A REVISION OF THE AMERICAN SPECIES OF *GONIA* MEIGEN (DIPTERA: TACHINIDAE); TOGETHER WITH A STUDY OF THE MALE GENITALIA IN CALYPTRATE DIPTERA, BASED ON THE SAME GENUS.

by

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I INTRODUCTION

The tachinid genus, Gonia Meigen, has long been known to contain several distinct American species. Descriptions of at least nineteen of these have been published. Determinations have been based on many different characters, of which those of the male genitalia have been favoured recently. It is, however, admittedly difficult, if not almost impossible, to describe in words slight differences in the shape or contour of such structures. Yet in no case has one of these characters been illustrated. As a result the accurate specific determination of Gonia has been practically impossible and in almost all dipterous collections various species of this genus may be found under the name Gonia capitata DeGeer, a European species, the occurrence of which in America is very doubtful.

The recent extensive work on biological control has brought into prominence our various entomophagous parasites, and especially those parasitic on pests of economic importance. Gonia is known to be parasitic on lepidopterous larvae and has been held (Strickland 1926) to be an important control factor in the case of damaging cutworm outbreaks in the grain growing areas of western Canada.

Townsend (1936), discussing the habit of this and related insects which lay their microtype eggs on plant foliage, where they are ingested with the foliage by lepidopterous and other larvae, goes so far as to suggest that such parasites might be bred and distributed as a control measure for certain pests.

At least, the interests of entomology should be served by a clarification of the taxonomy of this group. To this end the

present work was undertaken. An attempt has been made to clear up the taxonomy of the group, by illustrating the genital and other significant distinguishing characters. Where possible the work has been based on an examination of type material. A complete taxonomic bibliography of the genus and each species dealt with is included. Some synonomy is suggested, but it seems possible that, when further type material is available and especially when European forms can be studied, further synonomy may be shown. Four new species are described and figured.

In approaching this problem an anatomical study of the male genitalia of Gonia was found imperative. It was hoped that less easily exposed structures than those previously used might prove valuable in the taxonomic work. Although no characters of taxonomic value were found, it became evident from the literature on the morphology of the male genitalia of Calyptrate Diptera that, though extensively used for taxonomy, the morphology of these structures is as yet poorly understood. A review of the literature on dipterous genitalia, with the detailed anatomical study of these structures in Gonia, and some suggestions as to the possible homologies of the parts with those in other Diptera and with the parts of the male genitalia of more generalized insects, has been included in the third section of this paper. The taxonomy of Diptera in general cannot but be furthered by a more complete understanding of, and more uniform terminology for, the parts of these much used structures.

II TAXONOMY OF THE GENUS, GONIA MEIGEN.

A. Historical Review

The genus Gonia was established by Meigen (1803) but no species were named until 1826 (Meigen 1826) when the same author described thirteen species. Curtis (1834) designated Musca capitata deGeer as the type of the genus. Desvoidy (1830) described two genera, Rhedia and Reaumuria, which were synonomized with Gonia by Coquillet (1897). Desvoidy had wrongly supposed the term Gonia preoccupied in conchology. Two other generic descriptions published by Desvoidy (1851), Isomera and Pissemya, have been synonomized with Gonia Meigen by Schiner (1862) and Brauer and Bergenstamm (1893) respectively. Townsend (1934,5,6--), in his as yet only partly published "Manual of Myology", recognizes as separate genera, Reaumuria Desvoidy (type Gonia ornata Meigen) and Rhedia Desvoidy (type Gonia atra Meigen) as well as three American genera; Cnephalogonia Townsend (type Gonia distincta Smith), Cystogonia Townsend (type Gonia turgida Coquillet) and Knabia Townsend (type Knabia hirsuta Townsend) and at least one other exotic genus, Phosocephalops Townsend (type Gonia pallens Williston), all of which would fall within Gonia Meigen as considered here. Isomera Desvoidy he synonomized with Gonia Meigen, s.s. and Pissemya Desvoidy with Rhedia Desvoidy. It is impossible, however, to determine from the volumes published to date, the limits of Townsend's restricted genera or their synonomy with species considered in this paper.

Meigen and other European taxonomists depended largely on colour characters and the relative lengths of the aristal seg-

ments for specific determinations in this genus. The resulting descriptions are totally inadequate to allow any comparison of our now known American species with the European forms on the basis of these descriptions alone.

Say (1829) described the first known American species, Gonia frontosa Say, stressing colour. What is probably the same species was redescribed as new by Macquart (1842) as Gonia philadelphica Macquart, and again by Walker (1849) as Gonia albifrons Walker. Williston (1887) recognized the synonomy of the above mentioned names, redescribed the species as Gonia frontosa Say and described four new species, giving a key for the separation of the five species mentioned. He discarded the relative lengths of the aristal segments as a character variable in individuals and noted the colour of the antennae, colour of the thoracic vestiture, and length of the claws and pulvilli in the males.

Townsend (1892) added another species, Gonia sagax Townsend.

Coquillet (1897) reduced the previously described species to two, synonomizing Gonia sagax Townsend and Gonia senilis Williston, and synomizing Gonia frontosa Say, Gonia exul Williston, and the European species Gonia capitata DeGeer, and described a third, new species, Gonia turgida Coquillet. Gonia porca Williston he recorded as "unrecognized."

Smith (1915) described a new species Gonia distincta Smith, basing his description on females only. In the following year Townsend (1916) described a new, related genus, Cnephalogonia Townsend, with Gonia distincta Smith as the type of the genus.

Strickland (1923) working with cutworm outbreaks found very different types of larvae of Gonia present. Tothill (1924) revised the genus, largely on material reared by Strickland. Tothill's was the first classification based on male genitalia, the forceps of the genitalia being described but not figured. He recognized seventeen species, ten of which he described as new. Gonia frontosa Say, Gonia sagax Townsend, Gonia senilis Williston, Gonia porca Williston and Gonia sequax Williston, he recognized as distinct species along with Gonia distincta Smith and Gonia turgida Coquillet.

Reinhard (1924) described an additional new species, Gonia texensis Reinhard, again describing but not illustrating the male genitalia.

As was mentioned above, in discussing the genus, Townsend (1936) has listed several new generic names and at least one new species (Knabia hirsuta Townsend) in the generic keys of his latest publication. Further definition of these forms must await the publication of the additional volumes of his work containing the generic and specific descriptions.

B. Present Revision of the Genus.

The writer commenced work on this genus at the University of Alberta where a considerable collection of Gonia had accumulated. This was augmented by specimens from the University of Montana, the Dominion Entomological Laboratory at Saskatoon, Saskatchewan, and material collected by the writer and others at Macdonald College, Province of Quebec. Dr. McDunnough, Chief, Systemic Entomology, Division of Entomology, Department of Agriculture, Ottawa, kindly allowed the examination of Tothill's type material and of several hundreds of specimens in the Canadian National Collection.

Early in the investigation it became evident that, at least at present, accurate determination of female material must remain impossible. It is the hope of the writer to investigate, at a later date, the connection between the species, as here determined on male characters, and the different types of larvae found by Strickland (1923). This, in turn, together with a study of the female genitalia, might lead to the discovery of means of classifying females.

For the purposes of the present paper males only are considered except where the female definitely associated with these males is known. The key is based on combinations of characters of the genitalia and of other structures. The only portion of the male genitalia showing characters of taxonomic value is the (anal) forceps (Plate I, Figure 1). This compound structure is normally folded underneath the abdomen and concealed in the genital pouch beneath the lobes of the

fifth sternite. From this position it must be extruded with a hooked needle in order that lateral and dorsal views may be observed. The terms "dorsal" and "ventral" as used in this paper refer to the forceps in this extended position. The outline of the forceps in the dorsal and lateral views offers the best characters for separating the species.

The drawings presented here were prepared from genitalia (of type material where possible) first removed from the specimen, then treated for from twenty-four to thirty-six hours in cold ten per cent potassium hydroxide, and kept in vials of forty per cent alcohol and ten per cent glycerine solution. They were examined in glycerine with the aid of a binocular microscope. A camera lucida was attached to one tube of the microscope to aid in securing the outline. Permanent mounts were made in balsam or De Faure's solution but this is not advisable as it prevents any further moving of the material. For purposes of determination in later work it did not prove necessary to dissect out the genitalia from the body. They were merely extruded to reveal the forceps and dried in that position. A word of warning should be given here pointing out that unless the observations are made from perfectly similar positions in all cases, (i.e., lateral and dorsal views), appearances may be very misleading. The dorsal view is difficult to get in such a way that the two sides of the forceps are symmetrical. Thus an apparent asymmetry is seen in some of the diagrams given here.

In many species the appearance of the genitalia is not sufficiently distinct to serve alone as a distinguishing

character. Other morphological structures must then be used. Among the characters found of value are: the comparative widths of the parafacials and the compound eye; the density and length of the setal vestiture on the parafacials; the comparative lengths of the ungues and pulvilli and the last tarsomere; the colour of the vestiture of the occiput; the colour of the antennae; and the colour of the lobes of the fifth sternite. These make valuable key characters and coupled with the form of the genitalia make the definite determinations of all species dealt with here possible.

The key given has been built with one chief thought in mind; i.e., that it should be usable and make exact separation of the species possible. For this reason the species key out separately and not into the groups of related species which are discussed later.

Gonia Meigen

(1) 1803. GONIA Meigen. Illig. Mag. II: 280

(2) 1826. GONIA Meigen. Meigen, Syst. Beschr. V, I (13 spp. described).

(3) 1830. RHEDIA Desvoidy. Myodaires: 74 (Synonomy by Coquillet).

(4) ———. REAUMURIA Desvoidy. (Loc. cit.) 79 (Synonomy by Coquillet).

(5) 1834. GONIA Meigen, Curtis, British Entomology. Lnd. (Musca capitata DeGeer, designated as type).

(6) 1849. GONIA Meigen. Walker, List of Dipt. in Br. Mus. 4: 797-8.

(7) 1851. ISOMERYA Desvoidy. Annals Soc. Ent. France: 315. (Synonomy by Schiner).

(8) ———. PISSEMYA Desvoidy. (Loc. cit.): 318. (Synonomy by Brauer and Bergenstamm).

(9) 1862. GONIA Meigen. Schiner, Fauna Austriaca, (I): 441.

(10) 1878. GONIA Meigen. Osten Sacken, Catalogue etc., Smithson. Misc. 270: 150.

(11) 1887. GONIA Meigen. Williston, Can. Ent. XIX: 6 (Desc. and table of spp.).

(12) 1894. GONIA Meigen. Snow, Kans. Univ. Quart. III: 180. (Discussed generic limits).

(13) 1897. GONIA Meigen. Coquillet, Revis. Tachin: 132.

(14) 1924. GONIA Meigen. Tothill, Can. Ent. 56: 196-212.

(15) 1934. GONIA Meigen. Townsend, Manual of Myology. (Greatly restricted).

Gonia Meigen is easily separated from other genera of Tachinids by the following combination of characters: head very much inflated (except in G. distincta Smith), yellowish except on the occiput and the eyes, white pollinose with the front above largely translucent and more than twice as wide as either eye in both sexes (wider in females), the frontal

vitta not strikingly darker in ground colour, ocellar bristles strong and curved backward, orbitals present in both sexes, eyes bare, antennae black or yellow, the penultimate aristal segment always more than three times as long as wide, usually a strong bend at the junction of the second and third aristal segments giving the arista a geniculate appearance, facial ridges with only a few bristles at their bases, parafacials with hair or bristles; propleura bare; lower lobes of squamae bare above; infrasquamal setulae absent. It is to be noted that the generic keys of Williston (1908) and Coquillet (1897) would eliminate Gonia setigera Tothill, in which the first vein is setose, from this genus. The earlier generic descriptions also list the palpi as yellow but in the fissiforceps group specimens show palpi with varying degrees of infuscation to dark brown. Tothill describes the first two antennal segments as yellow in all cases. This is not quite correct as frequently only a slight reddish-yellow colour on the apical portions of these segments is obvious, the segments being otherwise dark.

Key to the males of Gonia Meigen, found in America north of Mexico.

(For the purposes of this key the genitalia are considered as extruded and extended until the forceps point backward in the direction of the long axis of the body. The terms dorsal, ventral, lateral, "turned up", and "turned down" refer to the structures in this position. Figures 1 to 22 are lateral views of the forceps, figures 1a to 22a dorsal views).

1. First, second and third segments of antennae entirely yellow, aristae black or mostly yellow - - - - - - - - - 2
   At least most of the third antennal segments as well as the aristae dark in ground colour - - - - - - - 3

2. Aristae mostly yellow, genal hairs white; forceps thick, straight on the ventral edge when viewed in profile, not over twice as long as the median width; as in Figs. 13. 13a. Plate II. - - - - - - - - - - - - (No. 13) senilis Williston.
   Aristae black, genal hairs dark; forceps three times as long as their median breadth, ventral edge convex toward the apex, as in Figs. 2, 2a. Plate I. - - - - - (No. 2) sagax Townsend.

3. First wing vein bare with at the most one or two setae - 4
   First wing vein setose on the dorsal side basally half way to the first cross vein; forceps as in Figs. 10, 10a, Plate II - (No. 10) setigera Tothill.

4. Forceps without a conspicuous doraal carina - - - - 5
Forceps with a strongly developed carina as deep as the forceps are thick and extending for $\frac{3}{4}$ the length of forceps - - - - (No. 21) carinata Tothill.

5. Pile on the occiput white - - - - - - - - - - - - - - - 6
Pile on the occiput brown; forceps as in Figs. 3, 3a, Plate I - - - - - -(No. 3) fusc̈icollis Tothill.

6. Pleurae without yellow pile; lobes of fifth sternite black; genal pile light or dark - - - - - 7
Pleurae with yellow pile; lobes of fifth sternite yellow; genal pile fine and yellow; forceps as in Figs. 16, 16a, Plate III - -(No. 16) porca Williston.

7. Lobes of the fifth sternite excised laterally (as in Fig. 18b, Plate III;) abdomen shining black, with dorsal segmental bases narrowly or not at all pollinose - 8
Lobes of the fifth sternite not excised laterally; abdomen frequently reddish on the sides, dorsal segmental bases often broadly pollinose - - - - - - 9

8. Forceps more than half as deep as wide at the base of the apical cleft, ventral edge almost straight, dorsal convexity extending only about one third of the distance to the apex, which is blunt; in dorsal view with the apical cleft extending beyond the middle, as in Figs. 18, 18a, Plate III - - - - - - - - - - - - - - (No. 18) fissiforceps Tothill.

Forceps at the base of the apical cleft more than half as deep as wide, ventral edge almost straight but the dorsal convexity extending almost one half the length of the forceps, apex blunt, apical cleft not extending beyond the middle, as in Figs. 20, 20a, Plate III - - - - - - - - - (NO. 20) yukonensis Tothill.

Forceps at the base of the apical cleft not half as deep as wide, ventral edge curved ventrally at the apex, which is almost hook-like, as in Figs. 19, 19a, Plate III -(No. 21) tenuiforceps new species.

9. Forceps almost as deep as long, dorsally with a subapical tuft of long black setae, ventrally with a cushion of yellowish setae in the hollow between the apical lobes, as in Figs. 17, 17a, Plate III - - - - - - - - - - (No. 17) texensis Reinhard.

Forceps much longer than deep, no cushion of yellowish setae between the apical lobes ventrally - - 10

10. Genal hairs light in colour - - - - - - - - - - - - - - - 11

Genal hairs dark in colour - - - - - - - - - - - - - - - 12

11. Forceps broad as in Fig. 12a, Plate II, ventral edge slightly curved dorsally at the apex as in Fig. 12, abdomen mostly yellow with a narrow dorsal dark stripe; abdominal venter yellow except at the base and apex; eastern species - (No. 12) sequax Williston.

Forceps narrow as in Fig. 9a, Plate II, ventral edge straight as in Fig. 9, Plate II; abdomen mostly yellow with dark dorsal stripe prominent; venter with a longitudinal black stripe - - - - - - - - - - -(No. 9) albagenae new species.

12. Parafacials narrower than the greatest width of the eye; pulvilli and ungues long as in Fig. 14b; forceps with dorsal convexity reaching almost to the apex, as in Figs. 14, 14a, Plate II - - - - - - - - - - - - (No. 14) distincta Smith.

Parafacials as wide or wider than the greatest eye width - 13

13. Parafacials unusually wide with numerous long black setae next to the eyes and directed medially, setal vestiture of front, parafacials, and genae generally denser, longer, and darker than in any other species; forceps with a straight ventral edge, dorsal convexity not conspicuous, as in Figs. 11, 11a, Plate II- - - - - - - - - - - - (No. 11) turgida Coquillet.

Parafacials as usual, with scattered black setae mostly short; forceps with ventral edge curved or if straight forceps are short or have a conspicuous dorsal convexity - 14

14. Forceps short with a straight ventral edge, with or without a strong dorsal convexity, rarely with the apex slightly dilated dorsally in breviforceps - - 15

Forceps short with a strongly curved ventral edge or longer with a very slightly to strongly curved ventral edge, the apex in profile always dilated dorsally, knob-like - - - - - - - - - - - - - 16

15. Forceps short, ventral edge straight, dorsal convexity conspicuous and extending about four-fifths of the distance to the apex, as in Figs. 15, 15a, Plate III; pulvilli as long as the last tarsal segment; ungues slender, as long as pulvilli, yellowish basally, as in Fig. 15b, Plate III - - - - - (No. 15) longipulvilli Tothill.

Forceps short, and small, ventral edge straight, apex rarely slightly dilated dorsally, as in Figs. 8, 8a, Plate II; pulvilli and ungues distinctly shorter than the last tarsomere - - - - - - - - - - - - - - - - - - (No. 8) breviforceps Tothill.

16. Forceps 2 to 4 times as long as deep, ventral edge strongly curved, apex distinctly knob-like as in Figs. 1, 1a, Plate I, small dark species; 7 mm. to 10mm. long; sides of abdomen sometimes reddish - - - - - - - - - - - - (No. 1) frontosa Say.

Forceps 5 to 8 times as long as deep, ventral edge almost straight to strongly curved, larger species; 9 mm. to 12mm. long - - - - - - - - - - - - - - - - - - - 17

17. Forceps in dorsal view triangular, tapering from the base to the apex, as in Figs. 4, 4a, Plate I; pulvilli and ungues shorter than the last tarsomere,

as in Fig. 4b, Plate I - - (No. 4) *aldrichi* Tothill.
Forceps in dorsal view continuing wide from the base or expanding, then tapering rapidly near the apex, as in Figs. 5, 5a, Plate I; pulvilli and ungues longer than last tarsomere, as in Fig. 5b, Plate I - - - - - - (No. 5) *grandipulvilli* new species.

Forceps in dorsal view tapering rapidly near the base, then extending long and narrow with almost parallel sides to the apex, as in Fig. 7a, Plate I - - - 18

18. Dorsal pile on abdomen long and erect; forceps as in Figs. 7, 7a, Plate I - - - - - - - - - - - - - (No. 7) *discalis* new species.
Dorsal pile on abdomen short and recumbent; forceps as in *discalis* (Figs. 6, 6a, Plate I) - - - - - - - - - - - (No. 6) *longiforceps* Tothill
(= *brevipulvilli* Tothill).

1. G. frontosa Say.

(1) 1829. Gonia frontosa Say. J. Acad. Philad. vi: 175. Complete Wr. ii; 365.

(2) 1840. Gonia philadelphica Macquart. Dipt. Exot. 11, 3, 51, 6. (Descr.) - Philadelphia.

(3) 1849. Gonia albifrons Walker. List of Dipt. etc. iv, 798. (Descr.) - Hudson's Bay Territory.

(4) 1878. Gonia frontosa Say. Osten Sacken, Catalogue, Smith, Misc. Coll. 270: 150.

(5) 1887. Gonia frontosa Say. Williston, Can. Ent. XIX: 8 (Redescribed).

= G. philadelphica Macq.

= G. albifrons Walk.

(6) 1897. Gonia capitata (DeGeer). Coquillet, U.S.D.A. Bur. Ent. Tech. Series 7. (Probably incorrect in synonomizing frontosa with the European capitata).

= G. philadelphica Macq.

= G. albifrons Walk.

= G. exul Willst. (Probably wrongly.)

= G. sequax Willst. (Probably wrongly.)

(7) 1905. Gonia capitata (DeGeer). Aldrich, Catalogue of Dipt. (follows Coquillet in synonomy).

(8) 1924. Gonia frontosa Say. Tothill, Can. Ent. LVI: 209 (redescribed - neotype named - no synonomy mentioned - distinguished from G. sequax Willst. - G. exul Willst. not mentioned).

There seems little doubt of the synonomy of Say's species with Gonia albifrons Walker and Gonia philadelphica Macquart. The synonomy with G. sequax Williston and G. exul Williston suggested by Coquillet and followed by Aldrich seems improbable in view of the original description of sequax, "with abdomen reddish yellow" and of exul, "with claws and pulvilli of male large." The synonomy of this species with the European G. capitata (DeGeer) is also doubtful. A specimen in the Canadian National Collection, from Europe, and bearing the label G. capitata (DeGeer), determined by Bezzi, has very different forceps, (Figs. 22, 22a, Plate III). Williston (1887), when he redescribed the species from Minnesota males, appears to have had this species but the New England, North Carolina and California material which he mentions was evidently a mixture of species with more red colouration on the abdomen, yellowish genal hairs, etc.

Considering the wide spread distribution of this species it is probably the oldest form phylogenetically speaking.

Type locality: Upper Missouri River.

Distribution: Widespread throughout Canada and United States.

Neotype: No. 785. Canadian National Collection.

2. G. sagax Townsend.

(1) 1893. Gonia sagax Townsend. Can. Ent. XXIV: 65

(2) 1897. Gonia senilis Willst. Coquillet, U.S.D.A. Bur. Ent. Tech. Series 7: 133. (Synonomy probably incorrect).

(3) 1905. Gonia senilis Willst. Ald. Catalogue Dipt. (Follows Coquillet).

(4) 1924) Gonia sagax Townsend. Tothill, Can. Ent. LVI: 200. (Redescribed). Neotype named from Middlesex County, N.J. (Figs. 2, 2a, Plate I.)

The Tothill neotype of this species was captured in April, in Middlesex County, N.J. Length 10 mm., width 4 mm. Abdominal segments three and four are slightly reddish on the sides; the antennae are all yellow except the aristae which are brownish black (a feature which checks with Townsend's original description); genal hairs dark; pulvilli short, small, oval; ungues not more than two-thirds the length of the last tarsomere; face and frontal vitta strongly yellow pollinose. Tothill has described the forceps as, "of medium length and not blunt as in G. senilis Williston, about three times as long as their median width and much narrower across the base of the apical cleft than at the middle."

In the Canadian National Collection is a female specimen from Aylmer, Que., 14, v, 1925, taken by G.S.Walley, with the same colour markings but it is very small being barely 8 mm. long and appearing at first glance to be frontosa Say.

Type locality: Ames, Iowa

Distribution: Iowa, New Jersey, Quebec (?).

Neotype: in the Canadian National Collection.

3. G. fuscicollis Tothill.

(1) 1924. Gonia fuscicollis Tot. Can. Ent. LVI: 207

(Figs. 3, 3a, Plate I.)

The only specimen of this species available was the male paratype, La Fayette, Ind. April, 1916 (J.M.Aldrich) in the Canadian National Collection. This specimen, Tothill tells us, bears the same data as the holotype in the United States National Museum. The general appearance of this small dark specimen (9 mm. by 4 mm.) is strikingly like frontosa Say. as is the ventrally arcuate line of the forceps. The ventral line however is more convex than in any frontosa observed. The occipital pile is sparse, long, and brown.

A female from Rosthern, Saskatchewan, May 4, 1925, (K.M.King), in the Canadian National Collection, has a light brownish yellow occipital pile, but the abdomen is broadly red on the sides, the colour spreading ventrally to leave only a narrow median longitudinal dark stripe.

The occipital pile of other species though generally white often shows varying degrees of yellowing to dark yellow especially in specimens reared in captivity and specimens which appear to have been "wet" at some time. Further

collecting may prove this species good or doubtful; at present it must be maintained on the strength of the type and paratype.

Type locality: La Fayette, Ind.

Distribution: ?

Type: United States National Museum.

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frontosa group.

The three above named species have short forceps with arcuate ventral edges and appear to form a closely related group. All specimens examined have been captured in April, May, or early June.

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4. G. aldrichi Tothill

(1) 1924. Gonia aldrichi Tothill

Can. Ent. LVI: 209

(Figs. 4, 4a, Plate I)

Among the many paratypes of Tothill's species aldrichi are two distinct species. His own description of the forceps, "unusually robust, being both long and wide. About three times as long as the median width and almost triangular in dorsal view the equal sides tapering from the base to tip. The dorsoventral flattening is very marked," is descriptive of the type, and sufficient to separate out this species. Add to this that the ungues and pulvilli in the male are distinctly shorter than the last tarsomere and no difficulty in separation from the following species should arise.

Tothill records aldrichi as bred by Strickland from Euxoa ochrogaster and Agrotis orthogonia (Lepidoptera; Noctuidae). Adults are collected in April and May.

Type locality: Coaldale, Alberta

Distribution : Across Canada and the northern United States.

Type : No. 786, Canadian National Collection.

5. G. grandipulvilli new species.

(Figs. 5, 5a, 5b, Plate I)

Male. Length 9 mm. - 12 mm. Width 4 mm. - 5 mm. A comparatively large, dark species. Face and front light yellow with a silvery sheen in some lights, front above with a waxy appearance on the sides; lines of the face and front in profile almost straight and meeting at an angle just less than a right angle; parafacials narrower at the oral margin than at the vibrissal base, at the narrowest point wider than the greatest eye width, with an uneven double or triple row of black setae (which vary greatly in size) along the inner edge of the eye and separated from the usual row of graduated bristles along the frontal suture by a bare area. Genae less than one half the eye height with numerous slender dark setae; antennae blackish with a greyish sheen in some lights; second antennal segment slightly reddish apically, with short dorsal setae, third segment five to seven times as long as the second; pile on the occiput white; palpi yellow. Dorsum of the thorax with five broad, longitudinal pollinose lines; scutellum yellowish at least apically, frequently dark basally, some yellow on the humeri, legs black. Pulvilli and ungues distinctly longer than the last tarsomere; the pulvilli broad and white to yellowish brown; ungues black, heavy and extended almost at right angles to the tarsomere; tarsomeres somewhat broad and flat; wings clear with but very slight costal infuscation, first vein (R_1) bare above, third vein (R_{4+5})

with a group of setae above and below at the point where R_{2+3} and R_{4+5} separate.

Abdomen with reddish patches on the sides of segments 2 and 3 (this reddish colour though involving considerable of the abdomen in a few specimens examined is characteristically limited to separate patches of varying size on the segments mentioned). Dorsally the abdominal tergites narrowly to broadly pollinose basally, the pollen spreading out laterally on the fifth segment to cover the sides. Dorsal vestiture short and semi-erect.

Forceps in lateral view resemble those of aldrichi, strong, long, and flattened; ventral edge slightly curved, apical dorsal convexity evident, dorsally with sides parallel or divaricating more than half way to the apex, then tapering rapidly to the blunt point, outline much less nearly triangular than in aldrichi.

Type: Edmonton, Alta. 25/4/23 (Collector not known.)
Canadian National Collection.

Paratypes from: Saskatoon, Sask. April 20, 1937. A.P.Arnason.

Saskatoon, Sask. 15, iv, 1915. ?

" " May K.M.King.

Edmonton, Alta. (as type).

" " 2,v, 1937. F.O.Morrison.

" " 2,v, 1937. E.H.Strickland

Lethbridge " _____ Seamans & Strickland.

Awene, Man. 5,v, 1920. P.N.Vroom.

and the following among Tothill's paratypes of aldrichi in the Canadian National Collection:

Ottawa, 15 April, 1915 (Genitalia slide No. 12).

One unlabelled.

Ottawa, 1905. James Fletcher.

Ottawa, 22, iv, 1906. J. Metcalf.

Jordan, Ont. 20, iv, 1919.

One not labelled.

Mont. Exp. Sta. Musselshell Mont. 5, 12, 1917.

Mac. Coll. 11/4/1915.

Toronto, Canada, 16, iv, 1895. E.M.Walker.

Hull 17, Apr. 15, ?

Logan, Ut. Je. 1915. H.R.Hogan.

Ottawa, Ont. Jn. 1,4,1906. W. Metcalf.

As above, 22, iv, 1906.

Toronto, Ont., April 21, 1897.

6. G. longiforceps Tothill *

(1) 1924. Gonia longiforceps Tothill

Can. Ent. LVI: 208.

(= Gonia brevipulvilli Tothill)

(Figs. 6, 6a, Plate I)

The figures show Tothill's description of the forceps in this species very accurate, "Forceps long and slender being about five times as long as the median width. In dorsal view the sides taper abruptly at the base and then continue almost parallel to the apex. Viewed in profile the dorsal declevity starts well beyond the middle and the ventral edge is arcuate."

There appears to be no difference between the type and paratypes of this species and those of Gonia brevipulvilli Tothill which is here made a synonym.

Among the paratypes of this species and other material previously grouped here occur specimens which have been segregated to form the following new species, G. discalis. This species differs from G. longiforceps in having the dorsal vestiture of the abdomen long, the setae often attaining a length equal to one half the length of the segments, and borne almost erect; whereas the dorsal abdominal vestiture of longiforceps is short and semi-recumbent.

Gonia longiforceps is recorded as bred from ~~Porosa~~Agrotis orthogonia.

Type locality: Lethbridge, Alberta.

Distribution: Across Canada and the United States.

Type : No. 784 Canadian National Collection.

*

NOTE: Names given by Tothill and ending in the word "- forceps" were published in this form. The type labels, however, carry the latin genitive form "-forcipis." The names stand as published and the same form has been adopted for new species names involving this word.

Where the word "forceps" itself occurs, apart from in names, in the text and key, it has been used in the anglicised form and sonsidered as plural comparable to the word "scissors." The singular and plural latin forms "forceps" and "forcipes" seem unnecessarily awkward.

7. G. discalis new species.

(Figs. 7, 7a, Plate II)

Male, length 9 - 13 mm. Dark species. Face and front light yellow, with a silvery sheen in some lights; the front from above has a waxy appearance on the sides; parafacials only slightly narrower at the oral margin than at the vibrissal bases, narrowest width greater than the greatest eye width, with a double or triple row of black setae along the inner edge of the eye, others scattered or in broken rows inside these and the usual short row of heavier bristles along the lower edge of the frontal suture, these bristles graduated in length from the shortest at the top of the row to the longest outside and considerably above the oral vibrissae; genae about half the eye height with a vestiture of slender black setae; antennae blackish often with a greyish sheen in some lights; second antennal segment yellowish with short, heavy, dorsal setae; third segment five to seven times as long as second. Pile on the occiput white. Palpi yellow. Dorsum of thorax black with five indistinct longitudinal pollinose lines; scutellum and small area preceding it yellow; some yellow on humeri. Legs black. Pulvilli and ungues distinctly shorter than last tarsomere. Wings slightly infuscated basally on the dorsal edge.

Abdomen shining black, segments 3, 4 and 5 pollinose basally, red colouration occurs on segments 3 and 4 and sometimes 5 in varying amounts. The dorsal abdominal vestiture on segments 3 and 4 is long and erect or almost

erect. The setae reach a length equal to half the length of these segments.

Forceps similar to those of longiforceps, dorsally, wide at the base, tapering rapidly then extending with almost parallel sides to the apex. In lateral view the basal dorsal convexity extends less than one half the length of the forceps; the apex is expanded dorsally, knob-like.

Type: Nicola, B.C. 28, iv, 1922. P.N.Vroom.

Paratypes: as type - 23, v, 1922 (vial No. 114)

" " - 29, v, 1922

Vernon, B.C. - 13, 4, 1927. I.J.Ward

" " - 20, iv,1927. "

Agassiz, B.C. - 29, iii, 1924. R. Glendenning.

" " - 6, iv, 1922. "

Cranbrook, B.C. - 11, iv, 1922. C.B.D.Garret

" " - 19, v, 1922 "

" " - 11, v, 1922 "

" " - 11, v, 1922 "

" " - 10, v, 1922 "

" " - 12, v, 1922 "

" " - 8, v, 1922 "

Penticton, B.C. - 12, iv, 1927 E.R.Bucknell.

Copper Mts., B.C. - 8, iv, 1928 M. Stace Smith.

Toronto, Ont. - 13, 4, 1905 ?

Ottawa, Ont. - 22, iv, 1906 W. Metcalf. Slide No.13

Earl Gray, Sask. - 25, iv, 1926 J.D.Ritchie.

Saskatoon, Sask. - 27, iv, 1923 K.M.King.

Lethbridge, Alta. - Apr. 30, 1915 E.H.Strickland.

and the following paratypes of longiforceps Tothill in the Canadian National Collection:

Vancouver, B.C.	- 10,	viii, 1907	R.S.Sherman.
" "	- 1,	4 , 1916	"
Treesbank, Man.	- 17,	iv, 1908	J.W.Tallis.
Awene[illegible], Man.	- 16,	iv, 1921	N. Criddle.
Chilcotin, B.C.	- 24,	iv, 1920	E.R.Buckell. Genitalia vial No. 115.

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aldrichi group.

Gonia aldrichi, G. grandipulvilli, G. longiforceps, and G. discalis form a second group of species all closely related. The dark colouration and arcuate ventral edge and apical swelling of the forceps suggest a close relationship to the first or frontosa group. In general the forceps in this group are longer and stronger than in the first and the flies are larger. Specimens have been captured throughout the breadth of the United States and Canada during the spring months.

The third, or breviforceps group which follows are also taken in the spring, but the ventral edge of the forceps is straight and the distribution of the species is largely limited to central and western Canada and the United States.

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8. G. breviforceps Tothill

(1) 1924. Gonia breviforceps Tothill, Can. Ent. LVI:210 (Figs. 8, 8a, Plate II).

From this species as described by Tothill the following new species, G. albagenae, has been separated. The new species includes one paratype of breviforceps Tothill, Vernon, B.C., 25, v, 1919, W.B.Anderson, genitalia slide No. 14, Canadian National Collection. G. breviforceps has distinctly dark setae on the genae while G. albagenae has a vestiture of fine white setae on the genae except for a few darker hairs at the lower edge in some specimens. In general the parafacials are slightly narrower in breviforceps Tothill.

G. breviforceps has been bred from Euxoa ochrogaster both in Alberta and Saskatchewan.

Type locality: Lethbridge, Alberta.

Distribution : British Columbia, Montana, California, Colorado.

Type : No. 788, Canadian National Collection.

9. G. albagenae new species.

(Figs. 9, 9a, Plate II)

Male. Length 9.5 - 11.5 mm. Specimens usually show considerable red, but dark ones occur. Face and front light yellow, with a silvery sheen in some lights; front from above has a waxy appearance on the sides; parafacials narrowing very little from the aristal bases to the vibrissae, at the narrowest point about equal in width to the greatest eye width, with an uneven double or triple row of slender black setae along the inner edge of the eye and others scattered or in broken rows inside these, the usual short row of graduated bristles along the frontal suture; genae about half eye height, covered with sparse fine white setae at the most a few dark setae occur next to the basal row of bristles; antennae blackish with a grayish sheen in some lights; second segment yellowish with short heavy dorsal setae, third segment 5 to 7 times as long as second. Pile on the occiput white. Palpi yellow. Dorsum of thorax black with five indistinct longitudinal pollinose lines; scutellum, small lateral areas preceding it and parts of humeri yellowish. Legs black. Pulvilli and ungues distinctly shorter than last tarsomere. Wings clear with very slight costal infuscation.

Abdomen usually broadly reddish on the sides of segments 3 and 4, the coloured areas sometimes extending onto other segments and ventrally leaving only basal and apical dark rings connected by a narrow dark stripe dorsally or by dark dorsal and ventral stripes. Lobes of fifth

sternite dark. Dorsal abdominal vestiture short and semi-erect.

The forceps resemble those of breviforceps, short, straight on the ventral edge, little dorsal convexity, dorsally with almost parallel sides for the greater part of their length.

A female, (Vaisseaux, B.C., 14, vi, 1919, W.B.Anderson), apparently of the same species has similar body markings and white genal hairs.

Type: Penticton, B.C. 12, iv, 1927. E.R.Bucknell.
Canadian National Collection.

Paratype: Penticton, B.C. 21, v, 1927. E.R.Bucknell.
Genitalia vial No. 113.

Lillooet, B.C. A.W.A.McPhair.

Naramata, B.C. 2, v, 1919 E.R.Bucknell.
Genitalia vial No. 132.

and a paratype of breviforceps Tothill in the Canadian National Collection.

Vernon, B.C. 25, v, 1919 W.B.Anderson.
Genitalia Slide No. 14.

10. G. setigera Tothill

(1) 1924. Gonia setigera Tothill. Can. Ent. LVI: 199.

(Figs. 10, 10a, Plate II)

Drawings were prepared from the one male paratype (No. 781) with same data as type in the Canadian National Collection. Two male specimens, one from Penticton, B.C., 21, iv, 1927, E.R.Bucknell, with forceps exactly as in the paratype and a second from Oliver, B.C., 23, iv, 1927, (genitalia vial No. 131), E.R.Bucknell, of which the forceps show a more evident dorsal convexity but are otherwise similar, are in the Canadian National Collection. Males and females of this species are easily distinguishable by the numerous setae on the first vein (R_1). The third vein (R_{4+5}) usually bears a greater number of setae than in any other species. As was pointed out in dealing with the generic limits of Gonia the generic keys of Williston and Coquillet exclude this species. In examining other species one specimen was noticed with one seta dorsally on the first vein of one wing only.

Type locality: Essex, Mass.

Distribution : Massachusetts, California, British Columbia.

Type : In the Museum of the Boston Society of Natural History.

11. G. turgida Coquillet.

(1) 1897. Gonia turgida Coquillet, U.S.D.A. Bur. Ent. Tech. Series 7: 133-4.

(2) 1924. Gonia turgida Coquillet. Tothill, Can. Ent. LVI: 200.

(3) 1936. Cystogonia turgida (Coq.). Townsend, Manual of Myology, (type of new genus Cystogonia Townsend).

(Figs. 11, 11a, Plate II)

Drawings were made from one of several male specimens from Idaho, May 2, 1919, E.H.Quales, in the Canadian National Collection, probably placed in this species by Tothill who redescribed the species from a male taken by E.G.Holt at Round Mountain, Nevada, 6,300 ft. (The writer was unable to locate this specimen). Tothill had his specimen compared with the type by Aldrich who mentions the striking colour pattern of the type. Among the material received from Saskatoon are two specimens, one from Three Mile Creek, Sask., 23, v, 1921, A.E.Cameron, and one labelled Mortlach, 31, v, 1909, which are evidently the same species. The original description of Coquillet, "the front near the eyes densely covered with rather long bristly hairs, sides of face each one and one-half times as wide as the median depression, densely covered with rather long black bristly hairs which are less numerous along the facial ridge," is sufficient to assure the identity of these specimens. The width of the parafacials compared to the eye width as used in Tothill's key is,alone, however, totally inadequate as a determining character.

Type locality: Los Angeles, California.

Distribution: California, Idaho, Saskatchewan.

Type : No. 3640 United States National Museum.

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breviforceps group.

The writer considers the straight ventral edge and general shape of the forceps in this group to be indicative of close relationship. The body colouration is characterized by a distinct dorsal, longitudinal dark stripe on the abdomen. Frequently a ventral dark stripe is also present.

There appears to be a decided break between the three groups of species described above; i.e., the frontosa, aldrichi, and breviforceps groups and the two groups to follow. Adults of all species dealt with up to this point are collected in the spring months, while all those to follow are found in the late summer. This suggests a different host relationship and means of spending the winter. No host records of the following species are known to the writer. Moreover, much wider variations in genital and other characters occur among the following forms. They are, as far as we have evidence, to date, generally more restricted in their habitats as well as specialized in genital structures.

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12. G. sequax Williston

(1) 1887. Gonia sequax Williston. Can. Ent. XIX: 12.

(2) 1897. Gonia capitata (De Geer). Coquillet, U.S.D.A. Bur. Ent. Tech. Ser. 7: 133.

= Gonia frontosa Say
= Gonia philadelphica Macquart
= Gonia albifrons Walker
= Gonia exul Williston

} Probably incorrect

(3) 1905. Gonia capitata (De Geer). Aldrich, Catalogue Dipt., (follows Coquillet).

(4) 1924. Gonia sequax Williston. Tothill, Can. Ent. LVI: 208. (Redescribed).

(Figs. 12, 12a, Plate II)

The drawings were prepared from a male specimen from Jordan, Ontario, 23, viii, 1915, C.H.Curran, in the Canadian National Collection. This locality is mentioned by Tothill, who no doubt examined this specimen. Four male and five female specimens were taken by the writer and his associates at Macdonald College during August and September 1938. It is not clear whether or not Tothill examined the type material of sequax but the large amount of yellow on the body stressed by Williston in his original description together with the short pulvilli make this determination fairly certain. Females taken at Macdonald College show a more widespread darkening on the dorsal surface of the abdomen than do the males which have a very narrow continuous or broken dorsal dark stripe widening out at the base and apex of the abdomen. No ventral longitudinal dark stripe is present. The genal hairs are yellow.

Synonomy with G. frontosa Say can be discarded on colour, size, colour of genal hairs and the appearance of

the forceps. Synonomy with G. capitata (De Geer) is similarly denied by the light colour and the yellow genal hairs. The forceps show a somewhat weaker dorsal convexity than do those of the specimen determined as G. capitata (De Geer) by Bezzi (See Figs. 22, 22a, Plate III) but are otherwise similar.

Tothill makes no mention of G. exul Williston. Coquillet and Aldrich synonomized this species with sequax Williston, and it seems probable that the female described as exul was the female of sequax. It is not possible to be certain of this since females cannot be separated as definitely as males. However, this description fits females taken at Macdonald College along with males of sequax. The California males with long pulvilli mentioned by Williston and considered conspecific with the described females were most probably G. longipulvilli Tothill, while the North Park specimen with narrow parafacials was G. distincta Smith.

Type locality: California.

Distribution : California, Colorado, Texas, Connecticut, Massachusetts, British Columbia, Ontario.

Type : ?

13. G. senilis Williston

(1) 1887. Gonia senilis Williston. Can. Ent. XIX: 9

(2) 1897. Gonia senilis Williston. Coquillet, U.S.D.A. Bur. Ent. Tech. Ser. 7.
= Gonia sagax Townsend.
(synonomy probably incorrect).

(3) 1905. Gonia senilis Williston. Aldrich, Catalogue of Diptera. (follows Coquillet).

(4) 1924. Gonia senilis Williston. Tothill, Can. Ent. XLVI: 199, (redescribed as distinct from sagax Townsend).

(Figs. 13, 13a, Plate II)

Drawings were prepared from a specimen in the Canadian National Collection labelled, Oak Grove, Virginia, Fls. Daucus, 2, viii, ?, C.H.Townsend. This locality is mentioned by Tothill in his redescription of this species. Among other specimens examined were: one male from College Park, Indiana, W.R.Walton; one male from Severn, Ontario, 16, 6, 1925, C.H.Curran, and two females apparently of the same species from Robinson, Delaware Co., Iowa, vii, 24, 1924, N.K.Bigelow. The suggested synonomy of this species with sagax Townsend, is incorrect if the specimens available are accurately determined. The differences in the forceps, which are shorter and much broader in senilis Williston, are evident from the diagrams. Tothill separated the two species on the presence of dark setae on the genae in sagax and yellow setae in senilis. In the male from Severn, Ontario, and one female from Delaware, at least numerous of the basal genal hairs are dark in some lights. The colour of the aristae, which in the original descriptions is given

as orange yellow except at the tip in senilis and as brown in sagax appears to be a good character but should be borne out by the forceps.

The differences in the forceps together with the fact that sagax has been captured in the spring months and senilis in the summer has led the writer to adopt the grouping in this paper and separate these two species so widely in spite of the similar colour of the third antennal segments.

Type locality: Western Kansas.

Distribution : Indiana, Virginia, New Jersey, Georgia, Florida, Ontario.

Type : ?

14. G. distincta Smith.

(1) 1915. Gonia distincta Smith. Psyche 22: 99.

(2) 1916. Gonia distincta Smith. Townsend, Proc. U.S. Nat. Mus. 51: No. 5152.(Made the type of a new genus Cnephalogonia Townsend.)

(3) 1924. Gonia distincta Smith. Tothill, Can. Ent. LVI: 207.

(Figs. 14, 14a, 14b. Plate II)

Gonia distincta Smith was described from three female specimens and the original description, except for the colour, gives us little information of specific value, especially as the specimen was a female. Townsend, making this the type of his new genus adds: "Female. Front not swollen ..... no median marginal macrochaetae on the first* abdominal segment; no closely set marginal machrochaetae on the third* segment. Parafacials below not over one-half greatest eye width, widening above to nearly eye width at base of antennae. Front marginal macrochaetae of parafacials sparse, few and weak."

Tothill redescribed the species from five males and two females, one of the females having been compared with the type by Mr. C.W.Johnston. The narrow parafacials are mentioned and the "abdomen in males yellow with a wide black dorsal stripe that spreads out posteriorly to cover part of the third and all of the fourth tergum, and with a median ventral longitudinal black stripe also, in the females black." The forceps are also briefly described.

* "First" and "third" refer to the "second" and "fourth" segments respectively, as understood in this paper.

Townsend (1936) in his Manual of Myology separates his genus Cnephalogonia, of which this species is the type, from related genera on the absence of median marginals on the first segment. This character is purely sexual, these median marginals being present in males of this species and absent in the females of many other species.

The writer prepared his diagrams from a specimen labelled Bar Harbor Me. 3, viii, 24 C.W.Johnston in the Canadian National Collection, one of the specimens studied by Tothill. Other specimens examined included: two males from Mt. Desert, Me.; two from Awene, Man.; two from Blackburn, Ont.; eleven males from Low Bush, Ont.; eight females from Lowbush; two from Blackburn and one from Mt. Desert, all in the Canadian National Collection, and one male from Bozeman, Montana.

It seems of value to redescribe this species more fully or at least fill in previous descriptions.

Male. Length 9 - 12 mm. Face and front much less swollen than in any other species of Gonia. Parafacials much narrower at the vibrissae than at the aristal bases with two or three uneven rows of setae which increase in size mesally, and the usual row along the frontal suture. No bare space between other setae and this last row. Genal setae dark, genae about 1/3 eye height. Occipital pile white. The dorsum of the thorax in certain lights appears to have the usual five wide longitudinal, pollinose lines separated by narrow dull dark lines. In other lights the narrow dull black lines appear pollinose, the wide lines shiny black. The scutellum, varying areas cephalic to the scutellum, and the humeri, yellow. Legs black.

Pulvilli and ungues longer than the last tarsal segment. Pulvilli white. Ungues slender, curved at the tips and in strong light yellow except at the tips. The abdomen has been well described as to colour by Tothill (quoted above). In most cases it is more orange than yellow. The dorsal and ventral longitudinal stripes are constant and conspicuous; the segmental bases are broadly pollinose. The pollen spreads out especially on the sides of segments 4 and 5 to almost the length of the segments. A pair of marginal macrochaetae are present on the second (Townsend's first) segment and a second pair on the third segment. The fourth bears a row of long, strong, marginals, the fifth a row of sub-marginals with a row of shorter bristles caudad of these.

The forceps are covered on the dorsal side with long, slender, black setae, the dorsal convexity extends down almost to the apex giving them a singular resemblance to those of longipulvilli Tothill, however the extension of the convexity in the last mentioned species is not quite so great.

Female. Face less swollen than in male, appearing almost flattened. Parafacials wider than in male, considerably narrower at vibrissae than at aristal bases, width at vibrissae about 2/3 greatest eye width.

Thorax as in male. Pulvilli and ungues variable in individuals, from 2/3 to full length of last tarsomere; ungues slender and yellowish basally. Abdomen shining black with only obscured reddening on sides and venter, no median marginals on the second segment.

Segments pollinose basally, pollen spreading laterally on segments 4 and 5.

Type locality: Westport Factory, Mass.

Distribution : Massachusetts, Connecticut, Maine, Manitoba, Saskatchewan, Montana, Ontario.

Type : Collection of Boston Society of Natural History.

The North Park specimen referred to by Williston when describing Gonia exul was probably of this species.

15. G. longipulvilli Tothill.

(1) Gonia longipulvilli Tothill. Can. Ent. LVI: 211

(Figs. 15, 15a, 15b. Plate III)

The drawings were prepared from type No. 789 in the Canadian National Collection. Specimens examined have the pulvilli and ungues of the male longer than the last tarsomere; a narrow or broken dark, longitudinal dorsal line on the abdomen, the remainder of the abdomen laterally and ventrally except for the very base and apex suffused with an orange yellow colour, no ventral longitudinal dark line being present; forceps with the dorsal convexity extending about $\frac{3}{4}$ of their length. The California specimens mentioned by Williston in section (a) following his description of exul were probably of this species. This species has been bred from Agrotis orthogonia in Saskatchewan.

Type locality: Royal Oak, B.C.

Distribution : The central and western parts of North America from north to south.

Type : In the Canadian National Collection.

16. G. porca Will.

(1) 1887. Gonia porca Williston, Can. Ent. XIX: 6 - 12.

(2) 1924. Gonia porca Williston. Tothill, Can. Ent. LVI:206. (Redescribed).

(Figs. 16, 16a. Plate III)

Drawings were made from a specimen labelled Lillooet, B.C. Aug. 1917, one of the specimens examined by Tothill during his study. As Tothill has pointed out, the yellow hair on the pleurae and mesonotum make identification of this species simple as do the yellow lobes of the fifth sternite and the shape of the forceps. The depth and chisel-like apex of the forceps is an extreme modification which sets this species very distinctly apart.

Several previously undetermined specimens are in the Canadian National Collection from Jesmond, British Columbia, 23, vii, 1932, J.K.Jacob, at altitude 7-7500 feet, and a series from Lake Louise, Banff, Alberta, 22, vii, 1938, G.S.Walley, 8600 feet.

Type locality; Mt. Hood, Oregon.

Distribution : Oregon, British Columbia, Alberta, Colorado, North Mexico. (Mountainous regions).

Type : ?

17. G. texensis Reinhard.

(1) 1924. Gonia texensis Reinhard. Ent. News 35: 357.

(Figs. 17, 17a. Plate III)

The drawings were prepared from paratype No. 791 in the Canadian National Collection, with the same data as the type. This species has been adequately described including the forceps. These latter structures resemble those of G. porca Williston in their unusual depth but are greatly modified in shape and vestiture setting this species, too, distinctly apart from all others.

Reinhard says, "In relationship this species is probably nearest to angusta Macquart which in Aldrich's catalogue is listed as a synonym of pallens Wiedemann, described from Brazil."

(Gonia angusta Macquart was described in Diptera Exotique, Paris, Vol. II (3): 51. The author notes that the abdomen is narrower than the thorax, a condition peculiar to texensis in our fauna. In 1849 Walker, in Diptera in the British Museum IV: 797 records angusta Macq. from Jamaica).

Type locality: College Station, Texas.

Distribution : Texas

Type : United States National Museum, Washington.

sequax group.

The above six species form the sequax group. The forceps are in general deep. As the group to follow, and unlike the preceding three groups, they are collected in the late summer. The last two species, at least, are widely divergent from the close relationships so evident between other species and are similarly of limited habitat. It seems probable that transition forms between these and the other types may exist.

The last or fissiforceps group consists of three species so closely related as to cause some doubt as to their specific rank and yet so widely separated from all the other species as to stand alone. Their habitat only they have in common with porca Williston and their occurrence in late summer in common with the sequax group.

18. G. fissiforceps Tothill.

(1) 1924. Gonia fissiforceps Tothill, Can. Ent. LVI: 207.

(Figs. 18, 18a, 18b. Plate III)

This large, dark, mountain species is easily recognizable from the diagrams given here and from the description by Tothill. It might be added that the palpi vary from yellow to black, the pulvilli are white and almost as long, to as long as, the last tarsomere in males. The "scalloped" inner edges of the lobes of the fifth sternite are characteristic of this and the following two species.

The new species tenuiforceps is being separated from

this species on the shape of the forceps alone. One of Tothill's paratypes labelled Banff, Alberta, N.B.Sanson, belongs to the new species.

Type locality: Lillooet, B.C.

Distribution : Banff, (Alberta) Colorado, Washington, California, Ontario.

Type : No. 782, Canadian National Collection.

19. G. tenuiforceps new species.

(Figs. 19, 19a; Plate III)

Male. Length 10 - 11 mm. Shiny black species. Face and front light yellow, with a silvery sheen in some lights; the front above with a waxy appearance on the sides; parafacials not narrowing greatly from opposite aristal bases to oral margin, at the narrowest point slightly less than or equal to the greatest eye width, with a double or triple irregular row of slender black setae along the inner edge of the eye. The usual row of setae along the edge of the frontal suture irregular in extent and in size of bristles; genae about one half the eye height with a few scattered black setae. Antennae black with a greyish tinge in some lights, second segment reddish or yellowish apically with short, dark, dorsal setae, third segment five to seven times as long as the second. Pile on the occiput white. Palpi yellow through various degrees of infuscation to black. Thorax shiny black sometimes with powdering of white pollen which may be distinctly divided into five lines by very narrow shiny areas; scutellum yellow; legs black, femora and tibiae (each or both) in strong light may show yellow areas.

Pulvilli and ungues (about) as long as last tarsomere. Pulvilli white. Ungues slender and in strong light yellow except at the base and tip.

Abdomen shining black, segments 3, 4, and 5 sometimes narrowly, evenly white pollinose basally. Rarely with indications of yellowish red colouring on the sides of segments 2, 3, and 4. The lobes of the fifth sternite are definitely excised laterally on the inside giving a "scalloped" effect, (Fig. 18b, Plate III), as in fissiforceps and yukonensis.

Forceps long, resembling those of fissiforceps but having much less depth medially, dorsal convexity extending less than one third of their length, apex turned ventrally (forward) to form a hook, in dorsal view the median apical cleft extends beyond the middle.

Type: Male.

Hopedale, Labrador,
21, vii, 1926.
W.W.Perret
(Canadian National Collection).

Paratypes: As above,

Male	23,	vii, 1926
	17,	vii, 1926
	25,	vii, 1926
	10,	vii, 1926
	22,	vii, 1926
Two females	18,	vii, 1926

and one paratype of fissiforceps Tothill.
Banff, Alberta
?
N.B.Sanson.

20. G. yukonensis Tothill

(1) Gonia yukonensis Tothill, Can. Ent. LVI: 210.

(Figs. 20, 20a, 20b. Plate III)

Drawings were prepared from the type, No. 786, Canadian National Collection.

Tothill records a paratype of this species from Tennessee Pass, Colo. (in the United States National Museum). His description of the median apical cleft of the forceps "extending about one third distance to base" proved a little inaccurate;when the forceps had been treated in potash. The cleft is seen to extend almost half the distance to the base. The similar habitat and the shape of lobes of the fifth sternite (not mentioned by Tothill) suggest a very close relationship with fissiforceps. The forceps, however, have the dorsal convexity extending further down the length of these structures (about 1/3 the distance to the apex) than in any fissiforceps observed. For the present it is thought best to maintain this name but there is considerable doubt in the writer's mind as to the specific rank of this specimen.

Type locality: Yukon Territory

Distribution : Yukon, Colorado

Type : No. 786, Canadian National Collection.

21. G. carinata Tothill

(1) 1924. Gonia carinata Tothill. Can. Ent. LVI: 208.

There being no known specimens of this species besides the holotype, which was not available to the writer, diagrams of this species could not be included. The following is Tothill's original description:

"Parafacials at narrowest point about three times the length of second antennal segment and only slightly wider at the base of the antennae that at vibrissae. Genal hairs fuscous. Third antennal segment black. Occipital pile white. Pleura without golden pile. First vein without bristles; third vein with a few small bristles at base. Abdomen reddish yellow except for a dorsal and a ventral narrow black stripe and except for the last tergum which is black.

"The forceps of genitalia remarkable for the long median carina that is as deep as the forceps are thick. Otherwise the forceps are long and narrow with the notch confined to the apical fourth and straight in ventral profile."

Holotype: Male. Salt Lake, Utah, in United States National Museum.

Tothill merely listed the species in the order in which they occurred in his key, though he suggested a western origin and eastward spread of this genus. The information at hand seems inadequate to support or deny this hypothesis. However, the tentative order of the species in this paper is based on distribution, time of occurrence and especially similarities in the structure of the forceps.

Frontosa is our most widely spread species, fuscicollis is undoubtedly closely related to it, and sagax though unique in its antennal colour resembles these two in the structure of the forceps. In the aldrichi group the forceps maintain to some extent their curved ventral edge and dorsal apical convexity but have become elongated and flattened. In the breviforceps group the ventral edge of the forceps has become straight and an increase in depth is evident. Moreover the range appears more restricted. The sequax group includes species from widely separated areas. They are separated from each other more distinctly than are the members of other groups. In all these species the forceps have increased markedly in depth. The fissiforceps group includes, as previously noted, extremely closely related species, but as a group shows no close affinities to any other species. The habitat of the last group is limited to mountainous areas. It may thus overlap the habitats of porca and possibly distincta. The shape of the lobes of the fifth sternite and the shape of the forceps set the fissiforceps group apart.

Since carinata could not be examined nor even the date of capture ascertained it could not be fitted into this arrangement and is consequently listed last.

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Explanation of Plates

The figures in Plates I to III inclusive have been prepared in so far as possible from type material. In many cases the sclerites behind the forceps were broken or twisted and were drawn as observed. The exact position of the structures when drawn was that in which the forceps were most distinctive and varies slightly with different specimens. In all cases it is the contour of the forceps and not the exact shape of the other sclerites which is specific. The density, distribution and length of setal vestiture varies and is often affected by the way material has been handled. It has, however, been indicated so far as possible. The linear magnification is in all cases approximately forty times.

PLATE I.

Figure

1 Lateral view of the forceps of *G. frontosa* Say.

1a Dorsal " " " " " " " "

2 Lateral " " " " " *G. sagax* Townsend.

2a Dorsal " " " " " " " "

3 Lateral " " " " " *G. fuscicollis* Tothill.

3a Dorsal " " " " " " " "

4 Lateral " " " " " *G. aldrichi* Tothill.

4a Dorsal " " " " " " " "

4b Anterior tarsus, claws and ungues of *G. aldrichi* Tothill.

5 Lateral view of forceps of *G. grandipulvilli* new species.

5a Dorsal " " " " " " " "

5b Dorsal view of last two tarsomeres, pulvilli and ungues of the prothoracic leg of *G. grandipulvilli*, new species.

5c Lateral view of the same.

6 Lateral view of the forceps of *G. longiforceps* Tothill.

6a Dorsal " " " " " " " "

PLATE I

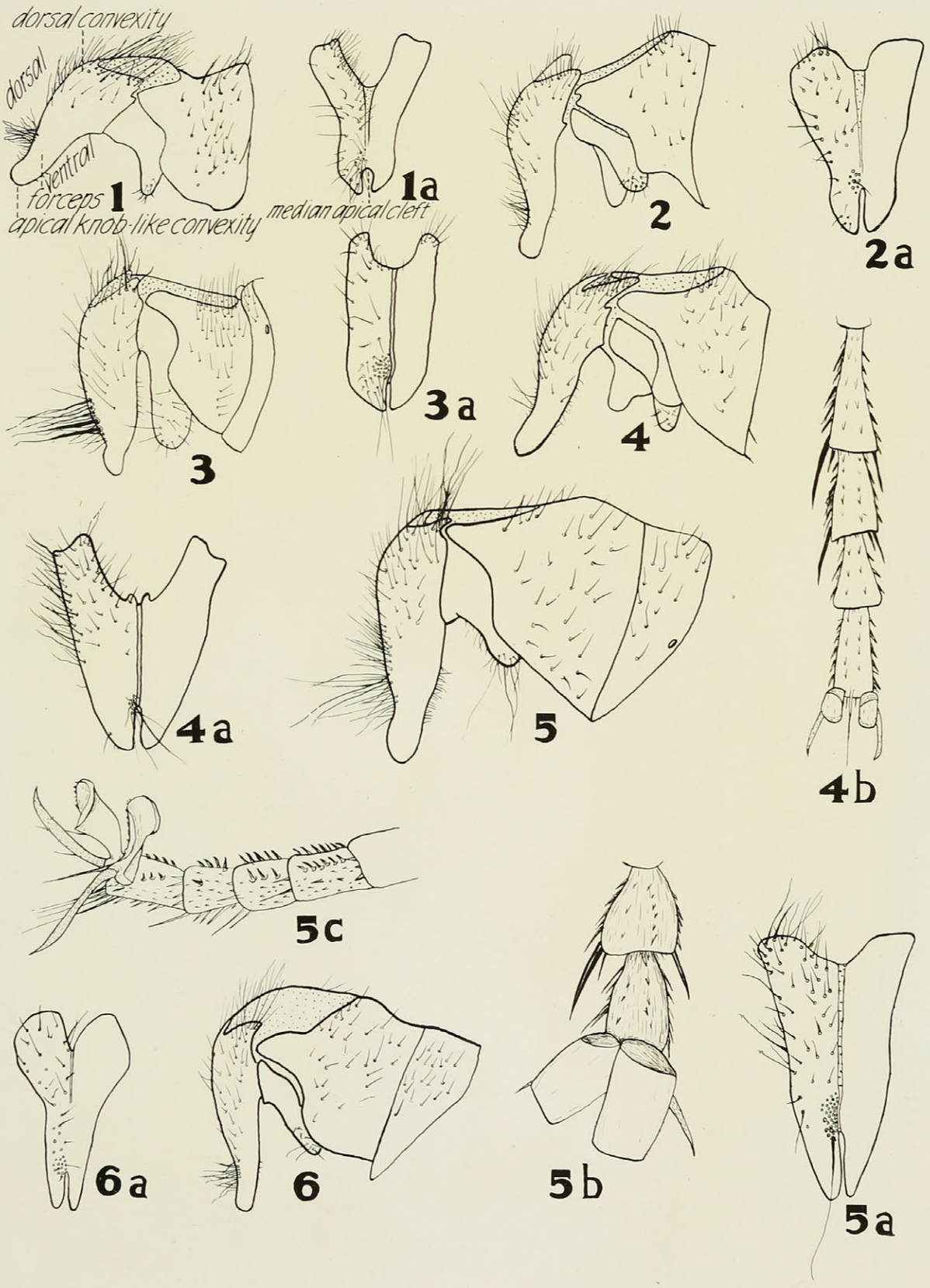

dorsal convexity
dorsal
ventral
forceps
1
apical knob-like convexity
1a
median apical cleft
2
2a
3
3a
4
4a
4b
5
5a
5b
5c
6
6a

PLATE II.

Figure

7 Lateral view of forceps of *G. discalis* new species

7a Dorsal " " " " " " " "

8 Lateral " " " " *G. breviforceps* Tothill

8a Dorsal " " " " " " "

9 Lateral " " " " *G. albagenae* new species

9a Dorsal " " " " " " " "

10 Lateral " " " " *G. setigera* Tothill

10a Dorsal " " " " " " "

11 Lateral " " " " *G. turgida* Coquillet

11a Dorsal " " " " " " "

12 Lateral " " " " *G. sequax* Williston

12a Dorsal " " " " " " "

13 Lateral " " " " *G. senilis* Williston

13a Dorsal " " " " " " "

14 Lateral " " " " *G. distincta* Smith

14a Dorsal " " " " " " "

14b Last tarsomere, pulvilli and ungues of the prothoracic leg of *G. distincta* Smith.

PLATE II

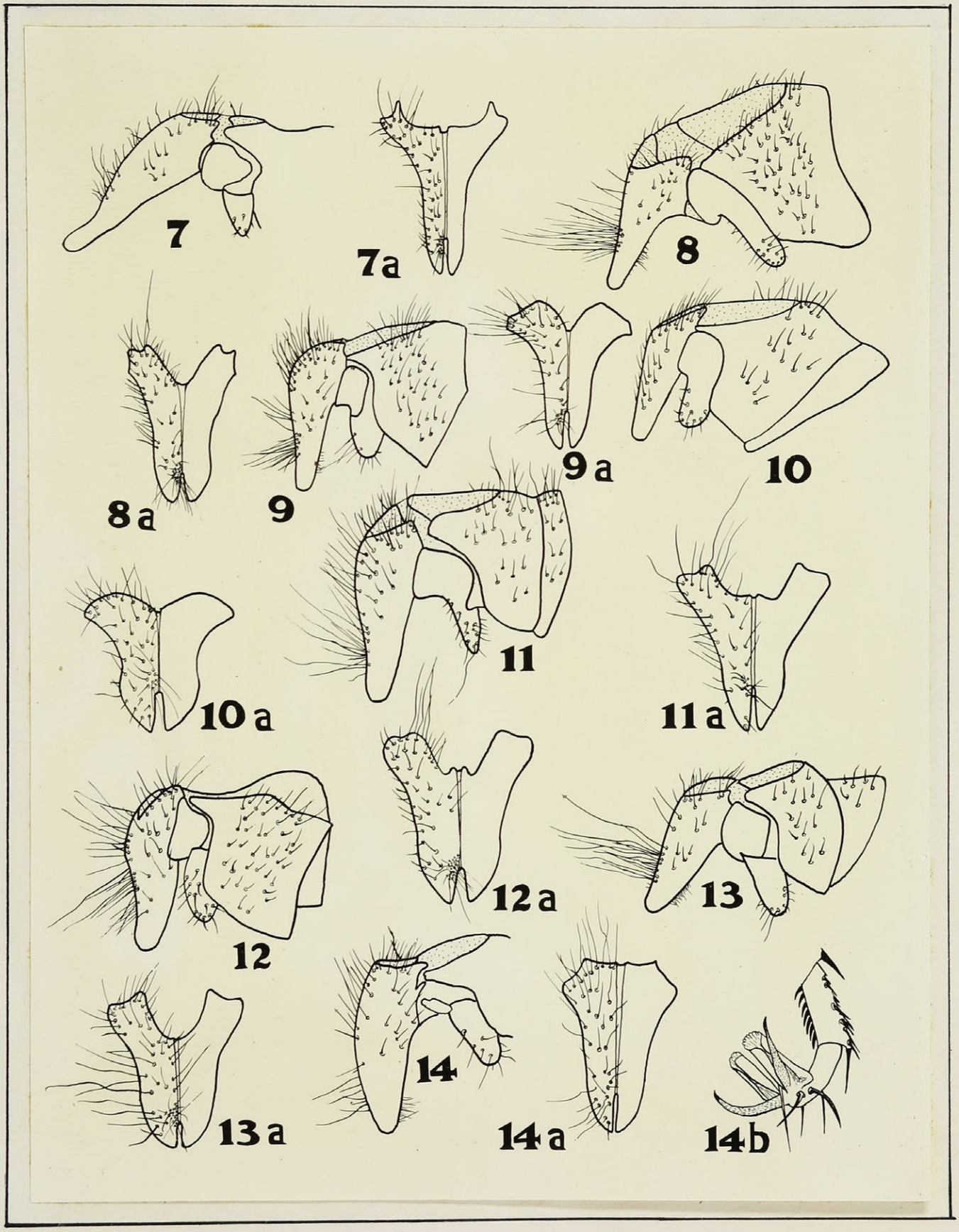


PLATE III.

Figure

15 Lateral view of forceps of G. longipulvilli Tothill (sclerites of segment 9 badly twisted).

15a Dorsal view of forceps of G. longipulvilli Tothill

15b Last tarsomere, pulvilli and ungues of the prothoracic leg of G. longipulvilli Tothill.

16 Lateral view of the forceps of G. porca Williston.

16a Dorsal " " " " " " " "

17 Lateral view of the forceps of G. texensis Reinhardt. (sclerites of segment 9 badly broken)

17a Dorsal view of the forceps of G. texensis Reinhardt.

18 Lateral view of the forceps of G. fissiforceps Tothill. (sclerites of segment 9 badly broken)

18a Dorsal view of the forceps of G. fissiforceps Tothill

18b Lobes of the fifth sternite " " " "

19 Lateral view of the forceps of G. tenuiforceps new species

19a Dorsal " " " " " " " " "

19b Lobes of the fifth sternite of " " " "

20 Lateral view of the forceps of G. yukonensis Tothill.

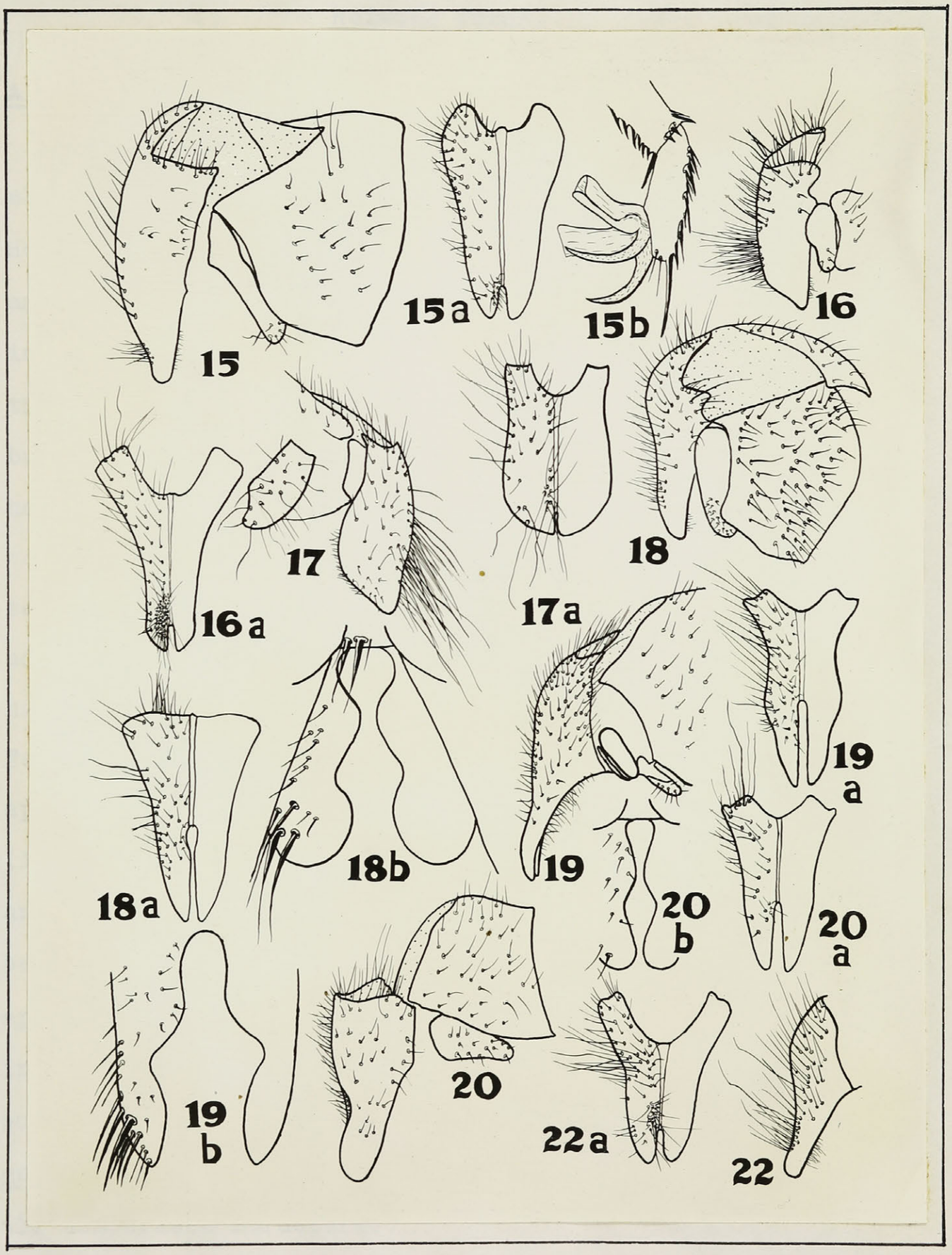
20a Dorsal " " " " " " " "

20b Lobes of the fifth sternite of " " "

21 Lateral view of the forceps of G. capitata (DeGeer)?

22 Dorsal " " " " " " " " ?

PLATE III



III. The Morphology of the Male Genitalia of Gonia and Related Forms.

A. Introduction.

The similarity in the structure of the apex of the abdomen, among higher Diptera, has long been recognized. However, the dissimilarity in this structure, from that among lower Diptera, or from that among other orders of insects, is none the less striking. For these reasons there have been no lack of studies on these genitalia but little agreement as to the segmental origin and general homologies of the parts.

An apparently varying number of apical abdominal segments have been modified for the purposes of effecting copulation. To this modified abdominal apex many terms have been applied. Thus Westhoff (1882), Snodgrass (1904), Feuerborn (1922), Petzold (1927) and others refer to this apical portion of the abdomen as the "hypopygium", Metcalf, (1921) refers to it as "the post-abdomen", Patton, (1932) and Gibbins (1935) argue that the term "terminalia" should be used and genitalia reserved for Segment IX and its appendages, while the term "genitalia" has been widely used in the literature to refer to the entire structure in question. The present writer has adopted the term genitalia to refer to the entire apex of the abdomen and all associated structures.

Other morphological terms used in this paper are for the most part those employed by Snodgrass (1935) or listed

by Torre-Buena (1937). Throughout the text nomenclature employed by the writer is underlined. Table I lists the terms used by those writers whose works are reviewed. It is not always possible to be certain of the exact synonomy of such terms. Other writers, (Awati (1916), Petzold (1927) and others) have given similar comparative tables. In some cases these tables do not agree with the one presented here. This is due to differences in interpretation and possibly to mechanical errors in building tables. Thus Awati (1916) lists his "alar projections of the theca" as synonomous with the "alar projections" of Hewitt (1907): the "double apodeme" of Wesche (1905) and the "great apodeme" of Lowne (1893-95). An examination of these papers reveals that the "alar projections" of Hewitt and Awati are the posterior angles of Sternite IX, which are directed posteriorly while the "double apodeme" of Wesche and "great apodeme" of Lowne is the apodeme of the phallus and is directed anteriorly. It is not perfectly clear from Awati's diagrams whether this is his "median process" or not. Again Awati appears to have misinterpreted Lowne with regard to segment VI, listing Lowne's segment VI? as equal to his segment V, while Lowne definitely states that sternite V is the last visible sternite and is deeply emarginate behind, thus identifying it with Petzold's sternite V.

Similarly Petzold (1927) appears to have confused Brüel's (1897) terms "lamina inferior" and "lamina superior" and Lowne's terms "hypophallus" and "paraphallus" wrongly synonomizing the first of the former with the

second of the latter.

The appended bibliography gives some idea of the extent of the accumulated literature on the copulatory apparatus or genitalia of the order Diptera alone. To review, even briefly, all of this work is not within the scope of the present paper. It is proposed, however, to discuss the major papers dealing with the genitalia of the calyptrate Diptera, and to show, in so far as possible, how our knowledge has advanced step by step. Points of disagreement in interpretation are not indicated in the historical review, each man's interpretation being given briefly. Such differences are, however, indicated in Table I or discussed in the sections dealing with the work of the present writer. Occasionally, however, for the sake of clarifying the descriptions of the authors discussed in the historical review, the terminology used in this paper for the same structure is included, with or without a reference to one of the figures given here. Such terms are within brackets and underlined.

B. Historical review.

1. Lowne (1893 - 1895)

Lowne was the first man to deal in detail with the genitalia of a calyptrate fly. In the course of his extensive study of the anatomy, physiology, morphology and development of the Blow-fly (Calliphora erythrocephala) Lowne discussed at some length the morphology of the male genitalia, figuring both the apex of the abdomen and the phallic structures. He says, "In the male Blow-fly the abdomen exhibits only five rings externally, and the fifth sternum is deeply emarginate behind. The notch in the fifth sternal plate is the external opening of a large cavity, the genital sinus. Four obvious segments are invaginated within this sinus, represented by distinct tergal plates, but only two sternal plates can be distinguished; the anterior of these is in front of and the posterior behind, the genital armature."

Numbering the tergites of the evident segments consecutively he arrived at the conclusion that the genital opening in the male, as in the female, is behind the eighth sternite. With regard to the sixth and seventh tergites he states that they are very similar to each other, "the former has two spiracles on each side near its posterior angle, and the latter only one." The asymmetric ventral sclerite (sternite VI and VII) he terms an "epipleuron." The progenital segment (segment IX) is numbered VIII, and

the anal segment IX. In Lowne's figure sclerotized cuticular bars of chitin are shown extending from his eighth tergite to the sternal plate which lies posterior to the penis. The lateral, lobular, "valvae externae" are shown solidly fused to tergite VIII.

In interpreting the presence of two pairs of lobes or appendages at the phallic base Lowne suggested evidence of two segments between the genital and anal segments but concluded by calling the posterior pair of lobes, "the posterior gonapophyses" and the anterior pair, "the anterior gonapophyses." The former he described among the parts of the penis, the latter he considered homologous with the great claspers of Hymenoptera.

Between the "valvae externae" he found a second pair of rod-like organs, belonging to the anal segment. These he termed "valvae internae." The "progenital sternum" is the cordate sternal plate in front of the penis. The male organ, termed the penis, is figured and described as follows:

"This membranous papilla contains a large blood sinus and is capable of erection; it is supported and protected by a complex chitinous framework, which consists of a pair of paraphalli enclosing its base, and of a large, curved, ventral plate which I shall term the hypophallus.....

"The whole penis is supported by two great apodemes, which are united in the middle line.....

"Two chitinous plates on the upper aspect of the root

of the penis, behind the ventral processes of the paraphalli, form a bulbous enlargement at the base of the organ."

2. Brüel (1897)

Brüel studied the internal and external parts of the reproductive organs in Calliphora erythrocephala. His work was more detalied and his observations in many ways more accurate than Lowne's. He too observed five complete externally visible segments in the abdomen and considered four more, evident in the invaginated genitalia. The tergites he numbered as Lowne, the genital being number IX. A sclerotic structure articulating with the phallic base and extending forward into the body cavity, ("the great apodemes" of Lowne) he called the "Tragplatte" and considered as sternite VIII, while the sternal plate just anterior to the penis, "der Gabelplatte", was sternite IX. His "valvula lateralis", a pair of long lateral lobes articulating but not fused with the tergite VIII, are shown connected to the posterior angles of the "Gabelplatte." by long sclerotic strips of chitin, the processi longi. A small internal sclerite associated with the ejaculatory duct was observed and termed the "Samenpritzt". He created a complete and useful nomenclature for all the parts. This is indicated in full in Table I.

Internally Brüel noted a curious winding of the ejaculatory duct of the male about the alimentary canal.

He also studied the musculation of these structures and claims to have found muscular connections between his "Tragplatte" (and"Gabelplatte") and the tergites of segments V and VI.

3. Wesché (1906).

Wesché attempted to compare dipterous genitalia and mouth parts. His figures are diagrammatic and since he has not numbered the segments neither this nor his later paper (1908) add any information on that subject. He homologizes the anal forceps of the calyptrates with the claspers of Anopheles because of the apparent dorsal positions of both, disregarding or unaware of the revolution of the parts in Anopheles through 180°, making morphologically ventral structures apparently dorsal. (Christophers 1915, Edwards 1920, Feuerborn 1922, Martini 1922, Reichardt 1929).

4. Hewitt (1907).

Hewitt studied the House-fly, Musca domestica Linn. He too found five visible segments, the fifth sternite having its lateral margins produced into short processes, "the primary forceps". Tergite VI is small and invaginated under tergite V. Tergite VII narrow and hidden beneath five articulates at its left end with the asymmetric sternite VI. The ventral arch of segment seven, he considered, to consist of a pair of curved sclerites (lobes of sternite X, Fig. 30, Plate IV) lying dorsal to the fifth ventral arch and ventral to the penis. These are his "secondary forceps". The lateral edges, which are thickened (processi longi Fig. 30, Plate IV), articulate with the alar processes of the body of the penis. Tergite eight forms the apex of the abdomen. Sternite eight is represented by a pair of convex ventral sclerites united on the mid-ventral line, (anal forceps, Fig. 30, Plate IV).

Hewitt described the somewhat specialized penis in detail. He noted too the presence of a sclerite associated with the ejaculatory duct, "the ejaculatory apodeme" and the winding of the ejaculatory duct about the alimentary canal.

5. Berlese (1909).

Berlese (1902) described the genital organs of the male Musca domestica. In his later work (1909) he changed the numbering of the segments. Originally he had considered the visible abdomen to consist of four segments only. In the later work he postulated the total disappearance of the most anterior abdominal segment and the fusion of the second and third so that the visible segments became III to VI, inclusive. Segment VII was found missing. The narrow dorsal sclerite lying free in the connective membrane behind and beneath his tergite VI is labelled tergite VIII. Tergite IX, also a narrow sclerite, is shown articulating at the right (?) end with a narrow asymmetrical sternal plate, labelled sternite IX. The genital tergite he considered as tergite X. Posterior to the anus, which opens in a membranous portion of tergite X, are two lateral plates, parts of tergite X, the mesocerci. (In his earlier work these were considered as of sternal origin). A second pair of lateral plates lying below the mesocerci (lobes of sternite X), are labelled sternite X.

6. Newstead (1911).

Newstead studied the genital armature of Glossina. The last unmodified body segment he considered to be number VI. The tergites of VII and VIII are shown in his figures but beyond them the segmental origin of the parts is not discussed. One large tergite is shown enveloping the entire hypopygium. It is considered to have the following appendages:

(1) Superior claspers - a pair of bristly lobes shown at the caudal extremity of the abdomen.

(2) Editum - a flange-like extension of the body wall, invariably bristly, lateral in position.

(3) Inferior claspers, which appear in the figures to be setae bearing lobes, one on either side of the penial base.

(4) Harpes - paired organs at the apex of the penis?

(5) Juxta - or penis sheath.

(6) Penis

(7) Median process - found only in one group, in the middle line between the inferior claspers. It is shown anterior to the penis but Newstead says, "It lies in the position in which one would expect to find the anus."

Note: Newstead's work is largely taxonomic and his figures and descriptions lack sufficient clarity to make morphological conclusions possible. Awati (1905 and 1916) makes a very different interpretation of the parts of this insect.

7. Awati (1916)

Awati dealt with the genitalia of Musca and attempted to show the homologies of the structures present with those in other Diptera. The presence of only seven pairs of abdominal spiracles, and the position of the male sex opening (which in most insects is behind the ninth sternite) (Peytoureau, 1895 and Snodgrass, 1935) led him to postulate that abdominal segment number VIII had disappeared in higher Diptera. Anterior to the segments modified for copulation he found five annuli. The fifth sternite bears the "accessory or primary forceps." Tergite VI is present as a free dorsal sclerite. Sternite VI is missing. Tergite VII follows tergite VI and is united at its left end with the asymmetric ventral sternite VII. The genital tergite is number IX. A pair of lateral appendages of this tergite, the "inner claspers" are also attached to the phallic base. A pair of posterior dorsal lobes are labelled "anal cerci." All sternites posterior to the seventh have disappeared, the large ventral plate supporting the penis is considered the body of that structure. Lateral processes of the body of the penis (theca) arise from the body of the theca. They are hollow structures covered with a few bristles and can be divided into anterior and posterior portions. A "median process" is described as "a thick blind process arising from the spot where the theca is articulated. It is wider at the end and tapers toward the base."

The progressive development of the genitalia is illustrated from the following different groups of Diptera:

(1) Bibio	(4) Musca
(2) Syrphid	(5) Calliphora
(3) Glossina	(6) Lispa

In passing from the first or Bibio type to the second or Syrphid type Awati says of the latter,

"The appendages of the genital segment are dorsal and not ventral as in Bibio. The anal segment has also undergone change inasmuch as the anal plates have disappeared and only the anal cerci are present."

He found that, in Lispa, the sixth segment had completely disappeared, the spiracles of that segment occurring in segment seven along with those of segment seven. The appendages of the genital segment are also wanting.

8. Newell (1918).

Newell came to the conclusion that in all insects, male and female, the genitalia were formed of segments VIII to XI inclusive. She attempted to demonstrate the presence of the modified appendages of the first three, and sometimes also the fourth, of these segments in most orders of insects. No description is given, merely a table of appendages involved and labelled figures. Among the insects figured are three Diptera, Tipula abdominatis, Tabanus sulcifrons and Calliphora viridescens. In the last of these segments VI and VII are shown as fused. The asymmetric sternite following sternite V is thus labelled sternite VI and VII, the pregenital tergite VIII, and the genital IX. The appendages of segments VII, VIII and IX are represented by lobular structures at the base of the penis (anterior and posterior basal phallic appendages), and a pair of apical phallic lobes respectively. It is not clear from the diagram just what structures the appendages of segment XI are, but they appear as elongate plates above the paired external lateral lobular appendages (the lobes of sternite X) and may be the upper portions of these.

9. Müeller (1920, 1922).

Müeller (1920) based a taxonomic paper on the lateral view of the genitalia. He considered Lucillia caesar (Calliphoridae) as representative of a ground plan.

Again in 1922, Müeller concerned himself with the phylogenetic knowledge to be gained from a comparison of the phallic structures in calyptrate flies. He divided the phallus into basal, middle, and apical segments and developed a terminology for the parts (Table I). The possible segmental origin of the penis, from segments X and XI, was suggested.

10. Feuerborn (1922).

Feuerborn studied both acalyptrate and calyptrate forms. Having noted the revolution of the genitalia of Anopheles and related forms through 180° (Ghristophers 1915, Edwards 1920, Martini 1922) and recalling the reference of Brüel (1897), (see also Keuchenius 1913), to the spiral winding of the ejaculatory duct about the alimentary canal in Calliphora, Feuerborn thought that in the latter the revolution of the apical abdominal segments had continued through the full 360° thus restoring the morphologically normal positions of the structures but winding the ejaculatory duct about the alimentary canal. In Calliphora he found the rotation to be between his segments VI and VII, two segments more than in Culicidae being involved.

Feuerborn subscribed to the theory that the basal abdominal segment is missing and thus postulated six segments anterior to the true hypopygium. Tergite VII was considered present and it was considered to be extended laterally on one side and ventrally forming a "Halbring." (sternite VI and VII). Sternite VII is represented by a ventral plate anterior to the penis, the"Gabelplatte" of Brüel. Of segment eight the tergite is evident while the sternite forms an internal plate, associated with the penis, "Tragplatte" of Brüel (1897). Tergite IX is the genital tergite, while the sternite is represented by a small "mushroom shaped" internal plate connected with the ejaculatory duct, and serving as a semen pump. The projections

lateral to tergite IX (lobes of sternite X) he labelled the true gonapods, homologous with the morphologically ventral appendages of segment IX in mosquitoes and other forms. Plates lateral to the anus are tergite X and posterior appendages of these plates "cerci."

11. Schräder (1927).

Schräder also studied the hypopygium of Calliphora erythrocephala. By sectioning the apices of the abdomen of pupae of different ages he demonstrated that somewhere about the fifth day certain of the terminal segments begin a clockwise rotation (viewed from behind) and inside of 24 hours rotate through 360°. This rotation causes the winding of the ejaculatory duct about the alimentary canal, a condition noted by earlier workers. Thus the "hypopygium circumversum" theory of Feuerborn (1922) is established. The exact number of segments taking part in the rotation is uncertain.

Schräder considered three abdominal segments to be fused in the apparent first or anterior one. The last completely visible segment is VI. The sternal plate anterior to the penis (sternite IX) he numbered VII, while the internal apodeme-like structure extending anteriorly from the phallic base is sternite VIII. In order to account for the sternites of each segment he considered that either the ventral "Halbring" following his sternite VI or the smaller internal sclerite associated with the ejaculatory duct as a pumping organ, must be sternal in origin. He decided in favour of the latter structure, labelling it sternite IX. The "Halbring" he considered as an extension of tergite VII. This structure did not take part in the rotation.

In studying the musculature Schräder found no muscular connections between the sunken ventral plates (his sternites VII and VIII) and tergites VI and VII ((tergites V and VI of Brüel 1897). This fact he held of importance in view of the rotation of the genitalia including the sunken ventral plates but not involving tergite VI, and probably not involving tergite VII.

Finally, from his work on the pupae, Schräder held, in regard to the development of the penis and its appendages, that the second pair of genital lobes ("Zaphen") form the parameres (posterior basal phallic appendages) and spine (of the penis) and probably part of the penis base. The first pair form the penis tube ("Ductusrohr"), and the penis, at least from its point to the spine.

The diagram showing the external morphology of the hypopygium of Calliphora erythrocephala originally given by Brüel and modified by Schräder has been copied for the purposes of the present paper, Fig. 31, Plate V.

12. Petzold(1927)

Petzold has carried out the most complete morphological study of male aalyptrate dipterous genitalia done to date. He studied intensively the structure of the genitalia of the Tachinid, Ernestia (Panzeria) rudis Fall and compared with this form several other species, many of which he figured.

He found five visible segments in the abdomen. The tergites of the first five segments are large and folded under at the sides almost surrounding the abdomen. The sternites are narrow and ventral. Sternite V is forked posteriorly. The sixth sternite is narrow and developed on the left side only where it articulates with tergite VII. Tergite VI is also present. Sternite VII he recognized in the anterior part of the ventral plate, the "vordere Gabelplatte", which lies anterior to the penis and which he found to be traversed by a narrow clear line or suture)see Fig. 34a, Plate VI). The eighth segment, a strong tergite without spiracles, has undergone expansion laterally to form a pair of lobes, the "valvulae laterales" which are connected with a ventral plate posterior to the penis, the "hintere Gabelplatte" by long rods, the"processi longi." The eighth sternite forms the posterior part of the "vordere Gabelplatte." The ninth tergite is rudimentary. It is demonstrable in some species in the intersegmental connective

membrane surrounding the anus. A pair of posterior lobes, the "valvulae mediales" are part of segment X. Petzold was unwilling to draw any conclusions regarding the segmental relations of the penis. The internal apodeme extending anteriorly from the penial base, the "Tragplatte", he did not consider to be of sternal origin. At the penial base are two pairs of short lobes or processes, the anterior or "Häkenfortsatze" and the posterior or "paramere." Between the bases of these appendages on each side Petzold found a small sclerotic plate articulating with each.

The numerous figures given are excellent and easily interpreted. Two of these have been adapted for the purposes of this paper. (Fig. 34 and Fig. 34a, Plate VI).

13. Cole (1927).

Cole undertook a comparative study of the terminal abdominal structures of male Diptera, in general. He found only five unmodified or but slightly modified abdominal segments. Segment eight he considered as present, but usually without spiracles and frequently fused with other sclerites. The genital segment is labelled IX. The "genitalia" are, in his opinion, formed of modified appendages and portions of segment IX only. Segments X and XI are fused to form the "proctiger." The ninth segment bears the "styles" (movable appendages). Behind the ninth tergite come the "cerci" and behind the ninth sternite the genital opening. It is difficult to determine when the structures present are "parapodial plates" and when they are "cerci" Lateral portions of segment IX may form accessory clasping organs or "surstyli." Cole's figures are not completely labelled in all cases and some confusion appears in the use of the terms "surstyli" and "parapodial plates".

14. Patton (1932).

Musca was studied in some detail by Patton for taxonomic purposes. Later (Patton 1935) he extended the terminology developed to the structures in other calyptrates. As pointed out in the introduction, he preferred the word "terminalia" to the term "genitalia". Following Awati (1916) he postulated the disappearance of segment VIII of the abdomen. The ventral asymmetrical sclerite following sternite V and united with tergite VII he considered as sternite VI. The ventral sclerite, posterior to which arises the penis, is labelled the "ninth tergo-sternum". "Coxite nine" is a rectangular sclerite on each side, anterior to the free margin of the "anal cerci". In form, it resembles a human hand. Anteriorly it articulates with the "ninth tergo-sternum". The genital tergite becomes tergite X in this scheme of numbering and its posterior lobes are the "anal cerci".

15. Townsend (1934-35).

The morphology of the dipterous abdomen is discussed by Townsend at the beginning of his work. He assumes twelve segments to have been originally present in the abdomen. The first structure modified for copulatory purposes is the sternite of segment five, which has its posterior corners produced as "anterior forceps". Tergite VI is narrow, sternite VI is missing. Tergite VII is plainly visible. The asymmetric sclerite above sternite V is sternite VII. Segment VIII is fused with VII, the spiracles of this segment being lost. Tergite IX, the "epandrium" is large; sternite IX, the "hypandrium" is a "chitinous framework" concealed within the genital cavity, for immediately bearing the genital organs. It consists of two pieces, the "vinculum" and the "vincular apodeme". The vinculum shows two processes which are integral parts of it and without any articulation, being the "paired vincular apophyses" which are attached to the posterior edge of the ninth tergite and on which articulate the secondary or accessory forceps. Segment X is represented by a tergite practically merged with XI and a sternite represented by lobular developments attached to tergite IX. These are often developed finger-like into a supplementary pair of posterior forceps with lateral action, being attached by their bases to tergite IX.

Tergite XI is a small supraanal plate fused with tergite IX, but the sternite persists in the "parapracts" attached to the ninth tergite posteriorly.

Segment 12 is represented by a thin membrane, the periproct, bearing the anus.

"'Anterior gonapophyses' arise from the primary gonapods, which are long basal plates articulating with the vincular apodeme, one on each side of the phallotheca."

"'Posterior gonapophyses' arise from very small basal plates situated behind the preceding and in close association with the base of the phallotheca."

The detailed structure of the "Phallus" is given with a terminology as indicated in Table I.

16. Snodgrass (1935).

Snodgrass deals very briefly with the genitalia of Pollenia rudis. Segment six is considered missing. The first tergite following V is thus labelled VII, and the second VIII. Since this last is united at one end with the asymmetric sternal sclerite immediately following sternite V, this asymmetric structure is termed sternite VIII. Sternite IX is the ventral plate just anterior to the penis and from it are said to extend a pair of lateral bars ("processi longi") to the tenth segment. Yet segment X is described as flat and membranous. (This interpretation is discussed later in this paper). Long lobes borne on the posterior angles of the ninth tergum are described. These may be flexible at their bases but are not provided with muscles.

C. TABLE I: Comparison of Terms Used by Different Writers.

1	Terms used in this paper	Sternite V Lobes of Sternite V	Tergite VI
2	Terms of Lowne, 1893-1895	Sternite V	"
3	Brüel, 1897	"	"
4	Hewitt, 1907	" Primary forceps	"
5	Wesché, 1908	laminae superiores	-
6	Berlese, 1909	Sternite VI primo forcipe	Tergite VIII
7	Newstead, 1911	Sternite VI	Tergite VII
8	Awati, 1915	Sternite V accessory forceps	Tergite VI
9	Newell, 1918	Sternite V	Tergite VI & VII
10	Müeller, 1920 & 1922	Sternite V	Tergite VI
11	Feuerborn, 1922	Sternite VI	Tergite VII
12	Petzold, 1927	Sternite V	Tergite VI
13	Schräder, 1927	Sternite VI	Tergite VII
14	Cole, 1927	Sternite V	Tergite VI
15	Patton, 1932	Sternite V Lateral processes	Tergite VI
16	Townsend, 1934	Sternite V anterior forceps	Tergite VI
17	Snodgrass, 1935	Sternite V	Tergite VII

TABLE I (sheet 2)

1	Sternite VI & VII	Tergite VII	Tergite IX
2	Epipleuron	"	Tergite VIII Progenital tergum
3	Chitinring ?	"	Tergite VIII
4	Sternite VI	"	"
5	--	--	--
6	Sternite IX	Tergite IX	Tergite X
7	--	Tergite VIII	--
8	Sternite VII	"	Tergite IX Genital tergite
9	Sternite VI & VII	"	Tergite IX
10	--	--	Tergite VIII
11	Halbring	Tergite VIII	Tergite IX
12	Sternite VI	Tergite VII	Tergite VIII
13	Basalring Extension of T.7 & 8	Tergite VIII	Tergite IX
14	?	Tergite VII & VIII	"
15	Sternite VI	Tergite VII	Tergite X
16	Sternite VII	"	Tergite IX
17	Sternite VIII	Tergite VIII	"

TABLE I (sheet 3)

1	Sternite IX	Tergite X Parapodial plates	Sternite X
2	Progenital sternum	?	Sternite IX
3	Sternite VIII	Tergite IX	--
4	body of the penis	--	--
5	part of the theca	--	--
6	--	Tergite XI	--
7	--	--	--
8	vinculum body of the penis	--	--
9	Sternite X ?	--	--
10	--	--	--
11	Sternite VII	Tergite X	--
12	vordere Gabelplatte Sternite 7 & 8.	Tergite IX	hintere Gabelplatte
13	Gabelplatte sternite VII	Tergite X-	--
14	Sternite IX ?	?	--
15	Ninth tergo-sternum	--	--
16	Vinculum = sternite IX	Tergite X	--
17	Sternite IX	"	--

TABLE I (sheet 4)

1	Lobes of Sternite X	Anal cerci (segment X)	Posterior angles of sternite IX
2	valvae externae	valvae internae	Posterior angles
3	valvula lateralis	valvula medialis	Arm der Winkelhebels
4	Sternite VII	Sternite VIII	alar processes of the penis
5	forceps inferior	forceps superior	--
6	forceps secundus Sternite X	mesocerci Tergite X	--
7	editum	superior claspers	--
8	inner claspers	anal cerci (segment X)	alar projections
9	Tergite X	mesocerci (Tergite X)	--
10	Seitenlappen ?	forceps	--
11	Gonopoden	cerci	--
12	valvula lateralis	valvula medialis	--
13	" "	" "	Hebelfortsätze
14	surstyli (lobes of T. IX)	cerci	--
15	ninth coxites	anal cerci	lateral processes to coxites
16	lobes of Sternite X	Paraprocts or Anal cerci (seg.XI)	vincular apophyses
17	lobes of Tergite IX	lobes of Tergite X	arms of Sternite IX

TABLE I (sheet 5)

1	anterior basal phallic appendages	posterior basal phallic appendages	anterior angles of Tergite IX
2	anterior gonapophyses	posterior gonapophyses	?
3	Hakenfortsätze	Paramere	Gelenk fortsätze
4	--	--	--
5	palpus genitalium	forceps interior	--
6	corpus penes	ala corporis penis	--
7	--	inferior claspers?	--
8	appendages of the vinculum? lateral processes	lateral processes?	--
9	--	appendages of segment VIII	--
10	--	--	Galenkfortsätze
11	--	--	--
12	Hakenfortsätze	Paramere	Processus brevis
13	"	"	Gelenkfortsätze der VIII T.
14	genital palpi	interior forceps	--
15	anterior part of paramere	posterior part of paramere	Processes of tergite X
16	anterior gonapophyses	posterior gonapophyses	--
17	median plates?	free pair of lobes embracing aedeagal base	--

TABLE I (sheet 6)

1	Processus longus	Phallus	Phallic base
2	epipleural ridge	penis	bulb
3	Processus longus	"	Pars basalis
4	--	"	theca?
5	--	--	theca?
6	--	--	--
7	--	--	--
8	--	theca	theca
9	appendages of segment XI ?	--	--
10	Processus longus	penis	Grundglied
11	--	"	Theka
12	Processus longus	"	--
13	" "	"	--
14	--	aedeagus	--
15	--	phallosome	--
16	--	aedeagus	phallotheca
17	lateral bars to segment X ?	phallus	phallobase

TABLE I (sheet 7)

1	Spine	Aedeagus	paraphallus
2	azygos spine	--	"
3	Dorn	--	lamina superior
4	superior apophysis	--	--
5	spinus titillatorius	--	paraphallus
6	apophysis spinosa penis	--	--
7	--	--	--
8	--	--	--
9	--	--	appendages of Segment IX
10	Dorn	Mittelstück	Furca
11	Dorn	--	--
12	Dorn	--	--
13	--	--	lamina superior
14	spinus titillatorius	--	paraphallus
15	posterior process	body of phallosome	--
16	inferior apophysis of phallobase	phallus	paraphallus
17	?	aedeagus	--

TABLE I (sheet 8)

1	hypophallus	ventralia	praeputium
2	hypophallus & ventralia	included in the hypophallus	?
3	lamina inferior	lamina lateralis	distaler Rand der weichen Innenröhre
4	--	--	glans ?
5	hypophallus	hypophallus	--
6	--	--	--
7	--	--	--
8	--	--	--
9	ends or horns = appendages of Seg. X	--	--
10	Vomer	Seitenmembrane	Endstück
11	--	--	--
12	--	--	--
13	lamina inferior	lamina lateralis	--
14	hypophallus	--	--
15	--	--	--
16	hypophallus	ventralia	Praeputium
17	--	--	--

TABLE I (sheet 9)

1	penis	double apodeme	sperm pump
2	--	giant apodemes	--
3	--	Tragplatte (sternite IX)	Samenpritze
4	--	--	ejaculatory apodeme
5	--	double apodemes	" "
6	--	--	--
7	--	--	--
8	--	--	--
9	--	ejaculatory duct ?	--
10	--	--	--
11	--	--	sternite IX
12	--	Penisstütze	Samenpumpe
13	--	Tragplatte Sternite VIII	Sternite IX
14	penis	double apodeme	--
15	--	apodeme of the phallobase	--
16	--	vincular apodeme	--
17	penis	apodeme	ejaculatory bulb

D. The Male Genitalia of Gonia

1. General Considerations

It has not been possible, during the preparation of this paper, to investigate the matter of the rotation of the apical abdominal segments as described by Feuerborn (1922) and Schräder (1927). Keuchenius (1913) indicates the ejaculatory duct in Dexia canina Fabr. as crossing over the alimentary canal but though he studied several forms does not make a point of the winding of the duct about the canal. Tullock (1906) says of Stomoxys, that the duct "does not encircle the rectum as in Glossina." Minchin (1905) found it encircling the canal in Glossina. It is thus not possible to conclude that the condition is general in Diptera and it is hoped when fresh material is available to investigate this matter in the species concerned here.

Neither has it been possible to do any detailed study of the musculature of the genitalia of Gonia. From what limited observations could be made on dried specimens it appeared that the musculature closely resembled that found by Schräder (1927) in Calliphora erythrocephala. No muscular connections between sternite IX or the apodeme and tergites V or VI were observed.

It has been possible, however, to thoroughly investigate the external morphology of the genitalia in Gonia and to compare it directly with that in many other forms. Drawings were prepared from Gonia breviforceps Tothill, (Figs. 35, 36 and 37, Plate VI), except for the drawing of sternite IX

and the associated phallus and phallic appendages (Fig 38, Plate VI), which was prepared from Gonia fissiforceps Tothill. Other original drawings included are: that of Tabanus (Fig. 26, Plate IV); those of Drosophila melanogaster (Figs 28 and 29, Plate IV); that of Musca domestica Linn (Fig. 30, Plate IV); and those of Cyanomya cadaverina Desv. (Figs. 32 and 33, Plate V). Material examined during the preparation of the paper included species of Calliphora, Asilus, Dolichopus, Syrphidae, Bibionidae, Stratiomyidae, Anthomyidae, Chironomidae, and Tachinidae other than Gonia.

2. Structure and Homologies of the Parts

(a) Gross structure.

The genitalia of Gonia consist of the sternite of segment V and the following segments VI to X inclusive. Segment XI has entirely disappeared or is included in X. Segment VI is mostly membranous and folded under segment V. Sometimes, however, a narrow dorsal plate, tergite VI, is present behind and beneath tergite V. Ventrally, sternites VI and VII are probably included in an asymmetric sclerite (S.vi & vii Figs. 35 and 36, Plate VI) just above the fifth sternite and closely united to it basally. On the left side this combined sternite articulates with tergite VII, which is a distinct narrow, dorsal, transverse plate, at rest, partly hidden under tergite IX. In the extended position a membranous area intervenes between segments VII and IX. It would seem that segment VIII has disappeared, a

condition postulated by Awati (1916) and Patton (1932). Segment IX is the genital segment and is represented by a large tergite, (T. IX, Fig. 35, Plate VI), and sternite (S. IX, Fig. 35, Plate VI), behind which the phallus is borne. The anus is a long slit-like opening on a membranous area just posterior to tergite IX. No sclerotic, parapodial plates, such as occur lateral to the anus in some Tachinids (Petzold 1927) are present in Gonia. A pair of terminal anal forceps (A.C. Figs. 35, 36 and 37, Plate VI) are fused into one structure. Lobes of sternite X (Lbs. S. X, Figs. 35, 36 and 37, Plate VI) are present. Placed laterally, just anterior to the anal forceps they articulate with the forceps and with tergite IX, and by means of long sclerotic rods, processi longi, (proc. l.) with the tenth sternal plate (s. pl. X).

A pair of anterior basal phallic appendages (Ant. b. ph. app., Fig. 38, Plate VI) are fused to the ninth sternite and appear as outgrowths of it. Posterior to these are a second pair of appendages, the posterior basal phallic appendages (Post. b.ph.app). These are movably articulated. The phallus (Phl.) is supported by sternite IX between the extended posterior angles of which it protrudes. Basally it articulates with the large internal double apodeme (Ap.) which extends anteriorly into the body. The phallus itself consists of a phallobase (Phlb.), aedeagus (aed.), and internal penis.

(b). Structure of the parts.

i. Sternite V (Fig. 36, Plate VI).

The fifth sternite in Gonia is the last externally visible one. It is considerably wider than the preceding sternites. Its lateral edges have folded over ventrally and the posterior lateral corners extended to form two prominent projections, the lobes of the fifth sternite (Lbs. S. V. Fig. 36). The inner edges of the external lobes are folded back and in the fissiforceps group curiously "scalloped." In all species the inner edges of the lobes bear many heavy black bristles. It is homologous with sternite V or VI of other authors, according to how many abdominal segments they recognized. The lobes have been variously termed "accessory forceps", "primary forceps", etc. (see Table I).

ii. Tergite VI (Fig. 35, Plate VI).

The sixth tergite in Gonia breviforceps Tothill is represented by a wide membranous area posterior to tergite V. Normally, when the genitalia are in the resting position, this area is invaginated and only exposed narrowly on the sides, where the spiracles are present. The latter structures, then, just show anterior to tergite VII. In some species a short, narrow, dorsal sclerotized area has been observed. At rest it is half hidden beneath tergite VII. A larger remnant of this tergite is present in Cyanomya cadaverina (Fig. 32, Plate V.). A portion of tergite VI, in this case, seems to be still

adhering to the anterior edge of tergite VII, especially at the left end where the combined tergite articulates with sternite VI & VII. In Cynomya these sclerites also articulate at their right ends. Tergite VI is well developed in Calliphora (Fig. 31, Plate V).

In Drosophila melanogaster segments six and seven have evidently fused completely. The segment posterior to five, and exactly similar to it in the structure of the tergite, has two spiracles on each side in the connective membrane just below it. A similar condition has been described by Awati (1916) in Lispa, where he considered it a further step in the evolution of the genitalia.

Since in Gonia and other related forms the penultimate spiracle lies just on the edge of the apparent seventh tergite and the ultimate within it and since in forms such as Musca domestica Linn. (Fig. 30, Plate IV) the apparent sixth and seventh tergites remain completely fused on the right side and overlap on the left where the apparent seventh crosses the sixth to articulate with sternite VI & VII, it would appear that these two tergites, once fused into one plate, became reduced and secondarily separated in the interests of flexibility at that point. If this is the case their exact limits, i.e. whether or not the split came on the old line of fusion, is not certain and would explain the position of the spiracles and the apparent connection of what seems to be sternite VI with what seems to be tergite VII. As pointed out above, in Cynomya cadaverina Desv. there is evidence of this

division not being along the only line of fusion as a portion of the original sixth tergite appears to be united with seven along its anterior border and to form a lobe at the left end. This lobe is involved in the articulation with sternite VI & VII which takes place on the suture.

iii Sternite VI & VII. (S. VI & VII, Figs. 35,36,Plate VI)

Immediately above the fifth sternite and connected closely to its base is an asymmetric sclerite which ends free in a somewhat expanded lobe in the membrane on the right side of the fly, but continues up on the left side to articulate with the seventh tergite. It appears homologous with a similar sclerite in other calyptrate flies (Fig. 30, Plate IV and Fig. 32, Plate V).

The close association of this sclerite with the seventh tergite has led some investigators (Awati, 1916, and others) to list it as sternite VII. This interpretation assumes that sternite VI has disappeared. Snodgrass (1935) considers that the entire sixth segment has disappeared. The apparent seventh tergite then becomes the eighth and this asymmetric sternal plate, closely associated with it, sternite VIII. Still other writers questioned the sternal nature of this sclerite. Lowne (1897) called it an "epipleurite" while Schräder (1927) interpreted it as a prolongation of his tergites VII and VIII. The pupal study of the last named author threw little light on the origin of this plate though he observed it early in the development and determined that it took no part in the rotation of the genitalia.

Comparative morphology at the present time does not seem sufficient to finally settle this matter. However, if we note the complete union of segments VI and VII in Drosophila, and in Lispa (Awati 1916) we can see how such a compound structure as tergite VI & VII might develop and maintain connection with a secondarily separated, apparent tergite VII and still remain closely united to sternite V. In Cyanomya (Fig. 32, Plate V) this asymmetric ventral sclerite maintains its articulation with the tergal plates on both sides though that on the left side is stronger and resembles the articulation in other forms. As previously pointed out the detached sclerite labelled tergite VI seems to be only a portion of this sclerite. The rest remains attached to tergite VII. Possibly it is all one sclerite which breaks easily when handled. Certainly the anterior lobes of tergite VII on the left side seems to be a part of tergite VI and it is just at the union of this lobe and tergite VII that the asymmetric sternal plate articulates. For these reasons the sternite in question is here considered as sternite VI & VII.

iv. Tergite VII (Fig. 35, Plate VI)

The seventh tergite in Gonia is a narrow strip of sclerotized chitin, bounded anteriorly by connedtive membrane and normally lying almost against tergite V. If a narrow apparent tergite VI is present the two may be fused on the right side. Posteriorly tergite VII is bounded and often overlapped by the large genital tergite, tergite IX. A spiracle is present near each end. At the right end tergite VII is free in the connective membrane or fused with the similarly free end of tergite VI. The left extremity widens and forks, one branch ending free and one articulating with the extremity of sternite VI & VII just posterior to spiracle VI.

In Musca (Fig. 30, Plate IV) the structure is similar, the left end being enlarged and crossing over the end of tergite VI to meet sternite VI & VII, while the right ends of tergites VI and VII are fused. In Calliphora (Fig. 31, Plate V) tergite VII is a prominent sclerite and according to Schräder is bound to the anterior end of sternite IX by a strong muscle band. As previously noted this segment is fused with segment VI in Drosophila and Lispa.

v. Segment VIII

Segment VIII in Gonia has disappeared or is entirely membranous. There is no indication of the presence of any eighth pair of spiracles. Reichardt (1929) found the sclerites of segment VIII very narrow and no spiracles

present in some Asilids such as Laphria flava (Fig. 24, Plate IV). In this species also the hypopygium including segment VIII has rotated through 180° necessitating a wide connective membrane in this area. In Tabanus (Fig. 26, Plate IV) segment VIII is also somewhat reduced. Again in the Dolichopodidae, Snodgrass (1904) notes the tendency of segment VIII to lose its spiracles and to almost entirely disappear on the right side, (Figs. 25 and 25a, Plate IV). In the Syrphidae, according to Metcalf (1921), segment VIII is large, but possesses no spiracles and is represented by the tergite only, which is often asymmetrical (Figs. 27 and 27a, Plate IV). In Drosophila (Fig. 29, Plate IV), there is a wide connective membrane and great flexibility between segments Vii and IX, but no spiracles or sclerites. Because of this tendency of segment VIII to weaken and lose its spiracles and because of the wide connective membrane in this area in calyptrate flies, the assumptions of Awati (1916), Patton (1932) and Townsend (1934), that segment VIII has disappeared seem more logical than the view of Snodgrass (1934) that segment VI is missing or that of earlier workers that the anterior abdominal segment is missing. The view that the genital segment is VIII, which has lost its spiracles, seems untenable in the light of the known reasonably constant occurrence of the opening of the male duct behind sternite IX, in insects.

Petzold (1927) noted the presence of a clear, transverse line across sternite IX (his "Gabelplatte") and held it as evidence of the presence of two sternites, VII and VIII, in

this structure. (Fig. 34a). The line is evident in the homologous ventral plate in Gonia and other forms examined. If it is indicative of the double origin of the plate, sternites VIII and IX must be involved as the exit duct is posterior to segment IX. However, in Tabanus (Fig. 36, Plate IV) that portion of sternite IX which is beneath sternite VIII is very similarly differentiated and has been designated the "apodeme of sternite IX" by Newell (1918).

Schräder (1927) found sternite IX bound to tergites VII and IX by muscular connections while Brüel (1897) found muscles connecting the same plate and the apodeme (his "Tragplatte") to tergites V and VI. All in all, the evidence is conflicting and seems too slight to postulate the presence of sternite VIII in the structure here called sternite IX or in any other structure observed.

vi. Tergite IX (Figs. 35 and 36, Plate VI).

The ninth or genital tergite is a large, dorsally convex plate with a V-shaped emargination in its posterior edge. It is folded under laterally and its antero-lateral angles extended as sclerotized rods (a.a.t. IX) which articulate with the outside of the extended posterior angles of sternite IX (Post a.s.IX) and are closely bound to these by connective membranes. The posterior angles articulate with processes on the anal forceps. The sides are emarginate posteriorly, and from beneath them extend the lobes of sternite X, which articulate with them. Ventrally, connective membrane extends across between the folded lateral edges

from the ninth sternite posteriorly to the anal forceps. In the connective membrane covering the V-shaped posterior emargination is found the long slit-like anal opening. The close connection of this sclerite with sternite IX; its position in relation to the anus; and its apparent similarity in form and function to tergite IX in the Syrphids (Figs. 27 and 27a, Plate IV), to tergite IX in the Dolichopodidae (Fig. 25, Plate IV), and to the same tergite in the Asilidae (Figs. 23 and 24, Plate IV), seem to determine what sclerite it is. It seems improbable that it is tergite VIII, as suggested by some workers (Petzold 1927 and others), or tergite X, as suggested by Townsend (1934).

vii. Sternite IX (Figs. 35 and 36, Plate VI).

Sternite IX is a slightly arcuate, shovel-shaped sclerite. Anteriorly it is rounded. The posterior "corners" or angles are produced caudad and upward into processes on either side of the phallus. In Gonia these produced posterior angles of sternite IX articulate laterally with the anterior angles of tergite IX and apically with sternite X, the sternal plate posterior to the phallus. In forms in which sternite X is absent or fused to these arms (Fig. 33, Plate IV) they appear to articulate apically with the processi longi of the lobes of sternite X.

In Gonia (Fig. 38, Plate VI) the posterior portion of sternite IX on either side of the phallus is prolonged into two ventrally directed lobes, the anterior basal phallic lobes. These are hollow, slightly curved, sickle-shaped, sclerotic projections bearing hairs on their apices and with their

upper posterior angles prolonged to articulate with the phallic base. Petzold (1927) found comparable lobes ("Hakenfortsätze") in Ernestia rudis but considered them as distinctly separate from sternite IX (his "Gabelplatte"). He shows them articulating with two projections on sternite IX and through a pair of very small sclerites at their bases with the phallus and the anterior basal phallic lobes. Whether these posterior basal phallic lobes are a part of sternite IX, or true appendages (Newell 1918), or part of the phallus, is uncertain. They are present in many calyptrate forms but rudimentary in the Housefly and absent in Drosophila. No homologous structures appear to be present in lower forms.

Distinctly articulated posteriorly with the above mentioned anterior basal phallic lobes are a second pair of elongate, almost straight, tubular, sclerotic lobes, the posterior basal phallic lobes (Fig. 38, Plate VI). Snodgrass (1935) considers these structures in Pollenia rudis as phallic lobes rather than as true appendages. He states that they are not musculated. Schräder (1927) found that they develop in the pupa from the second pair of genital lobes (see B. Historical Review: 11, Schräder). This is of interest in view of the work done in tracing the development of genital appendages through immature forms in other insects. This work has been well summarized by Snodgrass (1935) as follows:

"Studies on the development of the male genitalia in Trichoptera, Lepidoptera, and Hymenoptera, have shown that the tubular phallic organ of these insects is formed during larval development by the union of a pair of genital lobes

that grow out at the sides of the gonapore (Zander, 1900, 1901, 1903; Singh Pruthi, 1924, 1925; Mehta 1933). It is possible, therefore, that these larval phallic lobes of higher insects are homologues of the lateral phallomeres of Mantidae and Blattidae. According to Zander, the primitive phallic lobes divide each into a median lobe and a lateral lobe, the two median lobes uniting to form the intromittent organ, while, in Trichoptera and Lepidoptera, the lateral lobes move to the sides and become articulated to the margins of the annulus of the ninth segment. We might, therefore, regard the median lobes as gonapophyses of the gonapods, and the lateral lobes (valvae or harpagones) as the styli. However, since it is claimed by Mehta that the lateral lobes in Lepidoptera arise separately from the median lobes, we cannot accept it as established that the gonapods of the male insect take any part in the formation of the intromittent organ, though there appears to be little doubt that they give rise to the styli or the moveable claspers of the genital segment."

If Schräder's observations are accurate it would seem that these posterior basal phallic appendages are the true appendages of segment IX and hence homologous with the large claspers of lower Diptera (Tipulidae, etc.), Trichoptera and Lepidoptera. (See Lowne 1893-95). Certainly there do not seem to be any other structures present in calyptrate Diptera which represent the appendages of segment nine. Awati (1916) and others have considered the parts here called lobes of sternite X as the true appendages or at least as the coxites of segment nine. The evidence against this interpretation

lies in the dorsal position, and dorsal and post-phallic articulation of the structures. Awati himself has called attention to this difficulty and solved it by merely stating that in his Syrphid type the appendages of the genital segment are dorsal and not ventral as in Bibio (see under B. Historical Review, 7 Awati). Snodgrass considers that the appendages of segment IX are missing and that the structures in question, the posterior basal phallic appendages, are secondary outgrowths of the connective membrane about the base of the phallus. He thus terms them phallic rather than periphallic structures and his view is being adopted for the present.

viii. Tergite X

(1) Parapodial plates

There are no sclerites in the connective membrane surrounding the anus in Gonia. In Drosophila (Fig. 28, Plate IV) two small oval sclerites occur, posterior and lateral to the anus. These are here termed the parapodial plates. In Cynomya (Fig. 32, Plate V) they are represented by small triangular plates, on each side of the anus, and in Calliphora (Fig. 31, Plate V) by narrow lateral plates termed "tergite IX" by Brüel. Petzold (1927) shows similar plates in some tachinids, in some cases free, in others fused with tergite IX.

(2) Anal forceps. (Figs. 35, 36, 37, Plate VI).

The anal forceps are the terminal structures in Gonia, when the genitalia are extended. At rest, however, they are folded beneath the abdomen with their apices in the genital pouch above the lobes of sternite V. They are formed of two lateral sclerites, closely fastened together along the mid-dorsal line and divaricating only slightly at the apex. The lateral edges of the plates are rolled under and joined, at least basally, with connective membrane which is continuous with that extending ventrally across tergite IX. Dorsally the forceps articulate with tergite IX and laterally with the lobes of sternite X. They vary greatly in width, depth, curvature and setal vestiture, according to the species.

The anal forceps of Pollenia rudis and Calliphora are completely separate lateral lobes. In Musca (Fig. 30, Plate IV) they are flat and plate-like, but closely united with a very narrow sclerite inserted between them. Lowne (1893-95) labelled them "sternite X". In Cyanomya (Fig. 32, Plate V) they are rudimentary, the small setae bearing areas posterior to the parapodial plates being the only indication of them. Similarly reduced anal forceps are shown by Petzold (1927) in certain Tachinidae. Drosophila (Figs. 28 and 29, Plate IV) has two curved strips of slightly sclerotized chitin, below the parapodial plates, attached to the lobes of sternite X and marked by strong setae on their edges. These appear to represent the anal forceps. They are evident as posterior lobes of segment X in the Syrphids (Fig. 27a, Plate IV) and

appear in some forms to be jointed. The folded-under parts of tergite X in Tabanus may represent these structures. The Dolichopodidae and Asilidae show no very similar structures but it seems probable that they are contained in the plates of the anus-bearing proctiger.

Snodgrass (1935) and earlier workers find the anal forceps bound to tergite IX by muscular connections which closely resemble the dorsal, intersegmental muscle bands.

ix. Lobes of sternite X. (Figs. 35 and 36, Plate VI).

In Gonia there are present a pair of lateral lobes anterior to the anal forceps. These are peculiarly contorted sclerites. Ventro-laterally, on each side of tergite IX and somewhat beneath it, lies a somewhat triangular sclerite with the apex of the triangle curved ventrally and almost meeting its fellow from the other side in the membranous floor of the genital chamber. The base of the triangle is directed dorsally. Anteriorly it projects beneath tergite IX and articulates with it, while posteriorly it articulates with the anal forceps. Extending ventro-laterally from the anterior side of the triangle is a hollow, tubular, finger-like sclerite. The base of this projection is emarginate anteriorly. The projection is usually supplied with numerous setae apically. From the inside of the base a process, the processus longus, extends anteriorly in the floor of the genital chamber to articulate with the tenth sternal plate or directly with the posterior angles of sternite IX.

The origin of these curious triangular sclerites with their lobes and processes forms one of the major problems in the homologizing of the structures and explaining their segmental nature.

In Tabanus (Fig. 26, Plate IV) the tergite and sternite of segment X are conspicuous. Each is divided into lateral halves. The segment, the anus-bearing proctiger, extends anteriorly to sternum IX. The ventral plates of segment X articulate anteriorly with the ninth sternite, posterior to the phallic base.

In the Syrphidae (Fig. 27a, Plate IV) there are two styli-like lobes which articulate with tergite X and sternite X. Drosophila (Figs. 28 and 29, Plate IV) has two large lobes extending on either side, outside of but connected with the anal forceps. These lobes have definite processi longi which connect them with the phallic base, posteriorly. In Ernestia rudis (Fig. 34, Plate VI) and in Calliphora the lobes resemble those in Gonia but are more strongly developed. Schräder (1927) finds the processus longus connected by muscles to tergite IX but Snodgrass (1935) considers these as unmusculated lobes. The lobes of sternite X in Cynomya (Figs. 32 and 33, Plate V) have moved back to the place generally occupied by the anal forceps and have united basally. The processi longi have broadened and fused to form a definite tenth sternal plate posterior to the phallus and very similar to that present in some Syrphids. In Musca the lobes are flattened ventral plates mistaken for the seventh sternite by Hewitt (1907).

The position of these lobes and their articulation, always posterior to the phallus, indicates their origin from the tenth segment and probably from the sternite of the same. They have frequently been termed the coxites of segment nine but their position relative to the phallus makes this interpretation doubtful. Their shape, articulation, and lack of direct musculation suggests an origin other than from true appendages.

In view of the divided tenth sternite of Tabanus, the position of the lobes in question in Gonia, and other calyptrate flies, and the formation of a ventral plate posterior to the phallus by the fusion of the processi longi in Cyanomya, it is tentatively held here that these lobes have their origin in the tenth segment and are probably sternal. This is the view held by Townsend (1934) though he states no reasons for it.

x. Tenth sternal plate (Figs. 34 and 36, Plate VI and Fig. 33, Plate V)

Posterior to the phallus in Gonia (Fig. 36, Plate VI) lies a narrow, transverse, ventral plate with which the anterior ends of the processi longi articulate. In Pollenia rudis this plate is turned on edge extending into the genital cavity and forming with the posterior angles of sternite IX a basal shield for the phallus. In Musca (Fig. 30, Plate IV) such a plate is absent or has split and the parts fused with the posterior angles of sternite IX. The tenth sternal plate in Cyanomya has probably fused with the flattened and fused processi

longi. Ernestia rudis (Fig. 34, Plate VI) shows a condition similar to that in Gonia. Petzold (1927) has designated this structure the "hintere Gabelplatte." Lowne (1893-95) mentions a sternal plate posterior to the phallus in Calliphora but does not name it. In the Syrphidae (Fig 27a, Plate IV) the tenth sternal plate curiously resembles the composite plate in Cyanomya. Such a plate, posterior to the phallus might arise from a fusion of the extended posterior angles of sternite IX. However, it seems more probable that it represents sternite X.

xi. The phallus and phallic structures. (Fig. 38, Plate VI)

The anterior and posterior basal phallic appendages have been dealt with previously. (See vii - sternite IX). There remains the phallus proper and its double apodeme.

(1) The phallus

The theory of the segmental origin of the phallus in Diptera or any insect has been almost completely discarded. There is some evidence, according to Schräder (1927) of its origin in Diptera from portions of appendages which have fused. However, as pointed out in the quotation from Snodgrass (see vii - sternite IX) such an origin has not been proved the case in any insect. There is, however, a general basic plan according to which this structure in most calyptrate Diptera may be interpreted.

In general the phallus is an unpaired median structure. It is frequently referred to as the penis, but is a composite structure of more than the penis proper which it

ensheathes. Townsend (1934) refers to it as the "aedeagus". Lowne (1893-95) suggested a terminology for the parts. Brüel (1897) gave a more complete terminology. Müeller (1922) took Lucilia caesar as a basis and developed a new set of terms for the structures in a "basic plan." Townsend (1934) has chosen from earlier workers the names he prefers. Since the morphological homologies with structures in other insects are very doubtful as yet, any of these sets of terms serve the purpose of description equally well. The terms chosen for use here are those most frequently seen. Apparent synonomies have been listed in Table I, but since one term may in some cases cover parts of structures separately named by another worker, exact synonomy is not always indicated.

In Gonia the phallobase is tubular. Its anterior end articulates basally with the double apodeme and is produced dorsally to articulate on each side with dorsal extensions of the anterior basal phallic appendages. A membranous area occurs latero-dorsally in the phallobase. Anteriorly it is produced into a dorsal spine.

Closely attached to the phallobase at right angles and with lateral apodemes extending into it, is the aedeagus. It is narrow basally and expanded apically. A slightly sclerotized plate begins as the apodemes within the phallobase and extends on the dorsal side of the aedeagus where it divides forming a dorsal, spine-like structure, the paraphallus or united paraphalli ("Furca" of Müeller), and two large lateral expansions which envelope the greater part of the aedeagus laterally and may be narrowly united

basally on the ventral surface, the hypophalli ("vomer" of Müeller). These structures are sclerotized in successive small, scale-like patches, giving the surface a chequered appearance under high magnification.

The ventral part of the aedeagus, the ventralia, is entirely membranous. The apical praeputium is likewise membranous. The penis or true intromittent organ is a long narrow tubular structure equal in length to the aedeagus and concealed within it when at rest. This structure was observed once while material was being treated in cold potassium potash but was so delicate that it was destroyed before a drawing could be prepared.

(2) The double apodeme

Extending upward and anteriorly from the phallobase into the body, above sternite IX, is a sclerotic apodeme. Basally where it articulates with the phallobase this structure is narrow. It extends into segment V and broadens out transversely fan-like, with a vertical keel-shaped projection below. Many muscles are attached to this apodeme and these govern the movements of the phallus.

Lowne (1893-95) termed the similar structure in Calliphora the "great apodemes." Other writers have homologized it with certain sternites (see Table I) while Wesché (1906) uses the terms "double rod", "apodeme of the penis" and "double apodemes". The double nature of this structure is evident in some forms but in most calyptrate Diptera there is one fused structure. Newell (1918) has

shown Tabanus to have two entirely separate and distinct apodemes. Their homology with the structure in question is, however, uncertain. In Musca apodemes are entirely lacking and in Drosophila seem to be represented by a sclerotized portion of the ejaculatory duct. It does not seem that we are yet justified in postulating an origin sternal or otherwise for this structure.

As pointed out in the introduction, Awati (1916) misinterpreted certain early authors in their uses of terms for the "double apodeme."

E. Summary and Conclusions

1. From the Historical Review.

Over a period of over forty-five years numerous morphological studies have been carried out on the genitalia of calyptrate Diptera. In spite of the fact that the homologies of the structures within the group are reasonably evident, great confusion exists in the literature. Homologies of these structures with those possessed by less closely related insects are more difficult to prove and for the most part based on conjecture. The historical review and comparative table of terminologies indicate these facts. Three important problems are suggested by the historical review: (1) is the rotation of the parts of the male genitalia through 360° a condition common to all calyptrate flies and if so what is its origin? (2) is the musculation pattern of the genitalia of calyptrate flies constant and does it throw any light on segmentation? and (3) what is the developmental history of the structures described here?

2. From the Morphological Study.

Gonia has the fifth abdominal sternite and the segments posterior to it modified in the male, for the purpose of effecting copulation.

Sternite V has its posterior angles produced.

Segments VI and VII show evidence of having been

fused in ancestral forms. A small apparent tergite VI may be present or absent. Tergite VII is narrow and united at the left end to the small asymmetric sternite VI & VII.

Segment VIII has disappeared.

Segment IX is represented by a large convex tergite, and a flat, shovel-shaped sternite with prolonged posterior angles. This is the genital segment.

Segment X consists of a pair of small lateral lobes of the sternite, articulating with tergite IX; the anal forceps; and through long bars, the processi longi, with the narrow tenth sternal plate just posterior to the phallus. The slit-like anus occurs in a membranous portion of segment X, which extends over a V-shaped posterior emargination in tergite IX. The parapodial plates, present in this area in many other species as two plates lateral to the anus, are absent in Gonia. Attached posteriorly to tergite IX are the variously shaped anal forceps. These are lobes of tergite X.

Anterior and posterior pairs of phallic appendages occur at the phallic base. The anterior pair are fused to sternite IX. The posterior pair are moveably articulated and may be true appendages of segment IX. Internally, the double apodeme extends forward from the phallobase. The phallus extends posterior to sternite IX. It consists of a phallobase with a dorsal spine and a bell-shaped aedeagus extending at right angles to the phallobase. The aedeagus has a dorsal sclerotized spine-like para-

phallus, lateral and ventral hypophalli; ventral membranous ventralia; an apical membranous praeputium and a protrusable penis.

The entire modified apical part of the abdomen may be referred to as the genitalia. Its parts are easily homologized with those in other calyptrate Diptera. The segmental relations suggested are based on comparative anatomy and may be altered by a study of pupal development.

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G. Explanation of Plates

Abbreviations used in the Plates.

a.a.T. IX	- anterior angles of Tergite IX
A.C.	- anal cerci
aed.	- aedeagus
Ant. b. ph. app.	- anterior basal phallic appendages
Ap.	- double apodeme
D.	- dorsal spine
hp.	- hypophallus
Lb. S.V.	- lobe of Sternite V
Lb. S.X.	- lobe of Sternite X
M.	- muscle band
pa.	- paramere (true ventral appendage of Segment IX)?
par. pl.	- parapodial plates
pe.	- penis
Phl.	- phallus
Phlb.	- phallobase
Post. a. S. IX	- posterior angles of Sternite IX
Post. b. ph. app.	- posterior basal phallic appendages
pp.	- paraphallus
praep.	- praeputium
proc. l.	- processus longus
S.	- sternite
seg.	- segment
Sp.	- spiracle
s. pl. X.	- sternal plate X
T.	- tergite
vl.	- ventralia

Plate IV

Fig. 23 Lateral view of the apex of the abdomen of *Machimus atricalpus* (Asilidae) (after Reichardt, 1929).

Fig. 24 Lateral view of the apex of the abdomen of *Laphria flava*, (Asilidae) (after Reichardt, 1929) Note: hypopygium has revolved through 180^{o} ; segment 8 is very narrow.

Fig. 25 Lateral view of the apex of the abdomen of a Dolichopodid (after Snodgrass, 1904).

Fig. 25a The same as 25: segment 8 from the right hand side.

Fig. 26 Ventral view of the apex of the abdomen of *Tabanus* (Tabanidae)

Fig. 27 Tip of the abdomen of *Eristalis* (Syrphidae) (after Metcalf, 1921). Numbering of the segments and labelling of the structures by the present writer.

Fig. 27a Diagrammatic representation of the various parts represented in the male genitalia of the Syrphidae, dextro-cephalic view (after Metcalf, 1921) Numbering and labelling by the present writer.

Fig. 28 Apex of the abdomen of *Drosophila melanogaster*, viewed from behind.

Fig. 29 The same as 28, lateral view.

Fig. 30 Ventral view of the apex of the abdomen of *Musca domestica*.

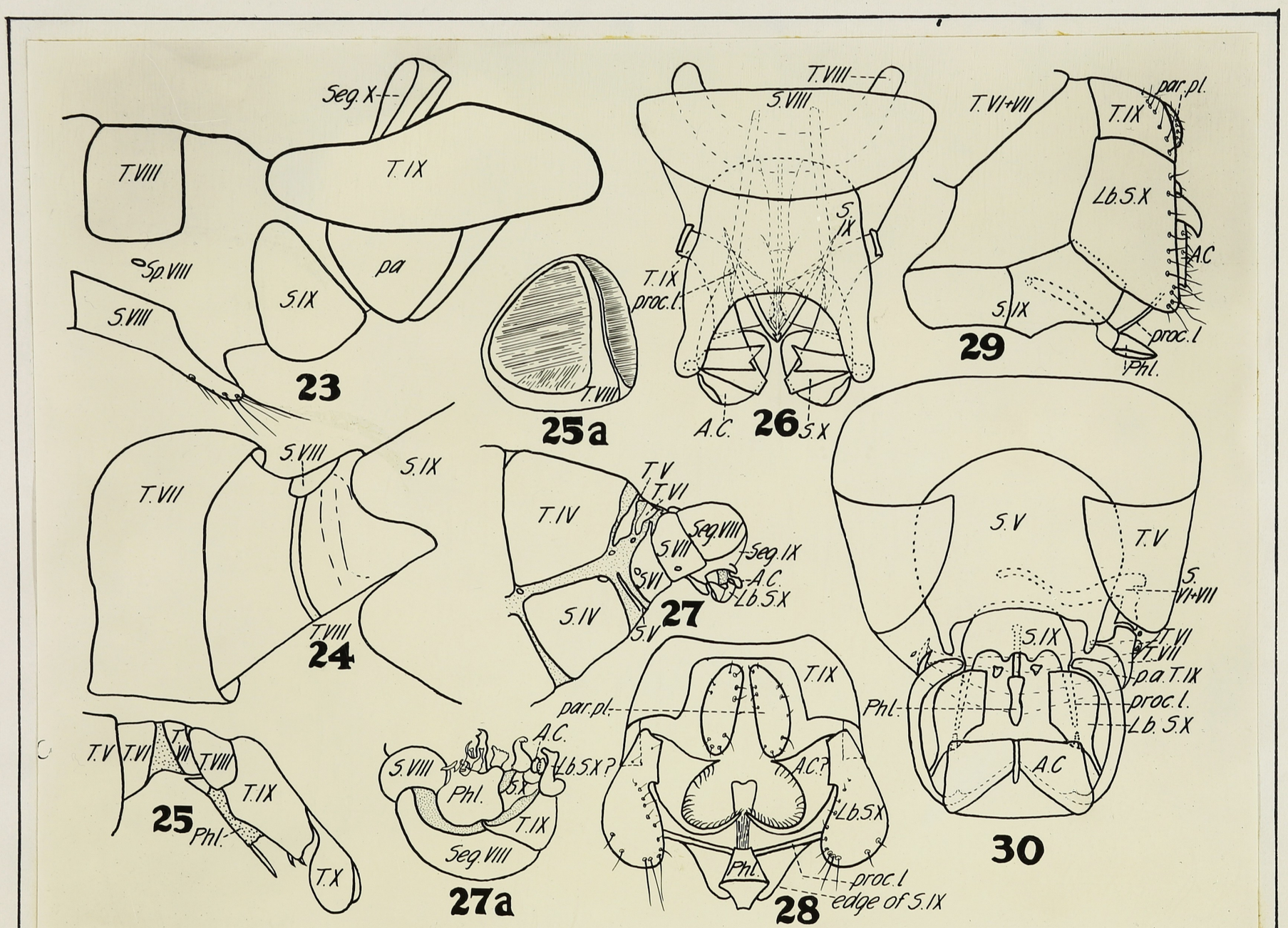

Seg. X
T.VIII
T.IX
pa
Sp.VIII
S.VIII
S.IX
23
T.VIII
25a
T.IX
proc.l.
S.VIII
S.IX
A.C.
26
S.X
T.VI+VIII
par.pl.
T.IX
Lb.S.X
A.C
S.IX
proc.l
Phl.
29
S.V
T.V
S.VI+VIII
T.VII
S.IX
p.a.T.IX
proc.l.
Lb.S.X
A.C
30
T.VII
S.VIII
T.IX
24
T.IV
T.V
T.VI
Seg.VIII
S.VII
Seg.IX
A.C.
Lb.S.X
S.IV
S.V
27
T.V
T.VI
T.VII
T.VIII
T.IX
25
Phl.
T.X
S.VIII
A.C.
Lb.S.X?
Phl.
S.X
T.IX
Seg.VIII
27a
par.pl.
T.IX
Phl.
A.C.?
Lb.S.X
Phl.
proc.l
edge of S.IX
28

PLATE IV

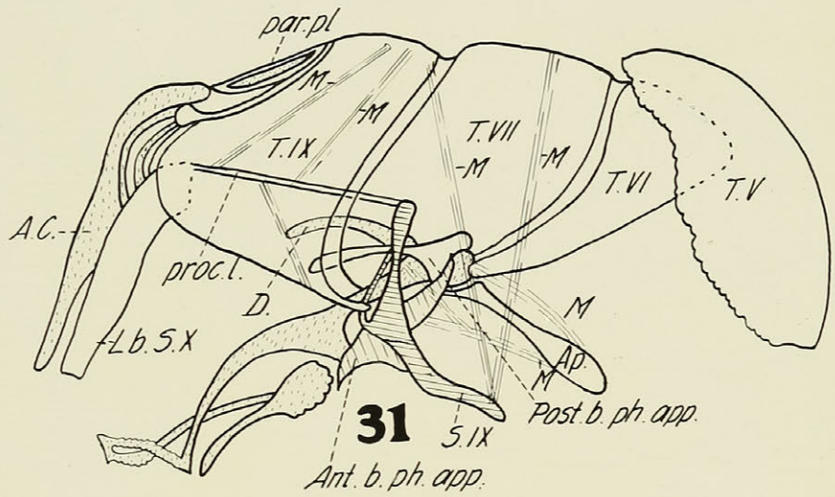
Plate V

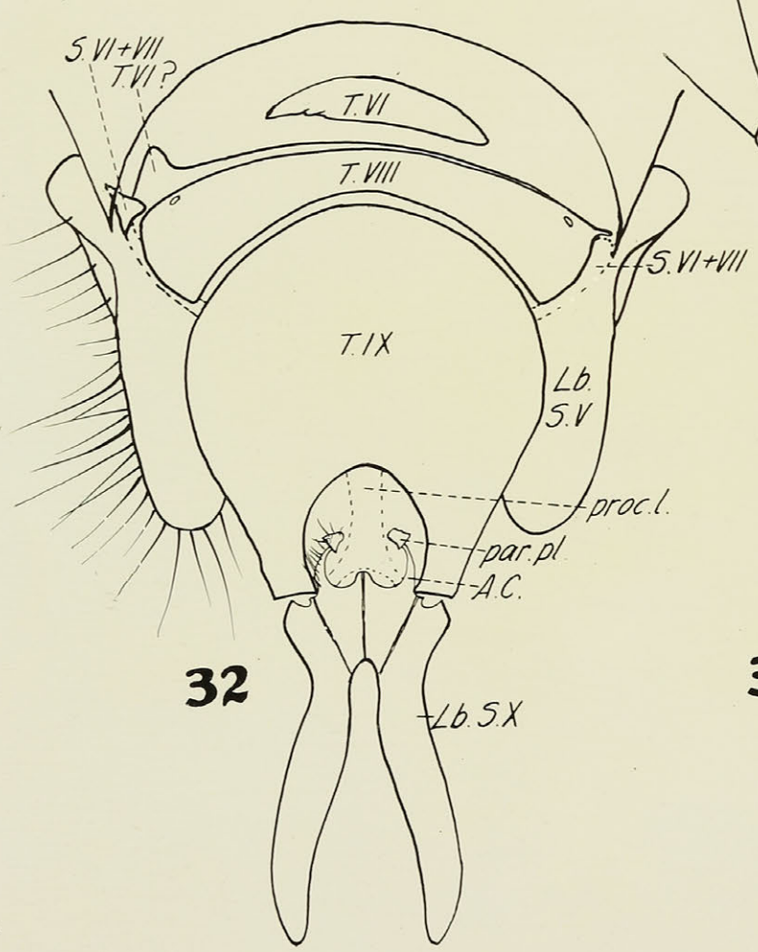
Fig. 31 Lateral diagram of the apex of the abdomen of *Calliphora erythrocephala* (after Schräder 1927). Numbering and labelling by the present writer.

Fig. 32 Dorsal view of the apex of the abdomen of *Cynomya cadaverina* Desv.

Fig. 33 The same as 32, ventral view, showing the fused, plate-like "*processi longi*"
The *phallus* and *phallic structures* have been omitted.

PLATE V


par.pl
M
M
T.IX
T.VII
M
M
T.VI
T.V
A.C.
proc.l.
D.
M
Lb.S.X
AD.
M
Post.b.ph.app.
31
S.IX
Ant.b.ph.app.


S.VI+VII
T.VI?
T.VI
T.VIII
S.VI+VII
T.IX
Lb.
S.V
proc.l.
par.pl
A.C.
32
Lb.S.X

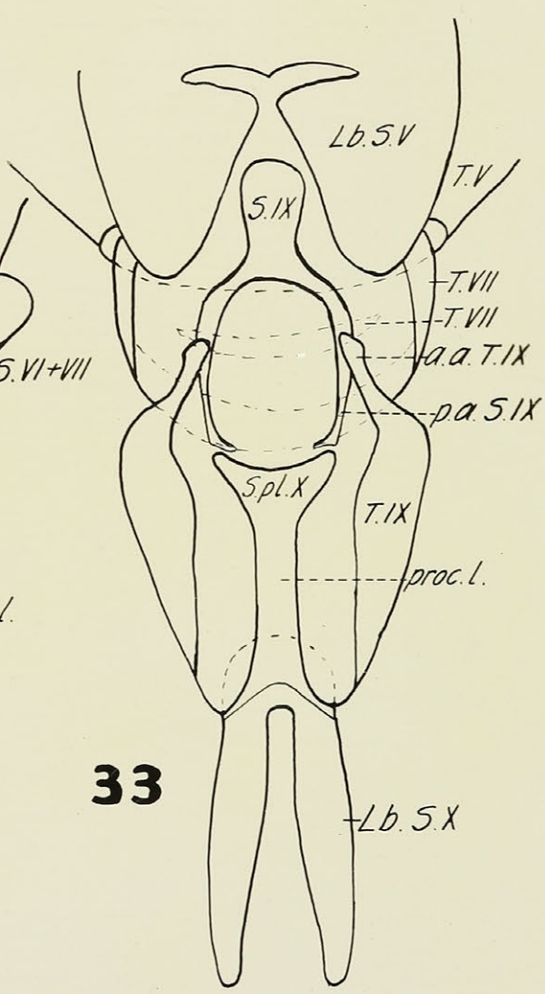

Lb.S.V
T.V
S.IX
T.VII
T.VII
a.a.T.IX
p.a.S.IX
S.pl.X
T.IX
proc.l.
33
Lb.S.X

Plate VI

Fig. 34 — Ventral view of the apex of the abdomen of *Ernestia rudis* (after Petzold, 1927). Numbering and labelling by the present writer.

Fig. 34a — Ventral view of *sternite IX* of *Ernestia rudis* (after Petzold, 1927).

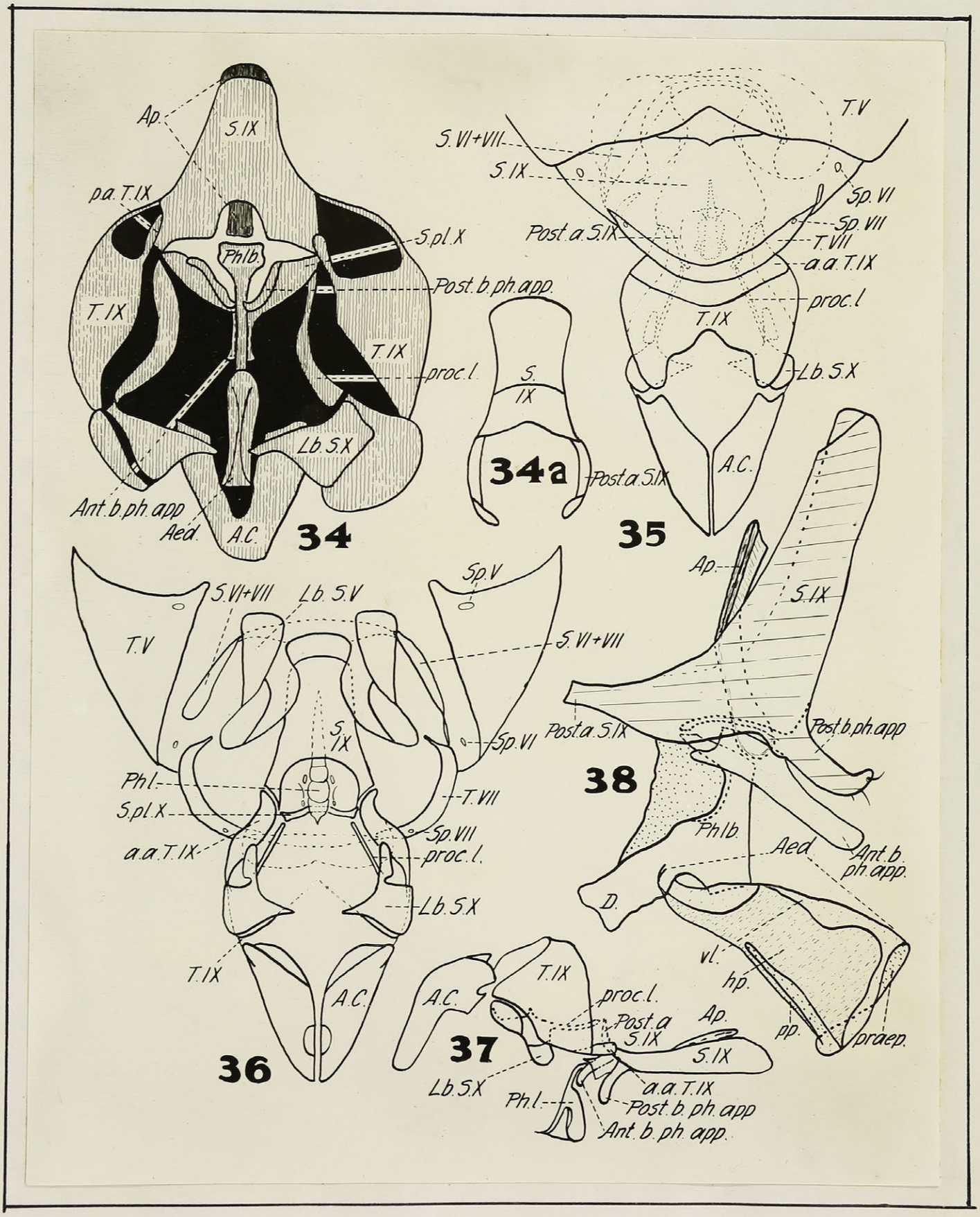
Fig. 35 — Dorsal view of the apex of the abdomen of *Gonia breviforceps* Tothill.

Fig. 36 — The same as 35, ventral view.

Fig. 37 — The same as 35, lateral view.

Fig. 38 — Lateral view of *sternite IX* and the *phallic structures* of *Gonia fissiforceps* Tothill.

PLATE VI


Ap.
S.IX
p.a.T.IX
Phlb.
S.pl.X
Post.b.ph.app.
T.IX
T.IX
proc.l.
Lb.S.X
Ant.b.ph.app
Aed.
A.C.
34
S.
IX
34a
Post.a.S.IX
T.V
S.VI+VII
S.IX
Sp.VI
Sp.VII
Post.a.S.IX
T.VII
a.a.T.IX
proc.l
T.IX
Lb.S.X
A.C.
35
T.V
S.VI+VII
Lb.S.V
Sp.V
S.VI+VII
S.
IX
Sp.VI
Phl.
S.pl.X
T.VII
Sp.VII
a.a.T.IX
proc.l.
Lb.S.X
T.IX
A.C.
36
Ap.
S.IX
Post.a.S.IX
Post.b.ph.app
38
Phlb.
Aed.
Ant.b.
ph.app.
D.
vl.
hp.
pp.
praep.
A.C.
T.IX
proc.l.
Post.a
S.IX
Ap.
S.IX
37
Lb.S.X
Phl.
a.a.T.IX
Post.b.ph.app
Ant.b.ph.app.

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