XI. THE EXTERNAL GENITAL APPARATUS OF MALE DROSOPHILIDAE IN RELATION TO SYSTEMATICS

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INTRODUCTION

Accompanying the development of genetical and evolutionary knowledge in the genus Drosophila, taxonomic studies in this genus have advanced rapidly in the past few decades. The extensive works of Sturtevant, Patterson, Spencer, Dobzhansky, Pavan, Wheeler, and many other investigators have furnished descriptions of many new species and have contributed detailed accounts on distribution and phylogenetic relationships among the members of the family.

In an earlier work on the taxonomy of Drosophila, Sturtevant (1921) mentioned the importance of male genitalia as an auxiliary tool to separate certain closely related species, e.g., *D. melanogaster* and *D. simulans*. In his later work (1942), as well as in publications from this laboratory (Patterson and Wheeler, 1942; Patterson, 1943; Patterson and Mainland, 1944) and in papers of other workers (Spencer, 1942; Dobzhansky and Pavan, 1943; etc.), the criteria for classification have been extended to numerous characters, including the external and internal morphology of the imagines, eggs, puparia, chromosomes, and behavior of larvae and adults. As for the genital system, however, only the internal genital organs have been emphasized, with but scant attention being paid to the external apparatus.

Studies of the genitalia in the genus Drosophila have been carried out largely in relation to genetical works. Only quite recently have scattered workers called attention to the importance of the genitalia in relation to systematics. Kikkawa and Peng (1938) drew several "male hypopygia" of oriental Drosophila species but presented no description of them in the text, and although their drawings are sometimes inaccurate, the main features can still be traced by skilled workers. Stalker and Spencer (1939), Buzzati-Traverso (1943), and especially Pomini (1940) have all presented some figures or descriptions of the external male genitalia of some Drosophila species. Streisinger (1946) was able to distinguish three morphologically similar species of the cardini group by means of genitalial structures. King (1947), in his report on the interspecific relationships within the guarani group, separated the six species he studied into two sub-groups which differ in some minor morphological traits as well as in the armature of the male genitalia. He claimed further that "these differences of genitalia and of Malpighian tubes are very striking. Unfortunately, there has been very little systematic investigation of the male genitalia of Drosophila although they undoubtedly offer many good characters."

Of particular importance is the recent report on the morphology of the external genital apparatus of *D. melanogaster* and *D. simulans* by

Salles (1947) who made detailed and accurate studies on both males and females.

It is becoming increasingly obvious that the working taxonomist needs a more extensive and comprehensive work, describing and figuring the male genitalia of the Drosophilidae, including all possible subgenera and species groups in which a comparison can be made. Whether or not the genitalial structures can be used by taxonomists in discriminating between closely related Drosophila species is an interesting question. Further, we would like to know whether species belonging to a certain species group or subgroup similar in most morphological and physiological characters would also have similar structure in the genitalia. It is equally important to learn whether a study of the variation of male genitalia among the various species could throw some light on the phylogenetic relationships within the genus as previously determined on the basis of other characteristics.

In the present article is presented a survey of the external male genitalia (hypopygia) of more than 170 species of the Drosophilidae, studied from a comparative point of view. It is realized that the internal genital apparatus and the female genital structure also exhibit a number of specific character, but these are beyond the scope of the present paper.

MATERIAL AND METHODS

The majority of the species used in this study were available in the Genetics Laboratory of The University of Texas. Most of the specimens used were taken from the living stocks maintained by this laboratory. A number of individuals were secured from the pinned specimens and several drawings were made from slide preparations made some time ago by Dr. Marshall R. Wheeler. We were also fortunate in receiving a large number of species from Switzerland through the courtesy of Mr. Hans Burla, and a smaller number of Brazilian species from Mr. Frota-Pessoa. Finally, there were available a number of Chinese species collected earlier by the author.

The pinned flies were bleached in 1 N NaOH for several days until they appeared clear and were then washed in tap water and dissected. In the case of fresh flies, or pinned specimens in which the genitalia were but weakly chitinized, the specimens were soaked in "cellosolve" (ethylene glycol monoethyl ether) and dissected directly. In dissection the internal apparatus was torn off and the hypopygium saved for study. The hypopygium was cut into two halves by the use of fine dissecting knives and these halves were passed through pure normal butyl alcohol and transferred directly into the mounting medium.

All the drawings were made with the aid of an Abbe camera lucida at the same magnification (ca 200X) and have been reduced to about half this size in the published figures.

THE EXTERNAL GENITAL APPARATUS OF MALE DROSOPHILA

For the purpose of the present study, it is not necessary to refer to the various parts of the internal genital organs. On the other hand, the terminology used by Salles *(op. cit.)* and most other authors for the external genitalia is not adequate for our descriptions. The external genital apparatus, or hypopygium, with which we are dealing, is composed of three main parts, namely, the genital arch, the anal plate, and the clasper. It is necessary to distinguish minor parts of these structures in order to give detailed descriptions of them and to discuss their comparative structures. Figure 1 is a hypothetical diagram representing all the possible parts in the hypopygium which will be referred to in the text.

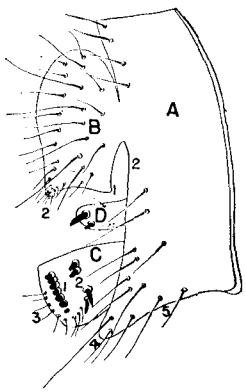

Fig. 1. A, Genital arch; 1. anterior margin; 2. posterior margin; 3. heel; 4. toe; 5. undermargin. B, Anal Plate: 1. rear angle; 2. tip. C, Primary Clasper: 1. primary teeth; 2. secondary teeth; 3. marginal bristles. D, Secondary Clasper.

The genital arch (Fig. 1, A) is actually an arch-like structure which, according to Salles' opinion, is the fusion product of 8T and 9T. In all the accompanying figures we are representing the right half of the hypopygium only.

The margin forming the right-hand border of the arch is called the dorso-anterior margin or simply the anterior margin (A-1). This margin connects in part with 6T and in part with 7T, coming downwards to an angle-like projection called the heel (A-3). The form of the heel varies in different species, being a very prominent horn-like process in the victoria group of Pholadoris, nearly rectangular in the funebris group and being entirely absent in the robusta group. Beginning from the heel, the margin (undermargin, A-5) runs inwards or downwards according to species. The direction, the curvature and hairiness of this margin are highly specific. The undermargin ends at the tip, known as the toe (A-4), which is again a good specific character. For instance, most species of the repleta group have the toe sharply pointed, but in other species it may be rounded or absent. The level of the toe as compared with the heel is also an important character (in the diagram, the level of the toe is lower than the heel). The posterior margin (A-2) is

less important except that in some cases it fuses with the anal plate and, more rarely, has outgrowths. As a rule the genital arch has more bristles on its middle and lower portions than on the upper half, which usually bears a few bristles arranged in a row running along the posterior margin.

The anal plate (B) is oval or oblong in shape in most cases. In a few species it is more or less triangular or kidney-shaped. In special cases, e.g., *D. histrio,* it has a long outgrowth. The bristles on the anal plate are often denser at the lower tip (B2), but in Siphlodora and a number of other species the tip may be absent, and without bristles on the lower portion. In the funebris group and some other species the anal plate possesses huge spikes which are, of course, excellent characteristics in identification. In some species groups, such as the quinaria group, there is a pronounced angle at the inner, lower portion of the anal plate, and is referred to as the rear angle (B-1). The anal plate is fused with the posterior margin of the genital arch in repleta group, virilis group, robusta group, etc.

The clasper is the most distinguishing part of male genital apparatus for taxonomic use. With the exception of the genus Gitona which lacks a true clasper, all genera so far studied have one or more pairs of claspers. The usual one is called the primary clasper (C), which, with very few exceptions, bears a row of heavily chitinized teeth-like structures known as the primary teeth (C-1) near its outer margin. On or very close to the outermargin of the primary clasper there is usually a semicircle of bristles, termed by us as the marginal bristles (C-3). The number of the teeth, their position, length, curvature of the row, the number of the marginal bristles, their pattern and degree of manifestation are all of remarkable value. Besides the primary teeth, the clasper may have extra teeth at various positions and in various numbers. These are referred to as secondary teeth (C-2).

Several species groups have additional claspers. The name "secondary clasper" (D) is not a definite term for there are several kinds of origins of the secondary clasper. For instance, the secondary clasper seems to have its origin in the separation of the lower portion of the anal plate in *D. auraria* and *D. rufa.* This is particularly true in *Scaptomyza graminum,* in which the secondary clasper is still fused with the anal plate by a bridge-like structure. In the saltans group the genital arch is rolled inwardly along its undermargin and is armed with horn-like processes at the edge. The rolled part forms a secondary clasper in the willistoni group, lying below the primary clasper. A number of other variations were noticed concerning the secondary clasper.

DESCRIPTIONS

Descriptions are made for each species. In definite species groups, the general characteristics for the group are presented under the group name, and descriptions for species refer to specific characters.

Genus Gitona

Gitona americana Patterson (Plate I-2).

Genital arch with anterior margin strongly convex; posterior margin and lower portion with about 21 bristles; heel roundish; a cylindric process bearing 2 short teeth is present on the toe region, pointing to the left. Anal plate separated, terminal region unknown. Clasper absent.

A single incomplete specimen from Big Bend Nat'l Park, Texas.

Gitona sonoita Wheeler (Plate I-1).

Like *G. americana* with following differences: posterior margin of genital arch with about 11 bristles; heel nearly absent; toe pointed downwards; 2 or 3 short teeth are present on the tip of toe, pointed downwards, no cylindric process.

A single incomplete specimen from Patagonia, Arizona.

Genus Sinophthalmus

Sinophthalmus pictus Coquillett (Plate I-3).

Genital arch uniformly broad, with about 12 bristles near posterior margin, only three of them on lower portion; heel rectangular; undermargin smooth; toe level nearly same as heel. Anal plate roundish, separated. Clasper one; primary teeth about 15,, dentate, not arranged in rows but irregularly distributed along outer margin; short bristles present on both upper and under surfaces.

A single specimen from Tonto Nat'l Forest, Arizona.

Genus Amiota

Amiota "kingstoni" Wheeler (Plate I–7).

Genital arch highly chitinized, anterior margin strongly convex; arch with 15–16 bristles, those on upper portion more or less arranged in a vertical row; heel absent; toe broadly roundish. Anal plate separated, oblong; no rear angle, no tip, the terminal portion with very dense bristles. Clasper one; primary teeth 11, occupying the middle portion of the outer margin, slightly convex; the first tooth about half as long as the rest; a finger-like process present at lower portion of clasper, with a few fine bristles.

A single specimen from Kingston Canyon, Nevada.

Amiota "arizonensis" Wheeler (Plate I-9).

Genital arch broader below; lower portion with a group of about 20–25 bristles along the convex undermargin; upper portion with 4–6 bristles along posterior margin; toe slightly pointed, not covering the clasper. Anal plate separated, long and narrow, no rear angle, no tip, bristles on plate very fine. Clasper one, long and relatively small, slightly constricted at middle; primary teeth 3, located at tip, hook-like; bristles on clasper fine, 12–14, all on lower portion of clasper.

Two specimens examined, one from Flagstaff, Ariz., the other from Tonto Nat'l Forest, Arizona.

Amiota "acadia" Wheeler (Plate I-4).

Genital arch broad, slightly elbowed; both margins chitinized; bristles along the posterior margin, in two rows or irregular, 6–9; lower portion with about 17–19 bristles. Anal plate separated, oblong, lower portion very densely bristled. Clasper one, primary teeth 5, unequal in length, first one shortest, fourth one longest (in a specimen from Michigan, clasper with 6 teeth) ; margin with a number of fine bristles.

Specimens examined: a single specimen from Jackson, Mich., and a number of specimens from Acadia Nat'l Park, Maine.

Amiota humeralis Loew (Plate I-5).

Genital arch with about 19 bristles, 6 of them along upper posterior margin, others distributed on lower portion; anterior margin broadly chitinized; heel a broad angle, toe roundish. Anal plate separated, small, long, oval, no rear angle, no tip, no densely bristled area. Clasper one, small; primary teeth about 7–8, occupying upper half of outer margin; a lobe-like process below the teeth, with fine bristles and hairs.

A single specimen from Acadia Nat'l Park, Maine.

Amiota leucostoma Loew (Plate I-8).

Genital arch strongly elbowed, with a row of about 5–8 bristles along upper portion of anterior margin and 20–22 evenly scattered bristles on lower portion; heel high and very prominent, nearly rectangular; undermargin slightly concave; toe portion long and pointed downwards. Anal plate separated, long and oval, no rear angle, no tip, no densely bristled area, bristles on plate rather long. Clasper one, roundish; primary teeth 5–6, long, arranged in a straight row, occupying the middle lower portion of outer margin; a number of fine bristles along outer and lower margins.

Specimens examined: Richmond, Virginia; Acadia Nat'l Park, Maine; Guarette, Maine.

Amiota "gigantea" Wheeler (Plate I-6).

Genital arch broad and roundish below; anterior margin nearly straight; heel broad and roundish, toe absent, undermargin strongly convex; bristles on arch over 30, continuous. Anal plate separated, oval, no rear angle, no tip, lower portion with denser bristles. Clasper one, primary teeth 8–12, arranged in a curve, first one or two shorter; there are about 3–4 short bristles above the teeth and two rows of stout bristles below teeth; also there are a number of thinner bristles at the outer lower corner.

Specimens examined: Acadia Nat'l Park, Maine; Guarette, Maine.

Genus Mycodrosophila

Mycodrosophila dimidiata Loew (Plate II-1).

Genital arch broader above and tapering below; anterior margin broadly chitinized below; bristles on arch forming a vertical row from top to bottom, lying midway between the anterior and posterior margins, 11–13; heel rather prominent; toe tapering, tip of toe below clasper. Anal plate oblong, separated, no rear angle, no tip, no densely bristled area, lower portion free from bristles. Clasper one; primary teeth 10-12, occupying almost the whole length of outer margin; marginal bristles few but long.

Specimens examined: Demopolis, Alabama.

Genus Paramycodrosophila

Paramycodrosophila mexicana Wheeler (Plate II-2).

Anterior margin of genital arch slightly concave; heel prominent; toe slightly lower, roundish; bristles present near the posterior margin, arranged in a straight row from top to bottom, 11. Anal plate oval, separated, lower portion broader, no tip, no densely bristled area. Primary teeth of clasper 4, located on lowest portion of outer margin; a tuft of long bristles surrounding teeth.

A single specimen from Jacona, Michoacán, Mexico.

Genus Zygothrica

Zygothrica dispar Wiedermann.

Genital arch with anterior and posterior margins parallel, gradually tapering to form a toe; heel absent; middle portion with 3 long bristles close to posterior margin, toe with 2 bristles. Anal plate unknown. Clasper with a concave row of teeth.

A single incomplete specimen from San Paulo, Brazil.

Zygothrica poeyi Sturtevant (Plate II–3).

Genital arch broad, anterior margin convex; heel prominent, undermargin sinuate, toe slightly lower, roundish; a row of 9 bristles near posterior margin, running from top to bottom; 4 minute bristles also present near undermargin. Anal plate separated; upper portion with bristles; lower portion free from bristles, being a highly chitinized, conical structure with a finger-like tip. Clasper relatively small, with about 12 huge bristles and about 10 shorter bristles, no teeth.

A single specimen from Peño de Gato, Mexico.

Genus Leucophenga

Leucophenga pulcherrima Patterson and Mainland (Plate III–1).

Genital arch broad, lower portion with about 9–11 bristles; upper portion with about 4 along posterior margin. Anal plate separated, oval, no rear angle, no densely bristled area. Clasper broad; primary teeth absent,

upper surface with about 6 bristles, undersurface and margins with about 30 bristles.

A single specimen from Coronado Nat'l Forest, Arizona.

Leucophenga varia Walker (Plate III-2).

Genital arch broad; anterior margin broadly chitinized on middle portion; there are 5 bristles along posterior margin and 2 bristles near heel; heel roundish. Anal plate oblong, separated. Outer margin of clasper straight, surface covered with fine hairs and a few sparse bristles; lower margin fringed with bristles; no teeth.

A single specimen from Oaxaca, Mexico.

Genus Rhinoleucophenga

Rhinoleucophenga obesa Loew (Plate II-4).

Genital arch broad, anterior margin strongly convex, heel with a constriction, giving a heart-shaped projection at bottom, with 9–11 bristles; upper portion of posterior margin with about 4–7 bristles. Anal plate separated, oblong, no rear angle, no tip, no densely bristled area. Clasper almost square; upper surface with about 13–18 bristles, 3 extraordinarily long bristles along the outer margin; no teeth, a number of fine bristles present along the margin, and a number of recurrent bristles on undersurface.

Specimens examined: one from Hidden Forest, Nevada; one from San Juan Nat'l Forest, Colorado.

Remarks: The figure of the male genitalia of this species shown by Malogolowkin (1946) do not agree with ours, having a large series of stout teeth on the clasper. Since Loew's type material came from Texas, it seems probable that the form studied by Malogolowkin is not *R. obesa* but a different species.

Genus Chymomyza

The general features of male genitalia of the five species studied are as follows:

Genital arch very broad above and narrow below, lower portion being a rod-shaped out-growth; bristles and hairs restricted at this rod-shaped portion, sockets usually large. Anal plate separated, oblong or oval, bristles on plate usually short. Clasper one, small, with a row of primary teeth, no secondary teeth, no marginal bristles.

Chymomyza procnemis Williston (Plate II-7).

Rod-shaped lower portion of genital arch narrow and uniform in width, with fine bristles. Clasper small, primary teeth 7–8, arranged in a convex row.

Specimens examined: stock from Galveston, Texas.

Chymomyza aldrichi Sturtevant (Plate II–6).

Genital arch very broad above, heel very pronounced; lower portion cylindric, much broader and shorter than *C. procnemis* and bearing longer

bristles. Anal plate oval, with longer bristles than *C. procnemis.* Clasper very small, primary teeth 6.

A single specimen from Earp, California.

Remarks: This species resembles *C. procnemis.*

Chymomyza mexicana Wheeler (Plate II–8).

Heel of genital arch well developed; rod-like lower portion rather long and broad, with uniform width and numerous bristles. Anal plate slightly triangular, with rear angle and tip, bristles sparse and short. Clasper small, primary teeth about 9, long and curved.

A single specimen from Peño de Gato, Mexico.

Chymomyza tetonensis Wheeler (Plate II–5).

Rod-shaped lower portion of the genital arch tapering and bearing numerous short bristles and large sockets. Anal plate long, narrow, slightly triangular, with moderate bristles. Primary teeth of clasper 6, extraordinary long and curved.

A single specimen from Teton National Park, Wyoming.

Remarks: This species resembles *C. mexicana.*

Chymomyza amoena Loew (Plate II–9).

Genital arch very broad above; rod-shaped lower portion strongly bent forwards; bristles and hairs present on the bent rod-like structure and along edges of lower portion; sockets large, especially those near tip; undersurface of arch with a tuft of bristles near the convex posterior margin. Anal plate long, lower portion with denser bristles. Primary teeth of clasper very long and curved, 9–11.

Specimens from Blue Mountain Lake, New York.

Genus Scaptomyza

Scaptomyza adusta Loew (Plate III-4).

Lower portion of genital arch with only 3 bristles at toe; posterior margin with a long, conical projection at middle portion; heel roundish, toe slightly lower, not covering the clasper. Anal plate separated, oval, bristles present on its upper half only. Clasper two sets; primary clasper semispherical, with 2 vertical rows of primary teeth, upper 9 and lower 7; secondary teeth about 19, distributed on middle and lower portions of clasper; secondary clasper connected with anal plate, small, with one large tooth and about 4 bristles at tip.

A single specimen from Aldrich Farm, Texas.

Scaptomyza hirsuta Wheeler (Plate III–3).

Genital arch simple, lower portion with about 9 bristles at heel and along undermargin, no bristles elsewhere; heel conical, toe high, roundish. Anal plate separated, very long; bristles definitely form two groups, the upper one has usual bristle pattern, the lower one is especially dense and the bristles are shorter and stouter; a long bristle-free region intervenes the

two groups. Clasper one, small; primary teeth 6–7, arranged in a straight row; marginal bristles about 5.

A single specimen from Peño de Gato, Mexico.

Scaptomyza nigrocella Wheeler (Plate III-8).

Genital arch broader below; lower portion with about 14–16 bristles condense at the toe region, middle and upper portions none; heel absent, toe pointed downwards. Anal plate separated; more or less triangular, with roundish rear angle; outer margin nearly straight; tip pointed, free from bristles, no densely bristled area. Clasper broad, short, low; primary teeth 14, short and blunt, occupying nearly the whole outer margin, slightly concave; marginal bristles long, undersurface of clasper with numerous bristles.

A single specimen from Jasper, New York.

Scaptomyza terminalis Loew (Plate III–7).

Genital arch broad above and narrow below; lower portion with about 11 bristles, the first four arranged in a vertical row, others condensed at toe. Anal plate separated, oval, bristles longer and more numerous on upper portion. Clasper small, primary teeth about 9–10, in two groups, upper one with 2–3 and lower one with 7 teeth, both oblique; marginal bristles 14–15, arranged in a semicircle.

A single specimen from Caliente, Nevada.

Scaptomyza montana Wheeler (Plate III–9).

Genital arch broad, lower portion with about 16 bristles at toe, middle portion with one; heel very broad, nearly absent, high; toe pointed downwards. Anal plate separated, bristles sparse, tip roundish, with no dense bristles. Clasper wide and short; primary teeth about 18, short and blunt, arranged in a concave row; lower margin with a row of stout bristles, undersurface with a number of stout bristles on lower half.

A single species from Glacier Nat'l Park, Montana.

Remarks: This species resembles *S. nigrocella.*

Scaptomyza graminum Fallén (Plate III-5).

Genital arch heavily chitinized along the upper half of anterior and posterior margins; 2 bristles at heel and 2 near posterior margin; undermargin concave; toe long and tapering, fringed with fine hairs on its upper side. Anal plate bent at middle, the upper part like ordinary anal plate, bearing bristles; the lower part in the form of a secondary clasper, bent, protruded, bearing one very large tooth at tip, one or two smaller teeth above the large one, and 4–5 stout bristle-like teeth below, also there are two very long and a group of 5–6 shorter bristles on this portion; the middle part less chitinized, incised, free from bristles. Clasper long and arched, bow-shaped; the arch coincides with the incision of undermargin of genital arch; a row of more than 20 long, bristle-like teeth is present

along the lower margin of clasper; a group of long bristles is also present at tip of clasper.

Many specimens from Jasper, New York.

Scaptomyza vittata Coquillett (Plate III-6).

Genital arch very broad, anterior margin sinuate, broadly chitinized above; heel sharply pointed down, with 3 huge and 1 smaller bristle; undermargin concave; toe roundish, nearly absent; posterior margin with a very long, big finger-like outgrowth. Anal plate separated, roundish, bristles present on its upper half only. Clasper one, oval, with about 18 bristles on its lower half, no teeth.

A single specimen from Peño de Gato, Mexico.

Genus Drosophila

Subgenus **Hirtodrosophila**

Duncani group

Drosophila duncani Sturtevant (Plate IV–1).

Genital arch broadly chitinized along anterior margin, lower portion with about 6–7 fine bristles along anterior margin and one huge bristle at tip of toe; heel nearly absent, toe pointed downwards. Anal plate roundish, separated, with no densely bristled tip. Primary clasper fan-shaped; primary teeth 14, arranged in a convex row; secondary clasper large, broad above and tapering below, bearing 2 long and numerous short, teeth-like bristles.

Specimens examined: Stock from Morrilton, Arkansas.

Longala Group

Heel of genital arch very prominent and pointed; undermargin even, toe nearly at same level as heel, pointed forwards, bristles continuous from top to bottom near posterior margin. Anal plate separated, large, rear angle present, tip area with dense hairs and bristles. Clasper two sets, primary clasper (inner process of Pomini) with a finger-like spur on top, primary teeth 6–7, may have some smaller teeth on the margin; secondary clasper (medium process) underneath the primary clasper, large, triangular, with strong teeth and marginal bristles.

Drosophila longala Patterson and Wheeler (Plate IV-3).

Genital arch with 18–19 bristles. Anal plate with rear angle less prominent. Primary teeth of primary clasper 7; 3 big teeth on secondary clasper, marginal bristles on secondary clasper numerous.

A single specimen from Zacatecas, Mexico.

Drosophila grisea Patterson and Wheeler (Plate IV–2).

Genital arch with 18 bristles. Anal plate with well developed rear angle. Primary clasper with 6 primary teeth, and 3 smaller teeth on margin; secondary clasper with 4 very large teeth, and 8 marginal bristles.

A single specimen from Chiricahua Mts., Arizona.

Cinerea Group

Drosophila cinerea Patterson and Wheeler (Plate IV–5).

Middle and lower genital arch with 12 bristles. Anal plate unknown. Clasper one, primary teeth 7, arranged in a straight row, occupying the upper 2/3 of outer margin; secondary teeth 7, along the lower margin of the clasper; marginal bristles 13, highly magnified and stout.

A single incomplete specimen from Nebraska.

Drosophila orbospiracula Patterson and Wheeler (Plate IV–4).

Anterior margin of genital arch strongly sinuate and chitinized, heel pronounced, toe roundish, at same level as heel; middle and lower portions of arch with about 13 bristles, upper portion 3. Anal plate with rear angle and tip, and an incision near tip. Clasper one, primary teeth 7, located on middle of outer margin, arranged in a concave row; secondary teeth 2, very strong, below the primary teeth, marginal bristles very stout, about 6.

A single specimen from Big Bend State Park, Texas.

Subgenus **Pholadoris**

Victoria Group

Genital arch broad below, densely bristled on lower portion; heel with a horn-like process; toe roundish, broad, covering the clasper a little. Anal plate separated, with dense bristles, especially at tip; no rear angle, Clasper one, with a lobe-like prolongation below primary teeth, primary teeth arranged in a concave row; numerous fine recurved hairs on clasper, no secondary teeth.

D. nitens Buzzati-Traverso (figured by Buzzati-Traverso, 1943) apparently belongs to this group.

Drosophila victoria Sturtevant (Plate IV–6).

Lower portion of genital arch with numerous bristles, upper portion with 6; undermargin concave. Primary teeth of clasper about 12, lobe-like prolongation less prominent.

Specimens examined: Stock from Prescott Nat'l Forest, Arizona.

Drosophila lebanonensis Wheeler (Plate IV–7).

Undermargin of genital arch not concave. Bristles on anal plate less dense, lobe-like process prominent, primary teeth about 9.

Specimens examined: Stock from Beirut, Syria.

Mirim Group

Genital arch broad below, lower portion with a few bristles; heel approximately rectangulary; toe slightly higher in level; undermargin smooth; toe broad and roundish. Anal plate separated, bristles fine and not dense, no rear angle, tip bristles not dense. Clasper small, one; more or less triangular, scarcely projecting from under the genital arch; primary teeth around 8, arranged in a straight row, no secondary teeth.

Drosophila baeomyia Wheeler (Plate IV–8).

Lower portion of genital arch with about 8 bristles.

Specimens examined: Stock from Zamora, Michoacán, Mexico.

Ungrouped Species

Drosophila coracina Kikkawa and Peng (Plate IV-9).

Genital arch broad below, lower portion with about 13–15 bristles, upper portion with 4–5; heel roundish; toe broad and roundish. Anal plate separated, oval; no rear angle. Clasper one, small, primary teeth about 12, arranged in a straight row.

Specimens examined: Meitan, China.

Subgenus **Dorsilopha**

Drosophila busckii Colquillett (Plate V-1).

Anterior margin of genital arch convex; middle and lower portions with about 21 bristles, upper portion with 2–3; heel roundish; toe nearly absent. Anal plate separated, with roundish tip. Clasper one, primary teeth 11–12, occupying nearly the whole outer margin, the upper 2–3 teeth may be located irregularly; teeth rather long and pointed, marginal bristles long and stout, 3–5.

Specimens examined: Switzerland, China, and stock from Aldrich Farm, Texas.

Subgenus **Phloridosa**

Drosophila floricola Sturtevant (Plate V-2).

Genital arch with a vertical row of 3 bristles at toe; heel present, toe sharply pointed. Anal plate oval, separated, tip prominent, with dense hairs. Clasper one, upper portion with a large expansion, primary teeth 6, located on lower half of outer margin; marginal bristles in a semicircle, 9; no secondary teeth.

A single specimen from Chila, Puebla, Mexico.

Drosophila lutzii Sturtevant (Plate V-3).

Genital arch narrow, lower portion with 7 bristles, heel a very broad angle, toe pointed downwards, not covering clasper. Fusion of anal plate unknown, the single specimen shows an indication of fusion on middle-lower portion; tip with dense bristles. Clasper one, primary teeth 6, situated on middle portion of outer margin, arranged in a straight row; marginal bristles 9, only 2 underneath teeth; no secondary teeth.

A single specimen from Brazil.

Subgenus **Siphlodora**

Drosophila sigmoides Loew (Plate V-5).

Genital arch rather broad; middle and lower portions with about 15 bristles, upper portion with 4; heel broad; toe low, pointed downwards, with about 5 stout bristles, not covering clasper. Anal plate semispherical, fusion unclear in this single specimen; bristles on plate very long, no

tip, no densely-bristled area, lower portion with few bristles. Clasper one, short and broad; primary teeth about 10, arranged in a straight row, no secondary teeth.

A single specimen from Alabama.

Drosophila subsigmoides Patterson and Mainland (Plate V-4).

Similar to *D. sigmoides,* lower portion of genital arch with about 16 bristles, upper portion with 3; heel broad, toe pointed downwards, far below the clasper. Primary teeth of clasper about 9.

A single specimen from Oaxaca, Oax., Mexico.

Subgenus **Sordophila**

Drosophila acanthoptera Wheeler (Plate VI-1).

Genital arch rather broad, especially the lower portion, undermargin with about 10–11 bristles. Anal plate separated, long and tapering; no rear angle. Clasper short but very broad; primary clasper with 6–7 primary teeth, occupying the middle of outer margin; below the teeth is a group of bristles varying in number; secondary teeth two groups: one on central part of clasper, always only a single tooth, the other group with 2–4 teeth, mostly 2, on upper portion of clasper; secondary clasper always underneath the primary one, bearing one small tooth.

Specimens examined: Stock from Oaxaca, Oax., Mexico.

Subgenus **Sophophora**

Saltans Group

Genital arch narrow above and very broad below; lower portion, with the exception of *D. sturtevanti,* rolled inwards; one or more horn-like processes always present on the edge of rolled part. Anal plate separated, with rather dense bristles, no rear angle. Clasper one, primary teeth in two or more rows, lying parallel or irregular.

Drosophila prosaltans Duda (Plate V-7).

Middle and lower portions of genital arch with about 11 bristles, upper portion 2; heel very prominent, rolling rather wide; horn-like process one, tapering, with wide base. Anal plate narrow, with less dense bristles. Clasper small, primary teeth clustered in a large group, about 25, lower portion of clasper with a group of bristles.

Specimens examined: Stock from Tamazunchale, Mexico.

Drosophila rectangularis Sturtevant (Plate V-9).

Middle and lower portions of genital arch with about 15–17 bristles, upper portion with 1–2; rolling of undermargin wide; horn-like process one, sword-shaped. Anal plate oblong, with rather dense bristles. Clasper small, primary teeth about 26, arranged in two irregular rows, bristles on lower portion of clasper always hidden behind arch and the process.

Specimens examined: Stock from Barrouca de Metlac., Mexico.

Drosophila emarginata Sturtevant (Plate V-6).

Genital arch very large and extremely broad below, middle and lower portion with more than 20 bristles, upper portion with about 5; rolling of arch very wide; undermargin with numerous hairs, horn-like processes two, all hidden behind arch, one sword-shaped, pointed upwards and one cylindric, pointed forwards. Anal plate small and roundish, bristles very dense. Clasper long, kidney-shaped, primary teeth short and blunt, more than 23, arranged in two irregular rows, lower portion of clasper with numerous bristles.

Specimens examined: Stock from Oaxaca, Oax., Mexico.

Drosophila sturtevanti Duda (Plate V-8).

Lower portion of genital arch not rolled, bristles on arch about 18–21, most of them on middle portion; horn-like process one, arising from heel, not covered by arch. Anal plate narrow, lower portion with denser bristles. Clasper two sets, upper one small, probably the primary one, with a row of primary teeth, about 10–12, and a tuft of bristles at end of teeth row; lower clasper large, bulging, conspicuous, with 6–9 irregularly arranged teeth across the middle.

Specimens examined: Stock from Quirigua, Mexico.

Willistoni Group

Genital arch very broad below, with bristles on lower portion and along inner margin (in D. fumipennis bristles are distributed evenly on the surface of arch); heel rather pronounced, undermargin folded in, often with fine hairs, toe not sharp. Anal plate narrow, separated, with short fine bristles. Clasper two sets, primary clasper small, primary teeth 11–17, unequal in length, no secondary teeth; secondary clasper tube-like, below the primary one, arising from the fold of genital arch, having one tooth at tip and one or two fine bristles.

Drosophila willistoni Sturtevant (Plate VI-3).

Anterior margin of genital arch broadly chitinized, especially the middle portion; posterior and undermargins nearly straight; lower portion with about 11–12 bristles, heel nearly rectangular; toe slightly wider than a rectangle, roundish; folding of undermargin near toe. Primary teeth of clasper 16–17, arranged in a convex row, tooth on secondary clasper small.

Specimens examined: Stock from Oaxaca, Oax., Mexico.

Drosophila nebulosa Sturtevant (Plate VI-4).

Lower portion of genital arch with about 13 bristles, upper portion with about 5 along posterior margin; undermargin convex, with numerous hairs, toe lobe-like, roundish. Primary teeth of clasper about 12, arranged in a slightly concave row, tooth on secondary clasper large.

Specimens examined: Stock from Monterrey, Nuevo Leon, Mexico.

Drosophila equinoxialis Dobzhansky (Plate VI-5).

Genital arch very broad below, anterior margin broadly chitinized on lower half; lower portion with about 8 bristles, upper portion with 3 along posterior margin; heel roundish; undermargin with a slit and bearing fine hairs; toe roundish. Clasper with about 15 primary teeth, 5 of them especially long, tooth on secondary clasper small.

Specimens examined: Stock from Teffe, Brazil.

Drosophila fumipennis Duda (Plate VI-6).

Genital arch very narrow above and broad below, anterior margin very broadly chitinized, bristles distributed widely over the posterior half, about 12–14; undermargin nearly straight, bearing numerous fine bristles. Primary teeth of primary clasper about 9–11, arranged in a concave row; tooth on secondary clasper small.

Specimen examined: Stock from Cantoreira, Brazil.

Drosophila sucinea Patterson and Mainland (Plate VI-7).

Genital arch very broad below, lower portion with about 15–17 bristles, upper portion with 4 along posterior margin; heel protruded; undermargin with incision, toe roundish. Primary teeth 11–13, the middle ones short; tooth on secondary clasper very large.

Specimens examined: Stock from Puebla, Mexico.

Alagitans Group

The characteristics of alagitans group are almost identical with those of the willistoni group, with but one exception, i.e., there are 2 primary teeth rows on clasper of alagitans group but only a single row in willistoni group.

Drosophila alagitans Patterson and Mainland (Plate VI-8).

Genital arch with about 38 bristles, among which 5–6 on the upper and middle portions; toe slightly higher; undermargin slightly concave, rolled in, with hairs on the margin. Anal plate oblong. Primary teeth of clasper in 2 rows, overlap at middle, upper row with about 7 teeth, lower row with about 11 teeth; secondary clasper with a large tooth at tip and 2 bristles.

A single specimen from Valle de Michoacan, Mexico.

Drosophila capnoptera Patterson and Mainland (Plate VI-9).

Genital arch very broad, upper portion with about 2–4 bristles, lower portion with 21; toe slightly lower in level, expanded; undermargin rolled in, bearing hairs. Anal plate and clasper like *D. alagitans*, upper row of primary teeth with about 6 and lower row with about 12 teeth; secondary clasper with a very large tooth at tip and one bristle.

A single specimen from La Placita, Hidalgo, Mexico.

Melanogaster Group

Drosophila ananassae Doleschall (Plate VII-3).

Genital arch wider below; middle and lower portion with numerous bristles, upper portion with a row of 6 or more bristles along posterior margin; heel an obtuse angle; undermargin slightly convex, toe low, pointed forwards; posterior margin with a lobe-like expansion covering a small part of primary clasper. Anal plate oval. Clasper two sets, the primary clasper fig-shaped; primary teeth in two sets, with a gap between upper and lower ones, the former with about 4–5 teeth and the latter with about 2–4 teeth; marginal bristles stout, about 9; there are two more bristles lying underneath marginal bristles, one of them especially large; secondary clasper above primary one, small, with a huge tooth at tip and several small bristles at base.

Specimens examined: San Antonio, Texas; Meitan, China.

Remarks: *D. ananassae* of Brazil described and figured by Malogolowkin (1948) seems to be identical with ours.

Drosophila melanogaster Meigan (Plate VII-1).

Genital arch with about 29–33 bristles, running from top of posterior margin along that margin down to toe; heel roundish, nearly absent, toe low, pointed downwards; posterior margin with a process covering the upper part of clasper. Anal plate oval, with denser bristles on lower portion. Clasper one, long and narrow, primary teeth arranged in a sinuate row, the upper 4 or 5 teeth covered by the process of posterior margin of arch; lower portion with two irregular rows of teeth, about 13–17; there is a tuft of bristles at the tip of clasper surrounded by teeth, one of the bristles especially long and usually pointed upwards.

Specimens examined: Stocks from Stephenville, Texas; Hangchow, China.

Drosophila simulans Sturtevant (Plate VII-2).

Genital arch with about 19–28 bristles, running from top of posterior margin and along this margin down to toe; heel nearly absent, toe pointed downwards; posterior margin with a very large process. Anal plate small, oval, slightly tapering, bristles denser on lower portion. Clasper one, long and narrow, covered by the process of posterior margin of arch; primary teeth arranged in a slightly irregular vertical row, 10–13; tip of clasper with a tuft of marginal bristles.

Specimens examined: Chinook, Montana.

Drosophila takahashii Sturtevant (Plate VII-9).

Genital arch long, both anterior and posterior margins sinuate; lower portion bag-like, far below clasper, with numerous fine bristles and hairs; upper portion with about 2 bristles. Anal plate small and roundish, with dense fine bristles. Clasper one, primary teeth long, about 14, arranged in a convex row, secondary teeth 2, on upper-inner corner; bristles few.

Specimens examined: Meitan, China; Hangchow, China.

Drosophila montium de Meijere (Plate VII-4).

Lower portion of genital arch with a big tuft of bristles at toe, posterior margin with a row of bristles; heel absent, toe pointed downwards, not covering clasper. Anal plate nearly quadrilateral, no bristled tip, nor highly magnified teeth. Claspers two sets; primary clasper sinuate in outline, with a conical projection on outer margin; primary teeth about 5, arranged in a straight row, lying at basal portion of clasper; secondary teeth very long, 9–10, arranged in an irregular pattern, apparently magnified marginal bristles; secondary clasper cylindrical, lying below anal plate, with 2 very large teeth, the lower one especially large, basal portion of secondary clasper with a few short bristles.

Specimens examined: Meitan, China; Hangchow, China.

Drosophila auraria Peng (Plate VII-6).

Anterior margin of genital arch convex; middle and lower portions with about 20 bristles, upper portion with 6 or more; heel absent, toe roundish, pointed downwards, low; a sharply pointed outgrowth present on posterior margin just above primary clasper. Anal plate small and roundish, with 2 large teeth at tip. Clasper two sets, primary clasper with a row of straight primary teeth, about 8; marginal bristles becoming large teeth, clustered at lower tip, 7–8; secondary clasper small and roundish, lying just below anal plate, with 2–3 very large, curved and equal sized teeth and a number of tiny bristles.

Specimens examined: Meitan, China; Hangchow, China.

Drosophila rufa Kikkawa and Peng (Plate VII-5).

Genital arch broad; lower portion with about 17 bristles, upper portion with a row of bristles along posterior margin; heel slightly observable; toe low, broad and roundish. Anal plate small and roundish, with 2 teeth on lower tip. Clasper two sets; primary clasper not covered by arch; primary teeth 6, arranged in a straight row; marginal bristles highly magnified into secondary teeth, about 8, clustered at tip; secondary clasper just below anal plate, with invariably 3 very large, curved teeth and a number of small bristles.

Specimens examined: Meitan, China; Hangchow, China.

Drosophila suzukii Kamizawa (Plate VII-7).

Genital arch slightly constricted at middle, with an irregular row of bristles along posterior margin; heel absent, toe with a bristle-bearing tube-like process. Anal plate oval. Clasper one, large, with tapering tip; primary teeth in two separate rows, upper one straight, 10–11, lower one; marginal bristles also in two sets, upper one 5, underneath the upper teeth row; lower one 3, at the pointed tip.

Specimens examined: Meitan, China; Hangchow, China.

Drosophila pulchrella Tan, Hsu, and Sheng (Plate VII-8).

Genital arch constricted at middle; upper portion with about 4 bristles, lower portion with about 10 along posterior margin; heel roundish, nearly

absent, with a group of about 12 bristles; toe with a bristle-bearing finger-like process. Anal plate small, oval. Clasper large, without tapering tip; primary teeth in two rows, upper one 7, arranged in a straight row; lower one 4; marginal bristles stout, also in two rows, upper one 4, lower one at tip, 6.

A single specimen from Meitan, China.

Obscura Group

Genital arch broad below, bristles along posterior margin and at toe, some of them especially large; toe low, pointed downwards or curved forwards. Anal plate oblong, separated, bearing short but stout bristles, tip long, with dense bristles. Clasper two sets, like those of the longala group of Hirtodrosophila, primary clasper (inner process of Pomini) small, highly chitinized, lying on the center of secondary clasper (medium process), the two looked like a single clasper; primary teeth a single straight row; secondary clasper larger, having short bristles.

Drosophila pseudoobscura Frolowa (Plate VIII-1).

Lower portion of genital arch with about 12–13 bristles, upper portion with about 6; heel roundish, toe pointed downwards. Primary clasper with a long and crooked chitinized process; primary teeth 6–8; secondary teeth 4, parallel to the primaries; secondary clasper with teeth on lower portion and a number of short fine bristles at tip.

Specimens examined: Stock from Mexico City, Mexico.

Drosophila obscuroides Pomini (Plate VIII-2).

Lower portion of genital arch with about 18–21 bristles, upper portion with 7–9; heel very high, toe sharp. Primary teeth 8–9, primary clasper with no crooked spur-like process, secondary clasper with less than 20 fine bristles at tip.

Specimens examined: Switzerland.

Drosophila bifasciata (Plate VIII-3).

Lower portion of genital arch with about 15–18 bristles, upper portion with 6–7; toe with roundish tip. Primary clasper with a short conical chitinized process; primary teeth 8–9, secondary clasper with a group of fine, long bristles.

Specimens examined: Switzerland.

Drosophila helvetica Burla (Plate VIII-4).

Lower portion of genital arch with about 12 bristles, upper portion with about 6; toe roundish. Primary clasper with broad chitinized process; primary teeth 8–9, unequal in length, the middle 3 or 4 longest; secondary clasper broad and roundish, with short fine bristles.

Specimens examined: Switzerland.

Drosophila subobscura Collin (Plate VIII-5).

Middle and lower portions of genital arch with about 17 bristles, upper portion with about 5 bristles; toe broad and roundish. Primary clasper with no prominent process; primary teeth 6–7, bristles on secondary clasper in a single row along margin, short and thin.

Specimens examined: Switzerland.

Drosophila algonquin Sturtevant and Dobzhansky (Plate VIII-6).

Lower portion of genital arch with about 15 or more bristles, upper portion with about 6–9; toe slightly bent forwards. Primary clasper with long, crooked spur; primary teeth 7–9, secondary clasper with a tuft of thin but long bristles at tip.

Specimens examined: Stock from Wichita, Kansas.

Drosophila affinis Sturtevant (Plate VIII-7).

Middle and lower portions of genital arch with about 15 or more bristles, upper portion with about 7; heel roundish, toe strongly bent forwards. Primary clasper with crooked process, primary teeth 8–11, mostly 9; secondary clasper with about 24 fine bristles.

Specimens examined: Stock from Black Hill Nat'l Forest, South Dakota.

Drosophila narragansett Sturtevant and Dobzhansky (Plate VIII-8).

Lower portion of genital arch with about 12 or more bristles, upper portion with about 7. Primary clasper with crooked process; primary teeth 8–9, secondary clasper with many short but stout bristles.

Specimens examined: Stock from Acadia Nat'l Park, Maine.

Drosophila azteca Sturtevant and Dobzhansky (Plate VIII-9).

Lower portion of genital arch with about 13–14 bristles, upper portion with about 4; toe bent forwards. Primary clasper with a crooked process, primary teeth 4–6, secondary clasper with a group of stout curved bristles.

Specimens examined: Stock from Durango, Mexico.

Nannoptera Group

Drosophila nannoptera Wheeler (Plate VI-2).

Anterior and posterior margins of genital arch nearly parallel, undermargin with 6–7 bristles; heel pointed downwards; toe slightly higher, very small; arch does not cover clasper at all. Anal plate separated, very long. Clasper one, very large; primary teeth in 2 rows, anterior one with 10–11 teeth, posterior one 7–9; a lobe-like process is present on the gap between two teeth rows, bearing 6–7 stout marginal bristles; secondary teeth in 2 series, first one being a scattered row of about 7–9 long, rod-shaped teeth above the anterior primary teeth, second series being a cluster of about 8 short, stout teeth at the corner near toe.

Specimens examined: Stock from Oaxaca, Oax., Mexico.

Subgenus **Drosophila**

Quinaria Group

Genital arch often highly chitinized on upper and middle portions; along lower border of the chitinized area, there is an oblique row of bristles; there is also a piece of chitinized area connecting the primary teeth and the chitinized arch; heel often an obtuse angle; toe low, not covering clasper. Anal plate separated, with rear angle; tip hairs not very dense. Clasper one, extending below the toe; primary teeth arranged in a straight row; secondary teeth present, distributed on rear portion of clasper (except *palustris, subpalustris,* and *limbata*), often longer and more slender than the primaries; marginal bristles not stout.

Drosophila quinaria Loew (Plate IX-1).

Lower portion of genital arch with about 12 bristles of which 9 along chitinized border; chitinized connection not very broad. Primary teeth of clasper occupying upper half of outer margin, 8 or less, last 1 or 2 not closely connected with the rest; secondary teeth about 10–11, distributed on rear portion of clasper.

Specimens examined: Stock from Currie, Minnesota.

Drosophila subquinaria Spencer (Plate IX-2).

Genital arch moderately chitinized, lower portion with 10–11 bristles, of which 4 along chitinized border; chitinized connection weak and thin; heel rather pronounced. Anal plate with prominent rear angle. Primary teeth of clasper about 5–6, located on upper portion of outer margin, the last one not closely connected with the rest; secondary teeth 6–7.

Specimens examined: Stock from Lake Irvine, North Dakota.

Drosophila munda Spencer (Plate IX-6).

Genital arch moderately chitinized, lower portion with about 9–11 bristles, of which 5 or 6 along chitinized border. Primary teeth of clasper 9–10, rather long; secondary teeth 11–14, rather long, distributed on the whole rear half.

Specimens examined: Stock from Black Hill Nat'l Forest, South Dakota.

Drosophila tenebrosa Spencer (Plate IX-4).

Genital arch very strongly chitinized, lower portion with about 13 bristles, of which 8 along chitinized border; chitinized connection very broad and strongly chitinized; heel rather pronounced. Anal plate rather compact and roundish, rear angle not very pronounced. Primary teeth of clasper about 9, secondary teeth about 12.

Specimens examined: Stock from Medicine Park, Oklahoma.

Drosophila innubila Spencer (Plate IX-7).

Genital arch broad and strongly chitinized, lower portion with about 12 bristles, of which 6 along the chitinized border; chitinized connection

rather broad; heel pronounced. Clasper with 12 primary teeth and 9–10 secondary teeth.

Specimens examined: Stock from Lincoln Nat'l Forest, New Mexico.

Drosophila palustris Spencer (Plate IX-5).

Genital arch moderately chitinized, lower portion with about 9 bristles, of which 7 along the chitinized border. Primary teeth of clasper about 12, secondary teeth stout, 34–35, distributed all over the surface of clasper.

Specimens examined: Stock from Bemidji, Minnesota.

Drosophila subpalustris Spencer.

Like *D. palustris*, primary teeth 10, secondary teeth 20–28, distributed all over the clasper.

Specimens examined: Stock from Richmond, Virginia.

Drosophila transversa Fallen (Plate IX-3).

Lower portion of genital arch with about 13–20 bristles arranged in 2 or more oblique rows. Primary teeth of clasper 11–12, occupying the upper 4/5 of outer margin; secondary teeth 13–14, on lower portion, marginal bristles rather stout, about 7.

Specimens examined: Switzerland.

Remarks: The American *transversa* differs from the typical European *transversa* considerably. Its genital arch has about 11 bristles on lower portion, of which 6 are along the chitinized border and arranged in a single oblique row like the ordinary *quinaria*. It has only about 9 primary teeth occupying the upper half of the outer margin. Secondary teeth about 11, distributed on lower portion of the clasper. It may not be the true *transversa*. The *transversa* from China may be still another species.

Drosophila phalerata Meigan (Plate IX-9).

Genital arch with 11–13 bristles on lower portion, of which 4–5 along chitinized border. Anal plate rather large. Primary teeth of clasper about 17–19, occupying upper half of outer margin; secondary teeth 12–14, on lower portion.

Specimens examined: Switzerland.

Drosophila limbata von Roser (Plate IX-8).

Genital arch with about 10–13 bristles on lower portion, of which 6–7 along chitinized border and 4–6 at toe; posterior margin concave. Anal plate large. Primary teeth of clasper about 13–14, occupying the upper 4/5 of outer margin; secondary teeth short and blunt, 17–18, widely distributed; marginal bristles 14–16, a part of them form a group occupying the rest 1/5 of outer margin.

Specimens examined: Switzerland.

Guttifera Group

Drosophila guttifera Walker (Plate X-1).

Middle portion of genital arch with 2 strong bristles, lower portion with 7 or more; anterior margin highly chitinized; heel prominent; undermargin rather straight and membraneous; toe level nearly same as heel, not covering clasper. Anal plate oblong, separated, rear angle not very pronounced, tip well developed. Clasper one, compact; primary teeth 7–9, mostly 9; secondary teeth 10–13, mostly 12, condensed at lower part.

Specimens examined: Stock from Morrilton, Arkansas.

Virilis Group

Genital arch with rather dense bristles on lower portion, upper portion usually free from bristles; heel rectangular or roundish; toe same level as or slightly lower than heel, pointed or roundish, covering clasper or not. Anal plate roundish, fused with arch along lower half, tip region with short but rather stout bristles. Clasper one, often small; primary teeth 5–7, arranged in a straight row; marginal bristles fine.

Drosophila virilis Sturtevant (Plate X-2).

Genital arch foot-shaped, lower portion with about 16–19 bristles; heel rectangular; undermargin straight; toe same level as heel, slightly pointed upwards, covering clasper. Clasper roundish; primary teeth 6–7, mostly 6.

Specimens examined: Stock from Pasadena, California.

Drosophila americana Spencer and *Drosophila americana texana* Patterson, Stone, and Griffen.

Similar to *D. virilis* with only a few minor differences: heel an obtuse angle; undermargin slightly convex, toe same level, pointed forwards, covering a part of clasper, primary teeth 5–7.

Specimens examined: *D. americana,* Anderson, Indiana; *D. americana texana,* New Orleans, Louisiana.

Drosophila novamexicana Patterson.

Similar to *D. virilis,* with but a few minor differences: toe lower, pointed downwards, covering a part of clasper.

Specimens examined: Stock from Gila, New Mexico.

Drosophila montana Patterson and Wheeler (Plate X-3).

Genital arch rather broad, lower portion with about 20 bristles; heel roundish; toe slightly lower, roundish, pointed downwards, not covering clasper. Primary teeth of clasper about 6–7.

Specimen examined: Stock from Salt Lake City, Utah.

Drosophila lacicola Patterson (Plate X-4).

Genital arch rather narrow, lower portion with 14 or more bristles; heel roundish; toe broadly roundish, like an expansion. Primary teeth of clasper 5–6, mostly 5.

Specimens examined: Stock from Fairbanks, Minnesota.

Tripunctata Group

Drosophila tripunctata Leow (Plate X-7).

Genital arch with 4–5 bristles at toe and 1 or 2 bristles above clasper; heel nearly rectangular, undermargin concave and then curved downwards, giving rise to a long toe pointed downwards, not covering clasper; chitinized connection present. Anal plate separated, rear angle present, tip not well developed, but with dense bristles. Clasper one, triangular in outline; primary teeth 9, occupying the middle of clasper; marginal bristles short but numerous, irregularly arranged in a semicircle.

Specimens examined: Stock from New Orleans, Louisiana.

Drosophila unipunctata Patterson and Mainland (Plate X-8).

Like *D. tripunctata* with following differences: genital arch with only 1 bristle at toe; heel with a spur-like projection; toe shorter and broader; anal plate larger, clasper smaller, primary teeth 6–7, marginal bristles about 10, stouter.

A single specimen from Sedeño Canyon, Arizona.

Drosophila crocina Patterson and Mainland (Plate X-9).

Middle and lower portions of genital arch with about 9 bristles arranged in an oblique row; heel nearly absent; toe roundish, pointed downwards, not covering clasper. Anal plate separated, roundish, rear angle present. Clasper fig-shaped, primary teeth about 7, arranged in a straight row; secondary teeth 4, long and sharp, above the primaries.

Specimens examined: Stock from Barrauca de Metlac, Mexico.

Testacea Group

Genital arch with bristles only at toe; chitinized connection present. Anal plate separated, with pronounced rear angle and tip. Clasper one, with lobe-like expansion above; primary teeth arranged in a straight row, about 12–14; marginal bristles in a half circle; no secondary teeth.

Drosophila testacea von Roser (Plate X-5).

Genital arch with only one or two bristles at toe; heel roundish; undermargin smoothly curved; toe roundish. Expansion of clasper conical, primary teeth 12–14, marginal bristles about 10.

Specimens examined: Stock from Superior Nat'l Forest, Minnesota.

Drosophila putrida Sturtevant (Plate X-6).

Genital arch with 2 bristles at toe; heel nearly rectangular; toe roundish. Expansion of clasper rather large, primary teeth about 12; marginal bristles 9–10.

Specimens examined: Stock from Palmetto, Texas.

Funebris Group

Genital arch very broad, free from bristles except those at toe; heel often very pronounced; toe lower, pointed downwards, not covering clasper.

Anal plate more or less triangular, separated, with large spikes on its outer and lower margins. Clasper one, teeth rather long, secondary teeth present or bristle-like.

Drosophila funebris Fabricius (Plate XI-1).

Genital arch very broad, with 6 teeth at toe. Anal plate with 10–20 large spikes, curvature of spikes clockwise. Clasper roundish, primary teeth about 12; secondary teeth 4–5, short and blunt; marginal bristles 5–6.

Specimens examined: Stock from Fredericksburg, Texas.

Drosophila subfunebris Stalker and Spencer (Plate XI-2).

Genital arch with 2–4 short but stout bristles at toe; heel very prominent; undermargin slightly concave; toe pointed downwards, roundish. Anal plate with about 7–8 large spikes along outer and lower margins, curvature of spikes counter clockwise. Clasper roundish, primary teeth sharp, 10–11, mostly 10; marginal bristles magnified, 9.

Specimens examined: Stock from Pasadena, California.

Drosophila macrospina Stalker and Spencer (Plate XI-3).

Genital arch broad, with 2–4 stout bristles at toe; undermargin concave; toe pointed downwards. Anal plate with 3–5 huge spikes, mostly 4, the uppermost one the largest, curvature of spikes counterclockwise. Primary teeth of clasper rather slender, 9–10; secondary teeth bristle-like, 11–14; marginal bristles about 5.

Specimens examined: Stock from Aldrich Farm, Texas.

Drosophila trispina Wheeler (Plate XI-4).

Genital arch with 3–4 short but stout bristles at toe; undermargin slightly concave, toe pointed downwards, roundish. Anal plate with about 4 (rarely 3) big spikes at the positions similar to those of *macrospina*, but of equal length and width; curvature of spikes counterclockwise. Clasper roundish, primary teeth slightly pointed, 8–9; marginal bristles magnified, 10–12.

Specimens examined: Stock from Earp, California.

Repleta Group

Genital arch fuses with anal plate in various degrees; bristles on genital arch mostly on lower portion, only a few species have bristles on upper portion along posterior margin; heel usually clearly seen; toe often sharply pointed, a few species with toe roundish or absent. Anal plate often oval, tip area with denser bristles. Clasper one, primary teeth in a single row, with 8–14 teeth, often concave; secondary teeth only seen in a few species; marginal bristles arranged in a semicircle, usually fine.

Drosophila hydei Sturtevant (Plate XI-5).

Lower portion of genital arch with about 25–30 bristles, 4 on upper portion; toe high, pointed; heel roundish. Anal plate fused along lower

1/3. Clasper rather large, primary teeth about 10; marginal bristles about 10.

Specimens examined: Stock from New Meadows, Idaho.

Drosophila nigrohydei Patterson and Wheeler.

Middle and lower portions with about 15–19 bristles; heel broad, undermargin curves downwards then turns upwards to the roundish toe. Primary teeth of clasper 10–11, mostly 11; marginal bristles 6–7.

Specimens examined: Stock from Nochixtlan, Oax., Mexico.

Drosophila hydeioides Patterson and Wheeler.

Like *D. nigrohydei* but bristles of genital arch restricted on lower portion, 13–19, toe more pointed than *nigrohydei;* primary teeth 9–11.

Specimens examined: Stock from Peño de Gato, Mexico.

Drosophila bifurca Patterson and Wheeler (Plate XI-6).

Genital arch comparatively long and narrow; anterior margin broadly chitinized; bristles fall into 3 groups: one on upper portion close to posterior margin, 3–4; one on middle lower portion, 5–6; one at bottom, 6, especially stout; heel pronounced; undermargin strongly convex; toe papilla-like, roundish at tip. Anal plate relatively long, fusion area very short, at lower region. Primary teeth of clasper 12, occupying whole outer margin except the bottom; marginal bristles about 8.

Specimens examined: Monterrey, Nuevo Leon, Mexico; Coronado National Forest, Arizona.

Drosophila repleta Wollaston (Plate XI-7).

Genital arch rather broad, lower portion with about 13 bristles, upper portion with 3; heel broad, roundish; undermargin strongly convex; toe about same level as heel, pointed. Anal plate fused along its lower 1/2. Clasper with about 10 primary teeth and about 8 marginal bristles.

Specimens examined: Stock from Guatemala.

Drosophila melanopalpa Patterson and Wheeler (Plate XI-8).

Anterior margin of genital arch slightly sinuate; lower portion with about 8–11 bristles, mostly 8; heel a broad angle; undermargin convex; toe sharply extended to level of teeth. Anal plate fusion broad. Primary teeth of clasper 8–10, mostly 9; marginal bristles about 7.

Specimens examined: Stock from Laguna Caurecuro, Mexico.

Drosophila canapalpa Patterson and Mainland.

Like *melanopalpa* with some minor differences: anterior margin of genital arch smoothly curved; lower portion with 8–9 bristles; undermargin more strongly convex. Primary teeth of clasper about 10, marginal teeth about 8.

Specimens examined: Stock from La Placita, Hidalgo, Mexico.

Drosophila nigrospiracula Patterson and Wheeler (Plate XVIII-2).

Genital arch with about 9 bristles on lower portion, heel broad, nearly absent; undermargin not strongly convex; toe same level as heel, covering clasper a little. Anal plate fuses with arch on middle 1/4. Primary teeth of clasper about 12, occupying upper 5/6 of outer margin; marginal bristles about 11, rather long.

A single specimen from Tucson, Arizona.

Drosophila fulvamacula Patterson and Mainland (Plate XI-9).

Anterior margin of genital arch straight, lower portion with about 12 bristles; toe broad and roundish. Anal plate fuses along middle half. Primary teeth of clasper 10–12, strongly concave, marginal bristles about 7.

Specimens examined: Stock from Oaxaca, Oax., Mexico.

Drosophila limensis Pavan and Patterson.

Close to *nigrospiracula* with a few differences: genital arch broader below; middle and lower portions with about 13 bristles; undermargin convex; toe pointed, reaching primary teeth; anal plate with broader fusion; primary teeth about 10, arranged in a concave row.

Specimens examined: Stock from Lima, Peru.

Drosophila mulleri Sturtevant and *Drosophila aldrichi* Patterson and Crow (Plate XII-1).

Lower portion of genital arch with 9–11 bristles; heel roundish; toe very high, covering a part of clasper, pointed. Anal plate fusion on upper half. Primary teeth of clasper about 9–10; secondary teeth about 8, clustered on the middle of clasper.

Specimens examined: *D. mulleri,* Austin, Texas; *D. aldrichi,* Nuevo Leon, Mexico.

Drosophila mojavensis Patterson and Crow and *Drosophila arizonensis* Patterson and Wheeler (Plate XII-2).

Lower portion of genital arch with about 9 bristles, upper portion with about 3; heel almost rectangular; undermargin straight; toe pointed, protruded beyond clasper. Anal plate with complete fusion. Primary teeth of clasper about 9–12 (*mojavensis* with 11–12, *arizonensis* with mostly 9); marginal bristles fine.

Specimens examined: *D. mojavensis,* California; *D. arizonensis,* Magdalena, Sonora, Mexico.

Drosophila buzzatii Patterson and Wheeler.

Lower portion of genital arch with about 10–11 bristles, upper half none; anterior margin straight; heel rectangular; undermargin smooth; toe very broad, high, rounlish. Anal plate fusion complete. Clasper fig-shaped, primary teeth 10–11; marginal bristles thin, 6–7.

Specimens examined: Stock from Aldrich, Texas.

Drosophila hamatophila Patterson and Wheeler (Plate XII-3).

Anterior margin of genital arch sinuate, lower portion with about 6–8 bristles; heel pronounced; undermargin convex; toe low, sharp, pointed downwards. Anal plate fusion complete. Clasper rather large, primary teeth about 12–13, long, marginal bristles about 7.

Specimens examined: Stock from Paila, Mexico.

Drosophila longicornis Patterson and Wheeler.

Lower portion of genital arch with about 10–13 bristles; heel roundish; toe an obtuse angle, covering clasper very little. Anal plate fusion complete. Primary teeth of clasper 11–12, marginal bristles 7–8.

Specimens examined: Stock from Nochixtlan, Oax., Mexico.

Drosophila ritae Patterson and Wheeler (Plate XII-8).

Anterior margin of genital arch slightly concave; lower portion with about 13–16 bristles, upper portion with about 3 near top; heel slightly over 100°; toe low, pointed downwards, far below clasper. Fusion of anal plate along middle half. Primary teeth of clasper about 12–14, mostly 14, arranged in a rather straight row; marginal bristles 7–8, rather stout.

Specimens examined: Stock from Morelia, Michoacan, Mexico.

Drosophila peninsularis Patterson and Wheeler.

Middle and lower portions of genital arch with about 11–12 bristles, upper portion with 2; heel pronounced; toe higher, pointed, near primary teeth. Fusion of anal plate complete. Primary teeth of clasper about 10–12, mostly 11; marginal bristles 6–7.

Specimens examined: Stock from Withlacoochee Nat'l Forest, Florida.

Drosophila anceps Patterson and Mainland (Plate XII-4).

Lower portion of genital arch with 9–10 bristles, upper portion with 1; heel slightly broader than rectangle; undermargin slightly concave; toe low, being a large roundish expansion covering half of clasper. Fusion of anal plate nearly complete. Primary teeth of clasper about 9–11; marginal bristles 6–7, rather stout.

Specimens examined: Stock from Oaxaca, Oax., Mexico.

Drosophila meridiana Patterson and Wheeler (Plate XII-5).

Genital arch with about 7 bristles on lower portion; heel broad and roundish; toe below clasper, pointed. Anal plate fused at lower half. Primary teeth of clasper about 8–14; one or two secondary teeth occasionally present, close to the primaries; marginal bristles 8, rather stout.

Specimens examined: Stock from Aldrich Farm, Texas.

Drosophila hexastigma Patterson and Mainland.

Close to *D. ritae* with following differences: lower portion of genital arch with about 11 bristles, upper portion 4; toe only slightly lower than heel, but still lower than clasper; primary teeth about 11–12, arranged in a strongly concave row; marginal bristles 7, 5 very stout.

Specimens examined: Stock from Oaxaca, Oax., Mexico.

Drosophila nigricruria Patterson and Mainland (Plate XII-7).

Genital arch rather narrow, lower portion with about 9–10 bristles, upper portion with 1–3; anterior margin nearly straight; heel slightly protruded; toe a broad roundish expansion. Anal plate fused at lower 1/2, bristles long and sparse. Primary teeth of clasper about 8, occupying upper half of outer margin, arranged in a rather straight row; marginal bristles stout, about 11.

Specimens examined: Morelia, Michoacan, Mexico.

Drosophila mercatorum Patterson and Wheeler (Plate XII-6).

Lower portion of genital arch with 9–11 bristles, middle portion occasionally with 1 bristle; heel rectangular; undermargin concave; toe high, pointed, partly covering clasper. Fusion of anal plate complete. Primary teeth of clasper about 10–11, arranged in a nearly straight row; marginal bristles 5–7.

Specimens examined: Stock from Santa Barbara, California.

Drosophila icteroscuta Wheeler (Plate XII-9).

Genital arch with about 13 bristles on lower portion and 3 on upper portion; anterior margin nearly straight; heel an obtuse angle; undermargin at first convex then concave; toe high, reaching primary teeth. Fusion of anal plate on middle half. Primary teeth of clasper 12, concave; marginal bristles 8.

A single specimen from Morelia, Michoacan, Mexico.

Polychaeta Group

Drosophila polychaeta Patterson and Wheeler (Plate XIV-1).

Genital arch rather long, anterior margin slightly concave at middle; lower portion with about 30 or more bristles, upper portion none; heel absent; toe pointed downwards, with a hook-like process. Anal plate fused with genital arch along upper half; bristles very dense. Clasper small, one, with a large lobe-like process on upper portion; primary teeth 5–6, arranged in a straight row, occupying the lower part of outer margin; marginal bristles rather stout, no secondary teeth.

Specimens examined: Stock from Galveston, Texas.

Robusta Group

Genital arch narrow and long; lower portion with many bristles, upper portion with a few along posterior margin; heel almost absent; toe roundish or pointed downwards, not covering clasper. Anal plate fused with arch. Clasper one, primary teeth in a single row, no secondary teeth.

Drosophila robusta Sturtevant (Plate XIII-1).

Genital arch narrow, anterior margin slightly concave; lower portion with 15–23 bristles, upper portion with 4; heel absent, bottom of arch roundish. Anal plate fused at middle half; tip roundish, with dense fine

bristles. Clasper bag-shaped; primary teeth about 8, arranged in a slightly concave row.

Specimens examined: Stock from Perry, Florida.

Drosophila cheda Tan, Hsu, and Sheng (Plate XIII-2).

Genital arch long and narrow, lower half with about 14–18 bristles, upper half with 3–6; heel nearly absent; toe pointed downwards. Anal plate fused with arch at the lower half; tip with slightly denser bristles. Clasper with invariably 9 teeth arranged in a straight row, teeth rather long; a small lobe-like expansion is present above the teeth.

Specimens examined: Hangchow, China.

Drosophila pullata Tan, Hsu, and Sheng (Plate XIII-3).

Genital arch narrow above and broader below; lower half with about 20 bristles, upper half with 2 or more; heel absent, toe pointed downwards. Clasper with about 7 primary teeth arranged in a straight row, a single magnified bristle is also present lying next to the lowermost tooth; no lobe-like expansion on clasper.

Specimens examined: Meitan, China.

Drosophila colorata Walker (Plate XIII-4).

Genital arch uniformly broad, anterior margin nearly straight; bristles along posterior margin and at toe, 14–17, another bristle group at heel portion, 7–8; heel roundish; toe slightly higher, roundish. Anal plate unusually large, oval; fusion on middle 1/4. Clasper relatively small; primary teeth about 7, arranged in a straight row, occupying the upper 3/5 of outer margin; a tuft of about 9 bristles is present below the teeth row.

Specimens examined: Garette, Maine; Chagrin Falls, Ohio.

Melanica Group

Genital arch banana-shaped; with bristles along posterior margin and at toe; heel almost absent; toe pointed downwards, not covering clasper. Anal plate fused with genital arch; no rear angle, tip bristles not very dense. Clasper one, roundish; primary teeth 8–12, arranged in a straight row; marginal bristles well developed; no secondary teeth.

Drosophila melanica Sturtevant (Plate XIII-7).

Genital arch with about 7–9 bristles on lower portion, and 6–7 on upper portion. Anal plate roundish. Primary teeth of clasper 8–9; marginal bristles about 11, 6 of them above the teeth, numerous fine hairs on upper surface of clasper.

Specimens examined: Stock from Bastrop Park, Texas.

Drosophila micromelanica Patterson (Plate XIII-8).

Genital arch with 9–10 bristles on lower portion, 2 on upper portion. Primary teeth of clasper 11–12; marginal bristles 7–9, 2 of them above teeth; no fine hairs on upper surface of clasper.

Specimens examined: Stock from Smithville, Texas.

Drosophila afer Tan, Hsu, and Sheng (Plate XIII-9).

Genital arch with about 13 bristles on lower portion, upper portion none. Primary teeth of clasper 11–12, arranged in a slightly concave row; marginal bristles 7–8, 3 above.

Specimens examined: Meitan, China.

Drosophila melanura Miller (Plate XIII-5).

Genital arch relatively broader than other melanica-species; lower portion with 14–16 bristles, upper portion with 4–5. Anal plate fused on lower 1/3. Primary teeth of clasper 10–13, mostly 11; upper surface with 7–9 bristles; marginal bristles numerous, those underneath teeth form more than a single row.

Specimens examined: Stock from Guarette, Maine.

Drosophila nigromelanica Patterson and Wheeler (Plate XIII-6).

Genital arch long; lower half with about 11–16 bristles, upper portion with 5–7. Anal plate fused at lower 1/3. Clasper covered with numerous hairs; primary teeth 14–15, mostly 14, arranged in a slightly concave row; 8–9 bristles on upper surface of clasper; marginal bristles 7–8.

Specimens examined: Stock from Williamston, North Carolina.

Carbonaria Group

Drosophila carbonaria Patterson and Wheeler (Plate XIV-2).

Genital arch narrow, anterior margin broadly chitinized, lower portion with about 11 bristles; heel roundish, toe roundish; with wavy outline. Anal plate fused at lower half; tip developed. Clasper two sets, first clasper just below anal plate, larger, with 8–9 teeth arranged in a straight row, occupying the middle portion of outer margin; the other clasper below the first one, smaller, highly chitinized, with an oblique row of about 6 teeth and many bristles.

Specimens examined: Stock from Quitobaquito, Arizona.

Cardini Group

Lower portion of genital arch rather membraneous, with a few or no bristles; posterior margin convex at middle. Anal plate separated, kidney-shaped; rear angle slightly developed; no pronounced tip but lower area heavily bristled. Clasper one, often long, primary teeth arranged in a single row; secondary teeth always present, in various groups.

Drosophila cardini Sturtevant (Plate XIV-3).

Genital arch with 2 bristles above clasper; heel pronounced. Anal plate with a few long bristles on undersurface at tip area. Primary teeth of clasper 6–7; secondary teeth clustered on upper margin of clasper, 8–9; marginal bristles about 6.

Specimens examined: Stock from Monterrey, Nuevo Leon, Mexico.

Drosophila neocardini Streisinger (Plate XIV-4).

Genital arch with one bristle above the clasper; heel pronounced. Clasper long, primary teeth 7–9, mostly 8; secondary teeth in 3 groups, one along upper margin, 6–7; one at center just above the primaries, 1; the third group on lower margin, 2–4; marginal bristles 7–9.

Specimens examined: Stock from Atlixco, Puebla, Mexico.

Drosophila cardinoides Dobzhansky and Pavan (Plate XIV-5).

Genital arch free from bristles; heel acute; posterior margin strongly convex. Clasper long, primary teeth about 6; secondary teeth in 2 groups, one clustered on anterior part, 7–9; the other on posterior part, 2–3; marginal bristles about 8–9.

Specimens examined: Stock from Teffe, Brazil.

Drosophila bandeirantorum Dobzhansky and Pavan (Plate XIV-6).

Genital arch with 3 bristles at toe; toe jointed. Primary teeth of clasper 12, the first tooth especially long; secondary teeth clustered on posterior part, about 12; marginal bristles about 9.

A single specimen from Compas de Jordao, Brazil.

Immigrans Group

Genital arch with not very dense bristles on lower portion; heel not very pronounced; toe pointed downwards, not covering clasper. Anal plate roundish or oblong; separated. Clasper one; primary teeth arranged in a single concave row, 7–15; marginal bristles especially stout, highly chitinized, sword-shaped; no secondary teeth.

Drosophila immigrans Sturtevant (Plate XIV-7).

Genital arch narrow, lower portion with about 8–9 bristles, rather long; heel not very pronounced, being an obtuse angle; toe pointed. Anal plate very large, roundish, with about 5 short but very stout bristles at tip. Clasper well protruded; primary teeth about 15, size of teeth gradually decreasing from top to bottom; marginal bristles about 9, all underneath teeth, about 6 of them very stout.

Specimens examined: Mexico City, Mexico; Meitan, China; Switzerland.

Drosophila nixifrons Tan, Hsu, and Sheng (Plate XIV-9).

Genital arch very broad above; bristles about 12, distributed from top to bottom, rather continuously; toe roundish. Anal plate roundish. Clasper with narrow stalk; primary teeth about 7, size decreasing; marginal bristles 6, 2 above, those underneath primary teeth very stout, size decreasing.

Specimens examined: Meitan, China.

Drosophila spinofemora Patterson and Wheeler (Plate XIV-8).

Genital arch rather broad, lower portion with about 8–10 bristles, not especially long; upper portion with about 4 bristles along posterior margin;

heel an obtuse angle; toe roundish, with bristles. Anal plate oblong, tip area with a number of very short, fine bristles. Clasper with a papilla-like process above, primary teeth invariably 7, equal sized; marginal bristles about 6, 2 above, those underneath teeth very stout, size decreasing.

Specimens examined: Stock from Oahu, Hawaii.

Guarani Group

Genital arch highly chitinized on upper and middle portions, with an oblique row of bristles along the lower chitinized border; chitinized connection present; heel pronounced; toe not covering clasper, roundish. Anal plate separate, with or without large hook-like spikes at rear angle, tip with no dense bristles. Clasper one, with primary and secondary teeth.

According to King (1947), the group can be separated into two subgroups, the guarani subgroup with spikes on anal plate and the guaramunú subgroup with no such spikes.

Drosophila subbadia Patterson (Plate XV-3).

Genital arch with 10–11 bristles on lower portion of which 3 along the chitinized border; bristles on toe short. Anal plate oblong, rear angle with two very large, hook-like spikes. Clasper rather small; primary teeth 6–7; secondary teeth 15–16, marginal bristles about 5 or more, rather short and stout.

Specimens examined: Stock from Atlixco, Puebla, Mexico.

Rubrifrons Group

Genital arch with very few bristles; heel present, rather pronounced; toe usually not covering clasper. Anal plate separated; with rear angle and tip. Clasper one, primary teeth in straight row, secondary teeth present in some species.

Drosophila rubrifrons Patterson and Wheeler (Plate XV-4).

Lower portion of genital arch with one bristle near posterior margin just above clasper and 2–3 at toe; heel pronounced; toe low, roundish, pointed downwards, not covering the clasper. Primary teeth of clasper 9–10, arranged in a straight row, occupying the upper 3/5 of outer margin; marginal bristles a semicircle, about 9, those on uppersurface larger.

Specimens examined: Peño de Gato, Mexico; D.F., Mexico.

Drosophila spadicifrons Patterson and Mainland (Plate XV-5).

Genital arch narrower above; anterior margin sinuate; heel pronounced; toe lower, pointed downwards, bearing 2 stout bristles. Anal plate rather long; rear angle well developed; tip with no dense bristles. Primary teeth of clasper 10–11, occupying almost whole outer margin; marginal bristles 7–8, 4 on upper surface, slightly magnified.

A single specimen from Valle de Huajumbro, Michoacan, Mexico.

Drosophila nubiluna Wheeler (Plate XV-6).

Genital arch very broad, lower portion with only one bristle above clasper and 4–5 bristles at toe; heel an obtuse angle; undermargin straight; toe low, roundish, pointed downwards, not covering clasper. Clasper rather large, upper margin straight; primary teeth short, 12; secondary teeth 5, long and bristle-like; marginal bristles few, 2 extremely long.

A single specimen from Morelia, Michoacan, Mexico.

Drosophila uninubes Patterson and Mainland (Plate XV-7).

Genital arch rather broad, anterior margin slightly sinuate, lower portion with 2 bristles above clasper and 2 short bristles at toe; heel rather pronounced; toe slightly lower, roundish, nearly absent, not covering the clasper. Clasper small, primary teeth about 13, arranged in a slightly concave row, secondary teeth about 7, on lower portion of clasper.

Specimens examined: Stock from Zamora, Michoacan, Mexico.

Drosophila parachrogaster Patterson and Mainland (Plate XVII-4).

Genital arch rather broad, lower portion with only one bristle above clasper and 5 at toe; toe roundish, nearly absent. Anal plate separated, with rather pronounced rear angle and tip. Clasper one, small; primary teeth 12–13, small; secondary teeth 6, rather long, clustered on rear portion of the clasper.

Specimens examined: Stock from Laguna Patzcuaro, Michoacan, Mexico.

Macroptera Group

Genital arch highly chitinized on upper and lower portions; bristles form a group at toe; chitinized border with or without bristles above toe; chitinized connection present between arch and clasper; heel not prominent, almost absent, toe roundish, not covering clasper. Anal plate long, with rear angle and tip; tip with no dense bristles. Clasper one, primary teeth arranged in a concave or straight row, occupying nearly the whole outer margin; marginal bristles in a semicircle; no secondary teeth.

Drosophila macroptera Patterson and Mainland (Plate XVI-2).

Genital arch with 5–7 bristles at toe and 0–2 bristles above clasper. Primary teeth of clasper 11–14, rather short, arranged in a concave row; marginal bristles 7–9.

Specimens examined: San Juan Nat'l Forest, Colorado; Tonto Nat'l Forest, Arizona; El. Mediñeua, Mexico.

Drosophila magnabadia Patterson and Mainland (Plate XVI-6).

Resembles *D. macroptera* but differs in following characters: longer chitinized connection; free from bristles at chitinized border above clasper; clasper with 11 teeth, arranged in a straight row; marginal bristles longer, tip of anal plate more pronounced.

A single specimen from D.F., Mexico.

Drosophila alafumosa Patterson and Mainland (Plate XVIII-4).

Resembles other two species with following differences: Genital arch with one bristle above clasper and 3 at toe; clasper small; primary teeth 11, arranged in a straight row; marginal bristles about 10, 5 on upper-surface, widely separated.

A single specimen from Morelia, Michoacan, Mexico.

Annulimana Group

Genital arch rather hairy; with prominent toe covering a part of clasper; undermargin usually sinuate. Anal plate fused with arch on middle or lower portions. Clasper one, rather large; primary teeth a single row, occupying nearly the whole length of outer margin; secondary teeth present, usually on lower portion; marginal bristles many.

Drosophila annulimana Duda (Plate XVI-3).

Genital arch with 10–20 bristles on lower portion, upper portion with 0–1; anterior margin slightly sinuate; heel pointed downwards; undermargin concave; toe higher, reaching the base of primary teeth, pointed. Anal plate very large, fusion at lower 1/4; tip with denser but tiny bristles. Primary teeth of clasper 9–10, relatively short, arranged in a concave row; secondary teeth 15–18, condensed at lower portion; marginal bristles numerous, forming a large tuft.

Two specimens from Brazil.

Drosophila gibberosa Patterson and Mainland (Plate XVI-4).

Middle and lower portions of genital arch with 20–22 bristles, upper portion with none; heel roundish; undermargin slightly sinuate; toe long and pointed, approaching primary teeth. Anal plate roundish, fusion short; tip with slightly denser bristles. Primary teeth of clasper 15–18, arranged in a sinuate row, occupying the whole outer margin; secondary teeth few, bristle-like, 3–4; marginal bristles 8–9.

Specimens examined: Stock from Mexico.

Drosophila sp. (Plate XVI-5).

Lower portion of genital arch with about 20 bristles, upper portion with 5; heel a sharp angle, pointed downwards; undermargin zigzag; toe higher, pointed. Anal plate long and large, fusion on middle 1/6. Primary teeth of clasper 9–10, arranged in a straight row, occupying the whole length of outer margin; secondary teeth 10–12, on lower portion, marginal bristles many, forming a tuft.

A single specimen from Sedeño Canon, Mexico.

Remarks: This unknown specimen was caught in Mexico. The structure of genitalia as well as other morphological characters suggest a new species in the annulimana group.

Melanderi Group

Genitalia large. Genital arch broad above and narrower below; anterior margin broadly chitinized; heel pronounced; toe a finger-like outgrowth,

pointed downwards. Bristles along posterior margin and on lower portion, especially dense on the finger-like toe. Anal plate separated, slightly triangular, bottom roundish; no tip, no densely bristled region; undersurface of plate with teeth along the outer margin. Clasper two sets, primary clasper large; primary teeth at lower portion, 7–8; marginal bristles very stout, situated above the primary teeth and on undersurface of clasper; secondary clasper smaller, simple, above the primary, with a row of teeth.

Drosophila melanderi Sturtevant (Plate XV-1).

Lower portion of genital arch with about 26 bristles, upper portion with 3. Teeth of undersurface of anal plate along lower-outer margin, those at the upper corner large and crooked. Primary clasper with a row of primary teeth, about 8, and a number of stout marginal bristles situated above the primary teeth and on undersurface of the clasper; secondary clasper with a row of 10 teeth.

A single specimen from Glacier Nat'l Park, Montana.

Drosophila magnafumosa Stalker and Spencer (Plate XV-2).

Lower portion of genital arch with about 20–23 bristles, upper portion 3–4. Teeth of underside of anal plate condensed near lower-outer margin, no extraordinary large teeth at corner. Primary clasper with a row of primary teeth, about 7; marginal bristles stout, 6 above the teeth; secondary clasper with a straight row of 7 teeth.

A single specimen from Great Smoky Mt. Nat'l Park, Tennessee, sent to us by Dr. W. K. Baker.

Ungrouped Species

Drosophila pallidipennis Dobzhansky and Pavan (Plate XVII-1).

Genital arch free from any bristles; heel very conspicuous; undermargin strongly convex. Anal plate large, separated; rear angle present. Clasper one, relatively small; primary teeth 8, arranged in a straight row; secondary teeth bristle-like, 3; marginal bristles 7 or more.

Specimens examined: Stock from Iporango, São Paulo, Brazil.

Remarks: *D. pallidipennis centralis* is identical to *D. pallidipennis pallidipennis* in respect to genitalial structures.

Drosophila gigas Duda (Plate XVI-1).

Upper and middle portions of genital arch narrow, lower portion expanded; middle and lower portions with about 40 bristles, upper portion with 5–6; heel roundish, undermargin strongly sinuate, toe very high, covering a part of clasper. Anal plate large, fusion on lower 1/4. Clasper one, primary teeth about 8, arranged in a slightly concave row; secondary teeth very long, about 8, on lower portion, margin bristles 5–6.

A single specimen from Cupatitzio Nat'l Park, Mexico.

Remarks: The genitalia of this species resembles that of the annulimana group in all the principal characteristics.

Drosophila fulvalineata Patterson and Wheeler (Plate XVII-2).

Genital arch with about 13–17 bristles on lower portion, arranged in two or more vertical rows; anterior margin slightly sinuate; upper portion with 3–4 bristles; heel roundish; undermargin concave, toe reaching primary teeth, pointed. Anal plate oval, fused at lower 2/3. Clasper one, more or less triangular; primary teeth 9–10, arranged in a slightly concave row, occupying the middle portion of outer margin, leaving a small space above and a larger space below; marginal bristles in a semicircle, about 8–9.

Specimens examined: Patagonia, Arizona.

Drosophila histrio Meigan (Plate XVII-5).

Genital arch very broad, especially the upper portion; lower portion with a transverse row of bristles along the chitinized border, 8. Lower portion of anal plate with a very pronounced finger-like projection which bears 3 teeth-like structures at tip. Clasper one, more or less triangular; primary teeth about 12, short and blunt, arranged in a slightly convex row; marginal bristles very fine.

Specimens examined: Switzerland; Meitan, China.

Drosophila tumiditarsus Tan, Hsu, and Sheng (Plate XVII-3).

Genital arch broad above, especially the middle portion; posterior margin with a row of more than 10 bristles; heel roundish, undermargin with a row of bristles; toe low, sharply pointed. Anal plate separated, oblong; tip with dense bristles. Clasper one, small; upper portion with an expanded lobe; primary teeth about 6, arranged in a straight row.

Specimen examined: Meitan, China; Hangchow, China.

Drosophila fragilis Wheeler (Plate XVII-6).

Genital arch with one bristle above clasper and 3 at toe; anterior and posterior margins nearly parallel; toe pointed downwards and roundish, not covering clasper. Clasper one, triangular; primary teeth about 8, in a straight row; marginal bristles 8, 3 above teeth; no secondary teeth.

A single specimen from Atlixco, Puebla, Mexico.

Drosophila subtilis Kikkawa and Peng (Plate XVII-7).

Genital arch broad below, middle and lower half with about 18–20 bristles; upper portion with 2; heel rather pronounced, less than 90°, undermargin slightly convex; toe roundish. Anal plate separated, no rear angle, no tip. Clasper small, primary teeth about 6, occupying the upper portion of outer margin, long; marginal bristles 6–7.

Specimens examined: Meitan, China.

Drosophila dreyfusi Dobzhansky and Pavan (Plate XVII-8).

Lower portion of genital arch with 18 bristles, upper portion unknown; heel rather conspicuous; undermargin convex; toe covering clasper a little. Anal plate unknown. Clasper rather large, primary teeth 11, arranged in a convex row; secondary teeth 15, 3 of them less chitinized.

A single incomplete specimen from Campos de Jordao, Brazil.

Drosophila littoralis Meigan (Plate XVII-9).

Genital arch with about 11–15 bristles on lower portion, upper portion none; heel a broal angle; toe broad and roundish. Anal plate relatively large, fusion at middle. Clasper one, primary teeth 7–8, relatively long and large, occupying the upper 3/4 of outer margin, arranged in a straight row, marginal bristles 6–9.

Specimens examined: Switzerland.

Drosophila crassa Patterson and Mainland (Plate XVIII-1).

Genital arch long and narrow, middle and lower portions with about 22–23 bristles, those near toe shorter; upper portion with 9–10 bristles; heel broad, toe pointed downwards, not covering clasper. Anal plate long, fused on lower half. Clasper one, large, with numerous bristles and hairs; primary teeth 6, occupying the upper half of outer margin.

A single specimen from Sedeño Canon, Jalopa Keracrug, Mexico.

Drosophila setapex Patterson and Mainland (Plate XVIII-3).

Genital arch with about 21 bristles on lower and middle portions, 5 on upper portion; heel unknown in this single specimen; undermargin undulate; toe high, roundish. Anal plate oval, fusion at middle for a short distance; tip present, with dense bristles. Clasper one, primary teeth 8, occupying the upper 2/3 of outer margin, marginal bristles 9.

A single specimen from Bluewater, New Mexico.

Drosophila unimaculata Strobl (Plate XVIII-5).

Genital arch with about 12–15 bristles on middle and lower portions, 3–5 on upper portion; heel and toe nearly absent, undermargin roundish, not covering clasper, bearing a tuft of bristles on undersurface. Anal plate large, separated; rear angle slightly developed, tip present. Clasper one, primary teeth about 13, arranged in a concave row, occupying the whole length of outer margin; marginal bristles numerous, arranged in an irregular semicircle.

Specimens examined: Switzerland.

Drosophila kuntzei Duda (Plate XVIII-6).

Genital arch with about 11–12 bristles on mildle and lower portions, arranged in a semivertical row; heel present; toe low, pointed downwards, not covering the clasper. Anal plate kidney-shaped, separated, rear angle slightly developed, no tip, terminal area entirely free from bristles. Clasper one, broad; primary teeth 12–15, arranged in a straight row and occupying almost the whole length of the outer margin except the extreme lowest portion; secondary teeth 4–6, very long, obviously magnified marginal bristles; marginal bristles about 6.

Specimens examined: Switzerland.

Drosophila castanea Patterson and Mainland (Plate XVIII-7).

Genital arch narrow above and broader below, middle and lower portions with about 21–27 bristles, mostly 23, upper portion with 0–3 bristles,

mostly 1; undermargin strongly convex; toe high, covers clasper. Anal plate oval, fused at middle-lower portion, tip bearing dense hair. Clasper one, primary teeth 10–12, arranged in a concave row, occupying the whole outer margin, the last two less chitinized; marginal bristles about 10–11.

Specimens examined: Stock from Atlixco, Puebla, Mexico.

Drosophila guyenoti Burla (Plate XVIII-8).

Genital arch narrow above and broad below; middle and lower portions with about 12–13 bristles; heel well developed; undermargin convex; toe same level as heel, roundish. Anal plate oval, with well developed tip; fusion at lower portion near tip, very short. Clasper one, primary teeth 9–10, long, arranged in a straight row, occupying the middle portion of outer margin; marginal bristles about 7–8.

Specimens examined: Switzerland.

Drosophila bromeliae Sturtevant (Plate XVIII-9).

Genital arch narrow, lower portion with 7 bristles along the posterior margin; heel not prominent; toe pointed downwards, roundish. Anal plate roundish, fusion not certain. Clasper one, primary teeth 9, arranged in a straight row; marginal bristles 6, rather long, 2 beneath teeth; no secondary teeth.

A single specimen from Campos de Jordao, Brazil.

DISCUSSION AND CONCLUSION

Before discussing the significance of the external male genitalia in taxonomy, it may be well to point out certain limitations of our material. In the first place, a number of the species are represented by a single specimen, and in some instances the specimen is incomplete. This was unfortunate since such specimens do not indicate the extent of variability within a species. In nearly all the species where an adequate number of specimens was available, a certain variability was observed. In the second place, in those cases where but a single species from a group was examined we have indicated the characters of the species, but we must not assume that the species is necessarily typical of the group as a whole. In spite of these limitations, however, certain tentative conclusions can be drawn for this study.

Among the eleven genera of the Drosophilidae studied, only the genus Drosophila has a great number of species, others having but a few or only a single species as their representative. With the exception of the genus Chymomyza, within which the five species examined show general agreement in the genitalial structure, the other genera are either insufficiently represented or too variable to allow any conclusions on the general characteristics for each genus. The lack of a clasper may be the most important feature for the genus Gitona, but this conclusion should not be considered valid until more extensive studies have been made on this genus. The same lack of adequate material is found among certain of the subgenera of the large genus Drosophila.

When the species groups are considered, however, the agreement in the morphology of the genitalia among the different members of a group is often striking. The first significant fact is that those species formerly regarded as belonging to a certain species group usually exhibit similar structures in the external genitalia. With only a few exceptions, which will be discussed later, each species group can be delimited on the basis of its genitalial characters. For instance, all members of the funebris group have spikes on the anal plate. There are many other significant groups, including the willistoni, saltans, macroptera, and melanica. A second significant fact is that each species group has its own characteristic genital structure which differs from that of other groups. In this connection genitalial structures are valuable in placing species into their appropriate groups. The genitalia of the Swiss fly, *D. limbata,* for example, agrees in all characteristics with those of the quinaria group, and later Dr. M. R. Wheeler confirmed this assumption by examining its other characters, especially the egg filaments and the abdominal pattern. In his paper (1949a, 1949b) the establishment of new groups is in many cases based on the genital apparatus, as well as on other morphological characters. For some time Dr. Wheeler had regarded *D. magnafumosa* as coming close to *D. melanderi,* but it was not until after a comparison of the genital morphology had been made of the two species was it decided to establish a melanderi group.

The hypopygium does not always show special characteristics for subgroups. For example, it fails to show such differences between the subgroups of such groups as the obscura and repleta. It does distinguish between the subgroups of the guarani group, and may probably do so between the subgroups of the rubrifrons and cardini groups, but the data are not adequate at the present time for a final decision.

As to the members within a species group, genitalial structure can usually be used to distingush the different species. As we have stated above, species belonging to the same species group have general characters of the genitalia for the group, but show differences among themselves. Superficially genitalial structure might be considered as a single character (like the number of acrostichal rows, proportion of second orbital bristle, cheek width, etc.), whereas it actually consists of a number of characteristics. If we were to include the internal apparatus and the female organs, the classification would be more critical, but even when only the external parts are considered the three principal components (genital arch, anal plate, clasper) already provide sufficient number of characters with which to identify most species. As a matter of convenience we pay more attention to some particular part or parts for a special group; e.g., the spikes on the anal plate of the funebris group, the secondary teeth on the clasper of the cardini group, the shape of the heel, undermargin and toe in the repleta group, and so on.

We do not intend to imply that the genital structures are the best characters for determining species and species groups. In many larger groups several aberrant forms were observed. In the repleta group, for example,

D. mulleri and *D. aldrichi* have secondary teeth on the clasper, whereas most other species lack such armature. The same has been observed in the obscura group where *D. pseudoobscura* is the sole representative having secondary teeth. On the other hand, some species that do not belong to a certain group may have characteristics of that group, such as *D. castanea* and *D. fulvalineata,* especially the latter, whose genitalial structures are quite similar to those of the repleta group. The same condition exists between *D. tumiditarsus* and *D. floricola.*

In some rare cases distinct species could not be distinguished by the external genital apparatus,, e.g., *D. virilis* and *D. americana, D. mulleri* and *D. aldrichi,* and *D. mojavensis* and *D. arizonensis.* These species are so similar to each other that no major distinction could be found. In this connection we would like to refer to the work of Mather and Dobzhansky (1939), who found a statistical difference in the number of teeth in the sex-comb among several geographical strains of *D. pseudoobscura* by using the method of variance analysis. Statistics may thus serve as a good means of attacking problems in taxonomy. In the investigation of *D. pseudoobscura, D. subobscura, D. persimilis* and *D. miranda,* Reed and Reed (1948) choose a number of statistical variations, such as the tooth number on the sex-comb, wing area and wing length, and found a significant difference between species, represented by an index which is the product of multiplying the mean values of the measured characteristics. External genitalia provide many such measurable characters, such as tooth number on the clasper, bristle number on the genital arch, etc. These characters vary even in pure strains, but fluctuate around definite mean values and standard deviations in a given environment. If large samples are analyzed and several characters are used in the investigation, significant results may be expected between species, subspecies, and probably even strains.

As a rule, subspecies do not exhibit significant differences in genitalia structure. *D. meridiana* and *D. m. rioensis, D. macrospina limpiensis* and *D. m. ohioensis, D. pallidipennis* and *D. p. centralis, D. americana* and *D. a. texana,* and some other examples all show identical structures between each pair.

With the general conclusions drawn above in mind, we wish now to consider certain subgenera and species groups in more detail. We can do very little with the subgenera containing only a single or a couple of species; but in the subgenera Pholadoris and Hirtodrosophila, each of which contain several known species, a more detailed analysis may be of interest. In the first subgenus (Pholadoris) the available species show that those of the blackish victoria group *(D. victoria, D. lebanonensis, D. nitens)* are similar in many morphological characters and genitalial structure. I have not had a specimen of the tiny yellowish Brazilian fly *D. mirim,* but it seems safe to predict the character of the genitalial structure of that species by a study of its close relative, *D. baeomyia.* The oriental species *D. coracina* is unique in that it has a black body but with genitalia similar to those of the mirim group.

We did not have enough species of the subgenus Hirtodrosophila for a thorough study. Of the five species described in this study, only *D. duncani* provided a large number of specimens from a living culture. All others were represented either by a single specimen or by incomplete specimens. The genitalia structures available reveal that those species deserve to be separated into species groups. It is very obvious that *D. longala* and *D. grisea* are more closely related than any other of the remaining species of the subgenus, and belong to the longala group. *Drosophila cinerea* and *D. orbospiracula* might tentatively be placed in a group, the cinerea group, on the basis of their genitalial structure, although the information is not entirely adequate. *Drosophila duncani* is an unusual form and no other species similar to it was found. Since the establishment of a species group on the basis of a single species is not uncommon in the literature, we therefore suggest a duncani group for this species.

We have mentioned that in a few species groups of the genus Drosophila the species do not agree well in the morphology of their genitalia. The most significant examples are to be found in the tripunctata and melanogaster groups. First of all, *D. histrio*, whose genitalia is very peculiar in having an outgrowth on the anal plate and a transverse row of bristles on the undermargin of the genital arch, should be excluded from the tripunctata group. Of the three remaining species of this group, *D. tripunctata* and *D. unipunctata* agree well in the structure of their genitalia. On the other hand, *D. crocina* differs from them in many respects in having heavily chitinized secondary teeth on the clasper, a different pattern arrangement of the marginal bristles, quinaria-like bristle pattern on the lower portion of the genital arch, lack of prominent heel, and above all, aside from the genitalia, possesses a row of short spinules on the under surface of the prothoracic femora in both sexes like those of the immigrans group. An alternative arrangement would be to divide the tripunctata group into two subgroups, one containing *tripunctata* and *unipunctata* and the other including *crocina*.

In the large melanogaster group the situation is more complicated. It consists of many Palaeartic and Oriental species. Sturtevant (1942) mentioned that *D. suzukii* in the melanogaster group is doubtful, for in some respects it is more like members of the obscura group (cf., also discussion of Sturtevant and Novitski, 1941). Of the nine species described in this article, together with information on other species taken from the papers of Kikkawa and Peng (1938) and Tan, Hsu, and Sheng (1949), the structures of the genitalia and other morphological traits suggests that this large group could be divided into smaller units or subgroups, as follows:

1. melanogaster subgroup:—Includes *D. melanogaster* and *D. simulans*. Genital arch with large process on posterior margin; one clasper, primary teeth long and somewhat irregularly arranged.

2. montium subgroup:—Includes *D. montium, D. rufa, D. auraria, D. ficusphila,* and probably *D. nipponica*. A large tooth-bearing secondary clasper present, seemingly originated by separation from anal plate; marginal bristles of primary clasper greatly enlarged.

3. takahashii subgroup:—Includes *D. takahashii* and *D. lutea.* One clasper, simple, with a convex row of long teeth; anal plate usually prolonged on lower portion.

4. ananassae subgroup:—Includes *D. ananassae* and *D. bipectinata.* Secondary clasper present, tooth-bearing; primary clasper flat, primary teeth in two groups, some of the marginal bristles especially long and stout.

5. suzukii subgroup:—Includes *D. suzukii* and *D. pulchrella.* Toe of genital arch with tube-like process; clasper one, large; primary teeth and marginal bristles separated into two groups.

Finally, it seems worthwhile to discuss the implications of phylogeny with respect to genitalial structures. It is, of course, dangerous to draw conclusions from a single or few characters. But, as pointed out above, genitalia consist of a number of characters, and for a comparison of the relationships among species groups and subgenera, these characters ought to be considered. We do not intend to draw any definite conclusions or to present a phylogenetic tree, but simply to give interpretations of the data for further consideration.

Sturtevant (1942), in his revision of the classification of Drosophila, has discussed the relationships in general from a phylogenetic point of view. Although he did not construct a phylogenetic tree, he did point out the trend. According to his opinion, *D. pinicola* might represent the primitive type from which have arisen the subgenera Drosophila and Sophophora. Unfortunately we do not have this primitive form for comparison. Sturtevant suggested a main trunk of phylogeny in the subgenus Drosophila, as follows: the pinicola-virilis-tripunctata-funebris-repleta-robusta-immigrans order. If we start with virilis and omit tripunctata and funebris, the sequence works beautifully, i.e., from virilis to robusta all species groups have similar male genitalia. The funebris and tripunctata groups, on the other hand, seem to be misplaced. Wheeler (1947) has also questioned the position of the tripunctata group on the basis of his experiments on the insemination reaction.

On the basis of the structure of the genitalia, the virilis, repleta, robusta, melanica and polychaeta groups are closer together than any other groups, inasmuch as they all have the anal plate fused, a single simple clasper which rarely possesses secondary teeth, and a rather hairy genital arch. *Drosophila carbonaria* may be related to these groups but is more remote. The annulimana group considered by Pavan and da Cunha (l.c.) as a species group in the subgenus Drosophila, exhibits some characteristics not typical for the genus, but has some characters close to the repleta group, including the genitalia. It is possible that the variation of the repleta group reaches the region close to the border line of the genus Drosophila where the annulimana group lies.

Another closely related section contains many small species groups in the subgenus Drosophila. These gruops are quinaria, guttifera, testacea, tripunctata, rubrifrons, macroptera, guarani, and probably funebris. Their general characteristics of genitalia structure are as follows: anal plate

separated, with rear angle and tip; genital arch with fewer bristles, mostly on toe, or in some groups also along the lower chitinized border; chitinized connection distinct and clasper with or without secondary teeth. Taking quinaria as their base, guttifera and tripunctata are its closer relatives. Arising from tripunctata lies testacea, and from guttifera two divergent lines split off, one the rubrifrons-macroptera line, and the other the guarani-funebris line.

The relation between the quinaria section and the virilis section is obscure. The subgenus Dorsilopha is best put midway between virilis and quinaria, but closer to virilis than to quinaria.

The immigrans group might come from the robusta group by the separation of the anal plate and some other changes. Cardini seems to fall near the quinaria section, but with ambiguous evidence.

The alagitans group has been transferred to the subgenus Sophophora (Wheeler, 1949a) because, in addition to many other morphological traits, the genitalial structures are so similar to those of the willistoni group that only a single minor difference could be detected. It is hard to believe that a group coming from remote origin can have genitalia nearly identical with those of another group. Sturtevant's interpretation of the relationships among the members of the subgenus Sophophora seems also to be valid on the basis of their genitalia. We do not know how the obscura group arose from the pinicola group, but the willistoni and saltans groups are obviously related by their broader genital arch, widely distributed bristles, rolled undermargin and the origin of the secondary clasper. The suzukii subgroup may well be considered as a bridge between the obscura group and the other melanogaster species, of which the melanogaster-takahashii subgroups seem to have evolved along one line, while the ananassae-montium subgroups along another. In both of these lines the first named subgroups appear to have given rise to the following one.

The longala group of Hirtodrosophila was possibly derived from the obscura group, or vice versa, or both of them may have come from a common ancestor. From the longala group may have arisen the cinerea group. The position of *D. duncani* is a complete mystery.

Available data on other genera in the family are as yet entirely insufficient to allow much speculation. Sturtevant (1942) pointed out that "Sinophthalmus and Gitona appear to be rather close to each other, and to be related to Amiota. This is possibly the most primitive group of genera in the family." It seems rather valid to regard Gitona as the most primitive form of the Drosophilidae, since it has no true claspers, whereas Sinophthalmus and Amiota have well developed claspers. The scattered blunt teeth on the clasper of *Sinophthalmus pictus* might well be considered more primitive than the more complex highly evolved structure of Amiota. Leucophenga with a clasper and no teeth might also be considered primitive. Chymomyza seems to be a very compact genus, whereas Scaptomyza is extremely variable. The positions of both of these genera are obscure.

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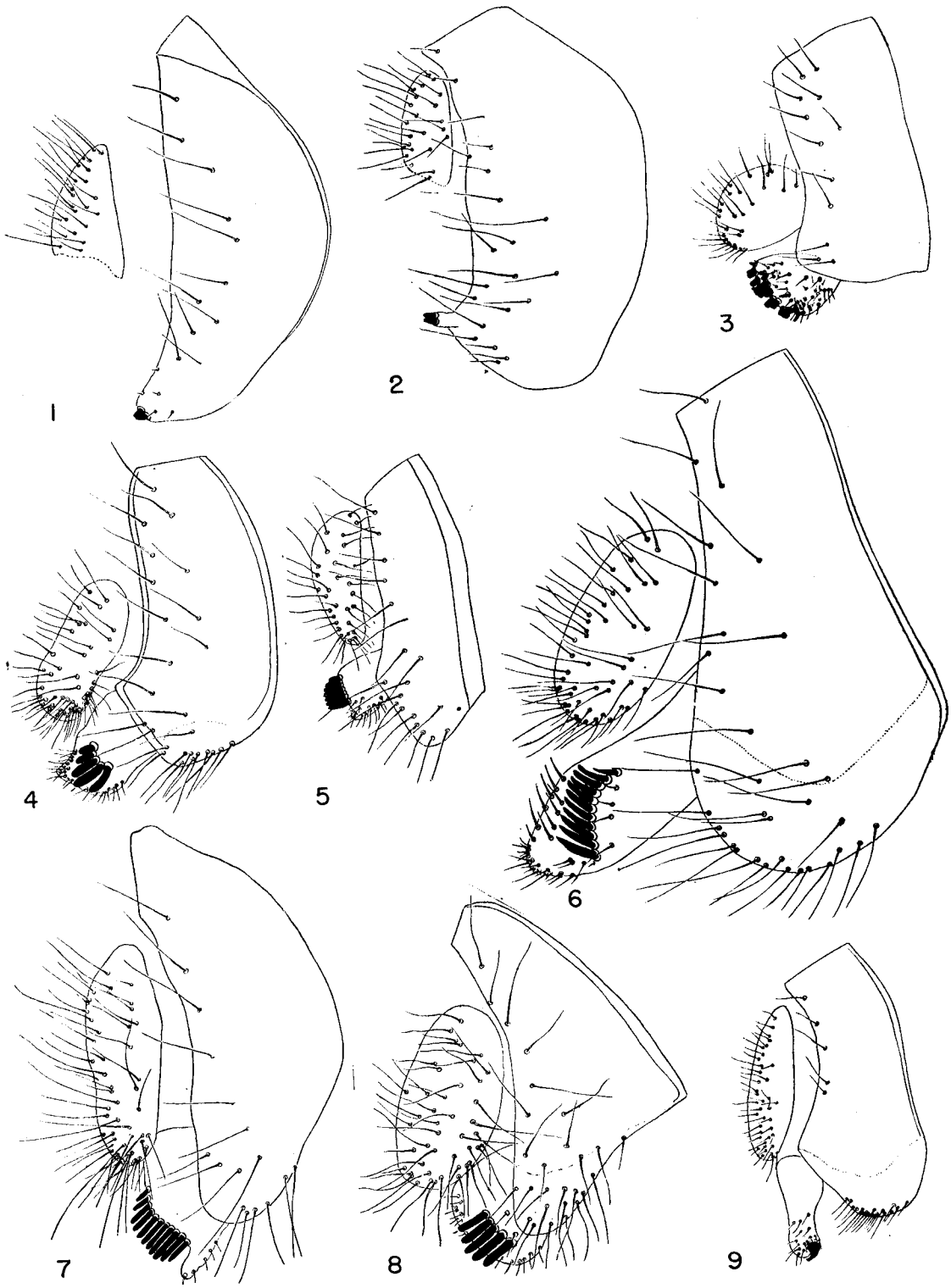

Plate I. 1, *Gitona sonoita*, 2, *G. americana;* 3, *Sinophthalmus pictus;* 4, *Amiota* "acadia," 5, *A. humeralis*, 6. *A.* "gigantea," 7, "kingstoni," 8, *A. leucostoma*, 9, *A.* "arizonensis."

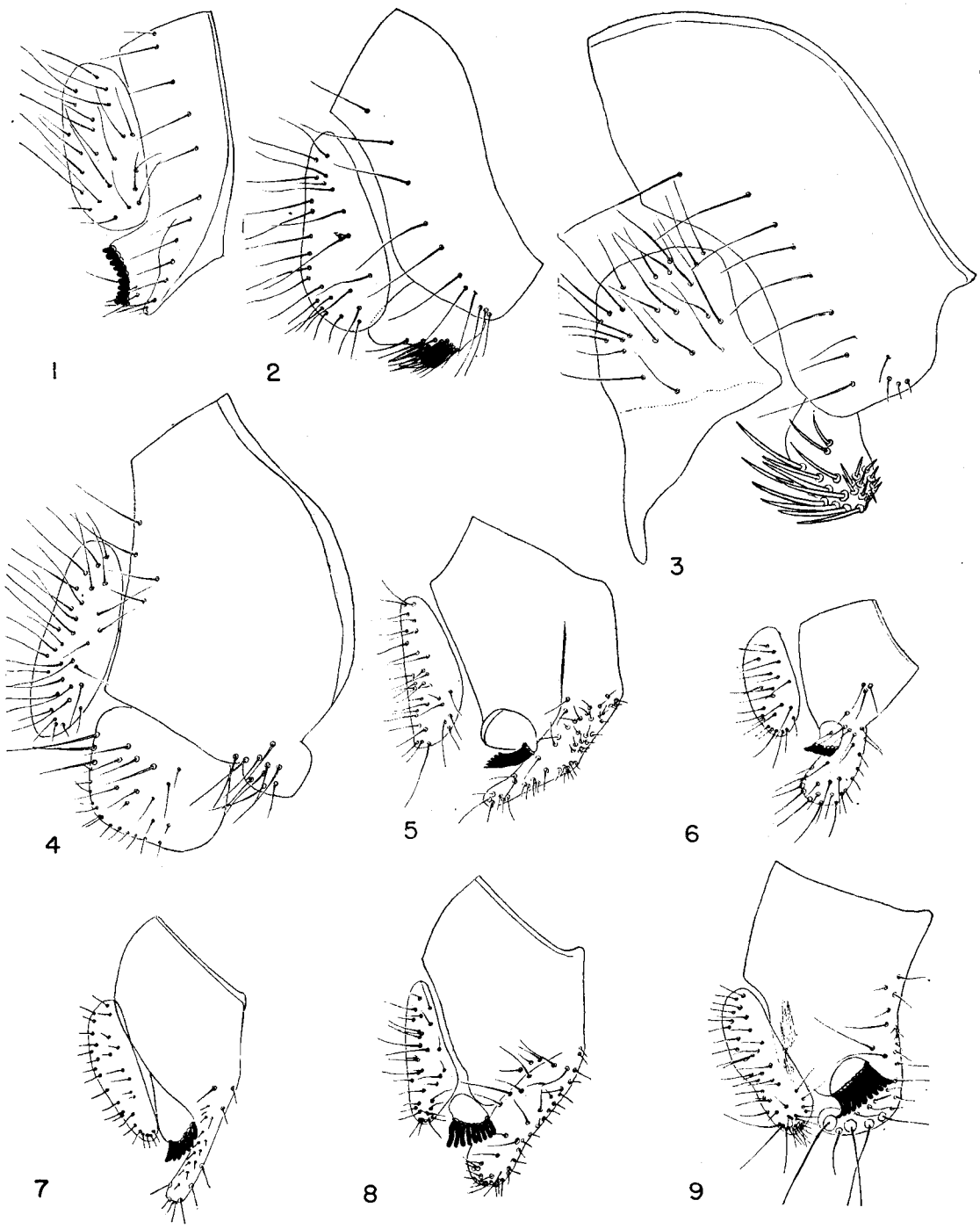

Plate II. 1, *Mycodrosophila dimidiata;* 2, *Paramycodrosophila mexicana;* 3, *Zygothrica poeyi;* 4, *Rhinoleucophenga obesa;* 5, *Chymomyza tetonensis,* 6, *C. aldrichi,* 7, *C. procnemis,* 8, *C. mexicana,* 9, *C. amoena.*

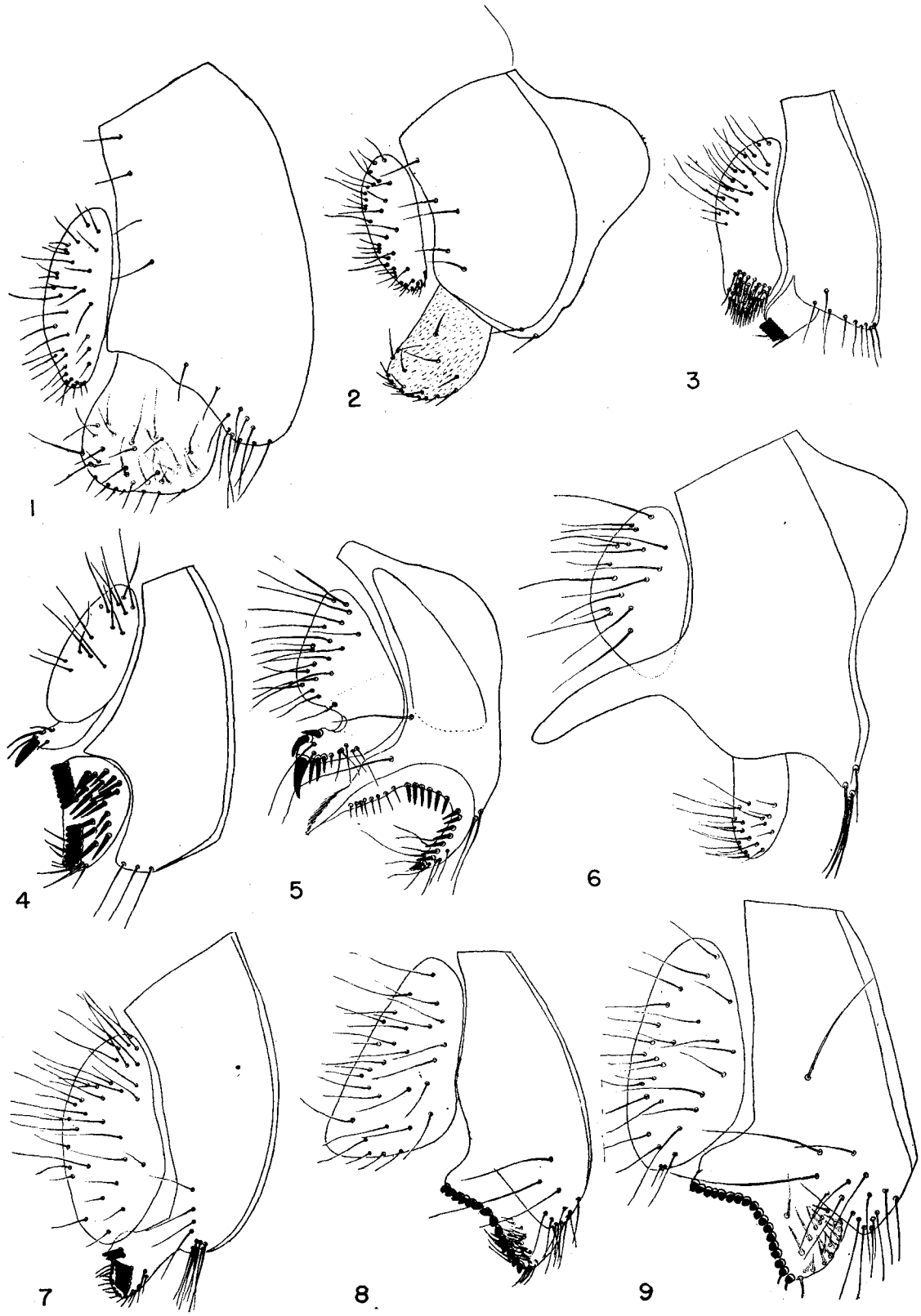

Plate III. 1, *Leucophenga pulcherrima*, 2, *L. varia;* 3, *Scaptomyza hirsuta*, 4, *S. adusta*, 5, *S. graminum*, 6, *S. vitatta*, 7, *S. terminalis*, 8, *S. nigrocella*, 9, *S. montana.*

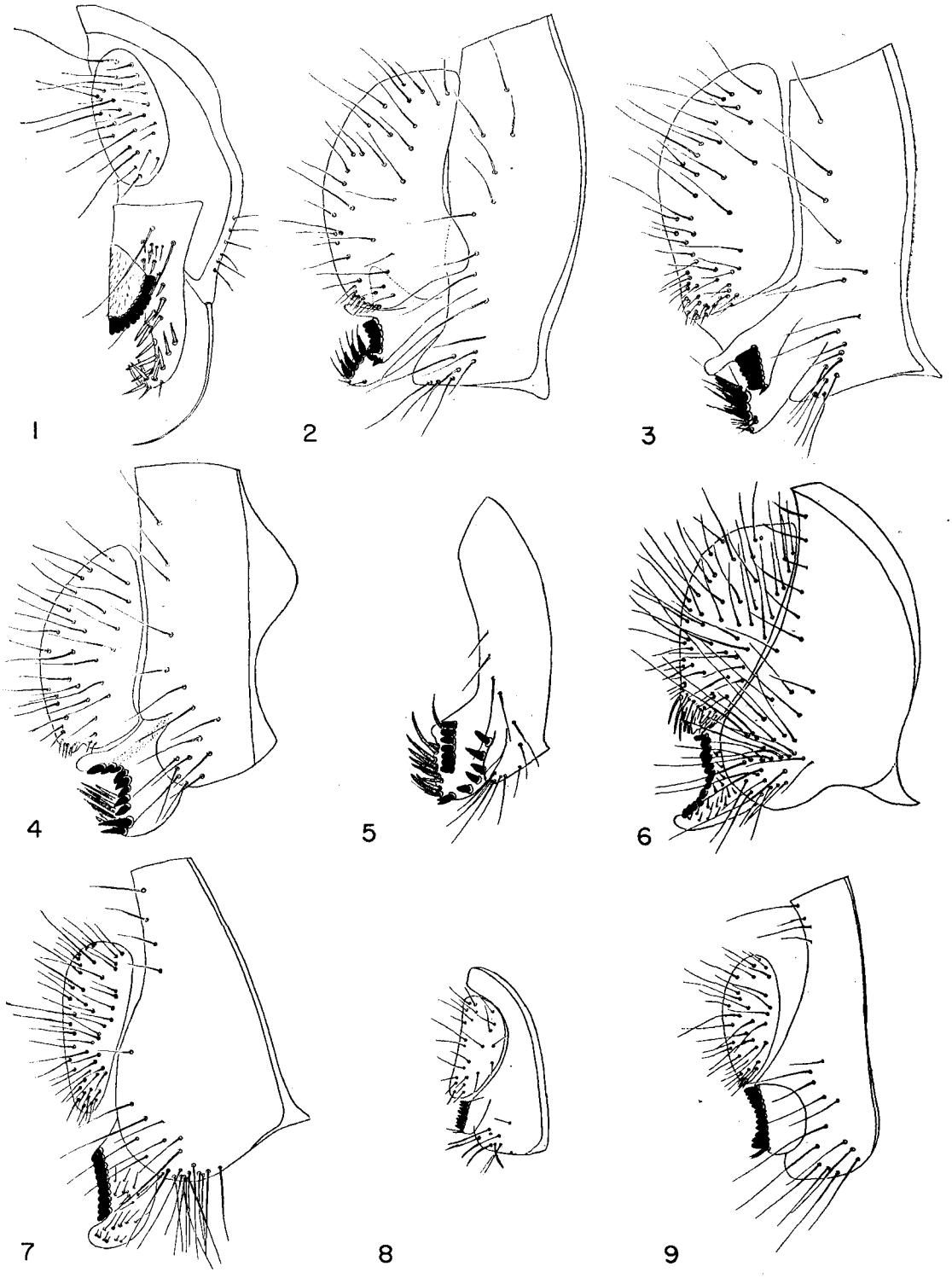

Plate IV. 1, *Drosophila duncani*, 2, *D. grisea*, 3, *D. longala*, 4, *D. orbospiracula*, 5, *D. cinerea;* 6, *D. victoria*, 7, *D. lebanonensis*, 8, *mirim*, 9, *D. coracina.*

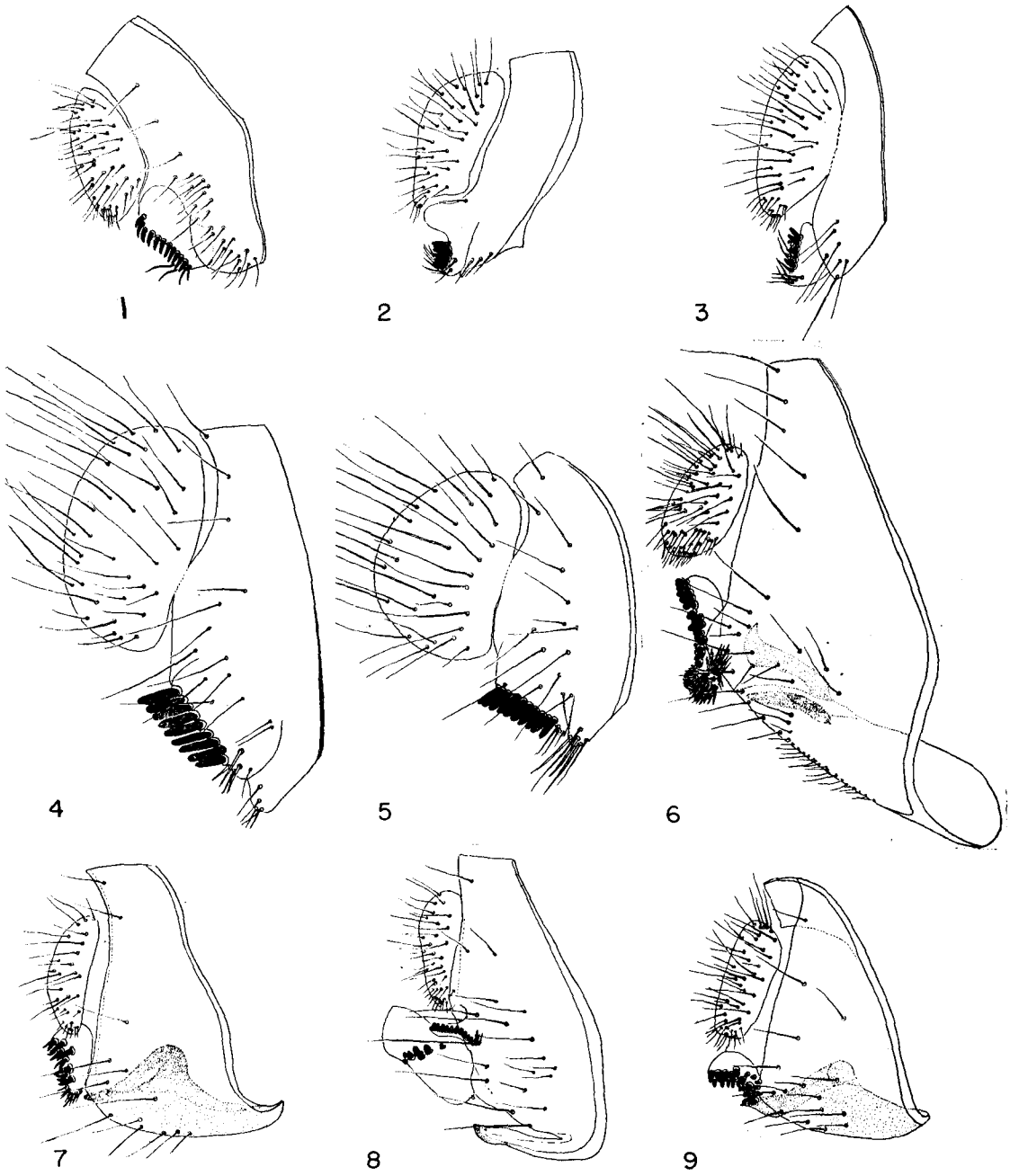

Plate V. 1, *Drosophila busckii;* 2, *D. floricola,* 3, *D. lutzii;* 4, *D. subsigmoides,* 5, *D. sigmoides;* 6, *D. emarginata,* 7, *D. prosaltans,* 8, *D. sturtevanti,* 9, *D. rectangularis.*

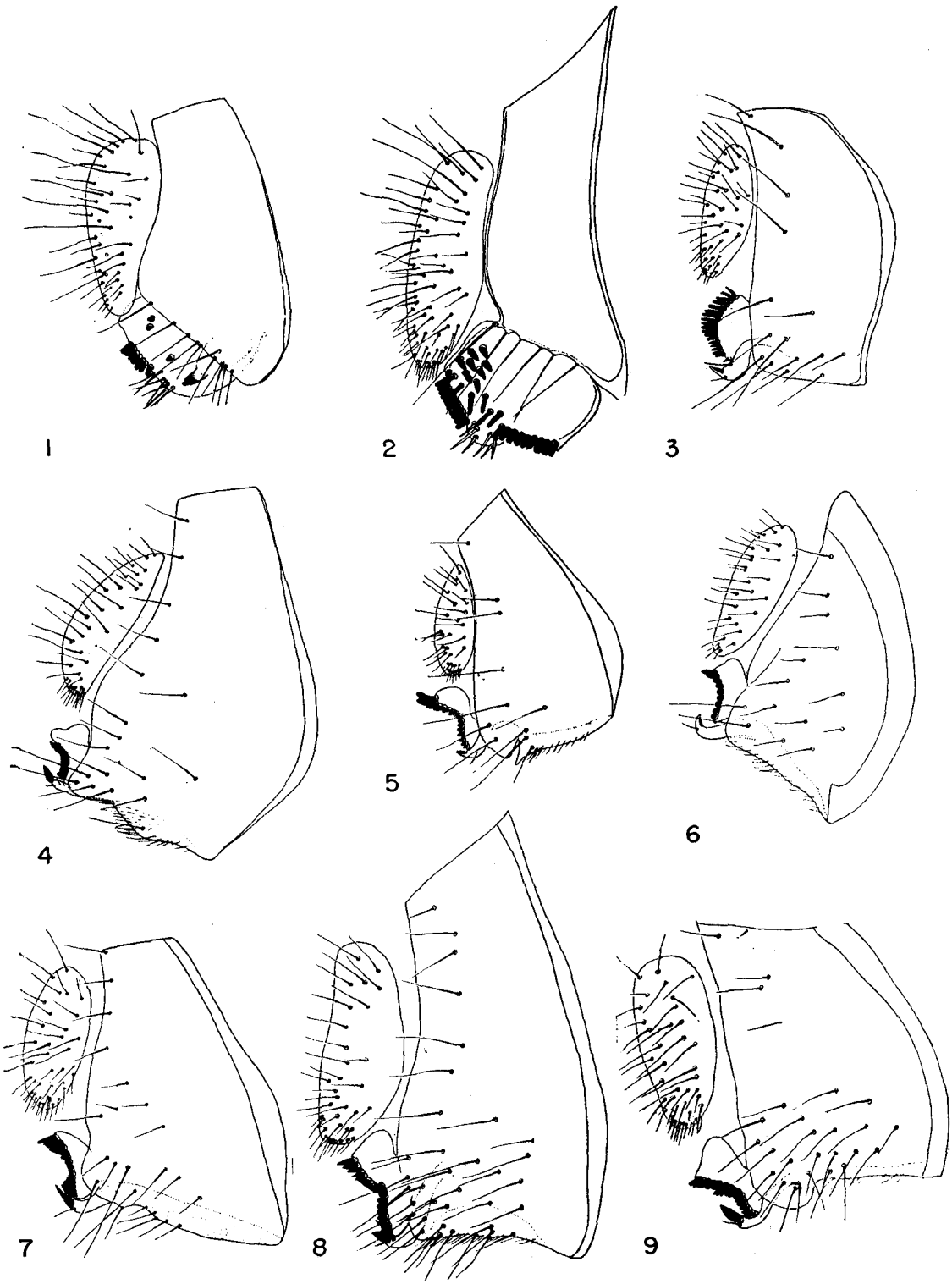

Plate VI. 1, *Drosophila acanthoptera;* 2, *D. nannoptera;* 3, *D. willistoni,* 4, *D. nebulosa,* 5, *D. equinoxialis,* 6, *D. fumipennis,* 7, *D. sucinea;* 8, *D. alagitans,* 9, *D. capnoptera.*

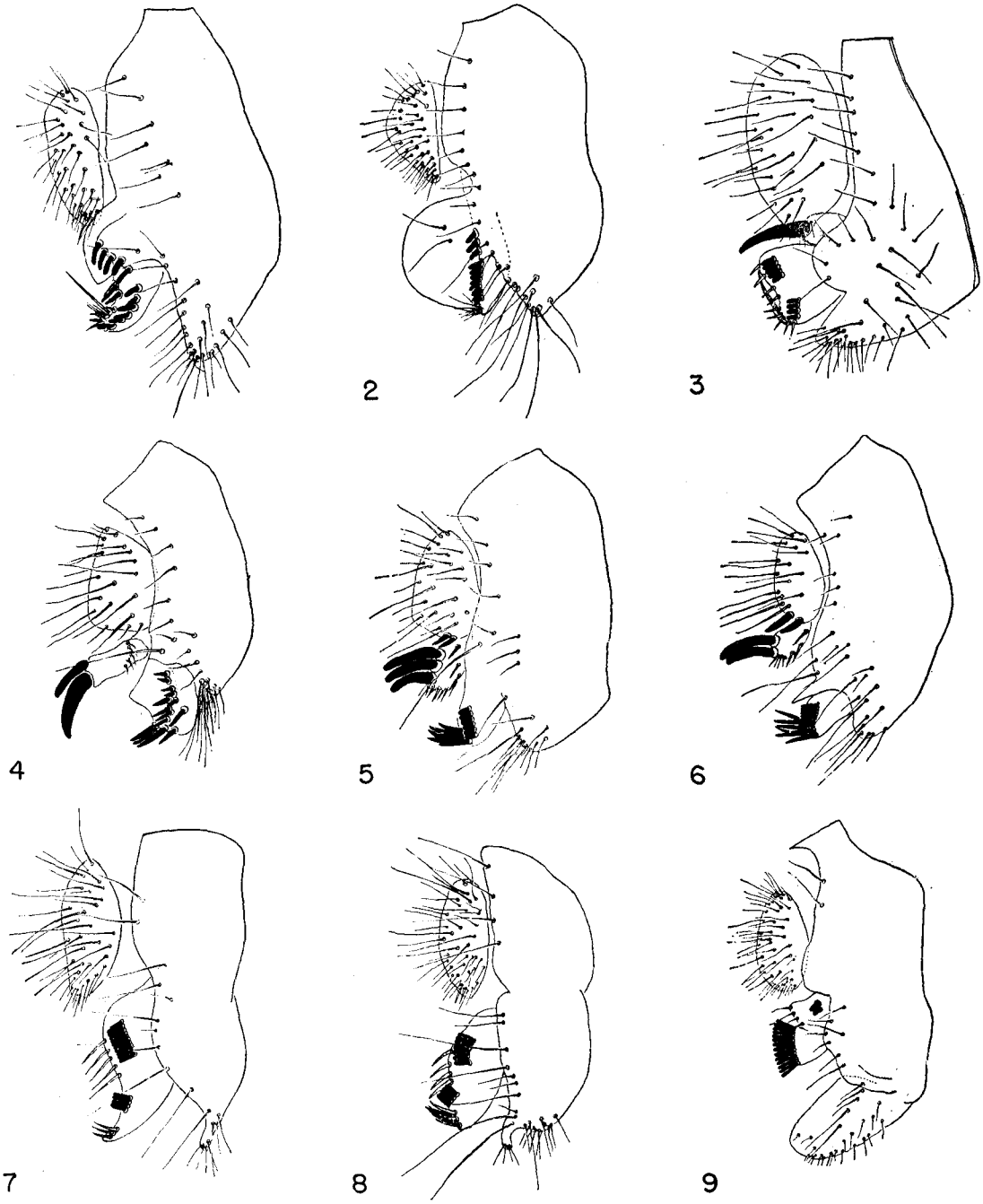

Plate VII. 1, *Drosophila melanogaster*, 2, *D. simulans*, 3, *D. ananassae*, 4, *D. montium*, 5, *D. rufa*, 6, *D. auraria*, 7, *D. suzukii*, 8, *D. pulchrella*, 9, *D. takahashii*.

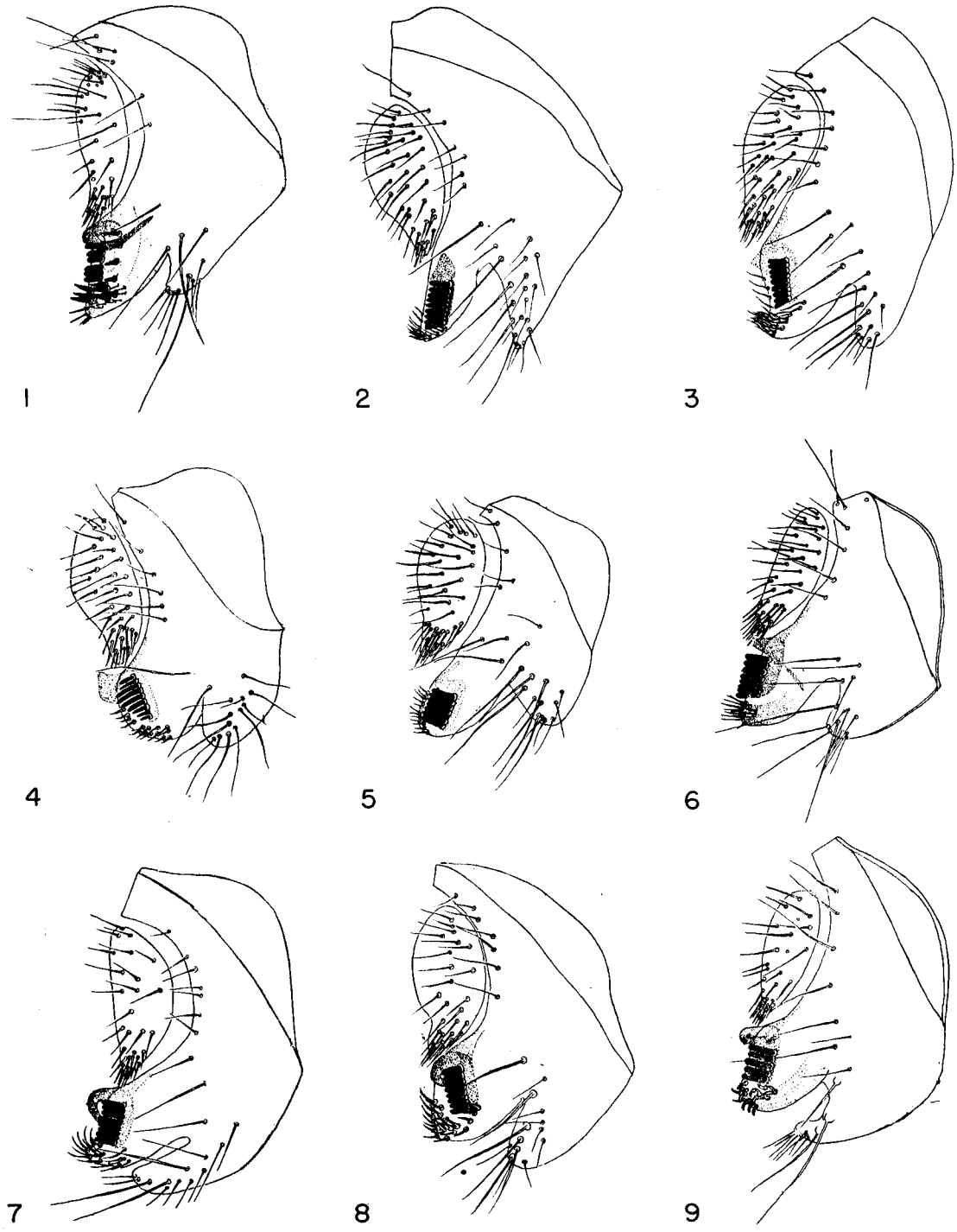

Plate VIII. 1, *Drosophila pseudoobscura*, 2, *D. obscuroides*, 3, *D. bifasciata*, 4, *D. helvetica*, 5, *D. subobscura*, 6, *D. algonquin*, 7, *D. affinis*, 8, *D. narragansett*, 9, *D. azteca*.

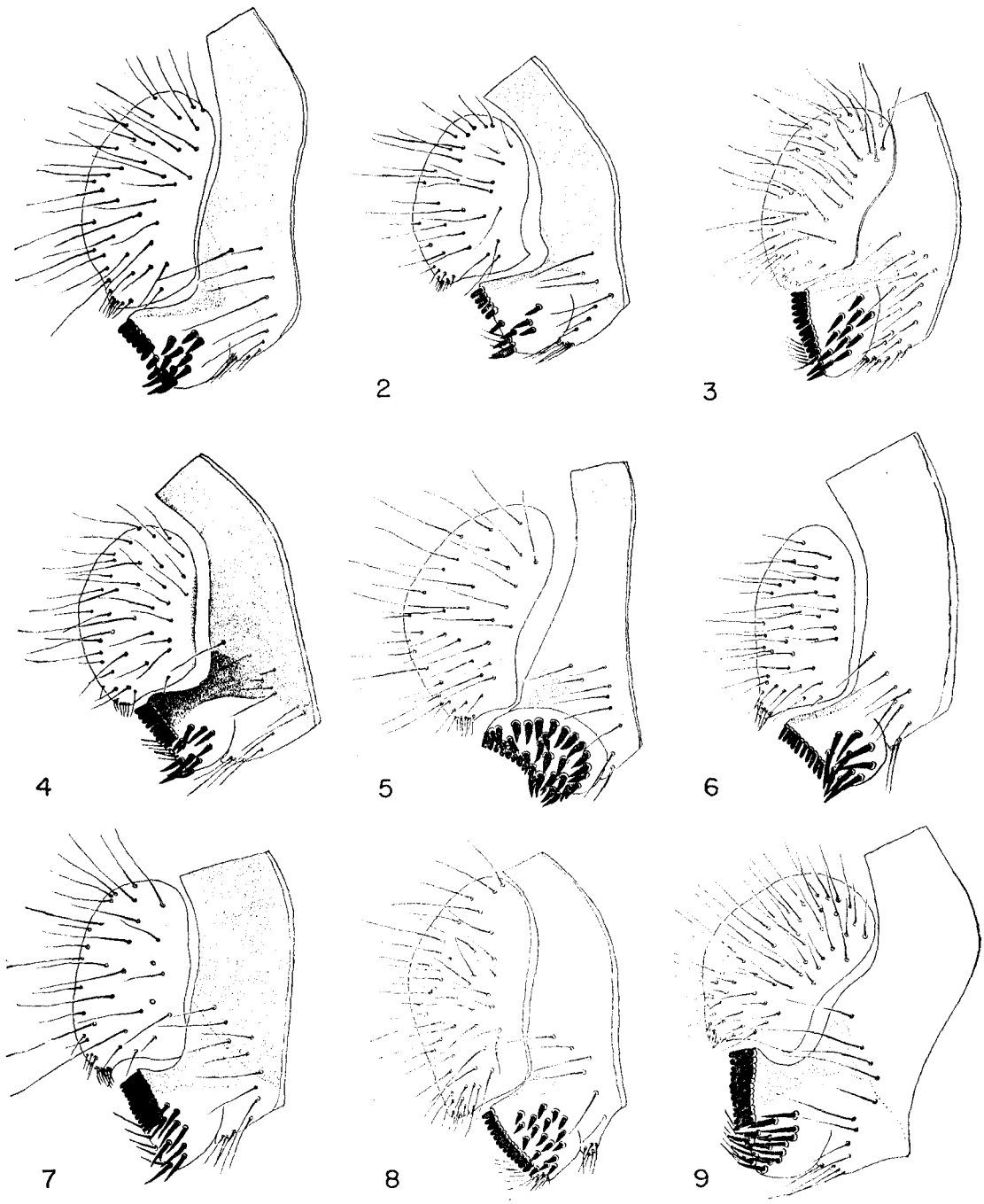

Plate IX. 1, *Drosophila quinaria*, 2, *D. subquinaria*, 3, *D. transversa*, 4, *D. tenebrosa*, 5, *D. palustris*, 6, *D. munda*, 7, *D. innubila*, 8, *D. limbata*, 9, *D. phalerata*.

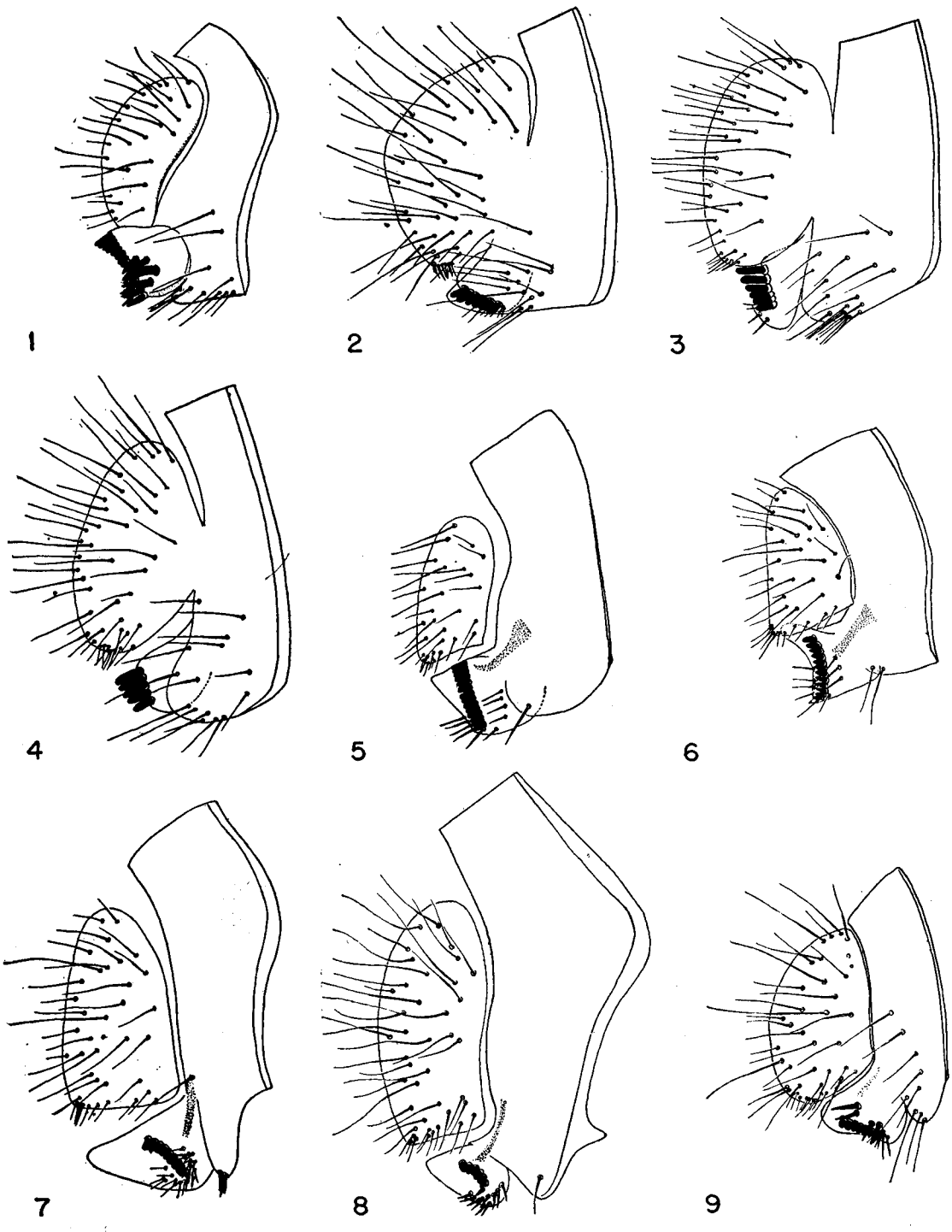

Plate X. 1, *Drosophila guttifera;* 2, *D. virilis,* 3, *D. montana,* 4, *D. lacicola;* 5, *D. testacea,* 6, *D. putrida;* 7, *tripunctata,* 8, *D. unipunctata,* 9, *D. crocina.*

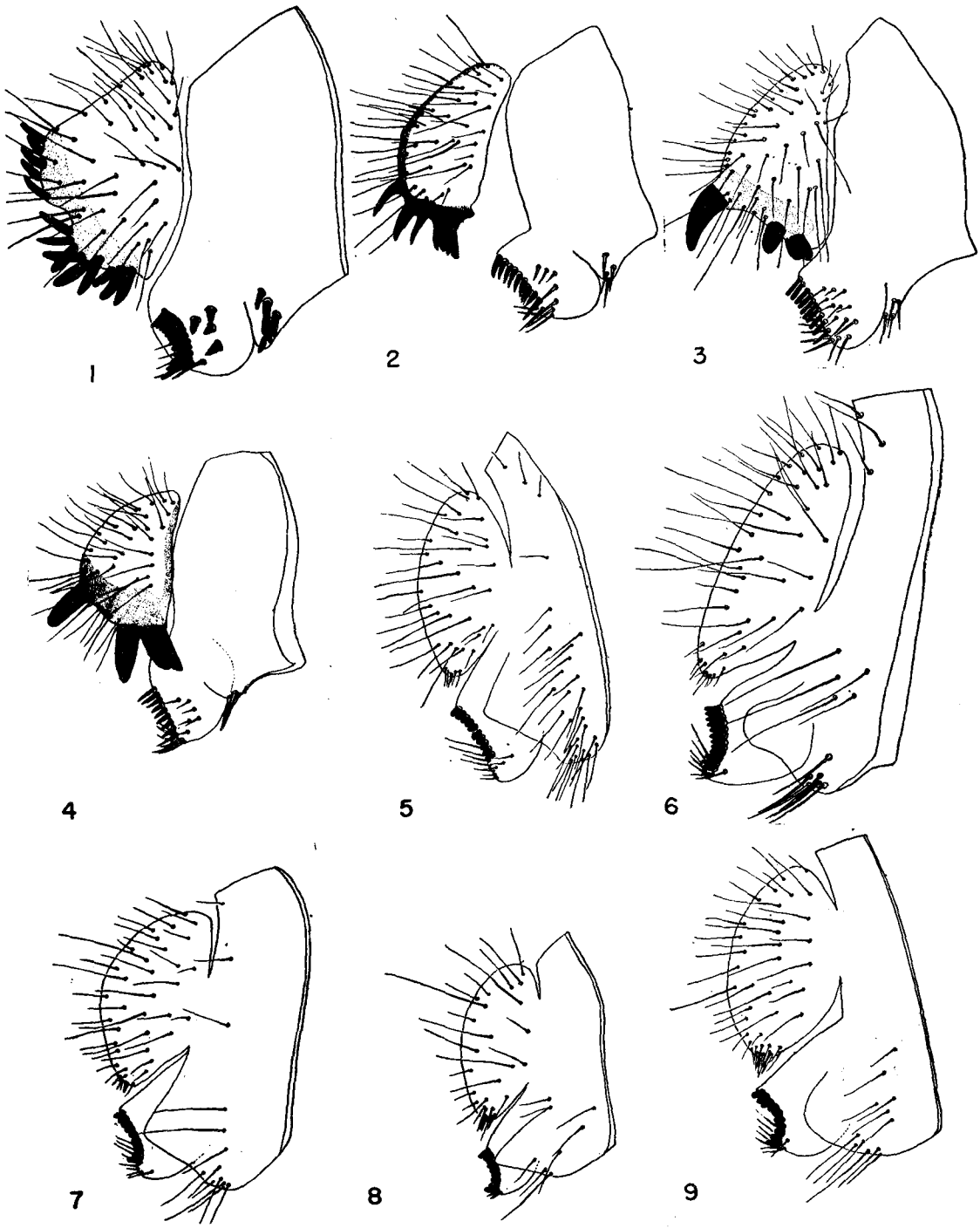

Plate XI. 1, *Drosophila funebris*, 2, *D. subfunebris*, 3, *D. macrospina*, 4, *D. trispina*; 5, *D. hydei*, 6, *D. bifurca*, 7, *D. repleta*, 8, *D. melanopalpa*, 9, *D. fulcamacula*.

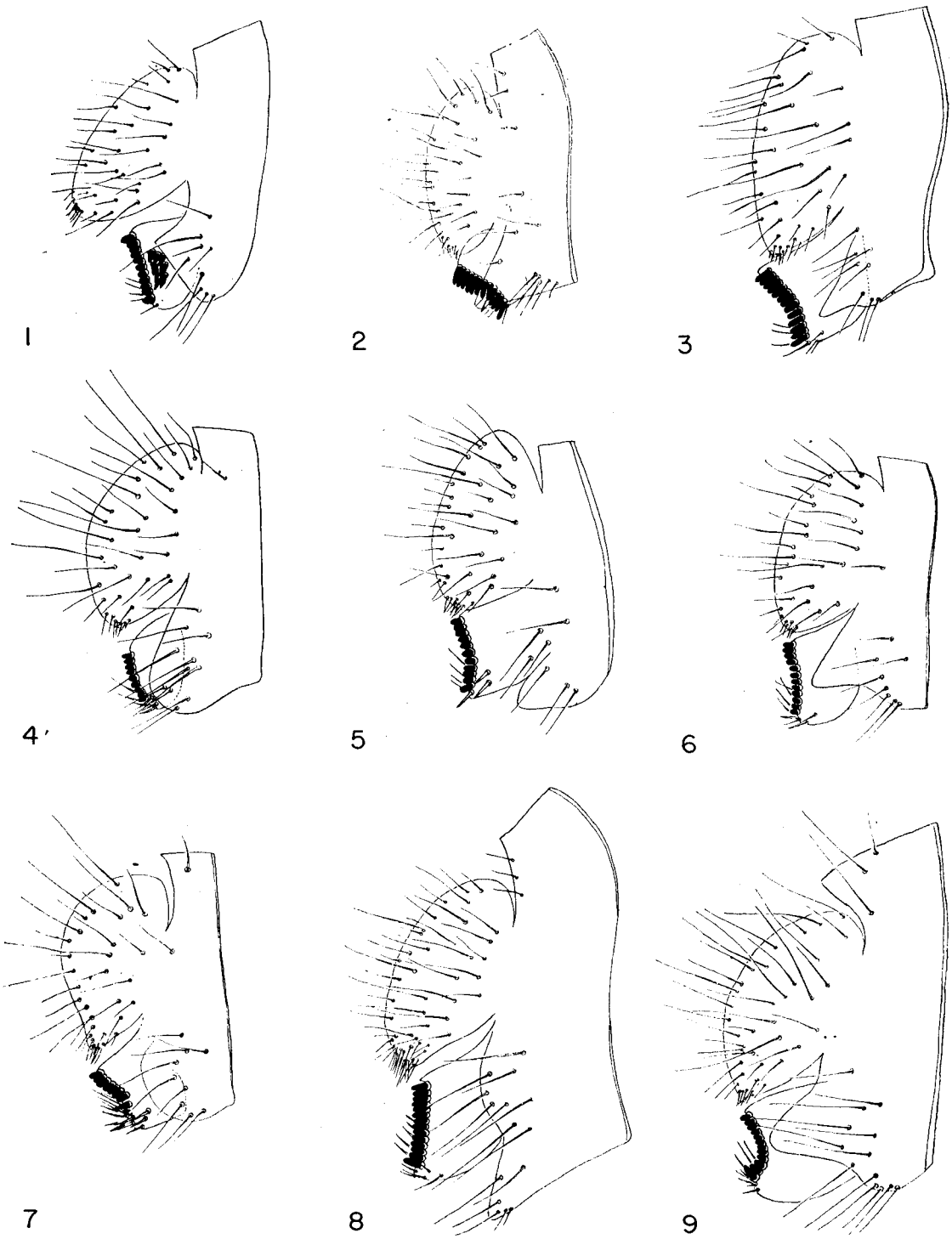

Plate XII. 1, *Drosophila mulleri*, 2, *D. mojavensis*, 3, *D. hamatophila*, 4, *D. anceps*, 5, *D. meridiana*, 6, *D. mercatorum*, 7, *D. nigrocruria*, 8, *D. ritae*, 9, *D. icteroscuta*.

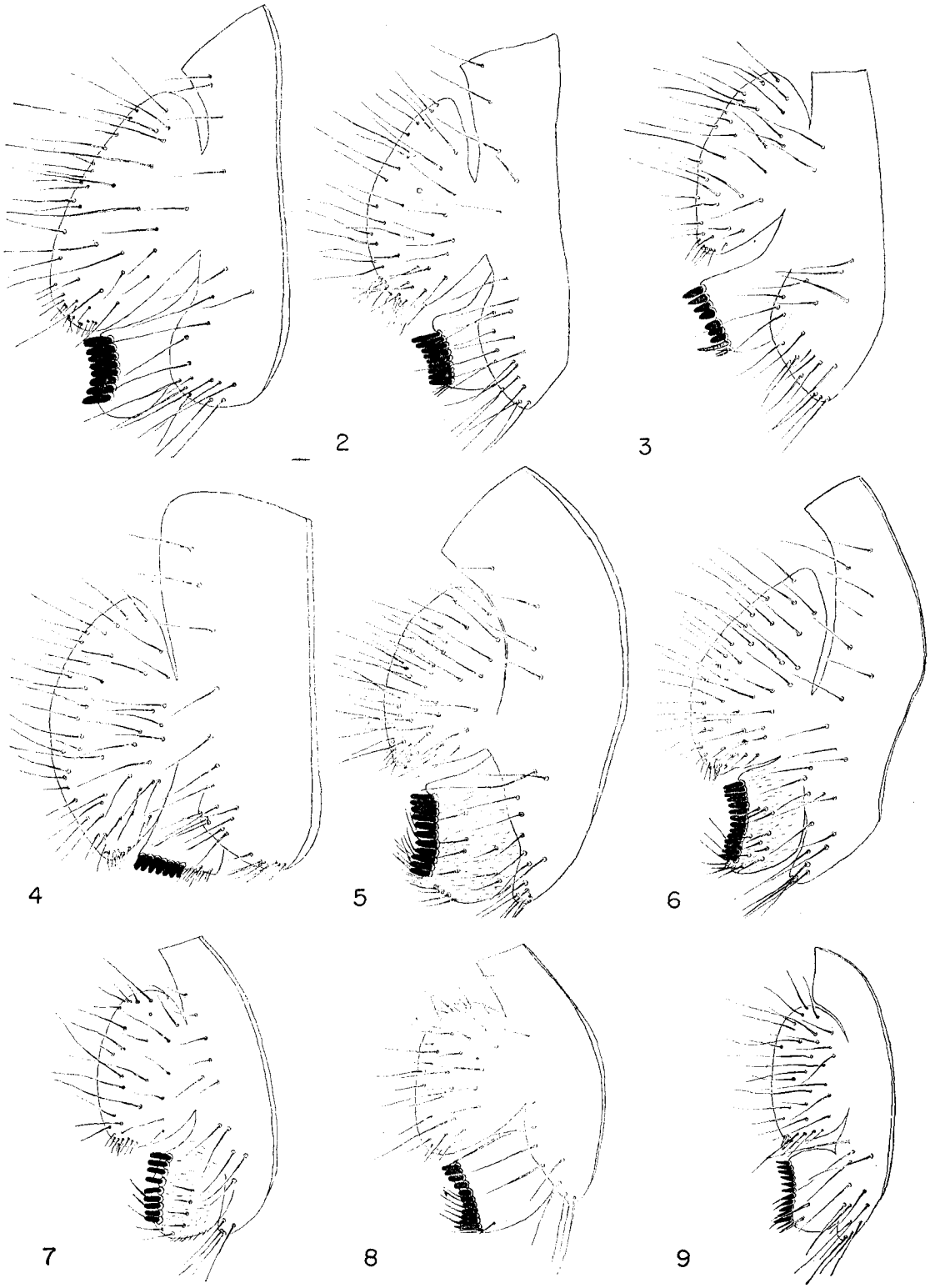

Plate XIII. 1, *Drosophila robusta*, 2, *D. cheda*, 3, *D. pullata*, 4, *D. colorata*; 5, *D. melanura*, 6, *D. nigromelanica*, 7, *D. melanica*, 8, *D. micromelanica*, 9, *D. afer*.

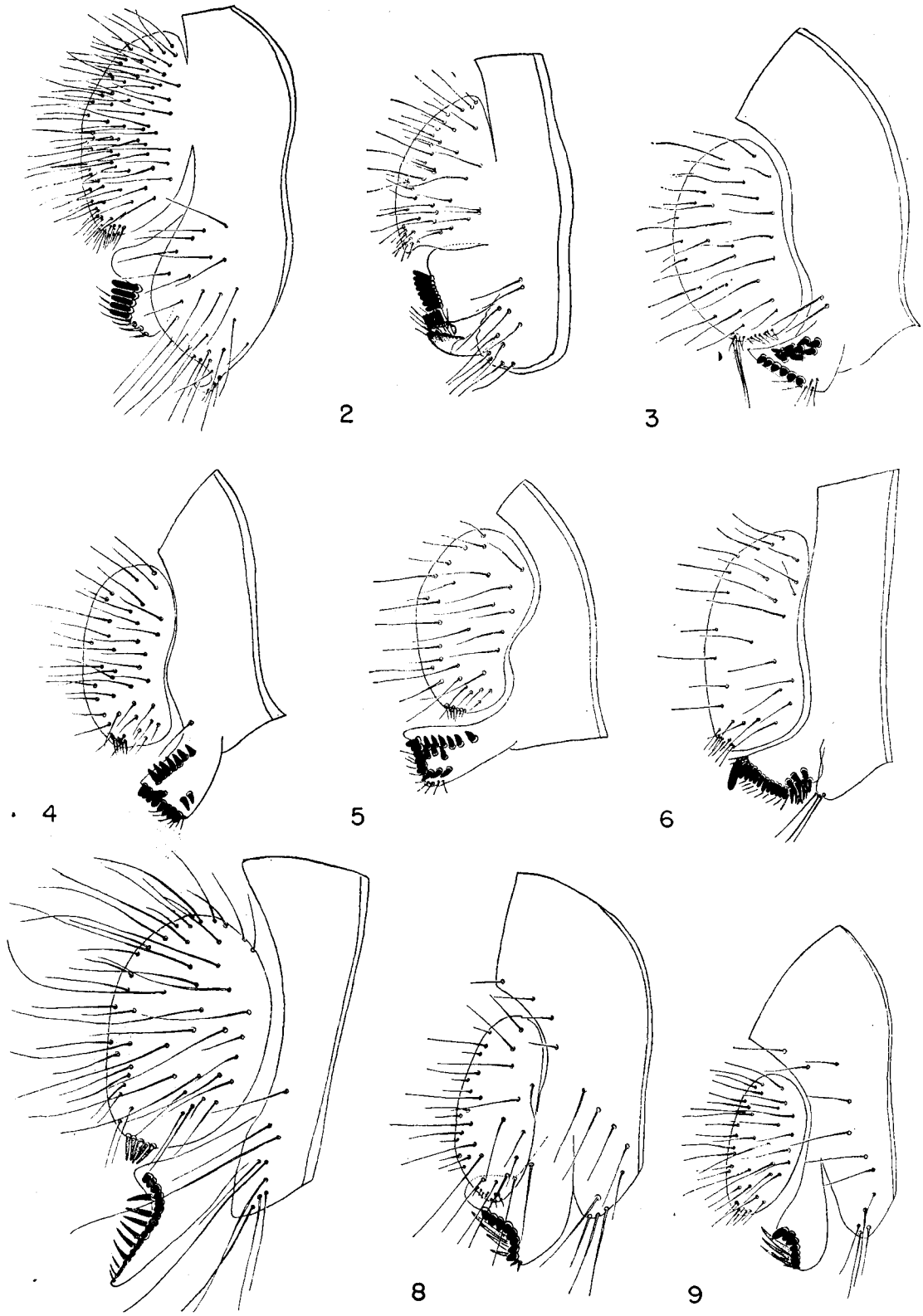

Plate XIV. 1, *Drosophila polychaeta;* 2, *D. carbonaria;* 3, *D. cardini,* 4, *D. neocardini,* 5, *D. cardinoides,* 6, *D. bandeirantorum;* 7, *D. immigrans,* 8, *D. spinofemora,* 9, *D. nixifrons.*

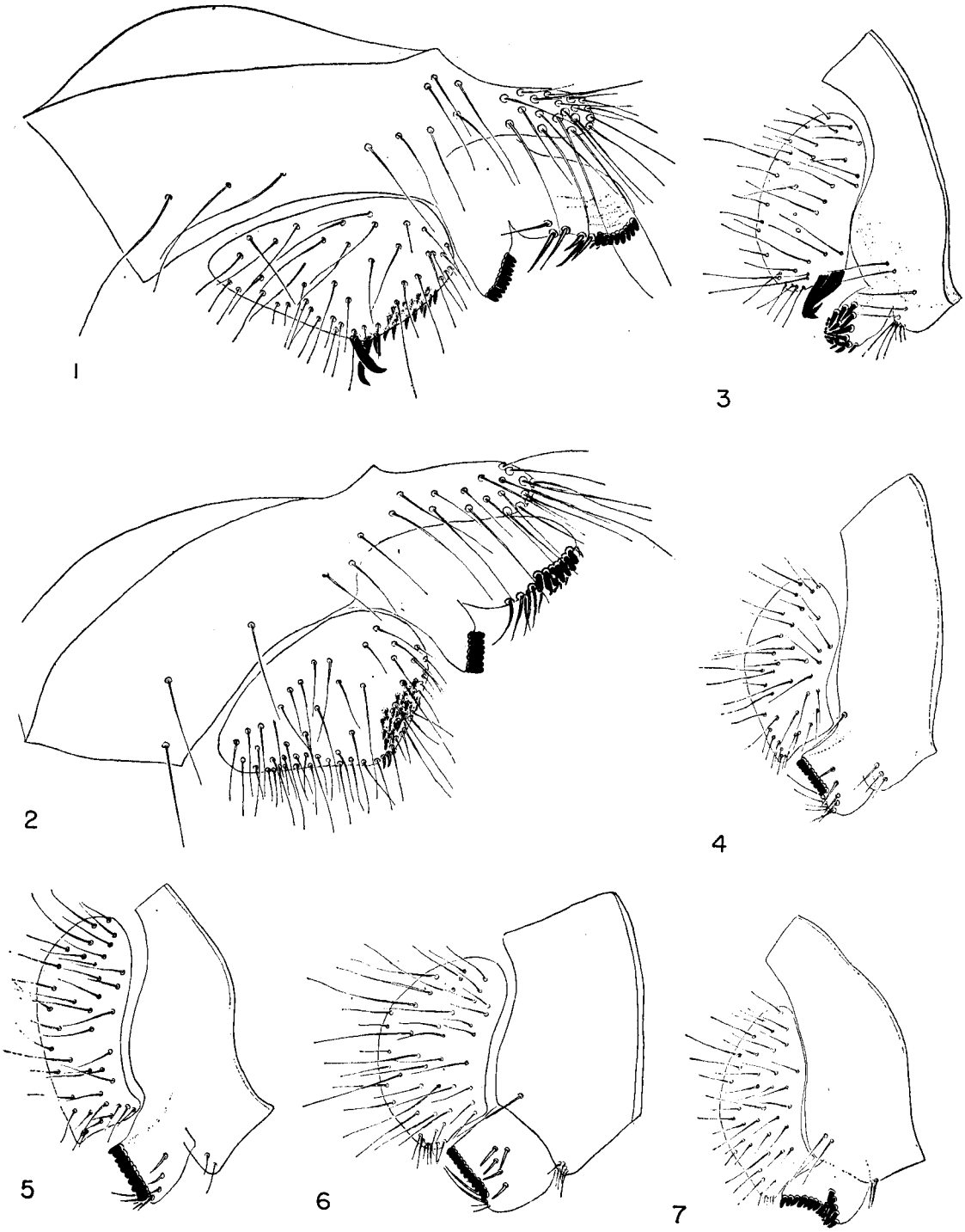

Plate XV. 1, *Drosophila melanderi*, 2, *D. magnafumosa;* 3, *D. subbadia;* 4, *D. rubrifrons*, 5, *D. spadicifrons*, 6, *D. nubiluna*, 7, *D. uninubes.*

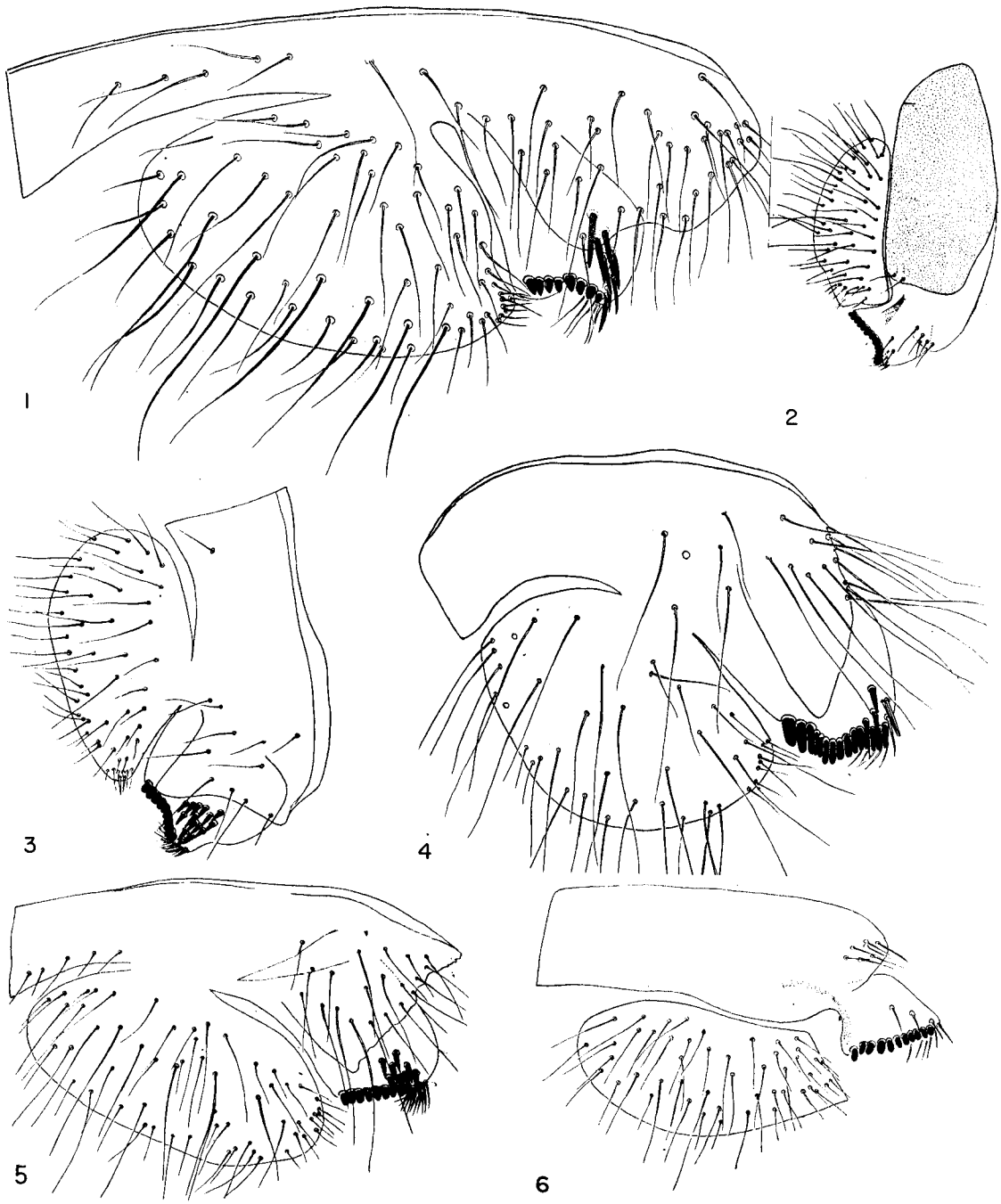

Plate XVI. 1, *Drosophila gigas*, 2, *D. macroptera*, 3, *D. annulimana*, 4, *D. gibberosa*, 5, *D.* sp. 6, *D. magnabadia*.

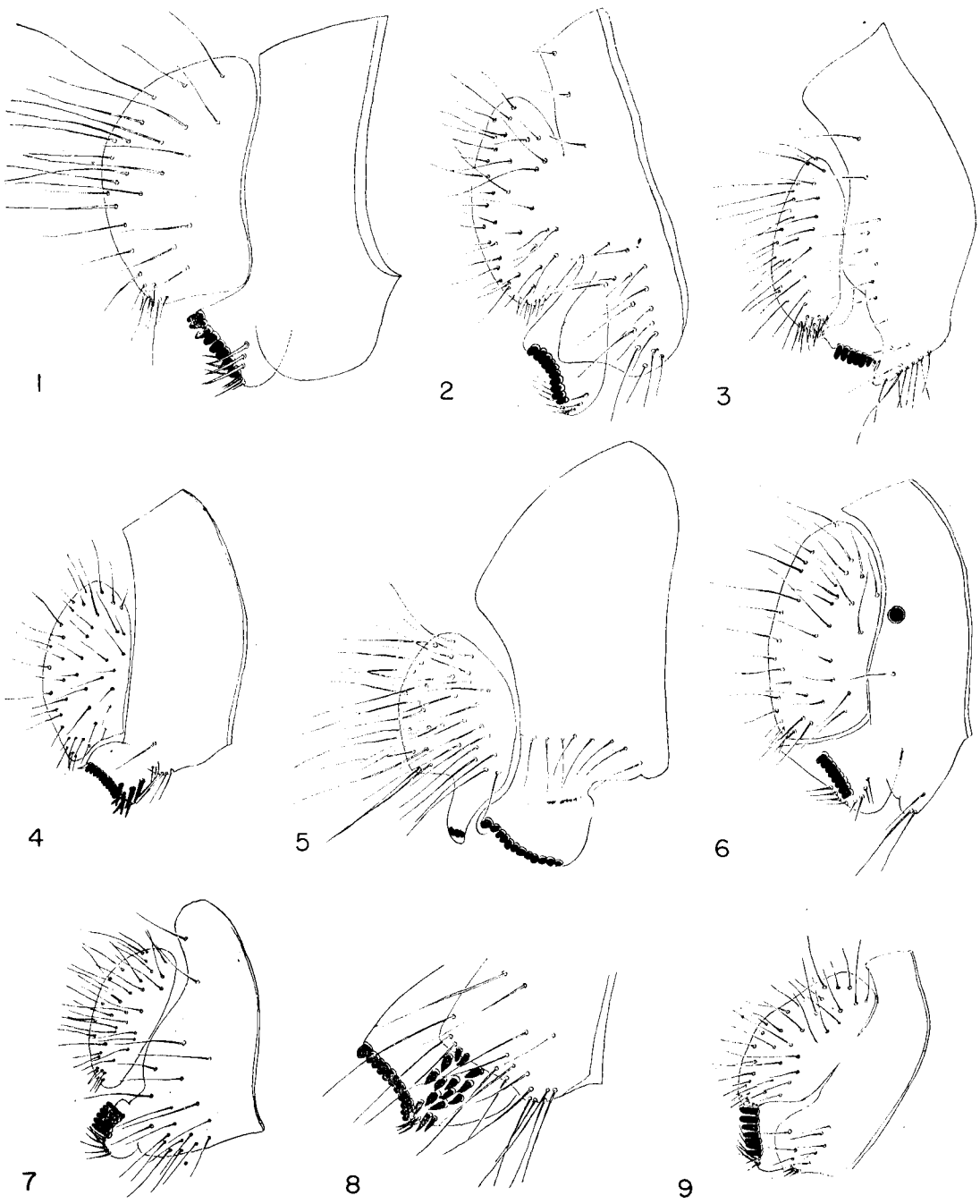

Plate XVII. 1, *Drosophila pallidipennis*, 2, *D. fulvalineata*, 3, *D. tumiditarsus*, 4, *D. parachrogaster*, 5, *D. histrio*, 6, *D. fragilis*, 7, *D. subtilis*, 8, *D. dreyfusi*, 9, *D. littoralis*.

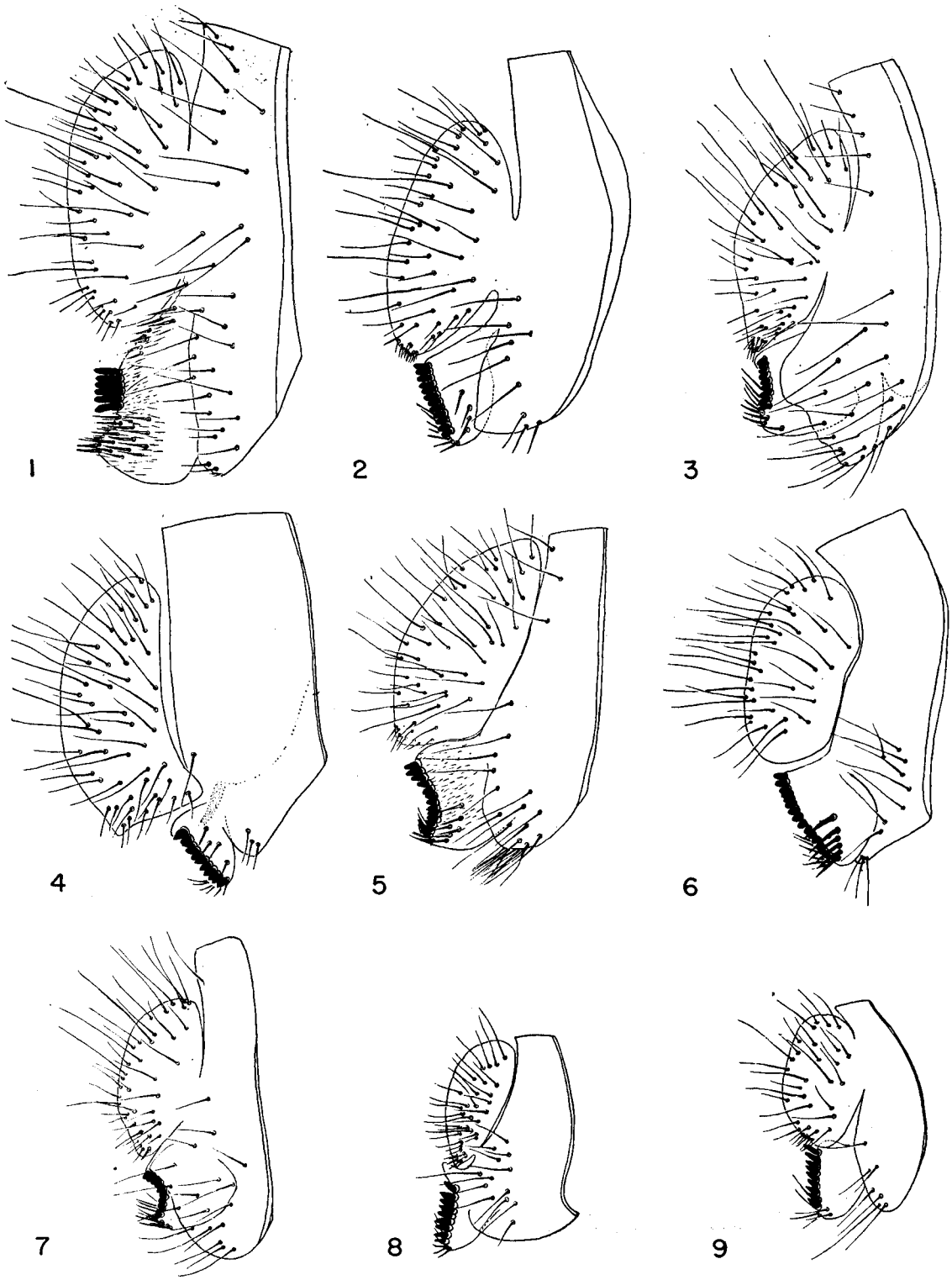

Plate XVIII. 1, *Drosophila crassa*, 2, *D. nigrospiracula*, 3, *D. setapex*, 4, *D. alafumosa*, 5, *D. unimaculata*, 6, *D. kuntzei*, 7, *D. castanea*, 8, *D. guyenoti*, 9, *D. bromeiliae*.