

GYNANDROMORPHS OF *BYRSOTRIA FUMIGATA* (GUÉRIN)(BLATTARIA: BLABERINAE)¹EDWIN R. WILLIS² AND LOUIS M. ROTH³

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ABSTRACT

An individual, remarkable in displaying gynandromorphism in its external morphology as well as in its primary sex organs, is described in detail. On its left side the head was larger; the legs stouter; the base of the pronotum angular; the tegmen brachypterous and the wing greatly reduced; the abdomen, cerci, and external and internal genitalia characteristically female. On its

right side the head and legs were smaller; the base of the pronotum rounded; the tegmen macropterous and the wing relatively large; the abdomen, cerci, and external and internal genitalia characteristically male. Comparisons with normal insects are made and illustrated. An addendum describes a second gynandromorph, discovered after the account of the first one was in press.

Gynandromorphism has been observed, not infrequently, in the following families of orthopteroids: Tettigoniidae, Phasmidae, Gryllidae frequently, in the following families of orthopteroids: Tettigoniidae, Phasmidae, Gryllidae (Chopard 1938), and Acrididae (Severin 1943). However, so far as we know, the only previous records of gynandromorphs in the Blattellidae are a specimen of *Periplaneta americana* (L.), which had ovum-like bodies in its testes (Thirumalacher 1928), and males of *Blattella germanica* (L.), in which theanlagen of the gonads were claimed to be normally "hermaphroditic" (Heymons 1890). Heymons stated that the testes of *B. germanica* are formed from only part of the genitalanlagen and that the remainder develops, to varying degrees, into rudimentary female sex glands. He described several specimens, one being a mature male which had two partly developed ovaries. In *B. germanica* and *P. americana* gynandromorphism was only evident in the internal sex organs, whereas in the specimen of *Byrsotria*

*fumigata*³ described below, the anomaly was expressed externally by secondary sexual characters as well as internally by the sex organs.

OBSERVATIONS

A gynandromorph of *Byrsotria fumigata* was discovered in our laboratory colony when it completed its imaginal molt on June 19, 1958. This insect was observed daily thereafter, until on July 25 it was seen to behave like an ovipositing female; that is, it periodically pushed apart its terminal sternal and tergal plates so that the genital cavity was alternately exposed, then closed again. This behavior continued throughout the remainder of the day, but the insect did not form an oötheca. The following day the gynandromorph was dissected; no oötheca was found in its brood sac, but about a dozen mature eggs from its left ovary were found free in the body cavity.

Sexual dimorphism is pronounced in *Byrsotria fumigata* (plate I, A, C), so, because of this, the gynandromorph (plate I, B) presents a particularly striking appearance. The gynandromorph is differentiated bilaterally according to sexual characters; its left side is like that of the female, but its right side is predominantly like that of the male. The overall size of the insect is very similar to that of the female. Because the tegmina of the macropterous male extend

well beyond the end of its abdomen, the male body is even smaller in comparison with the female than it appears in plate I. Relative sizes of the abdomens of male, female, and gynandromorph are shown in plate IV.

HEAD.—The head of the gynandromorph (plate II, B) is asymmetrical, the right side being smaller and more nearly male-like than the left side. Obvious sexual dimorphism exists in the following features of the gynandromorph, which may be compared with those of the male and female (plate II, A, C): (1) The right ocellus lies close to the antennal scrobe, as in the male; the left ocellus is further from the antenna, as in the female. (2) The right mandible is smaller than the left. (3) The right side of the labrum is smaller than the left. The sculpturing of the face is more rugose than in either the male or the female.

THORAX.—*Legs*.—The most pronounced differences are in the coxae, femurs, and the spines on the tibiae; these structures on the female-like left side of the gynandromorph are stouter and longer than those on the right. However, the legs on the right side are somewhat longer and stouter than those of the smaller male.

Pronotum (plate III).—The overall size and shape of the pronotum of the gynandromorph are similar to that of the female:

Sex	Size in Millimeters		No. of Insects
	Width	Length	
Gynandromorph.....	20.5	12.5	1
Female.....	21.2±0.39*	13.6±0.21	10
Male.....	14.2±0.15	10.0±0.10	10

*Standard error of the mean.

The anterior margin is broadly rounded on the left side, as in the female, but more narrowly curved on the right. The angle of the base with the lateral margin approaches a right angle on the left side, as in the female, whereas on the right the lateral margin curves sharply into the base, similar to the pronotum of the male. The translucent buff band along the anterolateral margin is broad on the left, as in the female, but narrower on the right.

Tegmina (plate I).—The right tegmen is over twice as long as broad, similar to that of the macropterous male. The following differences from the male tegmen were noted: The posterior margin of the right tegmen is broadly emarginated distal to the anal field; it is torn and crumpled from this notch to the apical margin. The apex is also crumpled. The left tegmen is brachypterous and typically female.

Wings.—The right wing is typically male; the preaxillary area is moderately developed; the apical end is crumpled and the apical margin is

missing, apparently broken off; the anal area is much reduced. The left wing is greatly reduced and typically female.

ABDOMEN.—*Dorsum*.—An excised portion of the dorsum, minus the lateral ends of the abdominal terga, is shown in plate IV, B. The left sides of these terga may be seen in plate I, B. Comparable terga of the female and male (wings removed) are shown in plate IV, A, C. A sharp line of demarcation divides the dorsum of the gynandromorph abdomen into distinct male (light brown) and female (dark brown) sides. Laterally, the cuticle of the right side of each tergum is sculptured in low relief similar to, but not identical with, that of the male. The cuticle of the left sides of the terga is female-like but considerably more rugose. The apical lateral corners of terga one through four on the right side are male-like, but the corners of terga five through seven on the right and two through seven on the left are elongated posteriorly, as in the female. The supra-anal plate (tenth tergum) is essentially female-like. The supra-anal plates of the male and female are compared in plate VI, F, G.

Cerci.—The male cerci are longer, more conical, and more obviously segmented than those of the female (plate IV; plate VI, F, G). The right cercus of the gynandromorph (seen from below in plate IV, D) is typically male, whereas the left cercus is short, broad, and typically female.

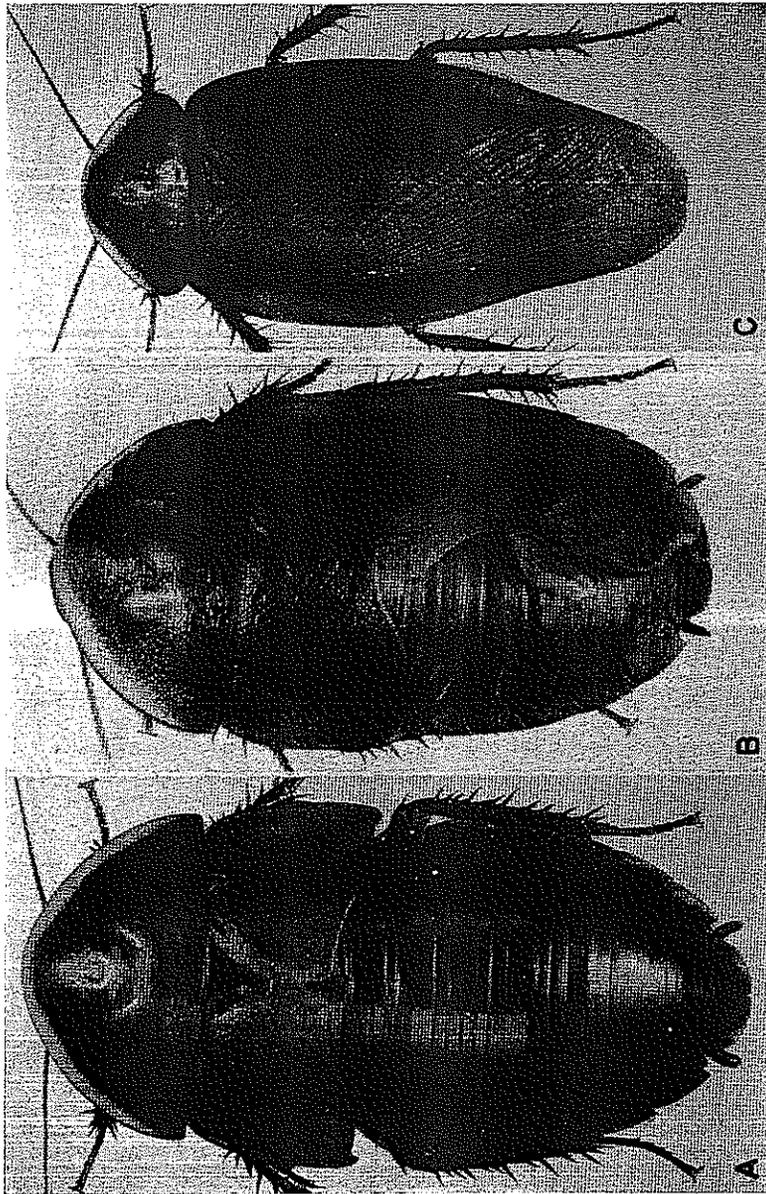
Venter (plate IV, D, E, F, G).—The sculpturing of the cuticle on the right side of the venter, up to and including the sixth segment, is male-like. The left side is typically female except that the apical halves of the sterna are more rugose. The seventh sternum of the female and the ninth sternum of the male are the subgenital plates; that of the female is large and symmetrical, whereas that of the male is small, asymmetrical, and bears a short stylus just medial to the left cercus and a long stylus close to the right cercus (plate IV, E; plate V, C). The seventh sternum of the gynandromorph (plate IV, D) is a highly modified subgenital plate; it is narrow (male-like) on the right, but wider (female-like) on the left. The cuticle is much more rugose than in either male or female. Rudiments of the eighth and ninth male-like sterna, which were partly concealed beneath the seventh sternum, are described with the external genitalia.

EXTERNAL GENITALIA.—*Female* (plate V, A).—Medially within the genital cavity, between the tenth tergum and seventh sternum, lies the ovipositor; it is composed of three sets of paired valvulae of which only the first and third pair can be seen; the second valvulae lie concealed behind the first pair. Dorsal to and behind the ovipositor, just beneath the supra-anal plate, are a pair of symmetrical paraprocts. Below and anterior to the ovipositor is the rugose brood sac, which is shown everted in the figure.

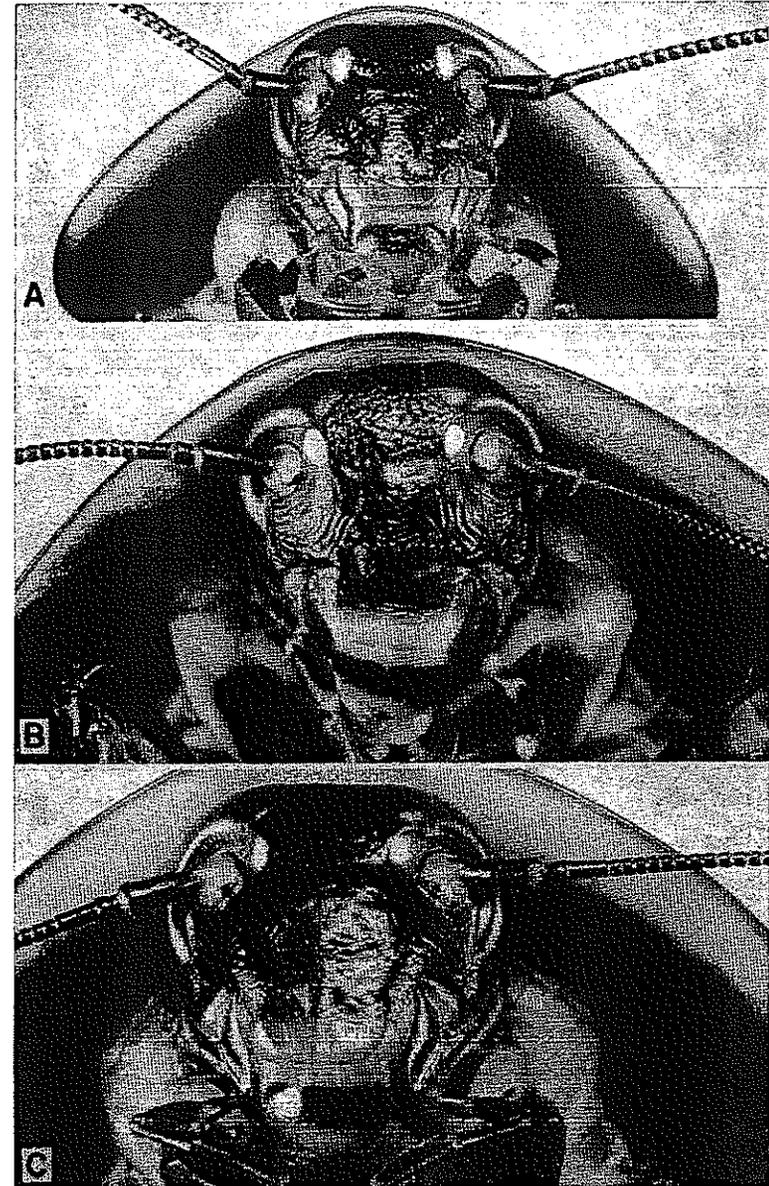
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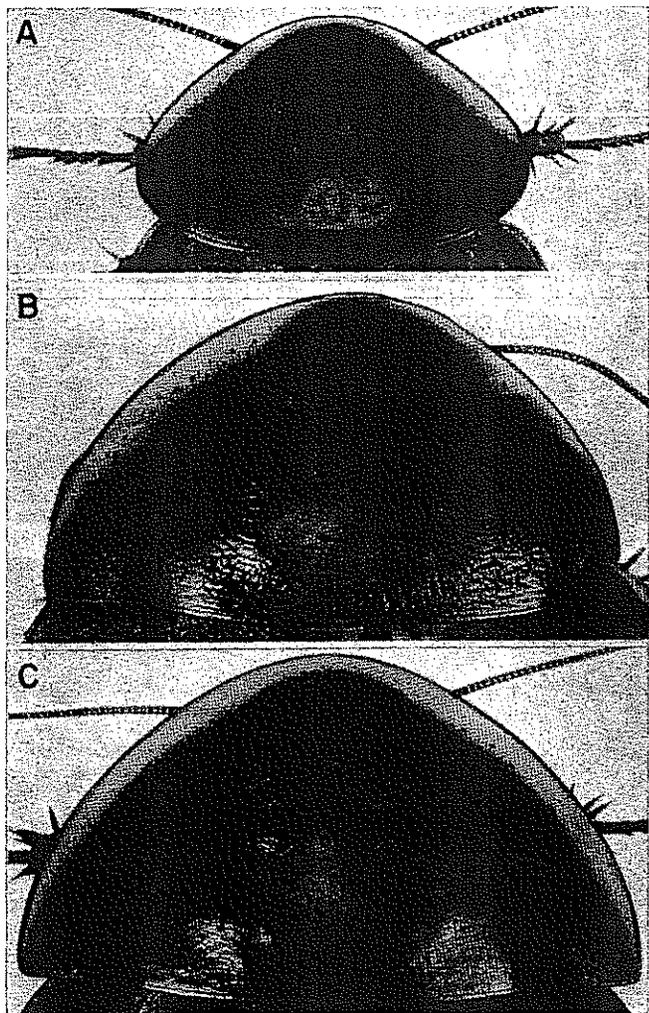
³We are indebted to Mr. James A. G. Rehn, The Academy of Natural Sciences of Philadelphia, for identifying this species, for reading the manuscript, and for calling our attention to the Severin (1943) reference. The taxonomy of this Cuban cockroach has been treated by Rehn and Hebard (1927).



Byrsotria fumigata, c.X2.7. A.—Male. B Gynandromorph. C.—Female.



Heads of *Byrsotria fumigata*, c.X8.6. The sides of the mandibles may be seen laterad to the clypeus and labrum. A.—Male. B.—Gynandromorph. C.—Female.



Pronotums of *Byrsotria fumigata*, c.X5.1. A.—Male. B.—Gynandromorph. C.—Female.

Male (plate V, C).—The phallic structures of this species occur as three distinct lobes. Located medioventrally in the genital cavity, between the tenth tergum and ninth sternum, is the membranous penis. A semicircle of short, stout spines surrounds the ventral edge of the penis; mesad to this row of spines, the penis is invaginated. A flat, narrow sclerotized rod lies along the dorsal surface of the penis; the distal end of this rod expands into an irregularly shaped, free-standing plate which lies in the invagination of the penis (plate VI, F). To the right of the penis is an extensible, hooked right phallomere; although shown partly extruded in the figures (plate V, C; plate VI, F), this phallomere is normally retracted within a membranous tube formed by its proximal attachment. To the left of the penis is a complex, three-lobed left phallomere, which is intricately sclerotized. Dorsal to and behind the phallic lobes are two asymmetrical paraprocts. Proximally, the medial end of the sclerotized part of the right paraproct is modified into a strong hook. The corresponding part of the left paraproct is membranous, but projecting medially from the sclerotized base is a small, straight, finger-like process.

Gynandromorph (plate V, B).—The right side has both male and female characters. The left side is entirely female-like; on the left are a typical female left paraproct, the three left valvulae of the ovipositor, and a small brood sac. On the right side are three sclerotized processes that are obviously rudiments of the right valvulae.

Recognizably male-like characters on the right side are the right paraproct, with sclerotized hook (see also plate IV, D); the right half of a narrow eighth sternum; and the incompletely sclerotized right half of a ninth sternum, which bears the right stylus. An unidentifiable sclerotized lobe lies to the right of the midline, below and anterior to the rudiments of the right side of the ovipositor; probably this structure is a rudiment of one of the phallic lobes.

INTERNAL GENITALIA.—Female (plate VI, A).—Paired ovaries are connected by oviducts to the median oviduct above the anterior end of the brood sac. On each side of the median oviduct is a lobe of the left colleterial gland, which is composed of many large, branched tubes. Between the lobes of the left gland is the right colleterial gland, a compact mass of coiled, branched tubules (plate VI, B). Beneath the colleterial glands on each side of the median oviduct is a spermatheca and its accessory gland.

Male (plate VI, D).—The only structures described from the male are those organs homologous with identifiable organs in the gynandromorph. The prominent accessory glands open into the anterior end of the ductus ejaculatorius. These glands are predominantly long, unbranched tubes which conceal a smaller mass of much shorter tubes. The accessory glands secrete material that forms the spermatophore. The ductus ejaculatorius of the illustrated specimen (see arrow) is partially distended, presumably with accessory gland secretion.

EXPLANATION OF PLATES IV, V, and VI.

PLATE IV

Abdomens of *Byrsotria fumigata*, c.X3.2. A.—Female dorsum. B.—Gynandromorph, excised terga three through nine. C.—Male dorsum. D.—Gynandromorph, seventh sternum and supra-anal plate from below. Note the hooked, male-like right paraproct (compare with Plate V, C); the conical, male-like right cercus; and the blunt, female-like left cercus. E.—Male venter. F.—Gynandromorph venter after dorsum had been removed. G.—Female venter.

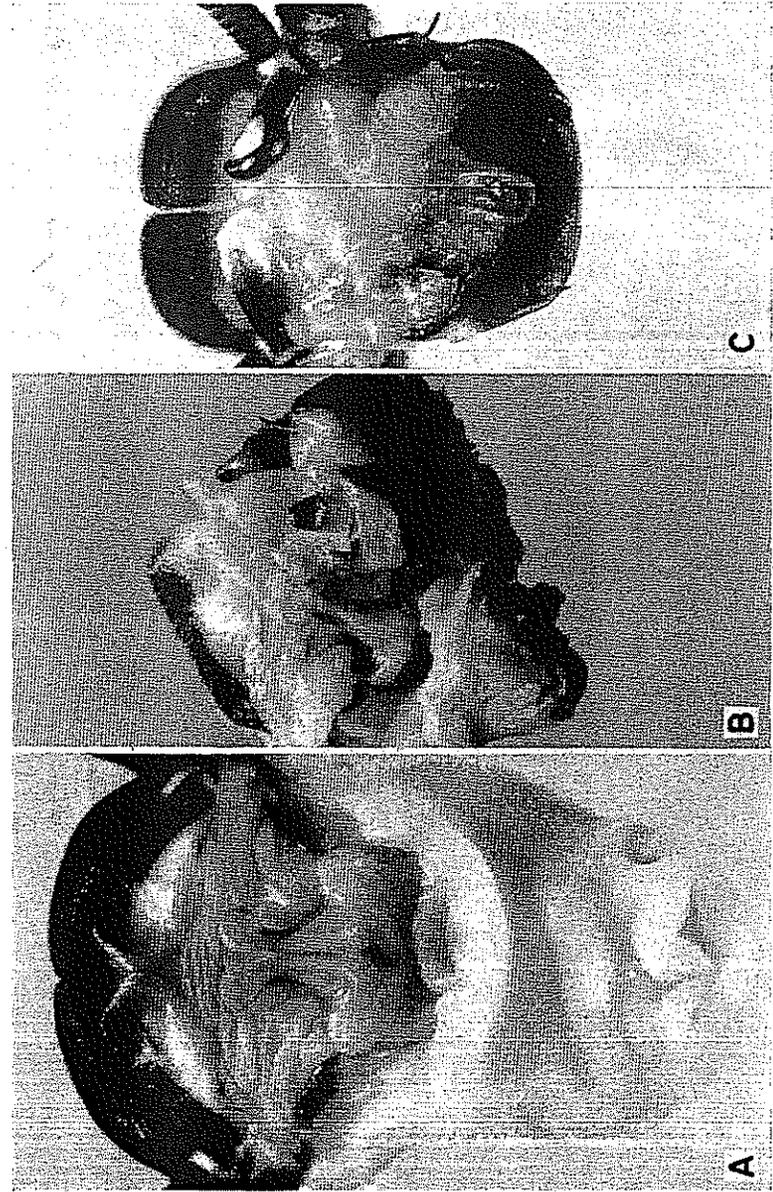
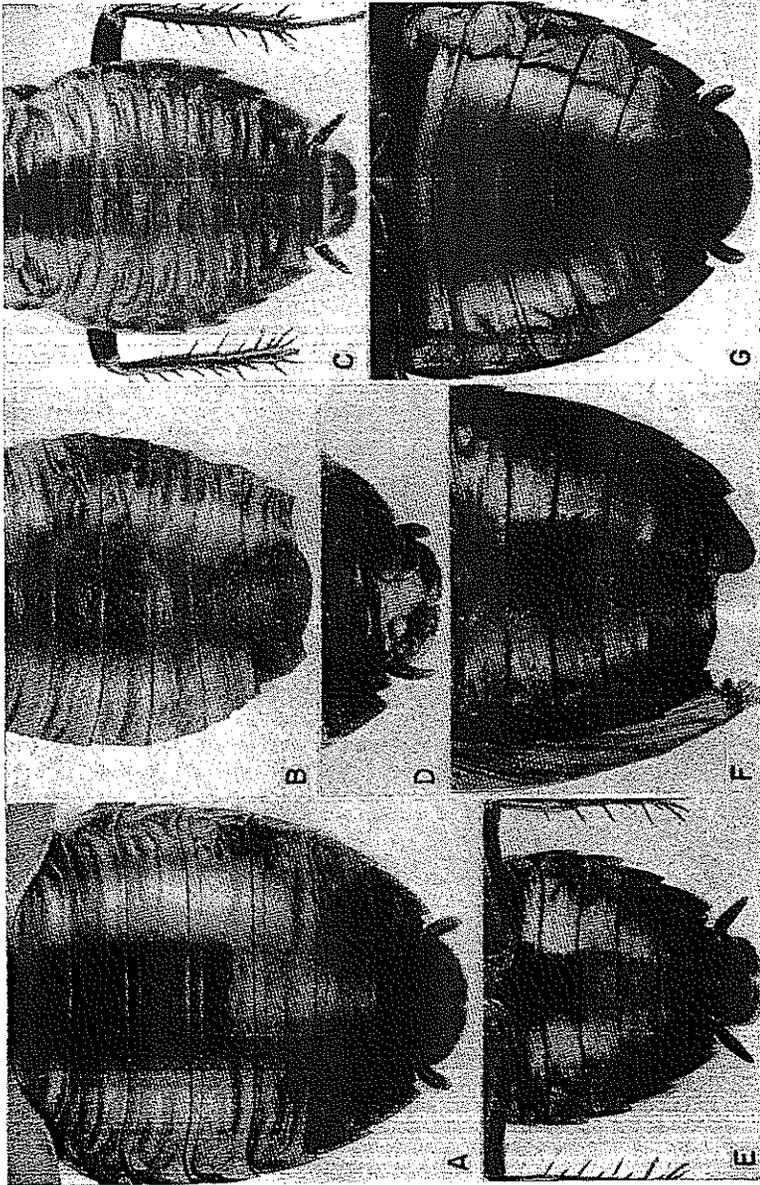
PLATE V

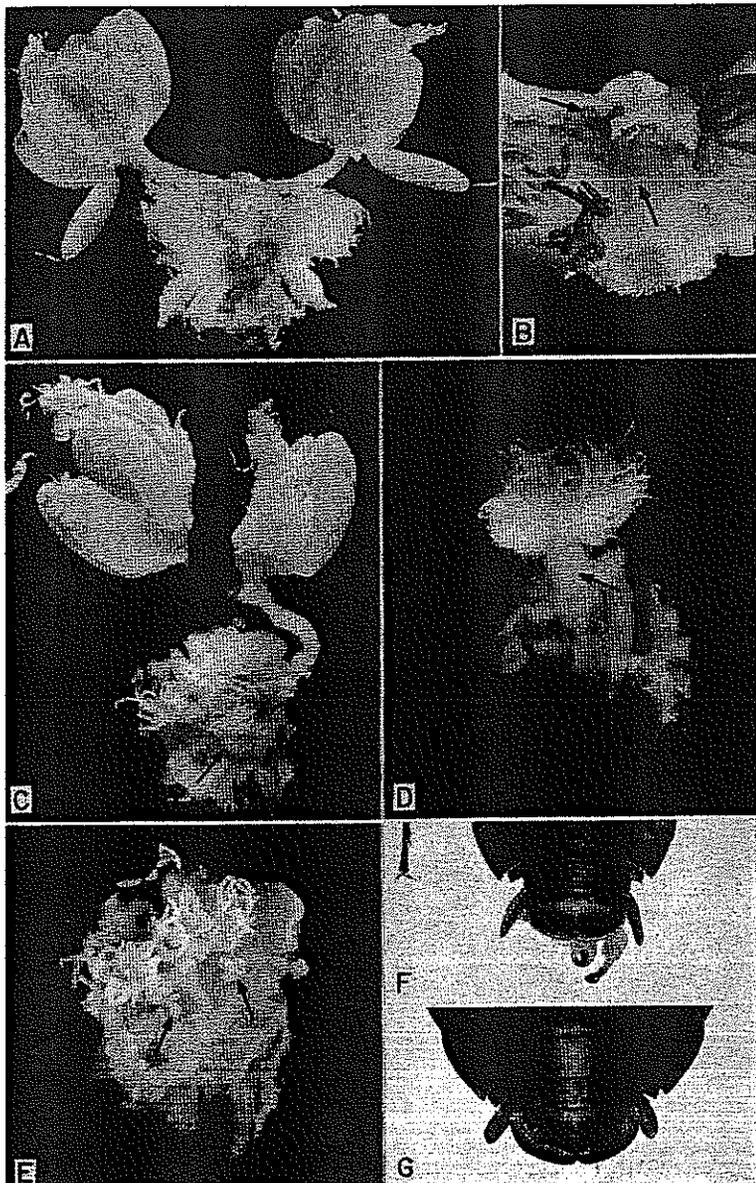
External genitalia of *Byrsotria fumigata*, c.X9.3. A.—Female genital cavity from below. The light colored brood sac has been everted. B.—Gynandromorph genital cavity from below. On the upper left is the female-like left paraproct. Beneath this is the ovipositor. At the lower left, below the base of the left side of the ovipositor, is the brood sac. On the upper right is the male-like, hooked, right paraproct. Below this is part of the male-like ninth sternum, bearing a stylus. The narrow, male-like eighth sternum is the black band beneath the right side of the ovipositor and the ninth sternum. C.—Male genital cavity from the rear; the supra-anal plate has been elevated and the subgenital plate depressed.

PLATE VI

A to E, internal genitalia of *Byrsotria fumigata*. A.—Virgin female about the same age as the gynandro-

morph, dorsal view, c.X3. The ovaries are the large lateral organs. The lobes of the left colleterial gland are immediately behind the oviducts. The right colleterial gland is between the lobes of the left gland (see also figure B). B.—Central part of preparation in figure A stained with hematoxylin, c.X6. The arrow at lower right indicates right colleterial gland. The arrow at upper left indicates a spermatheca. The tube with the bulbous end just to the right of the spermatheca is a spermathecal gland. C.—Gynandromorph, dorsal view, c.X4. The longitudinal axis approximately parallels the arrow. The detached, right ovary is misplaced to the left of the left ovary. Empty follicles, which had contained the eggs found free in the body cavity, are visible along the left side of the left ovary. The arrow indicates the ductus ejaculatorius with attached, male-like accessory glands. At the left of the male-like organs is the left colleterial gland. D.—Male, dorsal view, c.X6. The arrow indicates the ductus ejaculatorius. Posteriorly the left phallomere, the penis, and the retracted right phallomere can be seen. E.—Gynandromorph, c.X6. Part of the preparation in figure C with male-like organs removed. The arrows indicate the spermatheca-like structures. The base of the lower left arrow arises in the lumen of the severed hind gut. The lobe on the upper right is the brood sac. F.—Male terga, seven through ten, c.X3.2. The penis and the partly extruded, hooked right phallomere extend behind the tenth tergum. G.—Female terga, seven through ten, c.X3.2.





Gynandromorph (plate VI, C, E).—The reproductive tract is predominantly female. A small brood sac is present (see also plate V, B). There are two ovaries, both of which contain mature eggs as well as smaller oocytes. Only the left ovary (misplaced to the left of the left ovary in figure C) was connected to the posterior part of the tract by only a thin strand of tissue; this connection may have been a rudiment of the right oviduct or, perhaps, a male vas deferens. Only a portion of the left colleterial gland is present. The right colleterial gland is apparently missing, as are the testes. A cluster of short, unbranched tubes apparently represents the male accessory glands; these are attached to a ductus ejaculatorius (arrow, plate VI, C); this duct is distended, as though with accessory gland secretion. Beneath the male-like organs are small, lobed structures that undoubtedly represent the spermathecae and spermathecal glands (arrows, plate VI, E).

ADDENDUM

After the above account was in press a second gynandromorph of *Byrsotria fumigata* was found in our laboratory colony. Externally the dimorphism between the male and female sides of the second specimen is much less obvious than in the first. In the second specimen the male-like structures are on the left side rather than on the right as in the first. The following is a description of this second gynandromorph.

Head.—Very slightly asymmetrical, the left side being smaller than the right.

Thorax.—*Legs*: Similar on both sides of the body except that the left pro- and mesothoracic coxae are slightly smaller than those on the right. *Pronotum*: Female-like, but the left side is slightly smaller than the right. The buff-colored, lateral margin is slightly narrower on the left than on the right. *Tegmina*: Both are abnormal and incompletely expanded. The apical edge of the left tegmen is produced posteriorly into a sinusously edged lobe, making it longer than the normal female tegmen. *Wings*: Both are reduced in size and female-like.

Abdomen.—No differentiation of terga or sterna, except the subgenital plate, from normal female. *Cerci*: Left cercus typically male, right female. *Seventh sternum*: The subgenital plate is typically female on the right but modified from the female shape on the left by a shallow notch in the apical edge from the midline toward the left; the notch is about one fourth the width of the sternum and half as deep as wide. This notch exposes the male-like genital lobes which first drew our attention to this anomalous individual.

External Genitalia.—In the genital cavity sclerotized lobes on the left side are identifiable as male structures. One lobe bears a stylus and is obviously a rudiment of the male ninth sternum. To the right of this is a knob that may be referable to the hooked right phallomere. The penis is present as is the ovipositor. The ovipositor valvulae on the right side are normal; however, the second and third valvulae on the left are abnormal, their distal ends being twisted and bent. The right paraproct is typically female, but that on the left bears a sclerotized, hooked process; this latter is male-like but not typically so.

Internal Genitalia.—Male accessory glands and ductus ejaculatorius are present in the left side of the abdominal cavity. The testis, if present, was lost in dissection. The right ovary and oviduct are present together with a spermatheca and its accessory gland. Right and left colleterial glands are also present.

Both gynandromorphs have been deposited in the United States National Museum.

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