COMPARATIVE MORPHOLOGY OF THE DROSOPHILID FLIES. I

Phallic organs of the *melanogaster* group

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Introduction

The main parts of the male genitalia or the phallic organs of the drosophilid flies have fragmentarily been investigated by several authors, for example, by Frolova & Astaurov,[7] Rizki,[13] Pomini,[12] Cain et al[3] and Basden[2] for those of *obscura* group, and by Malogolowkin[10] and Cordeiro[4] for those of *willistoni* group. Momma & Takada[11] gave detailed figures of the organs of *Drosophila* (*Hirtodrosophila*) *alboralis*. Regarding the *melanogaster* group, however, very little is known of the organs. Although Ferris[6] wrote figures of those of *Drosophila melanogaster*, he mentioned that they are quite complicated and further studies are needed.

The present paper describes the results of investigation of the each component of the organs obtained in 16 species, including two undescribed and tentatively named species, of the *melanogaster* group. The group, established by Sturtevant[19] includes a total of 20 species, of which 4 were not available for investigation. These are *D. biarmipes* Malloch from India, *D. illata* Walker from Macassar, *D. miki* Duda from Austria and *D. serrata* Malloch from Australia.

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General structures of the phallic organs of the *melanogaster* group

The terminology of the phallic organs of the drosophilid flies is variable according to authors, and is greatly confused, totally independent to the systems applied for the other dipterous families. The author intended to unify it to a system adopted by several investigators for the sarcophagid flies, with slight changes according to other authors. The terminology adopted here with synonymy in parentheses, is as below.

Novasternum (9th sternite, hypandrium,[8,13] genital sternite,[14] "basal Sklerit",[1] "Chitinschild").[7]

Aedeagus (penis,[1,13,14] mesosome,[5] "innere stilettförmigen Plättchen",[7] phallus).[8]

Anterior paramere (forcep,[13] free lobe,[15] side piece,[5] shortest paired penial process,[2] "aüssere stilettförmigen Plättchen",[7] "distale Gonapophyse",[8] anterior uncus, anterior gonapophysis,[14] "vordere Haken").[1]

Posterior paramere (stylus,[13] lateral bar,[15] paramere,[5] longest paired penial process,[2] "mittere stilettförmigen Plättchen",[7] "proximale Gonapophyse",[8] posterior uncus, posterior gonapophysis,[14] "hintere Haken").[1]

Basal apodeme ("Chitinröhrchen",[7] "penisträgendes Sklerit",[1] "apodème du pénis",[14] "apodema superiore").[12]

Ventral fragma, or a proximal dilatation of the novasternum.

General characteristics of these elements of the *melanogaster* group are as follows.

The aedeagus is situated mesad to the organs, apparently bifid or fused to a mass, usually laterally flattened and curved dorsad at the apex. Sometimes it is pectinated, haired or branched.

The anterior parameres are paired, located ventrolaterad to the aedeagus, usually dark brown to black in contrast to the paler coloration of the remaining elements. This paramere is characteristic in having in every case several minute sensilla inserted dorsally, even when the paramere diminishes its shape to a minute organ. The posterior parameres are also paired, situated dorsolaterad to the aedeagus, each contiguous with aedeagus by one arm and with novasternum by another lateral arm, often with basal branches, and in some cases the organ degenerates to a compact mass attached on the dorsal surface of the aedeagus. The ventral fragma is usually well developed, quadrate, hemispherical or triangular. The basal apodeme is a long rod, as long as or longer than the aedeagus itself. The novasternum has sparse pubescence, often with a pair of submedian spines, and sometimes with a median notch on caudal margin.

Ferris[6] states that the basal projections of the aedeagus of *D. melanogaster* are immovably connected to the aedeagus and by no means parameres. But when the aedeagus is protruded by the contraction of the protractor of the ventral apodeme, the "basal projections" will open laterad to assume positions rectangular to the aedeagus, showing clear articulation of the former to the latter. Thus these basal projections are considered to be true parameres. The problem remains is that whether it is reasonable or not to accept the presence of two paires of parameres in higher Diptera.

Descriptions

1. **Drosophila suzukii** (Matsumura, 1931), Plate 2, fig. 1.

Aedeagus apparently bifid, pubescent ventroapically. Anterior paramere broad, abruptly narrowing near apex and with a few subapical sensilla. Posterior paramere dorsobasally dilated and pubescent. Ventral fragma triangular. Novasternum with low lateral processes, paired fine spines and a small median projection instead of a median notch.

Materials examined: Tokyo, Morioka.

2. **Drosophila pulchrella** Tan, Shu, and Sheng, 1949, Plate 2, fig. 2.

Closely resembling *D. suzukii*; distinguished from which, however, in the shape of anterior paramere, which is apically more narrowly pointed and curved than in *D. suzukii*.

Materials examined: Tokyo.

3. **Drosophila unipectinata** Duda, 1924, Plate 2, fig. 3.

Aedeagus apparently bifid, apically pubescent, laterally with dental serrations. Anterior paramere triangular, serrate on outer margin and with several sensilla on apical margin. Posterior paramere simple, without pubescence. Ventral fragma hemispherical, with long lateral processes. Novasternum without median notch, but with small subapical spines.

Materials examined: Hoppo (Nagano Pref.), Kujusan (Oita Pref.).

4. **Drosophila takahashii** Sturtevant, 1927, Plate 2, fig. 6.

Aedeagus pointed, apparently bifid, with very thin transparent membrane between 2 lobes. Anterior paramere abruptly narrowing near apex and with a few subapical sensilla. Posterior paramere with a short basal branch which looks like a pine-cone. Between this branch and the main stem of the posterior paramere, there is a simple conical process. Vental fragma hemispherical. Novasternum without prominent lateral processes and median notch, but with fine paired submedian spines.

Materials examined: Hanchow, Okinawa, Nepal, Sagawa (Kôchi Pref.).

5. **Drosophila lutea** Kikkawa & Peng, 1938, Plate 2, fig. 7.

Resembles *D. takahashii*, but differs from it as follows. Aedeagus somewhat blunt at tip. Basal branch of the posterior paramere as long as the main stem, and serrate with minute conical projections on its apical one fourth. The "conical process" between the branch and the main stem looks like a pine-cone, analogous to the basal branch of *D. takahashii*. Ventral fragma somewhat broader and submedian spines longer than in the latter species.

Materials examined: Tokyo.

6. **Drosophila** sp. from Kakani, Nepal, Plate 2, fig. 8.

Resembles *D. lutea*, espicially in having a long branch and a pine-cone process of the posterior paramere. The branch, however, has a row of dental serration along its lateral margin. Aedeagus and anterior paramere as in *D. lutea*. Ventral fragma triangular, and novasternum with strong submedian spines.

Materials examined: Kakani (Nepal).

7. **Drosophila melanogaster** Meigen, 1830, Plate 2, fig. 4.

Aedeagus apparently bifid, basally dilated ventrad, conspicuously pectinated at ventral edge, and with subapical branches especially long. Anterior paramere minute, apically with a few sensilla. Posterior paramere apically with a large, somewhat quadrate, mediodorsally directed flag-like flap and a short pointed rod, and, moreover, dorsobasally with a long branch, which has several small conical processes at apex. Novasternum with strong lateral processes, shallow median notch and rather short submedian spines. Ventral fragma nearly quadrate.

Materials examined: Tokyo.

8. **Drosophila simulans** Sturtevant, 1919, Plate 2, fig. 5.

Closely resembles the former species, but differs from it as follows. Aedeagus basally less strongly dilated, laterally pectinated more strongly. A flag-like flap of the posterior paramere rounded at tip, never quadrate as in the former species. Novasternum with median notch narrower and deeper than in the former species. Ventral fragma broader than long.

Materials examined: Texas.

9. **Drosophila ficusphila** Kikkawa & Peng, 1938, Plate 2, fig. 9.

Aedeagus fused, slightly pubescent on dorsum, apically broadened and slightly projected dorsad near apex. Anterior paramere minute, apically broadened and contacted with novasternum, and with a few apical sensilla. Posterior paramere with a long broad basal process which is conically dented dorsoapically. Ventral fragma triangular, broader than long. Novasternum with weak lateral processes, minute submedian spines, but without median notch.

Materials examined: Tokyo.

10. **Drosophila nipponica** Kikkawa & Peng, 1938, Plate 3, fig. 11.

Aedeagus bifid, each lobe is divided into 5 finger-like branches. Anterior paramere large, basally broadened and extending beyond articulation with the aedeagus, and medially with a few sensilla. Posterior paramere fused to become a massive body, and apically connected with aedeagus by mean of a pair of fine arms. Novasternum with weak lateral processes, but without submedian spines and prominent median notch.

Materials examined: Tokyo.

11. **Drosophila** sp. from Sapporo, Plate 3, fig. 12.

Aedeagus bifid, each lobe broad at base, serrate at dorsal margin, and with a long basal branch which looks like a wheat-ear. Anterior paramere small, irregularly triangular, and with sensilla at middle to apex. Posterior parameres fused with each other to be a small median fusiform body. Ventral fragma acute-triangular. Novasternum with strong lateral processes, but without submedian spines and median notch.

Materials examined: Sapporo.

12. **Drosophila ananassae** Doleschall, 1858, Plate 3, fig. 13.

Aedeagus fused, apically broadened, and rather densely pubescent on apical half. Anterior paramere with sensilla apical, and with a long basal process, directed caudad. Thus the paramere takes a U-shape. Posterior paramere as long as the aedeagus. Ventral fragma triangular. Novasternum with conspicuous lateral processes and a round median projection, instead of a median notch. Submedian spines short but strong, situated at the base of the median projection.

Materials examined: Texas, Hawaii, Mexico, Brazil, Africa.

13. **Drosophila bipectinata** Duda, 1923, Plate 3, fig. 14.

Aedeagus bifid, black, large, somewhat broadened at middle and apically pointed. Anterior paramere separated from aedeagus, curved in U-shape and with a few sensilla at tip. Ventral fragma triangular, twice as long as broad. Novasternum without lateral processes and median notch. Subapical spines widely separated from each other.

Materials examined: Taipei (Formosa), Patan, Katmandu (Nepal).

14. **Drosophila montium** de Meijere, 1916, Plate 3, fig. 15.

Aedeagus fused, spindle-shaped, apically pointed and strongly curved dorsad, bare. Anterior paramere broad and short, entirely separated from aedeagus and with a few median sensilla. Posterior parameres simple. Ventral fragma quadrate, slightly longer than broad. Novasternum with strong lateral processes, triangular median projection, but without median notch, and with a pair of very long submedian spines inserted near the apex of the median process.

Materials examined: Kyoto, Kumamoto, Honolulu.

15. **Drosophila rufa** Kikkawa & Peng, 1938, Plate 3, fig. 16.

Aedeagus fused, pubescent, apically broadened and ending in rounded tip, and with paired mediolateral claw-like projections. Anterior paramere as in the former species, but the sensilla are slightly more numerous than in the former, and arranged in a row at middle. Posterior parameres short, basally fused with each other and articulate with the aedeagus by a common platelet, and dorsally connected with each other by means of short transverse bar. Ventral fragma quadrate. Novasternum with weak lateral processes, deep median notch, and short submedian spines.

Materials examined: Tokyo, Kanagawa.

16. **Drosophila auraria** Peng, 1927, Plate 3, figs. 17–19.

Aedeagus fused, pubescent, rounded at tip. Anterior paramere broad, apically tapering. Posterior parameres simple, dorsobasally fused with each other by thin membrane. Ventral fragma quadrate. Novasternum with strong lateral processes.

This species is separable into 3 types, whose characteristics of the phallic organs are as shown below.

Type A. Aedeagus without lateral claws, but with a low medioventral projection. Anterior paramere not bifid at tip, and with a few sensilla at middle. Novasternum with minute submedian processes and shallow median notch, but without submedian spines.

Materials examined: Sapporo, Hakodate, Tokyo, Mishima, etc.

Type B. Aedeagus with a pair of lateral claws, but without medioventral projection. Anterior paramere bifid at tip into dorsal and ventral lubules, and with a few sensilla at apex——on the dorsal side of the ventral lobule. Novasternum with a pair of large submedian processes, and a deep median notch, and also with a pair of short submedian spines.

Materials examined: Akkeshi, Hakkoda, Tokyo, etc.

Type C. Having features intermediate between two foregoing types. Equal to type B in the presence of a pair of lateral claws on aedeagus, and prominent submedian processes as well as a deep median notch of the novasternum. Resembles, on the contrary, type A in the absence of paired submedian spines on the novasternum and in the single tip of the anterior paramere.

Materials examined: Oshima, Miyakejima, Tokyo, Kisofukushima, Susaki (Kochi Pref.) etc.

Discussion

To discuss the relationships of species based on one organ can be dangerous, but is allowable in a case such as that of the phallic organs, which are composed of several morphologically distinct elements. It was concluded that *D. suzukii* is the most primitive form of the *melanogaster* group and is closely allied to the *obscura* group (fig. 10). Alike the latter group, *D. suzukii* shows each element of the organs simplest of all the members of the *melanogaster* group. The similar conclusion was reached by Sturtevant and Noviskii[16] from their chromosomal comparison, and also by Hsu[17] from his study of the periphallic organs.

The following is a list of characters shown by *D. bifasciata* Pomini, a species of the *obscura* group (as well as several other members of the same group), which are designated by capital letters, A, B, C, D, E, F, G, H, I and K, together with the characters having opposite condition, designated by small letters, a, b, c, d, e, f, g, h, i and k. Every species of the *melanogaster* group may show a specific combination of these characters. Some characters may be intermediate between two series, and are designated as a', b', c' ··· ··· etc.

1. Aedeagus apparently bifid (A), or fused (a).
2. Aedeagus non-pectinated (B), or pectinated (b).
3. Aedeagus bare (C), or pubescent (c).
4. Anterior parameres large (D), or minute (d).
5. Anterior parameres articulated to the aedeagus (E), or non-articulated (e).
6. Anterior parameres with sensilla mesad to, or scattered evenly on the parameres (F), distad (f), or absent (f_0).
7. Posterior parameres non-contiguous (G), or contiguous (g) with each other.
8. Posterior parameres non-branched (H) or branched (h).
9. Novasternum with a pair of submedian spines on its caudal margin (I), or without such spines (i).
10. Novasternum without (K), or with (k) a median notch on its caudal margin.

A series of these signs alphabetically arranged in a row for each species is named "phallic formula" (p. f.) of the respective species. For example, the p. f. of *D. takahashii* and *D. montium* are ABCDEfGh'IK and aBCDeFGHIK respectively. If the capital letters are deleted from the formula, a simpler formula is obtained, which is named "divergency type" (d. t.), as it indicates

Table 1. The phallic formula (p. f.), divergency type (d. t.) and divergency index (d. i.) of each species of the *melanogaster* group, in reference to the *obscura* group.

Species	p. f.	d. t.	d. i.
obscura group	ABCDEFGHIK	—	0.0
D. suzukii	ABc'DEfGHIK	c'f	1.5
D. pulchrella	ABc'DEfGHIK	c'f	1.5
D. unipectinata	Abc'DEFGHIK	bc'f	2.5
D. takahashii	ABCDEfGh'IK	fh'	1.5
D. lutea	ABCDEfGhIK	fh	2.0
D. sp. from Nepal	ABCDEfGhIK	fh	2.0
D. melanogaster	AbCdEfGhIK	bdfh	4.0
D. simulans	AbCdEfGhIK'	bdfhk'	4.5
D. ficusphila	aBc'dEfGhIK'	ac'dfhk'	5.0
D. nipponica	AbCDEFgHiK	bgi	3.0
D. sp. from Sapporo	AbCDEFgHiK	bgi	3.0
D. ananassae	aBcDEfGHIK	acf	3.0
D. bipectinata	ABCdefg'HIK	defg'	3.5
D. montium	aBCDeFGHIK	ae	2.0
D. rufa	aBcDeFgHIk	acegk	5.0
D. auraria A	aBcDeFgHiK	acegi	5.0
D. auraria B	aBcDefgHIk	acefgk	6.0
D. auraria C	aBcDeFgHik	acegik	6.0

Table 2. Difference value (d. v.) between each two species of the *melanogaster* group, in relation to the *obscura* group.

	auraria C	*auraria* B	*auraria* A	*rufa*	*montium*	*bipectinata*	*ananassae*	sp. from Sapporo & *nipponica*	*ficusphila*	*simulans*	*melanogaster*	sp. from Nepal & *lutea*	*takahashii*	*unipectinata*	*pulchrella* & *suzukii*
obscura group	6.0	6.0	5.0	5.0	2.0	3.5	3.0	3.0	5.0	4.5	4.0	2.0	1.0	2.5	1.5
suzukii & *pulchrella*	7.0	4.5	6.0	5.5	3.5	3.0	1.5	4.5	3.5	4.0	3.5	1.5	1.0	1.0	
unipectinata	7.5	5.5	6.5	6.5	4.5	4.0	2.5	3.5	4.5	3.5	2.5	2.5	2.0		
takahashii	7.5	5.5	6.5	6.5	3.5	3.0	2.5	4.5	3.5	3.0	2.5	0.5			
lutea & sp. from Nepal	8.0	6.0	7.0	7.0	4.0	3.5	3.0	5.0	3.0	2.5	2.0				
melanogaster	10.0	8.0	9.0	9.0	6.0	3.5	5.0	5.0	3.0	0.5					
simulans	9.5	7.5	9.5	8.5	6.5	4.0	5.5	5.5	2.5						
ficusphila	7.0	5.0	7.0	6.0	5.0	4.5	2.5	8.0							
nipponica & sp. from Sapporo	5.0	7.0	4.0	6.0	5.0	5.5	6.0								
ananassae	5.0	3.0	4.0	4.0	3.0	4.5									
bipectinata	6.5	4.5	5.5	5.5	3.5										
montium	4.0	4.0	3.0	3.0											
rufa	1.0	1.0	2.0												
auraria A	1.0	3.0													
auraria B	2.0														

the qualitative degree of divergency of a species from the *obscura* group. The quantitative degree of divergency of a species from the *obscura* group is expressible by the number of diverged characters: the number of small letters plus, if present, incompletely diverged character valued at 0.5. This number is named "divergency index" (d. i.). For example, the d. t. and d. i. of the two species referred above are h', 1.5 and ae, 2.0 respectively. Likewise, the quantitative degree of difference of a species from another species is expressible by the number of characters differing between the respective two species. This number is named "difference value" (d. v.). For example the d. v. between the two species mentioned above is 3.5, where the difference between H and h' is valued at 0.5. The p. f., d. t. and d. i. of each species are shown in Table 1 and the d. v. between each two species in Table 2.

So far as the author examined, there exists no remarkable difference in the structure of the phallic organs between the species of the *obscura* group, all being d. i. =0.0. They show a close similarity to the *suzukii* subgroup, d. v. being 1.5, but differs from the latter in having very slender anterior paramere, on which the sensilla are scattered in a row from proximal to distal end of the lobe (fig. 10).

Basing upon the periphallic organs, Hsu[17] divided the *melanogaster* group into 5 subgroups: viz., *suzukii* (including *D. suzukii* and *D. pulchrella*), *ananassae* (*D. ananassae*, *D. bipectinata*), *melanogaster* (*D. melanogaster*, *D. simulans*), *takahashii* (*D. takahashii*, *D. lutea*) and *montium* (*D. montium*, *D. rufa*, *D. auraria*, *D. ficusphila*) subgroups. He did not examine *D. lutea*, *D. ficusphila*, *D. bipectinata* and *D. nipponica*, and probably determined the position of *D. lutea* and *D. bipectinata* after the figures drawn by Kikkawa & Peng,[9] and he placed *D. nipponica* in the *montium* subgroup with a question mark. Wheeler[18] adopted Hsu's classification and recognized this position of *D. nipponica* without the question mark. The periphallic organs of *D. ficusphila* seem not to have been described, and its position in the *montium* subgroup must have been determined by other characters such as well-developed male sex-combs.

Hsu[17] discussed the phylogeny of the *melanogaster* group with respect to the periphallic organs and suggested the following relationships.

obscura group—*suzukii* subgr.$\langle$ *melanogaster* subgr.—*takahashii* subgr.
ananassae subgr.—*montium* subgr.

His view is accepted by the author on the whole, except for the part relating to the "*melanogaster–takahashii* subgroup," which should better be inverse as "*takahashii–melanogaster* subgroup," because the *takahashii* subgroup shows d. i. = 1.5–2.0 and d. t. = fh'–fh, while the *melanogaster* subgroup 4.0–4.5 and bdfh-bdfhk' respectively. *D. unipectinata* has features of phallic as well as periphallic organs resembling that of *suzukii* subgroup, and must belongs to that subgroup.

D. ficusphila resembles the *melanogaster* subgroup, especially in having minute anterior parameres (d. v.=2.5–3.0), better than it does the *montium* subgroup (d. v.=5.0–7.0), and is also closely allied to the *takahashii* subgroup (d. v.=3.0–3.5), especially in having branches of the posterior parameres, and apical geniculation of the genital arch (novatergum). It is thought better to separate this species from the *montium* subgroup to establish a new subgroup. *D. nipponica* and *D.* sp. from Sapporo are the closely related species, taking equal p. f. and having similar periphallic organs, which will be described otherwise. The *nipponica* subgroup is proposed here newly involving the two allied species.

The author intended to divide the *melanogaster* group into three series, viz., *suzukii*, *melanogaster* and *montium* series. The *suzukii* subgroup belongs the *suzukii* series; the *takahashii*, *melanogaster* and *ficusphila* subgroups to the *melanogaster* series; the *nipponica*, *ananassae* and *montium* subgroups to the *montium* series. The interrelation between the three series and between the seven subgroups may be expressible as below;

melanogaster group
- H
  - ABD (if b, it shows G)···*suzukii* series·····*suzukii* subgroup
  - ABd or aBD (if b, it shows g) ·····*montium* series
- h···*melanogaster* series
  - b····· *nipponica* subgroup
  - B
    - E (if e, it shows d)····· *ananassae* subgroup
    - eD·····*montium* subgroup
  - d
    - D ····· *takahashii* subgroup
    - Ab····· *melanogaster* subgroup
    - aB ····· *ficusphila* subgroup

Key to species of the *melanogaster* group, basing upon the phallic organs

suzukii series

suzukii subgroup

1. Aedeagus with prominent serration ..... *D. unipectinata*
— Aedeagus without prominent serration 2
2. Anterior paramere with triangular apex ..... *D. suzukii*
— Anterior paramere with slender, curved apex ..... *D. pulchrella*

melanogaster series

takahashii subgroup

1. Posterior paramere with basal branch very short ..... *D. takahashii*
— Posterior paramere with basal branch very long 2
2. The branch of posterior paramere with conical processes ..... *D. lutea*
— The branch of posterior paramere with dental serration ..... *D.* sp. (Natal)

melanogaster subgroup

1. Novasternum without median notch. Aedeagus with short serrations. Posterior paramere with flag-like apical flap quadrate. Anterior paramere T-shaped ..... *D. melanogaster*
2. Novasternum with shallow median notch. Aedeagus with long serrations. Posterior paramere with flag-like apical flap oval. Anterior paramere rod-shaped ..... *D. simulans*

ficusphila subgroup ..... monotypic, *D. ficusphila*

montium series

nipponica subgroup

1. Aedeagus with finger-like branches. Anterior paramere as long as aedeagus ..... *D. nipponica*
— Aedeagus with spike-like branches. Anterior paramere much shorter than aedeagus ..... *D.* sp. (Sapporo)

ananassae subgroup

1. Aedeagus apparently fused and pubescent. Anterior paramere with long, recurved basal process. Novasternum with median projection on the caudal margin ..... *D. ananassae*
— Aedeagus apparently bifid and bare. Anterior paramere without long, basal process. Novasternum without median projection ..... *D. bipectinata*

montium subgroup

1. Aedeagus bare. Novasternum with prominent median projection, on which are inserted a pair of very long submedian spines ..... *D. montium*
— Aedeagus pubescent. Novasternum without median projection, and the submedian spines are short or absent 2
2. Aedeagus with a pair of lateral claws. Median notch of the novasternum deep and acute. Posterior parameres distinctly contiguous with each other on the dorsal side of aedeagus ..... *D. rufa*
— Aedeagus with or without lateral claws. Median notch of the novasternum rounded. Posterior parameres obscurely contiguous with each other ..... *D. auraria* 3
3. Novasternum with submedian spines. Anterior parameres apically bilobed

and with sensilla apically. Aedeagus with lateral claws···*D. auraria* type B
— Novasternum without submedian spines. Anterior parameres with sensilla medially ····· 4
4. Aedeagus without lateral claws. Median notch of the novasternum shallow ·····*D. auraria* type A
— Aedeagus with lateral claws. Median notch of the novasternum deep ·····*D. auraria* type C

Conclusion

The general features of the phallic organs of the *melanogaster* group show a gradual complication from species to species, except a few elements, e. g., the submedian spines of the novasternum and the anterior parameres, which show a gradual simplification. The organs have proved to be excellent as criteria to classify the group into subgroups, species and even races, and also to distinguish the group from the related *obscura* group.

In certain cases, two closely allied species, e. g. *D. takahashii* and *D. lutea*, or *D. melanogaster* and *D. simulans*, are more or less easily distinguished from each other by the organs.

Résumé

1) The phallic organs of 16 species of the *melanogaster* group of drosophilid flies are studied from the view point of comparative morphology.

2) An attempt is made to express by alphabetical signs and numerical figures the divergency of the phallic organs of any species from the *obscura* group, which is thought to be the most primitive species of the subgenus *Sophophora*.

3) Seven subgroups are distinguished in the *melanogaster* group, two being newly combined, viz., *ficusphila* and *nipponica* subgroups, with regard to the phallic as well as the periphallic organs.

4) The extent which a species differs from every other species is tentatively expressed by numerical figures.

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Explanation of Plates

Plate 2.

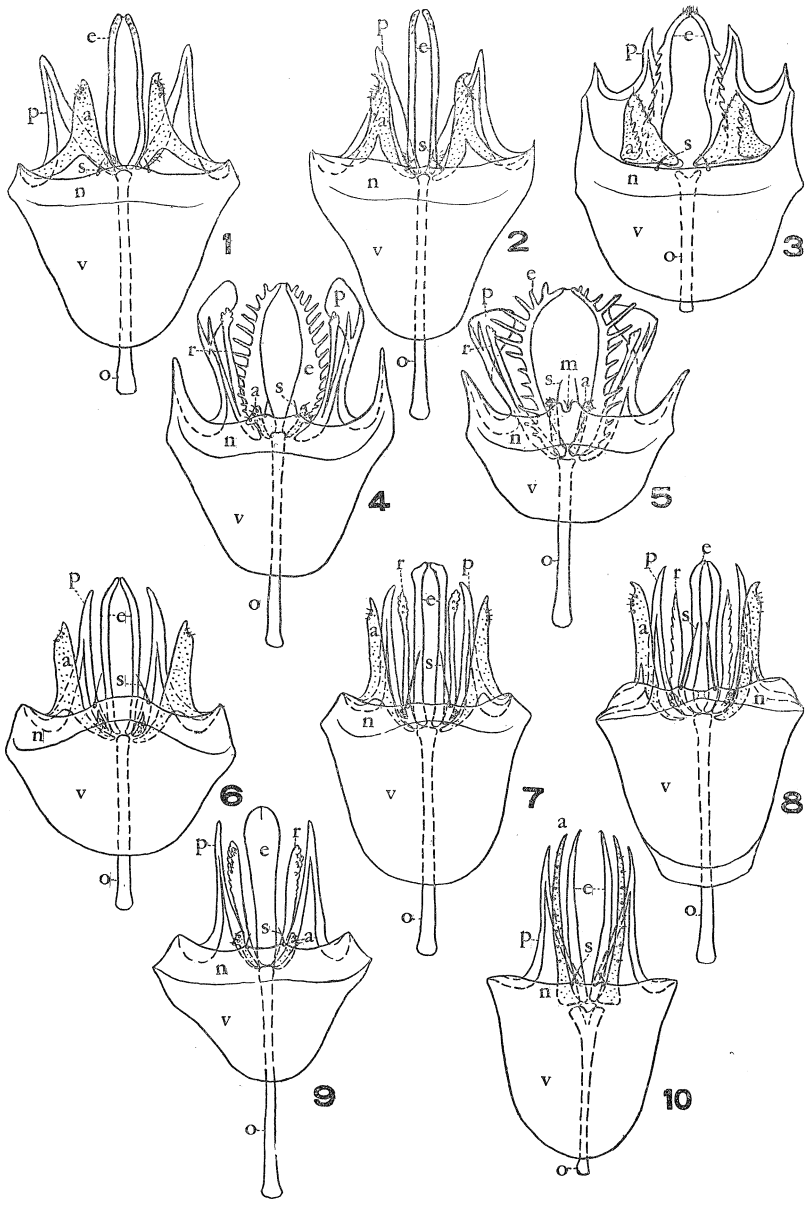
Phallic organs of the drosophilid flies belonging to the *suzukii* (Figs. 1-3) and *melanogaster* series (Figs. 4-9) of the *melanogaster* group and the *obscura* group (Fig. 10); ventral aspects, with caudal ends directed upward.

Fig. 1. *Drosophila suzukii* (Matsumura). Fig. 2. *D. pulchrella* Tan, Hsu & Sheng. Fig. 3. *D. unipectinata* Duda. Fig. 4. *D. melanogaster* Meigen. Fig. 5. *D. simulans* Sturtevant. Fig. 6. *D. takahashii* Sturtevant. Fig. 7. *D. lutea* Kikkawa & Peng. Fig. 8. *D.* sp. from Nepal. Fig. 9. *D. ficusphila* Kikkawa & Peng. Fig. 10. *D. bifasciata* Pomini. a : anterior paramere, showing sensilla which actually are inserted on the dorsal surface. e : aedeagus. m : median notch of the novasternum. n : novasternum. o : basal apodeme of the aedeagus. p : posterior paramere. r : basal branch of the posterior paramere. s : submedian spines of the novasternum. v : ventral fragma.

Plate 3.

Phallic organs of the drosophilid flies belonging to the *montium* series of the *melanogaster* group.

Fig. 11. *D. nipponica* Kikkawa & Peng. Fig. 12. *D.* sp. from Sapporo Fig. 13. *D. ananassae* Doleschall. Fig. 14. *D. bipectinata* Duda. Fig. 15. *D. montium* de Meijere. Fig. 16. *D. rufa* Kikkawa & Peng. Fig. 17. *D. auraria*, type A. Fig. 18. *D. auraria*, type B. Fig. 19. *D. auraria*, type C.



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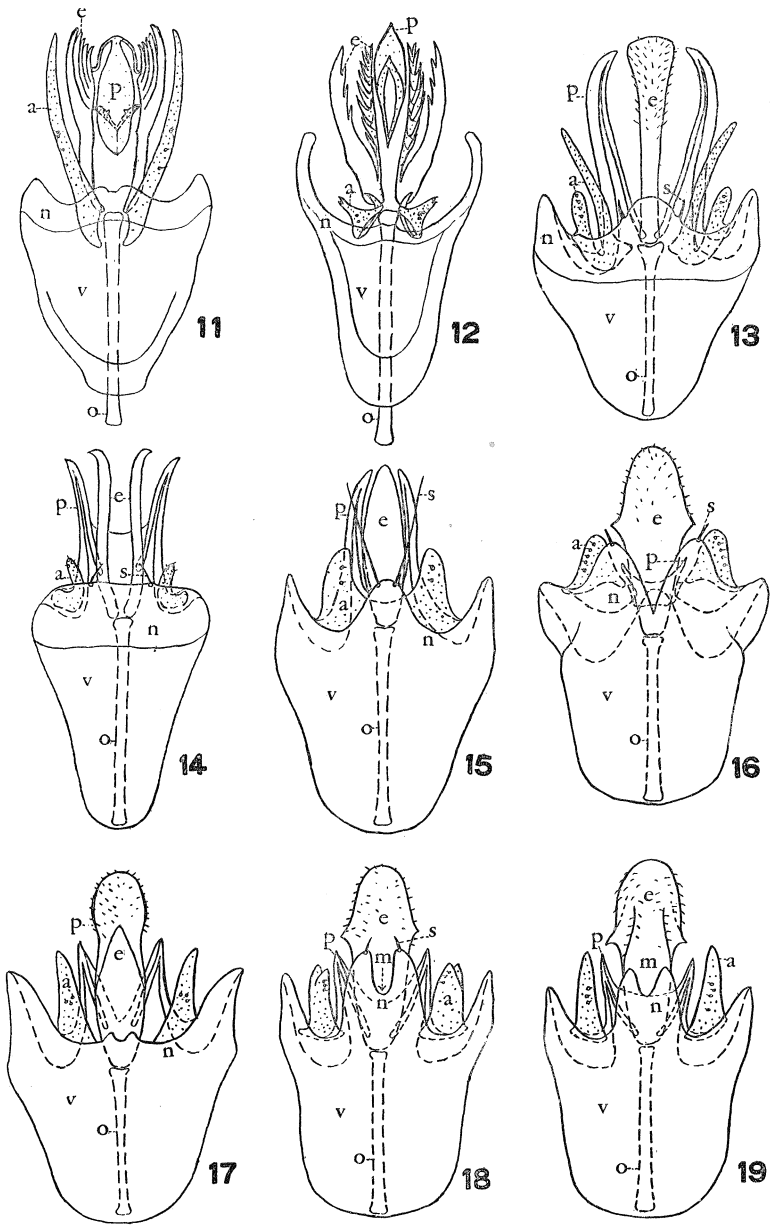

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