DROSOPHILID SURVEY OF INDIA

I. Variations in the Five Strains of *Drosophila melanogaster* Meigen and their Relationship with *Drosophila emulata* Ray-Chaudhuri and Mukherjee

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Abstract

The five Indian strains of *Drosophila melanogaster* from Kulu, Chandigarh, Bareilly, Bombay and Cuttack reveal that while the strains from Kulu and Chandigarh resemble *D. melanogaster* Meigen in all taxonomic characters that from Cuttack morphologically resembles *D. emulata* Ray-Chaudhuri and Mukherjee. The strains from Bareilly and Bombay, on the other hand, resemble those from Kulu and Chandigarh in some of the characters but in the others they are similar to that from Cuttack. From the fact that all these strains show high cross fertility and carry similar genic balance in the determination of sex, it appears that they form a continuous population undifferentiated by any isolating mechanism. On the basis of fecundity as well as morphology, Kulu and Chandigarh strains form one extreme and that from Cuttack the other extreme of this population with Bareilly and Bombay strains as the intermediate, connecting these extremities. It has been concluded that the differences between *D. emulata* and *D. melanogaster* do not seem to be of interspecific order.

Introduction

Drosophila melanogaster Meigen is almost a cosmopolitan species and has been reported from all the six geographical regions of the world (Patterson and Stone, 1952). It was reported, for the first time, in India by Sturtevant (1927) from Nungambaukam (Madras). Prabhu (personal communication to Dr. Sharma) collected this species from Matunga (Bombay) and Nai Basti (Bareilly, U.P.) while in this laboratory it is being cultured from Kulu, Chandigarh (Punjab) and Cuttack (Orissa).

In 1941, Ray-Chaudhuri and Mukherjee described from Calcutta a new species, *D. emulata*, which very closely resembles *D. melanogaster*, differing, however, in the general colouration of the body, wing vein indices and the relative size of the body and wing. From the study of the five collections from Kulu, Chandigarh, Bareilly, Bombay and Cuttack, it has been found that the flies from Cuttack exactly resemble the description of *D. emulata* while, on the other hand, the individuals from Kulu and Chandigarh resemble, in most of the details, *D. melanogaster*. The stocks from Bombay and Bareilly resemble *D. emulata* in some of the characters while in the others they resemble *D. melanogaster*.

The present investigations are based on a detailed study of these five strains from India. The extent of genetic variability, in terms of fertility and fecundity between the strains, has also been worked out to determine the genetic relationship of *D. melanogaster* and *D. emulata*.

Material and Methods

The following stocks were used for the present analysis.

1. *K350*

Raised from a single female collected from Kulu (hilly areas of the Punjab State) and mass inbred up to 10 generations.

2. *Ch43*

Raised from a single female collected from Chandigarh (Punjab) and mass inbred up to 14 generations.

3. *M9*

Raised from a single female collected from Matunga (Bombay) and mass inbred up to 66 generations in the Division of Animal Genetics, I.V.R.I., Izatnagar, and for further 12 generations in this department.

4. *Cu528*

Raised from a single inseminated female from Cuttack (Orissa) and mass inbred up to 8 generations.

5. *N58*

Belongs to Nai Basti (Bareilly, U.P.), mass inbred for more than 20 generations in the Division of Animal Genetics, I.V.R.I., Izatnagar, and for another 16 generations in this department.

The external and internal morphology of the imagine was worked out, as usual, with a Carl Zeiss stereomicroscope at various magnifications, mostly at $\times 100$.

Experimental procedure

The relationship of the various strains was tested by cross mating in a number of ways.

The first set of tests was designed to determine the willingness or the ability of the various strains to cross. Mass matings (10 ♀ $\times$ 10 ♂) of all the possible crosses between different strains and their reciprocals were made in half pint milk bottles. The cross fertility of the F_1 progenies was tested by inbreeding in three mass matings of the F_1 flies from each cross. After 7 and 12 days each bottle was checked for the larvae and the offspring respectively. The initial number of mass matings for each cross was two to three.

The first set of experiments indicated that these strains could cross with one another and the number of offspring in each cross was sufficiently large. It was, thus, desired to estimate precisely the percentage of cross fertility and to find out the differences in fecundity by making a comparison of the number of offspring in the various crosses. For such data, a second set of experiments was designed. For the analysis of the F_1, about 25 pair matings of each possible cross were made in $3'' \times 1''$ glass vials. For the F_2, again, the same number of crosses were made from as many as five randomly selected F_1 families. Seven days later, all vials were checked for the larvae. The vials, in which one or both the parents were dead or the food was contaminated or had gone dry, were discarded.

About 50 hours old flies were selected for the various crosses. The progeny in each vial was counted in 4–6 instalments up to the fifteenth day after the appearance of the first pupa.

The flies were bred on standard agar, yeast, raisin and maize food at a constant temperature of 25±1° C.

Observations

I. *Description of the various stocks*

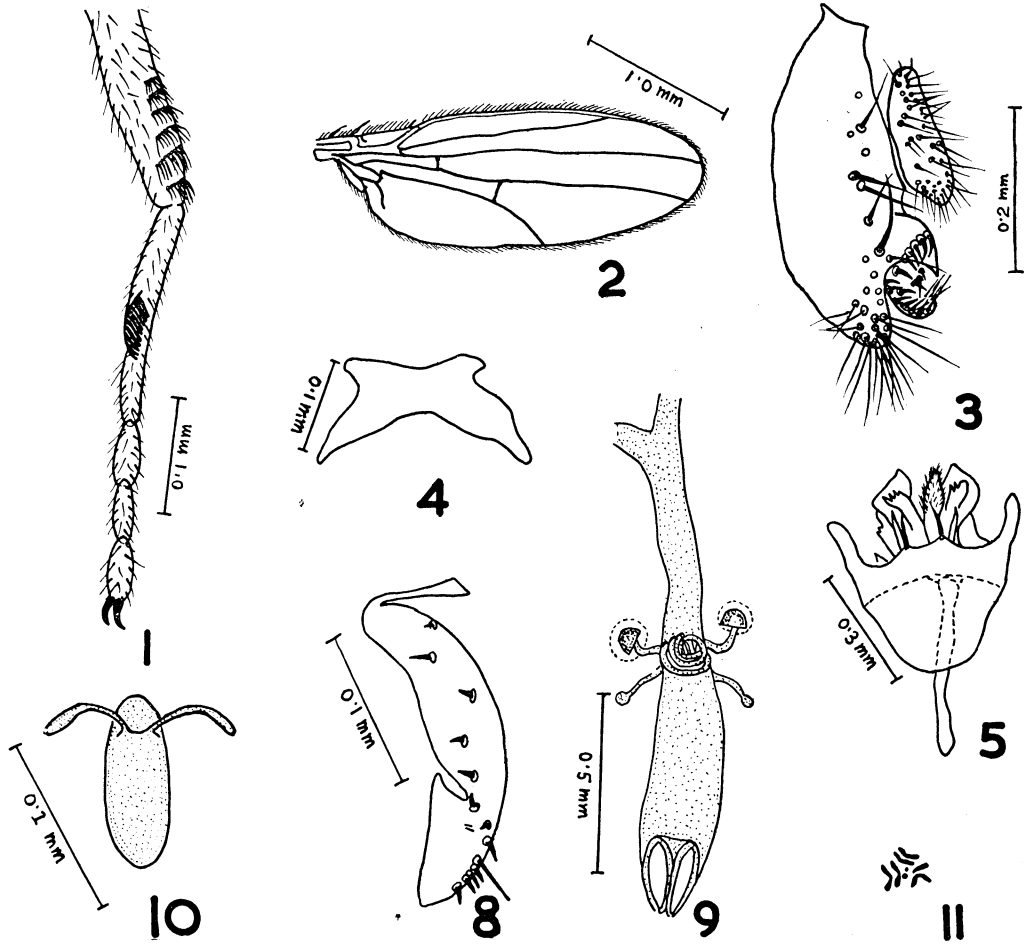
Drosophila melanogaster Meigen 1830

(1) *Kulu stock (K350)*

A. *Description of the imago*

Male imago

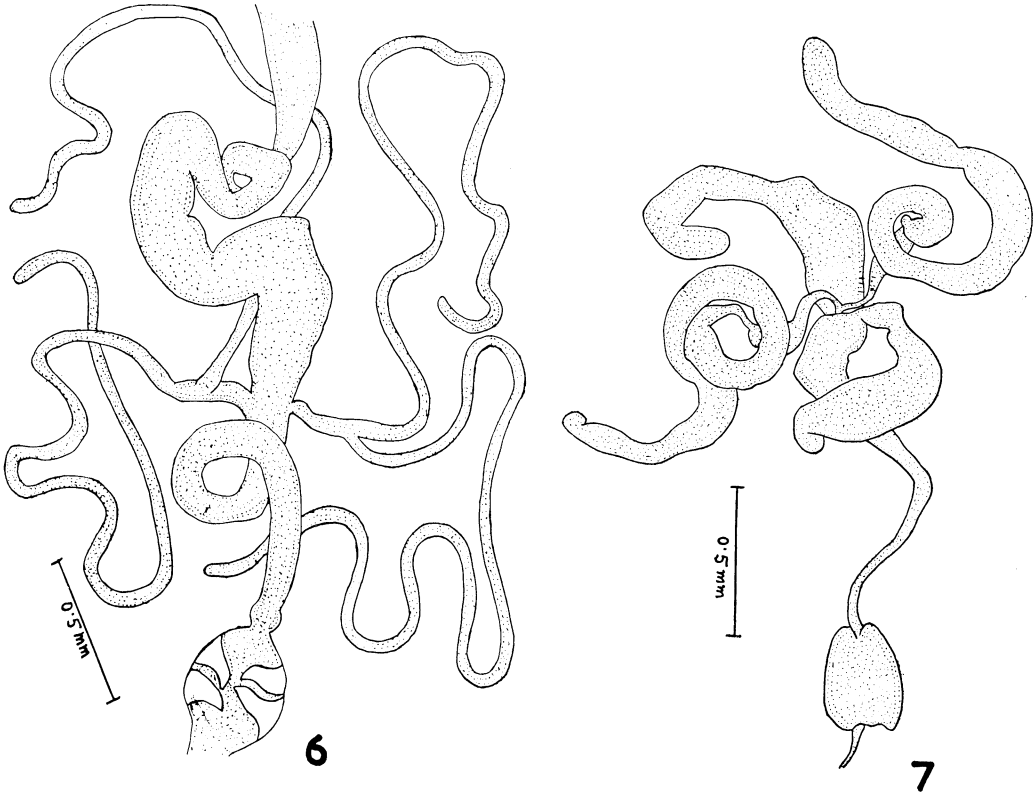
1. *External characters.*—Arista with 5 branches above and 3 below, excluding the terminal fork; antenna light yellowish-brown, 3rd segment yellowish-grey. Front over



Figs. 1 to 5 and 8 to 11. 1, Prothoracic leg of male showing the sex comb; 2, wing; 3, genital arch (lateral view); 4, decasternum; 5, phallic organs (ventral aspect); 8, egg guide; 9, female reproductive organs; 10, egg; 11, neuroblast chromosomes at metaphase ×880.

1/3 the width of head, wider above, yellow. Orb_2 1/3 the size of the other two. Second oral bristle about 5/8 the size of vibrissa. Carina broad, slightly narrow above, flat. Face yellowish-brown. Palpus pale yellow with a few bristles of almost equal size. Cheeks yellowish-brown, their greatest width about 1/5 the greatest diameter of eye. Eyes red with a rather thick pile, ocelli brown.

Acrostichal hairs in 8 rows; pre-scutellars absent, anterior scutellars convergent. Mesonotum and scutellum light yellowish-brown, shining. Humerals 2, equal. Pleura pale brown, sterno-index about 0·5.



Figs. 6 and 7. 6, intestine ; 7, male reproductive organs.

Legs pale yellow; prothoracic legs bearing sex combs (Fig. 1), each comprising 9–11 stout black bristles arranged in an oblique row on inner distal surface of first tarsal joint. Apicals on fore and middle tibiae, pre-apicals on all the three.

Abdomen yellowish-brown with posterior black bands on 2nd, 3rd and 4th tergites, last two tergites shining black.

Wings (Fig. 2) clear with C-1 bristles 2, nearly equal; C-3 bristles on basal 1/3. Costal index about 2·4; 4V-index 2·1; 4C-index 1·2 and 5X-index about 2·4.

Length of the body .. 1·83 mm.
Length of the wing .. 1·85 mm.

2. *Periphalic organs* (Fig. 3).—Genital arch with about 25 bristles from top to toe along the posterior margin; a portion of posterior margin forms an expansion which

covers a part of primary clasper. Heel slightly observable, roundish; toe low and directed downwards. Anal plate oval, its lower portion with comparatively denser bristles. Clasper single, long and narrow; primary teeth arranged in a wavy row, lower portion with two irregular rows of 13 teeth and a tuft of bristles at the tip of clasper surrounded by teeth, one of these quite long and pointed upwards.

Decasternum (Fig. 4).—In the form of broad transverse band, concave on proximal and distal margins.

3. *Phallic organs* (Fig. 5).—Aedeagus bifid, pectinate and with short serration. Anterior paramere small, brown with 3 sensillae. Posterior paramere branched with a flag-like quadrate apical flap. Novasternum without any notch or medium projection, a pair of submedian spines present. Apodeme longer than fragma. PI about 3·5.

4. *Internal structures* (Figs. 6 and 7).—Proximal intestine: C about 2·5. Malpighian tubules with short common stalks and long branches, posterior branches ending free. Rectal papillae: R about 1·7.

Testes yellowish, each with about 2·5 outer and a single inner coil, which is slightly darker in colour. Paragonia folded once and rounded at the apex. Ejaculatory bulb oval; proximal end narrow and incised, distal end broad and bilobed.

Female imago

1. Resembles male except in the absence of sex comb, having light yellowish-brown basal bands on the last 2 tergites as well and further in possessing a black spot on either side of the last tergite.

Length of the body .. 2·4–2·6 mm.
Length of the wing .. 2·4–2·6 mm.

2. *Egg guides* (Fig. 8).—Lobe pale yellow with about 9–12 marginal teeth; ultimate tooth slightly isolated from penultimate one; tip rounded, upper margin with a deep submedian incision. Subterminal hair present between 4th and 5th teeth. Basal isthmus narrow, long and slightly swollen in the middle.

3. *Internal structures* (Fig. 9).—Spermathecae small, toadstool-shaped and chitinized. Parovaria almost rounded and small, ventral receptacle with about 6 whorls lying against the ventral side of the uterus.

B. *Egg* (Fig. 10).—With two filaments, flattened at the tips.

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

D. *Puparium*.—Light amber coloured, posterior spiracles divergent. N.A. 7 and S.B. 1/26.

E. *Chromosomes*.—Salivary glands, 5 long arms and one small; neuroblast, 2 pairs of Vs, one pair of dots; rod-shaped X and J-shaped Y (Fig. 11).

(2) *Chandigarh stock* (*Ch43*).—It resembles in all details the general description of Kulu stock except:

(i) Slightly larger size of the body and the wing.

(ii) Comparatively larger wing indices, which are as follows:

Costal index	..	2·42
4V-index	..	2·28
4C-index	..	1·17
5X-index	..	2·40

(iii) Second oral bristle slightly larger, being 5/6 the size of vibrissa.

(3) *Matunga stock* (*M9*).—This also resembles the Kulu stock with the following differences: Comparatively smaller costal and 5X-indices, costal index 2·03 and 5X-index 2·25 and larger 4V- and 4C-indices being 2·4 and 1·3 respectively.

(4) *Cuttack stock* (*Cu528*).—Although it resembles in almost all morphological details the Kulu stock, its differences are quite pronounced inasmuch as:

(i) The wing length always smaller than that of body; length of the body 2·15 mm. and that of wing 1·92 mm.
(ii) Orb_2 one-half of the size of either.
(iii) Second oral bristle nearly equal to vibrissa.
(iv) Larger costal index and smaller 5X-index, being 2·51 and 1·68 respectively.

(5) *Nai Basti stock* (*N58*).—This resembles more the Cuttack stock than the rest. The following are the differences from the Kulu stock, which are in fact the resemblances with the collections from Cuttack:

(i) The wing length smaller than the length of the body, being 2·11 and 1·96 respectively.
(ii) Vb_2 almost equal to the size of the vibrissa.
(iii) Larger costal and 4V-index, being 2·43 and 2·51 respectively.
(iv) Quite a low 5X-index, being 1·67.

A comparative account of these differences and similarities in these five strains is given in Table I.

II. *Fertility and fecundity between five strains*

Twenty possible crosses between five strains were made by mass mating. A sufficiently large number of offspring were obtained in the F_1 and F_2, comparable to that obtained in the controls, indicating that they can cross with one another freely. The results obtained in these crosses are given in Table II.

The percentage of the cross fertility between the various strains in the F_1 and F_2 was determined by pair mating of all the possible combinations and by inbreeding the F_1 hybrids respectively. All pair matings yielded offspring indicating high fertility of each combination (Tables III and IV).

The actual counts of the F_1 and F_2 progenies of pair matings are given in Tables III and IV. In most of the crosses the males and females are approximately equal but in a few cases the normal sex ratio is deviated in favour of the females. The average number of offspring per fertile pair is also given in these tables.

It was also observed that the various fertile pairs in each combination differ from one another with respect to the number of their offspring (fecundity) and were graded as having high, normal, low and poor fecundity (Tables V and VI). When the number of offspring of a particular pair was more than the average progeny of that particular test, the fecundity was regarded as high; when it approached near that of average, it was placed as normal; when below the average, it was described as low, while the one sufficiently below the average was indicative of poor fecundity.

Discussion

From the description of the five strains, it becomes evident that, although K and Cu strains resemble, in all their details, *D. melanogaster* and *D. emulata* respectively, the

TABLE I

A comparison of the differences and similarities in the various strains of Drosophila melanogaster

Locality	K350	Ch43	M9	Cu528	N58
Characters					
Front head width ..	1/3	1/3	1/3	1/3	1/3
Second orbital bristle ..	1/3 of other two	1/3	1/3	1/2	1/2·6
Vb_2 Vb	5/8	5/6	5/6	10/11	equal
Cheek width/greatest diameter of eye	1/5	1/5	1/5	1/5	1/5
Length of the body ..	1·80 ± 0·06	2·25 ± 0·07	2·05 ± 0·04	2·12 ± 0·05	2·11 ± 0·03
Length of the wing ..	1·83 ± 0·04	2·28 ± 0·05	2·07 ± 0·03	1·92 ± 0·07	1·96 ± 0·06
Costal index	2·35 ± 0·07	2·42 ± 0·08	2·03 ± 0·04	2·51 ± 0·12	2·43 ± 0·14
4V-index	2·14 ± 0·07	2·28 ± 0·13	2·46 ± 0·08	2·14 ± 0·14	2·51 ± 0·17
4C-index	1·12 ± 0·10	1·17 ± 0·12	1·36 ± 0·03	1·08 ± 0·08	1·27 ± 0·11
5X-index	2·31 ± 0·01	2·40 ± 0·13	2·25 ± 0·13	1·68 ± 0·06	1·67 ± 0·07

TABLE II

F_1 and F_2 fertility between five geographical strains as determined by mass mating

Cross ♀ × ♂	Number tested ♀ × ♂	F_1	F_2
Ch × Ch	10 × 10	Fertile	Fertile
K × K	10 × 10	,,	,,
N × N	10 × 10	,,	,,
M × M	10 × 10	,,	,,
Cu × Cu	10 × 10	,,	,,
Ch × K	10 × 10	,,	,,
K × Ch	10 × 10	,,	,,
Ch × N	10 × 10	,,	,,
N × Ch	10 × 10	,,	,,
Ch × M	10 × 10	,,	,,
M × Ch	10 × 10	,,	,,
Ch × Cu	10 × 10	,,	,,
Cu × Ch	10 × 10	,,	,,
K × N	10 × 10	,,	,,
N × K	10 × 10	,,	,,
K × M	10 × 10	,,	,,
M × K	10 × 10	,,	,,
K × Cu	10 × 10	,,	,,
Cu × K	10 × 10	,,	,,
N × M	10 × 10	,,	,,
M × N	10 × 10	,,	,,
N × Cu	10 × 10	,,	,,
Cu × N	10 × 10	,,	,,
M × Cu	10 × 10	,,	,,
Cu × M	10 × 10	,,	,,

collections from Chandigarh, Bareilly and Bombay constitute the intermediate series indicating that they are the continuation of one and the same species. The same is further strengthened by the fact that different strains cross freely with one another without even the slightest sign of sterility as they are not differentiated by any isolating mechanism.

TABLE III

F_1 percentage fertility and average number of offspring per fertile pair

Cross ♀ × ♂	Number tested ♀ × ♂	Percentage fertility	Progeny			Average number of offspring per fertile ♀
			♀	♂	Total	
Ch × Ch	20 × 20	100	1,251	1,276	2,527	126·35
K × K	15 × 15	100	1,037	984	2,021	134·733
N × N	16 × 16	100	1,038	889	1,927	120·437
M × M	25 × 25	100	1,037	1,022	2,059	82·36
Cu × Cu	18 × 18	100	1,003	1,003	2,006	111·444
Ch × K	19 × 19	100	1,546	1,517	3,063	161·21
K × Ch	24 × 24	100	1,911	1,721	3,632	151·333
Ch × N	24 × 24	100	2,324	2,094	4,418	184·084
N × Ch	20 × 20	100	1,693	1,574	3,267	163·35
Ch × M	17 × 17	100	1,264	1,194	2,458	145·176
M × Ch	20 × 20	100	1,270	1,215	2,485	124·25
Ch × Cu	21 × 21	100	1,214	1,156	2,370	112·857
Cu × Ch	25 × 25	100	1,735	1,570	3,305	132·2
K × N	21 × 21	100	1,275	1,304	2,579	122·809
N × K	23 × 23	100	1,973	1,992	3,965	172·391
K × M	24 × 24	100	1,684	1,645	3,329	138·708
M × K	20 × 20	100	1,844	1,819	3,663	183·15
K × Cu	21 × 21	100	1,359	1,340	2,699	128·524
Cu × K	20 × 20	100	1,124	1,190	2,314	115·652
N × M	25 × 25	100	1,814	1,723	3,537	141·48
M × N	23 × 23	100	1,504	1,198	2,702	117·478
N × Cu	24 × 24	100	1,614	1,655	3,269	136·209
Cu × N	21 × 21	100	1,499	1,507	3,006	142·857
M × Cu	13 × 13	100	864	750	1,614	124·154
Cu × M	23 × 23	100	1,779	1,709	3,488	151·652

TABLE IV

F_2 percentage fertility and average number of offspring per fertile pair

Cross ♀ × ♂	Number tested ♀ × ♂	Percentage fertility	Progeny			Average number of offspring per fertile ♀
			♀	♂	Total	
Ch × Ch	24 × 24	100	1,809	1,805	3,614	150·583
K × K	20 × 20	100	992	949	1,941	97·05
N × N	22 × 22	100	1,264	1,210	2,474	112·45
M × M	21 × 21	100	1,066	1,141	2,207	105·95
Cu × Cu	25 × 25	100	1,802	1,820	3,622	144·88
Ch × K	24 × 24	100	1,287	1,277	2,564	106·833
K × Ch	25 × 25	100	1,651	1,768	3,419	136·76
Ch × N	22 × 22	100	1,305	1,347	2,652	120·545
N × Ch	25 × 25	100	1,279	1,400	2,679	107·18
Ch × M	23 × 23	100	1,225	1,149	2,374	103·217
M × Ch	25 × 25	100	1,718	1,559	3,277	131·08
Ch × Cu	18 × 18	100	883	831	1,714	95·222
Cu × Ch	25 × 25	100	1,616	1,482	3,098	123·92
K × N	22 × 22	100	1,401	1,402	2,803	127·409
N × K	25 × 25	100	1,647	1,682	3,329	133·16
K × M	21 × 21	100	1,351	1,414	2,765	131·666
M × K	22 × 22	100	1,327	1,259	2,586	117·545
K × Cu	21 × 21	100	1,331	1,423	2,754	131·143
Cu × K	20 × 20	100	1,245	1,149	2,394	119·673
N × M	25 × 25	100	1,077	1,046	2,123	84·92
M × N	25 × 25	100	2,247	2,062	4,309	172·36
N × Cu	19 × 19	100	784	695	1,479	77·842
Cu × N	24 × 24	100	1,932	1,921	3,853	160·542
M × Cu	22 × 22	100	1,026	1,060	2,086	94·818
Cu × M	19 × 19	100	935	1,003	1,938	102·000

TABLE V

F_1 fecundity in the various strains

Cross ♀ × ♂	Number tested ♀ × ♂	Fecundity			
		High	Normal	Low	Poor
Ch × Ch	20 × 20	6	8	6	—
K × K	15 × 15	3	10	2	—
N × N	16 × 16	6	5	5	—
M × M	25 × 25	6	15	3	1
Cu × Cu	18 × 18	6	7	5	—
Ch × K	19 × 19	5	8	6	—
K × Ch	24 × 24	10	4	10	—
Ch × N	24 × 24	7	7	10	—
N × Ch	20 × 20	6	7	7	—
Ch × M	17 × 17	5	5	7	—
M × Ch	20 × 20	4	11	4	1
Ch × Cu	21 × 21	7	10	2	2
Cu × Ch	25 × 25	6	13	5	1
K × N	21 × 21	4	14	2	1
N × K	23 × 23	1	20	2	—
K × M	24 × 24	6	13	5	—
M × K	20 × 20	3	14	3	—
K × Cu	21 × 21	7	9	4	1
Cu × K	20 × 20	5	8	6	1
N × M	25 × 25	5	13	6	1
M × N	23 × 23	9	8	6	—
N × Cu	24 × 24	7	12	5	—
Cu × N	21 × 21	3	13	5	—
M × Cu	13 × 13	6	2	5	—
Cu × M	23 × 23	5	15	3	—

The various crosses between the different strains show that the number of offspring produced by each in the F_2 is comparatively less than that in the controls. It follows that heterosis does not occur in the crosses, indicating the absence of beneficial mutational differences between these strains. The normal sex ratio, except in a few cases, further indicates that the genic balance in the determination of sex in the various strains is mostly similar so that a chromosome from one strain can replace its homologue in another without producing any gross phenotypic change.

The basic differences between the different populations come to surface only when we compare the fecundity. None of the crosses between Ch and K shows poor fecundity, indicating their high degree of cross fertility. But Ch and K, when crossed to Cu, show some cultures with poor fecundity in the F_1 as well as in the F_2, indicating their comparatively low degree of cross fertility. In crosses between N and M, only one reveals poor fecundity in the F_1 and F_2 but, since in the controls of M there also appeared one culture with poor fecundity, the cross fertility between these two may be considered as normal. When N and M are crossed with Cu and Ch, most of the cultures appear normal, none being with poor fecundity. The average progeny of the various crosses, per pair in the F_1 and F_2, also reflects the same. The average offspring per pair are the highest in the crosses between Ch and K, and the lowest when Ch and K are crossed with Cu, but they are intermediate between the two when Ch, K and Cu are crossed with M and N. It is also interesting to note that Cu when crossed as male with M, Ch and N yields comparatively less progeny than when used as female.

TABLE VI

F_2 fecundity in the various strains

Cross ♀ × ♂	Number tested ♀ × ♂	Fecundity			
		High	Normal	Low	Poor
Ch × Ch	24 × 24	3	16	5	—
K × K	20 × 20	5	12	3	—
N × N	22 × 22	3	17	2	—
M × M	21 × 21	3	14	4	—
Cu × Cu	25 × 25	1	21	3	—
Ch × K	24 × 24	5	15	4	—
K × Ch	25 × 25	6	15	4	—
Ch × N	22 × 22	6	11	5	—
N × Ch	25 × 25	6	15	4	—
Ch × M	23 × 23	5	15	3	—
M × Ch	25 × 25	3	21	1	—
Ch × Cu	18 × 18	7	5	5	1
Cu × Ch	25 × 25	6	14	5	—
K × N	22 × 22	5	15	2	—
N × K	25 × 25	—	24	1	—
K × M	21 × 21	5	12	4	—
M × K	22 × 22	3	16	3	—
K × Cu	21 × 21	10	4	6	1
Cu × K	20 × 20	5	9	5	1
N × M	25 × 25	6	13	5	1
M × N	25 × 25	7	12	6	—
N × Cu	19 × 19	3	15	1	—
Cu × N	24 × 24	6	13	5	—
M × Cu	22 × 22	4	15	3	—
Cu × M	19 × 19	8	7	3	1

On the basis of fecundity as well as morphology, these strains may be divided into three sub-groups:

1. Ch and K strains—at one extreme.
2. Cu strain—at the other extreme.
3. M and N strains—intermediate between the first and second sub-groups.

The fact that Ch and Cu not only cross with each other freely (100% fertility), but the F_1 hybrids are also equally fertile (100% fertility), leads one to doubt if these are *two* distinct species as proposed by Ray-Chaudhuri and Mukherjee (1941). The main question that poses is whether these two populations, with some morphological differences, be regarded as two distinct species in spite of the absence of any isolating mechanism to prevent their gene exchange. With the assembling of knowledge regarding the nature of species in the genus *Drosophila*, one principle, namely the 'isolating mechanism', has become especially evident. Elaborating the importance of isolating mechanism, Dobzhansky (1935, 1937 and 1959) states that species are groups of population in which the gene exchange is limited by one or more reproductive isolating mechanisms. To quote a few more references, Emerson (1938), Epling (1939), Huxley (1942), Muller (1942), Patterson (1942), Thorpe (1940), Mayr (1940, 1942, 1948 and 1949), Simpson (1943), Timofeeff-Ressovsky (1940), Cain (1944), Darlington and Mather (1949), Allee *et al.* (1949), Schmalhausen (1949), Bates (1949) and Stebbins (1950) are also of the opinion that the development of the

isolating mechanism is essential for the process of speciation. Gates (1948) and Sturtevant (1942), on the other hand, regard the species differences on the basis of morphology only.

There is no doubt that Ch and Cu populations are distinct with regard to some characters of taxonomic importance like the wing-vein indices and the proportion of the lengths of wing and body, but these morphological changes are incapable of separating a species into two non-interbreeding independent species.

With all the evidences at our hands, it is quite reasonable to assert that the populations, under study, represent the different strains of one species, *i.e. D. melanogaster*, but amongst these Cu (*D. emulata* according to Ray-Chaudhuri and Mukherjee, 1941) has become differentiated in some morphological characters and fecundity.

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