands of the Central or Southwest Pacific in 1944 and 1945, although over 100,000 such flies were collected in those areas. It is the most abundant species of *Phaenicia* in North America, occurring most frequently in collections in northern United States and southern Canada.

*Biology, habits, and immature stages.* *Egg.* Macrotype, large, pale yellow with thick chorion which is striate and faintly reticulate.

Wardle (1930) and Melvin (1934) studied the effect of temperature and humidity upon the incubation period of *sericata* eggs. The latter author found that 42.37 hours were required at 59° F., but only 8.09 hours at 99° F.; no eggs hatched at temperatures above 99°. The optimum temperature for development of eggs of this species appeared to be about 94° F., at which temperature only 8.10 hours were required to complete the stage.

*Larva.* The larvae of *sericata* are usually found feeding upon decomposing flesh. In one instance larvae of *sericata* were found in small numbers in hen manure (Illingworth, 1923), and Thomson and Hammer (1936) found occasional larvae in pig manure. In the vast majority of cases, however, the larvae of *sericata* will be found in decomposing meat or animal matter.

First instar: Wardle (1930) stated that this stage is a short, nonfeeding period, terminated by a molt within 2 or 3 hours after hatching.

Spines lightly pigmented, segments 2-7 each completely encircled with spines at the anterior border; on segment 8 spines absent on dorsal surface except on 12, which is provided with long, almost colorless spines on border of posterior cavity.

Second instar: According to Wardle, this is the true feeding period, lasting from 1½ to 9½ days, depending upon temperature; it is also terminated by a molt.

Segments 2-7 each bearing complete bands of spines at the anterior border, segment 8 usually with a narrow dorsal spine-

less area, but sometimes with a complete band of spines; segment 9 with spines extending from ventral to laterodorsal surfaces but absent on dorsum; generally restricted to ventral surface on segment 10; posterior borders of segments 11 and 12 with complete bands of spines, these narrowed to one or two irregular rows, or sometimes absent, on dorsal surface of segment 10. Distance between inner pair of tubercles on upper lip approximately equal to distance between inner and median pairs and never equal to distance between inner and outer pairs; anterior spiracles more often with seven to nine branches; cephaloskeleton (pl. 41, E) as illustrated.

Third instar: Wardle (1930) called the third stage the prepupal stage and defined it as a "non-feeding, edaphic, mobile phase of the blowfly life cycle which intervenes between the second larval moult and the commencement of pupation. It is a stage spent within the soil or close to the soil surface."

Average length 14 mm.; deep cream tinged with purplish; comparatively slender and cylindrical, all segments except cephalic of about same circumference; second segment constricted behind cephalic segment; ventral pads on abdominal segments with minute spines; spiracular pit with almost perpendicular face, the posterior spiracles on posteriorly directed face. Distribution of spines rather variable. Segments 2-8 each provided with complete encircling band of spines at the anterior margin; segment 9 also with spines sometimes forming a complete band on dorsal surface, but these more usually absent for a short space; segment 10 with or without one to two irregular broken rows on lateral surface; distribution of spines apparently more uniform in series from a single egg mass; in one series a large majority of the larvae with a complete band of spines on segment 9, in another a few larvae provided with a complete band of spines on this segment; posterior border of segment 11 with about four rows of spines; segment 10, bare on dorsum, spines usually restricted to the ventral and ventrolateral surfaces; segment 12 smooth on dorsal surface. Tubercles outlining stigmal field and on anal protuberance large, those on latter much larger than on former, comparative size of tubercles on border of stigmal field as in *illustris*, distance between inner tubercles on upper border approximately equal to distance between the inner and median ones and never separated by a distance equal to that between the inner and outer ones. Posterior spiracles (pl. 41, G) with usual form, peritreme narrow, yellowish, never black or dark brown, inner projection of peritreme usually faint and poorly developed if present, but often absent. Cephaloskeleton (pl. 41,

F) with dorsal cornua rather widely separated from ventral. Anterior spiracles with a variable number of branches, more often with 7 or 8, these rather prominent, the portion external to cuticle approximately equal in length to stigmatal chamber. Fuller (1932, p. 82) found the number of branches in the anterior spiracles to be 10 in Australia, Patton and Evans (1929), 10 to 11 in England, Knipling (1936, p. 283), 5 to 10 in North America.

*Pupa.* The length of the pupal stage of *Phaenicia sericata* varies from 3 to 5 days during July and August. Herms (1928) noted that 4 days were required for those individuals having the shortest larval feeding period and 7 days for those having the longest larval feeding period; and Wardle (1930) and Evans (1935a) recorded in some detail the effects of temperature and humidity upon the duration of the pupal period of this species.

Roberts (1930) observed that puparia of *sericata* may be found in soil at a depth of approximately 1½ inches, and Smith (1929) found that adults were able to emerge from puparia buried under 4 feet of loose soil. From depths of more than 3 feet, 50 percent of the emerging flies reached the surface.

*Generations.* According to Wardle (1930), there were four generations of *Phaenicia sericata* each year between May and October in the vicinity of St. Paul, Minn. There are probably as many as eight toward the southern limits of the distribution of the species.

*Hibernation.* Overwintering of *sericata* is accomplished in the larval or prepupal stage in North America. According to Holdaway and Evans (1930), this species successfully overwinters principally as larvae; puparia formed during the fall months were mostly parasitized by *Alysia manducator* Panz.

*Adult.* The preoviposition period probably lasts from 5 to 9 days.

Ovipositing females of *sericata* are attracted to media exposed to bright sunshine, although they actually oviposit upon the shaded portions of the medium's surface. Oviposition usually occurs between the hours of 11 a. m. and 2 p. m. when the sunshine is at its maximum intensity.

This species is the first of an ecological succession of saprophagous insects to attack dead animals. Oviposition begins within a few hours after death of the animals. Fresh meat is attacked within a few minutes after exposure.

Salt (1932) reported one female *sericata* that produced 1,882 eggs, while Mackerras (1933) recorded one which deposited 2,373 eggs and another (a hybrid between *sericata* and *cuprina*) which

deposited over 3,000 eggs. The latter investigator found the average number of eggs produced at one time by females of *sericata* to be about 182, this number depending upon the size of the individual and therefore upon the amount of food obtained by it in the larval stage.

Although some adults of *sericata* were found to migrate a maximum of 1.2 miles, Bishopp and Laake (1921) asserted that they had tested too few individuals to give reliable information on their disseminating tendencies. Smit (1929) stated, "It has been found that the flies will fly at least ten miles from their breeding place within a few days."

Wardle (1930) noted that the maximum abundance of *sericata* in nature might be expected in the vicinity of water courses in areas of low rainfall, in areas undergoing severe winter temperatures, and in urban districts where the prepupae have greater opportunities for securing positions of shelter from frosts.

Specimens of adult *sericata* may be collected in nearly every part of the United States and southern Canada, and during late June and early July this is the most abundant species of *Phaenicia* in middlewestern United States.

They frequent open habitation and are most active upon bright warm sunny days. Adults may be collected in abundance on almost any kind of garbage, particularly when it is mixed with meats of various sorts or with damaged fruits. In urban districts they may be collected on foliage where they apparently feed upon honey dew. Considerable numbers may be found under leaves of cucumbers and melons, on leaves of vines and on flowers of wild parsnip and wild carrot.

*Economic importance.* Reports of cutaneous myiasis caused by larvae of this species occur from almost the entire range of distribution of *sericata*. Bishopp (1915) stated that it "doubtless is the principal cause of cases of blown sheep which occur in midsummer in this country." Davies (1934) found it in 180 of 182 cases of sheep strike in Wales, and Radcliffe (1935) observed that, with only one exception, *sericata* alone was involved in sheep strike. Lewis (1933, p. 264), however, did not find *sericata* to be an important species in Kenya Colony, Africa, and Mackerras (1937) noted that it was concerned in sheep strike during only 1 year at Sydney and Canberra, Australia, and then apparently as a secondary invader.

As high as 92.6 percent of drying fruits were found by Donohoe (1937) to be contaminated by this and several other species of flies, and this is of considerable importance to fruit-drying industries in certain sections of California.

This is the greenbottle fly involved in experiments on the virus of poliomyelitis discussed by Sabin and Ward (1941).

*Use in surgery.* A full bibliography on the use of *sericata* larvae in surgery is given by Brumpt (1933). Dr. Wm. S. Baer, of Johns Hopkins Medical School, introduced this treatment in 1929 and 1930, and during the following 6 to 8 years maggots of this species were used throughout the world for the treatment of pus-discharging wounds because of the ability of the larvae to remove necrotic tissue.

*Phaenicia thatuna* (Shannon), new combination

*Lucilia thatuna* Shannon, Wash. Ent. Soc. Proc. 28(6):132, 1926; Aubertin, Linn. Soc. London Jour., Zool. 38:417, 1933. (Type, male from Mount Moscow, Idaho, No. 28889, U. S. National Museum.)

A blue-green species with the habitus of *Bufolucilia silvarum*, but without median marginal bristles on the second abdominal segment.

*Male.* Head width 11.6; length at antenna 5.4 and at vibrissa 5.5; eye height 7.6; height 9.7; epistoma short, curved strongly forward from clypeal plane, yellowish orange; metacephalon hardly apparent in profile; bucca 0.28 of head height, dark reddish brown to black, with thin silvery pollen, and with scattered dark hair, no pale hair before the metacephalic suture; frontale dark reddish brown, very narrow near middle but as wide as parafrontale at lunule; front at narrowest, 0.05 of head width, 0.15 at vertex and 0.22 at lunule, black, with silvery pollen and with a row of minute black setae near middle which extend anteriorly from near narrowest portion to foremost frontal bristle; frontal row of bristles composed of about 12 bristles, these long and well-developed anteriorly, the rows composed of weak and hairlike bristles at narrowest part of front, and diverging anteriorly as they follow the margins of the frontale, the foremost bristles placed nearly opposite the middle of the second antennal segment; ocellar triangle with several weak bristles, one or two pairs longer and in line with ocellar pair; clypeus yellow to orange; epistoma brown to black above, with thin silvery pollen; parafaciale dark brown to black, with silvery whitish pollen, 0.8 in width opposite lunule; facialium slightly convex in profile, orange colored below, orange brown above, with several rows of short black setae which ascend about one-third the distance to the antennal base; vibrissae set 0.6 above the oral margin and 2.4 apart; palpus 3.1 in length; first segment of an-

tenna dark brown to black, second segment orange to orange brown, lighter at apex, third segment orange at base, orange brown to brown apically, usually lighter below, and 3.2 times as long as second; arista brown, cilia brown and long; back of head black, with silvery pollen about occiput and on metacephalon, with two or three rows of postocular cilia and with some pale hairs particularly on metacephalon.

Thorax blue green with bronze and purplish luster, rather shining but slightly whitish or silvery anteriorly and on pleura in certain lights, with darker purplish or blackish longitudinal stripe outside acrostichal row which extends over the prothorax to just posterior of suture; humeral bristles three; hindmost pre-acrostichal bristle and predorsocentral bristles placed 2.2 and 1.4, respectively, before suture; intrapostalar bristle rather more apparent than in *sericata*.

Legs black, femora and tibiae often dark brown; middle femur with one (rarely with two) anterior bristle near middle; middle tibia with one posterodorsal bristle near apical third; hind tibia with an anterodorsal row of bristles about six of which are long, and usually with three posterodorsal bristles, if only two, then one near basal fourth and one near apical third, the one near basal third missing.

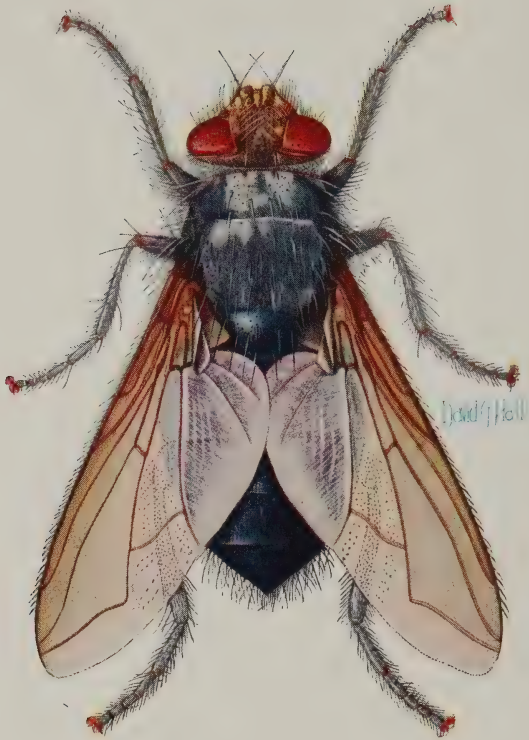
Wing hyaline, brownish anteriorly, especially so toward base; basicosta yellowish to orange; subcostal sclerite orange to orange brown, darker apically, with short fine decumbent orange pile; costal sections 2 to 6 in the proportions 65:44:94:89:8; third vein setulose fully two-thirds the distance to the anterior cross vein; second and third sections of fourth vein in proportion 7:6; upper squamal lobe hyaline and white basally, orange to brown apically; lower squamal lobe whitish basally, orange brown apically.

Abdomen colored like thorax, with faint whitish pollen especially on venter, this pruinescence not apparent except in certain lights; first segment black, only faintly metallic; second segment without dorsal anterior markings and with marginal bristles, the middle pair or two of which are longer and more erect than the lateral bristles (not to be considered as median marginal bristles); third segment with long marginal bristles; fourth segment with scattered erect bristles.

Genital segments larger than in *sericata*, black, mostly shining, only slightly greenish, and with scattered erect black hair. Internal anatomical features (pl. 25, H, I, and J) as illustrated.

*Female.* Head width 11.0; length at antenna 6.0 and at vibrissa 5.7; eye height 7.2; total head height 10.0; epistoma wider





CALLIPHORINI

Color plate IV.—*Cynomyopsis cadaverina* (Robineau-Desvoidy).  
Adult female, dorsal view, X 7.



than in male; bucca 0.27 of eye height; frontale 0.60 frontal width at ocellar triangle but narrowing toward lunule to 0.5 of front, dark reddish brown anteriorly, black posteriorly; frontal bristles eight, the rows sharply divergent in the foremost bristles; parafrontale with silvery pollen over dark reddish to almost black ground color, and with several scattered and one well-defined row of small black setae outside frontal row; parafaciale dark reddish, with silvery pollen, 1.3 in width opposite lunule; vertex mostly black with thin whitish pollen and only slightly greenish; back of head with almost entirely black hair but with tawny hair around occiput and on metacephalon. Thorax usually more bluish than in male, with stronger purplish reflections and with more whitish pollen on prothorax between humeri. Wing with costal sections 2 to 6 in the proportion 73:46:96:43:7; squamal lobes more whitish than in male. Abdomen colored as in male but first segment metallic, second segment with marginal bristles recumbent but still elongate, the middle pair or two considerably longer than the laterals. Otherwise similar to male except for normal sexual differences.

*Length.* 6-9 mm.

*Distribution.* Neartic: United States, Idaho.

*Phaenicia thatuna* is clearly related to *sericata*. The entire series at the National Museum was collected in an area a comparatively few miles in extent, on July 20 to July 27, over a period of about 10 years by the late J. M. Aldrich. Six specimens are from the type locality (Mt. Moscow), two specimens are from Lake Waha, three are from Gold Hill, Latah Co., and two are from Craig Mt., Nez Perce Co., all Idaho. The species appears to be decidedly local in distribution, occurring at an elevation of from 4,000 to 5,000 feet in the mountains of north-western Idaho.

*Biology, habits, and immature stages.* Unknown.

## TRIBE CALLIPHORINI

### (The bluebottle flies)

All North American representatives of this tribe (Color plate, IV) possess the following characters in common.

*Male and female.* Head (pl. 5, D) with epistoma elongate, nearly as wide as clypeus, and warped forward from clypeal plane, often strongly so; frontal bristles often extending to middle of second antennal segment, the rows widely diverging anteriorly; parafaciale setose on upper third or more; vibrissae strong and at or but slightly above the oral margin; palpus

clavate; third segment of antenna usually three, but sometimes four or more, times as long as second and reaching nearly to vibrissal level; arista with penultimate segment short, not bulbous, and with long plumosity above and below; back of head usually but slightly rounded or flattened, not protuberant.

Thorax with propleuron strongly setose; prosternum setose, of moderate size, narrowing posteriorly; tympanic pit setose on outer rim or more; sternopleural bristles three, arranged 2:1; parasquamal tuft absent; squamal process setose; lateral post-scutellar plates strongly setose; scutellum with three to six lateral bristles, the under surface bare in center.

Wing with lower squamal lobe pilose above.

### ACRONESIA, NEW GENUS

*Steringomyia* Shannon (nec Pokorny), *Insector Insectiae* Menstruus 11:107, 111, 1923; Wash. Ent. Soc. Proc. 28(6):134, 1926.

*Male and female.* Head (pl. 6, A) width about one-sixth greater than height; length at antenna and at vibrissa approximately equal; epistoma elongate, strongly warped forward from clypeal plane, and nearly as wide as clypeus; clypeus moderately depressed, wide, rather cup-like; eye small or of but medium size; frontal bristles extending anteriorly to lunule only; anterior portion of frontale usually obscuring lunule; inner vertical bristles strong, decussate, outer vertical bristles absent in male and about two-thirds as long as inner in female; frontoorbital bristles absent in male, two proclinate and one reclinate in female; ocellar bristles erect or proclinate; facial carina not apparent but often low and rather broad, not separating antennal bases; parafaciale of nearly equal width above and below, and with minute scattered black setae on upper third or more; faciale curved more or less anteriorly below toward vibrissal angle, and with stout black setae which ascend toward the antennal bases; vibrissae strong, slightly above the oral margin; proboscis nearly equal in length to head height; palpus narrow-clavate; antennal base at eye middle when head is viewed in profile, the bases approximated, third segment three times as long as second, reaching at least three-fourths the distance to the vibrissa; arista with penultimate segment about one and one-half times as long as the diameter, apical segment elongate, uniformly tapering to apex, with short to medium-length cilia for 0.60 its length; back of head slightly rounded, rather bulging below.

Thorax blackish, with four humeral bristles; propleural bristles

two or three; posthumeral bristle present; preintraalar bristles one or two; preacrostichal bristles two; predorsocentral bristles three; presupraalar bristle one; notopleural bristles two; prosternum flat, bulging anteriorly, wide, laterally and posteriorly setose; postalar declivity setose in center; tympanic pit bare in center; tympanic ridge with a few weak hairs; postalar bristles two; postacrostichal and postdorsocentral bristles three; postintraalar bristles two; postsupraalar bristles three; spiracles rather small; scutellum with one discal bristle, three lateral bristles and apical bristles absent.

Legs with middle femur having one to three anterior bristles near middle, about five anteroventral bristles in a row toward base, and a posteroventral row of bristles which are close-set toward base; middle tibia with one ventral bristle near apical third; hind femur with anteroventral row of about six bristles from basal third to apex, about three ventral bristles toward middle, and rows of strong dorsal and posterodorsal bristles.

Wing with single or double costal spine which is small but obvious; anterior cross vein at middle of second section of fourth vein.

Abdomen green to blue green, rather conical in male, ovate in female; ventral membrane not exposed; each segment with marginal bristles, these weak on first segment. Fifth sternite of male (pl. 26, A) long, divided, protruding ventrally and obvious in profile, the genital segments large, globose, first segment with row of long but weak marginal bristles.

*Genotype, Steringomyia aldrichia* Shannon.

The genus *Steringomyia* Pokorny does not occur in North America. Although the name has been used frequently in the North American literature, the genotype of *Steringomyia* (*styli-fera* Pok.) is quite different from the species included here under *Acronesia*.

The species of *Acronesia* are most closely related to the Palearctic species belonging to the genus *Acrophaga*, but, unlike these, they lack a row of marginal bristles on the first abdominal segment, they do not have hair on the tympanic pit, and they have but three lateral scutellar bristles.

The name *Cynomyia flavipalpis* Macquart (1851, p. 209) refers to a species unknown to me. The type, a female which cannot be found, was stated to be from "Terre Neuve," probably Newfoundland. Shannon (1926, p. 133) referred the name to *Steringomyia*, but he did not see the type. The description seems to apply to a species of *Acronesia*, but I am unable to identify it.

*Acronesia abina*, new species

*Steringomyia alpina* Shannon (nec Zetterstedt) (in part), Insector Inscitiae Menstruus 11:111, 1923.

*Male.* Head height 10.6; width 12.3; eye height 6.6; bucca 0.51 eye height, black, with thin gray pollen and with only black hair; frontale brownish black, 0.40 frontal width at narrowest, widening anteriorly; front at narrowest 0.18 head width, 0.30 at vertex and at lunule, black, with bright silvery or sometimes slightly yellow-tinged pollen, and with a few scattered black hairs outside frontal row of bristles; frontal bristles eight or nine, rather weak, all of about equal length; inner vertical bristles strong and decussate, outer vertical bristles a little longer than adjacent cilia; parafaciale 2.0 in width opposite lunule, orange in ground color on lower half or more, with thin silvery pollen, upper third with small scattered black setae; faciale orange, with two rows of short black setae which ascend about half the distance from the vibrissa to the antennal base; clypeus reddish brown, epistoma orange brown; vibrissae set 1.0 above oral margin and 3.0 apart; palpus orange, 5.0 in length; antenna with basal segments orange, third segment dark orange brown, 3.5 times as long as second; arista black, with medium-length cilia for slightly more than half its length; back of head rounded, rather bulging, black, with silvery pollen, with five or six rows of postocular cilia, a few pale hairs below on the metacephalon.

Thorax black, with thin whitish pollen, this apparent mainly on anterior of dorsum, with three to five indistinct, shining black stripes evident from posterior view, one between acrostichal rows, and one laterad of each dorsocentral row; preintraalar bristle one, the posterior one absent; hindmost preacrostichal and dorsocentral bristles before suture 2.6 and 2.2, respectively; scutellum laterally below with fine dark brown hairs.

Legs with fore tibia having two posterior bristles, one near middle and one near apical third; middle tibia with three anterodorsal bristles, two posterior bristles and one posterodorsal bristle; hind tibia with two anteroventral bristles near apical third, four anterodorsal bristles and four posterodorsal bristles.

Wing hyaline, slightly brownish toward base and anteriorly; costal sections 2 to 6 in the proportion 87:35:70:45:10; no spur at bend of fourth vein; squamal lobes white, inner portion of rims brownish.

Abdomen blue black with purple and olivaceous reflections, with thin whitish pollen particularly on second segment and laterally; second, third, and fourth segments each with a mar-

ginal row of bristles, the fourth segment with scattered long erect discal bristles.

Genital segments with forceps (pl. 26, B) as illustrated.

*Female.* Unknown.

*Length.* 7-8 mm.

*Type.* Male, No. 54931, U. S. National Museum.

*Type locality.* Tennessee Pass, Colo.

Three male specimens, the type, collected July 12, at 10,240 feet elevation by J. M. Aldrich, one paratype, collected August 28, at Brainard Lake, Colo., by T. D. A. Cockerell, previously determined as *Acrophaga alpina* (Zett.), and one paratype, collected in August 1924, in Pingree Park, Colo., by Paul Lawson and Raymond Beamer.

*Acrophaga alpina* (Zetterstedt), a species which occurs in northern Europe, has but one posterior bristle on the anterior tibia. As previously stated, North American species, originally placed in the genus *Acrophaga*, lack a tuft of hair on the tympanic pit. *Acrophaga stelviana* Brauer and Bergenstamm also differs from this species in having four well-defined lateral scutellar bristles.

*Biology, habits, and immature stages.* Unknown.

#### *Acronesia alaskensis* (Shannon), new combination

*Steringomyia alaskensis* Shannon, Insecutor Inscitiae Menstruus 11:112, 1923; Séguy, Encycl. Ent. (A) 9:122, 1928. (Type, male from Seward, Alaska, No. 26164, U. S. National Museum.)

*Male.* Head height 11.1; width 13.2; eye height 7.9; length at antenna 6.5 and at vibrissa 6.6; bucca 0.39 eye height, black, with coarse gray pollen and with black hair; front black, with silvery gray pollen, at narrowest 0.05 head width, 0.17 at vertex and 0.27 at lunule, with a few black hairs outside frontal row of bristles; vertex black, silvery; ocellar triangle with a number of long erect black hairs; frontal bristles about six, those toward lunule strong, the row continuing with a number of rather erect hairs toward vertex; parafaciale black with bright silvery pollen and with a few scattered black setae on upper third, 1.5 in width opposite lunule and a little wider below; faciale orange to orange brown, with a double row of short dark brown setae which ascend nearly one-half the distance from the vibrissa to the antennal base; vibrissae set 2.9 apart; clypeus dark brown to black; episoma orange; first and second antennal segments orange brown, the latter lighter orange apically; third segment 3.7 times as

long as second, orange at base and darker apically and dorsally; arista dark brown to black, with long black cilia for four-fifths its length; palpus orange, 4.2 in length; back of head rather flat above but rounded below, and with three or four rows of postocular cilia and abundant tawny hair especially on the metacephalon.

Thorax black, with heavy gray pollen especially anteriorly, and with indistinct dorsal longitudinal stripes; hindmost preacrostichal and dorsocentral bristles placed 2.0 and 1.2, respectively, before suture; sternopleural bristles usually three, arranged 2 + 1, but sometimes with one or more adventitious bristles in the series; tympanic ridge with several dark hairs; preparapтерon orange, with white pubescence, other sclerites at wing base black; scutellum as in *abina*.

Legs with fore tibia with one posterior bristle, middle tibia with one posterodorsal bristle; hind tibia with one anteroventral bristle; otherwise like *abina*.

Wing hyaline, brown basally; subcostal sclerite orange brown, orange pubescent toward base; costal sections 2 to 6 in the proportion 83:50:125:48:9; fourth vein sometimes with a very short spur at angular bend; upper squamal lobe brownish with brown rim; lower squamal lobe brown, with whitish rim.

Abdomen strongly bluish, tessellated, with silvery pollen; second segment with marginal row of minute bristles, each successive tergite with stronger and more erect marginal bristles; sternites successively wider.

Genital segments (pl. 26, C and D) as illustrated.

*Female.* Head with same proportions as that of male except eye shorter, bucca 0.48 eye height; parafaciale 1.4 in width opposite lunule; distance between vibrissae 2.4; front with nearly parallel margins, 0.38 of head width at vertex and 0.42 at lunule; frontale occupying three-fourths frontal width toward middle and narrowing anteriorly, velvety black; vertex mostly shining black; frontal bristles about five, the rows slightly diverging toward lunule and extending almost to middle of second antennal segment; back of head rounded. Wing with costal sections 2 to 6 in the proportion 60:40:100:36:6. Otherwise similar to male except for normal sexual differences.

*Length.* 6-9 mm.

*Distribution.* Nearctic: Alaska, Katmai (August), Naknek Lake (July and August), Kodiak (September), and Seward (July); United States, Wyoming, Lake Junction, Yellowstone National Park (August), Colorado, Pingree Park, (August).

*Biology, habits, and immature stages.* Unknown.

*Acronesia aldrichia* (Shannon), new combination

*Steringomyia aldrichia* Shannon, Insector Insectiae Menstruus 11:112, 1923. (Type, male from Tennessee Pass, Colo., No. 26163, in the U. S. National Museum.)

*Male.* Head (pl. 6, A) height 11.1; width 13.1; length at antenna and vibrissa 7.4; eye height 7.6; bucca 0.43 eye height; frontale half as wide as parafrontale, dark brown to black; front black, with silvery pollen, at narrowest 0.10 head width, 0.20 at vertex and 0.30 at lunule, with scattered minute black hair outside frontal row of bristles; frontal bristles 9 or 10, the rows following the margins of the frontale; parafaciale opposite lunule 1.7 in width and as wide below, black, with silvery gray pollen; faciale and epistoma orange to orange brown; vibrissae set 2.6 apart; first segment of antenna black, second orange brown apically, third 3.7 times as long as second, orange brown to brownish black; arista black with medium-length, black cilia; palpus orange, 4.3 in length; back of head not as rounded as in *abina*, black, with silvery pollen, with one or two rows of post-ocular cilia and with considerable scattered black hair.

Thorax black, with thin silvery pollen, with a shining black middorsal longitudinal stripe between acrostichal rows and a narrower lateral longitudinal stripe laterad of each dorsocentral row; preacrostichal bristles three, strong, hindmost placed 1.2 before suture; hindmost predorsocentral bristle placed 0.6 before suture; sclerites at wing-base dark brown to black; squamal process with a few dark hairs; scutellum with under surface laterally with black hair, one discal bristle (sometimes two), and three lateral bristles (sometimes a long thin hairlike bristle between basal and intermediate ones).

Legs black; middle femur with one anterior bristle near middle; hind tibia usually with three posterodorsal bristles, one at basal fourth, one at basal third, and one at apical third.

Wing hyaline, brownish; costal sections 2 to 6 in the proportion 83:51:128:47:10; bend of fourth vein acute, often leaving a short spur or fold; upper squamal lobe with rim and cilia brown; lower squamal lobe brown, the rim lighter in color.

Abdomen with intermediate sternites of about equal length, otherwise like *abina*.

Genital segments (pl. 26, E) as illustrated.

*Female.* Head height 10.5; width 14.0; eye height 7.1; bucca 0.49 eye height; length of antenna 7.5 and at vibrissa 8.4; front with nearly parallel margins, at vertex 0.38 of head width, 0.40 at lunule; parafaciale 1.9 in width opposite lunule; distance be-

tween vibrissae 3.3; frontale velvety black, often slightly orange brown at lunule, fully 0.70 of frontal width toward middle; back of head rounded. Wing with costal sections 2 to 6 in the proportion 85:65:137:47:10. Otherwise similar to male except for normal sexual differences.

*Length.* 7-9 mm.

*Distribution.* Nearctic Alaska (June to August); British Columbia, "Canada" (July); Quebec, (August); Colorado; Wyoming; Montana (August); Washington.

*Biology, habits, and immature stages.* One female in the collection has a first-instar larva protruding from the tip of the abdomen; the species may be larviparous, but nothing definite is known of the biology of the species.

#### *Acronesia anana*, new species

*Steringomyia alpina* Shannon (nec Zetterstedt) (in part), Insector Inscitiae Menstruus 11:111, 1923.

*Male.* Head width 11:5; height 10.0; eye height 6.5; length at antenna 6.7 and at vibrissa 7.1; bucca 0.47 eye height, black, with black hair, no pale hair before the metacephalic suture, with thin gray pollen; frontale as wide as parafrontale at narrowest, brownish; front at narrowest 17.5 head width, 0.30 at vertex and lunule, black, with silvery pollen and with a few weak hairs outside frontal row of bristles; frontal bristles about 10, the rows moderately diverging anteriorly as they follow the margins of the frontalia, and extending anteriorly to the lunule; parafaciale 1.8 in width opposite lunule, black on upper half and orange below, with silvery pollen which has a slight brassy tinge, upper half with a few minute black setulae; faciale, lower half of clypeus, and epistoma orange; vibrissae set 2.8 apart; palpus orange, 4.0 in length; antenna with basal segments orange to orange brown; third segment 3.5 times as long as second, orange basally, dark brown apically; arista black with medium-length, black cilia for two-thirds its length; back of head black, with silvery pollen, with at least five rows of postocular cilia and a few light hairs on the metacephalon.

Thorax colored and bristled like *abina* except with the hindmost preintraalar bristle present; hindmost preacrostichal bristle placed 2.7 before the suture.

Wing with costal sections 2 to 6 in the proportion 77:50:120:40:7; brownish; rim of upper squamal lobe orange brown.

Legs and abdomen like *abina*.



Genital segments(pl. 26, F and G) as illustrated.

*Female.* Head height 9.5; width 10.0; length at antenna and at vibrissa 5.6; eye height 6.0; bucca 0.41 of eye height; para-faciale opposite lunule 1.6 in width; distance between vibrissae 2.6; frontale 0.60 frontal width, reddish brown anteriorly, darker posteriorly; frontal bristles six, all strong; front at narrowest 0.40 head width, the margins only slightly diverging to 0.42 of head width at lunule; third segment of antenna 3.8 times as long as second. Wing with costal sections 2 to 6 in the proportion 70:48:120:40:6. Otherwise similar to male except for normal sexual differences.

*Length.* 7-8 mm.

*Type.* Male, No. 54932, U. S. National Museum.

*Type locality.* Savonoski, Naknek Lake, Alaska.

The type, three paratype males, and two paratype females are from the type locality; two paratype males are from Katmai, Alaska. These were collected during the summer of 1917 by the late J. S. Hine.

*Biology, habits, and immature stages.* Unknown.

#### *Acronesia collini*, new species

*Steringomyia popoffana* Collin (nec Townsend), Ann. and Mag. Nat. Hist. (10)15:373-374, 1935. (Type, male from Akpotok Island, Ungava Bay, Canada, in the Collin Collection at Newmarket, England.)

*Male.* "Rather smaller than females, eyes rather widely separated on frons, at narrowest quite as wide as facial orbits at base of antennae, and quite  $1/3$  width of one eye seen from above. Frons with a complete row of almost equally long bristles each side from opposite ocellar bristles to frontal lunule. Arista thickened on more than basal half, pubescence very short at base, becoming longer toward end of thickened part. Labium polished black. Thorax with usual chaetotaxy; intra-alars 2:2 without a small additional one in front of anterior one; sternopleurals 2:1. Abdomen with rather strong, outstanding bristles across hind margin of apparent second tergite and discal as well as marginal bristles on third and fourth tergites (but discal ones on third not so strong as on fourth). Sternites densely clothed with long black bristly hairs, but shorter on the not very prominent lobes of fifth sternite. Second sternite about as long as broad, in female distinctly longer than broad. Hypopygium comparatively small, prehypopygial tergite concealed

beneath apparent fourth tergite, mesolobe of same length but narrower than paralobes, both clothed with rather short fine dark hairs. Legs with usual chaetotaxy, including a strong ventral bristle just beyond middle of middle tibiae. Squamae whitish, upper side of thoracal with a few hairs on basal half only. Halteres darkened about base of knob. Length 7.5 mm. (females 9-10 mm.). One male, five females. On herbaceous valley slope, 6, 1♂, 2♀♀ : on plateau dip wet from recent snow, 28 viii, 1♀ ; near tent, 29 viii, 1♀ ; in tent, 9 ix, 1♀, 1931."

This species evidently differs from *popoffana* by the long, outstanding bristles across the hind margin of the second tergite, and by the possession of discal as well as marginal bristles on the third tergite, the latter being not so strong as those on the fourth, however. The lobes of the fifth sternite of the male (pl. 26, A) are not so prominent, the second sternite is about as long as broad in male, distinctly longer than broad in female and the hypopygium is smaller.

This species has not been seen during the course of the present study, and the characters used in the key were abstracted from the above original description.

*Acronesia montana* (Shannon), new combination

*Steringomyia montana* Shannon, Wash. Ent. Soc. Proc. 28(6): 135, 1926; Curran, Ontario Ent. Soc. Ann. Rpt. 56:58, 1925. (Type, male, apparently lost.)

*Male*. Supposedly differs from *alaskensis* (Shannon) in that "forceps of male are distinctly more slender, similar to those of *aldrichia* (Shannon)."

The types of this species cannot be found in the National Museum although it was stated in the original description that they were deposited there. No specimens have been seen during the course of these investigations which would appear to belong to this species. No formal description is possible, and no attempt has been made to differentiate between this and other species of *Acronesia* in the key.

*Acronesia popoffana* (Townsend), new combination

*Calliphora popoffana* Townsend, Smithsn. Misc. Collect. 51:117, 1908. (Type, female from Popoff Island, Alaska, No. 10885, U. S. National Museum.)

*Cynomyopsis popoffana* (Townsend) Townsend, Insecutor Inscitiae Menstruus 3:118, 1915.

*Steringomyia popoffana* (Townsend) Shannon, Insector Insectiae Menstruus 11:113, 1923.

*Male.* Head height 8.0; width 9.2; length at antenna 5.2 and at vibrissa 5.5; bucca 0.40 eye height, black, with black hair and with thin gray pollen; frontale black, rather brown at lunule; frontal row consisting of either eight or nine strong bristles, the rows only narrowly diverging as they follow the margins of the frontalia and extend anteriorly to base of second antennal segment; front at narrowest 0.17 of head width, 0.26 at vertex and 0.30 at lunule, black, with silvery pollen; faciale orange to orange brown, well rounded, strongly convex anteriorly toward vibrissa, and with one or two rows of short black setae which ascend over half the distance from the vibrissa to the antennal base; clypeus mostly black, only moderately depressed; epistoma warped strongly forward from clypeal plane and a little narrowed from clypeal width, orange; palpus orange, 4.0 in length; antenna black, second segment orange brown apically, third segment four times as long as second, reaching fully 0.65 the distance to the vibrissae; arista with short black cilia for 0.65 its length; back of head rounded, black, with silvery pollen, with about five or six rows of postocular cilia and only a few pale hairs on the metacephalon; parafaciale 1.2 in width opposite lunule; vibrissae set 2.8 apart.

Thorax and scutellum like *abina*.

Legs with fore tibia with but one posterior bristle; hind tibia with two long anterodorsal bristles, one near basal fourth and one near middle; otherwise like *abina*.

Wing without spur or fold at bend of fourth vein; squamal lobes white; costal sections 2 to 6 in the proportion 54:30:90:30:4.

Abdomen blue, tessellated, with heavy whitish pollen in certain lights especially anteriorly and laterally, often with olivaceous green reflections; only third and fourth segments with strong erect marginal rows of bristles.

Genital segments (pl. 26, H and I) as illustrated.

*Female.* Head height 10.8; width 13.2; length at antenna 7.6 and at vibrissa 8.4; eye height 7.4; frontale 0.60 frontal width toward middle, narrower toward lunule; inner vertical bristles erect, outer vertical bristles two-thirds as long as inner; at vertex 0.38 head width, the margins diverging to 0.40 at lunule; frontal row consisting of six strong bristles; parafaciale 2.2 in width opposite lunule, a little narrower below; vibrissae set 3.4 apart; palpus 5.5 in length; third segment of antenna 4.5 times as long as second. Wing with costal sections in the proportion 85:50:

140:50:8. Otherwise like male except for normal sexual differences.

*Length.* Male, 6.5 mm.; female, 8.0-10.0 mm.

*Distribution.* Nearctic: Alaska and northern Canada.

Five male and seven female specimens from Savonoski, Naknek Lake, Alaska (August), are presumably this species but are considerably smaller, especially the males. The above description is based upon the female holotype. There is a pair collected in copula in the series at Ohio State University; the male description is based upon the male of this pair.

*Biology, habits, and immature stages.* Unknown.

### EUCALLIPHORA TOWNSEND

*Eucalliphora* Townsend, Smithsn. Misc. Collect. 51:118, 1908; Manual of Myiology, vol. 2, p. 170, 1935; *ibid.*, vol. 5, p. 148, 1937; Séguy, Encycl. Ent. (B. II), Dipt. 8:133, 1935. Genotype. (*Calliphora latifrons* Hough) = *Musca lilaea* Walker. Monobasic.

*Male and female.* Head (pl. 6, B) width over twice head length at antenna; epistoma nearly as wide as clypeus, only slightly elongate, and warped forward from clypeal plane; metacephalon flattened and not apparent with head in profile; bucca high; eye of moderate size and set in head at a 15-degree angle; frontale nearly smooth; front wide in both sexes but widest in female; frontal rows of bristles widely divergent anteriorly, the foremost three bristles on outer third of parafaciale; inner vertical bristles reclinate; outer vertical bristles small but present in both sexes; frontoorbital bristles, one reclinate in male, two proclinate and one reclinate in female; accessory ocellar bristles present; clypeus deeply sunken, narrow and more or less cup-like; facial carina apparent between second antennal segments only, narrow, low; parafaciale narrowed below, setose on upper half or more; faciale slightly convex in profile with one row of strong and one or two rows of weaker bristles for one-half to three-fourths the distance to the antennal base; vibrissae slightly above the oral margin and well separated; proboscis one-half head height; palpus clavate, tip well clubbed; antennal base slightly above eye center with head in profile; third antennal segment almost four times as long as second, reaching nearly to the vibrissa; arista with long cilia above, shorter cilia below, for three-fourths its length; back of head flat or but very slightly rounded.

Thorax with four humeral bristles arranged in a definite

triangle; propleuron with abundant black setae; preintraalar bristles three, the hindmost considerably removed from the second and close to suture; preacrostichal bristles three, strong; predorsocentral bristles three, strong; posthumeral bristle present; presupraalar bristle one; sternopleuron with scattered hair on posterior half; pteropleuron bare on anterior fourth; prosternum of medium size, laterally setose; postalar declivity on posterior two-thirds with black hair; tympanic pit bristly on outer rim, the ridge with sparse hair; squamal process with sparse hair; postalar bristles two; postsupraalar bristles three, postacrostichal bristles three; postdorsocentral bristles three; postintraalar bristles two or three; mesothoracic spiracle elongate-ovate; scutellum with one discal bristle, three to six lateral bristles, only three strong, no apical bristles.

Legs with fore femur with bristles arranged as in *Calliphora*; fore tibia with one posterior bristle at apical third; middle femur with four posteroventral bristles ranging from base to middle, and with an anteroventral row of bristles, those toward base longest and rather widely spaced; middle tibia with one ventral bristle near apical third, and two posterior bristles, one at basal third and one at apical third; hind femur with two rows of bristles near anterodorsal surface, the uppermost row composed of stronger bristles, and with an anteroventral row of strong bristles; hind tibia with an anterodorsal row of alternating long and short bristles, two short anteroventral bristles from basal third to apical third, and with four or five strong posterodorsal bristles; tarsi as long as tibiae, claws and pulvilli as long as last tarsal segment.

Wing with strong costal spine, sometimes double; third vein with from one to three basal setulae; fourth vein without fold or appendage, bent at 90 degrees, the apical cross vein with a decided curve inward; anterior cross vein oblique, at middle of second section of fourth vein; posterior cross vein doubly arcuate; last section of fifth vein one-sixth as long as preceding section; lower squamal lobe elongate, ovate, pilose on inner half or more of upper surface.

Abdomen with second, third, and fourth segments each with a marginal row of bristles, the row on second segment weak and depressed; only fourth segment with erect discal bristles; sternites of nearly equal width in male, the fourth shorter than preceding sternites.

Genital segments of male large, first segment flattened on dorsum, and without marginal row of bristles; second segment comparatively large and globose.

*Eucalliphora lilaea* (Walker)

- Musca lilaea* Walker, List of the Specimens of Dipterous Insects in the Collection of the British Museum, vol. 2, p. 894, 1849. (Type, from Saint Martin's Falls, Albany River, Hudson's Bay, in the British Museum.)
- Musca ilerda* Walker, List of the Specimens of Dipterous Insects in the Collection of the British Museum, vol. 4, p. 895, 1849; Osten Sacken, Smithsn. Inst. Misc. Collect. 270:160, 1878; Aubertin, Ann. and Mag. Nat. Hist. (10)8:616, 1931. (Type, from Saint Martin's Falls, Albany River, Hudson's Bay, in the British Museum.)
- Calliphora lilaea* (Walker) Osten Sacken, Smithsn. Inst. Misc. Collect. 270:160, 1878; Aubertin, Ann. and Mag. Nat. Hist. (10)8:616, 1931.
- Calliphora latifrons* Hough, Zool. Bull. 2:286, 1899; Parker, Mont. State Bd. Ent. Bien. Rpt. 1914:44; Ent. News 28:281, 1917; Shannon, Insecutor Inscitiae Menstruus 11:109-110, 1923. (Type, from Moscow, Idaho, in the Field Museum.)
- Eucalliphora latifrons* (Hough) Townsend, Smithsn. Inst. Misc. Collect. 51:118, 1908.
- Eucalliphora lilaea* (Hough) Townsend, Manual of Myiology, vol. 2, p. 172, 1935; *ibid.*, vol. 5, p. 148, 1937.

A species of variable size, the males usually small; both sexes with the general habitus of *Calliphora*, but with strong bristles on the facialia.

*Male.* Head (pl. 6, B) width 11.8; length at antenna 5.8 and at vibrissa 5.6, slightly longer at oral margin; eye height 6.4; head height 8.5; bucca 0.40 eye height, black, with thin whitish gray pollen, and with black hair, no pale hair before the metacephalic suture; frontale 0.61 of frontal width, black; front at narrowest 0.21 head width, 0.28 at vertex and 0.35 at lunule, black, with thin whitish pollen, and with some black hair not in rows outside frontal row of bristles; frontal row consisting of about six bristles, extending anteriorly to apical third of second antennal segment and widely divergent anteriorly to the lateral third of parafaciale; outer vertical bristle one-half as long as inner; vertex black, subpollinose, velvety black; parafaciale 1.6 in width opposite lunule, black on upper two-thirds or more, with yellowish gray pollen, and with scattered minute black hair; faciale orange to red orange; facial grooves orange; vibrissae above oral margin by 0.6, and separated by 2.4; palpus orange, 4.0 in length; antenna orange, third segment with the

apical portion orange brown, 3.8 times as long as second, reaching four-fifths the distance to the vibrissa; arista black, with black cilia; back of head black, with silvery pollen and with three or four sparse rows of postocular cilia and whitish to yellowish hair.

Thorax black, with thin grayish pollen and with suggestions of darker dorsal longitudinal stripes which do not extend beyond the scutellar suture; pleura lightly dusted with gray pollen; hindmost preintraalar, dorsocentral and acrostichal bristles before suture by 0.6, 1.4 and 2.4 respectively; sclerites at wing base mostly black, preparapтерon orange with whitish pubescence; postparapтерon orange brown; prothoracic spiracle with orange hair on lower half; scutellum with the under surface laterally with fine black hair.

Legs black, middle tibia with two anterodorsal bristles, one near basal third, one near apical third and one posterodorsal bristle near apical third.

Wing hyaline; basicosta black; subcostal sclerite orange basally, brown apically, orange pubescent; costal sections 2 to 6 in the proportion 80:46:102:105:8; upper squamal lobe with black rim; lower squamal lobe with white rim.

Abdomen dark metallic bluish, tessellated, silvery pollinose in most lights.

Genital segments black, shining, with scattered black setae. Internal anatomical features (pl. 27, A and B) as illustrated.

*Female.* Head width 14.1; length at antenna 6.6 and at vibrissa 6.7; eye height 6.9; head height 10.1; bucca 0.48 of eye height; front at vertex 0.38 of head width, 0.42 at lunule; parafaciale 2.1 in width opposite lunule; vibrissae set 2.9 apart; third antennal segment 4.2 times as long as second. Legs with middle tibia with three anterodorsal bristles. Wing with costal sections 2 to 6 in the proportions 84:51:110:51:10. Otherwise similar to male except for normal sexual differences.

*Length.* 5-9 mm.

As originally noted by Hough (1899), the number of postintraalar bristles varies from two to three in this species. The character is not of apparent value in the further separation of segregates of this form. Large specimens usually have two well-developed postintraalar bristles, but sometimes one is lacking on one side or there is an additional smaller bristle anteriorly. Smaller specimens often lack this additional postintraalar bristle, and the smallest specimens invariably do. The weakening of bristles in this species may also be noted in the accessory ocellar bristles and in the lateral bristles of the scutellum. Large speci-

mens show well-developed accessory ocellar bristles and from four to six lateral scutellar bristles. The smallest specimens of this species often have weak accessory ocellar bristles and but three lateral scutellar bristles.

*Distribution.* Nearctic: Highlands of northern Mexico to British Columbia and east to Ontario, Canada; most abundant in the Rocky Mountain states north of Colorado. Numerous specimens which I collected at high elevations during June, 1945 on the island of Oahu, Hawaiian Islands, are doubtfully placed under this name. Although the species may occur as early as February at Tempe, Ariz., it is most abundant during June and July from Colorado northward.

The type series of *Calliphora latifrons* Hough has been distributed among a considerable number of collections. Several (from Moscow, Idaho) were in the Aldrich collection, now in the National Museum; a Seattle, Wash., specimen is also evidently part of this series and is in the same collection. Several specimens in the Hough Collection in the Field Museum at Chicago, Ill., are evidently part of the type series. They comprise three specimens from Seattle, Wash., four from Moscow Mountain, Idaho, and one from Pullman, Wash. Hough did not indicate his holotype; I have selected a male from Moscow, Idaho, in the Field Museum as the lectotype.

*Biology, habits and immature stages.* *Egg.* Approximately 1.8 mm. in length and 0.4 in greatest diameter, white, striate, and slightly reticulate.

The eggs are deposited in small clusters of from 6 to 8 eggs each. They hatch in 24 to 48 hours during late July and early August in the vicinity of Logan, Utah.

*Larva.* Second instar: Segments 2 to 8 anteriorly with complete spinose bands, segment 9 bare dorsally, segments 10 and 11 with complete posterior spinose bands, segment 12 bare dorsally; segments 7 to 11 ventrally with both anterior and posterior spinose bands. Inner and outer tubercles on dorsal margin of posterior depression large and of about equal size, the inner tubercle smaller and set closest to outer; the outer tubercle on ventral margin of posterior depression largest, the median tubercle but slightly smaller, these two set closest together. Anterior spiracles each with 8 (sometimes 7 or 9) rounded orifices; posterior spiracles (pl. 42; C) each with two well-defined, more or less slit-like apertures, the outer one of which is bent outward toward the middle, the "button" indistinct and peritreme lightly pigmented toward the "button" area. Cephaloskeleton (pl. 42, A) well sclerotized, the labial sclerite broad basally as



illustrated, hypostomal sclerite posteriorly prolonged, parastomal sclerite long and narrow, pharyngeal sclerite pigmented medially and toward dorsopharyngeal sclerite.

Third instar: Mainly as in previous instar. Cephaloskeleton (pl. 42, B) with length and breadth of labial sclerite in proportion 1.5:2, cornua lightly pigmented dorsally and ventrally. Posterior spiracles separated by a distance nearly equal to the diameter of one spiracle, each (pl. 42, D) with three slitlike apertures, the outer slits being nearly in a horizontal plane, the "button" in peritreme, large, both "button" and peritreme well pigmented.

The larvae complete feeding in 4 or 5 days during midsummer and form puparia 8 to 12 days later. The total larval period is usually about 13 days although a few larvae may postpone forming puparia for as long as 25 to 30 days.

*Adult.* Both male and female specimens may be collected upon excrement of carnivorous animals or upon decaying substances, particularly meat. Many specimens may be seen about entrances to gopher burrows but the reason for this habit has not been ascertained. This species is one of the most abundant blowflies in the Rocky Mountain section of the United States where it appears early in the spring and remains until late in September.

It has been noted by Townsend (1937, p. 148-149) that females of this species with partially extruded larvae often occur in collections, and that this indicates a double-sac uterus of the *Onesia* type. The uterus of *lilaea* is similar in most respects to that of *Calliphora*.

Hough (1899) erroneously referred *Musca lilaea* Walker to *Calliphora erythrocephala* (Meigen). He did not see the Walker type.

#### *Eucalliphora arta*, new species

Differs from *lilaea* only in the following characters:

*Male.* Head height 8.4; eye height 6.3; bucca 0.33 eye height; length at antenna 5.0 and at vibrissa 5.1; parafaciale 1.2 in width opposite lunule; vibrissae set 2.4 apart; front at narrowest 0.18 head width, 0.23 at vertex and 0.31 at lunule. Legs with femora obviously less bristly; middle tibia with two posterodorsal bristles. Wing with costal sections 2 to 6 in the proportions 60:32:85:42:6. Posterior view of forceps of genitalia (pl. 27, C) as illustrated.

*Female.* Head height 8.8; eye height 6.0; bucca 0.43 eye height; length at antenna 5.3 and at vibrissa 5.9; parafaciale 1.5 in width opposite lunule; vibrissae set 2.5 apart; front at vertex

(which is narrowest) 0.36 head width. Wing with costal sections 2 to 6 in the proportions 80:40:90:52:8.

*Length.* 7-8 mm.

*Type.* Male, No. 54933, U. S. National Museum.

*Type locality.* San Luis Potosi, Mexico.

Three male and 6 female specimens of this saprophagous species were reared from decaying beef Mar. 23, 1931, by R. A. Roberts (Bishopp No. 17216).

### ALDRICHINA TOWNSEND

*Aldrichina* Townsend, Rev. de Ent. 4:111, 1934; Manual of Myiology, vol. 2, p. 170, 1935; *ibid.*, 5:135, 1937. Genotype. *Calliphora grahami* Aldrich. Monobasic.

*Aldrichiella* Rohdendorf, nec Hendel, Zool. Anz. 95(5-8):177, 1931; Villeneuve, Arkiv för Zool., 27A(34):9, 1936. Genotype, *Calliphora grahami* Aldrich. Isogenotypic with *Aldrichina*.

*Male and female.* Head width considerably greater than head height; length at antenna and at vibrissa about equal in male but vibrissal length greater than antennal length in female; epistoma elongate, nearly as wide as clypeus and warped forward from clypeal plane at an angle of nearly 30 degrees; meta-cephalon hardly apparent in profile view; eye large, ovate, set at a low but obvious angle from rear of head; parafrontale wide in both sexes but wider in female; frontale striate; rows of frontal bristles moderately divergent anteriorly; inner vertical bristles reclinate in male, decussate in female; outer vertical bristles two-thirds as long as inner vertical bristles in female; frontoorbital bristles absent in male, two proclinate and one reclinate in female; ocellar triangle large in both sexes, reaching nearly half way to lunule in female; clypeus about twice as long as wide; facial carina absent; parafaciale but slightly narrowed below, the upper half or more setose; faciale slightly concave in profile, and with two or three rows of short black setae extending about four-fifths the distance from the vibrissa to the antennal base; vibrissa above the oral margin; haustellum nearly one-third as long as head height; palpus long clavate; antenna at eye middle when head is viewed in profile, bases approximated; arista with long plumosity above and below for about two-thirds its length; back of head rather flat in male but more or less rounded in female.

Thorax with four humeral bristles, three of which are in

nearly a straight transverse row while the fourth is slightly anterior to the two median bristles; propleural bristles one or two; preintraalar bristles two, the anterior one weak, the normal posterior bristle absent; preacrostichal and predorsocentral bristles three, the foremost one of each row weak; presupraalar bristles one; posthumeral bristle present; notopleural bristles two; sternopleural bristles three; prosternum flat, elongate, wide anteriorly but narrowing posteriorly, setose laterally and posteriorly; postalar declivity in center and posteriorly with scattered hair; tympanic pit bare; squamal process and preepaulet with black setae; postacrostichal bristles and postsupraalar bristles three; scutellum with one discal bristle and three or four lateral bristles, usually only three of them strong.

Legs. Bristling of fore femur similar to that of *Calliphora vomitoria*; fore tibia with about six bristles in anterodorsal row, and with one posterior bristle near apical three-fifths; middle femur with one anterior bristle near middle, sometimes with two or three slightly basad of these, and with rows of anteroventral and posteroventral bristles, those on former surface longer basally, shorter and more closely-set apically; middle tibia with two anterodorsal bristles on basal half, with a third weaker bristle sometimes at basal sixth, one ventral bristle near apical third, three posterior bristles, one at basal fifth, one near basal third and one near apical third, sometimes a weaker bristle near base, and with one posterodorsal bristle near apical two-thirds; hind femur with anterodorsal and anteroventral rows of bristles, each row almost double toward base; hind tibia with about five anterodorsal bristles, only three long, three anteroventral bristles toward middle and apically, and three posterodorsal bristles, one near basal third, one near middle, and one near apical third; claws elongate in male, shorter in female.

Wing with minute costal spine; only third vein setulose, and here with about three basal setulae; fourth vein with rounded angle but bent toward costa at an angle of nearly 90 degrees, the apical cross vein bent inwardly; anterior cross vein at middle of second section of fourth vein, oblique; posterior cross vein doubly arcuate; fifth vein with last section one-sixth as long as preceding section.

Abdomen wide, short, ovate; third and fourth segments each with marginal rows of bristles, no median marginal or discal bristles on intermediate segments.

Genital segments large, both segments globose, the second considerably larger than in other closely related genera. Internal anatomical features unique for the family.

*Aldrichina grahami* (Aldrich)

*Calliphora grahami* Aldrich, U. S. Natl. Mus. Proc. 78(1):1-3, 1930; Patton, Ann. Trop. Med. and Parasitol. 29(1):28, 1935; Senior-White, Fauna of British India, Diptera, vol. 6, p. 35, 1940. (Type, male from Szechuen Province, China, No. 26865, U. S. National Museum.)

*Aldrichiella grahami* (Aldrich) Rohdendorf, Zool. Anz. 95(5-8): 176-177, 1931; Villeneuve, Arkiv för Zool. 27A(34):9, 1936.

*Aldrichina grahami* (Aldrich) Townsend, Rev. de Ent. 4:111, 1934; Manual of Myriology, vol. 5, p. 135, 1937.

This species is indigenous to Asia, and it has evidently been imported into the western part of the United States in comparatively recent years. Dr. D. C. Graham, for whom the species was named, has supplied the National Museum with a long series of specimens from Szechuen Province, China. It is evidently a common species in Asia, and it has become a rather common form within the past few years in the vicinity of Sacramento, Calif.

Normally the largest of the North American species related to the genus *Calliphora*; with the general coloring and habitus of *vomitorea*.

*Male*. Head width 16.0; length at antenna 7.1 and at vibrissa 7.7; oral margin slightly protruding beyond vibrissal angle when head is viewed in profile; eye height 9.0; head height 13.4; bucca 0.43 eye height, black, with gray pollen and with scattered black hairs, none of which are pale before the metacephalic suture; frontale 0.54 frontal width, orange red anteriorly and black posteriorly; front at narrowest 0.14 of head width, 0.18 at vertex and 0.30 at lunule, black, moderately covered with silvery pollen, with some black hairs not in rows which are scattered outside frontal bristles and extend anteriorly to the middle of the parafaciale; frontal rows consisting of about 8 bristles each, the rows moderately divergent anteriorly and extending to the base of the second antennal segment; vertex black, with silvery pollen; clypeus dark reddish brown, slightly silvery; parafaciale 2.2 in width opposite lunule, with silvery to gray pollen and black setae; faciale orange to orange brown; vibrissa above oral margin by 1.0 and separated by 3.4; palpus orange, 4.2 in length; antenna orange brown to brown, third segment three times as long as second; arista black with black cilia; back of head black, silvery pollinose, with four or five rows of postocular cilia and

with abundant yellowish white hair particularly on the meta-cephalon.

Thorax blue black, moderately silvery pollinose, with black longitudinal stripes on dorsum; pleura lightly dusted with gray pollen; propleuron with black setae; preacrostichal and predorso-central bristles before suture by 2.2 and 1.6 respectively; prosternum with black hair; preparapteron orange, with white pubescence; other sclerites at wing-base black; greater ampulla with white pubescence; metathoracic spiracle with orange to brown tawny hair; lateral postscutellar plates with black setae; under surface of scutellum laterally with fine black hair.

Legs black.

Wing hyaline, rather brown basally; costal sections 2 to 6 in the proportions 94:60:138:48:10; subcostal sclerite orange, with orange pubescence; basicosta black; fourth vein without apical section or fold; upper squamal lobe white at base, rim brown; lower squamal lobe brown, rim white.

Abdomen black with bluish luster, strongly silvery pollinose, tessellated.

Genital segments black, shining, with black setae. Internal anatomical features (pl. 27, D) as illustrated.

*Female.* Head width 18.0; length at antenna 8.0 and at vibrissa 8.2; eye height 8.7; head height 13.0; bucca 0.48 eye height; frontale with considerable scattered black hair, 0.59 frontal width; front with nearly parallel margins, at vertex (which is narrowest) 0.38 of head width and 0.42 at lunule; parafaciale 2.8 in width opposite lunule, black, with brownish pollen; vibrissae set 3.5 apart; palpus 4.8 in length; third segment of antenna 3.4 times as long as second. Legs with bristles usually longer and finer than in male; the claws shorter. Wing with costal sections 2 to 6 in the proportion 101:62:150:46:12. Abdomen with marginal bristles on fourth segment more erect than in male. Otherwise similar to male except for sexual differences.

*Length.* 8-14 mm.

*Distribution.* Palearctic: Hong Kong and Hankow, China to Siberia. Nearctic: Southern California to northwestern Oregon. Adults have been collected during almost the entire year at Nice, Calif., by A. W. Lindquist.

*Biology, habits, and immature stages.* None of the habits or details of the biology of this species are known. Lindquist's collections were made in a blowfly trap baited with decaying meat and the habits of the species must be essentially similar to those of *Calliphora vomitoria*.

## CALLIPHORA ROBINEAU-DESVOIDY

*Calliphora* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 433, 1830; Schiner, Fauna Austriaca, Die Fliegen, vol. 1, p. 583, 1862; Brauer und Bergenstamm, Zweiflügler des Kaiserlichen Museums zu Wien, vol. 4, no. 1, p. 89, 1889; *ibid.*, vol. 6, no. 3, p. 192, 1893; Van der Wulp, Biologia Centrali-Americana, Insecta, Dipt., vol. 2, p. 294, 1896; Brauer, Akad. Wiss. Wien, Math.-Nat. Kl. Sitzber., (1) 107:1, 1899; Hough, Ent. News 10:65, 1899; Bezzi, Katalog der Paläarktischen Dipteren, vol. 3, p. 545, 1907; Williston, Manual of North American Diptera, p. 343, 1908; Townsend, Smithsn. Misc. Collect. 51:118, 1908; Bezzi, Boll. Lab. Portici 6:67, 1912; Shannon, Insecutor Inscitiae Menstruus 11:107, 1923; Malloch, New Zeal. Inst. Trans. and Proc. 55:640, 1924; Shannon, Wash. Ent. Soc. Proc. 28(6):134, 119, 1926; Lundbeck, Diptera Danica, vol. 7, p. 149, 1927; Malloch, Linn. Soc. N. S. Wales Proc. 52:299, 1927; Curran, Amer. Mus. Nat. Hist. Bull. 52:363, 1928; Séguy, Encycl. Ent. (A) 9:135, 1928; Patton and Cushing, Ann. Trop. Med. and Parasitol. 28(2):205-216, 1934; Townsend, Manual of Myiology, vol. 2, p. 165, 1935. Genotype. *Musca vomitoria* Linnaeus. (By original designation.)

All species placed in this genus have the following characters in common.

*Male and female.* Head (pl. 5, D) width greater than height; epistoma slightly protuberant, only slightly narrower than the clypeus and warped strongly forward from clypeal plane; metacephalon nearly flat; eye of medium size and set at a slight angle with posterior plane of head; frontale striate, narrow in male and wider in female; parafrontale with some hairs not in rows outside the frontal bristles which extend anteriorly to about the middle of the parafaciale; inner vertical bristles strong and decussate at tips; outer vertical bristles one-half to two-thirds as long as inner ones in female, absent in male; postvertical bristles of moderate size and proclinate; frontoorbital bristles absent in male, two (sometimes three) proclinate and one reclinate in female; ocellar bristles strong and proclinate; clypeus shallowly sunken, and nearly twice as long as wide; facial carina short, narrow, sharp, appearing only between and narrowly separating the basal antennal segments; parafaciale narrowed above, setose in middle on upper half or slightly more; faciale rounded, slightly convex in profile, and with several rows of short black setae which ascend fully one-half the distance to the antennal base; vibrissa

strong, slightly above the oral margin; proboscis three-fourths head height, haustellum about two-fifths head height; palpus clavate as long as or slightly longer than haustellum; antenna at or slightly below eye-middle when head is viewed in profile, the bases approximated or only slightly separated by narrow carina, third segment elongate, reaching from four-fifths to nine-tenths the distance to the vibrissa; arista with apical segment one-third longer than third antennal segment, with long cilia above and below for from two-thirds to four-fifths its length.

Thorax with propleural bristle strong; preintraalar bristles three; posthumeral bristle present; presupraalar bristle one; mesopleuron and sternopleuron setose except on anteroventral margins; sternopleural bristles three, arranged 2 + 1, the two anterior bristles close together; hypopleuron bare on anterior half or more; pteropleuron bare on anterodorsal fourth but with a well-defined tuft of longer setae near center; squamopleuron with a nap of short fine pubescence; prosternum short and wide, setose; postalar declivity with setae in center; tympanic pit with a few hairs on posterior margin, the ridge sparsely setose toward base; postacrostichal and postdorsocentral bristles three; intrapostalar, intrapostsutural and intrapostsupraalar bristles absent; mesospiracular bristle strong, in center of pre-sternopleural area; metathoracic spiracle oval, directly below squamopleuron, without long hairs on margins; mesothoracic spiracle with tawny brown hair; scutellum with one subapical discal bristle and with four or five lateral scutellar bristles, the basal lateral bristle often weak and sometimes absent; lateral postscutellar plates with tuft of short setae.

Legs with claws and pulvilli about as long as or but slightly shorter than last tarsal segment; fore tibia with dorsal row of short bristles and with one posterior bristle between middle and apical third; middle femur with an anteroventral and a posteroventral row of bristles; middle tibia with two ventral bristles near middle; hind femur with anterodorsal row of short bristles among which are several long bristles, usually one near basal third, one near middle, and one near apical fourth.

Wing without costal spine; subcostal sclerite pubescent; third vein with three to five short setulae at base; fourth vein without fold or spur, the angle 90°, the apical cross vein sharply curved toward apex of costa near wing-tip; anterior cross vein at middle of second section of fourth vein and strongly oblique; apical cross vein strongly doubly arcuate; seventh vein long and straight.

Abdomen with scutellar depression extending to posterior

margin of first segment; no discal or median marginal bristles on intermediate segments; third and fourth segments each with a marginal row of erect bristles; fourth segment also with erect discal bristles.

Genital segments of medium size, first segment largest and rather flattened dorsally in profile; both segments with abundant erect black hair.

### *Calliphora coloradensis* Hough

*Calliphora coloradensis* Hough, Zool. Bull. 2(6):286, 1899; Parker, Mont. State Bd. 1st Ent. Bien. Rpt.: 44,1914; Bishopp, Jour. Econ. Ent. 10:273, 1917; Shannon, Insecutor Inscitiae Menstruus 11:109, 1923; Walton, U. S. Natl. Mus. Proc. 48(2070):175, 1915; Parker, Ent. News 28:281, 1917; Pierce, Calif. State Dept. Agri. Sacramento, Spec. Pub. 22:9, 1922; Wilson, Science 77:560, 1933; Cushing and Patton, Ann. Trop. Med. and Parasitol. 28(2):211,213, 1934; Parish and Cushing, Jour. Econ. Ent. 31(6):750-763, 1939. (Type, male from Colorado, in the Field Museum of Natural History.)

*Male.* Head height 13.5; eye height 8.8; length of head at vibrissa 8.1 and at antenna 7.8; bucca 0.44 eye height, red orange on anterior half or more, with thin gray pollen and with black hair, no pale hair before the metacephalic suture; frontale black posteriorly, sometimes reddish toward lunule, slightly silvery, twice as wide as parafrontale at narrowest and widening toward lunule; head width 16.6; front at narrowest 0.13 of head width, 0.20 at vertex and 0.30 at lunule, black, covered with dense silvery pollen, and with only a few hairs posteriorly but with considerable long thin hair anteriorly outside frontal row; vertex slightly silvery; frontal row consisting of about 10 bristles, those toward vertex thin and hair-like, the rows diverging anteriorly to the middle of the parafaciale, and descending to a point nearly opposite the middle of the second antennal segment; clypeus orange, silvery toward antennal base; carina vestigial; parafaciale 2.9 in width opposite lunule, black, with heavy silvery pollen and with black setae in a central area that extends well below the middle; faciale yellow orange, with several rows of weak black setae which ascend fully two-thirds the distance to the antennal base; vibrissae separated by 3.3; palpus bright orange; second antennal segment yellow orange to orange brown, third segment 4.8 times as long as second, orange at base, orange brown to dark brown apically, and reaching four-fifths the dis-



tance to the vibrissa which is above the oral margin; arista black with long black cilia above, shorter below, for three-fourths its length; back of head black, strongly silvery pollinose, with about four rows of postocular cilia and with considerable pale hair about the occiput; metacephalon black with a few pale hairs.

Thorax black, silvery pollinose, with five dorsal longitudinal stripes which are apparent from posterior view; hindmost pre-aerostichal, predorsocentral and preintraalar bristles 2.4, 1.8, and 0.8 respectively before suture; postintraalar bristles three; preparapтерon orange.

Middle tibia with three or four anterodorsal bristles and three posterior bristles; hind tibia with three anteroventral bristles, otherwise like *vomitioria*.

Wing with costal sections 2 to 6 in the proportion 105:72:140:50:10; lower squamal lobe with hind margin widely whitish.

Abdomen blue, with heavy whitish pollen apparent in most lights, the second segment with a narrow shining mediodorsal longitudinal stripe.

Genital segments black, outer forceps straight, the marginals parallel, the tips rounded and blunt; inner forceps weak, elongate and narrow. Internal anatomical details (pl. 27, E, F, and G) as illustrated.

*Female.* Head height 12.8; eye height 8.3; length of head at vibrissa and at antenna 8.1; width 18.0; bucca 0.51 eye height; parafaciale opposite lunule 2.9 in width; distance between vibrissae 3.3; third antennal segment 4.7 times as long as second; front at narrowest (at vertex) 0.36 head width, 0.42 at lunule; frontale reddish anteriorly; parafrontale and parafaciale often with pollen yellowish or brownish. Wing with costal sections 2 to 6 in the proportions 100:70:140:50:12. Otherwise similar to male except for normal sexual differences.

*Length.* 9-12 mm.

*Distribution.* Nearctic: San Martin, Mexico, to Alaska, and as far east as Indiana and Ontario. Most abundant in Colorado and New Mexico. It does not occur in Southeastern United States so far as I know. It is the most abundant species of *Calliphora* in Menard County, Texas, occurring throughout the year in that locality according to Parish and Cushing (1939b). They found it uncommon only during the summer season. It was collected most frequently in moderate shade, with little or no wind protection, in either woods or open country, and at low to moderate elevation.

*Biology, habits and immature stages.* *Egg:* As described for *vicina*.

*Larva.* Third instar: Color, size, and habitus as in *vicina*. Segments 2 to 8 (sometimes 9) anteriorly with complete spinose bands, segments 2 to 12 anteroventrally with spinose bands, these not continuing over dorsum on segments 9 to 12; segments 6 to 11 with posteroventral spinose bands, segments 10 and 11 with posterior band complete over dorsum and the band on segment 10 weak dorsally. All spines minute and simple. Anterior spiracles each with 8 or 9 (more often 8) circular openings; posterior spiracles (pl. 42, E) each with three slit-like apertures, the "button" and peritreme obvious, the latter complete. Cephalic segment with obvious branching oral grooves radiating from the oral aperture. Cephaloskeleton (pl. 42, F) with pharyngeal sclerite with ventral ridges. Posterior cavity margined by six dorsal equidistant tubercles and eight nearly equidistant ventral tubercles; dorsally, the median pair of tubercles largest, these separated by a distance equal to two times the diameter of one spiracular plate; ventrally, outer two tubercles largest, the inner pairs smallest, the usual innermost pair hardly discernible, the median tubercle situated dorsally to a line between the inner and outer tubercles.

The species is saprophagous with habits essentially similar to those described for *vicina* and *vomitorea*.

It has been assumed in the past that *coloradensis* is larviparous, for females of this form are often found in collections with first star larvae protruding from their abdomens. This species deposits eggs in the normal calliphorid manner and the presence of larvae in female flies is probably due to withholding the incubating eggs for deposition in a desirable location.

Wilson (1933) found puparia of *coloradensis* in the burial crypt of a dog, in the "hard-pan" of the so-called "White Dog Cave" in northeastern Arizona. He estimated these to be from 6 to 10 thousand years of age.

### *Calliphora livida*, new species

*Calliphora viridescens* (of North American authors, nec Robineau-Desvoidy), Hough, Zool. Bull. 2(6):286, 1899; Felt, 26th Ann. Rept. N. Y. St. Ent. 1910:66; Walton, Ent. Soc. Wash. Proc. 15(1):22, 1913; Whiting, Ent. Soc. Amer. Ann. 6:265, 1913; Bishopp, Jour. Econ. Ent. 10:273, 1917 (misspelled *iridescens*); Malloch, Canadian Arctic Expedition Rpt., vol. 3, p. 58e, 1919; Shannon, Insector Inscitiae Men-

struus 11:109, 1923; Johnson, Boston Soc. Nat. Hist. Occas. Papers 7(15):217, 1925; West, in Leonard, Mem. 101, Cornell Univ., p. 827, 1928; Roberts, Ent. Soc. Amer. Ann. 23:790, 1930; Johnson, Bird-banding 3:26, 1932; Patton and Cushing, Ann. Trop. Med. and Parasitol. 28(2):213-216, 1934.

The very brief original description of *Calliphora viridescens* by Robineau-Desvoidy was of a female. Hough's (1899) determination was followed for over a quarter of a century. Aldrich saw the type of *viridescens* in 1928 and found that it was not the same as the *viridescens* of North American authors, but he could not be certain to which of the other species the name *viridescens* should be applied, for the type is in poor condition. Hough (1899) erroneously considered *Calliphora terrae-novae* Macquart to be a synonym of this species. He also placed *Calliphora violacea* Meigen as a synonym, and this synonymy was accepted by Bezzi (1908), but I am unable to verify it.

A typical *Calliphora* species with the general aspect of *vicina*, but with the bucca black.

*Male.* Head height 13.6; eye height 10.1; bucca 0.32 eye height, head black, with thin gray pollen and with black hair; cheek grooves orange to red orange; length at antenna 7.2 and at vibrissa 8.3; frontale mahogany red especially anteriorly, nearly obliterated at narrowest portion (1.0 before the foremost ocellus), but widening to three times as wide as parafrontale at lunule; front at narrowest 0.05 of head width, 0.12 at vertex and 0.28 at lunule, black, with silvery pollen and scattered black hairs; frontal row consisting of about 7 or 8 bristles, with weak hairs from middle toward vertex, diverging more rapidly than margins of frontale anteriorly, and extending to about the middle of the second antennal segment; vertex black, with gray pollen; clypeus orange brown, with gray pollen; carina low and hardly apparent; parafaciale 1.7 in width opposite lunule, black, often deep mahogany red on lower third or less, with sparsely scattered black setae at middle of upper half; faciale orange to orange brown, with several rows of short black setae which ascend about one-half the distance to the antennal base; vibrissae slightly above the oral margin and set 3.6 apart; epistoma as wide as clypeus; palpus 4.2 in length, orange; antenna orange brown to black, apex of second and base of third segments orange, third segment 4.7 times as long as second, reaching fully four-fifths the distance to the vibrissa; arista black, apical third bare, ciliation black, long above and shorter below; back of head flat-

tened, black, silvery pollinose, with three or four rows of post-ocular cilia and some yellowish hair about occiput; metacephalon black with mostly black hair.

Thorax with color and chaetotaxy mainly like *vicina* but with three postintraalar bristles; hindmost preacrostichal, dorsocentral and preintraalar bristles 2.8, 1.6 and 1.0, respectively, before the suture; sclerites at wing-base black; spiracles with dark tawny brown hair.

Legs with bristles as in *vomitorea* but middle tibia with two anterodorsal bristles, two posterior bristles and one posterodorsal bristle; hind tibia with three or four anterodorsal bristles, two or three posterodorsal bristles.

Wing brownish at base; basicosta black; subcostal sclerite orange brown with orange pubescence; costal sections 2 to 6 in the proportion 83:54:104:40:8; squamal lobes similar to those of *vicina*.

Genitalia with forceps (pl. 27, H and I) as illustrated.

*Female.* Head height 14.7; length at antenna 6.8 and at vibrissa 7.8; eye height 7.2; bucca 0.44 eye height; parafaciale 1.9 in width opposite lunule; vibrissae set 3.6 apart; front at narrowest (at vertex) 0.34 of head width, 0.40 at lunule; frontale wide, usually velvety black but sometimes rather brownish toward lunule. Wing with costal sections 2 to 6 in the proportion 90:60:142:50:6. Otherwise similar to male except for normal sexual differences.

*Length.* 7-11 mm.

*Type.* Male, No. 54934, U. S. National Museum.

*Type locality.* Savannah, Ga.

Eastern males sometimes have the front at the narrowest slightly narrower than 0.05 head width; the width at the lunule especially may be reduced.

Walton (1913) investigated variation in the chaetotaxy in a series of 247 specimens of this species which had been reared from a dead snake. He stated "In nearly all cases where supernumerary intraalar bristles occurred they were smaller than normal. In other words there was an apparent tendency of the most cephalad toward obsolescence. In several cases no less than five macrochaetae replaced the usual three, the more frequent number, however, was four and the aberration was bisymmetrical or otherwise. Two individuals possessed but a single pair of posterior intraalars on each side and could therefore not be distinguished structurally from *Calliphora vicina*."

*Distribution.* Nearctic: California and Georgia to as far

north as British Columbia and Ontario. Most abundant in the central part of the United States during April 15 to May 1.

*Biology, habits and immature stages.* *Egg.* As described for *vicina*.

*Larva.* Third instar: Segments 2 to 8 with anterior spinose bands complete, segments 9 to 12 bare anterodorsally, segments 2 to 5 bare posteriorly, segments 10 and 11 with complete posterior bands of spines, segments 2 to 9 bare posterodorsally, segment 12 bare dorsally. Posterior depression with inner and outer tubercles on dorsal margin largest and of about equal size, the median smaller and closest to inner; outer tubercle on ventral surface largest, the median nearly as large, inner tubercle smallest, the median and outer set closest together. Anterior spiracles each with about 8 circular orifices; posterior spiracles (pl. 43, A) each with three slit-like apertures as illustrated, the "button" small, the peritreme well pigmented. Cephaloskeleton (pl. 43, B) with basal portion of labial sclerite about as wide as length of apical tooth-like portion, the length of the entire sclerite about two times the width of the basal portion.

*Puparium.* With most of the external characters of the third instar larva.

The species is saprophagous as are all the species of *Calliphora*. Johnson (1932) reared adults of *livida*, June 25, 1931, at Groton, Mass., from a nest of barn swallows, containing several dead nestlings. My larvae were reared upon decomposing meat. This form appears to be abundant during the spring months in Middle Western states. Adults may be trapped over beef until late in April. The species is not abundant during fall months. The National Collection contains specimens collected during February, March, April, June, and October.

### *Calliphora mortica* Shannon

*Calliphora mortica* Shannon, Insector Inscitiae Menstruus 11:109, 1923. (Type, male from Kodiak, Alaska, No. 26126, U. S. National Museum.)

A small species with the general habitus of *terrae-novae* and *vomitaria* but with entire head, except faciale, palpus and sections of antennae, black.

*Male.* Head height 10.8; eye height 8.0; bucca 0.34 of head height, head totally black, with thin grayish pollen, and with black hair, no pale hair before the metacephalic suture; frontale reddish anteriorly, obliterated at narrowest (just anterior to ocellar triangle), widening to fully three times as wide as para-

frontale at lunule; frontal bristles thin, hair-like, and numerous toward vertex, which is black with gray pollen; front black, with heavy gray pollen, thickly setose at narrowest where it is 0.4 of head width, 0.13 at vertex and 0.28 at lunule; carina low but apparent; parafaciale black, with thin gray pollen, 1.3 in width opposite lunule and wider below; faciale orange red with several rows of short black setae which ascend fully four-fifths the distance to the antennal base; palpus orange, 4.0 in length; apical portion of second and basal portion of third antennal segments red orange, otherwise dark brown to black; third segment of antenna 3.7 times as long as second, reaching slightly more than two-thirds the distance to the vibrissae, which are above the oral margin and 3.1 apart; back of head black, silvery, with three or four rows of postocular cilia and considerable yellowish or tawny hair.

Thorax black, with pollen apparent only in favorable lights on prothorax behind head, and with dorsal longitudinal stripes indistinct; hindmost acrostichal, dorsocentral and intraalar bristles before the suture by 2.0, 1.2, and 0.8 respectively; sclerites at wing base black; spiracles with yellowish brown hair; scutellum with five lateral bristles, the intermediate ones weak.

Legs like *vomitorea* and *vicina* except middle tibia usually with two anterodorsal and two posterior bristles.

Wing brownish; subcostal sclerite orange brown; basicosta black; costal sections 2 to 6 in the proportion 85:55:110:40:8; squamal lobes tinged with dark brown, shaded as in *vicina*.

Abdomen deep purplish blue, with whitish pollen, the hind margin of the segments mostly shining.

Genital segments small, black, with abundant thin black hair; outer forceps thick at base but gradually tapering to a narrow apex; inner forceps long and thin, the inner margins not divergent.

*Female.* Head height 11.4; eye height 7.4; bucca 0.44 of eye height; length at antenna 6.8 and at vibrissa 7.7; parafaciale opposite lunule 1.9; vibrissae set 3.6 apart; head width 14.5; front at narrowest (at vertex) 0.34 head width, 0.39 at lunule; palpus 4.5 in length; third segment of antenna 5.5 times as long as second. Wing with costal sections 2 to 6 in the proportion 90:60:142:50:6. Otherwise similar to male except for normal sexual differences.

*Length.* 5-8 mm.

*Distribution.* Nearctic: Alaska.

In addition to the type series mentioned by Shannon, the National Collection contains 2 females and 10 males collected July

27, Savonoski, Naknek Lake, Alaska, by J. S. Hine. The species is not uncommon in Alaska during July and August.

The first impression of *mortica* is one of the striking similarity of this form to small specimens of *vomitorea* and *terrae-novae*, both of which also have black buccae. The presence of numerous reddish or tawny hairs before the metacephalic suture of *vomitorea* satisfactorily separates it from *mortica*, which also has the head entirely black, and has only the faciale, vibrissal angle, palpi, and small portions of the antennal segments orange red. The species *terrae-novae* has the vibrissal angle orange to orange red. The male genitalia of *mortica* and the parafaciale-vibrissal proportion are also distinctive.

*Biology, immature stages, and habits.* Unknown.

### *Calliphora peruviana* Robineau-Desvoidy

*Calliphora peruviana* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 438, 1830. (Type, male from Peru, in the Bigot Collection, Newmarket, England.)

*Calliphora nigribasis* Macquart, Diptères exotiques, sup. 4, no. 2, p. 215, 1851; Shannon, Ent. Soc. Wash. Proc. 28(6):134, 1926. (Type, male from Colombia, in Paris.)

The type specimens of *nigribasis* Macquart, a male and a female, are now in the Paris Museum. Although the labels on these specimens indicate that they were collected in Mexico, I have not seen the species from North America. Macquart's description states that the type was from Colombia.

Shannon (1926, p. 134) synonymized Townsend's *Calliphora irazuana* with *peruviana*, but the former is possibly a synonym of *Calliphora terrae-novae* Macquart.

*Calliphora peruviana* Macquart (Diptères exotiques, vol. 4, p. 216, 1851) is a synonym of *Neta chilensis* (Walker).

A normal *Calliphora* with the bases of the wings darkened.

*Male.* Head height 13.0; length at antenna 7.7 and at vibrissa 8.7; eye height 9.3; bucca 0.36 eye height, black, silvery pollinose, with black hair, no pale hair before the metacephalic suture; frontale deep mahogany red, about as wide as parafrontale at narrowest, but about twice as wide anteriorly; front at narrowest 0.10 of head width, 0.16 at vertex and 0.39 at lunule, black, with silvery pollen, and with a few scattered long black hairs outside frontal row; frontal row consisting of 10 to 12 bristles which are hair-like posteriorly, the rows diverging more rapidly than margins of frontalia, and descending almost to the base of the second antennal segment; parafaciale 2.2 in

width opposite lunule, black on upper half or more, deep reddish below, with silvery pollen, and with black setae on upper half; clypeus dark reddish brown, thinly silvery; epistoma only slightly narrower than clypeus and elongate; vibrissae 1.4 above oral margin and set 3.1 apart; faciale deep red, with several rows of short black setae which ascend about three-fourths the distance to the antennal base; cheek grooves and vibrissal angle deep red; palpus yellow orange to orange, 4.5 in length, with abundant black setae on dorsal and ventral margins, the setae on middle of ventral margin in a group and three-fourths as long as palpus; antennal segments orange brown to brownish black, apex of second and base of third segments orange; third segment 4.1 times as long as second, reaching four-fifths the distance to the vibrissa; arista black, the middle yellowish, ciliation black, long above and below, the apical third bare; back of head silvery, with two or three rows of postocular cilia, around occiput and below with pale yellowish hair.

Thorax purplish black to black, hardly shining but with silvery pollen which is only apparent on dorsum behind head; chaetotaxy like that of *vomitorea*; sclerites at wing base black; squamopleuron with dark brown pile; scutellum with six lateral bristles.

Legs black, claws somewhat elongate; chaetotaxy mainly like that of *vicina* except middle tibia with two anterodorsal bristles, one ventral bristle near apical third and two posterior bristles, and hind tibia with three anterodorsal bristles, one anteroventral bristle and two posterodorsal bristles.

Wing hyaline, base from basal third of second section of costa and second section of fifth vein tinged with dark brown; basicoستا black; subcostal sclerite dark orange brown with brown pubescence; costal sections 2 to 6 in the proportions 100:60:140:50:14; squamal lobes tinged with dark brown, their rims nearly black.

Abdomen ovotuncate posteriorly, deep greenish blue, mostly shining, with only thin whitish pollen and with erect black hairs; first segment almost black; second segment with a narrow medio-dorsal longitudinal black stripe; fourth segment shining dark blue; sternites wide, the fifth widest.

Genital segments black, with long black hair; both segments large, globose; outer forceps longer than inner (pl. 27, J and K) as illustrated.

*Female.* Head height 16.0; eye height 10.0; bucca 0.60 eye height; length at antenna 9.0 and at vibrissa 10.0; parafaciale opposite lunule 3.2 in width; distance between vibrissae 4.0; frontale mahogany red, darker posteriorly, 0.5 frontal width;



front at narrowest (at vertex) 0.33 head width, and 0.43 at lunule; with abundant erect black hair outside frontal row of bristles; third antennal segment five times as long as second; frontal rows of bristles nearly parallel, considerably removed from margins of frontalia along each of which is a single row of weak bristles anteriorly; palpus 6.0 in length; third antennal segment five times as long as second. Wing with costal sections 2 to 6 in the proportions 120:80:160:60:16. Otherwise similar to male except for normal sexual differences.

*Length.* 10-13 mm.

*Distribution.* Neotropical: Mexico (?) and Colombia to Peru.

Two males and one female of this species are in the collection.

*Biology, habits, and immature stages.* The habits and biology of this species are unknown.

### *Calliphora terrae-novae* Macquart

*Calliphora terrae-novae* Macquart, Diptères exotiques, vol. 4, no. 2, p. 217, 1851; Séguy, Encycl. Ent. (B II.) Dipt. 2:86, 1925. (Type, female from Terre-Neuve, in Paris.)

*Calliphora viridescens* Bezzi (nec Robineau-Desvoidy), Katalog der Paläarktischen Dipteren, vol. 3, p. 547, 1907.

?*Calliphora irazuana* Townsend, Smithsn. Misc. Collect. 51:118, 1908; Shannon, Insecutor Inscitiae Menstruus 11:116, 1923. (Type, female from Irazu, Costa Rica, No. 10886, U. S. National Museum.)

*Calliphora vomitoria* var. *nigribarba* Shannon, Insecutor Inscitiae Menstruus 11:116, 1923; Patton and Cushing, Ann. Trop. Med. and Parasitol. 28 (2):210, 1934. (Type, male from New York, No. 26165, U. S. National Museum.)

*Calliphora nigribucca* Hough, Ent. News 10:66, 1899 (nomen nudum); Shannon, Insecutor Inscitiae Menstruus 11:115, 1923.

*Calliphora uralensis* Collin (nec Villeneuve), Ann. and Mag. Nat. Hist. (10) 7 (37):79, 1931; Roy. Ent. Soc., London, Trans. 80:423, 1932.

*Male.* Head height 13.7; eye height 9.8; bucca 0.37 of eye height, head black, with black hair, no tawny or orange hair visible on the metacephalon, shining anteriorly, with thin gray pollen posteriorly; frontale brown to black, at narrowest less than half as wide as front but rapidly widening anteriorly toward lunule; front at narrowest 0.05 head width, 0.17 at vertex and 0.29 at lunule, black, with thin gray pollen; frontal

row consisting of from 10 to 12 bristles which are weak and hairlike posteriorly at the narrowest portion of the frontale, the rows extending anteriorly to the lunule; clypeus reddish orange to brownish black, with thin grayish pollen; parafaciale 1.9 in width opposite lunule, black, often reddish on lower third, with bronze colored pollen; epistoma nearly in clypeal plane; vibrissae set 2.9 apart; antennal bases not separated, the carina inconspicuous, third segment 4.0 in length, and reaching four-fifths the distance toward the vibrissa; arista dark brown to black, with long black cilia above and below for two-thirds its length; back of head slightly concave above occiput, the metacephalon rounded in profile, black, with three or four rows of postocular cilia and with tawny to yellow orange hair around the occiput and below, which sometimes covers the metacephalon and occurs sparsely on the bucca.

Thorax black with but thin grayish pollen; humeral bristles three, strong, in nearly a straight row, and usually with a weaker fourth humeral bristle slightly anterior to these; preintraalar bristles three, the foremost weak, the hindmost 0.8 before the suture; preacrostichal bristles only two strong, the hindmost 2.4 before the suture; predorsocentral bristles three, the foremost weak, the hindmost 2.0 before the suture; prosternum, postalar declivity and squamal pit with black setae; postalar bristles two, and a weak third median to hindmost; sclerites at wingbase black, greater and lesser ampulla and preparaperteron with white decumbent pile; postintraalar bristles two; postsupraalar bristles four, the bristle between the first and third weak and sometimes absent; mesothoracic spiracle tawny brown; metathoracic spiracle dark brown; scutellum with dark hair on lateral margins of under surface.

Legs like those of *vomitorea*, but hind tibia with three or four anteroventral bristles.

Wing hyaline, often slightly brownish toward costal margin and base; costal sections 2 to 6 in the proportion 100:65:135:45:12; basicosta black; subcostal sclerite orange, with orange pubescence; fourth vein terminating in costa 1.0 before wing apex; upper squamal lobe brownish, the rim nearly black; lower squamal lobe dark brown, the rim whitish.

Abdomen metallic blue with thin whitish pollen apparent only in certain lights; first segment nearly black; intermediate segments with strong lateral bristles, the second segment with a marginal row of bristles, the lateral ones strong, those toward center of dorsum very weak; fourth segment with considerable erect black hair.

Genital segments black, the first without a marginal row of bristles; inner and outer forceps of about equal length, elongate, narrow, the tips narrowly rounded; outer forceps gently curved anteriorly; inner forceps gradually separating to tips. Internal anatomical features (pl. 28, A and B) as illustrated.

*Female.* Head height 15.0; eye height 8.2; bucca 0.54 of eye height; length of head at antenna 7.0 and at vibrissa 8.0; parafaciale 2.5 in width opposite lunule; distance between vibrissae 3.1; head width 17.0; front at narrowest (at vertex) 33.5 of head width, 0.39 at lunule. Wing with costal sections 2 to 6 in the proportion 115:80:160:49:12. Otherwise as in male except for normal sexual differences.

*Length.* 9-13 mm.

A few specimens, particularly females, have a small amount of reddish or tawny hair before the metacephalic suture. In such cases other characters are available to separate this species from others closely related. About five percent of the adults have three posterior bristles on one middle tibia or the other.

*Distribution.* Neartic: Alaska and Newfoundland south to Colorado and New York. The species is most abundant in the northern United States and southern Canada, particularly in the Rocky Mountain districts. It occurs in late July and August.

Aldrich saw the type of *terrae-novae* in Paris in 1929. He noted that it was a female and difficult to classify satisfactorily, but that he agreed with Séguy in placing it near *nigribarba* Shannon. Séguy (1925) noted that the type had reddish hair posteriorly on the metacephalon but this is not invariably the case. The type of *terrae-novae* is undoubtedly one of these.

*Biology, habits, and immature stages.* *Egg.* Similar to that described for *vicina*.

*Larva.* Third instar: Segments 2 to 9 anteriorly with complete spinose bands, segments 10 to 12 bare anterodorsally, segments 2 to 5 bare posteriorly, segments 10 and 11 posteriorly with complete spinose bands, segments 2 to 9 bare posterodorsally, segment 12 bare dorsally. Inner tubercle on dorsal surface of posterior depression largest, the median and inner tubercles smallest and usually closer together, the outer tubercle on ventral surface of posterior depression largest, the median nearly as large, the inner much the smaller of the three. Spines usually single-pointed but numerous spines have two or three points. Anterior spiracles each with 10 (10-11) rounded apertures, posterior spiracles (pl. 43, C) and cephaloskeleton (pl. 43, D) as illustrated.

The species may be reared in exactly the same way as *vicina*

for both are saprophagous and the adults may be collected over carrion or in carrion-baited traps.

Aldrich indicated, by his arrangement of specimens in the National Collection, that he considered both *terrae-novae* Macquart and *uralensis* Villeneuve synonymous with *vomitória* (Linnaeus). But males of the European *uralensis* have the length of the head at the antenna 0.78 of the length of the head at the vibrissa, 0.89 in the female, the front at the narrowest is 0.38 of the head width in the female, widening to 0.44 at the lunule, and the outer forceps of the male genitalia are truncate at the tips.

*Calliphora uralensis* is much more closely related to *vomitória* than to *terrae-novae*. There are normally three posterior bristles on the middle tibia in *vomitória* and in about 20 percent of the specimens of *uralensis*. Specimens of *uralensis* with tawny or reddish hair anterior to the metacephalic suture and with three posterior bristles on the middle tibia are difficult to separate from *vomitória*. It is possible that both *uralensis* and *terrae-novae* are either recently differentiated species or are but variants of *vomitória*. It appears to me that the former is probably the true interpretation, *terrae-novae* being further removed from the typical *vomitória* parent stock than *uralensis*.

*Calliphora terraenovae* is sometimes found in collections determined by Hough under the name *nigribucca*. This name was *nomen nudum* until Shannon validated it by citation in synonymy with his variety *vomitória nigribarba*.

Collin's (1931, 1932) specimens of *uralensis* from Greenland are probably this species.

Only the holotype female of *Calliphora irazuana* Townsend remains in the National Collection. Apparently it is *terraenovae*. A male, identified by Aldrich as *irazuana*, is *vomitória*. Another male in the same series and from the same locality is *terraenovae*. The form differs from typical *terraenovae* only in having the base of the wing darkened. The type locality for *irazuana* is far south of the normal range for *terraenovae*, and I hesitate to synonymize it positively without additional material.

*Calliphora germanorum* Villeneuve is very close to this species, judging from two female specimens from Sweden in the National Collection which were determined by Villeneuve. These two specimens differ from *terraenovae* in having but one ventral bristle on the middle tibia, a character which is not entirely constant in other species of *Calliphora*, and in having the mesothoracic spiracle with brown hair.

*Calliphora vicina* Robineau-Desvoidy

?*Volucella vomitoria* Fabricius (nec Linnaeus, 1758), Fauna Groenlandica, p. 207, 1780. Preoccupied.

*Calliphora vicina* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 435, 1830. (Type, from Philadelphia, Pa., possibly lost; a female so labeled in the Bigot Collection, at Newmarket, England, now in poor condition, is possibly type.)

*Musca erythrocephala* Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 5, p. 62, 1826; Wiedemann, Aussereuropäische zweiflügelige Insekten, vol. 2, p. 395, 1830; Schiner, Fauna Austriaca, Die Fliegen, vol. 1, p. 584, 1862. (Type, sex not stated, in Paris.) Preoccupied.

*Calliphora rufifacies* Macquart, Diptères exotiques, Sup. 4, no. 2, p. 216, 1851; Séguy, Enc. Ent., Dipt. 2:86, 1925; *ibid.*, 9(1):137, 1928. (Type, male from New York, in Paris.) New synonymy.

*Calliphora erythrocephala* (Meigen). Van der Wulp, Biologia Centrali-Americana, Insecta, Dipt., vol. 2, p. 294, 1896; Hough, Ent. News 10:66, 1899; Howard, Insect Book, p. 164, 1901; Banks, U. S. Dept. Agric. Bur. Ent. Tech. Bull. 22:20, 1912; Paine, Psyche, 19:158, 1912; Froggatt, Austr. Dept. Agric., Bull. 95, p. 21, 1915; Mueller, Arch. f. Naturgesch. 88A(1-3):88, 1922; Zool.-Bot. Gesell. Wien, Verhandl. 73:66, 1923; Shannon, Insector Insectiae Menstruus 11:109, 1923; Senior-White, Indian Mus. Rec. 28:129, 1926; Bezzi, Bull. Ent. Res. 17:242, 1926; Malloch, Linn. Soc. N. S. Wales, Proc. 52:314, 1927; Schröder, Ztschr. f. Morph. u. Ökol. der Tiere 8:1-40, 1927; Lundbeck, Diptera Danica 7:151, 1927; Edwards and Shannon, Inst. Bact. [Argentina] Rev. 4:658, 1927; Wainwright, London Ent. Soc. Trans. 78:239, 1928; Kramer, Konowia 7:63, 1928; Roberts, Ent. Soc. Amer. Ann. 23:789, 1930; Malloch, Rec. Cant. Mus. 4(5):316, 1930; Wainwright, London Ent. Soc. Trans. 80(2):423, 1932; Patton and Cushing, Ann. Trop. Med. and Parasitol. 28(2):206-208, 1934; Hennig, Ztschr. f. Morph. u. Ökol. der Tiere 31(2):328-370, 1936; Townsend, Manual of Myiology, vol. 5, p. 142, 1937; Miller, Cawthron Inst. Sci. Res. Monog. no. 2, p. 35, 1939; Senior-White, Fauna of British India, Diptera, vol. 6, p. 33, 1940. New synonymy.

The name *Musca erythrocephala* was first used by Degeer (Mémoires pour servir à l'histoire des insectes, vol. 6, p. 146,

1776) for a species which may belong to *Rutilia* although it is impossible to be certain of this. The type locality was not located but the author stated that the species was exotic to Europe. Apparently the type specimen is lost. Fabricius (*Mantissa Insectorum* 2:351, 1787) applied the same name to a species of fly which was possibly an ortalid or a trypetid.

Séguy (1928) stated that there are two specimens in the type series of *Calliphora rufifacies*, the first (type) is from New York and is a small specimen of *vicina*, and the second specimen is *Protophormia*.

*Male.* Head height 11.9; width 14.9; length at antenna 6.4 and at vibrissae 7.6; eye height 8.0; bucca 0.46 eye height, black on posterior portion and orange to red orange on anterior half or more, slightly golden pollinose, with black hair; frontale deep mahogany red, very narrow at narrowest part of front but twice as wide as parafrontale at lunule; front at narrowest (slightly anterior to foremost ocellus) 0.10 head width, 0.17 at vertex and 0.30 at lunule, black, silvery pollinose toward vertex but yellowish anteriorly, with considerable scattered black hair outside frontal rows of bristles; frontal row consisting of about 10 bristles, those toward vertex weak, the rows diverging anteriorly as they follow the margins of the frontale and reaching almost to the base of the first antennal segment; parafaciale opposite lunule 0.64 the distance between the vibrissae, widening below, black above, orange to orange red on lower third or more, with yellowish to golden pollen, and with black hair on upper half; faciale orange to orange red, with several rows of short black setae which ascend fully three-fourths the distance to the antennal base; clypeus orange below, darker above; carina low and narrow but apparent between second antennal segments; vibrissae separated by 3.1; palpus bright orange, 4.0 in length; bases of antennae not separated; first antennal segment orange brown, second orange apically, third orange basally but dark brown apically, and 4.2 times as long as second, reaching four-fifths the distance to the vibrissae; back of head with silvery pollen, with two or three rows of postocular cilia and with considerable pale hair about occiput; metacephalon black with some pale hair posteriorly.

Thorax black with silvery pollen, and with indistinct striping in certain lights, in posterior view with a narrow mediodorsal longitudinal black stripe between acrostichal rows and wider stripes beside dorsocentral and intraalar rows usually apparent; hindmost preacrostichal, predorsocentral and preintraalar bristles 2.8, 2, and 0.8, respectively, before the suture; postintraalar

bristles two; mesothoracic spiracle with bright orange hair; meta-thoracic spiracle brown; squamopleuron with dark brown pubescence; preapapteron orange; other sclerites at wing-base dark brown.

Wing with preapaulet, basicosta, and subcostal sclerite usually bright orange; costal segments 2 to 6 in the proportion 89:60:126:45:10.

Legs with bristling as in *vomitória*.

Abdomen blue, faintly metallic, whitish pollinose, tessellated; first segment nearly black; second segment with marginal row of short bristles which are longer and stronger laterally.

Genital segments black, strongly setose above, the setae black; outer forceps long, margins parallel, the tips rounded. Internal anatomical features (pl. 28, C and D) as illustrated.

*Female*. Head height 12.4; eye height 8.2; bucca 0.49 eye height; length at antenna 7.2 and at vibrissa 8.2; parafaciale opposite lunule 0.82 the distance between the vibrissae; width 16.4; front at vertex (which is narrowest) 0.33 head width, 0.40 at lunule; third antennal segment 4.7 times as long as second; palpus 5.0; distance between vibrissae 3.3. Wing with costal sections 2 to 6 in the proportions 94:65:140:45:10. Otherwise similar to male except for normal sexual differences.

*Length*. 6-12 mm.

There is often considerable variation in the intensity of the orange color in this species. The anterior half of the bucca is most often orange, as are the preapaulet and the basicosta. But the bucca may sometimes be mahogany red, particularly in specimens from the far north. The basicosta is nearly always orange although a few specimens among those studied have both the preapaulet and the basicosta orange brown. Male specimens obviously differ from *vomitória* and *terrae-novae* in the width of the front at the narrowest, but dark females of *vicina* are difficult to separate from those two species, although few specimens of *vomitória* lack the obvious tawny-red hair on the bucca and this is nearly always lacking in *vicina*.

*Distribution*. Holarctic. In North America, *vicina* is fairly common from Mexico City, Mexico, to Alaska, but it is most abundant from Virginia and Oklahoma northward into southern Canada. It is especially abundant in the middle-western part of the United States. There it is one of the first blowflies to appear in the spring and it is probably the most abundant blowfly in this area during March and early April. Although a few specimens may be collected during the entire summer, the species is uncommon from May until early in October when it may

again be found in considerable numbers. It is among the last of the blowfly species to disappear in the fall.

*Biology, habits, and immature stages. Egg.* Length approximately 2.0 mm., diameter, 0.75 mm.; translucent white, feebly striate; elongate ellipsoidal, smaller at anterior and broader at posterior end, the ventral surface slightly curved, the dorsal surface flattened or slightly concave; micropyle at anterior end situated in a cuplike depression in the chorion, this prolonged into a groove which extends along the dorsal surface almost to posterior end.

About 180 eggs may be deposited at one time although the usual number is considerably less than this. A total of 540 to 720 eggs may be deposited during the lifetime of an individual female. Brown (1936) found the incubation period to be about 11 hours at a temperature ranging from 25-35° C. with a 40 percent relative humidity.

*Larva.* First instar: Spinose bands very narrow, the spines weak and not pigmented, apparent only on anteroventral margins of segments. Segments 2 to 7 with complete anterior bands; segments 6 to 11 with posterior spinose bands, those on segments 6 to 8 or 9 not continuous over dorsum and those on segments 6 and 7 very narrow. All spines with dome or wedge-shaped tips. Metapneustic; posterior spiracles each with two ovate orifices which appear more or less united basally, the peritreme hardly apparent toward "button" area. Cephaloskeleton (pl. 44, B and C) slender, weak, the pharyngeal sclerite strongly arched, the dorsopharyngeal sclerite with a weakly pigmented process.

Second instar: Segments 2 to 9 with complete anterior spinose bands, those on segments 8 and 9 weak and sometimes absent dorsally; segments 7 to 11 with posteroventral spinose bands, those on segments 8 to 11 complete; spines on dorso-posterior portion of segments weak; all spines larger and bands wider than in previous instar. Anterior spiracles each with 7 to 9 (most often 8) circular orifices; cephaloskeleton (pl. 44, D) with labial sclerite strongly arched, hypostomal sclerite elongate, dorsal cornua long, weakly pigmented along dorsal margin, dorsopharyngeal sclerite with pigmented process, ventral cornua truncate posteriorly and lightly pigmented ventrally with ventral longitudinal grooves apparent.

Third instar: Form stout, tapering anteriorly from sixth or seventh segments and slightly tapering posteriorly in the three terminal segments. Length from 6.8 to 18 mm., and 1.5 to 3.5 mm. in width; fully matured larvae average about 17



mm. in length, and are translucent creamy-white when first molted but gradually yellow with maturity. All spines minute, usually single-pointed (rarely with two or three points) and lightly pigmented except at tip. Cephalic segment with branching oral grooves which radiate from the oral opening. Segments 2 to 9 anteriorly with complete spinose bands, anterior bands not complete dorsally on segments 10 to 12; segments 6 to 11 posteriorly with spinose bands, these complete on segments 9 to 11; segment 12 with a large area of ventral spines. Anterior spinose bands composed of posteriorly directed spines, posterior bands composed of anteriorly directed spines; spines in posterior bands usually smaller and with sharper tips than spines in anterior bands. Anal protuberance surrounded with spines. Posterior cavity (pl. 44, A) outlined by six tubercles on upper and eight tubercles on lower margin; inner tubercles on dorsal margin separated by a space equal to that from inner to outer tubercles, the median tubercle sometimes nearer the outer than to the inner tubercle; ventrally, two minute tubercles situated close together and dorsally to two inner tubercles, outer and median tubercles largest, median tubercle situated closest to outer, and dorsally to a line drawn between inner and outer tubercles. Anterior spiracles as in preceding instar; posterior spiracles (pl. 44, F) each with three well-defined slitlike orifices, the "button" obvious and the peritreme complete. Cephaloskeleton (pl. 44, E) with hypostomal sclerite short, stout, strongly sclerotized and pigmented; dorsal cornua elongate, ventral cornua with obvious ventral longitudinal grooves.

Bishopp (1915) found the larval stage of this species to be from three to four days in duration in eastern Texas, and Brown (1936) noted it to be from 6.5 days to 8.75 days in southern Canada at 28 degrees C. and 70 percent relative humidity. The latter author observed that mature larvae begin to migrate from their food in about 4.5 days and that pupation usually occurs in 7.5 days after oviposition.

Parker (1922) suggested that this species was able to reproduce by paedogenesis during the fall months. Keilin (1924) disproved the assumption of either paedogenesis or polyembryony. The latter author states "Dissections and breeding experiments involving the examinations of 661 larvae have clearly proved that neither paedogenesis nor polyembryony occurs in the larvae."

Roy (1937) described the morphology and physiology of the larva of *vicina*, and discussed the difference between the morphology of larvae which are clearly saprophagous and those which are clearly parasitic. Ratcliffe (1935) gave experimental

evidence to suggest that the species is physiologically unable to act in the role of a primary invader in subdermal myiasis.

*Pupa.* Possessing the external characters of the mature larva. Bishopp (1915) stated that the pupal period of this species lasts from 7 to 9 days in Texas.

The larvae pupate in soil at a depth of from 1½ to 2 inches according to Roberts (1930), who also found that adults would emerge from puparia buried at a depth of 18 inches of closely packed, fine, sandy soil.

*Adult.* The slow-flying and loud-buzzing blue bottle fly of early spring and late fall is usually this species. It is commonly found in houses during the cooler seasons of the year and may sometimes become a nuisance to housewives under such circumstances. It may be collected upon foliage in urban areas, and females commonly occur about carrion or other types of refuse. In the cool weather of early spring specimens may be seen upon the sunny sides of buildings or on rocks. Adults of *vicina* are attracted to any ill-smelling product of decay. During warm days in late November I have often collected many specimens of *vicina* which were feeding upon wind fallen apples in my garden. Carrion is by far the most satisfactory attractant.

The preoviposition period lasts as long as three or four weeks according to Lowne (1890-1892) who stated that this is "a condition which probably prevents the fertilization of females by males of the same brood." The males are apparently sexually mature within a few hours.

Hibernation in Australia seems to be accomplished in the pupal stage according to Holdaway and Smith (1932).

Various parasites have been recorded as attacking this blowfly. In England, Graham-Smith (1919) found two species of ichneumon-flies to be parasitic upon puparia of *vicina*. These were *Phygadenon speculator* Thomson and *Acractodes bicolor* Gravenhorst. He also observed that adults were occasionally attacked by a fungus disease. He noted that 61 percent of the autumn pupae were parasitized by *Alysia manducator* (Panzer) and 71 percent of the spring pupae by *Melittobia acasta* (Walker). James (1928) also claimed a reduction of 30 percent of the numbers of this species due to larval parasitism by the cynipids *Figites anthomyiarum* Bouché and *Kleidotoma marshalli* Cameron.

The average time between "parental and filial emergence" is between 33 and 38 days according to Wardle (1927), the absolute minimum being not less than 29 days at the mean temperature prevailing in England throughout the summer. Bishopp

(1915) indicated that the total cycle may be accomplished in from 15 to 20 days in eastern Texas.

*Economic importance.* Attempts to produce sheep strike experimentally with this species have generally proved unsuccessful. McLeod (1937) produced a doubtful case in which the larvae developed on an exuding wound, but they were confined to the cotton-wool plug over the lesion. Where the species has been reared from wounds, the available information indicates that the wound was in either a medium or advanced stage.

Harvey (1934) reported the rearing of this species from a man in England. In this instance more than 100 specimens were reared. According to Harvey the original site of infestation was probably a permanent opening into the bladder made for extravasation of urine following obstinate urethral strictures.

### *Calliphora vomitoria* (Linnaeus)

*Musca vomitoria* Linnaeus, Systema Naturae 10(1) :595, 1758; Fauna Suecica (2nd Ed.), 452, 1761; Fallen, Monographia Muscidum Sueciae, p. 47, 1821; Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 5, p. 60, 1826; Zetterstedt, Insecta Lapponica, p. 656, 1840; Diptera Scandinaviae, vol. 4, p. 1328, 1845; Schiner, Fauna Austriaca, Die Fliegen, vol. 1, p. 584, 1862; Fitch, N. Y. Agric. Soc. Trans. 9:802, 1849. (Type, from Sweden, in Kiel, destroyed.)

*Musca carnaria caerulea* Degeer, Mémoires pour servir à l'histoire des Insectes, vol. 6, p. 57, 1776.

*Musca carnivora* Fabricius, Entomologia Systematica, vol. 4, p. 313, 1784; Systema Antliatorum, p. 285, 1805.

*Calliphora fulvibarbis* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 434, 1830; Macquart, Histoire Naturelle des Insectes Diptères, vol. 2, p. 262, 1835.

*Calliphora vomitoria* (Linnaeus). Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 435, 1830; Histoire Naturelle des Diptères des Environs de Paris, vol. 2, p. 692, 1863; Harris, Insects of Massachusetts, p. 412, 1841; Macquart, Diptères exotiques, vol. 2(3), p. 284, 1842; Osten-Sacken, Berl. Ent. Zeit. 31(1) :17, 1887; Lugger, Minn. State Ent. Rpt. 2:162, 1896; Hough, Zool. Bull. 2(6) :285, 1899; Howard, Ent. Soc. Wash. Proc. 4:490, 1901; Grimshaw, Fauna Hawaiiensis, vol. 3, p. 27, 1901; Williston, Manual of North American

Diptera, p. 338, 1908; Cole, Calif. Acad. Sci. Proc., ser. 4, 11:172, 1921; Mueller, Arch. f. Naturgesch., 88A, Heft 1-3:64, 1922; Walton, No. Amer. Fauna 46(2):228, 1923; Shannon, Insecutor Insectiae Menstruus 11:109, 1923; Lundbeck, Diptera Danica, vol. 7, p. 151, 1927; Swezey and Bryan, Hawaii. Ent. Soc. Proc. 6:415, 1926; Senior-White, Indian Mus. Rec. 28:129, 1926; Kramer, Konowia 7:63, 1928; Wainwright, London Ent. Soc. Trans. 80:237, 1928; Séguy, Encycl. Ent. (A) 9:140, 1928; Johnson, Psyche, 36(2):144, 1929; Curran, Amer. Mus. Nat. Hist. Bull. 61:89, 1930; Townsend, Rev. de Ent. 1:71, 1931; Manual of Myology, vol. 2, p. 169, 1935; *ibid.*, 5:141-142, 1937; Swezey and Williams, Hawaii. Ent. Soc. Proc. 8:191, 1932; Patton and Cushing, Ann. Trop. Med. and Parasitol. 28(2):208, 1934; Senior-White, Fauna of British India, Diptera, vol. 6, p. 35, 1940.

*Calliphora erythrocephala* Hutton (nec Meigen), New Zealand Inst. Trans. 33:64, 1900.

*Calliphora rubrifrons* Townsend, Smithsn. Misc. Collect. 51:116, 1908. (Type, male from Stickeen River, British Columbia, no. 10884, U. S. Natl. Mus.)

A large blue and black species with a tawny red beard.

*Male.* Head (pl. 5, D) width 17.5; height 14.4; length at antenna 8.2 and at vibrissa 8.4; bucca 0.47 of eye height, black, with black and dull red-orange or tawny hairs before the meta-cephalic suture, and with thin silvery pollen; eye height 9.4; epistoma slightly protuberant, one-half as long as width and warped forward from clypeal plane at a 60-degree angle; frontale 0.5 width of front, reddish anteriorly, black posteriorly; front black, thinly silvery, at narrowest 0.5 head width, 0.14 at vertex and 0.29 at lunule, with considerable short black hair outside of frontal row which extends to upper third or more of parafaciale; frontal row consisting of about eight or nine bristles, the rows extending anteriorly to the antennal bases and diverging as they follow the margins of the frontale; vertex shining black; clypeus brownish black; facial carina short and narrow, separating the antennal bases by a very narrow margin; parafaciale one-half as wide as clypeus at middle, 1.8 in width opposite lunule, black, with thin silvery pollen; facialia orange red, with several rows of short black setae almost one-half the distance to the antennal base; vibrissae above oral margin by 0.75, and separated by 3.2; palpus orange yellow, 5.0 in length; antennal segments dark brown to black, apex of second segment

and base of third orange; third segment 4.5 times as long as second, reaching three-fourths the distance to the vibrissae; arista brownish black, with long black cilia both above and below for two-thirds its length; back of head flat, black, with silvery pollen, with two rows, and a partial third, of postocular cilia and with abundant tawny or reddish orange hair.

Thorax blue black with thin silvery-whitish pollen and with black longitudinal dorsal stripes which extend to the scutellar suture; pleura with silvery pollen; humeral bristles three in a row, and a fourth slightly anterior to these; preintraalar bristles three, the hindmost placed 1.0 before the suture; preacrostichal bristles two, the posterior one 3.0 before the suture; predorso-central bristles three, the hindmost 1.6 before the suture; rim of postparapteron with fine tawny pile; greater ampulla orange brown with fine whitish pile; postacrostichal bristles and post-dorsocentral bristles three; postintraalar bristles two; post-supraalar bristles three, with sometimes a weak fourth; mesothoracic spiracle with yellowish orange to brown pile; metathoracic spiracle dark brown; scutellum usually concolorous with thorax but sometimes with apex rather reddish, discal bristle one, with sometimes a weaker bristle laterally, lateral bristles four strong, and usually one or two weak; lateral postscutellar plates with tufts of short black setae.

Legs black; middle femur with two anterior bristles near middle; middle tibia usually with four anterodorsal bristles, one at basal fourth, one near middle, one near apical third and one near apex (sometimes with only two or three bristles), two ventral bristles, one near middle and a stronger bristle just apical to it, and two or three posterior bristles, always one at basal fourth and one at apical fourth, and sometimes one near middle, and one or two posterodorsal bristles, always one at apical fourth and sometimes one near middle; hind tibia with two or three anterodorsal bristles, one near basal fourth, one near middle, and rarely with one at apical third, two anteroventral bristles, one at apical third and one at apical fourth, and two or three posterodorsal bristles, one at basal fourth, one sometimes near basal third, and one at apical third.

Wing hyaline, infuseate toward base; costal sections 2 to 6 in the proportions 95:75:132:42:12; subcostal sclerite yellow to yellow orange, with whitish yellow pile; basicosta black; fourth vein entering costa 1.5 before wing apex; upper and lower squamal lobes brown, rim on former dark brown, rim on lower lobe light brown.

Abdomen bluish, mostly shining, but with silvery white pollen,

the degree of pattern changing with the light position; second segment with a row of depressed marginal bristles which are longest laterally; all segments with considerable erect black hair. Fifth sternite (pl. 28, F) as illustrated.

Genital segments black, relatively small, both segments with long erect black hair; inner and outer forceps of nearly same length, inner forceps with diverging inner margins. Internal anatomical details (pl. 28, E, F, and G) as illustrated.

*Female.* Head width 17.9, length at antenna 8.2 and at vibrissa 8.7; height 13.7; eye height 8.4; bucca 0.65 eye height; frontale 0.5 width of front, reddish anteriorly and black posteriorly; front at narrowest 0.35 of head width and 0.41 at lunule, the margins nearly parallel toward lunule where they diverge strongly, thinly covered with silver pollen, and with abundant short black hair outside frontal rows; frontal row consisting of eight to ten bristles, the rows not diverging anteriorly; outer vertical bristles two-thirds as long as inner, proclinate fronto-orbital bristles two; rarely an adventitious third; parafaciale 2.9 in width opposite lunule; vibrissae set 3.4 apart; palpus 5.0 in length; third antennal segment 4.2 times as long as second. Wing with costal sections 2 to 6 in the proportion 95:75:150:48:12. Otherwise like male except for normal sexual differences.

*Length.* 10-14 mm.

*Distribution.* Holarctic. In North America from Alaska and Greenland southward to California and Virginia. Theoretically native to the Palearctic region this species has supposedly been widely distributed by commerce. It is probably much less widespread than generally believed. It is not common anywhere in North America but it is apparently most abundant in Alberta and along the Canadian-United States border.

Townsend (1937, vol. 5, p. 142) considered *vomitorea* and *vicina* to be synonymous, with the latter a "color variant, without standing even as a restricted species, the color of the head and beard not being constant but dependent upon fluctuation of environmental factors." The occurrence of variation in the coloration of these two species is not questioned, but there are few specimens which cannot be placed properly upon color alone. Furthermore, the differences found in the width of the front of the male offer a character that appears sufficiently stable to establish the distinctness of the two species. The differences indicated in the male aedeagus were questioned by Townsend (*ibid.*), who stated that those figured by Rohdendorf are illusory and not constant. I do not find them so.

In addition, Miss MacGill (*in* Myers, 1929, p. 358) found that there are more olfactory pits in the antennae of *Calliphora vomitoria* than in those of *vicina*. Myers also found that *Alysia manducator*, a common pupal parasite of *vicina*, did not parasitize *vomitoria*, and Wardle (1927) reported *vomitoria* to be much more readily attracted to baits in shade than is *vicina*.

*Calliphora germanorum* Vill. differs from *vomitoria* in having the anterior half of the bucca orange or orange red, and the buccal hairs before the metacephalic suture black. In addition, Wainwright (1932, *Trans. Ent. Soc. Lond.* 80(2):423) stated that the second sternite is nearly square. If a female specimen determined as *germanorum* by Villeneuve, and now in the National Collection, is correctly identified I am unable to find distinctive differences between this form and that described by Townsend under the name *rubrifrons* in 1908, which is treated here as a synonym of *vomitoria*.

*Biology, habits, and immature stages.* Larva. MacGregor (1914) described the larval anatomy of this species in part and Herms (1911) reported upon some of the reactions of the larvae. The posterior spiracle (pl. 44, G) and the cephaloskeleton (pl. 44, H) in the third instar larva are as illustrated. The habits of the larvae of *vomitoria* have not been studied so extensively as those of *vicina*; they are probably similar in most respects.

*Adult.* What was supposedly this species has served as illustrative material for many of the general studies on the anatomy of flies. Ritter (1912) studied the flying apparatus, Whiting (1913) the variation of the chaetotaxy, and Peterson (1916), the head capsule.

The species is not very common in the United States and few collections contain many specimens, most of the material determined as this species being *Calliphora terrae-novae* or *vicina*. Bruce and Knipling (1936) found only one specimen in trapping operations at Ames, Iowa, during 1933-1934. Although relatively uncommon, it may be collected throughout most of the northern part of North America, especially in the far north during summer months. In nature, *vomitoria* and *vicina* seem to react in similar fashion. The former is often larger than *vicina*, and it appears to be slower on the wing.

Hugo Summa (1889, p. 347) reported upon a case of human myiasis in Missouri, supposedly due to this species, which was summarized by Townsend (1890, *Insect Life*, vol. 3, pp. 39-40). *Calliphora vomitoria* rarely occurs in cases of myiasis, however, and then only as a secondary invader in old and pustular wounds for it is saprophagous.

The following two names were supposedly used for species of *Calliphora* from North America which remain unknown to me:

*Calliphora melanaria* Van der Wulp, Biologia Centrali-Americana, Diptera 2:295, 1896. Guerrero, Mexico, 6,000 ft.

*Calliphora praepes* Giglio-Tos, Boll. R. Univ. Torino, 8:147, 1893; Ditt. del Mess. 4:1, 1898. Mexico.

*Calliphora stygia* (F.), described originally in *Musca*, was erroneously stated by Wiedemann to be from Newfoundland, and the species was listed as North American by Osten Sacken in his catalog. The type is from New Zealand, however, and Townsend places the species in *Neopollenia*.

### ONESIA ROBINEAU-DESVOIDY

*Onesia* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 365, 1830; Schiner, Fauna Austriaca, Die Fliegen, vol. 1, p. 575, 1862; Hendel, Wien. Ent. Ztg. 20:31, 1901; *ibid.*, 21:83, 1902; Williston, Manual of North American Diptera, p. 350, 1908; Aldrich, Sarcophaga and Allies, p. 21, 1916; Mueller, Arch. f. Naturgesch. 88A(1-3):58, 1922; Zool.-Bot. Gesell. Wien, Verhandl. 73:56, 1923; Shannon, Insecutor Inscitiae Menstruus 11:107, 1923; Villeneuve, Konowia 5:130-133, 1926; Bezzi, Bull. Ent. Res. 17:243, 1926; Lundbeck, Diptera Danica, vol. 7, p. 152, 1927; Séguéy, Encycl. Ent. (A)9:124, 1928; Malloch, Linn. Soc. N. S. Wales Proc. 57:68, 1932; Curran, Families and Genera of North American Diptera, p. 405, 1934; Townsend, Manual of Myiology, vol. 2, p. 170, 1935; *ibid.*, 5:158, 1937. Genotype (*Onesia floralis* Robineau-Desvoidy, 1830) = *Musca sepulchralis* Meigen (1826). Designation of Townsend (1916).

*Male and female.* Head (pl. 6, C) width slightly greater than height; length at antenna and at vibrissa nearly equal; eye rather small; epistoma slightly elongate, gently receding from clypeal plane and narrower than clypeus; clypeus at least twice as long as wide, shallow but still distinctly depressed; metacephalon not protuberant; frontal rows of bristles extending anteriorly only to lunule; inner vertical bristles strong, decussate; outer vertical bristles about two-thirds as long as inner in female; frontoorbital bristles two proclinate and one reclinate in female; facial carina very slightly apparent, broad, shallow, low, and not separating antennal bases; parafaciale nearly as broad below as above, setose; proboscis only slightly shorter than head height; haustellum half head height; palpus stout, cylindric; antennal base at eye middle with head in profile view, bases approximated



or only slightly separated; third segment reaching nearly three-fourths the distance to the vibrissa; arista with penultimate segment about 1.5 times as long as diameter, apical segment elongate, thickened toward base and then uniformly attenuate to apex, with long cilia above and short cilia below on about the basal two-thirds; back of head flat or evenly rounded above and bulging below.

Thorax with four humeral bristles arranged in an obtuse angle; propleural bristles one or two; posthumeral bristle present; preintraalar bristles two or three, the posterior bristle either present or absent; preacrostichal bristles one to three; predorsocentral bristles three; presupraalar bristle one; notopleural bristles two; sternopleural bristles usually three, these arranged 2 — 1; prosternum widening and bulging anteriorly, narrowed and setose posteriorly; postalar declivity in center with a tuft of black hairs; tympanic pit setose on upper posterior margin, the setae black; squamopleuron with short fine brown pubescence; postsupraalar bristles three; postalar bristles two or three; postacrostichal bristles three; postdorsocentral bristles three; postintraalar bristles two or three; spiracles as in *Calliphora*; scutellum with two or three discal bristles (rarely four or one), and two or three (rarely four) lateral bristles.

Legs with fore femur as in *Calliphora*; fore tibia with several anterodorsal bristles and with one or two posterior bristles; mid-femur with an anterior series of about six short bristles toward middle, four anteroventral bristles toward base and a posteroventral row of about seven long bristles extending from base to apical fourth; hind femur with anterodorsal and anteroventral rows of bristles which are set rather closely together, and a ventral row of bristles which are spaced further apart; hind tibia with about three anterodorsal bristles, one or two anteroventral bristles and three posterodorsal bristles; male claws elongate.

Wing with a minute but distinct costal spine; anterior cross vein at middle of second section of fourth vein; upper squamal lobe rather small in comparison to lower; lower squamal lobe rounded, with brown pile on upper disc in middle.

Abdomen rather conical in male, ovate in female, ventral membrane somewhat exposed in female, not in male; second segment with weak marginal bristles which are erect in center of dorsum; third and fourth segments each with a row of strong and erect marginal bristles.

Genital segments rather small to medium in size, fifth sternite large but not protruding ventrally.

The generic name *Onesia* has been retained for two species of North American calliphorine flies because the present generic treatments of the group are not satisfactory. Sufficiently long series of such flies from which to evaluate the numerous characters have not been available. It is impossible for me to know which of the characters are of generic importance and which are of but specific value. It appears that this group of flies may have been too finely divided. *Onesia* in the broad sense includes about fifteen species, all of which are very similar. Most of them are Palearctic. The species assigned by Robineau-Desvoidy to his genus *Melinda* may be easily separated from the rest of *Onesia* by the lack of pile on the disc of the lower squamal lobe. But all of the remaining species are so similar in most respects that to divide them would conceal their unmistakable relationship to each other, although it is fully realized that there are a number of characters in the chaetotaxy of the species that might be considered of generic value. Subgeneric names for the species groups might be useful. If the characters now used for the separation of these genera in the Palearctic region are found to be constant, and of generic value, then the two North American species referred to *Onesia* below must be placed in two different new genera. These possibly distinct genera may be separated by the following key.

1. Lower squamal lobe setose on disc above..... 2  
    Lower squamal lobe bare above. . *Melinda* Robineau-Desvoidy
2. Lower squamal lobe with black hair above..... 3  
    Lower squamal lobe with white hair above.....  
    ..... *Abonesia* Villeneuve.
3. Preacrostichal bristles present..... 4  
    Preacrostichal bristles absent..... *Macronesia* Villeneuve.
4. Two or more postacrostichal bristles..... 5  
    One postacrostichal bristle..... *Pseudonesia* Villeneuve.
5. Hindmost preintraalar bristle absent.....  
    ..... *Onesia* Robineau-Desvoidy.  
    Hindmost preintraalar bristle present.....  
    ..... *Macrophallus* Mueller.

The genus *Onesia* appears to be a homogeneous group, and Keilin (1915) in Europe and Fuller (1933) in Australia show that the biologies are similar. The latter author has reported upon the biology, habits, and immature stages of *Onesia accepta* Malloch, which is parasitic upon *Microcolex* and other earth-

worms in Australia. The following is an abstract of her report upon the species:

The female is larviparous; the ovaries of one female were found upon dissection to contain 550 larvae in various stages of development.

*Larva.* First instar: Length approximately 1.5 mm.; typically calliphorid in shape; translucent. Segments 2 to 12 with spinose bands anteriorly; segments 4 to 11 dorsally each with a tuft of recurved, semitransparent, larger spines. Amphipneustic; posterior spiracles each with but a single aperture which has an inward projection at one side. Cephaloskeleton with pharyngeal sclerites divided posteriorly into the usual dorsal and ventral cornua; labial sclerites two narrow pointed and slightly ventrally curved hooks which articulate with the anterior branches of the pharyngeal sclerite, and ventrally and toward base with a pair of small triangular sclerites. Four or five days are spent in this instar under the skin of the host.

Second instar: Second segment constricted in middle and spinose on anterior half; segments 2 to 12 with anterior spinose bands, usually with five rows, these not in the form of tufts as in the previous instar, but equally developed dorsally and ventrally; segments 5 to 8 with a few spines on posterior dorsal and ventral borders; segment 9 with some rows around dorsal and ventral margins. Anterior spiracles small, projecting laterally from posterolateral border of second segment; posterior spiracles on mediodorsal margin of weak depression, each slightly raised and with two slit-like apertures. Anal protuberance large, rounded, covered with minute spines. Cephaloskeleton with anterior edge of pharyngeal sclerite with a narrow chitinous rod projecting forward over dorsum of middle sclerite; hypopharyngeal sclerite small and closely connected with basal sclerite; ventrally, with a blunt projection, and a narrow curved rod-like sclerite projecting forward to the base of the labial sclerite which is shorter and broader than in the previous instar, with a ventral projection in middle, strongly curved, sharp, and with two small sclerites near ventral projection. About 4 days are passed in this instar.

Third instar: Color creamy white, of typical calliphorid habitus. No conspicuous oral grooves but with fine branched transparent lines radiating from oral aperture. Segments 2 to 12 with spinose bands anteriorly, each band composed of small light brown spines which are arranged in broken undulating lines, each spine projecting backwards; bands equally conspicuous on dorsal and ventral surfaces, less strongly developed

laterally; ventrally on posterior margins of all but segments 5 and 6 with a few rows of spines. No development of swollen spinose pads which occur on under surface of most calliphorid larvae. Anterior spiracles laterally near posterior border of second segment, each with four apertures. Posterior spiracles in weak posterior depression, separated by one and one-half times the spiracular length, each circular in outline, bulging very slightly at "button," which is above a median line; peritreme not continuing around "button," which does not cause a gap in peritreme and is not enclosed by the peritreme; each spiracle with three short, wide, nearly straight, well-separated slit-like apertures which converge toward the "button." Three pairs of tubercles on anterior margin of posterior depression and two pairs on lower margin, with another pair below the latter. Cephaloskeleton mainly as in the previous instar; ventral surface of ventral cornua smooth; labial sclerites larger and more heavily sclerotized than in previous instar. This instar requires about eleven days and this time may or may not be spent within the host. Third instar larvae readily feed upon dead material, while those of the earlier instars apparently are unable to do so.

*Puparium.* With the major external characters of the third instar larva. The prepupal stage requires from three to four days, and the pupal period lasts about twelve days in the soil.

The larvae are deposited in the soil. The means of entry of the larvae into the host has not been determined. The first instar larva may be found beneath the skin of the host and parasitized earthworms may be easily recognized by constrictions of the skin along the "tracks made by the larvae crawling under the skin, the larvae traveling around the worm in a spiral path and moving toward either end." The third instar larva enters the body cavity of the host and it completes its development as a parasite, or, if the earthworm dies, it feeds saprophagously.

#### *Onesia bisetosa*, new species

*Onesia agilis* Shannon (nec Meigen), Insecutor Insectiae Menstruus 11:108, 1923.

*Onesia* sp. Séguy, Encycl. Ent. (B II.) Dipt. 2:86, 1925.

Séguy was correct in his assumption that Shannon's *agilis* is different from *agilis* Meigen. Superficially, the species resembles *biseta* Vill. and will run to that species in the keys of Stein (1924) and Séguy (1928), as do specimens determined as *agilis* by Villeneuve, Stein, and Séguy, now in the National Collection. The North American form differs most obviously from the Euro-

pean *biseta* in that the male has a bristle between the foremost postdorsocentral and postintraalar bristles. The females lack this bristle, as do all of the specimens of Palearctic species which I have seen.

A small blue black species with the aspect of *Calliphora*.

*Male.* Head (pl. 6, C) width 11.7; length at antenna 7.1 and at vibrissa 6.8 eye height 7.5; head height 10.5; bucca 0.39 eye height, black, with dull gray pollen and black hairs; frontale as wide as one parafrontale, dull black; front black, silvery gray pollinose, at narrowest (just anterior to foremost ocellus), 0.08 head width, 0.18 at vertex and 0.32 at lunule, with considerable fine black hair just outside frontal rows of bristles which extend forward only to lunule and are moderately divergent as they follow the margins of the frontale, each row consisting of about ten bristles, of which only the foremost are strong; vertex black, with rather silvery pollen; parafaciale 1.8 in width opposite lunule and below, black, with gray pollen, bare along eye margin; faciale reddish, with two or three rows of short black setae which ascend about one-third the distance to the antennal base; vibrissae separated by 2.2; palpus orange, 3.2 in length; antenna black, apex of second segment often reddish, third segment only 2.0 times as long as second; arista black, thickened only at base, and with fine short black cilia above, shorter below; ocellar bristles set rather far back on ocellar triangle which has a number of erect black hairs posteriorly; back of head black, covered with silvery pollen, and with three or four rows of postocular cilia, pale hairs only around occiput and a few below on metacephalon.

Thorax black, with gray pollen which is most apparent anteriorly, and with several indistinct dorsal longitudinal stripes; preintraalar bristles three, hindmost present; hindmost preacrostichal and dorsocentral bristles set 2.4 and 1.2, respectively, before suture; sternopleural bristles usually three, arranged 2 — 1 (sometimes four and in one instance observed, five); preparapтерon yellow brown, other sclerites at wing-base black; postalar callus without the usual weak third postalar bristle which is normally placed medianly and posterior to large hindmost bristle; postintraalar bristles two; intrapostsupraalar bristles present; spiracles small, with dark brown hair; under surface of scutellum laterally with dark brown hair.

Legs black, thinly covered with whitish pollen; fore tibia with two posterior bristles, one near middle and one near apical fourth; middle tibia with two posterior bristles and usually with two posterodorsal bristles.

Wing hyaline, tinged with brown anteriorly and basally; basicoستا brownish black; subcostal sclerite orange brown with brown pubescence; costal spine distinct; costal sections 2 — 6 in the proportion 68:37:95:42:5; fourth vein with obtuse bend toward apex; apical cell clearly open although sometimes rather narrowly so; squamal lobes white, the lower lobe often tinged with orange apically.

Abdomen olivaceous to bluish green with whitish tessellated pollen; second, third, and fourth segments each with a row of marginal bristles, those on second segment only strong laterally; fourth segment with considerable black erect discal hair; sternites of nearly equal width.

Genital segments black, shining, globose, with considerable, scattered black erect hair. Internal morphological features (pl. 28, H and I) as illustrated.

*Female.* Head height 10.4; eye height 6.3; bucca 0.54 eye height; length at antenna and at vibrissa 7.0; parafaciale opposite lunule 2.4 in width; vibrissa set 2.4 apart; head width 12.0; front at narrowest (at vertex) 0.34 head width, 0.48 at lunule; the margins strongly diverging anteriorly; palpus 4.0 in length. Wing with costal sections 2 to 6 in the proportion 73:45:115:52:5. Legs with but one posterior bristle on fore tibia. Thorax without intrapostsupraalar bristle. Otherwise similar to male except for normal sexual differences.

*Length.* 7-8 mm.

*Type.* Male, No. 54935, U. S. National Museum.

*Type locality.* Riverton, N. J.

*Biology, habits, and immature stages.* Unknown. It seems probable that both this and the following species are parasites of earthworms, since species of this genus from the Palearctic and Australian regions have been found to be parasitic upon such hosts.

The two males and five females comprising the type series were collected from June 9 to Aug. 15, 1921 and 1922, at Riverton, N. J., by T. H. Frison. A part of the series were reared "from meadow soil."

### *Onesia townsendi*, new species

*Onesia aculeata* Shannon (nec Pandellé), Insecutor Inscitiae Menstruus 11:108, 1923; Johnson, Boston Soc. Nat. Hist. Occas. Papers 7(15):217, 1925.

A small blue black species with hyaline wings and with the general aspect of *Calliphora*.

*Male.* Head similar to that of *bisetosa* but less elongate at antenna and vibrissa and with different height proportions of the parts; height 8.4; eye height 5.8; bucca 0.49 eye height; length at antenna and at vibrissa 6.2; head width 9.2; front at narrowest only 0.04 head width; parafaciale opposite lunule 1.4 in width; distance between vibrissae 2.0.

Thorax with one preacrostichal bristle, this set 1.4 before suture; hindmost predorsocentral bristle set 1.0 before suture; preparapton and greater ampulla orange brown, other sclerites at wing-base black; postalar bristles two, both strong; under surface of scutellum with fine short dark hair.

Legs with anterior tibia having one posterior bristle near middle; middle tibia with one anterodorsal bristle near middle.

Wing tinged with brown throughout but darker basally; costal spine minute; costal sections in the proportion 62:40:84:40:4; squamal lobes infuscated.

Abdomen olivaceous green with blue reflections, thinly covered with whitish pollen, all weak hair rather long and erect particularly on third and fourth segments; second, third, and fourth segments each with a marginal row of long erect bristles.

Genital segments small, black, globose, with erect black hair. Forceps (pl. 29, A and B) as illustrated.

*Female.* Unknown.

*Length.* 6 mm.

*Type.* Male, No. 54936, U. S. National Museum.

*Type locality.* Melrose Highlands, Mass.

*Biology, habits, and immature stages.* Unknown.

One specimen "on flowers of *Solidago*" collected Sept. 13, 1914, by C. H. T. Townsend.

This species would go into the genus *Pseudonesia* by extending the limits of that genus to include species with male front wide in relation to the head width, and the abdomen more strongly pollinose. The species *townsendi* is less brilliantly blue than *pusilla*, genotype of *Pseudonesia*.

### CYNOMYOPSIS TOWNSEND

*Cynomyopsis* Townsend, *Insecutor Inscitiae* Menstruus 3:118, 1915; *Manual of Myiology*, vol. 2, p. 170, 1935; *ibid.*, vol. 5:146, 1937. Genotype. *Cynomya cadaverina* Robineau-Desvoidy. By original designation.

*Male and female.* Head (pl. 6, D) length at antenna slightly less than at vibrissa; epistoma about one-third as long as wide, warped strongly forward from clypeal plane, and as wide as

clypeus; bucca nearly half eye height; eye set in head at nearly 20 degree angle; accessory ocellar bristles weak or absent in male; frontale about half frontal width; frontal rows of bristles moderately divergent anteriorly; no frontoorbital bristles in male; clypeus shallow and wide; parafaciale narrowed below, with short hair on upper half or more; faciale bristled fully half the distance from the vibrissa to the antennal base; width between vibrissae nearly twice as wide as parafaciale opposite lunule.

Thorax with pteropleuron bare on anterior one-sixth; tympanic pit with long setae on upper posterior margin; under surface of scutellum with fine hair nearly to center; only one postacrostichal bristle.

Legs with middle femur having two or more anterior bristles, usually two long anteroventral bristles near middle and a row of long posteroventral bristles near base, the row continuing apically with shorter and more closely set bristles; hind tibia with three or four anteroventral bristles; femora of male without long bushy hair below.

Wing with a minute costal spine.

Abdomen long ovate, apex blunt in male (pl. 29, C), pointed in female (pl. 29, D); only fourth segment with long erect discal bristles; third and fourth segments each with a marginal row of bristles laterally and below with considerable long hair; fifth sternite of male not elongate and protuberant.

Genital segments of male of only moderate size, the second segment hardly one and one-half times as long as first.

Townsend (1915) placed *Calliphora texensis* Townsend, *Calliphora popoffana* Townsend, and *Cynomyia elongata* Hough in this genus. In my opinion, the first is a synonym of *Cynomyopsis cadaverina* (Robineau-Desvoidy), the second a species of *Acronesia*, and the last named, a species of *Cyanus*.

### *Cynomyopsis cadaverina* (Robineau-Desvoidy)

#### (The Shiny Bluebottle Fly)

*Cynomyia cadaverina* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 365, 1830. (Type, male from Carolina, in Paris or lost.)

*Calliphora myoidea* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 436, 1830; Hough, Zool. Bull. 2(6):285, 1899. (Type, from Philadelphia, Pa., in Paris or lost.)



- Calliphora aurulans* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 437, 1830; Hough, Zool. Bull. 2(1):285, 1899. (Type, from Carolina, in Paris or lost.)
- Calliphora compressa* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 438, 1830; Hough, Zool. Bull. 2(1):285, 1899. (Type, from Carolina, in Paris or lost.)
- Musca mortisequa* Kirby, Fauna Boreali-Americana, Insects vol. 4, p. 316, 1837; Canad. Ent. 13:168, 1881; Coquillett, Wash. Acad. Sci. Proc. 2:440, 1900. (Type, from Alaska, in the British Museum of Natural History.) New synonymy.
- Cynomyia americana* Hough, Ent. News 9:105, 1899; Zool. Bull. 2(6):285, 1899. (Type, female from Opelousas, La., No. 5013, U. S. National Museum.)
- Calliphora texensis* Townsend, Smithsn. Misc. Collect. 51:116, 1908; Shannon, Insecutor Inscitiae Menstruus 11:115, 1923. (Type, female from Paris, Tex., No. 10883, U. S. National Museum.)
- Cynomyopsis texensis* (Townsend) Townsend, Insecutor Inscitiae Menstruus 3:118, 1915.
- Cynomyia cadaverina* Robineau-Desvoidy, Howard, Wash. Acad. Sci. Jour. 2:567, 1900; Bishopp, Jour. Econ. Ent. 10:273, 1917; Felt, N. Y. St. Mus. Bull. 194:22, 1917; Malloch, Canadian Arctic Expedition Rpt., vol. 3, p. 58e, 1919; Cole and Lovett, Calif. Acad. Sci. Proc., ser. 4, 11(15):308, 1921; Johannsen, Canadian Arctic Expedition Rpt. 3:12k, 1921; O'Donoghue, Canad. Field Nat. 35 (Oct.-Dec.):129, 1921; Bishopp, Mitchell and Parman, U. S. Dept. Agri., Farmers Bull. 857, 14, 1917; Shannon, Insecutor Inscitiae Menstruus 11:108, 1923; Johnson, Bost. Soc. Nat. Hist. Proc. 38:90, 1925; Psyche 36(2):140, 1929; McDunnough, Canada Natl. Mus. Bull. 53:119, 1928; Cole, Calif. Acad. Sci. Proc., ser. 4, 16(14):487, 1927.
- Cynomyopsis cadaverina* (Robineau-Desvoidy) Townsend, Insecutor Inscitiae Menstruus 3:118, 1915; Manual of Myiology, vol. 2, p. 170, 1935; *ibid.*, vol. 5, p. 146, 1937.

A large black and gray species with the abdomen shining blue green and the head with gray or yellow to brownish golden pollen.

*Male.* Head (pl. 6, D) width 14.2; length at antenna 7.3 and at vibrissa 7.6; eye height 8.6; head height 12.2; bucca 0.42 eye height, the anterior third orange brown, posterior two-thirds black, with thin grayish pollen, and with scattered black hair,

a few of which are pale before the metacephalic suture; frontale 0.5 frontal width; front at narrowest 0.18 of head width, 0.23 at vertex and 0.30 at lunule, black, heavily silvery to brownish pollinose, and with some scattered hair outside the frontal row which extend anteriorly to about the middle of the parafaciale; frontal row consisting of about eight bristles; vertex with abundant fine black hair, subpollinose, brown and silvery; clypeus yellowish to reddish brown; parafaciale 2.2 in width opposite lunule, black on dorsal half, orange to reddish brown below, and with scattered black hair in the middle above; faciale orange to brown; vibrissae set 3.4 apart; palpus orange, 5.0 in length; antennal segments orange brown to brown, second segment usually orange apically, third segment 4.5 times as long as second; back of head black, silvery, with four or five rows of postocular cilia and with sparse tawny hair on the metacephalon.

Thorax blue black, moderately covered with silvery pollen and with darker longitudinal stripes, one between the acrostichal rows of bristles and one lateral to each dorsocentral row of bristles; pleura lightly silvery; preparapteron light brown; other sclerites at wing-base black; spiracles with brown hair; postacrostichal bristles two.

Legs black, rarely tinged with brown; middle tibia with one median ventral bristle.

Wing hyaline, brown basally; basicosta black; subcostal sclerite orange, with yellowish pubescence; upper squamal lobe white basally, orange brown on disk, margin brown; lower squamal lobe white, brown on disk, margin white; costal sections 2 to 6 in the proportion 100:67:144:43:10.

Abdomen blue green, deep olivaceous green, or nearly blue black; sternites as in *Cynomya mortuorum*, fifth sternite (pl. 29, C) as figured.

Genital segments black, shining; second segment about 1.5 times as long as second. Internal anatomical features (pl. 29, E and F) as illustrated.

*Female.* Head width 16.0; length at antenna 8.0 and at vibrissa 8.4; eye height 7.7; head height 12.0; bucca 0.50 of eye height; frontale 0.70 of frontal width; front at narrowest (at vertex) 0.38 of head width, 0.42 at lunule; parafaciale 2.5 in width opposite lunule; vibrissae set 3.8 apart; palpus slightly longer than in male; third antennal segment 5.0 times as long as second. Legs with two median ventral bristles on middle tibia. Wing with costal sections 2 to 6 in the proportion 110:70:160:60:12. Abdomen (pl. 29, D) rather pointed apically; discal

bristles on fourth segment strong, erect, nearly in rows. Otherwise similar to male except for normal sexual differences.

*Length.* 9-14 mm.

Hough (1899) first called attention to "variation" in the chaetotaxy of this species. My own investigation of this subject does not alter the conclusions originally drawn by him. He found that approximately 18 percent of the specimens showed some sort of chaetotaxal variation and that such variation might be of three kinds, (1) deficiency in size of a macrochaeta, (2) absence of a macrochaeta normally present, and (3) the presence of a macrochaeta normally absent. Some individuals among 244 specimens examined by Hough, showed both the second and the third kinds of variation, and a few showed bilateral variation. Southern specimens sometimes have the parafaciale and, more rarely, the parafrontale reddish in ground color. In this, and in the orange or golden pollinosity, they superficially resemble *elongata* or *mortuorum*. Neither of these two species, however, has been seen from southern localities.

*Distribution.* Nearctic: As far north as Ungava Bay and as far south as Brownsville, Tex., most abundant along the Canadian-United States border. It is an early spring and late fall species. In Ohio, occasional specimens may be collected on warm days throughout the winter in protected places. About 50 percent of all flies trapped during the spring belong to this species. It is present in considerable numbers during early spring, disappears during June, and reappears in late September.

*Biology, habits, and immature stages.* The species is a common carrion-breeding form. Cured meats are often blown.

*Egg.* Elongate-ellipsoidal, feebly striate longitudinally, white, averaging about 2.00 in length.

As many as 25 to 50 eggs may be deposited at one time although the usual number is considerably less. Hatching occurs within 24 to 72 hours depending upon the season of the year but the exact incubation period has not been determined.

*Larva.* First instar: Segments 2 to 9 evidently with complete segmental spinose bands anteriorly, segments 10 and 11 with bands more or less restricted to ventral region, segment 10 with band incomplete laterally. Spines very fine in structure but heavily sclerotized. Six tubercles on dorsal and ventral margins of posterior depression. Cephaloskeleton (pl. 45, A) with labial sclerite strongly arched, hypostomal sclerite long and narrow, pharyngeal sclerite with widely separated cornua. Posterior spiracles each with two weakly sclerotized oval apertures which are more or less united basally; no anterior spiracles.

Second instar: Segmental spinose bands wider than in previous instar and essentially as in following instar. Anterior spiracles each with 8 (8-10) rounded orifices; posterior spiracles each with two well-defined slitlike apertures. Cephaloskeleton (pl. 45, B) with labial sclerite more strongly sclerotized than in previous instar, still strongly arched, the hypostomal sclerite and pharyngeal sclerite more strongly sclerotized, the latter with dorsal and ventral cornua not so obviously separated as in the previous instar.

Third instar: Cephalic segments (pl. 45, C) with distinct, branching oral grooves radiating from oral opening. Segments 2 to 9 with complete anterior spinose bands, segments 10 to 12 bare anterodorsally, segments 2 to 5 bare posteriorly; segments 9 to 11 with complete posterior spinose bands, segment 12 bare dorsally. Spines minute, single-pointed, deeply pigmented. Inner tubercles on dorsal surface of posterior depression separated by nearly two times the diameter of one spiracular plate, median and outer tubercles closest together, tubercles on ventral margin nearly equidistant. Anterior spiracles as in the preceding instar; posterior spiracles (pl. 45, D) more heavily sclerotized, the three slit-like apertures, peritreme and "button" more distinctly outlined. Anal protuberance surrounded by a wide band of spines which is narrowest laterally and widest dorsally. Cephaloskeleton (pl. 45, C) with labial sclerite not so strongly arched as in previous instar but basal portion wide.

According to Bishopp (1915) the larvae are ravenous and mature within three to five days; puparia are formed in from five to 39 days after the larvae emerge from the eggs. They are killed by low temperatures according to Roberts (1930), who stated that probably only those which have finished feeding and are ready to migrate prepare for hibernation at the approach of cold weather.

*Puparium.* With the habitus of the puparium of *Calliphora vicina* and the major external characters of the mature larva. Bishopp (1915) stated that the pupal stage lasts for from 6 to 58 days and that the complete developmental period is from 19 to 99 days. Roberts (1930) found that puparia were formed from one and one-half to two inches below the surface of the soil.

*Adult.* The preoviposition period lasts from 7 to 20 days according to Bishopp (*ibid.*). Overwintering apparently occurs principally in the pupal stage.

Adults of *cadaverina* may be found in houses during early spring and late fall, especially in kitchens, pantries, or cellars. In the District of Columbia they often occur in considerable

numbers in apartment houses during the month of March before screens are put in windows. They are slow-flying insects and are easily caught on windowpanes. Adults may be collected upon foliage in the sun on warm days during early spring months. They are attracted to human excrement or to carrion of the most putrid sort, and occur abundantly in traps after the bait has become old and odoriferous. The species becomes of economic significance under conditions wherein it blows cured meats in shops or homes.

A number of cases have been reported in which *cadaverina* has been found to occur in cases of subdermal myiasis in warm-blooded animals. When this species occurs in cases of myiasis, it is a secondary invader in an old and pustular lesion.

### CYANUS, NEW GENUS

*Male and female.* Head (pl. 7, A) similar in shape and proportion to *Cynomya* but less protuberant at facio-frontal juncture, the eye larger and not so flattened, and the parafacio-eye angle less acute; front wider in relation to head width, the width at vertex only slightly less than at lunule; vertical bristles slightly developed; accessory ocellar bristles present; male with one reclinate frontoorbital bristle; postvertical bristles strong; distance between vibrissae nearly equal to width of parafaciale opposite lunule in male and parafaciale as wide above as below; frontal row consisting of only about five bristles, the rows diverging only moderately below and reaching to antennal base; vertex without abundant hair.

Thorax essentially as in *Cynomya* but with three preintraalar bristles, the presutural one present and obvious; preacrostichal bristles two, the posterior bristle placed 3.8 before the suture; predorsocentral bristles three, the hindmost one 2.0 before the suture; postacrostichal bristles three.

Legs without long villose hairs except basally on femora; fore tibia with one posterior bristle; middle femur with one anterior bristle; middle tibia without ventral bristles in male, one in female.

Wing with small but obvious costal spine.

Abdomen with medium-length, erect black hair laterally and below; sternites narrower than in *Cynomya*.

Genital segments of male with second segment hardly longer than first and globose, forceps about as long as second segment.

*Genotype.* *Cynomyia elongata* Hough.

*Cyanus elongata* (Hough), new combination

*Cynomyia elongata* Hough, Ent. News 9:106, 1898. (Type, male from Torrey's Lake, Wyoming, in the Field Museum, Chicago, Ill.)

*Calliphora elongata* (Hough) Shannon, Insecutor Insectiae Menstruus 11:109, 1923; Ent. Soc. Wash. Proc. 28(6):134, 1926.

A large black and gray species with the abdomen shining blue green and the front and parafaciale yellowish golden.

*Male.* Head (pl. 7, A) height 15.0; eye height 10.0; bucca 0.30 eye height, yellow to yellow orange anteriorly, with thin yellow golden pollen, black with silvery pollen on posterior fourth, and with scattered black hair; length at antenna 10.0 and at vibrissa 11.0; head width 19.0, front at narrowest 0.23 of head width, 0.32 at vertex and 0.36 at lunule, black glistening, with yellowish white pollen, and with a few minute black hairs outside frontal row; frontale 0.42 frontal width, black, yellowish pollinose; vibrissae set 3.4 apart; vertex black, without abundant black hair, yellowish pollinose; parafaciale orange brown, yellowish pollinose; 3.4 in width opposite lunule; palpus 6.2 in length, orange; antennal segments orange to orange brown, second segment usually orange, third segment 3.5 times as long as second; arista orange-brown.

Thorax colored as in *Cynomyia*.

Legs black, slightly silvery.

Wing with basicosta orange; costal sections 2 to 6 in the proportion 120:70:170:54:12; squamal lobes white, rims orange to brown.

Abdomen mostly shining dark blue or blue green but with definite basal pollinose areas in certain lights.

Genital segments with internal features (pl. 30, A, B, and C) as illustrated.

*Female.* Head height 12.4; eye height 8.0; bucca 0.28 eye height; length at antenna 8.8 and at vibrissa 9.0; head width 16.8; parafaciale 2.8 in width opposite lunule; distance between vibrissae 3.2; front at vertex 0.36 of head width, 0.39 at lunule; abdomen generally blue green. Otherwise essentially like male except for normal sexual differences.

*Length.* 12-14 mm.

*Distribution.* Nearctic: From South Dakota and Colorado to Oregon and Alberta, Canada. The species appears not to be abundant anywhere; it is a summer species occurring from May to September.

*Biology, habits, and immature stages. Egg.* Macrottype, approximately 2.0 mm. in length and about three times as long as the greatest diameter; clearly white, rather glistening, longitudinally striate, feebly reticulate.

The eggs hatch in from 24 to 48 hours during early August in the vicinity of Logan, Utah.

*Larva.* Third instar: Length 12-22 mm., typically muscoid in habitus, creamy white in color. Cephalic segment (pl. 45, E) with well-defined, branching, oral grooves radiating from the oral opening. Segments 2 to 7 anteriorly with complete spinose bands, segments 8 to 11 bare anterodorsally, segments 2 to 5 bare posteriorly, segments 10 and 11 posteriorly with complete spinose bands, segments 2 to 9 bare posterodorsally; segment 12 with complete anterior spinose band. Spines minute, single-pointed, lightly pigmented. Anal protuberance large, above and below with extensive spinose areas. Inner tubercle on dorsal margin of posterior depression largest, median and outer tubercles smaller and closer together; outer tubercle on ventral margin of posterior depression largest, median slightly smaller, these two tubercles closer together than inner and median tubercles; each of these tubercles becomes pigmented with maturity of larva. Anterior spiracles large, each with 7 or 8 rounded orifices; posterior spiracles each (pl. 45, F) with three nearly parallel slitlike apertures, the "button" well-defined and located in peritreme, small, lightly pigmented. Cephaloskeleton (pl. 45, E) strongly sclerotized and deeply pigmented, labial sclerite strongly curved, the width of the basal portion nearly one and one-half times the length of the entire sclerite, both dorsal and ventral cornua pigmented throughout, the ventral cornua with longitudinal ridges typical of saprophagous larvae, hypostomal sclerite short, the pair united ventrally.

Larvae leave their food in three or four days and most of them pupate in about 9 days. A few may pupate as soon as 6 days and others may delay pupation for as long as 15 days.

*Puparium.* With most of the external characters of the mature larva.

*Adult.* The species occurs during July and August at an altitude of from 6 to 9 thousand feet in meadow areas in the northern portion of the Rocky Mountain ranges of the United States. It is one of the most difficult of all of the blowflies to catch in nature. The adults are not only very active, but they are also among the swiftest flying species of the *Calliphoridae*. They do not circle slowly in flight as do species of *Calliphora* or

*Cynomyopsis*, but fly in straight courses like species of *Oestridae* or *Sarcophagidae*. Adults may be seen about swampy areas particularly in the vicinity of gopher holes. Both sexes may be infrequently collected upon swampy ground as they come in for water or they may be collected still less frequently as they dart into gopher burrows or as they rest in the shade of dense sagebrush thickets. Two male specimens were collected by my son upon regurgitated dog food, but this is the only instance known to me of specimens attracted to any attractant. As many as five collectors made numerous collecting trips to areas where the species was known to be present, but approximately 20 specimens comprised the total collection of nearly 5 weeks' effort.

Adult females deposited eggs upon decaying meat in rearing cages. One female collected on July 30, 1940, at 8500 feet elevation, along a seepage area on Beaver Creek in Upper Logan Canyon, Utah, deposited 76 eggs in batches of 6 to 10 eggs each. Another female collected in the same area remained alive for 38 days in a small cage and probably would have lived considerably longer had not an attempt been made to transport it to the east.

As indicated by Hough in the original description of *elongata*, one male and one female of this species were collected in copula. These specimens are in the National Collection. In the type series were two other specimens, a male (Lectotype) from Torrey's Lake, Wyo., and a female from Brookings, S. Dak. The latter two specimens are in the Field Museum, Chicago, the male marked "Type." All were originally treated as cotypes.

#### CYNOMYA ROBINEAU-DESVOIDY

*Cynomya* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 363, 1830; Histoire Naturelle des Diptères des Environs de Paris, vol. 2, p. 577, 1863; Townsend, Insector Inscitiae Menstruus 3:118, 1915; Curran, Families and Genera of North American Diptera, p. 407, 1934; Townsend, Manual of Myiology, vol. 2, p. 170, 1935; *ibid.*, 5:145, 1937. Genotype. *Musca mortuorum* Linnaeus. By designation of Macquart, Insectes Diptères du Nord de la France, vol. 5, p. 40, 1834.

*Cynomyia* Robineau-Desvoidy, Macquart, Soc. Sci. Lille, 176, 1833; Schiner, Fauna Austriaca, Die Fliegen, vol. 1, p. 574, 1862; Brauer and Bergenstamm, Zweiflügler des Kaiserlichen Museums zu Wien, vol. 3(1), p. 54, 1889; *ibid.*, vol. 6(3), p. 75, 1893; Hough, Ent. News 10:64, 1899; Zool. Bull.



2(6):285, 1899; Williston, Manual of North American Diptera, p. 350, 1908; Shannon, Insecutor Inscitiae Menstruus 11:107, 1923; Ent. Soc. Wash. Proc. 28(6):133, 1926; Lundbeck, Diptera Danica, vol. 7, p. 160, 1927; Séguy, Encycl. Ent. (BII.) Dipt. 8:143, 1935.

*Cynophaga* Liroy, Atti Instit. Ven., ser. 3, 9:890, 1864. Isogenotypic with *Cynomyia*.

*Carcinomyia* Townsend, Biol. Soc. Wash. Proc. 28:21, 1915; Insecutor Inscitiae Menstruus 3:117, 1915. Isogenotypic with *Cynomyia*.

*Cyanomyia* Wilson, N. Y. Ent. Soc. Jour. 40:89, 1932. (*lapsus*).

*Male and female.* Head (pl. 7, B) width approximately four-fifths greater than height; length at antenna and at vibrissa about equal; epistoma elongate, warped forward from clypeal plane, and slightly narrower than clypeus; metacephalon not apparent in profile; bucca high, fully half eye height; eye small in comparison with size of head, ovate, set obliquely in head at 20 degree angle; front wide in both sexes but wider in female; frontal row consisting of only about five bristles, the rows but moderately divergent anteriorly; frontoorbital bristles two proclinate and one reclinate in female; ocellar bristles strong, proclinate; strong proclinate accessory ocellar bristles present in male; clypeus shallowly sunken, twice as long as wide; facial carina between basal antennal segments, low, inconspicuous; parafaciale as wide below as above or only slightly narrowing below, and with minute scattered bristles on upper half; faciale slightly convex in profile, with several rows of minute setae which ascend about one-third the distance from the vibrissa to the antennal base; vibrissa slightly above oral margin; proboscis three-fourths head height; palpus slender clavate; antennal base at or but slightly above eye middle with head viewed in profile, bases approximated; arista with a short penultimate segment, thickened only at base and uniformly tapering to apex and with the cilia long above, short below; back of head evenly rounded.

Thorax with four humeral bristles arranged in an obtuse angle; preintraalar bristle one, the presutural one weak or absent; preacrostichal bristles two; predorsocentral bristles three; posthumeral bristle present; presupraalar bristle one; notopleural bristles two; sternopleural bristles three, pteropleuron bare on anterior fourth; prosternum elongate, of medium-size, narrow, and slightly widening anteriorly, hirsute posteriorly; postalar declivity in center with tuft of hair; preepaulet setose; tympanic

pit and ridge bare; squamal process long setose; postacrostichal bristles one; postdorsocentral bristles three; postintraalar bristles two, postsupraalar bristles three strong and one weak; scutellum with one discal bristle and three lateral bristles; under surface of scutellum laterally setose.

Legs with anterior femur having dorsal, posterodorsal, and posteroventral rows of long bristles, the posterior surface with considerable long hair; anterior tibia with several dorsal or anterodorsal bristles in a row, and one or two long posterior bristles, usually one near middle and one near apical third; middle femur with one anterior bristle near middle (often with a weaker bristle just basally), and with ventral and posteroventral rows of long shaggy bristles; middle tibia with two anterodorsal bristles, one at basal third and one at apical third (often a weak bristle at basal fourth), three posterior bristles, one at basal sixth, one at basal third and one at apical third, and one postero-dorsal bristle toward middle; hind femur with anterodorsal row of long closely-set bristles, and anteroventral and ventral rows of long and shaggy bristles; hind tibia with four anterodorsal bristles, one near base, one at basal fourth, one at basal third, and one toward apical third, two anteroventral bristles, one at or near middle, and one at apical third (often two weaker bristles basad of these), and two posterodorsal bristles, one at basal fourth and one near middle (sometimes a weak bristle between these); claws and pulvilli of male long and strong, shorter in female than in male.

Wing with strong costal spine, third vein with only two or three setulae at base; no apical section or fold at bend of fourth vein which has an angle of nearly 90 degrees; apical cell clearly open and ending considerably before wing apex; anterior cross vein at middle of second section of fourth vein, oblique; posterior cross vein doubly arcuate; last section of fifth vein one-fifth as long as preceding section; upper squamal lobe small, bare; lower squamal lobe large, hind margin wide and truncate.

Abdomen elongate-conical in male, elongate-oval in female; entirely shining, only faint traces of pollen; ventrally with long hair; first and second segments with lateral bristles only; third and fourth segments each with a row of marginal bristles; discal bristles on fourth segment, these hair-like in male, strong and erect in female; first sternite twice as wide as long in male, the following sternites successively wider, the fourth at least three times as wide as long.

Genital segments of male from medium to large in size, second segment narrow and twice as long as first.

*Cynomya mortuorum* (Linnaeus)

*Musca mortuorum* Linnaeus, Systema Naturae, Ed. 10, p. 595, 1758; Fauna Suecica, Ed. 2, p. 452, 1761; Fabricius, Systema Entomologiae, p. 775, 1775; Fallen, Vet. Acad. Handl., p. 247, 1816. (Type, from Sweden, in Uppsala or lost.)

*Sarcophaga mortuorum* (Linnaeus) Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 5, p. 16, 1826; Zetterstedt, Diptera Scandinaviae, vol. 4, p. 1303, 1845; Walker, List of the Specimens of Dipterous Insects in the Collections of the British Museum, vol. 4, p. 834, 1849.

*Calliphora mortuorum* (Linnaeus) Pandellé, Rev. de Ent. 15:212, 1896.

*Cynomya mortuorum* (Linnaeus) Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 364, 1830; Histoire Naturelle des Diptères des Environs de Paris, vol. 2, p. 578, 1863.

*Cynomyia mortuorum* (Linnaeus) Macquart, Soc. Sci. Lille, p. 40, 1834; Histoire Naturelle des Insectes Diptères, 2:233, 1835; Portschesky, Soc. Ent. Ross. Hor. 11:38, 1872, 1875; Osten Sacken, Berl. Ent. Ztschr. 31(1):20, 1887; Lundbeck, Vid. Medd., p. 306, 1898; Villeneuve, Soc. ent. France Bul., p. 363, 1900; Frey, Acad. Sci. Russ. Mem. 29(10):3-5, 1915; Cole, Calif. Acad. Sci. Proc., ser. 4, 11:172, 1921; Rohdendorf, Ent. Mitt. 13(6):284, 1924; Mueller, Arch. f. Naturgesch., 88A (1-3):70, 1922; Zool.-Bot. Gesell. Wien Verhandl. 73:70, 1923; Collin, Ann. and Mag. Nat. Hist., ser. 9, 14:204, 1924; Johnson, Boston Soc. Nat. Hist. Occas. Papers 7(15):217, 1925; Psyche 36(2):140, 1929; Lundbeck, Diptera Danica, vol. 7, p. 161, 1927; Wainwright, London Ent. Soc. Trans. 76:241, 1928; Séguy, Encycl. Ent. (A) 9:123, 1928; Collin, Ann. Mag. Nat. Hist., ser. 10, 7:79, 1931.

A large black and gray species with the abdomen shining blue green and the front and parafaciale brilliant golden pollinose.

*Male.* Head (pl. 7, B) width 17.8, height 14.5; eye height 9.6; length at antenna 10.2 and at vibrissa 10.7; bucca 0.57 the eye height, orange, black behind the suture, with scattered black hair of medium-length, no pale hair before the metacephalic suture, mostly shining, but sometimes with golden pollen; frontale 0.50 frontal width, yellow orange anteriorly, brown posteriorly; front at narrowest, 0.22 of head width, 0.29 at vertex, and 0.35 at lunule, yellow orange in ground color, with

yellowish silvery to golden pollen, and with a few brown hairs scattered outside the frontal rows of bristles, and occurring as far anteriorly as the foremost frontal bristle; frontal row consisting of only five or six weak and hairlike bristles, the rows only narrowly divergent anteriorly; inner vertical bristles straight; postvertical and postocellar bristles weak; vertex with brown to black pollen; clypeus yellow golden; parafaciale 3.2 in width opposite lunule, slightly narrower below, orange, with bright golden pollen, and with minute hairs above; faciale orange; vibrissae above oral margin by 1.0 and separated by 4.0; palpus orange, 6.6 in length; antenna orange, third segment 4.8 times as long as second, orange basally and below, brown dorsally; arista and cilia black; back of head black, silvery, with three or four rows of postocular cilia and abundant whitish yellow hair.

Thorax blue black with thin silvery pollen and with three dorsal longitudinal black stripes, one of which is middorsal and one lateral to each dorsocentral row; pleura mostly black, with long, thin, black hair; propleuron black setose; hindmost pre-acrostichal and dorsocentral bristles placed before suture by 3.6 and 2.0, respectively; ampullae black, other sclerites at wing-base brown; metathoracic spiracle with brown hair.

Legs black, fore tibia with two posterior bristles, middle tibia with one ventral bristle toward middle.

Wing hyaline, rather brownish; basicosta black; subcostal sclerite orange to brown, with orange pubescence; costal sections 2 to 6 in the proportion 118:81:190:56:15; apical cell ending before wing-tip by 2.2; upper squamal lobe white with brown rim; lower squamal lobe white with white rim.

Abdomen shining usually metallic blue green with purple reflections but often nearly green, with long thickly-set, black hair ventrally and apically.

Genital segments shining black with long black thick-set hair, the first segment without a marginal row of bristles. Internal morphological features (pl. 30, D, E, and F) as illustrated.

*Female.* Head width 16.1; length at antenna 9.1 and at vibrissa 9.3; eye height 8.0; head height 12.8; bucca 0.59 eye height; front across foremost ocellus 0.31 of head width, 0.37 at vertex and 0.43 at lunule; ocellar triangle golden pollinose; parafaciale 3.0 in width opposite lunule, nearly bare above, only a few brownish hairs on upper half; vibrissae set 4.0 apart; third antennal segment 3.9 times as long as second; outer vertical bristles two-thirds as long as inner. Wing with costal sections

2 to 6 in the proportion 100:75:165:50:11. Abdomen with fourth segment with strong erect scattered discal bristles. Legs with middle tibia having two ventral bristles. Otherwise similar to male except for normal sexual differences.

*Length.* 8-14 mm.

*Distribution.* Holarctic. Northern Europe and Asia. North America along the Arctic Circle, increasingly less abundant southward. The species is common only in the far north; most of the specimens I have seen are from Alaska and Greenland, collected during the latter part of July and in August.

*Biology, habits, and immature stages.* The details of the biology of this species have not been worked out so far as I am aware. It is most often collected on decaying fish along shores and is undoubtedly saprophagous.

### *Cynomya hirta* Hough

*Cynomyia hirta* Hough, Ent. News 9:166, 1898; Cole, Calif. Acad. Sci. Proc., ser. 4, 11(14):172, 1921; Walton, No. Amer. Fauna 46(2):228, 1923; Shannon, Insecutor Inscitiae Menstruus 11:115, 1923. (Type, male from St. Paul's Island, Alaska, in the Field Museum, Chicago.)

A large species with the general aspect of *mortuorum* but the abdomen more yellowish green and the body hair longer and thinner.

*Male and female.* Similar to *mortuorum* in general aspect, the legs with long fine hair and the faciofrontal profile protuberant, but bucca only 0.30 eye height, parafaciale slightly wider in relation to distance between vibrissae, front at vertex and lunule 0.33 head width, third antennal segment only three times as long as second, and the body hair long, thin, erect, and abundant.

*Length.* 15-18 mm.

*Distribution.* Nearctic: Alaska, George Island and St. Paul Island.

The type series now contains two specimens, one male and one female. Another specimen, a male from St. George Island, is marked "Holotype," although it was not collected until July 4, 1914 (Hough died in 1903). The male collected on St. Paul Island, Alaska, must be the holotype.

## SUBFAMILY POLLENIINAE

The species belonging to the subfamily Polleniinae (Color Plate V\*) are mostly dull black with thin silvery pollen and small eyes. *Pollenia rudis*, a common parasite of earthworms in the United States and southern Canada, has tawny-yellow crinkly hair over much of the body. The species belonging to the tribe Melanodexiini occur only on the Pacific Coast and their biologies and habits are unknown. None of the species belonging to this tribe are known to occur in the American tropics.

*Male and female.* Head width and height approximately equal; bucca high, often one-half the eye height or more; eye small, oblique; epistoma usually long and narrow; frontale striate, widening toward lunule; frontal width rarely exceeding 0.10 of head width in male, often as much as 0.40 of head width in female, with considerable hair outside of frontal row of bristles and on vertex; frontal row of bristles obsolete toward vertex in male, the rows widely diverging in both sexes and converging again in the foremost one or two bristles; inner vertical bristles strong; outer vertical bristles absent in male; postvertical and postocellar bristles weak, proclinate; ocellar bristles strong; frontoorbital bristles absent in male; clypeus broad and shallow, depressed laterally; parafaciale with scattered coarse setae; faciale rounded, concave in profile, with a few weak setae above vibrissa which is strong and usually above the oral margin; palpus long; facial carina present; antennal bases distinctly separated by a carina; third segment of antenna short, from one and one-fourth to two and one-half times as long as second; arista with penultimate segment short, apical segment thickened at base, plumose nearly to apex; back of head flattened or dished above, rounded below.

Thorax with three humeral bristles in a straight line; propleuron and prosternum bare; predorsocentral bristles two; notopleural bristles two; sternopleural bristles two; hypopleuron without fine hair; pteropleural bristles in a tuft; prosternum large, wide, bulging anteriorly; postalar declivity setose posteriorly; tympanic pit bare; postalar bristles two or three, rather approximated; postdorsocentral bristles three; postsupraalar

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\*The black impression used in Plate V is that of an etched zinc plate photoengraved from a drawing by E. Hart (U. S. Dept. Agr. Farmers' Bull. 1569). The two tint impressions (yellow and sepia) are from etched zinc plates photoengraved from pen drawings on sheets of celluloid which were superimposed over the original black and white Hart illustration.



POLLENIINI

Color plate V.—*Pollenia rudis* (Fabricius). Adult female,  
dorsal view, X 8.







4. Middle tibia with ventral bristles; hind tibia with antero-ventral bristles..... 5  
 Middle and hind tibiae without ventral or anteroventral bristles (Nearctic).....  
 ..... *Melanodexiopsis tristina*, new species, p. 359
5. Two postacrostichal bristles..... 6  
 Only one postacrostichal bristle (Nearctic).....  
 ..... *Melanodexiopsis pacifica*, new species, p. 359
6. Frontal bristles in one row (Nearctic).....  
 ..... *Melanodexiopsis nox*, new species, p. 358  
 Frontal bristles in two rows (Nearctic).....  
 ..... *Melanodexiopsis grandis* (Shannon), p. 357
7. Two or more postacrostichal bristles..... 8  
 Only one postacrostichal bristle (Nearctic).....  
 ..... *Melanodexia glabricula* (Bigot), p. 354
8. Two postacrostichal bristles (Nearctic).....  
 ..... *Melanodexia satanica* Shannon, p. 355  
 Three postacrostichal bristles (Nearctic).....  
 ..... *Melanodexia californica*, new species, p. 354

#### TRIBE POLLENIINI

Only one genus and one species belonging to this tribe occur in North America.

*Male and female.* Head with palpus half as long as head at antenna, thick, clavate; antennal bases narrowly separated; third antennal segment twice as long as second, reaching four-fifths the distance to the vibrissa; arista thickened one-third the distance to the apex, with cilia to apex. Thorax, abdomen, and coxae usually with thick, yellowish or tawny, crinkly pile or hair; hindmost preintraalar bristle present and placed close to suture; posthumeral bristle present. Wing with only third vein provided with setulae and these at base; anterior cross vein before the middle of the second section of fourth vein in the proportion 8:7; last section of fifth vein one-fourth as long as preceding section; both squamal lobes entirely bare on disc.

#### POLLENIA ROBINEAU-DESVOIDY

*Pollenia* Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 412, 1830; Schiner, Fauna Austriaca, Die Fliegen, vol. 1, p. 585, 1862; Brauer and Bergenstamm, Zweiflügler des Kaiserlichen Museums zu Wien, vol. 4(1), p. 87, 1889; *ibid.*, vol.

6(3), p. 91, 1893; Hough, Ent. News 10:63, 1899; Zool. Bull. 2(6):283, 1899; Williston, Manual of North American Diptera, p. 342, 1908; Townsend, Indian Mus. Rec. 13:200, 1917; Senior-White, Indian Mus. Rec. 27:83, 1925; Shannon, Ent. Soc. Wash. Proc. 28(6):136, 1926; Malloch, Linn. Soc. N. S. Wales Proc. 52:318, 1927; Lundbeck, Diptera Danica, vol. 7, p. 133, 1927; Séguy, Ztschr. f. angew. Ent. 14:374, 1928; Encycl. Ent. (A) 9:170, 1928; Malloch, Rec. Cant. Mus. 4(5):318, 1930; Townsend, Manual of Myiology, vol. 2, p. 159, 1935; *ibid.*, vol. 5, p. 118, 1937; Senior-White, Fauna of British India, Diptera, vol. 6, p. 115, 1940. Genotype. *Musca rudis* Fabricius. Original designation.

*Cephysa* Robineau-Desvoidy, Histoire Naturelle des Diptères des Environs de Paris, vol. 2, p. 677, 1863. Genotype. *Musca rudis* F. (= *Cephysa muscidea* R. D.). Sole species.

*Orizia* Robineau-Desvoidy, Histoire Naturelle des Diptères, vol. 2, p. 678, 1863. Genotype. *Musca rudis* F. (= *Orizia conjuncta* R. D.). Designation by Townsend (Insector Insectiae Menstruus 4:8, 1916).

*Male and female.* Head (pl. 7, C) length at antenna slightly greater than at vibrissa; bucca high, nearly half eye height; epistoma elongate, narrowed at vibrissa, widening below, and warped slightly from clypeal plane; frontale nearly obliterated in male, wide in female; frontal row consisting of eight or nine bristles, which are weak posteriorly, the rows obsolete from near the middle in male, diverging anteriorly as they follow the margins of frontale; inner vertical bristles present; fronto-orbital bristles, two proclinate and one reclinate in female; clypeus twice as long as wide; facial carina apparent only between basal antennal segments, short, narrow, low, sharp; parafaciale narrowed above and setose on upper half; faciale slightly convex in profile and rounded, almost bare; vibrissa strong, slightly above oral margin and separated by a distance equal to width of parafaciale opposite lunule in male, slightly less in female; palpus as long as haustellum, stout, clavate; antennal bases slightly below middle of eye seen in profile; third segment reaching four-fifths the distance to the vibrissa; arista thickened on basal third, with long cilia above to apex, and on basal half below; back of head with two or three rows of postocular cilia.

Thorax with preintraalar bristles two, the posterior one close to suture; preacrostichal, predorsocentral and presupralar bristles two in each row, strong; pteropleuron with thick-set hair; postalar declivity posteriorly with a tuft of hair;

postacrostichal and post supraalar bristles three each row; scutellum large, flattened on disc, with one discal bristle, four to six lateral bristles, the foremost intermediate lateral placed further down on side of scutellum than the others in the series, and laterally with fine tawny hair which extends to lateral dorsal margins.

Legs with fore femur with scattered bristles on the posterior surface; middle femur with about five anterior bristles in a series toward middle, two anteroventral bristles toward middle, and a ventral row of bristles basally; middle tibia with two anterodorsal bristles near middle, one ventral bristle near apical third, four posterodorsal bristles, one near basal fourth, two near middle and one near apical sixth; hind tibia with three anterodorsal bristles, two toward middle and one near apical fourth, three anteroventral bristles between middle and apical third, one long dorsal, subapical bristle, and a row of five or six posterodorsal bristles which are shortest basally; claws and pulvilli small.

Wing without costal spine; subcostal sclerite with a few long fine hairs; bend of fourth vein rather rounded, without fold or apical section; apical cell usually clearly open; anterior cross vein oblique; posterior cross vein doubly arcuate.

Abdomen with scutellar depression extending from 0.20 to 0.25 the distance to the hind margin of the first segment; third segment with a marginal row of short weak bristles; first sternite of male as long as broad, third and fourth sternites smaller, edges overlapped by margins of tergites; margins of tergites and the sternite with long yellowish pile.

Male genital segments of medium size; first segment with a marginal row of bristles.

### *Pollenia rudis* (Fabricius)

#### (The cluster fly)

*Musca rudis* Fabricius, Entomologia Systematica, vol. 4, p. 314, 1794; Systema Antliatorum, p. 287, 1805; Fallen, Monographia Muscidum Succiae, p. 48, 1821; Meigen, Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten, vol. 5, p. 66, 1825. (Type, "Germania Dom. Smidt," evidently lost.)

*Pollenia rudis* (Fabricius) Robineau-Desvoidy, Essai sur les Myodaires, Paris, p. 412, 1830; Hoffmeister, Die bis jetzt bekannten Arten aus den Regenwürmer, Braunschweig,

Vieweg u. Sohn, p. 27, 1945; Schiner, Fauna Austriaca, Die Fliegen, vol. 1, p. 586, 1862; Mann, Psyche 3:378, 1882; Riley, Amer. Nat. 17:83, 1883; Hough, Zool. Bull. 2(6):283, 1899; Keilin, Comp. Rend. Soc. Biol. 67(26):201, 1909; Ent. Soc. Wash. Proc. 13(3):182-184, 1911; Bull. Sci. France & Belg. 49:25-106, 1915; Townsend, Indian Mus. Rec. 13:201, 1917; Blackman and Stage, N. Y. St. Coll. Forestry, Bull. 10:108, 1918; Weiss and Dickerson, N. Y. Ent. Soc. Jour. 29:144, 1921; Cole and Lovett, Calif. Acad. Sci. Proc., ser. 4, 11(15):308, 1921; Mueller, Arch. f. Naturgesch. 88A (1-3):67, 1922; Zool.-Bot. Gesell. Wien Verhandl. 73:68, 1923; Senior-White, India Dept. Agri. Mem. Ent. Ser. 8:50, 1923; Indian Mus. Rec. 27:84, 1925; Blackman and Stage, Tech. Publ. 17, N. Y. St. Coll. Forestry, p. 216, 1924; Shannon, Ent. Soc. Wash. Proc. 28(6):136, 1926; Essig, Insects of Western North America, p. 587, 1926; Cole, Calif. Acad. Sci. Proc. 16(14):489, 1927; Dennys, Ent. Soc. Brit. Col. Proc. 24:22, 1927; Lundbeck, Diptera Danica, vol. 7, p. 135, 1927; Séguy, Encycl. Ent. (A) 9:176, 1928; West, in Leonard, Mem. 101, Cornell Univ., p. 828, 1928; De Coursey, Ent. Soc. Amer. Ann. 20:368, 1927; Wainwright, London Ent. Soc. Trans. 76:236, 1928; Walton, U. S. Dept. Agr. Farmers' Bull. 1569:10, 1928; Tao, Amer. Jour. Hyg. 7:754, 1927; Roberts, Ent. Soc. Amer. Ann. 23:791, 1930; Stewart, N. Y. Ent. Soc. Jour. 38:45, 1930; Felt, Jour. Econ. Ent. 24:1278, 1931; DeCoursey, Science, 75(1941), 287, 1932; Senior-White, Fauna of British India, Diptera, vol. 6, p. 191, 1940.

*Pollenia obscura* Bigot, Ent. Soc. de France, Bull. CLXXXI, 1887; Soc. Zool. de France, Bull. 597, 1887; Brauer, Akad. der Wiss. Wien, Math.-Nat. Kl. Sitzber. (1)108:517, 1899. New synonymy.

A black and gray species (Plate 4) with tawny crinkly hair on the thorax, and with the abdomen marmorate.

*Male.* Head (pl. 7, C) width 10.7; length at antenna 6.6 and at vibrissa 6.3; length at the oral margin slightly greater than at vibrissa; height 10.7; eye height 8.0; bucca 0.33 eye height, and heavily golden pollinose, with abundant short to medium-length setae and light yellow hair before the metacephalic suture; frontale nearly obliterated at middle, brown to black anteriorly; front at narrowest 0.02 of head width, 0.12 at vertex and 0.46 at lunule, with grayish golden to brown pollen; vertex subpollinose, whitish; clypeus yellowish silvery; parafaciale with

yellowish golden to brown pollen; vibrissae above oral margin by 1.0 and separated by 1.8; palpus 3.5 in length; antennal segments orange brown to black, third segment two times as long as second; back of head black, with two or three rows of post-ocular cilia and with abundant yellowish white hair.

Thorax black, with thinly silvery pollen, and with shining black dorsal longitudinal stripes; fresh specimens with long crinkly yellowish brown or golden-yellow (rarely yellowish white) pile or hair, this partially or almost totally lacking in old or rubbed specimens; pleura lightly to strongly gray pollinose; hindmost preacrostichal and dorsocentral bristles before the suture by 2.0 and 1.75, respectively; postalar declivity with tuft of long crinkly pile; sclerites at wing-base brownish black; mesothoracic spiracle rather small, with bright orange hair; mesothoracic spiracle with orange hair; lateral margins of scutellum with long crinkly pile.

Legs black, pulvilli brownish black.

Wing hyaline, slightly infuscated with brown basally; costal sections 2 to 6 in the proportions 84:45:120:38:6; subcostal sclerite orange brown; basicosta black; upper and lower squamal lobes orange brown on apical half or more.

Abdomen black, thinly covered with silvery pollen, tessellated about as in *Muscina stabulans*, with a shining black middorsal longitudinal stripe; fifth sternite (pl. 31, B) as illustrated; all sternites and the ventral edges of tergites with yellow pile.

Genital segments black, first segment with a marginal row of about five bristles; second segment smaller, with thin pollen and scattered black setae. Internal anatomical features (pl. 31, A and C) as illustrated.

*Female.* Head width and height 9.6; length at antenna 6.2 and at vibrissa 5.4; eye height 6.1; bucca 0.46 eye height; front at vertex 0.33 of head width, 0.51 at lunule; outer vertical bristles two-thirds as long as inner; frontal row of bristles not obsolete above. Otherwise similar to male except for normal sexual differences.

*Length.* 6-12 mm.

The above description was drawn from North American specimens which were compared with European specimens determined as *Pollenia rudis* by Brauer and Bergenstamm, and Villeneuve. I find no essential differences between them, but Keilin (1915) noted that the favored host of *Pollenia rudis* was *Allolobophora chlorotica* (Sav.) in Europe; this is not the favored host in North America. In both North American and European specimens the width of the bucca in relation to the eye height varies

somewhat (from 0.44 to 0.50 in the female and from 0.29 to 0.42 in the male). In most specimens the length of the head at the antenna is somewhat greater than the length at the vibrissa in the male, but several specimens have these lengths nearly equal. It may be possible, by extensive rearing, to show that more than one form of *Pollenia* occurs in North America; but it is difficult to prove specific limits with collected material. As stated by Townsend (1935, pp. 104-105), "What is called *Pollenia rudis* shows a great range of variation in several characters that are ordinarily of generic value, which condition may be interpreted as the probable result of an intermixture of two or more closely related forms long kept apart, but later fluxed as they spread and met on removal of the barriers that formerly existed between them."

*Distribution.* Holarctic: Central and northern Europe; North America, common from Virginia and Tennessee to Nova Scotia and British Columbia. It may be collected as far south as northern Florida and southern Georgia during warm winters. Séguy (1934) stated that *rudis* is common in middle Europe, rare in north Africa.

*Biology, habits, and immature stages.* The species has been reported as a parasite of the following species of earthworms: *Helodrilus roseus* (Sav.), *Allolobophora caliginosa* (Sav.), and *Allolobophora chloroticus* (Sav.). It apparently will parasitize many species of earthworms, but the first named has been found to be the favored host in North America. Parasitism by *Pollenia rudis* upon earthworms was first recorded by Hoffmeister (1845).

*Egg.* Described by DeCoursey (1927) (pl. 46, A and B) as follows: "About 1 mm. long, 0.3 mm. in length, the ventral side convex, dorsal side flat or slightly concave; two carinae extend along the dorsal side almost to posterior end; surface with exception of two ridges and groove between them, is finely etched into irregular figures."

The duration of the egg stage in the vicinity of Washington was found to be approximately three days, according to Webb and Hutchinson (1916).

*Larva.* The larva of *Pollenia rudis* has been described and figured by Keilin (1915) and DeCoursey (1927).

First instar: 1.0 to 1.5 mm. in length, 0.2 to 0.25 mm. in diameter, with complete spinose bands anteriorly on segments 1 to 4 and 11, and ventral anterior and posterior bands of larger spines on segments 4 to 12. Cephaloskeleton (pl. 46, C\*) with

\*Redrawn from Keilin (1915, plate 7, figures 31, 32, 33, and plate 8, figures 36, 37, and 38) by the kind permission of Dr. Keilin.

single labial sclerites, elongate, not strongly curved, the basal portion only lightly sclerotized, and with a well-developed "hatching spine." Amphipneustic, posterior spiracles lightly sclerotized, each with two more or less united slit-like apertures.

Second instar: Length 2-5 mm. Cephaloskeleton (pl. 46, D) strongly sclerotized, the labial sclerites short, strongly hooked and paired; the dorsal cornua anteriorly prolonged. Anterior spiracles each with four apertures, posterior spiracles (pl. 46, F) each with two well-separated slitlike apertures.

Third instar: Length 6-12 mm. Mostly smooth. Anal segment with eight protuberances, only the anal pair strong. Cephaloskeleton (pl. 46, E) strongly sclerotized, the labial sclerites strong, long, and curved; dorsal cornua weak, elongate, both anteriorly and posteriorly prolonged; ventral cornua heavily pigmented and strongly sclerotized. Anterior spiracles (pl. 46, G) each with four apertures, posterior spiracles (pl. 46, H) each with three well-defined slitlike apertures, rather lightly sclerotized, the "button" in peritreme.

Keilin (1909 and 1915) stated that eggs of *Pollenia rudis* are deposited in soil toward the latter part of August or early in September and hatch in from 4 to 6 days. The first-instar larva enters the earthworm host by the male genital orifice and then passes into the body cavity of the genital segments, probably during copulation. The parasite then supposedly remains dormant in the body cavity of the host from September or October until the following April or May, when it becomes active and migrates to the anterior end of the host. When it arrives at the prostomium, the posterior spiracles become exposed to air and the larva begins feeding upon the anterior segments of the worm. Six to 10 days later, it molts. The second stage requires 9 days. In the final instar, the parasite feeds aggressively on all tissues of the host, then leaves the host, which is still alive, and pupates in the soil. The pupal stage lasts from 39 to 45 days.

In the United States, phases of the biology of this species have been reported as follows. Eggs are deposited in suitable locations in soil by over-wintering females as soon as spring temperatures have reached 80° F. Two or three eggs are usually deposited within a few inches of each other. Individual females have deposited as many as 97 eggs in one day according to DeCoursey (1932), who stated that there is apparently no oviposition stimulus derived from the presence of earthworms in the soil. He found that adults deposit eggs upon many different materials but never upon carrion.

DeCoursey (1927) found that the larva enters the host through



the cuticula and apparently feeds with the posterior spiracles exposed. It usually penetrates the host in the anterior portion in the region of the tenth segment or a few segments posterior to the clitellum. All the larvae observed by DeCoursey entered the host from the dorsal side, usually in the intersegmental furrows, although a few entered thicker portions or through the clitellum. Parasitism usually occurs within 1 or 2 days after exposure of the host to hatching larvae. The larval stage lasts for approximately 13 days during the month of June in the midwestern United States.

No investigator in North America has found the quiescent stage in the first-instar larva nor the feeding details of the larvae as reported by Keilin.

Larvae of *Pollenia rudis* apparently have never been reared upon foods other than living earthworms. DeCoursey tried to feed them upon cow dung, horse manure, loam soil, clay soil, grass sod, decayed roots of grasses in soil, decayed wood, decaying meat, and dead earthworms. Tao (1927) reported that she was unable to rear first-instar larvae of this species upon any normal blowfly medium. Riley's record (1883) of the rearing of *Pollenia rudis* from cow dung in Virginia is probably erroneous.

In Europe, larvae of *rudis* are parasitized by *Trichopria brevipennis* Kieff., according to Séguy (1934).

*Puparium.* Length 7 mm., diameter 2.5 mm., with the major external characters of the mature larva.

When fully mature, the parasitic larva leaves the body of the host, which may or may not be dead, and pupates in the soil. Keilin (1915) found that the pupal stage lasts from 39 to 45 days. In the United States, Webb and Hutchinson (1916) found it to last from 11 to 14 days. Keilin's investigations were conducted during the fall months, while Webb and Hutchinson conducted their experiments during midsummer.

*Adult.* There are apparently four generations of *Pollenia rudis* each year in the United States. Hibernating and newly emerging adults may be collected on warm days during any winter month. When the weather permits flight in the spring, the flies may be collected upon early flowering plants, decaying fruits, or souring sap of trees. Copulation evidently occurs at this time, for DeCoursey (1927) found no spermatozoa in the spermathecae of hibernating females and ovaries of such specimens were not developed.

*Pollenia rudis* is a rather cumbersome, slow-flying insect and is one of the easiest blowflies to capture in a hand net. During

spring months females may be seen in considerable numbers flying slowly over moist grassy areas. Many specimens, particularly males, may be collected upon umbelliferous flowers, where they are not easily disturbed while feeding. The species is apparently uncommon during midsummer, although it may frequently be collected in deep woods where numbers congregate about bases of trees. Most of the specimens that I have collected at this season of the year have been upon flowers of wild parsnip. Dr. C. H. Kennedy and I collected large numbers of adults upon parsnip during July in southern Ohio. Stewart (1930) reports collecting them upon *Melilotus*.

Flies of the fourth and last generation of the year become numerous during the latter days of September and abundant by October 15. As cold weather progresses, both males and females try to find protection in trees, buildings, and under debris. In British Columbia, Dennys (1927) found that they hibernated in considerable numbers in the tunnels of wood-boring insects in Douglas Fir trees which had been killed by lightning, and which had a certain amount of loose bark and decayed wood.

During 1916, Kisliuk conducted a series of trapping experiments with *rudis*. He exposed a large number of organic baits in traps and during the month of July, banana and milk and banana and vanilla extract attracted the species in considerable numbers.

*Economic importance.* During the winter months hibernating adults of *Pollenia rudis* sometimes become a nuisance in households, where they may be found in conspicuous swarms or clusters in closets, in unused rooms, or other retreats. Dall, Riley, Felt, and other North American economic entomologists have written upon this problem. Dall (1882) stated, "People soon learned to look for them (the flies) everywhere; in beds, in pillow slips, under table covers, behind pictures, in wardrobes nestled in bonnets and hats, under the edge of carpets, and in all possible and impossible places. A window casing solidly nailed on, will, when removed, show a solid line of them from top to bottom; they are uncanny. They like new houses, but are often found swarming in old unused buildings and go regularly to church, or perhaps only a few good ones abide in sanctuaries; anyway they are there. Best of all they like a clean dark chamber seldom used, and if not disturbed form in large clusters about the ceilings. They are very cold and feel in the hand like small bits of ice. They are very oily; if crushed, leave on the floor a great grease-spot." Although the construction of the modern house has apparently eliminated much of the problem of the

cluster fly, that it is a nuisance at times is illustrated by the following letters.

Elmhurst, Ill., Feb. 4, 1929.—“My house here in Elmhurst has been teeming with blowflies all winter. They seem to come up through the opening where the window ropes pass through and settle in the air-space between the regular windows and the storm sashes. They survive even at eighteen degrees below zero.” Union, Ohio, Sept. 22, 1935.—“This week, cluster flies are coming in wholesale numbers. They appeared first in the attic where the windows are screened and not a housefly has ventured all summer. Next they appeared in a bed-room on the second floor—the very same places in which they appeared last year, only to continue until no part of the house was free from them. It isn't just a fly or two—or even a half a dozen, but anywhere from fifty to a hundred on a window, first between the blind and glass, then later out into the room.”

#### TRIBE MELANODEXIINI

The species placed in this tribe belong to two genera, and evidently occur only in the far western part of the United States. Little is known of the habits of these species, and nothing is known of the immature stages.

*Male and female.* Head (pl. 7, D) with palpus filiform or slightly clavate at tip; antennal bases conspicuously separated by a narrow and high, or wide and low, carina; third antennal segment rarely longer than one and one-half times the second and not reaching over two-thirds the distance to the vibrissa; arista thickened slightly at base, the penultimate segment rather bulbous but not longer than its greatest diameter.

Thorax and abdomen mostly bare or with short, black hair but without crinkly hair or pile; propleura bare; notopleural bristles two; preintraalar bristle one, the presutural absent; presupraalar bristle one; postalar declivity posteriorly with a tuft of hair; postalar bristles three; prosternum large, bulging anteriorly; posthumeral bristle absent.

Middle femur with from four to five anterior bristles near middle, about four posteroventral bristles in a row toward base; hind tibia with from three to five bristles in anterodorsal and anteroventral rows.

Wing with a minute costal spine, third vein bare; fourth vein without apical section or fold, the bend obtuse, the apical cross vein sinuate only toward margin; apical cell open or closed to

slightly petiolate; anterior cross vein oblique, beyond middle of second section of fourth vein in proportion 8.5:7; last section of fifth vein one-sixth as long as preceding section; both squamal lobes with very fine short pile over most of upper surface, the lower lobe narrow.

Abdomen with scutellar depression extending about one-third the distance to the hind margin of the first segment; first sternite of male small, rounded apically, overlapping margins of tergite; second and third sternites smaller and narrower; sternites of female as in male but narrower.

It appears that many of the characters of the species belonging to this tribe are in a state of flux, and some of them are so variable that they cannot be used for the separation of forms. Some of the characters usually considered to be of generic or specific value do not appear to be constant enough to allow accurate identification of forms through their use. The specimens are often bilaterally asymmetrical, especially in the pre-acrostichal series. As in *Pollenia*, variation of head parts is so wide that it is difficult to draw conclusions as to the exact meaning of the differences.

### MELANODEXIA WILLISTON

*Melanodexia* Williston, N. Amer. Fauna 7:256, 1893; Manual of North American Diptera, p. 355, 1908; Shannon, Wash. Ent. Soc. Proc. 28(6):136, 1926; Townsend, Manual of Myiology, vol. 2, p. 260, 1935; *ibid.*, vol. 6, p. 226, 1937. Genotype. (*Melanodexia tristis* Williston) = *Nitellia glabricula* Bigot. Monobasic.

*Male and female.* Head width only slightly greater than head height; length at antenna greater than length at vibrissae; epistoma long, slightly narrowed, almost in clypeal plane and gently curved; bucca 0.35 to 0.5 eye height in male, 0.40 to 0.55 eye height in female; frontale in male narrow near ocelli, wider anteriorly, and slightly narrowing again just posterior to lunule, but in female three-fifths frontal width at narrowest, striate in both sexes; front narrow in male, wide in female, with a few scattered hairs outside frontal rows of bristles; frontal bristles long and strong anteriorly where the rows diverge widely and extend to the middle of the second antennal segment; inner vertical bristles present; frontoorbital bristles one reclinate and a row of about five proclinate in female; vertex with long proclinate bristles; clypeus only slightly depressed, a little longer

than broad; facial carina short, broad, rounded, low, the antennal bases obviously separated; parafaciale narrowed and setose above; faciale convex in profile, short, without setae except at vibrissae, which are considerably above the oral margin and hardly stronger than bristles immediately below it; palpus three-fourths as long as haustellum, rather filiform; antennal base at eye middle when head is viewed in profile, third segment one and one-half to two times as long as second, reaching only about two-thirds the distance to the vibrissa; arista with short plumosity above and below; profile of back of head in male flattened or slightly concave above and evenly rounded below, slightly rounded in female.

Thorax with considerable short soft hair; preacrostichal bristles one or two; predorsocentral bristles two; postacrostichal bristles one or two; scutellum with two or three discal bristles, lateral bristles two strong and two weak, apical bristles absent.

Male genital segments large, globose; first segment without marginal row of bristles; second segment smaller than first. Internal morphological features typically calliphorid as illustrated.

This genus was placed in the tribe Moriniini, family Melanophoridae, by Townsend (1935, p. 260). The head shape of *Melanodexia* is certainly like that of *Morinia*, and the characters used by Townsend in his keys will place melanodexiid flies in that family and tribe. But the genital structures of these flies are obviously calliphorid, the head shape is similar to that of *Pollenia* and other related flies, and the characters which are used in this paper place the species as close relatives of *Pollenia*. There is little or no similarity in the genital structures between *Melanodexia* and *Morinia*, nor between *Melanodexia* and any of the sarcophagid flies. Occasional specimens show a few intrapostocular cilia, a character not exhibited by any sarcophagid flies now known to me. The similarity of the internal sexual structure to that of *Pollenia* is especially striking. Due to these facts, I am unable to see close resemblances between *Melanodexia* and other genera which I consider to be closely related to *Melanophora*.

While there are a good many differences between *Nitellia* and *Melanodexia*, Bigot was correct in concluding that his *Nitellia glabricula* was related to *Pollenia*, and Brauer, in referring *glabricula* to *Pollenia*, did not overlook the resemblances. One cannot help but appreciate the similarities in the head shape, especially the character of the carina and general aspect presented by the genital segments of the male and female.

*Melanodexia californica*, new species

Similar to *glabricula*, but with three postacrostichal bristles.

*Male*. Head width 15.0; head height 13.3; length at antenna 8.5 and at vibrissa 7.7; bucca 0.39 eye height; parafaciale 2.5 in width opposite second antennal segment; distance between vibrissae 2.3; front at narrowest 0.10 head width, 0.16 at vertex, and 0.46 at lunule; eye height 9.4; second and third antennal segments in the proportion 1.3:1.9; facial carina high, sharp and well-defined.

Thorax with three postacrostichal bristles.

Legs with middle femur with two or three anterior bristles near middle, about three anteroventral bristles and four or five posteroventral bristles basally in a short row; middle tibia with two or three anterodorsal bristles, one ventral bristle, two or three posterior bristles, and one or two posterodorsal bristles; hind tibia with one or two anteroventral bristles slightly beyond middle.

*Female*. Unknown.

*Type*. Male, No. 54937, U. S. National Museum.

*Type locality*. Placerville, Calif.

Four male specimens, the type (Calif. Dept. Agric., No. P3012), May 19, 1930; one paratype from the same locality, May 19, 1930; one paratype, Shingle Springs, El Dorado Co., Calif., May 16, 1931, H. H. Keifer; and one paratype, Los Angeles, Calif., May 23, 1908, E. D. Ball.

*Melanodexia glabricula* (Bigot)

*Nitellia glabricula* Bigot, Soc. Zool. de France, Bull., p. 594, 1887; Ent. Soc. de France, Bull. 7:clxxxii, 1887. (Type, female from California, in Newmarket, England.)

*Pollenia glabricula* (Bigot) Brauer, Akad. der Wiss. Wien, Math.-Nat. Kl. Sitzber. 1(108):27, 1899.

*Melanodexia tristis* Williston, N. Amer. Fauna 7:257, 1893. (Type, male from Death Valley, Calif., in Kansas University.) New synonymy.

*Melanodexia glabricula* (Bigot) Shannon, Ent. Soc. Wash. Proc. 28(6):139, 1926.

A medium-sized, glabrous, black species with a sharply defined carina and one postacrostichal bristle.

*Female*. Head height 9.5; head width 10.6; length at antenna 6.0 and at vibrissa 5.4; eye height 6.0; bucca shining black, 0.50

of eye height; parafaciale 2.2 in width opposite lunule; distance between vibrissae 1.6; front at vertex 0.30 head width, 0.50 at lunule; vibrissae 2.4 above oral margin; antennal segments orange to brown, second and third segments in proportion 1.5:2.4, the third reaching nearly two-thirds the distance to the vibrissae; palpus black, 3.5 in length; frontal bristles in two rows, the outer row composed of weaker bristles; one proclinate and one reclinate frontoorbital bristle.

Thorax shining black, with little or no silvery or gray pollen; preacrostichal bristle one; postacrostichal bristle one; scutellum with one discal bristle.

Legs with middle tibia with one ventral bristle at apical third, one posterior bristle at apical third, and one to three posterodorsal bristles, one always near middle and usually one at apical third; hind tibia with one or two anteroventral bristles, one always at apical third and one sometimes near middle.

Wing heavily infuscated basally; apical cell closed in wing-margin, rarely short petiolate.

*Male.* With head proportions similar to those of *satanica* Shannon, otherwise as in female except for normal sexual differences; genital segments (pl. 31, D) as illustrated.

*Length.* 7-8 mm.

The National Museum has two female specimens which I consider to be this species. Both are in poor condition; one specimen (Humboldt Co., Calif., June 9, Barber) determined as this species by Aldrich has the abdomen broken off and poorly replaced. The other specimen (Monterey Co., Calif., no other data) is abraded. I have seen the Williston type of *tristis*; there is little doubt that it is the male of *glabricula*. There is also a female specimen of this species in the general collection of Kansas University labelled "Kern County." This specimen is probably a paratype of Williston's *tristis*, for several of his type specimens were from that locality.

Bigot described the species in the genus *Nitellia*, and Brauer (1899, p. 27) later placed it in *Pollenia*. Aldrich saw the Bigot type at Newmarket; I accept his determination of the species.

### *Melanodexia satanica* Shannon

*Melanodexia satanica* Shannon, Ent. Soc. Wash. Proc. 28(6):138, 1926. (Type, male from Fresno County, Calif., no. 28893, U. S. National Museum.)

With the general aspect of *glabricula*, but with two postacrostichal bristles.

*Male.* Head height 10.0; head width 11.0; length at antenna 6.5 and at vibrissa 6.0; bucca 0.33 eye height; parafaciale opposite second antennal segment 1.5 in width; distance between vibrissae 2.2; front at narrowest 0.07 of head width, 0.15 at vertex, and 0.47 at lunule; eye height 7.4; carina high and sharp; third antennal segment 1.5 times as long as second.

Thorax with two postacrostichal bristles.

Legs with middle tibia with two or three anterodorsal bristles, one (rarely two) ventral bristles, three posterior bristles, and one posterodorsal bristle; hind tibia with two anteroventral bristles slightly beyond middle, and anterodorsal and posterodorsal rows of bristles.

Genital segments (pl. 31, E and F) as illustrated.

*Female.* Like male except head height 11.4; head width 10.6; length at antenna 7.2 and at vibrissa 6.4; bucca 0.57 eye height; parafaciale opposite second antennal segment 2.6 in width; distance between vibrissae 2.2; front at narrowest (at vertex), 0.41 of head width and 0.62 at lunule; eye height 6.6; third antennal segment 1.8 times as long as second.

*Length.* 7-9 mm.

I have seen fifteen male and female specimens of *satanica*: the six specimens in the type series, collected at Los Gatos Canyon, Mt. Diablo Ridge, Calif. (June 6-8, 1907, Bradley); three, Sacramento, Calif. (May 24, 1930, Keifer); two, Giant Forest, Calif. (July 28, 1929, Oman and Anderson); one, Eureka, Calif. (July 18, 1935, Beamer); one, Humboldt Co., Calif. (June 19, Barber); and one, Forks, Wash. (July 23, 1933, Wilcox).

The Sacramento specimens differ slightly from the type series. The bucca is obviously wider and the width of the front in both sexes is narrower. I am unable to find other characters to substantiate an opinion that they might represent a different species. The male genitalia appear exactly like those of males in the type series.

### MELANODEXIOPSIS, NEW GENUS

*Male and female.* Species belonging to this genus differ from those of *Melanodexia* in the shape of the facial carina. In *Melanodexia* this is short, sharp, obvious in profile, and extends only to about the middle of the short third antennal segment. In *Melanodexiopsis* the carina is apparent only at the lunule and between the basal antennal segments; it is low and rounded and does not divide the clypeus into two distinct parts. Species of



*Melanodexia* are apparently more glabrous and tend toward shining black, while species of *Melanodexiopsis* have the abdomen rather silvery pollinose and marmorate.

The shape of the carina and details of the male genital segments of *Melanodexiopsis* appear to be similar in many respects to those parts in species belonging to the Oriental genus *Xanthotryxus* Aldrich.

*Genotype.* *Melanodexiopsis tristina*, new species.

***Melanodexiopsis grandis* (Shannon), new combination**

*Melanodexia grandis* Shannon, Wash. Ent. Soc. Proc. 28(6):138, 1926. (Type, male from Monterey County, Calif., No. 28894, U. S. National Museum.)

Similar to *tristina* but middle tibia with ventral bristles and frontal row of bristles doubled.

*Male.* Head (pl. 7, D) height 13.2; head width 14.2; eye height 9.5; bucca 0.39 eye height; length at antenna 8.5 and at vibrissa 8.2; parafaciale 2.8 in width opposite lunule; width between vibrissae 2.4; frontal bristles in two rows; front at narrowest 0.09 of head width, 0.20 at vertex and 0.50 at lunule; carina hardly apparent except between antennal bases; vibrissae high above oral margin; third antennal segment about 1.5 times as long as second; palpus 3.6; haustellum 0.5 head height.

Thorax with two postacrostichal bristles.

Legs with middle femur with three or four anterior bristles on middle third; middle tibia with two or three anterodorsal bristles apically, one ventral bristle at apical third, two posterior bristles, and one or two posterodorsal bristles.

Genital segments (pl. 31, I and J) as illustrated.

*Female.* Head height 12.5; head width 14.7; eye height 8.0; bucca 0.42 eye height; length at antenna 7.8 and at vibrissa 7.0; distance between vibrissae and width of parafaciale opposite lunule approximately equal (2.8:2.8). Otherwise as in male except for normal sexual differences.

*Length.* 8-9 mm.

One male (type), two males (paratypes) and one female (allotype), from the type locality; one male, Pacific Grove, Calif. (May 4, 1906, Aldrich), and one male, Monterey, Calif. (July 22, 1935, J. Russell).

***Melanodexiopsis idahoensis*, new species**

Similar to *tristina* but epistoma short and wide, the vibrissae only slightly above the oral margin.

*Female.* Head with epistoma short, nearly as wide as clypeus,

and not widening much below the vibrissae, which are only slightly above the oral margin.

Middle femur with three strong anterior bristles near middle and a basal posteroventral row of bristles; middle tibia with three anterodorsal bristles, two ventral bristles, three posterior bristles, and three posterodorsal bristles; hind tibia with two anteroventral bristles.

*Male.* Unknown.

*Length.* 8.5 mm.

*Type.* Female, No. 54938, U. S. National Museum.

*Type locality.* Genesee, Idaho.

Two female specimens were collected at an altitude of 2,000 ft., May 23, 1936, by R. E. Miller.

### *Melanodexiopsis nox*, new species

A species with the general aspect of *tristina* but which has the middle tibia provided with a ventral bristle.

*Male.* Head height 10.8; width 10.7; eye height 7.8; length at antenna 7.2 and at vibrissa 6.5; parafaciale 2.0 in width opposite lunule; distance between vibrissae 2.5; front at narrowest 0.09 of head width, 0.17 at vertex and 0.51 at lunule; bucca 0.33 eye height; frontal bristles in a single row; antenna short, only extending three-fourths the distance to the vibrissae, second antennal segment one-half as long as third; facial carina low and not very apparent; epistoma elongate and slightly narrowed at vibrissae which are much above the oral margin.

Thorax with two postacrostichal bristles.

Wing with apical cell either closed in margin or but slightly open.

Legs with middle femur with three anterior bristles near middle; middle tibia with three anterodorsal bristles, one ventral bristle near apical third, three posterior bristles, and one or two posterodorsal bristles; hind tibia with three or four posterodorsal bristles.

*Female.* Unknown.

*Length.* 8-9 mm.

*Type.* Male, No. 54941, U. S. National Museum.

*Type locality.* Hood River, Ore.

Four male specimens: The type, and one paratype collected July 14, 1917, Claremont, Calif. (Baker), one labeled Oregon (without other data), and one, Seattle, Wash., from my collection.

*Melanodexiopsis pacifica*, new species

A species with the general aspect of *tristina*, but which has the middle tibia with ventral bristles and only one postacrostichal bristle.

*Male*. Head with epistoma long, slightly narrower than clypeus, and then widening below vibrissae which are high above the oral margin.

Thorax with one postacrostichal bristle.

Legs with middle tibia with two strong and one weak ventral bristles, two strong anterodorsal bristles, and three strong posterior bristles; hind tibia with two anteroventral bristles.

*Female*. Unknown.

*Type*. Male, No. 54940, U. S. National Museum.

*Length*. 9 mm.

*Type locality*. Pacific Grove, Calif.

One female (June 8, 1917, T. E. Snyder).

*Melanodexiopsis tristina*, new species

*Melanodexia tristis* Shannon (nec Williston), Wash. Ent. Soc. Proc. 28(6):137, 1926.

This species was considered to be the same as *Melanodexia tristis* Williston by Shannon, but Williston's type, a male at Kansas University, is *glabricula* Bigot according to Aldrich.

A glabrous black species with hyaline wings and with the middle and hind tibia without ventral bristles.

*Male*. Head width and height 11.5, length at antenna 7.3 and at vibrissa 6.8; eye height 8.5; bucca 0.39 eye height, shining black or with thin silvery pollen, and with scattered black hairs, none of the hairs pale; frontale very narrow near ocelli, rapidly widening anteriorly to slightly above lunule where it becomes narrower again, anteriorly reddish orange, posteriorly black; front at narrowest 0.7 of head width, 0.17 at vertex and 0.5 at lunule, with thin silvery pollen, and with scattered black hair which becomes most abundant anteriorly and extends to facial groove below; frontal row consisting of nearly 14 bristles, the rows extending to base of third antennal segment anteriorly, the bristles long and strong toward lunule, weaker posteriorly, and weak or hairlike just anterior to foremost ocellus; vertex subpollinose, black; ocellar triangle with long, black, erect or proclinate hair; parafaciale narrowed above, about 2.4 in width opposite lunule, black, with silvery pollen; vibrissae strong, above oral margin by 1.2 and separated by 2.0; palpus 3.0 in length,

brownish black; antennal segments orange brown; third segment one and one-half times as long as second, reaching about two-thirds the distance to the vibrissa; arista with short plumosity above and below nearly to apex; back of head with three or four rows of postocular cilia and with rather abundant brownish to black hair.

Thorax black with thin whitish pollen and without longitudinal stripes; pleura mostly black but sometimes with thin whitish pollen; anterior acrostichal bristles two, the posterior one 1.0 before suture; hindmost predorsocentral bristle 0.6 before suture; sclerites at wing base black, greater ampulla with fine decumbent whitish pile; postacrostichal bristles two; spiracles with black hair; scutellum with two discal bristles, one apically and one laterally; lateral bristles four, the subbasal, the basal, and the subapical ones strong, lateral margins with brownish black hair.

Legs black; middle femur with about three anterior bristles near middle, four or five anteroventral bristles in row toward base, and about four ventral bristles toward base; middle tibia with one or two anterodorsal bristles near middle, two posterior bristles near middle, and one posterodorsal bristle near middle; the middle tibia has no ventral bristles and the hind tibia no posteroventral bristles.

Wing tinged with orange brown, strongly so basally; costal spine minute but present; costal sections 2 to 6 in the proportion 15:40:110:44:4; subcostal sclerite black; fourth vein without apical section or fold and bent at a 45-degree angle toward apex; apical cell open and ending considerably before wing tip; apical cross vein sinuate only toward wing margin; anterior cross vein oblique, doubly arcuate; last section of fifth vein 0.15 as long as preceding section; squamal lobes tinged with yellow orange to brown.

Abdomen black, with thin silvery pollen, the pattern even and the ground color shining in certain lights; third segment with some erect setae; third and fourth segments each with a row of marginal bristles. Genital segments (pl. 31, H and G) as illustrated.

*Female.* Unknown.

*Length.* 8-9 mm.

*Type.* Male, No. 54939, U. S. National Museum.

*Type locality.* San Bernardino Co., Calif.

The type series was collected as follows: San Bernardino, Calif. (May, Coquillett); Claremont, Calif. (Metz); San Diego,

Calif. (Apr. 20, 1921); San Bernardino, Calif. (June 8, 1930, Hall); San Antonio Canyon, Ontario, Calif. (July 25, 1907).

*Biology, habits, and immature stages.* Nothing is known of the habits, biology, or immature stages of this species.

The two specimens which I collected were in much the same ecological habitat as that in which one would expect to find *Pollenia rudis*.

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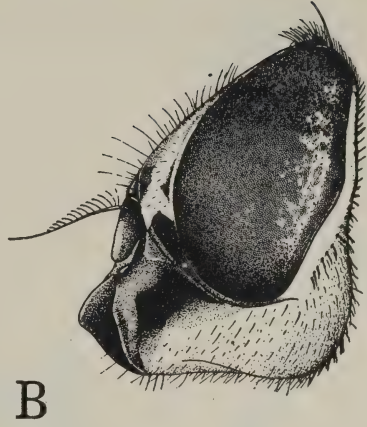
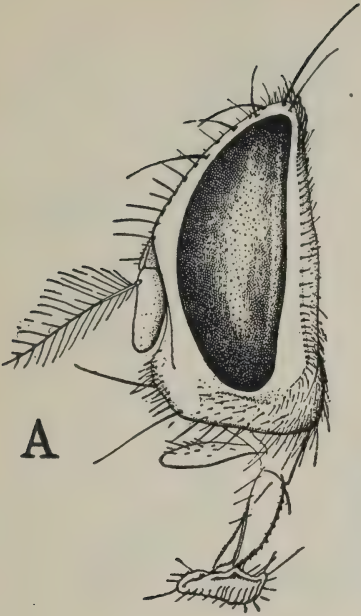
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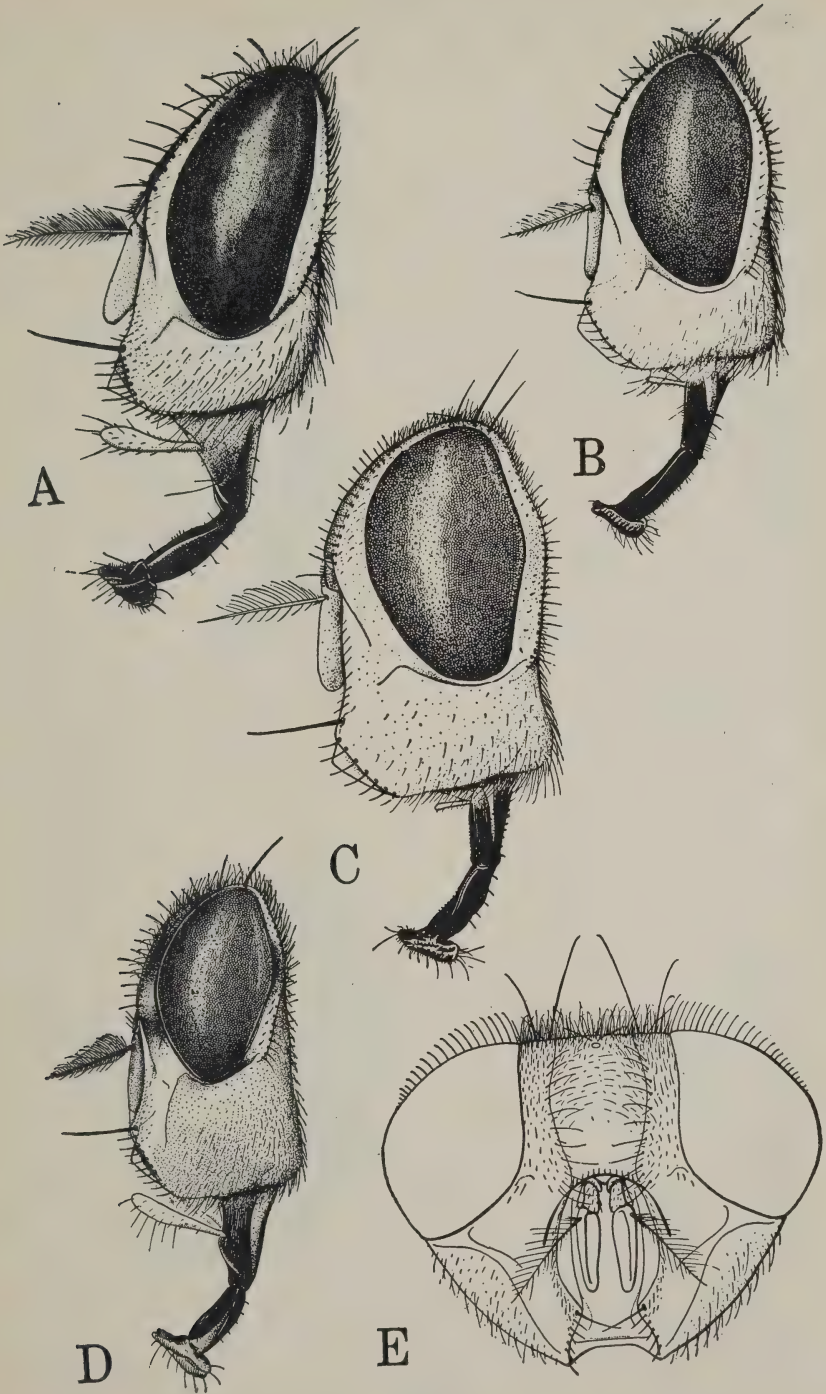
## PLATE 1

- Huascaromusca bicolor* (Fabricius)  
A. Head of female.  
*Stomorphina lunata* (Fabricius)  
B. Head of male.  
*Hemilucilia segmentaria* (Fabricius)  
C. Head of female.  
*Myiolucilia lyrcea* (Walker)  
D. Head of female.



## PLATE 2

- Chloroprocta fuscianipennis* (Macquart)  
A. Head of female.
- Callitroga macellaria* (Fabricius)  
B. Head of female.
- Callitroga americana* (Cushing and Patton)  
C. Head of female.
- Paralucilia wheeleri* (Hough)  
Head of female
- D. Lateral view.
- E. Front view.



## PLATE 3

*Phormia regina* (Meigen)

Head of male

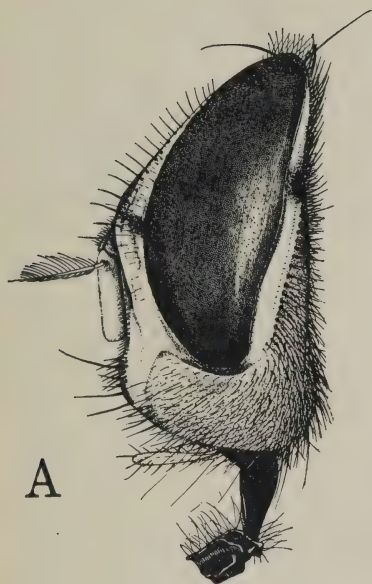
- A. Left lateral view.
- B. Dorsal view.

*Boreëllus atriceps* (Zetterstedt)

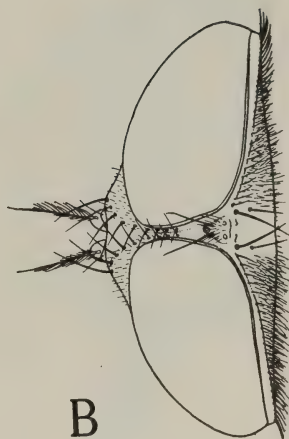
Head of male

- C. Left lateral view.
- D. Dorsal view.

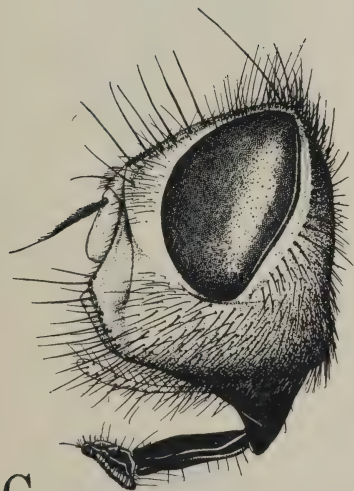
PLATE 3



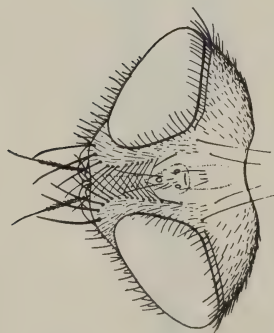
A



B



C



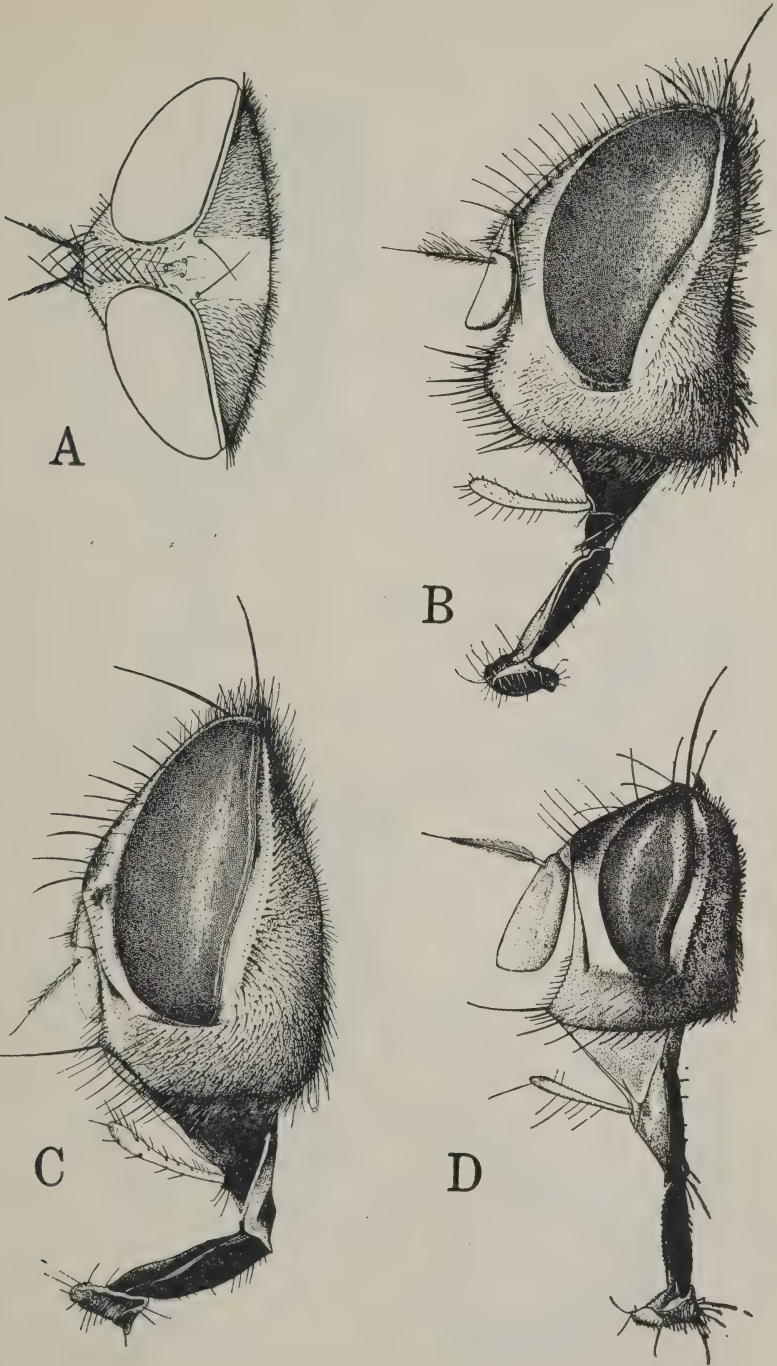
D

## PLATE 4

*Protophormia terrae-novae* (Robineau-Desvoidy)  
Head of male

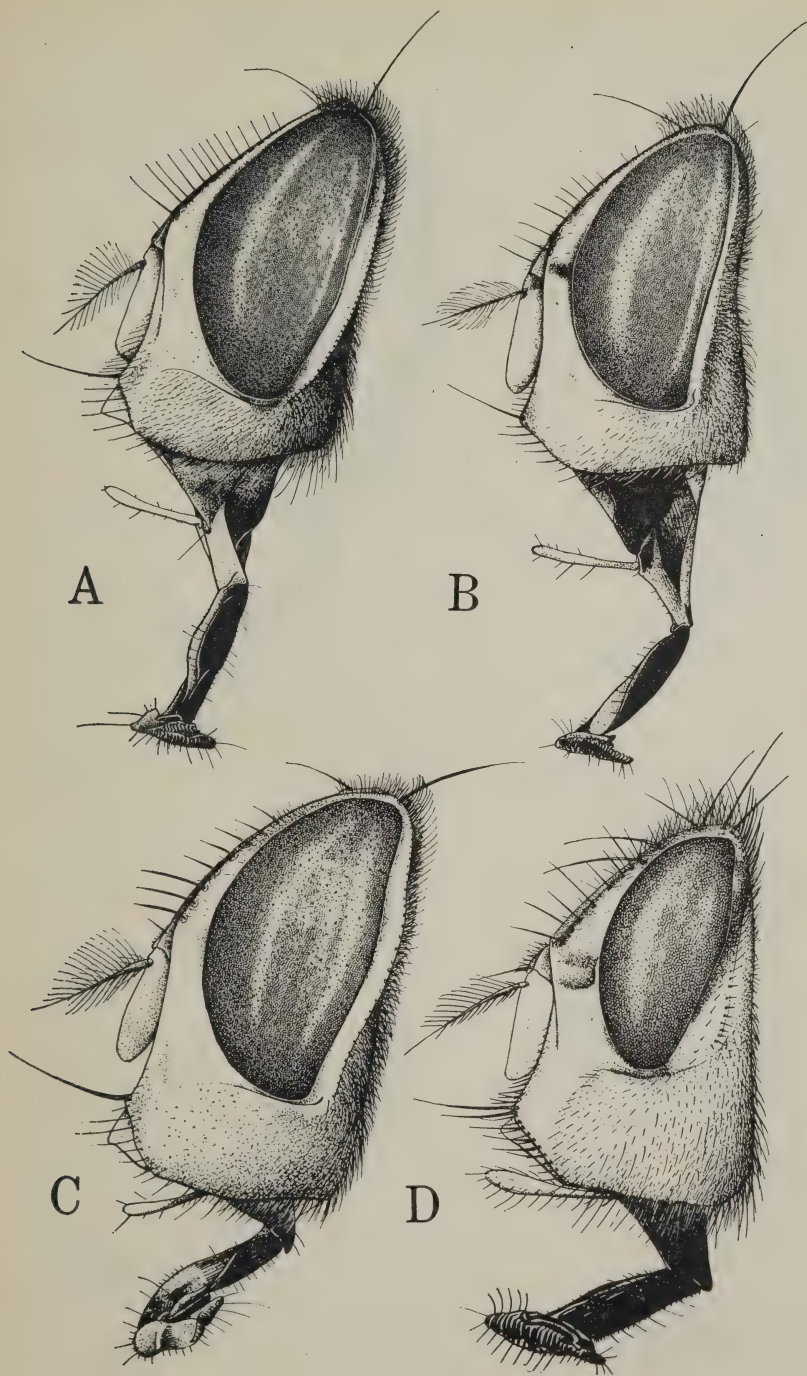
- A. Dorsal view.
- B. Left lateral view.
- C. Head of male.  
*Apaulina metallica* (Townsend)
- D. Head of female.  
*Francilia alaskensis* Shannon





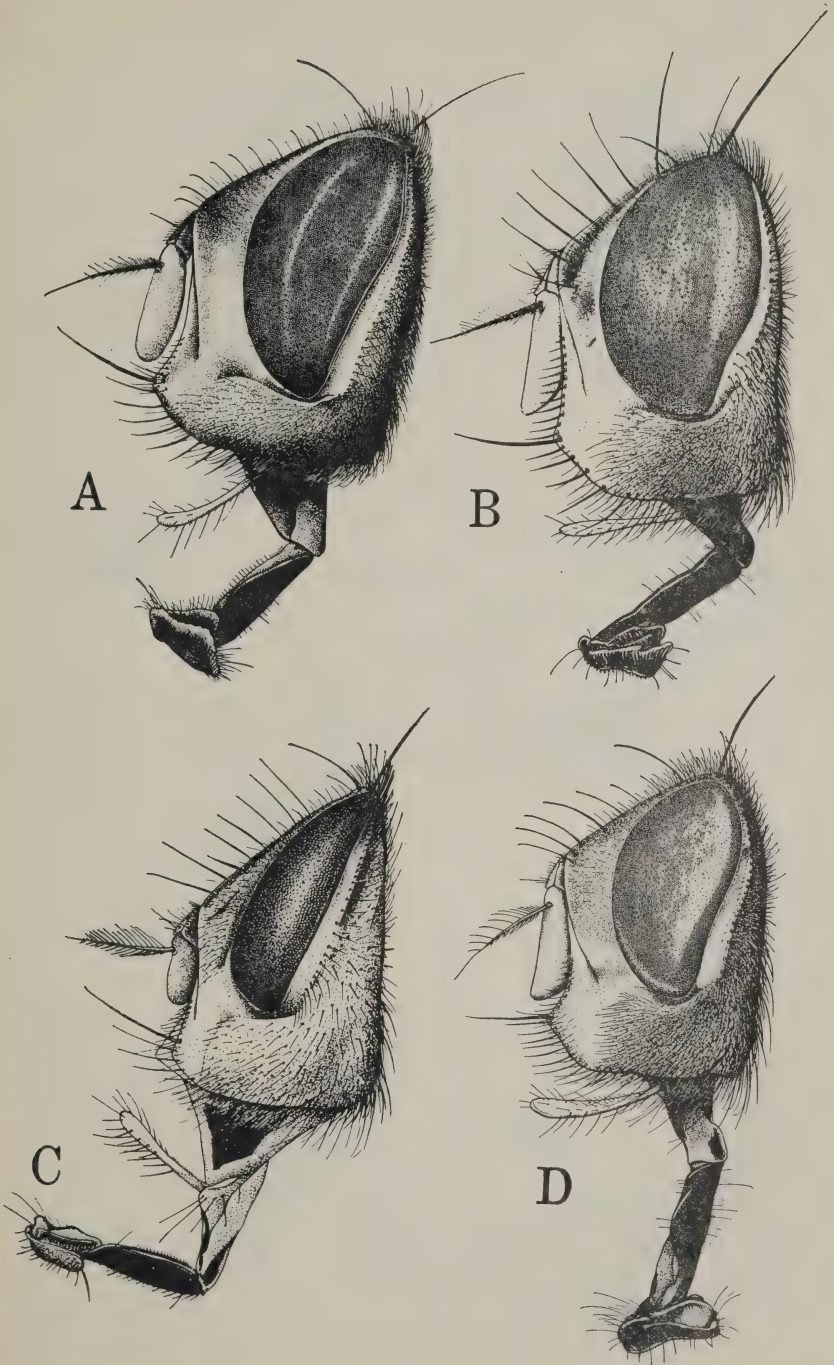
## PLATE 5

- BufoLucilia silvarum* (Meigen)  
A. Head of male.  
*Lucilia illustris* (Meigen)  
B. Head of male.  
*Phaenicia sericata* (Meigen)  
C. Head of male.  
*Calliphora vomitoria* (Linnaeus)  
D. Head of female.



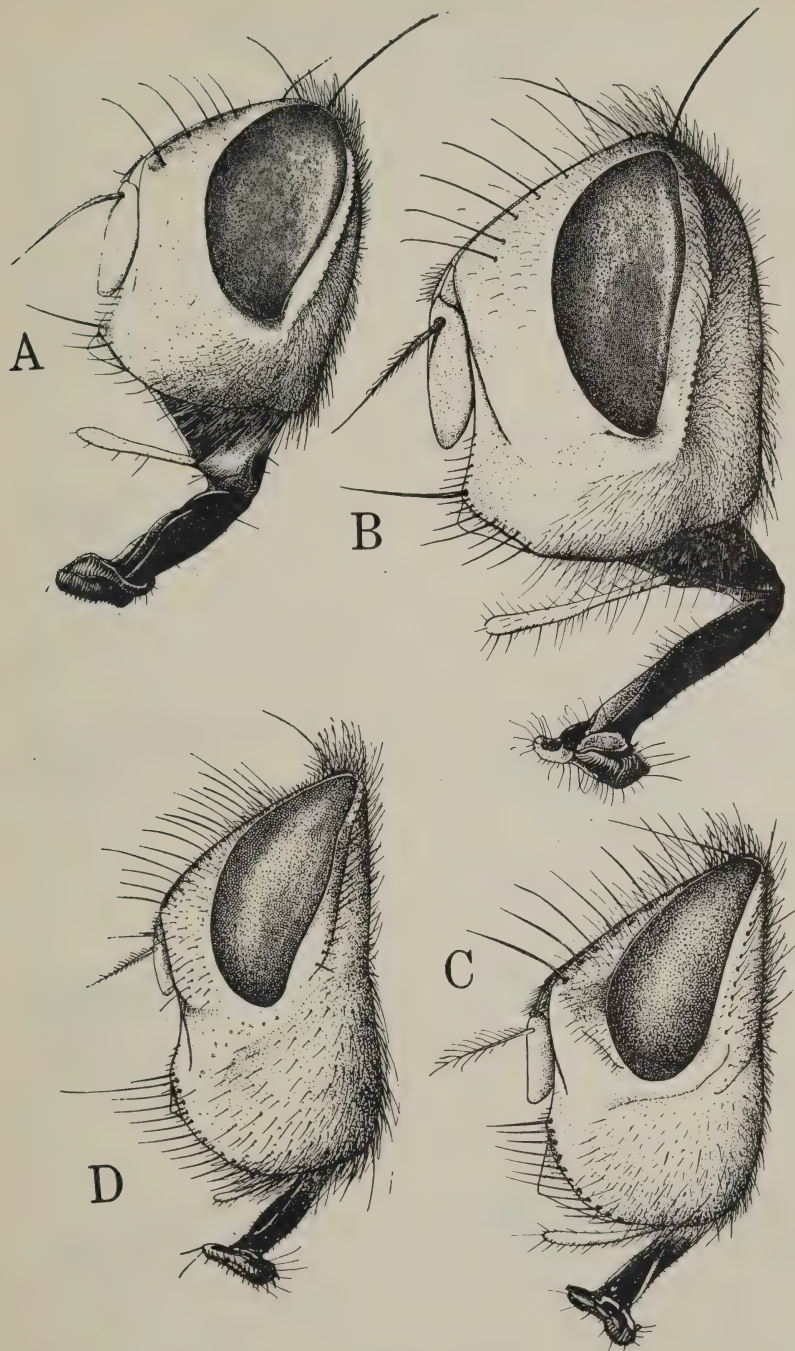
## PLATE 6

- Acronesia aldrichia* (Shannon)  
A. Head of male.  
*Eucalliphora lilaca* (Walker)  
B. Head of male.  
*Oncsia bisetosa* Hall  
C. Head of male.  
*Cynomyopsis cadaverina* (Robineau-Desvoidy)  
D. Head of male.



## PLATE 7

- Cyanus elongata* (Hough)  
A. Head of male.
- Cynomya mortuorum* (Linnaeus)  
B. Head of male.
- Pollenia rudis* (Fabricius)  
C. Head of male.
- Melanodexiopsis grandis* (Shannon)  
D. Head of male.



## PLATE 8

- Promesembrinella semiflava* (Aldrich)  
A. Wing of female.
- Huascaromusca bicolor* (Fabricius)  
B. Wing of female.
- Huascaromusca facialis* (Aldrich)  
C. Wing of female.
- Huascaromusca flavicrura* (Aldrich)  
D. Wing of female.
- Huascaromusca formosa* (Aldrich)  
E. Wing of female.
- Huascaromusca spicata* (Aldrich)  
F. Wing of female.
- Huascaromusca tibialis* (Aldrich)  
G. Wing of female.
- Huascaromusca umbrosa* (Aldrich)  
H. Wing of female.
- Huascaromusca uniseta* (Aldrich)  
I. Wing of female.
- Huascaromusca xanthorhina* (Bigot)  
J. Wing of female.
- Hemilucilia flavifacies* (Engel)  
K. Wing of female.

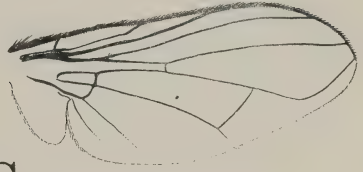




A



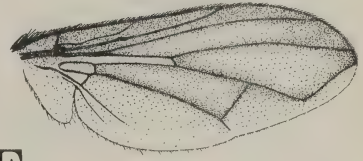
B



C



D



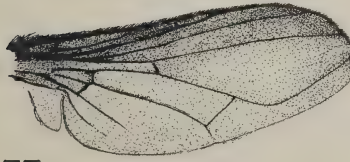
E



F



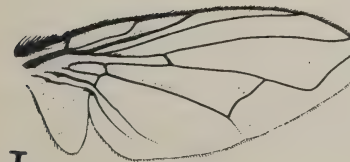
G



H



I



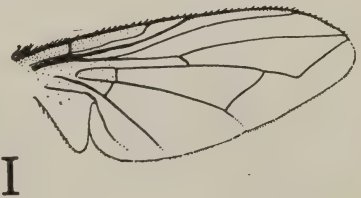
J



K

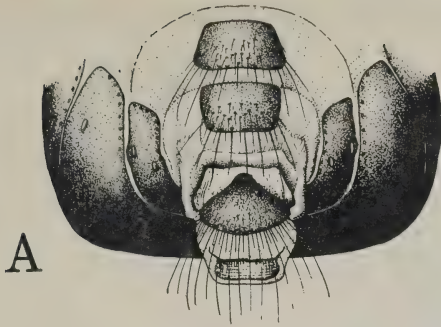
## PLATE 9

- Hemilucilia segmentaria* (Fabricius)  
A. Wing of female.
- Myiolucilia lyroca* (Walker)  
B. Wing of female.
- Chloroprocta fuscianipennis* (Macquart)  
C. Wing of female.
- Paralucilia wheeleri* (Hough)  
D. Wing of female.
- Phormia regina* (Meigen)  
E. Wing of male.
- Boreëllus atriceps* (Zetterstedt)  
F. Wing of male.
- Protophormia terrae-novae* (Robineau-Desvoidy)  
G. Wing of male.
- Apaulina metallica* (Townsend)  
H. Wing of male.
- Francilia alaskensis* Shannon  
I. Wing of male.
- Bufolucilia silvarum* (Meigen)  
J. Wing of male.
- Phaenicia sericata* (Meigen)  
K. Wing of male.

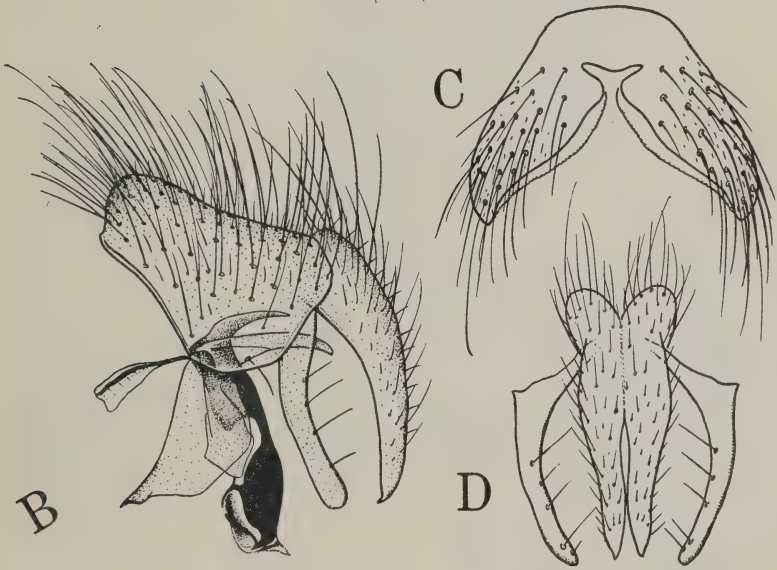


## PLATE 10

- Huascaromusca bicolor* (Fabricius)  
A. External portion of female genital segments.  
*Promesembrinella semiflava* (Aldrich)  
Genital segments of male  
B. Left lateral view of composite.  
C. Fifth sternite.  
D. Forceps, rear view.  
*Huascaromusca abaca* Hall  
Genital segments of male  
E. Left lateral view of composite.  
F. Forceps, rear view.



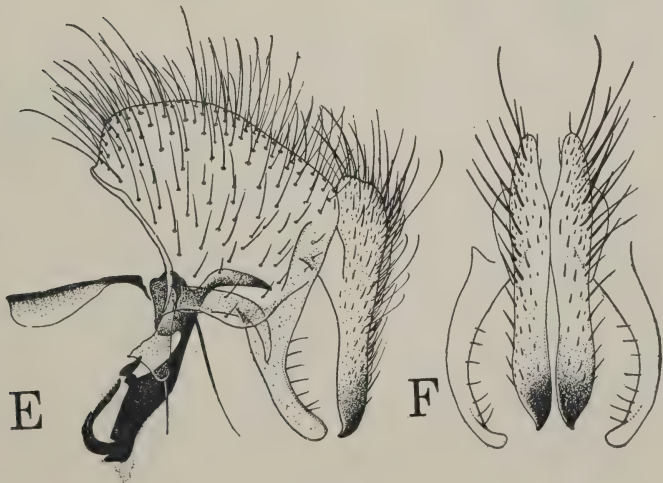
A



B

C

D



E

F

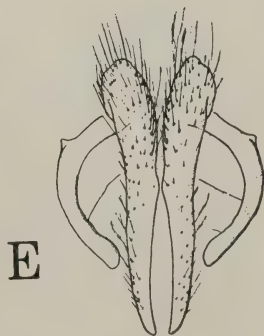
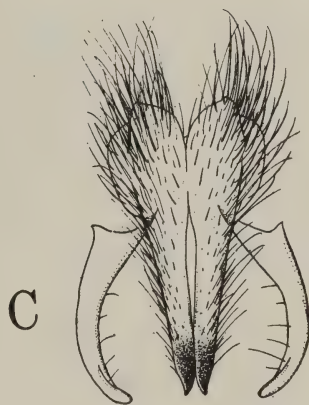
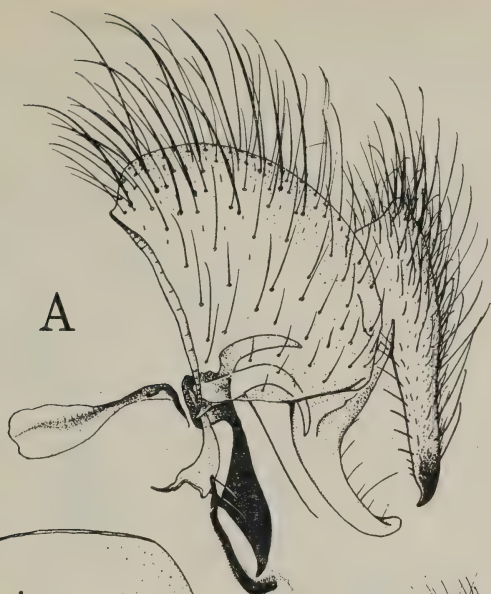
## PLATE 11

*Huascaromusca bicolor* (Fabricius)  
Genital segments of male

- A. Left lateral view of composite.
- B. Fifth sternite.
- C. Forceps, rear view.

*Huascaromusca facialis* (Aldrich)  
Genital segments of male

- D. Left lateral view of composite.
- E. Forceps, rear view.



## PLATE 12

*Huascaromusca flavicrura* (Aldrich)

Genital segments of male

- A. Left lateral view of composite.
- B. Forceps, rear view.

*Huascaromusca spicata* (Aldrich)

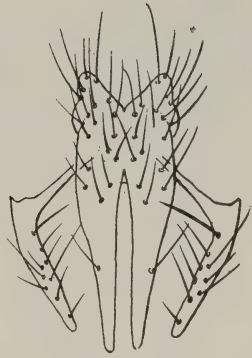
Genital segments of male

- C. Abdomen, left lateral view.
- D. Sternites.
- E. Left lateral view of composite.
- F. Forceps, rear view.

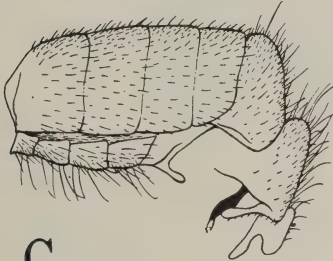




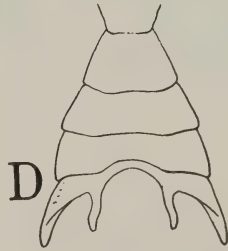
A



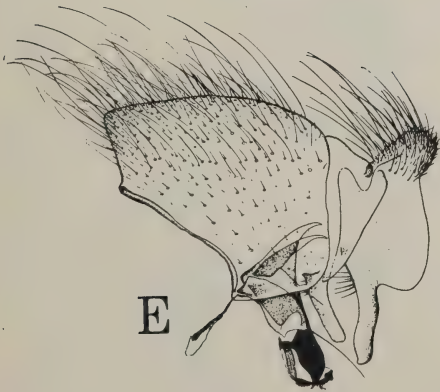
B



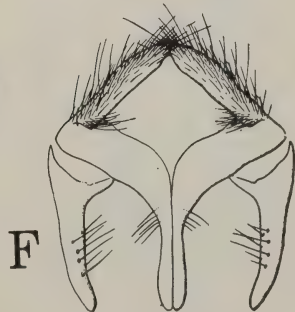
C



D



E



F

## PLATE 13

*Huascaromusca tibialis* (Aldrich)

Genital segments of male

- A. Left lateral view of composite.
- B. Forceps, rear view.

*Huascaromusca umbrosa* (Aldrich)

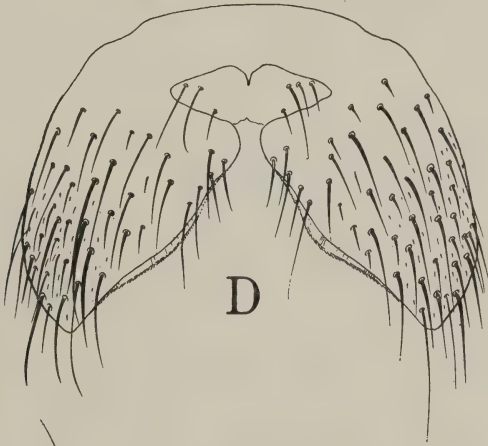
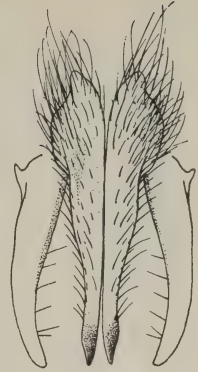
Genital segments of male

- C. Left lateral view of composite.
- D. Fifth sternite.
- E. Forceps, rear view.

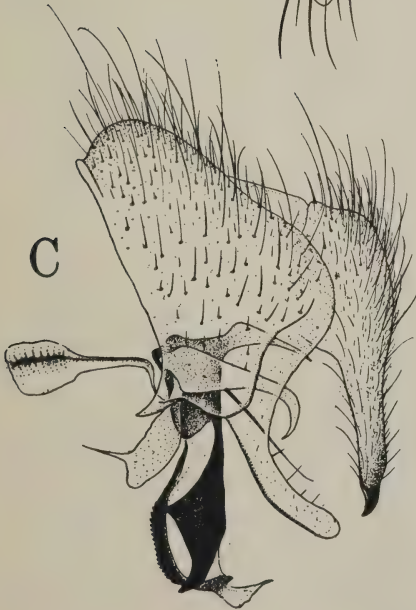


A

B

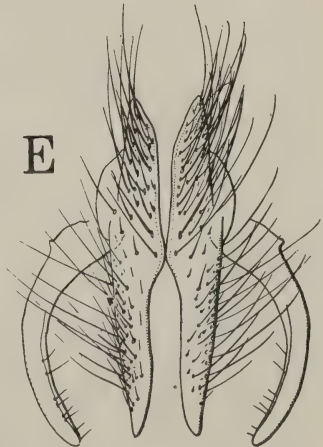


D



C

E



## PLATE 14

*Huascaromusca uniseta* (Aldrich)

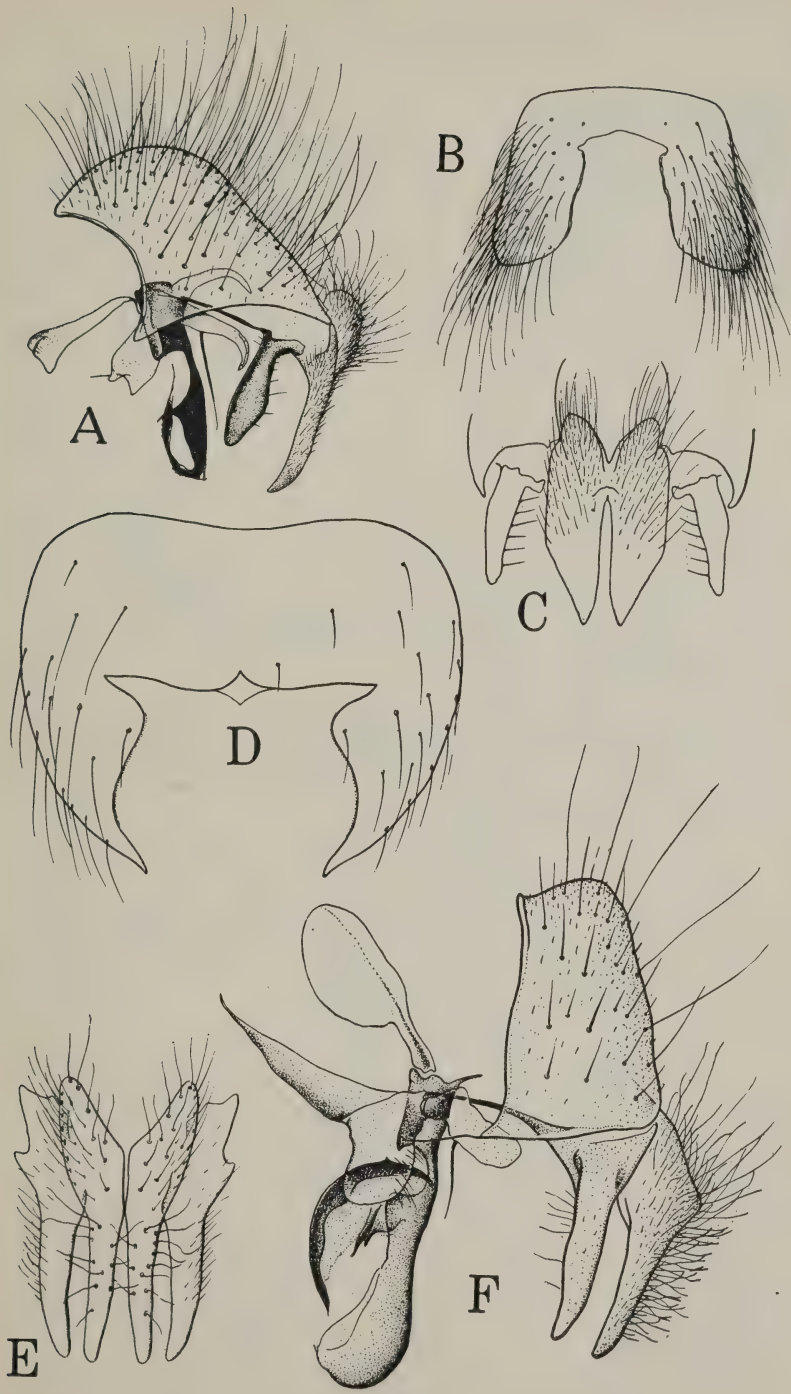
Genital segments of male

- A. Left lateral view of composite.
- B. Fifth sternite.
- C. Forceps, rear view.

*Stomorphina lunata* (Fabricius)

Genital segments of male

- D. Fifth sternite.
- E. Forceps, rear view.
- F. Left lateral view of composite.



## PLATE 15

*Hemilucilia flavifacies* (Engel)

Genital segments of male

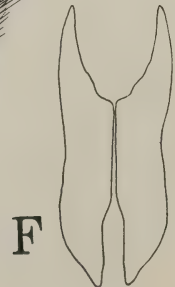
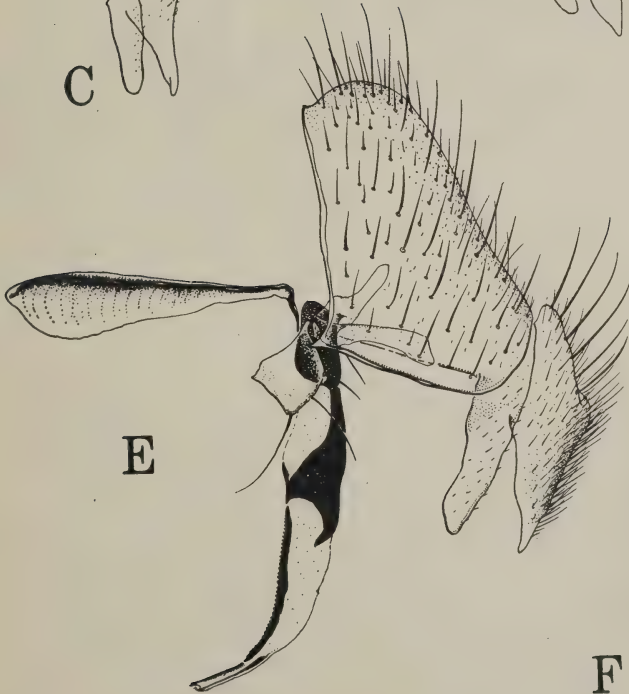
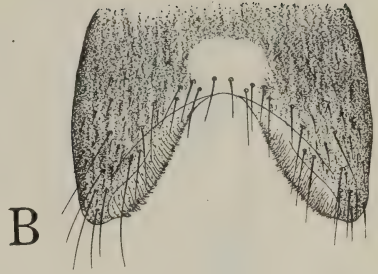
- A. Left lateral view of aedeagus and composite.
- B. Fifth sternite.
- C. Forceps, left lateral view.
- D. Forceps, rear view.

*Hemilucilia segmentaria* (Fabricius)

Genital segments of male

- E. Left lateral view of composite.
- F. Forceps, rear view.

PLATE 15



## PLATE 16

*Myiolucilia fulvinota* (Walker)

Genital segments of male

A. Left lateral view of composite.

*Myiolucilia lyrcea* (Walker)

Genital segments of male

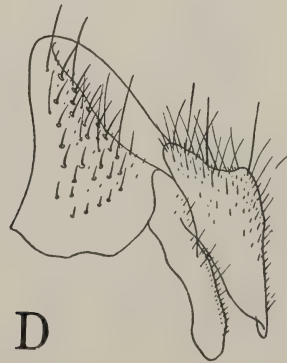
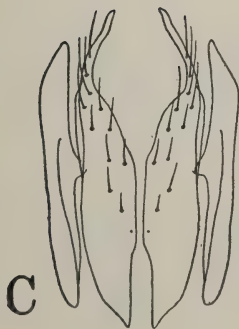
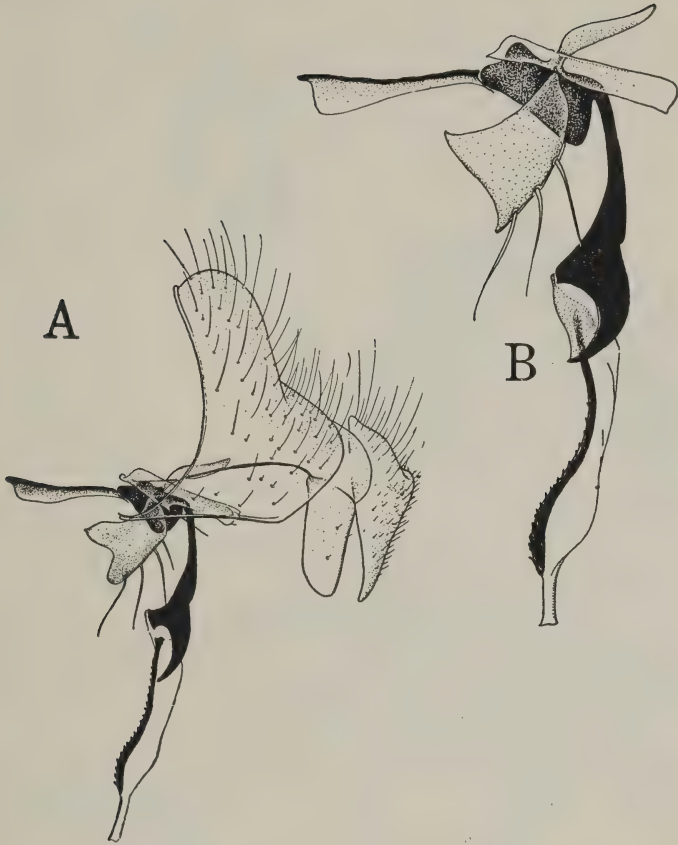
B. Aedeagus with accessory sclerites, left lateral view.

C. Forceps, rear view.

D. Left lateral view of forceps and second genital segment.



PLATE 16



## PLATE 17

*Chloroprocta fuscianipennis* (Macquart)

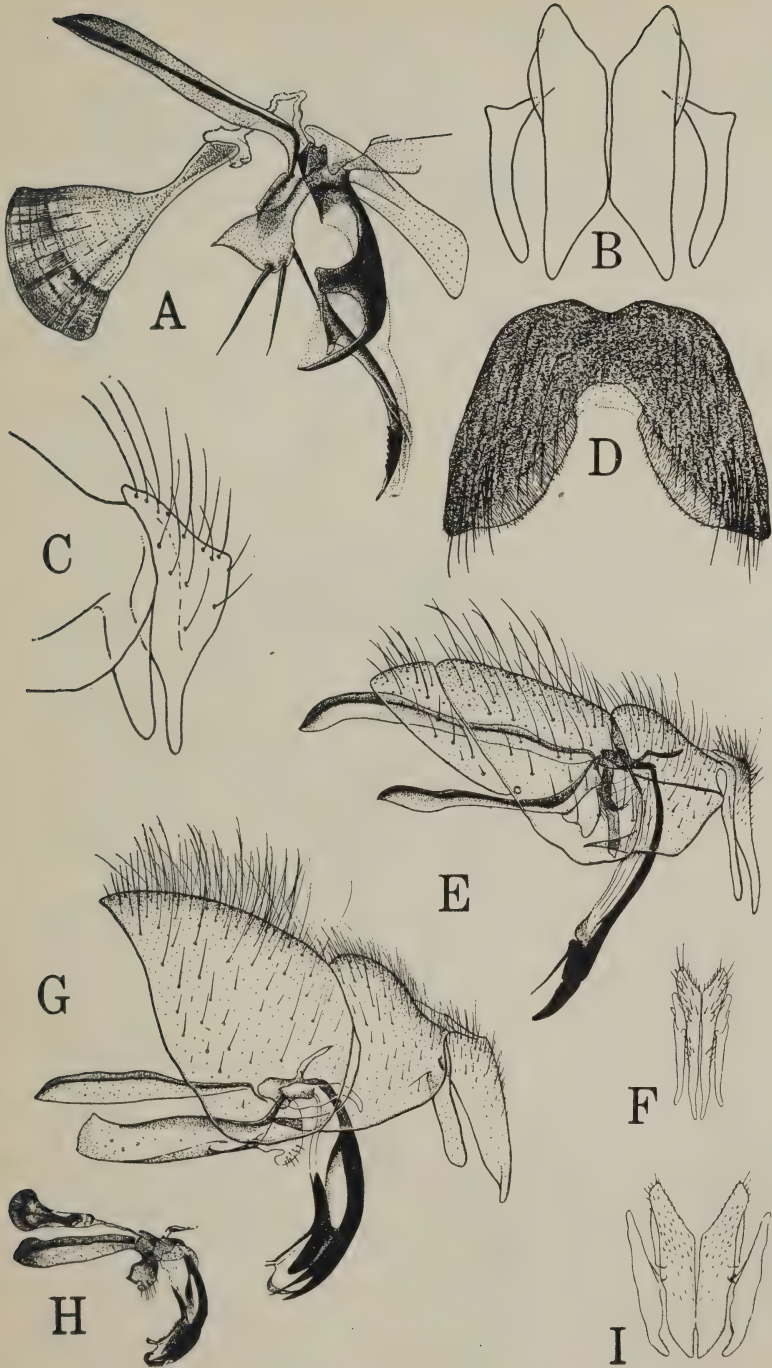
Genital segments of male

- A. Aedeagus with accessory sclerites, left lateral view.
- B. Forceps, rear view.
- C. Forceps and second genital segment, left lateral view.
- D. Fifth sternite.

*Callitroga aldrichi* (Del Ponte)

Genital segments of male

- E. Left lateral view of composite.
  - F. Forceps, rear view.
- Callitroga americana* (Cushing and Patton)
- Genital segments of male
- G. Left lateral view of composite.
  - H. Aedeagus and accessory sclerites, left lateral view.
  - I. Forceps, rear view.



## PLATE 18

*Callitroga macellaria* (Fabricius)

Genital segments of male

A. Left lateral view of composite.

B. Forceps, rear view.

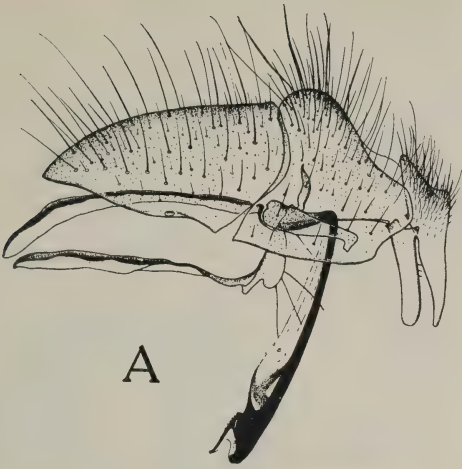
*Callitroga minima* (Shannon)

Genital segments of male

C. Left lateral view of composite.

D. Forceps, rear view.

E. Fifth sternite.



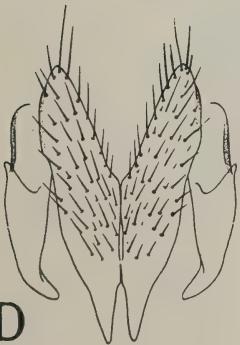
A



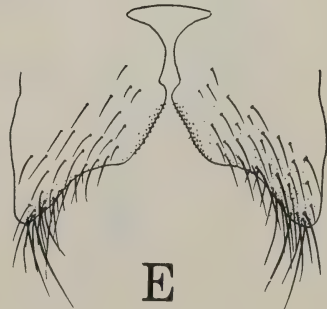
B



C



D



E

## PLATE 19

*Paralucilia wheeleri* (Hough)

Genital segments of male

- A. Forceps, rear view.
- B. Aedeagus and accessory sclerites, left lateral view.
- C. Fifth sternite.
- D. Forceps and second genital segment, left lateral view.

*Paralucilia fulvipes* (Macquart)

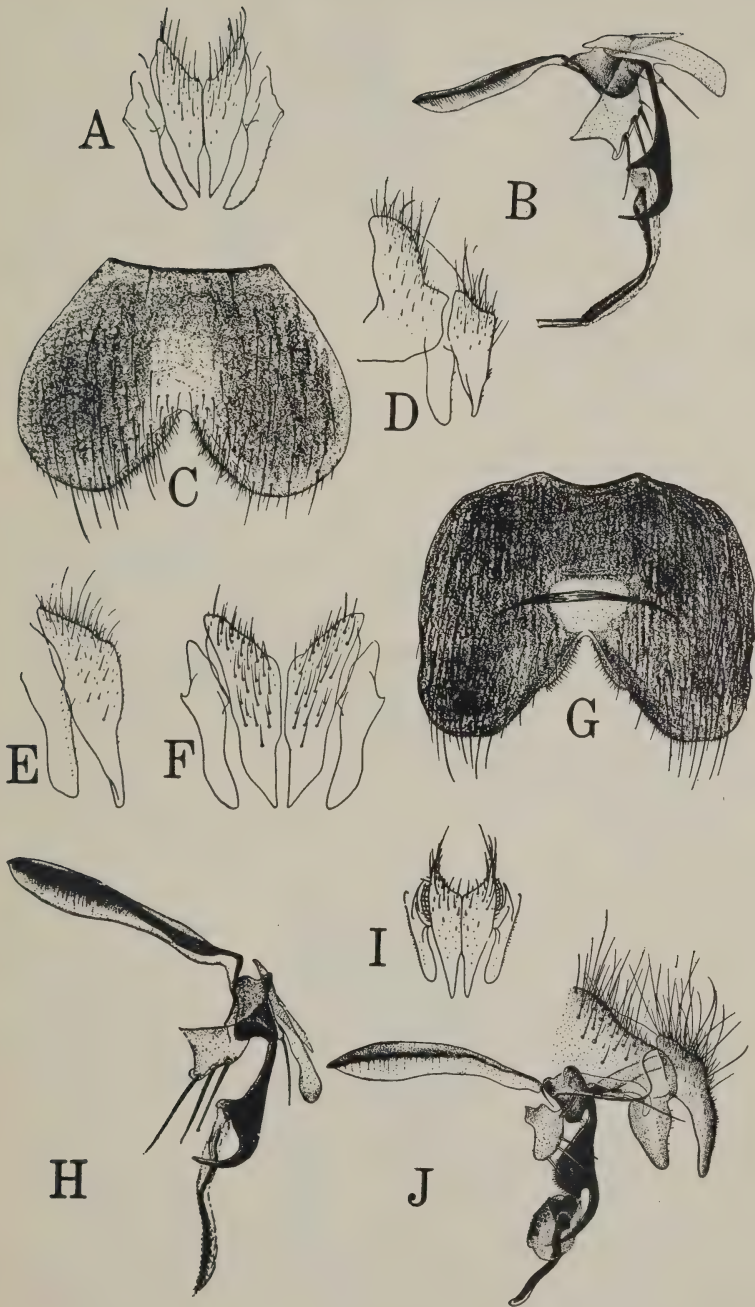
Genital segments of male

- E. Forceps and second genital segment, left lateral view.
- F. Forceps, rear view.
- G. Fifth sternite.
- H. Aedeagus and accessory sclerites.

*Phormia regina* (Meigen)

Genital segments of male

- I. Forceps, rear view.
- J. Left lateral view of composite.



## PLATE 20

*Boreëllus atriceps* (Zetterstedt)

Genital segments of male

- A. Left lateral view of composite.
- B. Aedeagus, rear view.
- C. Forceps and second genital segment, rear view.
- D. Fifth sternite.

*Protophormia terrae-novae* (Robineau-Desvoidy)

Genital segments of male

- E. Left lateral view of composite.
- F. Forceps, rear view.

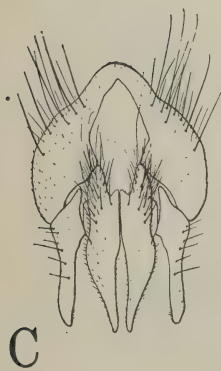




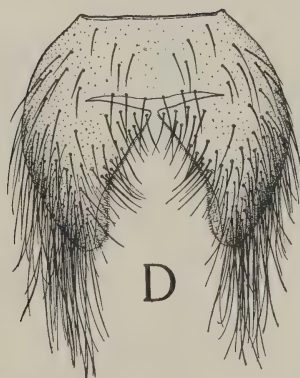
A



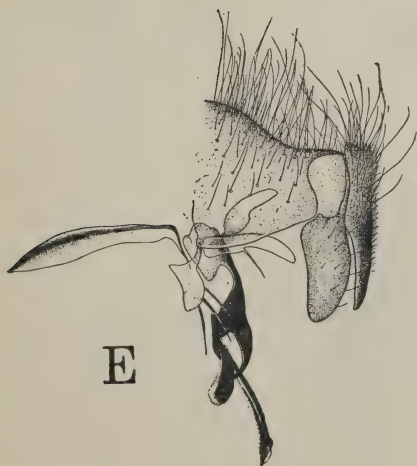
B



C



D



E



F

## PLATE 21

*Apaulina avium* (Shannon and Dobrosky)  
Genital segments of male

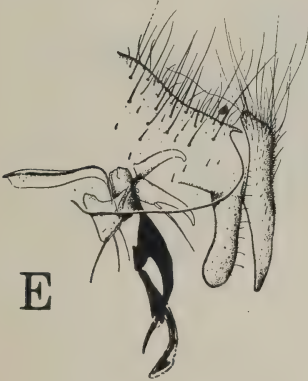
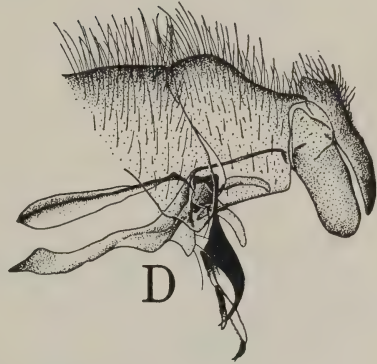
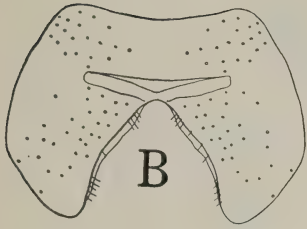
- A. Left lateral view of composite.
- B. Fifth sternite.
- C. Forceps, rear view.

*Apaulina basingeri* Hall

- D. Genital segments of male. Left lateral view of composite.

*Apaulina hesperia* (Shannon and Dobrosky)  
Genital segments of male

- E. Left lateral view of composite.
  - F. Forceps, rear view.
- Apaulina hesperia* (Shannon and Dobrosky)
- G. Genital segments of male. Left lateral view of composite.



## PLATE 22

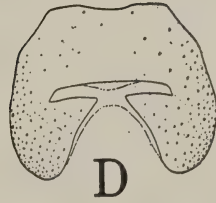
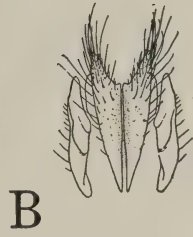
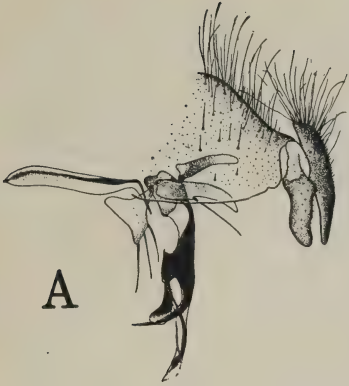
*Apaulina hirundo* (Shannon and Dobrosek)  
Genital segments of male

- A. Left lateral view of composite.
- B. Forceps, rear view.

*Apaulina metallica* (Townsend)  
Genital segments of male

- C. Left lateral view of composite.
- D. Fifth sternite.
- E. Forceps, rear view.

*Apaulina sialia* (Shannon and Dobrosek)  
F. Genital segments of male. Forceps, left lateral view.



## PLATE 23

*Francilia alaskensis* Shannon

Genital segments of male

A. Left lateral view of composite.

B. Posterior portion of abdomen.

C. Forceps, rear view.

*BufoLucilia elongata* (Shannon)

D. Genital segments of male. Forceps, lateral view.

*BufoLucilia silvarum* (Meigen)

Genital segments of male

E. Left lateral view of composite.

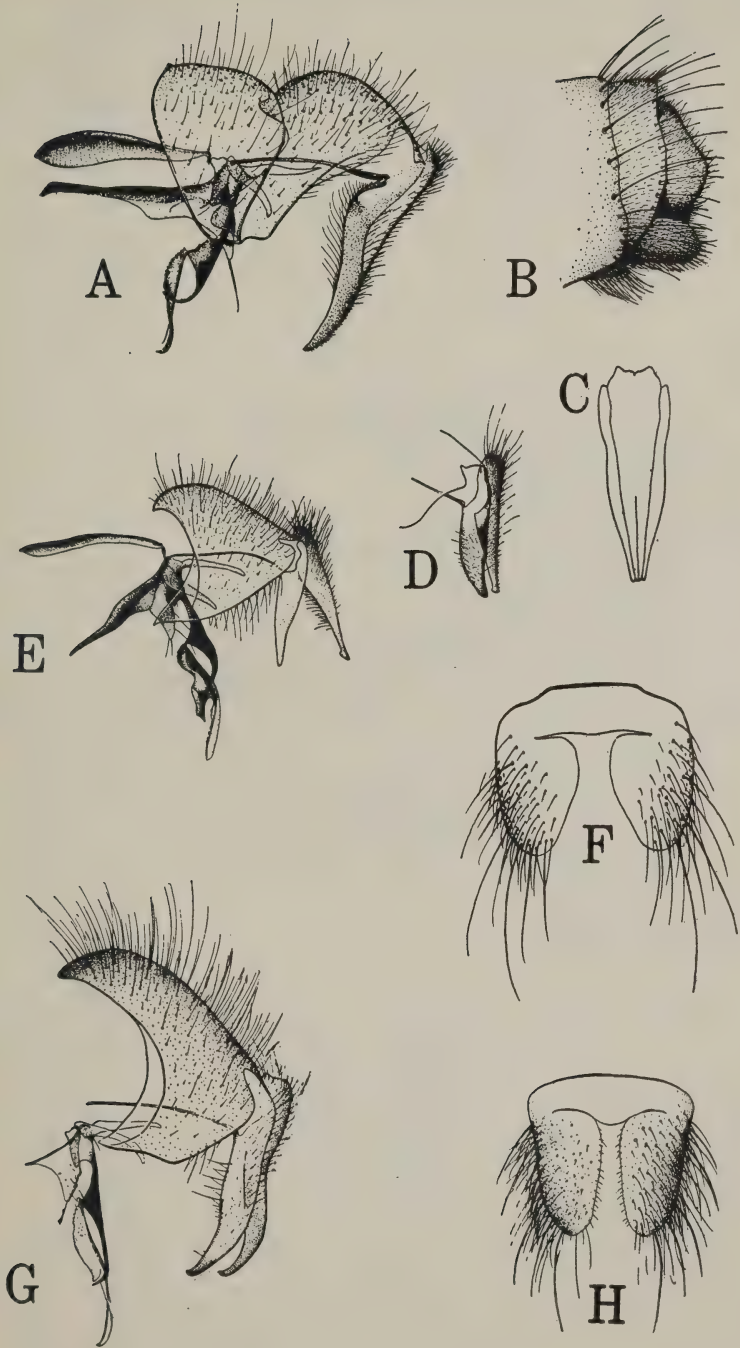
F. Fifth sternite.

*Lucilia illustris* (Meigen)

Genital segments of male

G. Left lateral view of composite.

H. Fifth sternite.



## PLATE 24

*Phaenicia caeruleiviridis* (Macquart)

Genital segments of male

- A. Aedeagus and accessory sclerites, left lateral view.
- B. Forceps, lateral view.
- C. Forceps, rear view.

*Phaenicia cluvia* (Walker)

Genital segments of male

- D. Aedeagus, left lateral view.
- E. Forceps, rear view.

*Phaenicia eximia* (Wiedemann)

Genital segments of male

- F. Aedeagus and accessory sclerites, left lateral view.
- G. Forceps, lateral view.
- H. Forceps, rear view.

*Phaenicia mexicana* (Macquart)

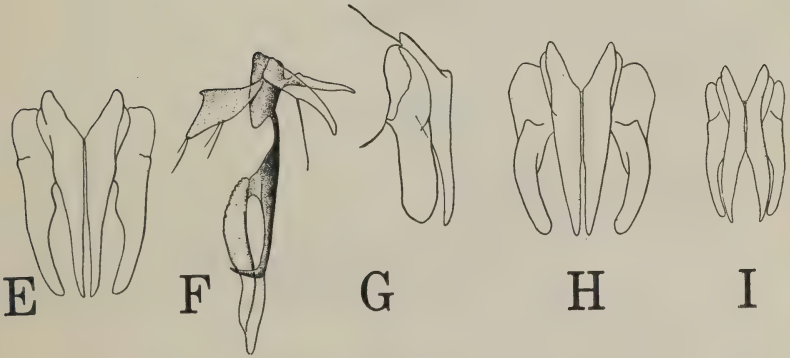
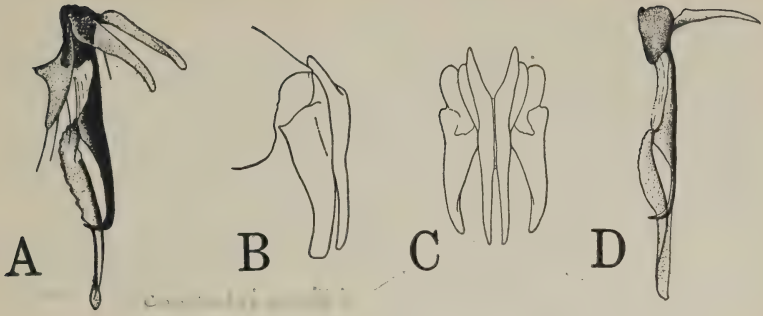
- I. Genital segments of male. Forceps, rear view.

*Phaenicia pallescens* (Shannon)

Genital segments of male

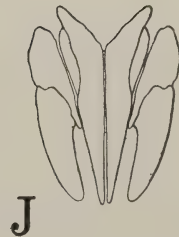
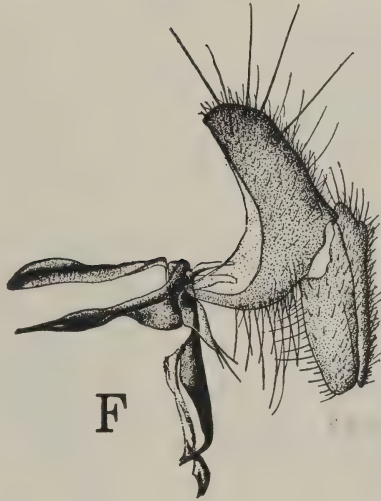
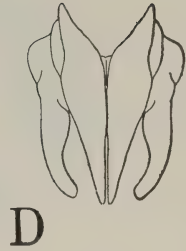
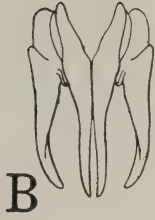
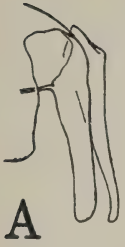
- J. Aedeagus and accessory sclerites, lateral view.
- K. Forceps, lateral view.
- L. Forceps, rear view.
- M. Fifth sternite.





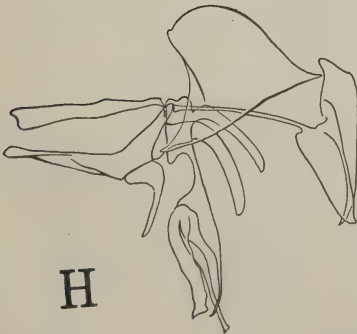
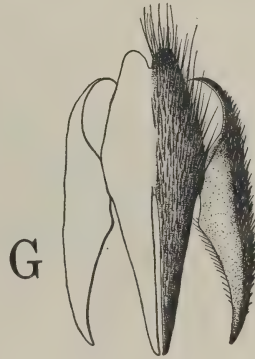
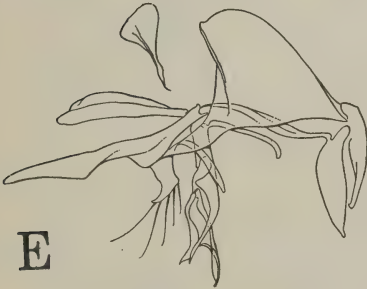
## PLATE 25

- Phaenicia problematica* (Johnson)  
Genital segments of male
- A. Forceps, lateral view.  
B. Forceps, rear view.
- Phaenicia purpurescens* (Walker)  
Genital segments of male
- C. Forceps, lateral view.  
D. Forceps, rear view.
- Phaenicia rica* (Shannon)  
E. Genital segments of male. Forceps, rear view.
- Phaenicia sericata* (Meigen)  
Genital segments of male
- F. Left lateral view of composite.  
G. Forceps, rear view.
- Phaenicia thatuna* (Shannon)  
Genital segments of male
- H. Aedeagus and accessory sclerites, left lateral view.  
I. Forceps, lateral view.  
J. Forceps, rear view.



## PLATE 26

- Acronesia collini* Hall .  
 A. Posterior portion of male abdomen. (After Collin.)
- Acronesia abina* Hall  
 B. Genital segments of male. Rear view of forceps.
- Acronesia alaskensis* (Shannon)  
 Genital segments of male
- C. Left lateral view of composite.
- D. Forceps, rear view.
- Acronesia aldrichi* (Shannon)  
 E. Genital segments of male. Left lateral view of composite.
- Acronesia anana* Hall  
 Genital segments of male
- F. Forceps, lateral view.
- G. Forceps, rear view.
- Acronesia popoffana* (Townsend)  
 Genital segments of male
- H. Left lateral view of composite.
- I. Forceps, rear view.



## PLATE 27

*Eucalliphora lilaea* (Walker)

Genital segments of male

- A. Left lateral view of composite.
- B. Forceps, rear view.

*Eucalliphora arta* Hall

- C. Genital segments of male. Forceps, rear view.

*Aldrichina grahami* (Aldrich)

- D. Genital segments of male. Left lateral view of composite.

*Calliphora coloradensis* Hough

Genital segments of male

- E. Left lateral view of composite.
- F. Fifth sternite.
- G. Forceps, rear view.

*Calliphora livida* Hall

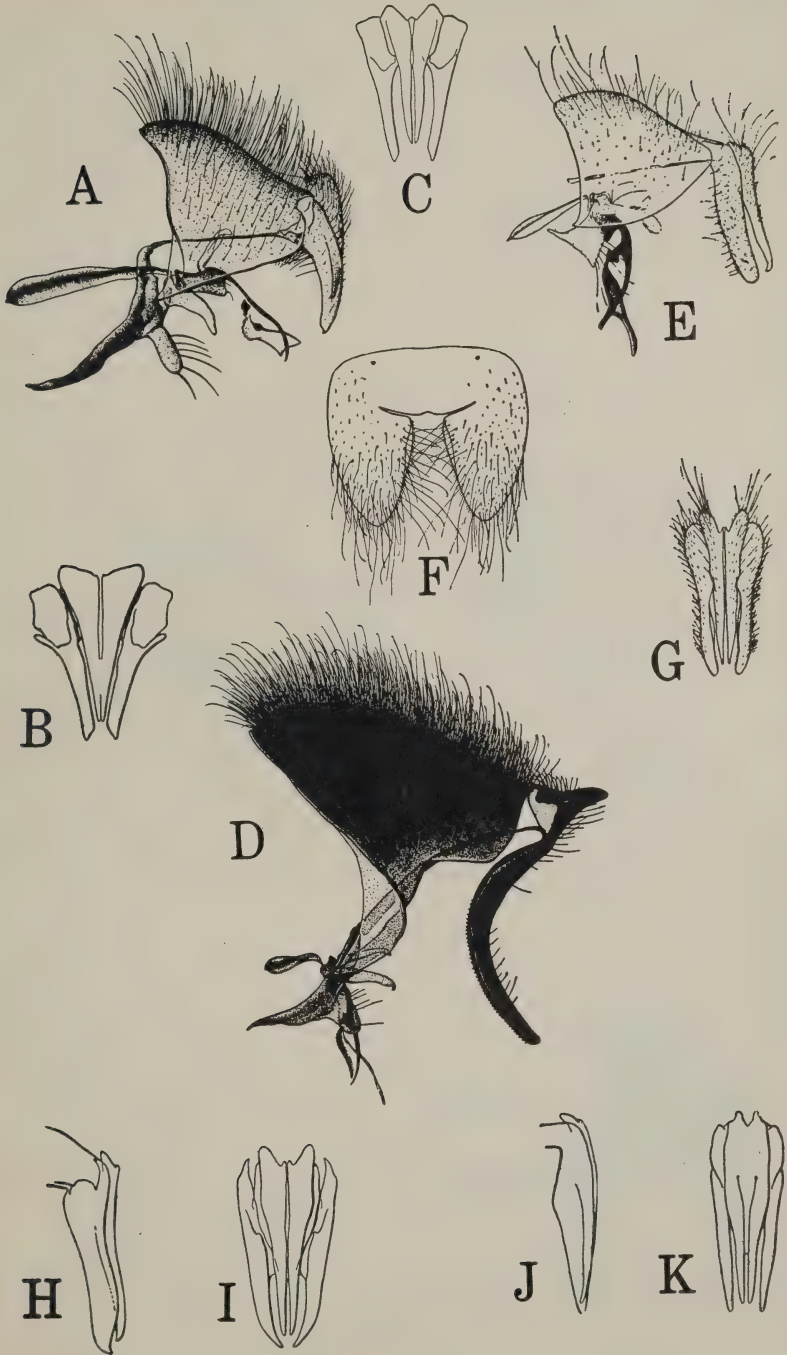
Genital segments of male

- H. Forceps, left lateral view.
- I. Forceps, rear view.

*Calliphora peruviana* Macquart

Genital segments of male

- J. Forceps, left lateral view.
- K. Forceps, rear view.



## PLATE 28

*Calliphora terrae-novae* Macquart

Genital segments of male

A. Forceps, left lateral view.

B. Forceps, rear view.

*Calliphora vicina* Robineau-Desvoidy

Genital segments of male

C. Forceps, left lateral view.

D. Forceps, rear view.

*Calliphora vomitoria* (Linnaeus)

Genital segments of male

E. Left lateral view of composite.

F. Fifth sternite.

G. Forceps, rear view.

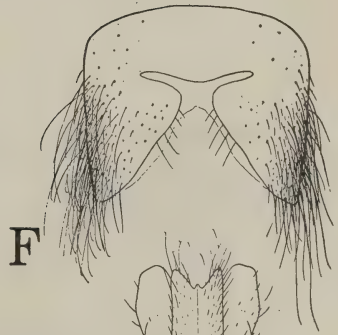
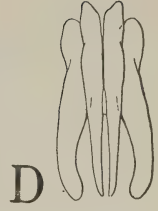
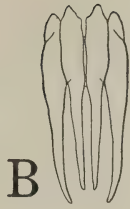
*Onesia bisetosa* Hall

Genital segments of male

H. Forceps, rear view.

I. Left lateral view of composite.





## PLATE 29

*Onesia townsendi* Hall

Genital segments of male

A. Forceps, left lateral view.

B. Forceps, rear view.

*Cynomyopsis cadaverina* (Robineau-Desvoidy)

Abdomen, ventral view

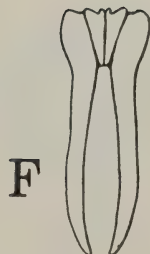
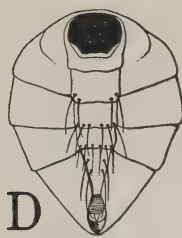
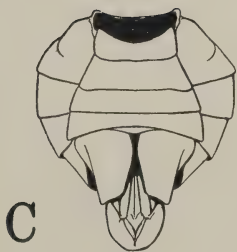
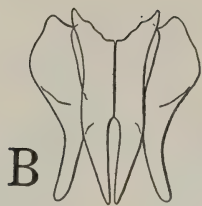
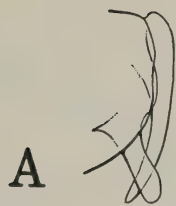
C. Male.

D. Female.

Genital segments of male

E. Left lateral view of composite.

F. Forceps, rear view.



## PLATE 30

*Cyanus elongata* (Hough)

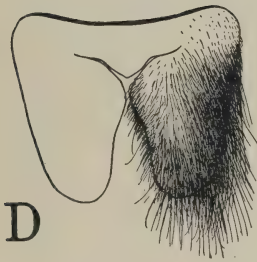
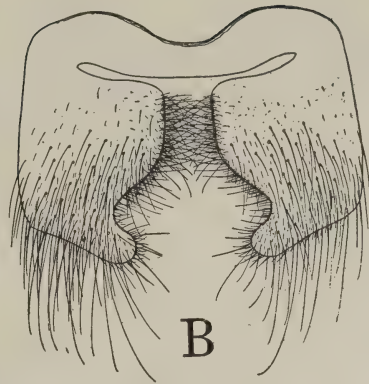
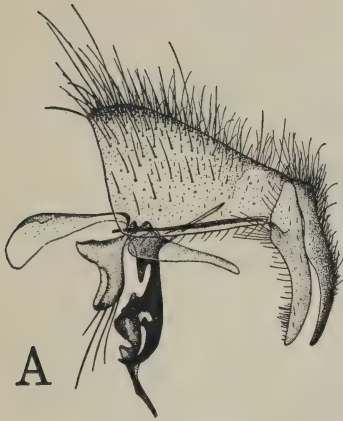
Genital segments of male

- A. Left lateral view of composite.
- B. Fifth sternite.
- C. Forceps, rear view.

*Cynomya mortuorum* (Linnaeus)

Genital segments of male

- D. Fifth sternite.
- E. Forceps, rear view.
- F. Left lateral view of composite.



## PLATE 31

*Pollenia rudis* (Fabricius)

Genital segments of male

- A. Left lateral view of composite.
- B. Fifth sternite.
- C. Forceps, rear view.

*Melanodexia glabricula* (Bigot)

- D. Genital segments of male. Forceps, rear view.

*Melanodexia satanica* (Shannon)

Genital segments of male

- E. Left lateral view of composite.
- F. Forceps, rear view.

*Melanodexiopsis tristina* Hall

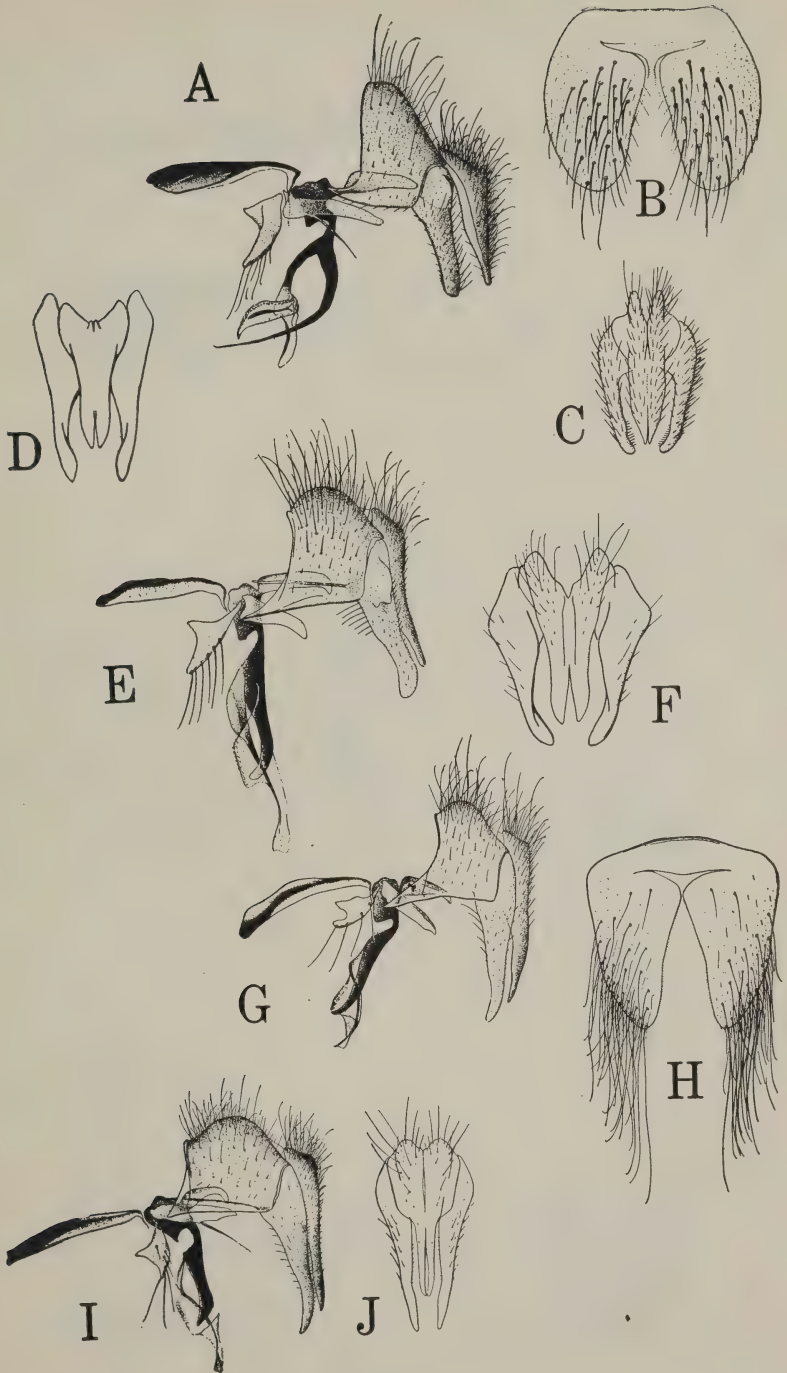
Genital segments of male

- G. Left lateral view of composite.
- H. Fifth sternite.

*Melanodexiopsis grandis* (Shannon)

Genital segments of male

- I. Left lateral view of composite.
- J. Forceps, rear view.



## PLATE 32

*Huascaromusca bicolor* (Fabricius)

Larva, first instar

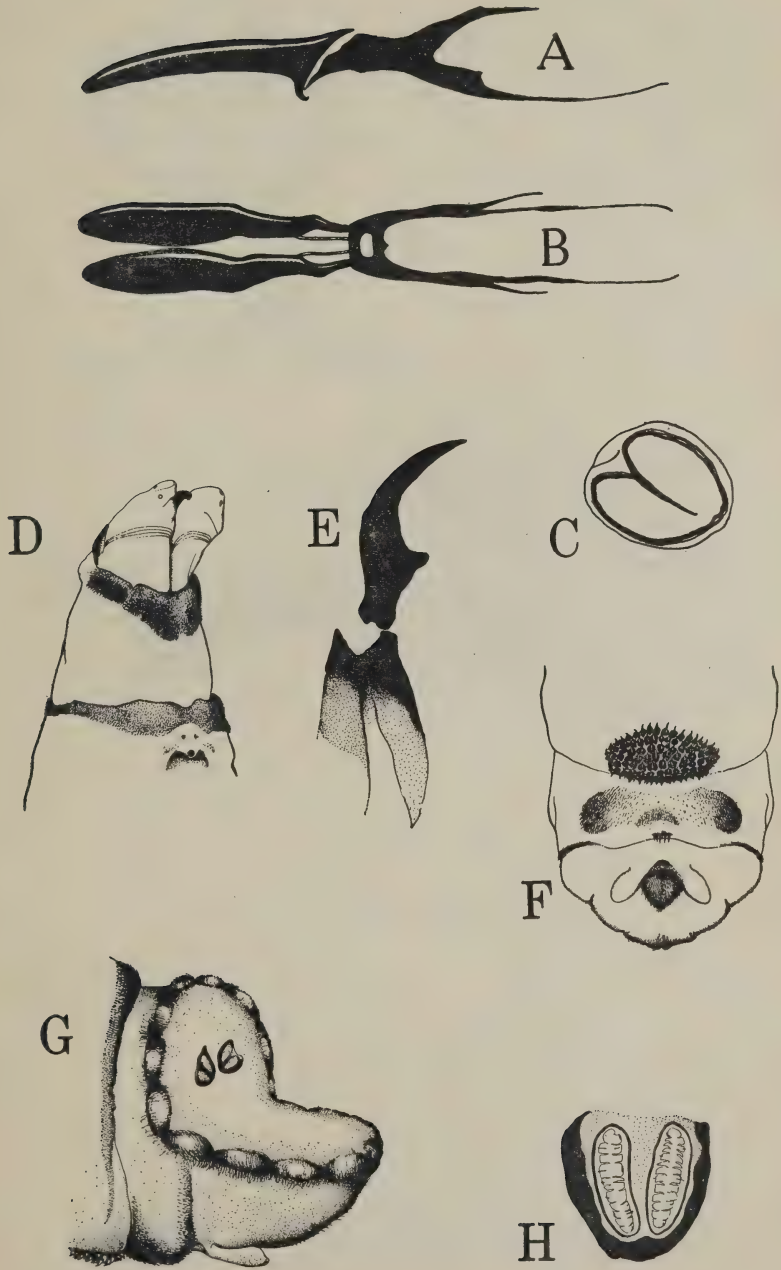
- A. Cephaloskeleton, left lateral view.
- B. Cephaloskeleton, dorsal view.
- C. Posterior spiracle.

*Huascaromusca facialis* (Aldrich)

Larva

- D. Cephalic segments
- E. Cephaloskeleton.
- F. Posterior segments, ventral view.
- G. Posterior spiracles and stigmal field, posterolateral view.
- H. Posterior spiracle.



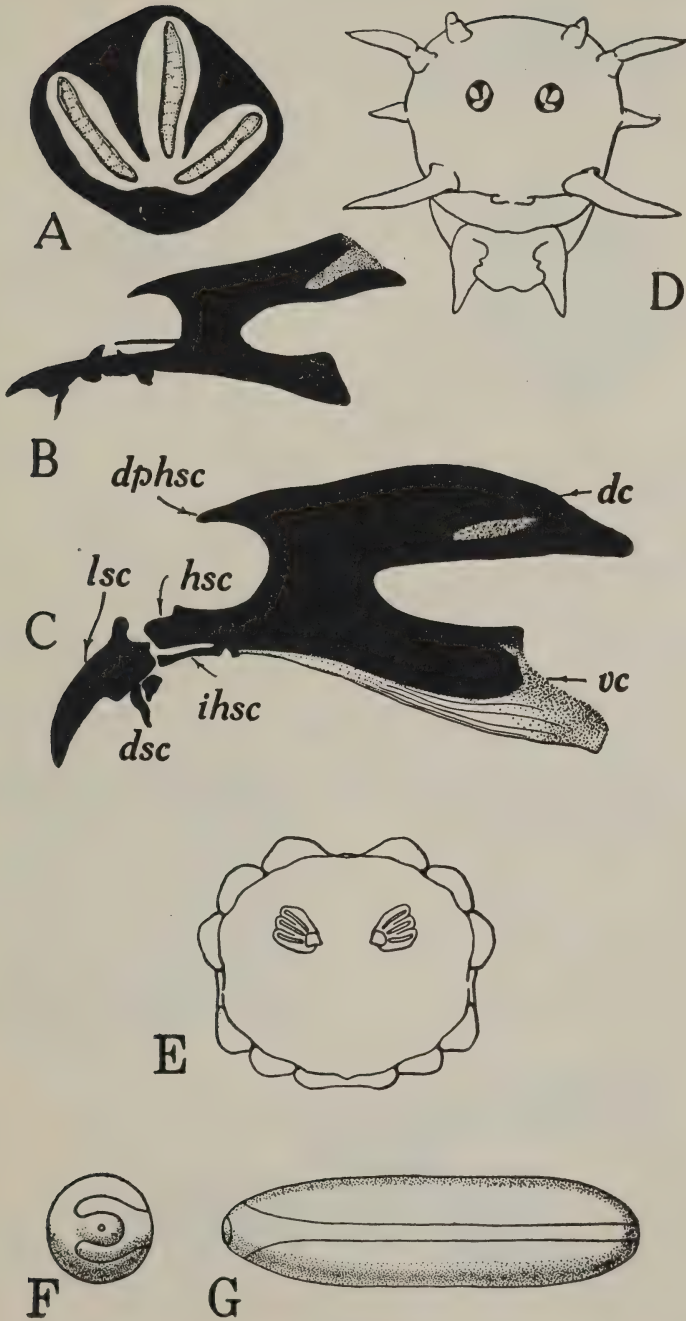


## PLATE 33

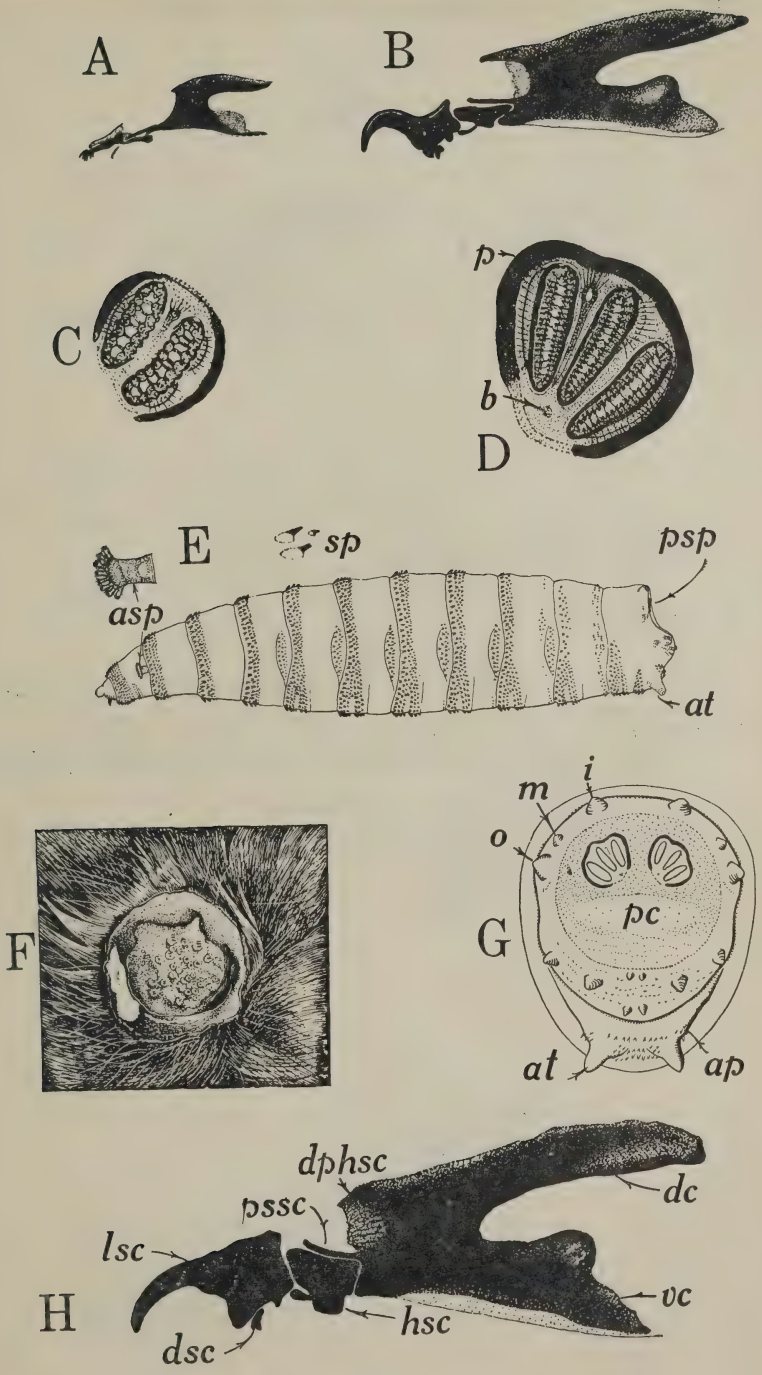
*Stomorphina lunata* (Fabricius)

Larva

- A. Posterior spiracle, third instar.  
 B. Cephaloskeleton, second instar.  
 C. Cephaloskeleton, third instar; *dphsc*, dorsopharyngeal sclerite, *dc*, dorsal cornua, *dsc*, dental sclerite, *hsc*, hypostomal sclerite, *ihsc*, infrahypostomal sclerite, *lsc*, labial sclerite, *vc*, ventral cornua.  
 D. Anal area, third instar.  
*Chloroprocta fuscianipennis* (Macquart)  
 E. Larva. Anal area, third instar.  
*Callitroga americana* (Cushing and Patton)  
 Egg  
 F. End view.  
 G. Lateral view.



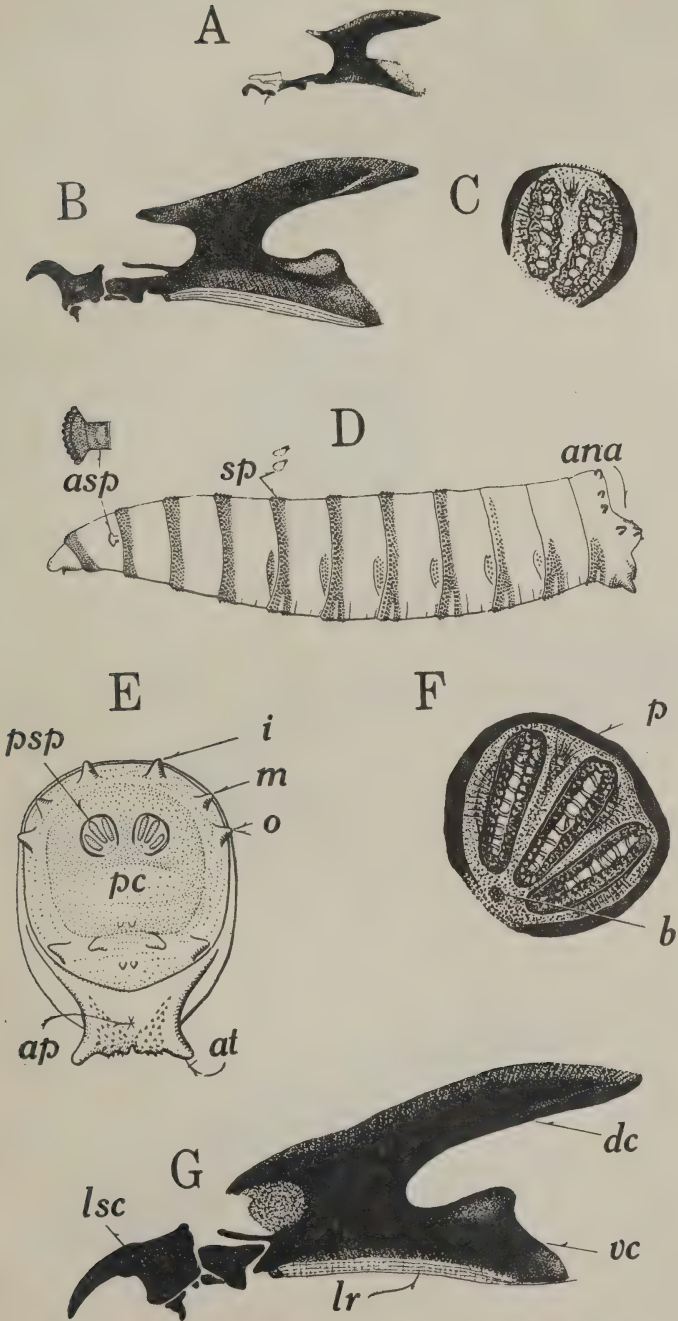




## PLATE 35

*Callitroga macellaria* (Fabricius)

- A. Larva, first instar. Cephaloskeleton.  
Larva, second instar
- B. Cephaloskeleton.
- C. Posterior spiracle.  
Larva, third instar
- D. Mature larva; left lateral view, *sp*, spines, *asp*, anterior spiracle, *ana*, anal area.
- E. Anal area; *psp*, posterior spiracle, *i*, inner tubercle, *m*, median tubercle, *o*, outer tubercle, *ap*, anal protuberance, *at*, anal tubercle, *pc*, posterior cavity.
- F. Posterior spiracle; *b*, button, *p*, peritreme.
- G. Cephaloskeleton; *lsc*, labial sclerite, *lr*, longitudinal ridges, *dc*, dorsal cornua, *vc*, ventral cornua.



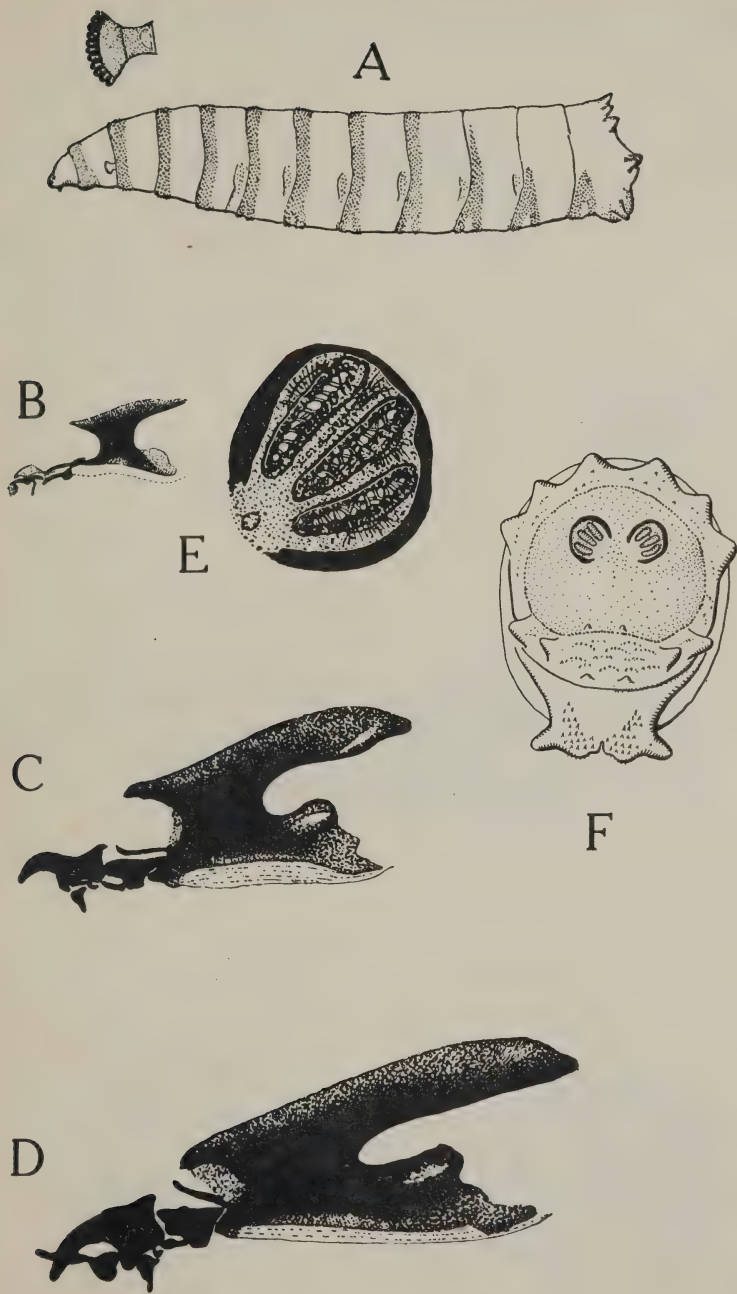
## PLATE 36

*Paralucilia wheeleri* (Hough)

Larva

- A. Mature larva, left lateral view.
- B. Cephaloskeleton, first instar.
- C. Cephaloskeleton, second instar.
- D. Cephaloskeleton, third instar.
- E. Posterior spiracle, third instar.
- F. Anal area, third instar.





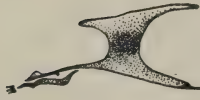
## PLATE 37

*Phormia regina* (Meigen)

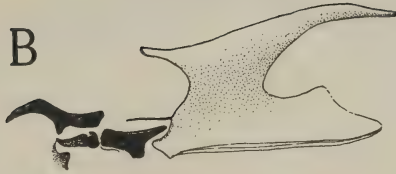
Larva

- A. Cephaloskeleton, first instar.
- B. Cephaloskeleton, second instar.
- C. Cephaloskeleton, third instar.
- D. Posterior spiracle, second instar.
- E. Posterior spiracle, third instar.
- Protophormia terrae-novae* (Robineau-Desvoidy)
- F. Larva, third instar. Posterior spiracle.

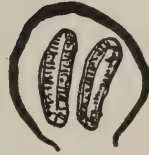
A



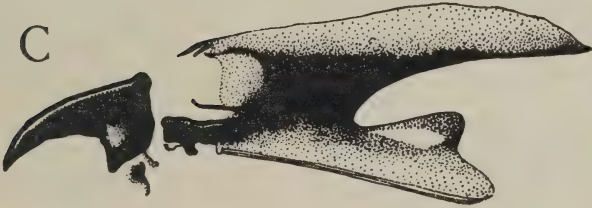
B



D



C



E



F



## PLATE 38

*Apaulina avium* (Shannon and Dobrosky)  
Larva, third instar

- A. Posterior spiracle.
- B. Cephaloskeleton.

*Apaulina metallica* (Townsend)  
Larva, third instar

- C. Posterior spiracle.
- D. Cephalic segments.
- E. Cephaloskeleton.

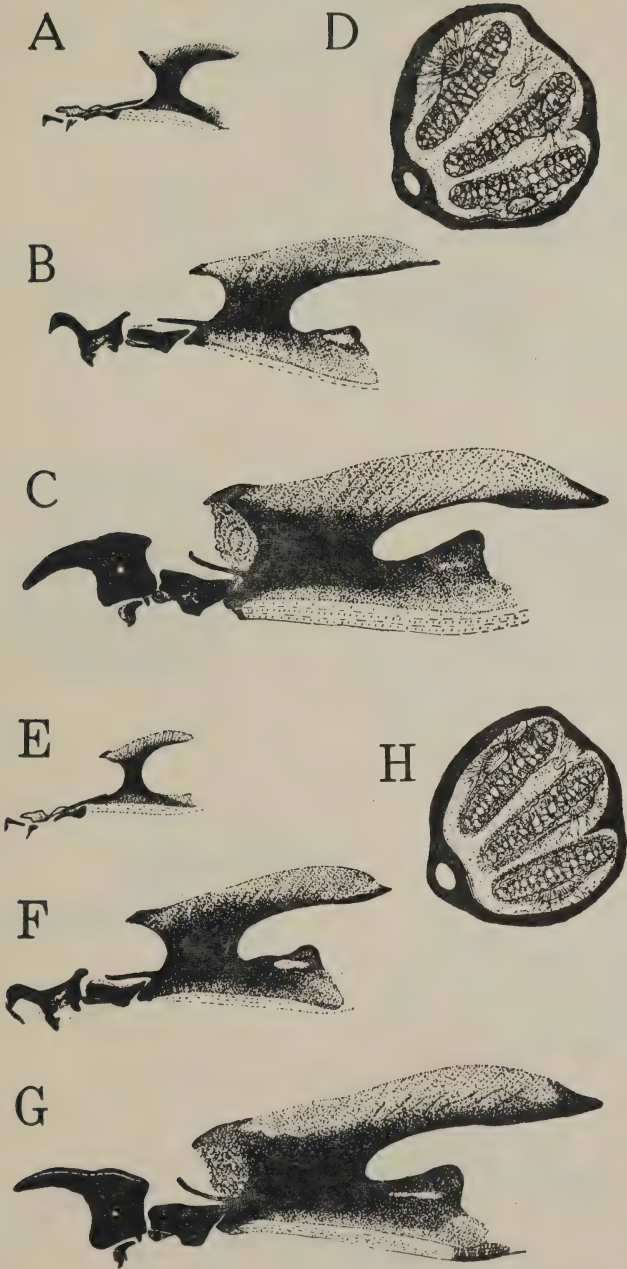


## PLATE 39

*Bufolucilia silvarum* (Meigen)

Larva

- A. Cephaloskeleton, first instar.
  - B. Cephaloskeleton, second instar.
  - C. Cephaloskeleton, third instar.
  - D. Posterior spiracle, third instar.
- Lucilia illustris* (Meigen)
- E. Cephaloskeleton, first instar.
  - F. Cephaloskeleton, second instar.
  - G. Cephaloskeleton, third instar.
  - H. Posterior spiracle, third instar.

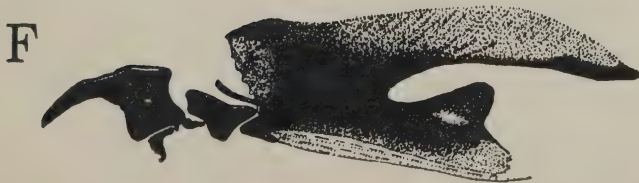
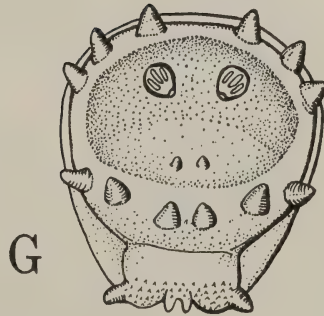
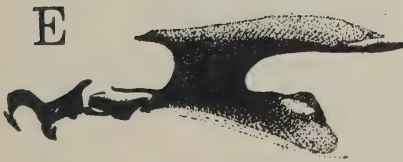
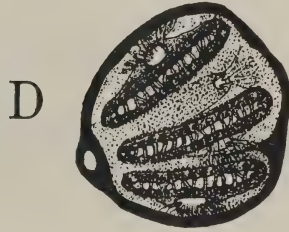
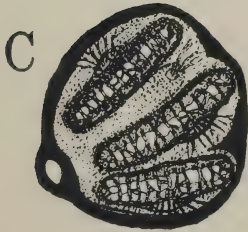
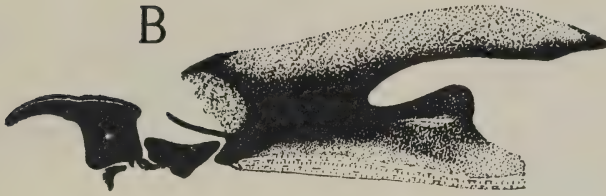


## PLATE 40

*Phaenicia caeruleiviridis* (Macquart)  
Larva

- A. Cephaloskeleton, second instar.
  - B. Cephaloskeleton, third instar.
  - C. Posterior spiracle, third instar.
- Phaenicia mexicana* (Macquart)
- D. Posterior spiracle, third instar.
  - E. Cephaloskeleton, second instar.
  - F. Cephaloskeleton, third instar.
  - G. Anal area, third instar.





## PLATE 41

*Phaenicia pallescens* (Shannon)

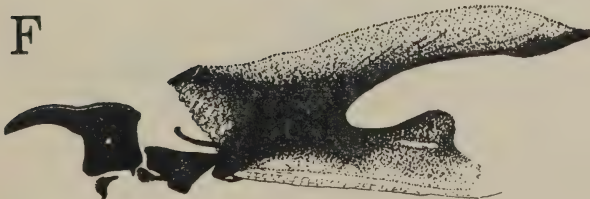
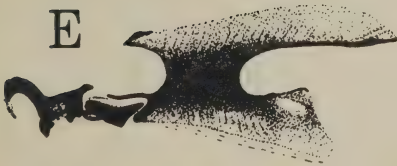
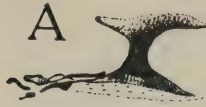
Larva

- A. Cephaloskeleton, first instar.
- B. Cephaloskeleton, second instar.
- C. Cephaloskeleton, third instar.
- D. Posterior spiracle, third instar.

*Phaenicia sericata* (Meigen)

Larva

- E. Cephaloskeleton, second instar.
- F. Cephaloskeleton, third instar.
- G. Posterior spiracle, third instar.

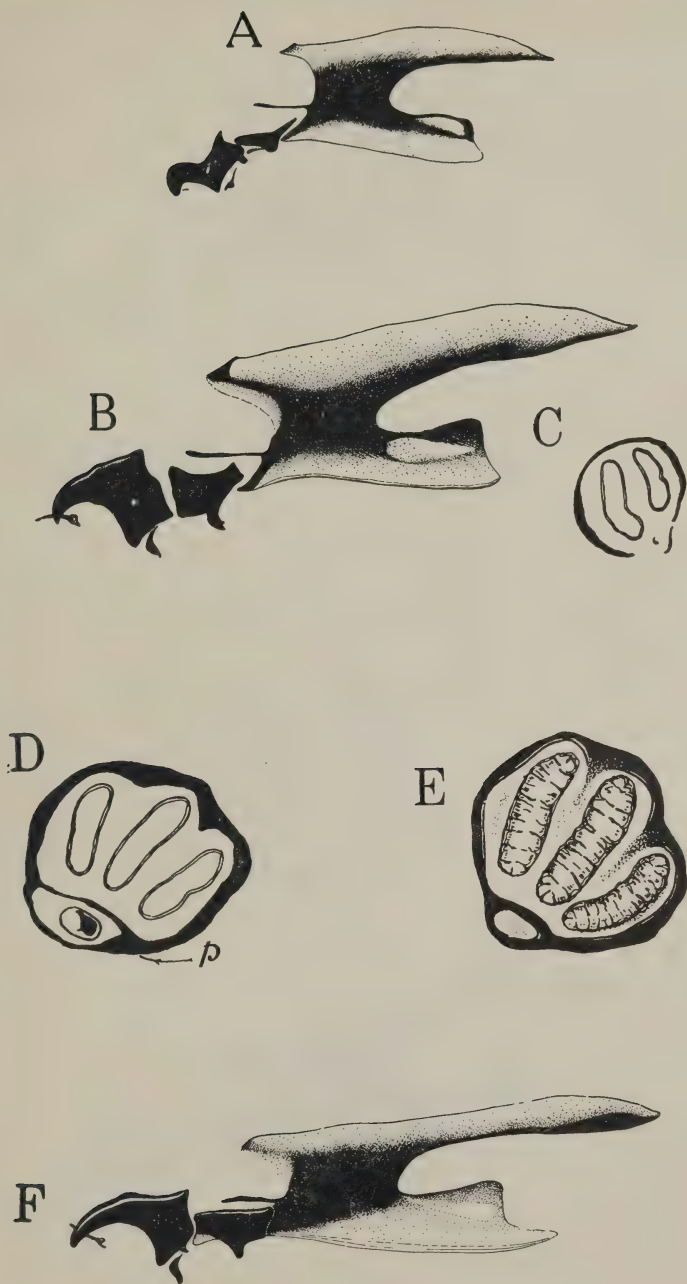


## PLATE 42

*Eucalliphora lilaea* (Walker)

Larva

- A. Cephaloskeleton, second instar.
  - B. Cephaloskeleton, third instar.
  - C. Posterior spiracle, second instar.
  - D. Posterior spiracle, third instar; *p*, peritreme.
- Calliphora coloradensis* Hough
- Larva, third instar.
- E. Posterior spiracle.
  - F. Cephaloskeleton.



## PLATE 43

*Calliphora livida* Hall

Larva, third instar

A. Posterior spiracle.

B. Cephaloskeleton.

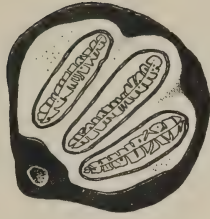
*Calliphora terrae-novae* Macquart

Larva, third instar

C. Posterior spiracle.

D. Cephaloskeleton.

A



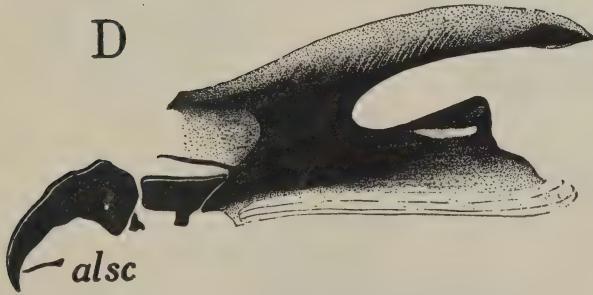
B



C



D



## PLATE 44

*Calliphora vicina* Robineau-Desvoidy  
Larva

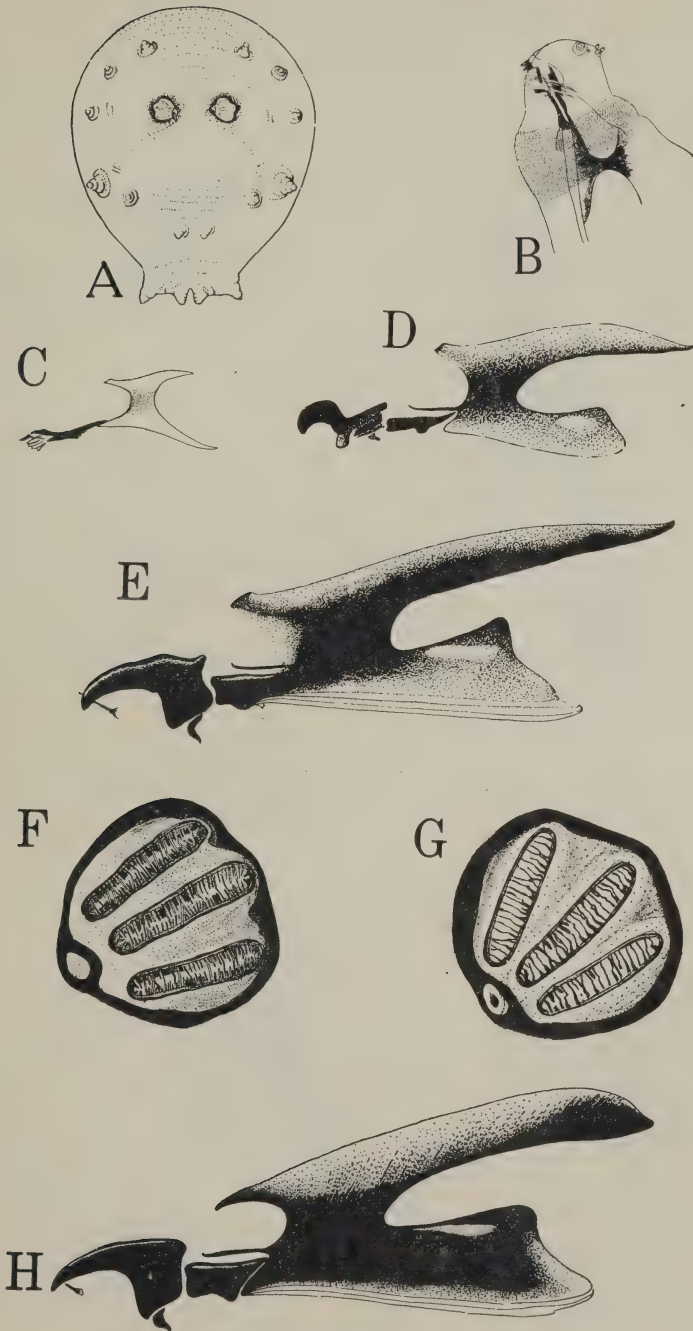
- A. Anal area, third instar.
- B. Cephalic segments, first instar.
- C. Cephaloskeleton, first instar.
- D. Cephaloskeleton, second instar.
- E. Cephaloskeleton, third instar.
- F. Posterior spiracle, third instar.

*Calliphora vomitoria* (Linnaeus)

Larva, third instar

- G. Posterior spiracle.
- H. Cephaloskeleton.





## PLATE 45

*Cynomyopsis cadaverina* (Robineau-Desvoidy)

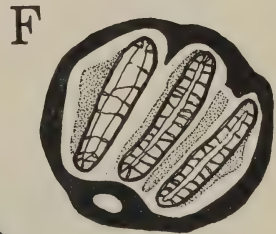
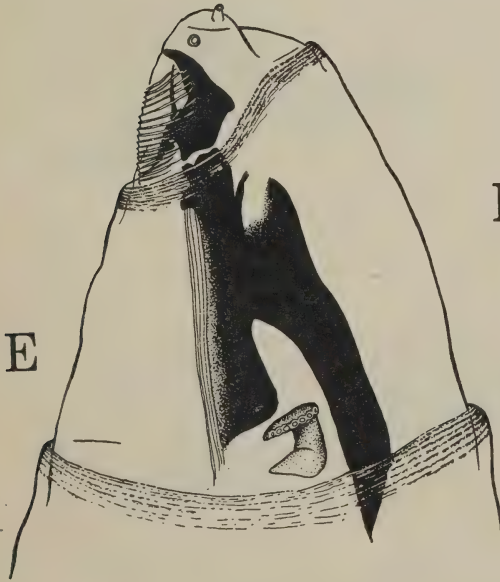
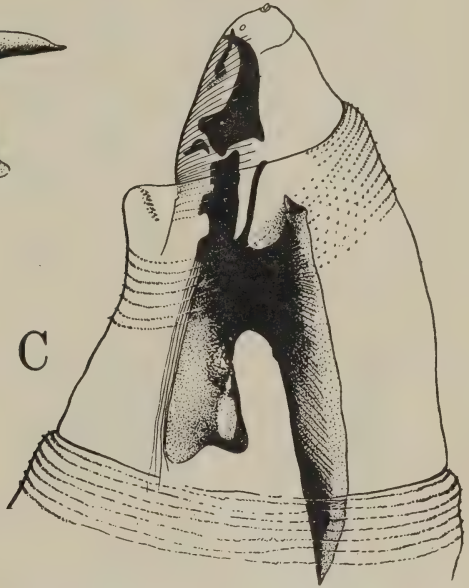
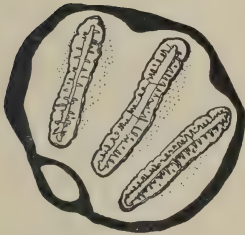
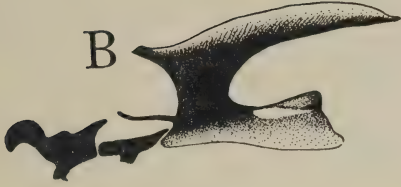
Larva

- A. Cephaloskeleton, first instar.
- B. Cephaloskeleton, second instar.
- C. Cephalic segments, left lateral view, with cephaloskeleton, third instar.  
anterior spiracles omitted.
- D. Posterior spiracle, third instar.

*Cyanus elongata* (Hough)

Larva, third instar

- E. Cephalic segments, left lateral view, with cephaloskeleton.
- F. Posterior spiracle.

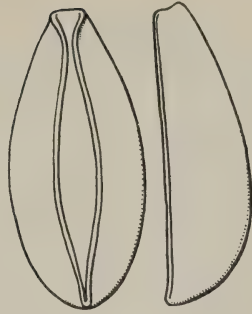


## PLATE 46

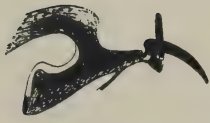
*Pollenia rudis* (Fabricius)

Egg

- A. Dorsal view.
  - B. Lateral view. (After DeCoursey.)
- Larva
- C. Cephaloskeleton, first instar.
  - D. Cephaloskeleton, second instar.
  - E. Cephaloskeleton, third instar.
  - F. Posterior spiracle, second instar.
  - G. Anterior spiracle, third instar.
  - H. Posterior spiracle, third instar.



A B



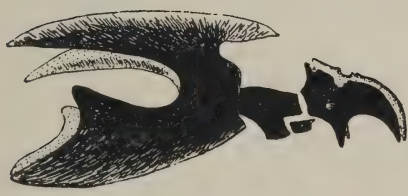
C



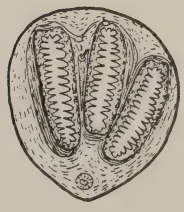
F



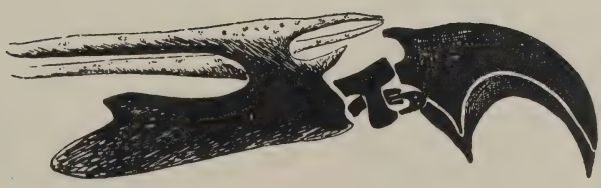
G



D



H



E



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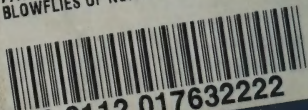


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