DROSOPHILID SURVEY OF INDIA

II. Taxonomy and Cytology of the Subgenus *Sophophora* (*Drosophila*)

Ram Parshad *and* Inder Jit Paika (1964)

(*Department of Zoology, Panjab University, Chandigarh, India*)

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Abstract

The present investigations are based on the taxonomy and cytology of the ten species belonging to the subgenus *Sophophora*, genus *Drosophila*, of which three are novo and a single novo subspecies. Of the remaining, two, which are already represented by more than one chromosomal race, have been recognized at the racial level. The distribution of the various species from October, 1961, to September, 1962, and the relationship of the novo species have also been discussed in detail.

Introduction

In spite of extensive data available on the cytology and taxonomy of the genus *Drosophila*, all over the world, our knowledge about the Indian species is quite meagre. Bezzi (Sturtevant, 1921) was the first to report *Drosophila repleta* from Calcutta. Brunetti (1923) described a new species, *D. prashadi*, from Calcutta, while in the same year Duda (1923) reported *D. bipectinata* from Darjeeling. Sturtevant (1927) studied four species, *D. melanogaster*, *D. ananassae*, *D. montium* and *D. tristipennis*, from the collections of Miss Eleanor D. Mason from Madras. Ray-Chaudhuri and Mukherjee (1941) reported two more new species, *D. emulata* and *D. brunettii*, from Calcutta. Recently Okada (1955) reported six species, *D. bipectinata*, *D. immigrans*, *D. nepalensis*, *D. takahashii*, *D. melanogaster* and *D. kikkawai*, from Nepal

The present communication on the Drosophilid Survey of India is the second of the series undertaken with a view to collecting more information on the various species of the subgenus *Sophophora* of the genus *Drosophila* collected mainly from Chandigarh and adjoining localities. During the collection of the various species from October, 1961, to September, 1962, nearly 5,000 Drosophilid flies were collected of which 3,850 belonged to the subgenus *Sophophora* covering as many as eleven species. Out of these, three are novo, while another one, *D. suzukii indicus*, is a new subspecies of *D. suzukii*. Of the remaining six species, two, *D. takahashii* and *D. kikkawai*, which are represented by more than one chromosomal race, have been recognized at the racial level.

In addition to the taxonomical and cytological account of ten species of *Sophophora* (*D. melanogaster* being already described; Parshad and others, 1964), an account of the distribution of the various species during the different months of the year along with the relationship of the novo species has also been discussed in detail.

Material and Methods

I. The various species of *Drosophila* (*Sophophora*), which constitute the material for the present investigations, were collected from Kulu Valley, Malerkotla, Pinjore,

Chandigarh and adjacent localities. Different methods were designed so as to procure a maximum number of flies of a particular species as well as the different species with a minimum expenditure of time and material. The following two methods were commonly employed:

1. Trap-bait method
2. Direct capture method :
   (*a*) By net sweeping
   (*b*) Collection as such

1. *Trap-bait method*

The fundamental principle underlying this method involves the exposure of either fermenting or decaying organic matter in an empty container, so as to lure and trap the flies. The most common type of container used was an empty tin of either canned fruit or one kilo-capacity ghee. The base of the tin was punctured so as to drain off any excessive liquid which appears in the bait.

The various fruits as recommended by Sturtevant (1921) and Basden (1954) were tried, but the fermenting banana was found to be the best 'all-purpose bait'. The overripe bananas were crushed along with their peelings into a meshed pulp, which constituted the bait. Before placing the bait in the trap, a circular piece of blotting paper was put at the base of the trap so as to facilitate recharging of the bait handy.

Such bait-traps were placed at different places; mostly in gardens, nurseries, fruit shops, and shady and cool places near the slow-moving streamlets.

The mouth of the trap was covered over by a lid of almost the same diameter as that of its mouth, which was supported by a pair of slender wooden sticks leaving a circular opening around the rim through which only flies or other insects of nearly that size could enter. A heavy weight was placed over the lid so that it may not be disturbed by wind or small animals.

The flies from such a trap were collected almost daily and at different hours of the day. To achieve this, a large glass funnel with a specimen tube inverted at the terminal part of its stem was inverted over the bait-trap and the lid quickly removed. The flies would come up, partly due to their positive phototropic nature and partly due to disturbance caused by vigorous shaking of the trap, into the specimen tube which was then quickly plugged.

Trap-bait method proved to be most efficient for collecting flies of a large variety particularly where the density of the population was meagre.

2. *Direct capture method*

(*a*) *By net sweeping.*—The sweeping with the help of common hand muslin net over the dry leaves and fermenting fruits underneath the trees, garbage, dustbins with refuse and fermenting fruits and various kinds of vegetation yielded many interesting specimens.

(*b*) *Collection as such.*—In a few cases, the larvae and pupae from fermenting fruits were collected from nature as such and these were allowed to develop in the sterilized milk bottle in the control room till the adult flies emerged.

The methods of collections, place along with the source or bait food for the various species are given in Table I.

TABLE I

Methods of collection, source and locality of the various species of subgenus Sophophora

Name of the species	Methods of collection	Source	Locality
1. *D. bifasciata*	Bait	Banana	Panjab Univ. Nursery, Chandigarh
2. *D. suzukii indicus*	(i) Bait	Banana	Near the slow-moving streamlet, Rana Gardens, Manimajra (Suburb, Chandigarh)
	(ii) Sweep	(*a*) Fermenting 'loquat' fruits	Manali, Kulu
		(*b*) Discarded apples	Panjab Univ. Nursery, Chandigarh
3. *D. takahashii*	Bait	Banana	Botanical Garden, Government College, Chandigarh
4. *D. nepalensis*	(i) Bait	Banana	Panjab Univ. Nursery, Chandigarh
	(ii) From nature as such	Larvae and pupae on fermenting banana peelings	Manali, Kulu
	(iii) Sweep	Underneath chestnut trees	Panjab Univ. Nursery, Chandigarh
5. *D. melanogaster*	(i) Bait	Banana	Malerkotla
	(ii) Sweep	(*a*) Fruit shops	Government Nursery, Sector-23, Chandigarh
		(*b*) Dustbins containing decaying vegetables	Kulu
		(*c*) Discarded apples	Kulu
6. *D. ananassae*	Sweep	Overdiscarded apples	Botanical Garden, Government College, Chandigarh
7. *D. malerkotliana*	(i) Bait	Banana	Ehsan Gardens, Malerkotla
	(ii) Sweep	Overfermenting guava fruit	Chandigarh
8. *D. kikkawai*	(i) Bait	Banana	Panjab Univ. Hostels, Chandigarh
	(ii) Sweep	Dustbins containing decaying potatoes and other vegetable matter	Chandigarh
9. *D. rufa*	Bait	Banana	Malerkotla
10. *D. jambulina*	(i) Bait	(*a*) Banana	Panjab Univ. Nursery, Chandigarh
		(*b*) Jambulin (Jaman)	Outskirts of Chandigarh
	(ii) Sweep	(*a*) Fermenting Jambulin fruits	Ehsan Gardens, Malerkotla
		(*b*) Discarded guava fruits	Malerkotla
11. *D. punjabiensis*	(i) Bait	Banana	Mughal Gardens, Pinjore
	(ii) Sweep	Dustbins containing fruits and peelings, etc.	

II. *Rearing of the stocks.*—The males from the collections were studied as such while the females, on the assumption that they were already inseminated in nature, were bred singly in 3″×1″ glass vials on the standard agar-maize-raisin-yeast food. The stocks were daily checked for any natural infection of mites or bacteria. The identifications were based on the F_2 progenies and the further stocks, if desired, were mass cultured in half-pint milk bottles.

III. *Morphological studies.*—For the study of the external characters of the imagine, the flies were etherized or sometimes overetherized, if necessary, and studied under Carl Zeiss 'Jena' stereo-microscope at various magnifications, but mostly at ×100.

For the detailed study of genitalia, the overetherized flies were boiled in 10% KOH for about 20 minutes and washed in tap water. The dissections of the hypopygium, phallic organ and decasternum in the case of male and egg guides in the female were made in a drop of pure glycerine. The various structures were then dehydrated in 90% ethanol, absolute alcohol and finally mounted in euparal.

The wing, for the study of wing indices, was dehydrated by passing through different grades of alcohol and mounted in euparal.

The permanent preparations of the prothoracic leg of male and puparium were made by keeping the material in 10% acetic acid for about a day or so, washing in tap water and then placing in 1% KOH overnight. This was subsequently washed in tap water, dehydrated, cleared and mounted in Canada balsam.

For the study of internal anatomy of the imagine, the flies were etherized and fixed in a wax dish and dissected in the physiological solution at a magnification of ×100. To make the structures more clear, the soft parts were often stained with 1% aqueous solution of methylene blue.

IV. *Cytological Techniques.*—For the salivary gland chromosomes the larvae, just before pupation, mostly in the F_2 generations, were used. They were dissected in a few drops of physiological solution or Ringer's solution on a cavity slide. For the neuroblast chromosomes, on the other hand, comparatively younger larvae were preferred as they were found to carry more division stages.

The salivary glands, after the removal of their fat bodies, were treated with freshly prepared 1*N* HCl for 2-3 minutes and were fixed and stained in 45% aceto-orcein, as recommended by Darlington and La Cour (1960), for about 10 minutes on a clean albumenized slide.

The larval brain was directly fixed and stained in a few drops of 45% aceto-carmine (Darlington and La Cour, 1960) for about 15–20 minutes on a clean albumenized slide. The stained material was then squashed under the cover-slip by exerting the pressure of the thumb.

In case of the salivary gland chromosomes, the slides, after flattening the cells, were checked for an optimum spreading under the low magnifications of the microscope. These slides were then made permanent following Darlington and La Cour (1960).

V. *Diagrams.*—All the diagrams pertaining to the taxonomical studies were drawn with the help of a 'Beck' camera lucida at the table level and at varying magnifications.

The metaphase configurations in the neuroblast cells were drawn with the help of 'Beck' camera lucida on Carl Zeiss 'Jena' microscope.

The holotypes and a large number of paratypes of the novo-species are with the senior author.

Description

I. *Drosophila* (*Sophophora*) *bifasciata* Pomini, 1940.

Drosophila (Sophophora) bifasciata. Hsu, 1949. *Univ. Texas Publ.*, **4920**, 98; Wheeler, 1949. *Univ. Texas Publ.*, **4920**, 175; Patterson and Stone, 1952. *Evol. gen. Dros.*, 18; Buzzati-Traverso, 1953. *Advances in Genet.*, **7**, 57; Okada, 1956. Syst. St. Drosophilidae Allied Fam. Japan, 101.

♂ and ♀: *General features.*—Carina narrow above and wider below, high. Face black, palpus pale brown, the latter with a single prominent seta. Sterno-index 0·6. Metatarsal sex comb extends to more than half the length of metatarsus (Fig. 1). C-1 bristles 2; C-3 bristles over basal one-third the 3rd costal section. Other features as described by Okada (1956).

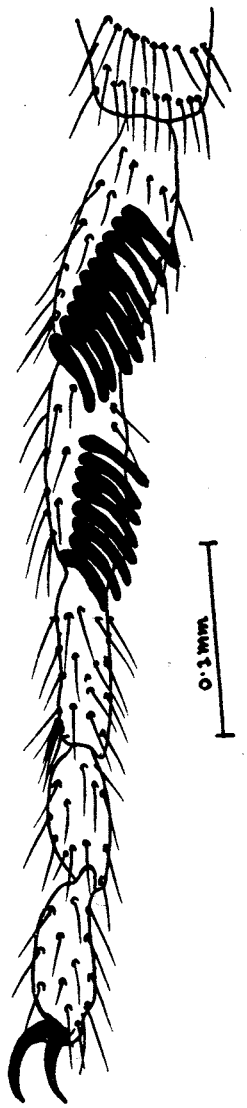

Fig. 1. *D. bifasciata*, sex comb.

Periphallic organs.—Primary clasper with 6–9 primary teeth. Secondary clasper slightly extended below the lower tip of primary clasper, otherwise as figured and described by Hsu (1949) and Okada (1956).

Phallic organs.—As described by Okada (1956).

Internal structures.—As figured and described by Okada (1956).

Egg guides.—Marginal teeth 19; sub-terminal hair in between 4th and 5th teeth, otherwise as figured and described by Okada (1956).

Specimens examined: Chandigarh and Manimajra.

II. *Drosophila (Sophophora) suzukii indicus* subspecies novo

A. *Description of imago*

Male imago

1. *External characters.*—Arista with four branches above and three below, in addition to the terminal fork; antenna yellow, third segment pale grey. Front over one-third the width of head, brown. First orbital bristle equal to third but second half the size of either. Second oral bristle three-fourths the first. Carina high, narrow above and wider below, light yellowish-brown. Palpus with one large terminal seta in addition to a number of small ones. Cheeks pale yellow, their greatest width about one-fifth the greatest diameter of eye. Eyes red with a thick pile. Ocelli reddish-brown.

Acrostichal hairs in 8 rows; pre-scutellars absent, anterior scutellars convergent. Mesonotum and scutellum light brown, shining. Humerals 2, equal. Pleura yellowish-brown. Sterno-index about 0·7. Legs pale yellow, proximal parts paler. Apicals on first and second tibiae, pre-apicals on all the three. Sex comb (Fig. 2) in two sets, the metatarsal comb of a transverse row of 4-5 short stout teeth and tarsal comb of 2-3 similar teeth. Halteres pale light brown. Abdomen light yellowish-brown, abdominal tergites with narrow, black uninterrupted, caudal bands; last two tergites black.

Wing (Fig. 3) with an apical black patch occupying the marginal, sub-marginal and a part of first posterior cells. C-1 bristles 2, C-3 bristles over basal one-third the 3rd costal section. Costal index about 3·45; 4V-index 2·0; 4C-index 0·84 and 5X-index 1·6.

Length of the body: 2·10 mm.
Length of the wing: 2·40 mm.

2. *Periphallic organs* (Fig. 4).—Genital arch long, slightly constricted in the middle with an irregular row of about 13 bristles and another row of about 6 very long bristles on the posterior margin. Heel absent; toe quite low, tubular, directed downwards, with about 7–9 bristles. Anal plate separate from arch, with about 40 bristles, more or less oval with its tip produced into a sharp angle bearing about 10 bristles, which are comparatively shorter, thicker and densely crowded. Clasper single, rectangular, broad; primary teeth in 2 sets, upper set comprising of 10-11 teeth arranged in a single convex row, lower set of 4-5 teeth, crowded on the cylindrical projection at the caudal margin; marginal bristles in 2 sets, upper set formed by 6 bristles and lower one by 4, the latter situated on the narrow prolongation of the clasper. Discal teeth 2-3, present at the base of projection.

Decasternum (Fig. 5).—Trilobed, median piece heart-shaped and as long as broad.

3. *Phallic organs* (Fig. 6).—Dark brown. Aedeagus bifid without serration, distally curved, pointed and pubescent at the tip. Anterior paramere dark brown, *L*-shaped, ending abruptly with a triangular apex, sensillae restricted at the distal end. Posterior

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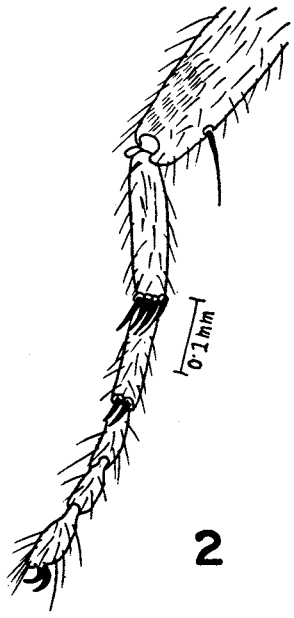
Figs. 2 to 11. *Drosophila suzukii indicus.* 2, sex comb; 3, wing; 4, genital arch; 5, decasternum; 6, phallic organs; 7, proximal intestine; 8, male reproductive organs; 9, egg guide; 10, female reproductive organs; 11, puparium.



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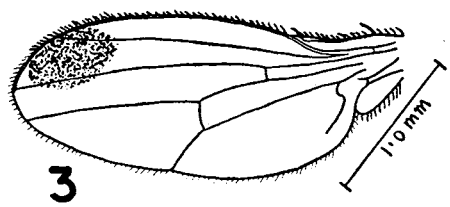

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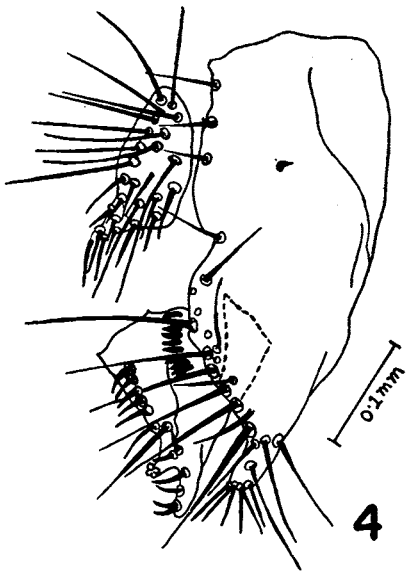

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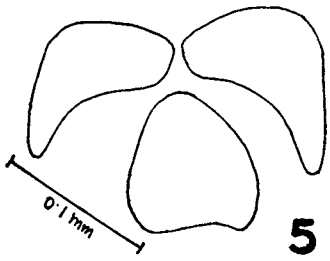

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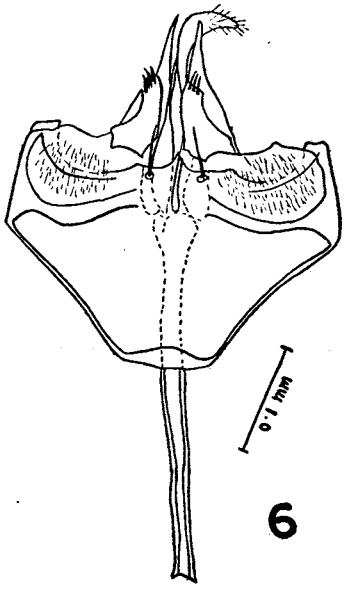

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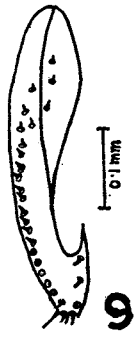

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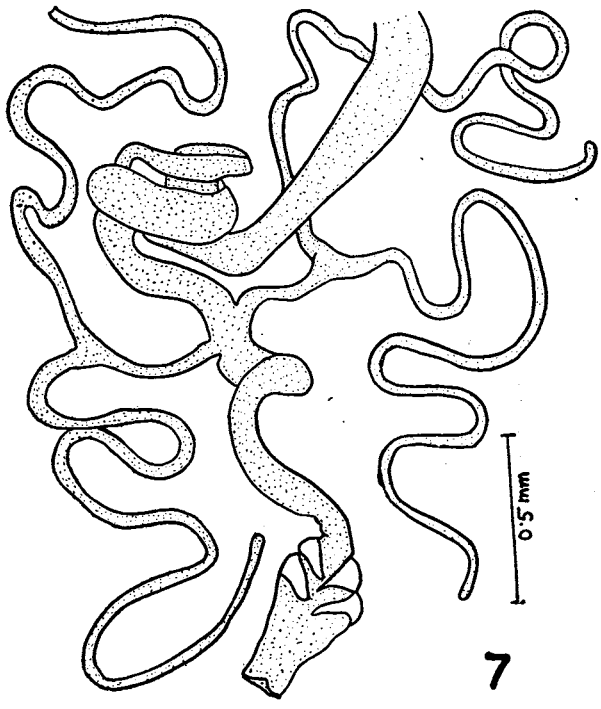

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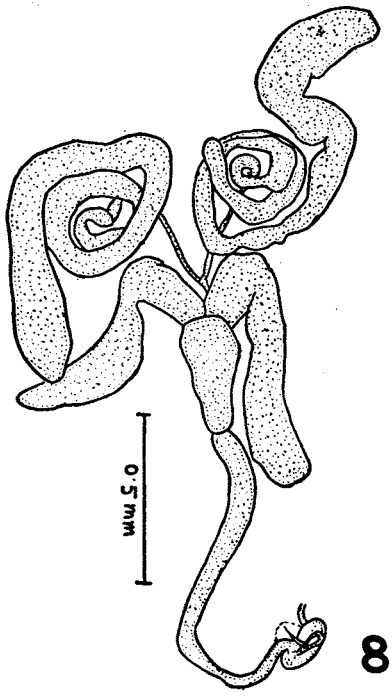

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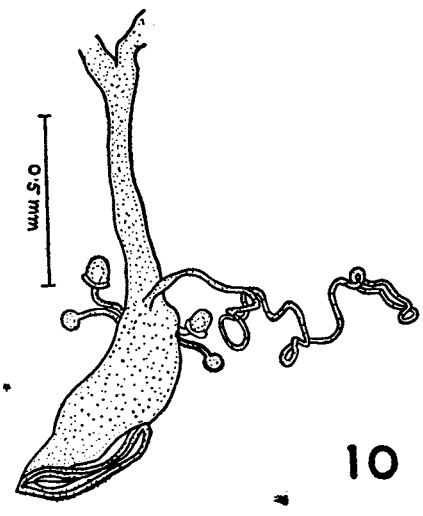

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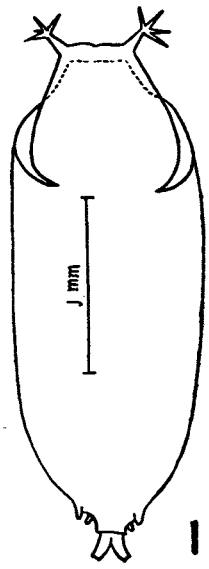

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paramere large, without branch, not contiguous. Ventral fragma nearly triangular, novasternum pubescent and produced into a small cone-like median process with a pair of fine sub-median spines arising from either side of it. Basal apodeme dark brown, elongated, slightly dilated near the tip and more than one and a half times as long as aedeagus. Phallosomal index about 0·6.

4. *Internal structures* (Figs. 7 and 8).—Proximal intestine; coiling index 3·5; Malpighian tubules with short common stalks and long branches, posterior branches ending free. The common stalk of anterior branch of Malpighian tubules slightly larger than that of posterior branch.

Testes of cream-yellow colour, each with 2·5 outer and 1·5 inner coils. Paragonia folded once.

Female imago

1. Resembles male except in the absence of black patch on the wing and sex comb, and caudal black bands on last two tergites.

Length of the body : 2·58 mm.
Length of the wing : 2·70 mm.

2. *Egg guides* (Fig. 9).—Lobe orange-brown, slender, long and somewhat rounded apically with about 22 black marginal teeth, excluding 3–5 discal and 3 upper marginal teeth, which are smaller than the lower ones; first three marginal teeth quite close. Subterminal hair present near the 3rd marginal tooth.

Internal structures (Fig. 10).—Spermathecae brownish-black, longer than broad and proximally swollen, parovaria roundish; ventral receptacle with about 7 transverse ventrally placed folds.

B. *Egg.*—With 2 slender filaments.

C. *Larvae.*—Third larva with blackish hooklets.

D. *Puparium* (Fig. 11).—Yellowish-brown, posterior spiracles divergent. N.A. 7; S.B. 1/18.

E. *Specimens examined.*—Chandigarh and Manimajra.

III. *Drosophila* (*Sophophora*) *takahashii* Sturtevant, 1927

Drosophila takahashii Sturtevant, 1927. *Philip. Journ. Sci.*, **32**, 371; Kikkawa and Peng, 1938. *Jap. Jour. Zool.*, **7**, 534.

Drosophila (*Sophophora*) *takahashii* Sturtevant, 1942. *Univ. Texas Publ.*, **4213**, 29; Hsu, 1949. *Univ. Texas Publ.*, **4920**, 96; Wheeler, 1949. *Univ. Texas Publ.*, **4920**, 175; Tan, Hsu and Sheng, 1949. *Univ. Texas Publ.*, **4920**, 197; Patterson and Stone, 1952. *Evol. gen. Dros.*, 16; Okada, 1955. *Sci. Result Japan. Exped. Nepal Himalaya*, **1**, 388; Okada, 1956. Syst. St. Drosophilidae Allied Fam. Japan, 109.

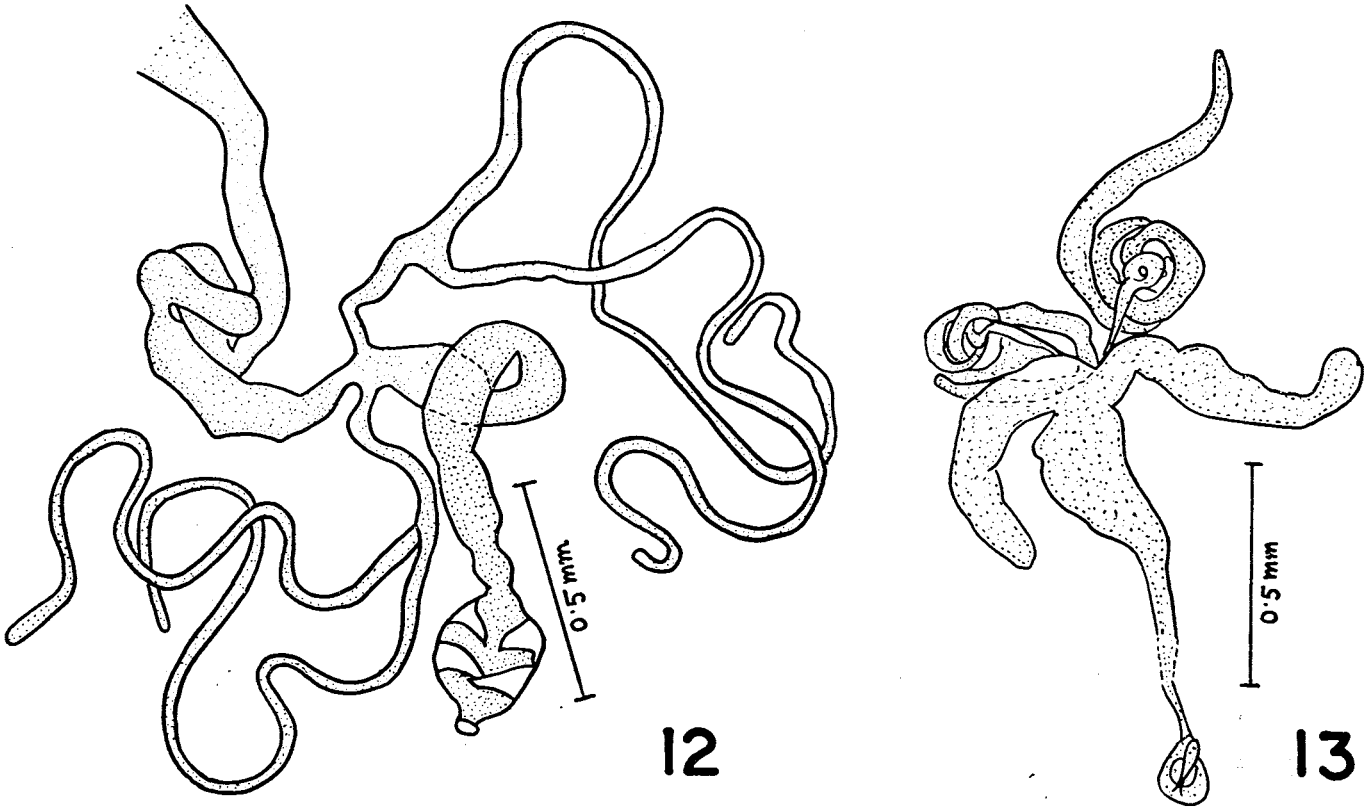
♂ and ♀ : *General features.*—Wing with C-3 bristles on basal one-half. Other structures as described by Sturtevant (1927), indicated by Kikkawa and Peng (1938) and Okada (1956).

Periphallic organs.—Lower end of the genital arch with 3 long bristles in a transverse row. Upper posterior margin with a row of 5–8 bristles. Secondary teeth 2–4. Discal bristles about 6. Other features as figured by Kikkawa and Peng (1938), figured and described by Hsu (1949) and Okada (1956).

Decasternum.—As figured and described by Okada (1956).

Phallic organs.—Basal branch of the posterior paramere about one-half the length of the posterior paramere itself, otherwise as described and figured by Okada (1954 and 1955).

Internal structures (Fig. 12).—Proximal intestine; coiling index 2·5; rectal index 1·7. Malpighian tubules with long branches. The posterior branches of Malpighian tubules ending free.



FIGS. 12 and 13. *Drosophila takahashii.* 12, proximal intestine; 13, male reproductive organs.

Testes (Fig. 13) pale cream, each with two inner and 3·5 outer coils, distal end straight and narrow, paragonia almost without any fold. Anterior ejaculatory duct long and proximally swollen.

Egg guides.—Sub-terminal hair between 4th and 5th teeth, otherwise as described and figured by Okada (1956).

Spermathecae, ventral receptacle and parovaria as described and figured by Okada (1956).

Egg.—With 2 slender filaments flattened distally.

Larva.—As indicated by Kikkawa and Peng (1938).

Pupa rium.—Light brown. Posterior spiracles divergent. N.A. 6; S.B. 1/18.

Chromosomes (Fig. 13*a*).—Neuroblast: 2 pairs of V's, one pair of dots, X and Y both rod-shaped, Y being smaller.

FIG. 13*a*. Neuroblast chromosomes of *D. takahashii*.

Salivary gland

Five long and one short arms.

Specimens examined.—Kulu and Chandigarh.

IV. *Drosophila* (*Sophophora*) *nepalensis* Okada, 1955

Drosophila sp. Okada, 1954. *Kontyû*, **22**, 38.

Drosophila (*Sophophora*) *nepalensis* Okada, 1955. *Sci. Result Japan. Exped. Nepal Himalaya*, **1**, 388; Okada, 1956. Syst. St. Drosophilidae Allied Fam. Japan, 108.

A. *Description of imago*

Male imago

1. *External characters.*—Arista with 4 branches above and 3 below, in addition to the terminal fork. Front over one-fourth the greatest width of head. Second orbital about one-half of either two. Second oral only slightly smaller than the first. Palpus black, face milky white. In some specimens, all the tergites are black.

Length of the body: 2·16 mm.
Length of the wing: 2·00 mm.

Other structures as described by Okada (1955).

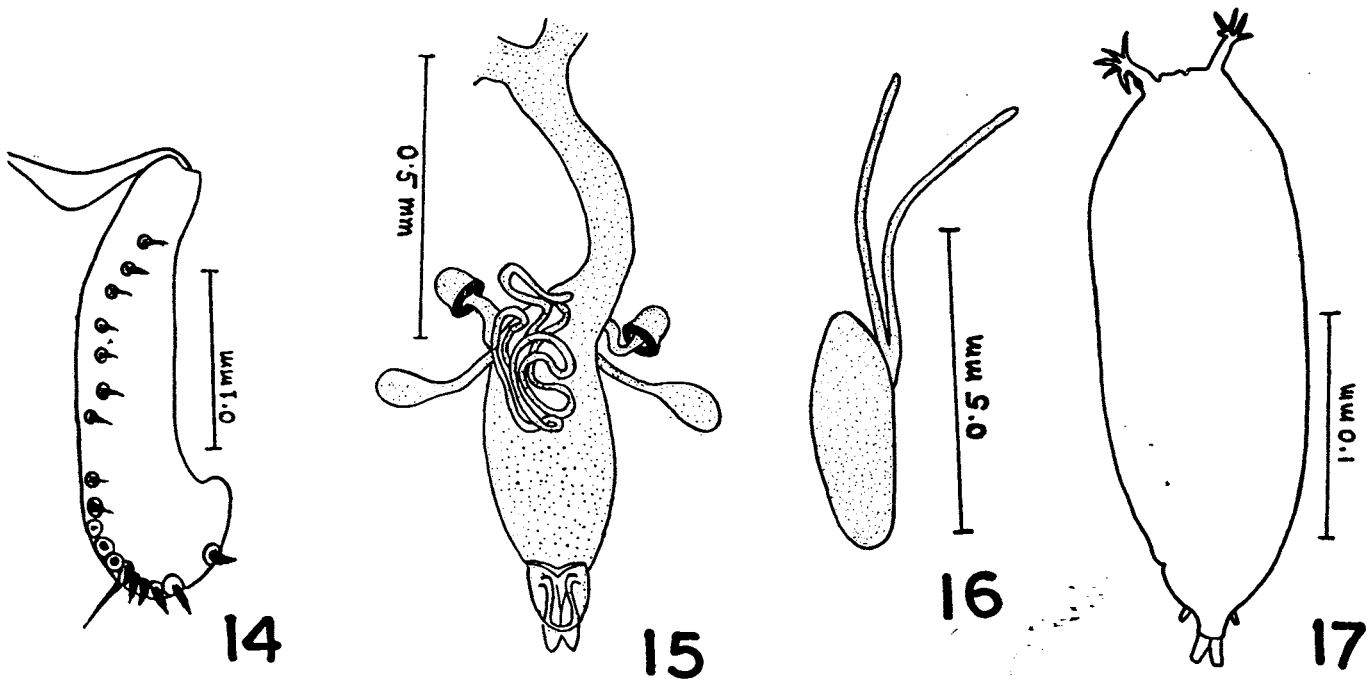
2. *Periphallic organs.*—As described and figured by Okada (1955).

3. *Phallic organs.*—As described and figured by Okada (1955).

4. *Internal structures.*—Proximal intestine with about 3 coils. Rectal index 1·6. Other structures as described by Okada (1955).

Female imago

1. *External characters.*—Differs from male in the general colouration of the body, which varies from yellowish-brown to black, especially the legs being yellow. Sex comb absent. Dark patch on the apex of the wing also absent.



Figs. 14 to 17. *Drosophila nepalensis*. 14, egg guide; 15, female reproductive organs; 16, egg (lateral view); 17, puparium.

2. *Egg guides* (Fig. 14).—Lobe pale yellow, apically rounded with about 18 marginal teeth; discal teeth absent, penultimate tooth quite closer to 3rd tooth than to first one. Basal isthmus long and concave proximally. Sub-terminal hair near the 6th tooth.

3. *Internal structures* (Fig. 15).—Spermathecae brownish-black, proximally swollen. Ventral receptacle with about 7 folds.

B. *Egg* (Fig. 16).—With 2 long and slender filaments.

C. *Larva*.—Third larva with black hooklets.

D. *Puparium* (Fig. 17).—Amber coloured. Posterior spiracles divergent. N.A. 5; S.B. 1/15.

E. *Specimens examined*.—Manali (Kulu Valley) and Chandigarh.

V. *Drosophila* (*Sophophora*) *ananassae* Doleschall, 1858

Drosophila ananassae Doleschall, 1858. Duda, 1923. *Ann. Mus. Nat. Hung.*, **20**, 53; Sturtevant, 1927. *Phil. Journ. Sci.*, **32**, 371; Kikkawa and Peng, 1938. *Jap. Jour. Zool.*, **7**, 526.

Drosophila (*Sophophora*) *ananassae* Sturtevant, 1942. *Univ. Texas Publ.*, **4213**, 29; Patterson, 1943. *Univ. Texas Publ.*, **4313**, 74; Hsu, 1949. *Univ. Texas Publ.*, **4920**, 96; Wheeler, 1949. *Univ. Texas Publ.*, **4920**, 175; Tan, Hsu and Sheng, 1949. *Univ. Texas Publ.*, **4920**, 197; Patterson and Stone, 1952. *Evol. gen. Dros.*, 16; Okada, 1956. Syst. St. Drosophilidae Allied Fam. Japan, 116; Mather, 1960. *Univ. Queensland Papers*, I, **9**, 233.

♂ and ♀: *General features*.—Second orbital one-third the size of other two. Second oral nearly one-half the first. Costal index 1·54, 4V-index 2·37, 4C-index 1·62 and 5X-index 1·95. Other structures as described by Kikkawa and Peng (1938) and Patterson (1943).

Periphallic organs.—As figured by Kikkawa and Peng (1938), figured and described by Hsu (1949).

Decasternum.—Small narrow median piece, narrowing apically and with a posterior notch.

Phallic organs.—As described and figured by Okada (1954).

Egg guides.—Sub-terminal hair between 3rd and 4th teeth, otherwise as figured and described by Okada (1956).

Internal structures.—As described and figured by Patterson (1943) and Okada (1956).

Egg and Larva.—As described by Kikkawa and Peng (1938) and Patterson (1943).

Puparium.—Light chrome-yellow with divergent posterior spiracles. N.A. 10; S.B. 1/20.

Chromosomes.—As described by Kikkawa and Peng (1938) and Patterson (1943).

Specimens examined.—Kulu, Jaipur, Izatnagar, Cuttack and Calcutta.

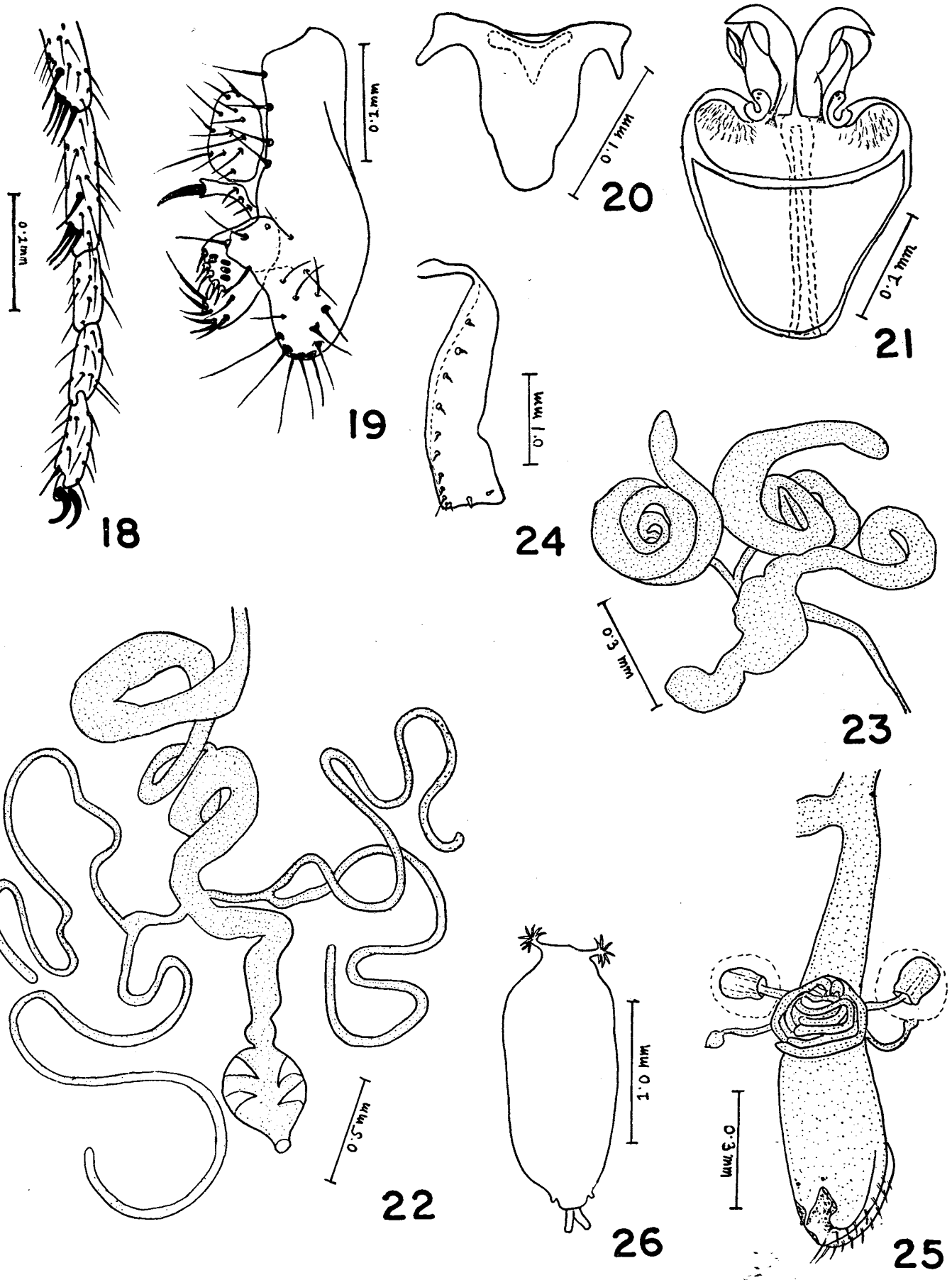
VI. *Drosophila* (*Sophophora*) *malerkotliana* sp. novo.

Drosophila (*Sophophora*) sp. Okada, 1964. Nature and life in South-east Asia, **3**, 439.

A. *Description of imago*

Male imago

1. *External characters*.—Arista with 4 branches on the dorsal and 3 on the ventral side with a terminal fork; antenna yellow, third segment grey. Front over one-third the width of head. Second orbital half the size of other two. Second oral about three-fifths the size of the first. Carina high and narrow. Face and palpus pale yellow, the latter



FIGS. 18 to 26. *Drosophila malerkotliana.* 18, sex comb; 19, genital arch; 20, decasternum; 21, phallic organs; 22, proximal intestine; 23, male reproductive organs; 24, egg guide; 25, female reproductive organs; 26, puparium.

with one prominent seta and 4–6 small bristles. Cheeks pale yellow, one-fifth as broad as the greatest diameter of eye. Eyes vermilion with a thick pile. Ocelli brown.

Acrostichal hairs in 6–8 rows, no pre-scutellars, anterior scutellars convergent. Mesonotum and scutellum greyish-yellow. Humerals 2, unequal. Pleura slightly yellowish-brown. Sterno-index 0·6. Legs pale yellow. Pre-apicals on all the three tibiae, apicals on fore and middle tibiae. Sex comb (Fig. 18) in 2 sets, proximal metatarsal comb of 2 transverse rows of 1–4 small brown teeth and distal tarsal comb of 2 transverse rows of 1–3 similar teeth. Halteres yellow.

Abdominal tergites black except first, second and third where only black stripe is present on the posterior margin. Sternite pale and squarish.

Wing: C-1 bristles 2, equal. C-3 bristles over basal half. Costal index about 1·54, 4V-index 2·5, 4C-index 1·62 and 5X-index 2·3.

Length of the body: 1·80 mm.
Length of the wing: 1·86 mm.

2. *Periphallic organs* (Fig. 19).—Genital arch elongated, narrow dorsally, broad in the middle and with a blunt process from posterior margin covering the base of the primary clasper. Heel absent. Toe pointed with about 13 bristles. Claspers 2; primary clasper well developed, boat-shaped with primary teeth in 2 sets, anterior set of 2 and posterior of 3, marginal bristles about 12, well developed; secondary clasper with a single long well-developed and about 7 small bristles along the posterior end.

Decasternum (Fig. 20).—Elongated median piece with tapering tip and a notch at the anterior end, sclerotized.

3. *Phallic organs* (Fig. 21).—Aedeagus yellowish-brown, long, bifid, unbranched and curved distally. Anterior paramere short, J-shaped and rounded at the tip. Posterior paramere as long as aedeagus, branched. Novasternum almost flat, pubescent with a pair of well-separated and short sub-median spines. Ventral fragma almost rectangular, longer than broad and narrow anteriorly. Basal apodeme as long as fragma. Phallosomal index = 0·46.

4. *Internal structures* (Figs. 22 and 23).—Proximal intestine; coiling index 3·0. Malpighian tubules with long branches which end free. Rectal index 1·3.

Testes lemon-yellow, each with 3·5 outer and 1·5 inner coils. Paragonia folded twice. Ejaculatory bulb globular.

Female imago

1. Differs from male in having posterior tergites not black and in the absence of the sex comb.

2. *Egg guides* (Fig. 24).—Lobe narrow anteriorly and broad at the posterior border, which is flat. Marginal teeth black, about 13, with a gap between penultimate and 3rd tooth. Sub-terminal hair between 4th and 5th teeth. Basal isthmus swollen in the middle and about one-third the size of the lobe.

3. *Internal structures* (Fig. 25).—Spermathecae brown, chitinized and slightly swollen distally. Parovaria with long stalks and acute distally. Ventral receptacle with about 6 ventrally placed transverse folds.

B. *Egg*.—With 2 filaments flattened at the tips and almost of the same size as the egg.

C. *Larvae.*—Third larva with blackish hooklets.

D. *Puparium* (Fig. 26).—Yellowish; spiracles short, posterior spiracles divergent. N.A. 12; S.B. 1/20.

E. *Specimens examined.*—Chandigarh, Pinjore and Malerkotla.

VII. *Drosophila* (*Sophophora*) *kikkawai* Burla, 1954

Drosophila (*Sophophora*) *kikkawai* Burla, 1954. *Rev. Brazil. Biol.*, **14**, 4. Okada, 1955. *Sci. Result Japan. Exped. Nepal Himalaya*, **1**, 387; Okada, 1956. Syst. St. Drosophilidae Allied Fam. Japan, 118.

Drosophila montium Duda, 1923. *Ann. Mus. Nat. Hung.*, **20**, 53; Kikkawa, 1936. *Jap. Jour. Genet.*, **12**, 137; Kikkawa and Peng, 1938. *Jap. Jour. Zool.*, **7**, 530.

Drosophila (*Sophophora*) *montium* Sturtevant, 1942. *Univ. Texas Publ.*, **4213**, 118; Hsu, 1949. *Univ. Texas Publ.*, **4920**, 97; Tan, Hsu and Sheng, 1949. *Univ. Texas Publ.*, **4920**, 197; Wheeler, 1949. *Univ. Texas Publ.*, **4920**, 175; Patterson and Wheeler, 1949. *Univ. Texas Publ.*, **4920**, 211; Patterson and Stone, 1952. *Evol. gen. Dros.*, 16; Mather, 1960. *Univ. Queensland Papers*, I, **9**, 233.

♂ and ♀: *General features.*—Abdominal tergites having four transverse rows of bristles, posteriormost being well developed. Other characters as described by Kikkawa and Peng (1938), Burla (1954) and Okada (1956).

Periphallic organs.—As figured by Kikkawa and Peng (1938), figured and described by Hsu (1949) and Burla (1954).

Descasternum.—As figured and described by Okada (1956).

Egg guides.—Sub-terminal hair at the level of 5th tooth. Basal isthmus almost straight, about one-fourth the length of the lobe. Other features as figured by Burla (1954), described and figured by Okada (1956).

Internal structures.—As described and figured by Okada (1956).

Egg.—With 2 tapering filaments.

Larvae.—As described by Kikkawa and Peng (1938).

Puparium.—Light yellowish-brown. Posterior spiracles divergent. N.A. 9; S.B. 1/20.

Chromosomes (Fig. 26*a*).—Neuroblast: 2 pairs of V's, 2 pairs of rods, X and Y both rod-shaped, Y being smaller.

Fig. 26*a*. Neuroblast chromosomes of *D. kikkawai*.

Salivary gland

Five long and one short arms.

Specimens examined.—Chandigarh, Malerkotla.

VIII. *Drosophila* (*Sophophora*) *rufa* Kikkawa and Peng, 1938

Drosophila rufa Kikkawa and Peng, 1938. *Jap. Jour. Zool.*, **7**, 229.

Drosophila (*Sophophora*) *rufa* Sturtevant, 1942. *Univ. Texas Publ.*, **4213**, 29; Hsu, 1949. *Univ. Texas Publ.*, **4029**, 97; Wheeler, 1949. *Univ. Texas Publ.*, **4920**, 175; Tan, Hsu and Sheng, 1949. *Univ. Texas Publ.*, **4920**, 197; Patterson and Stone, 1952. *Evol. gen. Dros.*, 16; Okada, 1956. Syst. St. Drosophilidae Allied Fam. Japan, 121.

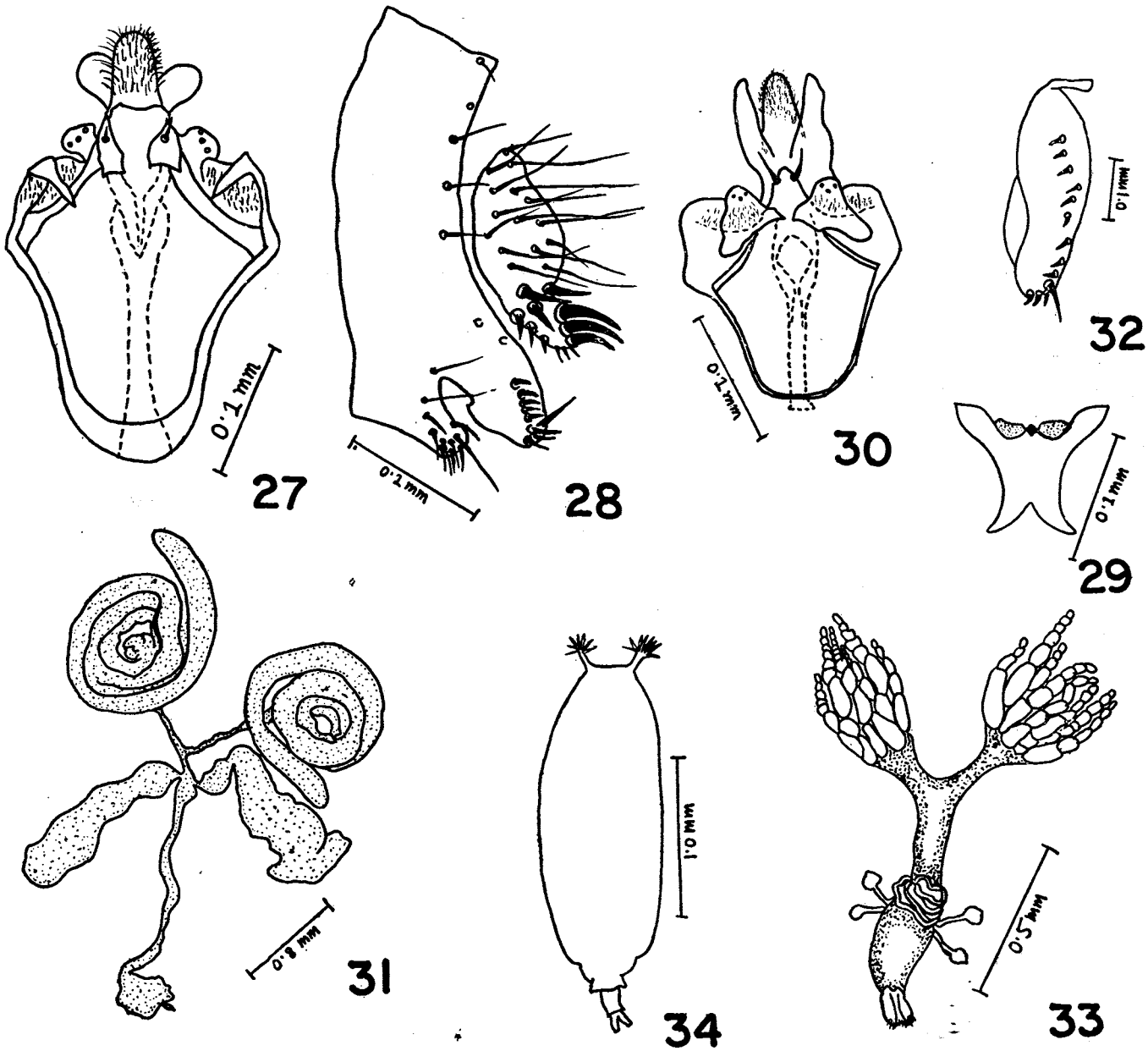
♂ : *General features.*—Prothoracic leg with a proximal comb of 17–20 stout black teeth on first tarsal joint and a distal comb of about 12–14 similar teeth on the second tarsal joint. Costal index 3·0 and 4C-index 1·1. Other characters as described by Kikkawa and Peng (1938) and Okada (1956).

Periphallic organs.—Genital arch, upper portion with a row of about 6 bristles along the posterior margin, ventralmost being distinct and quite long; lower portion with 7–10 bristles. Primary teeth seven; secondary clasper with three long teeth encircled by 8–10 small ones. Other characters as described and figured by Hsu (1949).

Decasternum.—As described and figured by Okada (1956).

Phallic organs (Fig. 27).—Median projection of novasternum broad and obtuse. Other characters as described by Okada (1954).

Specimens examined.—Only males from Chandigarh.



FIGS. 27 to 34. 27, *Drosophila rufa*, phallic organs; 28 to 34, *Drosophila jambulina*—28, genital arch; 29, decasternum; 30, phallic organs; 31, male reproductive organs; 32, egg guide; 33, female reproductive organs; 34, puparium.

IX. *Drosophila* (*Sophophora*) *jambulina* sp. novo

A. *Description of imago*

Male imago

1. *External characters.*—Arista with 5 branches above and 3 below, in addition to the terminal fork; antenna pale yellow, third segment grey. Front over one-half the greatest width of head, wider above, yellowish-brown. Second orbital one-third of either two. First oral about 1·5 times as long as the second. Carina narrow above, broad below, high and milky white. Face milky white, clypeus and palpus light yellow, the latter with a single large prominent seta. Cheeks pale yellow, their greatest width about one-eighth the greatest diameter of eye. Eyes wine red with a rather thick pile. Ocelli light brown.

Acrostichal hairs in 6–8 (usually 6) rows, no pre-scutellars, anterior scutellars slightly convergent. Mesonotum and scutellum light yellowish-brown. Humerals 2, sub-equal, upper one larger. Pleura shaded, sterno-pleura pale brown and sterno-index about 0·5.

Legs pale brown, distally paler. Apicals on 1st and 2nd tibiae, pre-apicals on all the tibiae. Sex comb in 2 sets; proximal comb of 24 stout black teeth on first tarsus and a distal comb of 15 similar but smaller teeth on the second tarsus. Halteres pale yellow.

Abdomen yellow, 2nd, 3rd, 4th and 5th tergites with black, broad, uninterrupted caudal bands, last tergite shining black.

Wing clear, C-1 bristles 2, equal; C-3 bristles over basal one-half. Costal index about 2·4, 4V-index about 3·0; 4C-index 1·6 and 5X-index about 3·5.

Length of the body: 2·2 mm.
Length of the wing: 1·8 mm.

2. *Periphallic organs* (Fig. 28).—Genital arch long, brown, darker posteriorly with about 12 bristles from top to toe, posterior margin with 5–7 bristles in a row, ventralmost being quite long. Heel distinctly pronounced; toe low, rounded with about 5 bristles. Anal plate large, dark brown, oval with 16–18 bristles; 3 large curved teeth present in the dark area below the circus. Claspers 2; primary clasper with 4-5 primary teeth as well as highly-developed marginal bristles clustered at the tip, secondary clasper just below and fused to anal plate, carrying 3 long black stout and curved teeth which are encircled by about 6–8 small black spines.

Decasternum (Fig. 29).—Median piece, almost squarish, posterior margin forked, anterior end with a notch and a pair of lateral arms.

3. *Phallic organs* (Fig. 30).—Aedeagus pubescent, slightly curved, without any branch or lateral claw. Anterior paramere large, compact, triangular and separate from aedeagus. Posterior paramere large, not contiguous. Novasternum pubescent with a median projection and having a pair of short sub-median spines. Fragma almost rhomboidal with a rounded anterior end. Basal apodeme slightly longer than fragma. Phallosomal index about 0·65.

4. *Internal structures.*—Posterior branches of Malpighian tubules ending free. Rectal index about 1·5.

Testes yellow, each with about 3 coils (Fig. 31). Seminal vesicles slender. Paragonia weakly folded and ejaculatory bulb globular.

Female imago

1. Almost resembles male except in the absence of sex comb and the posterior-most tergite not being black.

Note: In nature, two types of females are met with regard to the colouration of abdomen. One type with posterior tergite yellow and the other black.

2. *Egg guides* (Fig. 32).—Lobe yellowish-brown, apex weakly pointed, tip narrow and rounded with about 13 black marginal teeth. Sub-median hair between 3rd and 4th teeth. Basal isthmus cylindrical and short.

3. *Internal structures* (Fig. 33).—Spermathecae globular and hyaline. Ventral receptacle with about 4 transverse semicircular folds placed against the ventral wall of the uterus.

B. *Egg*.—With 2 slender tapering filaments about one-half the length of the egg.

C. *Larva*.—Third larva with blackish hooklets.

D. *Puparium* (Fig. 34).—Amber-yellow with divergent posterior spiracles. N.A. 8; S.B. 1/19.

E. *Specimens examined*.—Chandigarh, Malerkotla.

X. *Drosophila* (*Sophophora*) *punjabiensis* sp. novo

A. *Description of imago*

Male imago

1. *External characters*.—Arista with 5 dorsal and 3 ventral branches, excluding the terminal fork; antenna dark grey. Front over one-half the greatest width of head, wider above. Second orbital one-third the size of other two. Second oral less than three-fourths the size of the first. Carina almost cylindrical, high and pale. Face pale white, clypeus and palpus pale, the latter with a single large terminal seta. Cheeks light pale, their greatest width about one-sixth the greatest diameter of eye. Eyes red with a rather thick pile. Ocellar triangle close and ocelli brown.

Acrostichal hairs in 6 rows, pre-scutellars absent, anterior and posterior scutellars convergent, posterior scutellars crossing at their free ends. Mesonotum and scutellum pale brown, the former being shining and the latter dull. Humerals 2, sub-equal. Pleura light brown, without dark stripe; pteropleura shaded, sterno-pleura yellowish-brown and sterno-index about 0·55.

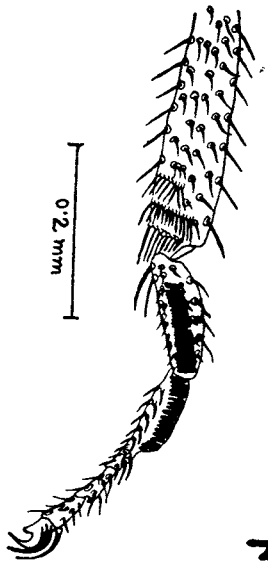
Legs yellow, proximally paler. Apicals on 1st and 2nd tibiae only, pre-apicals on all the three. Sex comb (Fig. 35) distinct, in 2 sets; proximal metatarsal comb of about 24 stout teeth and distal tarsal comb of about 19 similar teeth. Halteres light brown.

Abdomen yellow, each tergite with a black, uninterrupted, posterior band, last tergite totally black.

Wing (Fig. 36) clear, C-1 bristles 2, unequal. C-3 bristles over basal one-third the 3rd costal section. Costal index about 2·1, 4V-index 2·46, 4C-index 1·3 and 5X-index 3·0.

Length of the body : 1·75–1·90 mm.
Length of the wing : 1·85–2·00 mm.

2. *Periphallic organs* (Fig. 37).—Genital arch long, concavo-convex, lower portion with about 6 bristles and a row of about 4 bristles along its upper posterior margin. Heel not observable; toe low, roundish with about 5 bristles. The posterior margin on its lower



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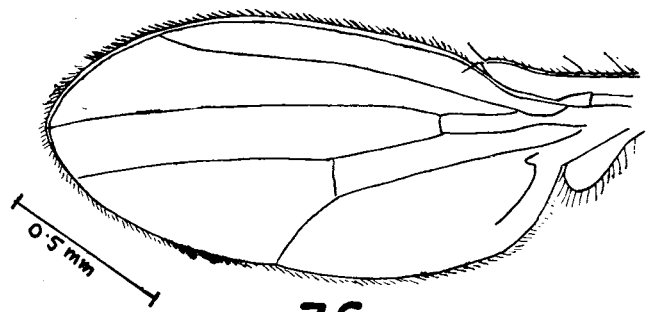

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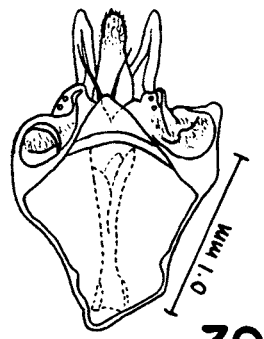

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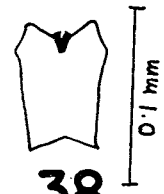

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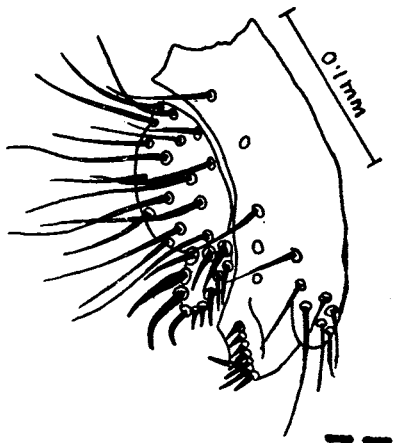

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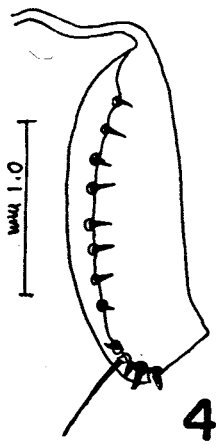

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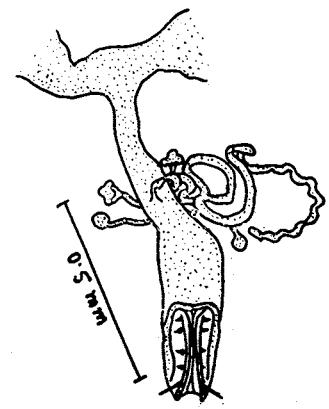

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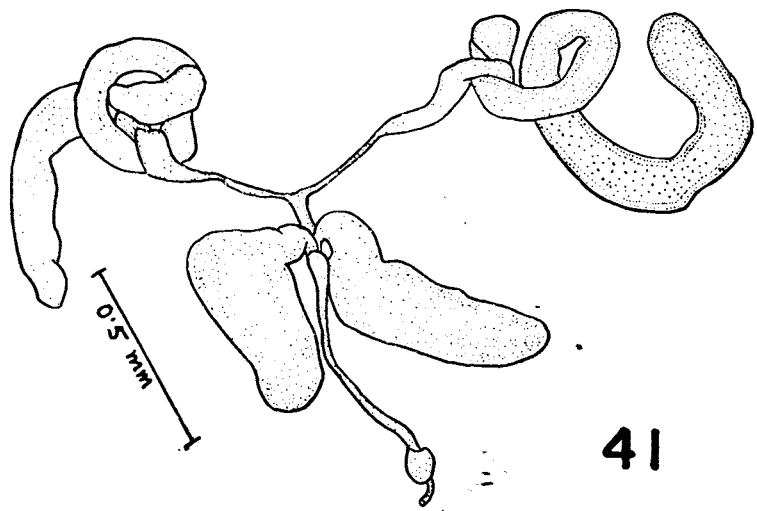

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FIGS. 35 to 43. *Drosophila punjabiensis*. 35, sex comb; 36, wing; 37, genital arch; 38, decasternum; 39, phallic organs; 40, proximal intestine; 41, male reproductive organs; 42, egg guides; 43, female reproductive organs.

surface produced into an outgrowth which bears primary clasper. Anal plate large, oblong with about 16 bristles. Clasper in 2 sets; primary clasper with a straight row of about 5 primary teeth, marginal bristles fewer, clustered at the lower tip; secondary clasper small, roundish, fused with the anal plate and with three very large curved and unequal teeth, which are encircled by about 7 bristles.

Decasternum (Fig. 38).—Broad median piece, slightly tapering on one side, without lateral horns and with a median notch.

3. *Phallic organs* (Fig. 39).—Yellowish-brown, aedeagus large, not bifid and slightly pubescent apically. Anterior paramere large, broad, compact with 3 sensillae. Posterior paramere long, unbranched and separate. Novasternum pubescent with a pointed median projection bearing a pair of long sub-median spines. Ventral fragma almost quadrangular, narrowing anteriorly. Basal apodeme of the aedeagus dilated distally and slightly longer than the length of aedeagus. Phallosomal index about 0·86.

4. *Internal structures* (Figs. 40 and 41).—Proximal intestine: CI = 2·5. Malpighian tubules with long branches, posterior branching ending free. Rectal index = 1·6.

Testes chrome-yellow, each with 2·5 outer and 2 inner coils. Paragonia folded once and swollen distally.

Female imago

1. Resembles male except in having no sex comb, face being pale yellow and further in the last tergite of its abdomen being not black.

2. *Egg guides* (Fig. 42).—Lobe pale yellow, proximal half paler, apex rounded and with about 12 marginal teeth, discal teeth being absent. The ultimate tooth not isolated from penultimate one. Sub-terminal hair situated between 3rd and 4th teeth. Basal isthmus feebly concave.

3. *Internal structures* (Fig. 43).—Spermathecae somewhat hyaline, triangular. Parovaria oblong, flattened distally. Ventral receptacle with about 4 transverse coils placed against the ventral wall of uterus, the distal part of the last coil wavy.

B. *Egg.*—With 2 slender filaments.

C. *Larva.*—Third larva with blackish hooklets.

D. *Puparium.*—Pale amber with divergent posterior spiracles. N.A. 9; S.B. 1/22.

E. *Specimens examined.*—Kulu Valley and Chandigarh.

Seasonal Changes in the Natural Population of *Sophophora* from October, 1961, to September, 1962, in Chandigarh

The distribution of the various species of *Sophophora* during the different months from October, 1961, to September, 1962, is given in Table II.

From Table II it becomes evident that the population density of the different species fluctuates during the various months. These fluctuations can be regarded as due to seasonal changes involving variations in the temperature and humidity, though the importance of abundance of food, on which the particular species feed, cannot be overlooked.

Most of the fluctuations can be correlated with the variation in the temperature and other environmental agencies. During the extreme hot or cold weather, the population, in most of the species, either sinks to quite a low level or becomes almost zero, the only exception being *D. melanogaster* which appears to tolerate even the extreme physical

TABLE II

Collection record (in percentage) of the various species of the subgenus Sophophora *during the various months of the year 1961-62*

Species	Oct., 1961	Nov., 1961	Dec., 1961	Jan., 1962	Feb., 1962	Mar., 1962	April, 1962	May, 1962	June, 1962	July, 1962	Aug., 1962	Sept., 1962
D. bifasciata	—	—	—	4·2	5·7	1·2	—	—	—	—	—	—
D. suzukii indicus subspecies novo	—	—	—	—	—	—	1·10	—	—	2·3	—	—
D. takahashii	5·5	3·9	10·6	4·2	2·2	0·6	1·7	—	—	—	1·9	6·4
D. nepalensis	—	92·1	88·9	78·8	75·0	80·4	39·0	—	—	—	—	—
D. melanogaster	9·0	0·9	0·5	4·2	17·0	15·3	29·5	61·2	37·6	6·4	7·6	37·7
D. malerkotliana sp. novo ..	34·5	1·8	—	—	—	—	—	—	—	—	10·9	13·4
D. kikkawai	16·9	1·3	—	—	0·1	0·8	—	—	—	—	3·7	2·0
D. rufa	—	—	—	8·5	—	1·7	0·9	—	—	—	—	—
D. jambulina sp. novo ..	17·6	—	—	—	—	—	27·8	23·6	34·4	51·1	43·5	29·3
D. punjabiensis sp. novo ..	16·4	—	—	—	—	—	—	15·2	28·0	40·2	32·4	11·2

conditions. The latter species is almost available throughout the year, although the density of its population varies, being highest during spring and just after monsoon. It, thus, presents two frequency distribution peaks in the collection, one in the month of May and the other during September.

The fluctuations are not only seasonal, but are also evident in the various hours of the day. The biggest catches, both from bait and sweeping, were available in the morning, just before sunrise during the summer and just before noon during winter. Moreover, most of the species show a diurnal rhythm of activity which can be roughly correlated with the changes in temperature and humidity ; especially when there is a sharp fluctuation of temperature there is a large influx of flies to the bait-trap or the food on which they feed, court, copulate and lay eggs. It was also observed that the density of the flies becomes quite low during the extreme conditions of weather, particularly the temperature.

D. bifasciata constitutes the only species of the species group *Obscura* reported so far from India. It was available only during the winter months of January and February and the beginning of spring, *i.e.* March.

D. suzukii indicus was collected in quite a few numbers either in spring or in the pre-monsoon days.

D. nepalensis appeared suddenly in the baits on the onset of winter in November and the collection was at its peak as well as dominated throughout the winter and to a great extent in spring. Although a good number of specimens were collected from Manali (Kulu Valley) during September, not even a single specimen could be made available from Chandigarh till the beginning of November. This can be correlated with low temperature and humidity during September at Manali which is situated at 7,000 ft. above sea level. The distribution of this species is, thus, associated with low temperature and humidity.

D. melanogaster can be regarded as wonderfully plastic to cope with the extreme physical conditions and has been found to occur throughout the year with the frequency distribution peaks, one during May and the other during September, *i.e.* during spring and just after the monsoon, respectively.

D. ananassae was collected from Kulu Valley and Cuttack during September, 1961, and January, 1962, respectively. Not even a single specimen of this species was available from Chandigarh and adjacent localities.

D. malerkotliana presents a well-defined association with the guava fruit which is its favourite menu. The sweep over the discarded or fermenting guava fruits yielded this fly to an extent of 90% of the entire collection. This species could be made available only during the monsoon and just after the rains.

D. kikkawai has again been found to occur in abundance during the monsoon and, just after the rains, to continue, although in a very low concentration, right up to February and March.

The collections of *D. rufa* were very poor and were available only during extreme winter conditions.

D. jambulina started appearing in the baits during spring with a steady rise in its population until July when its collection is at its peak. With the advent of the rains its population falls steadily till it is zero during the winter season.

D. punjabiensis, occurs mainly along with the above-mentioned species with the exception that it starts appearing from May onwards.

Status and Relationship of the various Species of the Subgenus *Sophophora*

1. *Drosophila bifasciata*

This is the only species of the subspecies group *Obscura*, which is being recorded for the first time from India. In the details of description, it resembles the Japanese population (Okada, 1956) excepting, however, that:

(1) Palpus is pale brown with a single prominent seta as opposed to brown with a few setae of the Japanese form.
(2) Sterno-index is 0·6, whereas it is 0·7 in the Japanese species.
(3) The real difference lies in the proportion of metatarsal sex comb in relation to the size of the metatarsus itself. In the Japanese as well as European populations the sex comb occupies less than half the length of the metatarsus, whereas it extends to more than half in the material under investigation.

2. *Drosophila suzukii* subspecies *indicus*

The population of this species from India resembles the descriptions of *D. suzukii* given by Kikkawa and Peng (1938), Hsu (1949) and Okada (1956) with the following differences:

(1) Second oral bristle three-fourths the length of the first, but it is nearly equal in the species from Kulu and the Japanese population (Kikkawa and Peng, 1938).
(2) Palpus has only a single prominent seta in the Japanese form while in the Indian collection a few small additional bristles are also recognizable.
(3) The number of teeth in the metatarsal comb is 4–6, while in the Japanese material the maximum number being 4.
(4) The maximum costal index is 3·46, whereas it is 4·0 in the Japanese one.
(5) In the details of periphallic organs, it agrees with the description of Hsu (1949), except that the tip of the anal plate is produced into a sharp angle, bearing comparatively shorter, thicker and densely crowded bristles. Moreover, the marginal bristles are comparatively shorter, thicker and situated on the narrow prolongation of the clasper. These features are, of course, absent in the Chinese material examined by Hsu (1949). Further, the primary teeth are in a convex row, like that in *D. pulchrella*, whereas these are in a straight row in the description of Hsu (1949).
(6) Decasternum, which is trilobed with a heart-shaped median piece and two J-shaped lateral pieces, resembles more with that of *D. pulchrella* than of *D. suzukii* as described by Okada (1956). In the latter, the median as well as the lateral pieces are comparatively longer than broad.
(7) Egg guide carries about 22 marginal teeth, whereas in the Japanese form the number is as high as 30 (Okada, 1956).

3. *Drosophila takahashii*

The description of the species under investigation resembles that given by Kikkawa and Peng (1938) and Okada (1955 and 1956) with the following differences:

(1) Whereas Okada (1956) observed that the number of secondary teeth on the clasper varies from 2 to 3, the present study reveals that, within the individuals of the same generation, their number ranges between 2 and 4.

(2) Okada (1955) observed that the basal branch of the posterior paramere of the phallic organ is reduced to just a conical process, which is not so in the material under investigation, its length being about half the length of the posterior paramere. In fact, it appears to be of intermediate size between *D. takahashii* (Okada, 1955) and *D. lutea* where it is well developed.

Kikkawa and Peng (1938) described the chromosome complement from the neuroblast cells of this species as consisting of 2V's, 1 dot; rod-shaped X and Y in the form of a small rod. Sturtevant (1942), however, described 2V's, J-shaped X and a small rod-shaped Y. Thus, there appears to be two distinct cytological strains of this species (Ward, 1949). The present study on the neuroblast chromosomes reveals that the Indian population resembles that of the Japanese (Kikkawa and Peng, 1938) in having 2V's, 1 dot; long rod-shaped X and a small rod-shaped Y.

4. *Drosophila nepalensis*

It was Okada in 1955 who described this species on the basis of a few males from Nepal. It is interesting to mention that the female of this species, like that of *D. suzukii*, is completely devoid of a black patch on the apices of the wings. In the details of descriptions, the present collections resemble that of Okada (1955) except minor differences in the wing indices. Okada (1955) placed this species in the sub-group *takahashii* of the species-group *melanogaster*. The present study, on both the males as well as the females, further confirms this relationship in the following respects:

(1) The egg guide almost resembles that of other members of this species sub-group, except that the number of marginal teeth is large and the basal isthmus is more concave than that in *D. takahashii* and *D. lutea* (Okada, 1956).

(2) The internal anatomy of the female agrees in many respects with that of *D. takahashii* (Okada, 1956) except that the number of loops in the ventral receptacle is more.

5. *Drosophila ananassae*

The present descriptions of this species agree in all its details with those described by Kikkawa and Peng (1938), Patterson (1943), Hsu (1949) and Okada (1956).

6. *Drosophila malerkotliana* sp. novo

Superficially *D. malerkotliana* resembles *D. ananassae*, *D. bipectinata* and *D. szentivanii* in the number of branches in arista, 2 claspers and the secondary clasper with a single large tooth.

It resembles *D. ananassae* in the following features:

(1) The ratio of the cheek width and the greatest diameter of the eye.
(2) The extent of heavy C-3 bristles.
(3) The wing indices, especially the 4V-, 4C- and 5X-index.
(4) The primary teeth of the clasper being in 2 sets with a gap in between.

It, however, differs from *D. ananassae* as follows:

(1) Second orbital one-half the size of other two.
(2) Palpus with a number of small bristles in addition to a large terminal seta.
(3) Sex comb consisting of only 4 transverse rows of 1–4 bristles; 2 on the first and 2 on the second tarsal joint respectively.
(4) Abdomen black except first two tergites, which are pale yellow and with broad basal dark bands.
(5) The blunt portion of the posterior margin of genital arch covering only the base of the primary clasper.
(6) The fewer number of primary teeth, which are usually 2 and 3 in the upper and lower sets, respectively, as opposed to 5 and 3 in *D. ananassae*.
(7) The decasternum is an elongated median piece with a tapering tip and a notch anteriorly.
(8) In the phallic organs.

It, however, resembles more closely with *D. bipectinata* and *D. szentivanii* in the following respects:

(1) Wing indices.
(2) A blunt process from the posterior margin covering the base of primary clasper.
(3) Absence of heel.
(4) The anterior and posterior sets of the primary teeth with the same number of teeth, *i.e.* 2 and 3 respectively, of course, with a gap in between the two.
(5) The similarity in the shape and size of the aedeagus and anterior parameres.

Further, it differs both from *D. szentivanii* (Mather and Dobzhansky, 1962) and *D. bipectinata* in the following respects:

(1) Second orbital one-half the size of other two, whereas it is one-third in *D. szentivanii*.
(2) Sex comb comprises of two transverse rows of 1–4 weak bristles on the metatarsus and tarsus, whereas it consists of two oblique rows of 4–9 strong teeth on the first tarsal joint and 1–2 similar teeth on the second tarsal joint.
(3) The abdomen is black as opposed to that of *D. bipectinata* and *D. szentivanii* where it is yellow.
(4) Puparium with as many as 12 branches of each horn as opposed to only 10 in *D. szentivanii*.

It, thus, becomes apparent that *D. malerkotliana* is a distinct and clearly demarcated species being reported for the first time.

Relationship : Belongs to *ananassae* species sub-group of species group *melanogaster*.

7. *Drosophila kikkawai*

Burla (1954), on examination of the type specimen of *D. montium* De Meijere from Java, discovered that what the various authors, Sturtevant, 1942, Kikkawa and Peng, 1938, Wheeler, 1949, Hsu, 1949, and Okada, 1956, identified as *D. montium* is quite a distinct species differing from the type specimen in the following respects:

(1) Body colour light brownish-yellow with a greyish hue.
(2) The colour of 6th tergite is lighter than the proximal ones.

(3) Genital arch is large and the secondary clasper low and broad with 2 strong curved teeth and not fused with the anal plate.

(4) Wing index differences are as follows:

	D. montium	*D. kikkawai*
Costal index ..	2·7	2·0
4V-index	2·5	2·4
4C-index	3·2	2·2

The descriptions of collections from India resemble in all its detail with that of Burla (1954) and Okada (1956).

Kikkawa (1936) described 2 strains of this species, A and B, with different chromosomal types from Japan. In strain A there are 2 pairs of large V's and another pair of small V's, while in strain B there are 2 pairs of long V's and a pair of rods. Ward (1949) described another strain C differing from strain B in having rod-shaped Y which is otherwise V-shaped in both the strains A and B.

The metaphase configurations from the neuroblast cells of the collections from India reveal 2 V's, 2 rods, large rod-shaped X and a small rod-shaped Y, thus resembling strain C (Ward, 1949).

8. *Drosophila rufa*

The males on which the observations of this species have been made resemble almost in all respects with those described by Kikkawa and Peng (1938), Hsu (1949) and Okada (1956) except the phallic organ where the median projection of novasternum is broad and obtuse in contrast to that by Okada (1956).

9. *Drosophila jambulina* sp. novo

Superficially this species resembles *D. rufa*, *D. kikkawai* and *D. auraria*, all of which belong to the species sub-group *montium*, in the following characters:

(1) Arista with 8 branches, 3 below, excluding the terminal fork.

(2) Second orbital one-third the size of other two.

(3) A very large sex comb, comprising of 2 longitudinal rows of stout, transversely packed teeth on first and second tarsal joints of the prothoracic leg.

It, however, differs from *D. rufa* in the absence of black stripe on the pleuron as well as in the wing indices, which are as follows:

	D. rufa	*D. jambulina* sp. novo
Costal index ..	3·0	2·4
4V-index	2·6	3·0
4C-index	1·1	1·6
5X-index	3·0	3·5

From *D. kikkawai* it can be distinguished in having its secondary clasper fused with the anal plate as well as in having more than 2 long and curved teeth of the secondary clasper.

From *D. auraria*, it differs in the following characters:

	D. auraria	*D. jambulina* sp. novo
(i) Front width of head	1/3	1/2
(ii) Cheek width/greatest diameter of eye	1/6	1/8
(iii) Wing indices:		
Costal index ..	2·0	2·4
4V-index ..	2·7	3·0
5X-index ..	2·0	3·5
(iv) Periphallic organs: Lower posterior margin of the genital arch with a projection covering a part of the clasper		No such projection
Secondary clasper provided with only two large curved teeth		Three large curved teeth
Lower tip of the anal plate with two stout bristles		No such bristles but 3 large curved teeth present in the dark area below the circus
Decasternum: Median piece oblong and distally bifid		With two divergent lateral arms

These differences are themselves sufficient to regard this as a distinct and novo species, belonging to the species sub-group *montium* of the species group *melanogaster* of the subgenus *Sophophora*.

10. *Drosophila punjabiensis* sp. novo

Casually, this species can be confused with *D. jambulina* sp. novo and *D. seguyi*. The following are the superficial resemblances of this species with *D. jambulina* sp. novo:

(1) General colouration of the body.
(2) The number of branches in the arista.
(3) Colour of the face.
(4) Large sex comb.

However, these two species differ in the following major respects:

		D. punjabiensis sp. novo	*D. jambulina* sp. novo
(1)	Cheek width/greatest diameter of eye	1/6	1/8
(2)	Wing indices:		
	Costal index ..	2·1	2·4
	4V-index ..	2·46	3·0
	4C-index ..	1·3	1·6
	5X-index ..	3·0	3·5
(3)	Periphallic organs: (*a*) Secondary clasper: with 3 large curved teeth		With two large and one comparatively smaller teeth
	(*b*) Decasternum: Median piece without any distinct lateral horns		Broad median piece
(4)	Phallic organs:	Basal apodeme not projecting beyond the fragma	Projecting beyond the fragma
(5)	Phallosomal index:	0·86	0·65

This species further resembles *D. seguyi* in the following characters:

(1) General colouration of the body.
(2) Thick bristles present along the posterior margin of tergites.
(3) Wing indices, especially the costal and 4V-indices.

These two species, however, differ in the following respects:

		D. seguyi	*D. punjabiensis*
(1)	Periphallic organs:	A very long bristle can be recognized to arise from the lower posterior margin of the arch	No such bristle present
		Secondary clasper with 3–5, usually 4, long curved teeth	The number of such teeth is invariably 3
(2)	Phallic organs:	The median process of the novasternum is parallel sided	Rather tapering towards the anterior side

D. punjabiensis, thus, forms a distinct novo species belonging to the species subgroup *montium* of species group *melanogaster*, which is further included in the subgenus *Sophophora*.

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