CROSSING AND SEXUAL ISOLATION OF EGYPTIAN FORMS
OF MUSCA DOMESTICA (DIPTERA, MUSCIDAE)

Dissertation

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INTRODUCTION

House flies are important factors in the public health of Egypt. In order to assess fully the best methods for control of flies in Egypt, the United States Naval Medical Research Unit No. 3 and other institutions have undertaken studies on insecticides and bionomics of these insects (Peffly 1953). As soon as these studies were begun, it became apparent that there was little agreement among taxonomists concerning the various forms of Musca domestica in Egypt. Morphological characters tended to be confusing, and biological differences were poorly understood. It was therefore decided to attempt to clarify these matters on the basis of (1) field and laboratory biological studies, and (2) investigations of crossing and sexual isolation. In conjunction with the latter phase, a specialist in muscoid taxonomy made a brief field survey chiefly to advise on diagnostic morphological characters (Sabrosky 1952).

Although the typical form, Musca domestica L., must be introduced frequently into Egypt via ships and planes, it has seldom or never been recognized there. The chief forms in Egypt are vicina Macq. and cuthbertsoni Patton. They were considered valid and distinct species by Van Emden (1939), but Sabrosky (1952) tentatively regarded them as subspecies of domestica. These forms would not

be regarded as subspecies by Mayr (1942) because they occur in the same geographic area. Sabrosky believed flies from Egypt identified as nebuloso Fab. to be merely occasional variant individuals.

Van Emden (1939) differentiated these forms from typical domestica and from each other chiefly by variations in length and strength of postsutural dorsocentral bristles (in both sexes) and by relation of frons width to width of the third antennal segment of males.

Van Emden separated the forms in this complex as follows:

1. All postsutural dorsocentral bristles strong 2

The anterior 2-3 postsutural dorsocentral bristles

weak, obviously shorter and weaker than the two

nearest the scutellum; frons of male about as

wide as the third antennal segment or narrower;

abdomen bright orange, not or only slightly

infusate on the fourth segment, median vitta

narrow on third segment and usually absent on

fourth Musca cuthbertsoni Patton

2. Male frons* about three times as wide as third an-

tennal segment; abdomen largely infusate in

female, at least third and fourth segments in-

fusate in male Musca domestica L.

*Van Emden demonstrated a gradual transition between domestica, vicina and nebuloso.

Male frons* less than three times as wide as third antennal segment; abdomen more or less bright orange, especially at sides of base, usually darkened on fourth segment and at least apex of third in male M. vicina Macq. (including form nebuloso Fab.)

Sabrosky (1952) suggested that, instead of the relation between frons width and third antennal segment, the relation between frons width and head width be used. In the studies described herein, this relationship and the bristle character were used.

In general, a male specimen having long and strong postsutural dorsocentral bristles and a frons width about 10 per cent of the head width would be identified as vicina. A specimen having the first two or three pairs of postsutural dorsocentrals short and frons width about 5 per cent of head width would be identified as cuthbertsoni. These percentages were determined from measurements of laboratory strains (tables 1 and 2). In cuthbertsoni the ratio of frons width to head width was 0.046 (range 0.019-0.093, S.D. 0.012), in vicina this ratio was 0.092 (range 0.042-0.120, S.D. 0.013).

*Van Emden demonstrated a gradual transition between domestica, vicina and nebuloso.

TABLE 1

Percentage distribution of the ratio of the first to the fourth postsutural dorsocentral bristle of laboratory strains of vicina (long) and cuthbertsoni (short) and crosses between the two

Ratio	: Long x : long	: Short x : short	: Long x : short (F_1)	: Int.* x : int. (F_2)	: Int. x : int. (F_3)	: Int. x : long	: Int. x : short
.101-.150	--	1	1	1	1	--	1
.151-.200	1	3	2	1	3	2	1
.201-.250	1	6	2	3	3	2	5
.251-.300	1	12	3	4	3	--	14
.301-.350	--	26	5	2	5	1	19
.351-.400	--	19	9	4	5	1	14
.401-.450	3	14	10	8	11	4	18
.451-.500	8	10	22	18	23	12	8
.501-.550	10	5	21	16	18	18	11
.551-.600	27	4	14	25	13	21	8
.601-.650	29	1	11	14	9	22	1
.651-.700	16	--	2	6	5	13	1
.701-.750	5	--	--	--	1	4	--
.751-.800	1	--	--	--	--	--	--
No. of flies	176	235	666	177	186	256	80
Mean	.591	.368	.480	.510	.477	.558	.394
S.D.	.084	.097	.107	.113	.126	.108	.112

*Int. = intermediate, progeny of crosses between longs and shorts.

TABLE 2

Percentage distribution of the ratio of the frons to head width of males of laboratory strains of vicina (long) and cuthbertsoni (short) and crosses between the two.

Ratio	: Long x : long	: Short x : short	: Long x : short (F_1)	: Int.* x : int. (F_2)	: Int. x : int. (F_3)	: Int. x : long	: Int. x : short
.011-.020	--	1	--	--	--	--	--
.021-.030	--	3	--	1	--	--	--
.031-.040	--	30	--	2	--	--	--
.041-.050	1	29	1	5	1	--	12
.051-.060	2	28	12	10	10	--	12
.061-.070	1	6	29	8	18	2	37
.071-.080	13	2	26	19	10	14	10
.081-.090	24	--	17	9	17	19	17
.091-.100	29	1	9	29	5	18	7
.101-.110	28	--	5	10	21	34	5
.111-.120	4	--	1	6	8	11	--
.121-.130	--	--	--	--	10	1	--
.131-.140	--	--	--	--	1	--	--
.141-.150	--	--	--	2	--	--	--
No. of flies	136	139	470	108	189	135	41
Mean	.092	.046	.075	.083	.089	.096	.070
S.D.	.013	.012	.014	.022	.022	.014	.016

*Int. = intermediate, progeny of crosses between longs and shorts.

EFFECT OF INTERBREEDING ON DIFFERENTIATING TAXONOMIC CHARACTERS

Laboratory strains of vicina and cuthbertsoni were crossed to determine the effect of these crossings on characters used to differentiate the two forms. The vicina strain was obtained from an Egyptian village near Cairo and the cuthbertsoni strain from a suburban slaughter house. When these experiments were started, the vicina strain had been reared in the laboratory for over 70 generations and the cuthbertsoni strain for over 20 generations.

Flies newly emerged from the laboratory strains were segregated by sexes. Individuals were selected for long- and short-bristledness. To make the selections, flies were immobilized with carbon dioxide and observed through the medium power of a dissecting microscope. A suitable male and a suitable female were placed in a 3- by 9-inch cylindrical screen cage and provided with food (milk-soaked cellucotton).

The record of each pair included bristle measurements, date of pairing, dates of egg laying, and number and sex of emerging flies.

To determine the normal range in bristle ratios of each type, long-long pairings and short-short pairings were made. Long- and short-bristled flies were paired as

well as two generations of their progeny. Progeny of long-short crosses were also backcrossed.

Unless needed for further pairings, emerging flies were not fed and consequently died in about 1 day. Twenty-five of each sex were pinned and placed in a Schmidt box. Measurements were made of the first and fourth post-sutural dorsocentral bristles, of frons width at its narrowest point, and of the head at its widest point. The ratio of the length of the first to fourth bristle of each specimen and of frons to head width of each male was calculated. Averages of these ratios and their percentage distribution were determined. Intervals of 0.05 and 0.01 were used to distribute the bristle ratio and frons-head-width ratios, respectively.

The results of these calculations are shown in tables 1 and 2.

Although there was overlapping between the two forms, each had a distinct and separate distribution of ratios. Most of the progeny resulting from crosses between the two forms had bristle ratios intermediate between the two parent forms, but more had long bristles than short ones. In second- and third-generation progeny the distribution of these ratios was almost like that of the first generation. Progeny produced from backcrosses tended to fall into the type group to which the backcross

had been made.

The results of these crosses on frons-head-width ratios of males were equally distinctly marked. It should be recalled that original crosses were made between flies selected for a given bristle character. Short-bristled flies produced narrow-frons specimens, long-bristled flies produced wider frons. Progeny of crosses between the two had intermediate frons-head-width ratios. Second and third generations had ratios distributed over the entire range, though most fell into the wider-frons, long-bristled group. Progeny of backcrosses to shorts tended to have narrow frons, those of backcrosses to longs had wider frons.

These studies provide information on what may be expected in field collections. If the two forms do interbreed in nature, as they readily did in these tests, most progeny would appear to be vicina.

Because the range of both the bristle character and frons-head-width ratio of each group overlaps, the group to which "intermediate" specimens belong cannot readily be determined.

SEXUAL ISOLATION TESTS

In the previous tests flies of the two kinds were confined together and were forced to mate. While these tests were in progress, it was noted that pairings of

short-bristled flies were not so successful as those of long-bristled ones. More time was required to obtain the first viable eggs and a smaller percentage of pairings resulted in viable eggs. Dr. Dobzhansky, who was consulted on this problem, suggested that male-multiple-choice tests with flies two generations removed from the field would better determine the degree of sexual isolation, if any.

Dobzhansky (1950) pointed out that it was not sufficient evidence to report that two forms interbred and produced fertile offspring in the laboratory. Many insects, when "forced" in the laboratory, do just that. What really matters is not whether Mendelian populations do or do not exchange genes in nature, but, if they do, whether it is at a rate that destroys the adaptive equilibrium of the populations concerned.

Colonization of Field Strains

Field collections were made at two locations, a Cairo dump and a suburban slaughter house. Both types of flies were present at both places, but vicina (long-bristle) was predominant at the dump and cuthbertsoni (short-bristle) at the slaughter house.

Females with the desired bristle character were isolated in 3- by 9-inch cylindrical screen cages. The food material, milk-soaked cellucotton, was examined

daily for eggs or larvae. Eggs or larvae were counted and placed in CSMA media at the rate per egg or larva of 1.5 grams of the mixed media. Adults reared from them were selected for further propagation. Enough flies were used to provide an ample number of flies for tests with the subsequent generation.

At first progeny of each isolated wild female were kept separate. This procedure entailed a great amount of labor and space. It was observed that differences in mating behavior of the two strains were so constant that the additional work of keeping isolated strains from individual wild females was discontinued. Thereafter, groups of selected females from the two field sources were isolated. This procedure was less arduous and also guaranteed a constant supply of both types of flies for multiple choice and other tests.

Difference in Mating Propensity

In male multiple choice tests it is important that only 50 per cent of the females be inseminated. Several series of tests were run to determine conditions under which 50 per cent insemination might be expected. Half as many males as females were used. Longs were confined with longs and shorts with shorts. With laboratory strains 50 per cent insemination occurred between 2 and 3 days.

With flies two generations from the field, the long-bristled type mated readily but the short-bristled type did not. Newly emerged flies were confined in cages for 2, 3, 4, and 5 days. No short females were inseminated in 3 days, but 86 per cent of the long females were. Only 19 per cent of the shorts were inseminated in 4 days and 17 per cent in 5 days.

In other tests the sexes of newly emerged flies were segregated and united, longs with longs and shorts with shorts, after 1, 2, 4, 5, or 6 days. On the following day the females were dissected. Under these conditions 50 per cent of the long-bristled flies were inseminated between the third and fourth days, but even when 7 days old only 25 per cent of the shorts were inseminated.

In the above tests flies taken at random from each strain were used. It has been our experience, however, that there is a considerable amount of overlapping of bristle ratios between the two strains. Therefore, the experiments were repeated with flies which were individually examined before use. Short-bristledness was considered to be 0.4 or less, i.e., the length of first bristle no more than 0.4 that of last bristle. Flies were considered as long-bristled when this ratio was 0.5 or more. Selected 3-day and 7-day old flies were placed in 600-ml. beakers, covered with stockinet, and were held

for exactly 24 hours.

The results (table 3) show that long-bristled flies mated much more readily than short ones. Insemination among short-bristled females did not reach 50 per cent. Increased age to 7 days did not alter the mating propensity of either type. Laboratory strains of both types mated much more readily than flies only two generations from the field.

Male-Multiple-Choice Tests

In male-multiple-choice tests as described by Bateman (1949), equal numbers of two strains of females are enclosed in one cage with half as many males of one of these strains. In another cage males of the other strain are enclosed with both types of females. After a lapse of time sufficient to give 50 per cent insemination, the distribution of inseminated females between the strains is observed. The sum of the interstrain matings divided by the sum of the intrastrain matings is the sexual-isolation estimate (Merrell 1950). When the estimate is 0, complete isolation exists, i.e., no interstrain matings occur. If the estimate is 1, no isolation exists, i.e., mating between both types occurs at random.

In each of the male-multiple-choice tests described in this paper two cages were used. In one cage, 10 short- and 10 long-bristled females were confined with

TABLE 3

Mating propensities of long- and short-bristled flies. Five males and 10 females used in each test. Ten tests each 24 hours long.

Source		Age	Bristle	Percentage of females inseminated	
		:(days):	type :	Average	Range
F ₂ - field	4		Short	6	0-30
			Long	65	40-100
	8		Short	10	0-40
			Long	60	30-80
Laboratory	4		Short	80	50-100
			Long	87	60-100

10 long-bristled males. In the other cage, 10 females of each of the two strains were confined with 10 short-bristled males.

Male-multiple-choice tests with flies confined in 600-ml. beakers, although showing a high degree of sexual isolation between the two forms, were not completely satisfactory, largely because of lack of mating by short-bristled flies.

In similar tests using 1-cubic-foot screen cages, there was considerably more breeding of the short-bristled strain. The results (table 4) are of tests with flies that were 3 days old when the tests were begun and 7 days old when they were finished. The two forms are sexually isolated. The isolation was especially significant with selected second- and third-generation flies and with unselected third-generation flies. By the fourth generation, however, especially with unselected flies, so many more than half the females were inseminated that the tests were of no value in showing isolation. The reason for the isolation shown was the considerably greater amount of mating among long-bristled flies.

Tests with Selected Flies

A colony of short-bristled flies was maintained at the laboratory for more than 20 generations. In order to keep the colony short-bristled, it was important to

TABLE 4

Summary of male-multiple-choice tests of long- and short-bristled flies. Flies 3 to 7 days old during tests.

Generation : from field	Type : of : Male :	Ratio of inseminated : to total females	Percent of : total females : inseminated	Merrell : isolation : estimate	Adjusted : chi : square
		Short : Long			
Flies selected for bristle character					
Second	Short	17/84	8/92	14	
	Long	12/89	82/92	52	0.202
Third	Short	29/91	41/96	37	
	Long	26/92	91/97	62	.558
Fourth	Short	32/46	24/46	62	
	Long	24/48	39/45	68	.676
Flies not selected for bristle character					
Second	Short	3/26	0/27	6	
	Long	9/26	22/30	55	.360
Third	Short	77/137	61/133	51	
	Long	56/136	120/127	67	.594
Fourth	Short	24/30	23/29	80	
	Long	19/28	28/29	82	.807
Fourth ^{1/}	Short	59/110	45/109	47	
	Long	50/110	64/109	52	.772

^{1/} Flies 3-4 days old during tests.

select parents having short bristles. Otherwise the short-bristled character was suppressed by long-bristledness. It is true that long-bristled flies are closely related genetically to the short-bristled flies in this strain, and it would seem that they should act similarly with regard to their desire to mate. Male-multiple-choice tests and mating-propensity tests were run with succeeding generations of both strains to determine whether selected and unselected flies reacted differently--that is, whether long- and intermediate-bristled flies in the short-bristled strain mated just as their short-bristled sibs.

Table 4 shows that over 10 per cent more inter-strain mating occurred among unselected flies than among selected ones. This resulted in a higher sexual isolation estimate. By the fourth generation so much mating occurred that the tests were not valid. That is, so many more than half the females were inseminated that the point at which sexual isolation could be demonstrated was exceeded. When 3- to 4-day tests were made with this generation, close to 50 per cent insemination occurred, but there was so much interstrain mating that the sexual isolation estimate was high.

In mating-propensity tests 5 males and 10 females were confined together, long females with long males and

shorts with shorts. Flies were selected until the fourth generation; in later generations it was difficult to find enough short-bristled flies in the short colony. Until the third generation no marked differences were shown between the number of selected and unselected females that were inseminated. By the fourth generation, however, especially among short-bristled flies, a marked difference was shown. It appears then that there may be an association between bristle length and mating propensity in the short-bristled strain. Long-bristled flies from the short strain mated more readily than their short-bristled siblings.

Table 3 shows a difference in the number of inseminated females between long- and short-bristled field strains. The table also shows that, after many generations in the laboratory, the mating propensity of both strains increased until there was very little or no difference between them. It was noted that erroneous conclusions might be made if laboratory rather than field strains were used.

Mating-propensity tests were run with flies from each generation from the second to the seventh. As shown in table 5, the percentage of inseminated females in the short strain was markedly higher in the fourth generation than in previous generations and continued

TABLE 5

Percentage of females inseminated by their own kind of males in succeeding generations in the laboratory.

Generation from field	Short-bristled		Long-bristled	
	females		females	
	Selected	Unselected	Selected	Unselected
F ₂	6	0	65	53
F ₃	0	0	65	78
F ₄	6	37	55	73
F ₅	--	34	--	63
F ₆	--	45	--	64
F ₇	--	67	--	88
Laboratory colony	80	--	87	--

at the higher rate in the next three generations. No marked change occurred among the long-bristled flies.

Loss of Short-Bristled Character During Continued Rearing of Field Strain

After the laboratory strain of cuthbertsoni was started from short-bristled specimens, it was observed that many progeny had long bristles. It was found that in order to keep the colony short-bristled, all parents had to be selected for short-bristledness. During the summer and autumn, ample numbers of short-bristled females were collected from the field source of this strain, but when the weather became cooler, fewer and fewer short-bristled females were collected. The percentage of shorts present in collections from June to September was 70 per cent; it decreased to 50 per cent in October, to 15 per cent in November, to 7 per cent in December, and to 0 in January.

As previously described, wild females were selected for short bristles and their progeny were also selected for the same character. As a result, most second-generation flies were short-bristled. No further selection of parents was made in succeeding generations. The length of the first and fourth postsutural dorsocentral bristles of 50 males and 50 females in each generation from the first to the seventh was measured. The findings (table 6)

TABLE 6

Percent distribution of ratios of the first to fourth postsutural dorsocentral bristles of field strains of long- and short-bristled flies with continuous laboratory rearing.

Ratio	Long strain						Short strain					
	F ₂	F ₃	F ₄	F ₅	F ₆	F ₇	F ₂	F ₃	F ₄	F ₅	F ₆	F ₇
.051-.100	1	--	--	--	--	--	--	--	--	--	--	--
.101-.150	1	--	--	--	--	--	2	--	--	--	--	--
.151-.200	--	--	--	--	--	--	3	--	--	--	--	--
.201-.250	--	--	--	--	--	--	6	--	--	--	1	--
.251-.300	--	--	--	--	--	--	19	--	1	2	--	--
.301-.350	1	--	--	--	--	--	23	7	3	2	1	--
.351-.400	--	--	--	--	--	--	23	17	3	2	3	--
.401-.450	1	--	--	2	--	1	15	14	12	9	12	4
.451-.500	2	8	1	1	3	2	6	27	13	14	13	8
.501-.550	9	9	5	9	4	10	2	12	13	13	9	21
.551-.600	24	31	30	23	14	31	1	14	20	25	23	21
.601-.650	27	29	39	30	38	22	--	5	15	16	18	23
.651-.700	23	19	21	28	26	24	--	4	17	13	13	18
.701-.750	9	4	3	7	14	9	--	--	3	3	6	5
.751-.800	2	--	--	--	1	--	--	--	--	1	1	--
.801-.850	--	--	1	--	--	1	--	--	--	1	--	--

show that higher percentages of long-bristled flies occur in successive generations of the original short-bristled strain, but that the distribution in the original long-bristled strain changed only slightly from generation to generation.

The distribution of frons to head width ratios of succeeding generations (not including the third) is shown in table 7. In the short strain this character did not change so rapidly as the bristle character, but by the fourth and following generations a higher percentage of wider frons appeared.

INTERBREEDING OF VICINA AND DOMESTICA

Reasons and Methods

Because of the difficulty in differentiating vicina and domestica, these forms have been regarded by many authors as a single one with world-wide distribution. However, Patton (1936) and Van Emden (1939) differentiated between the two. They claim that vicina apparently occurs throughout the warmer parts of the Old World, including Africa, India, and the warmer parts of the Palearctic region. It also extends into the New World, at least in the West Indies. M. domestica occurs throughout the Temperate regions.

According to Patton, domestica has never become established in Africa. This assertion arouses interest because domestica is undoubtedly introduced almost daily

TABLE 7

Percent distribution of ratios of frons to head width
of males from field strains of long- and short-
bristled flies with continuous laboratory rearing.

Ratio	Long strain					Short strain				
	F ₂	F ₄	F ₅	F ₆	F ₇	F ₂	F ₄	F ₅	F ₆	F ₇
.021-.030	--	--	--	--	--	2	--	--	--	--
.031-.040	--	--	--	--	--	19	--	--	--	--
.041-.050	--	--	--	--	4	28	6	2	12	10
.051-.060	--	--	--	--	--	35	24	5	--	--
.061-.070	3	--	--	2	20	9	12	21	16	18
.071-.080	13	2	--	22	--	3	24	26	20	20
.081-.090	27	4	2	8	32	3	12	21	4	14
.091-.100	35	20	20	24	14	1	10	12	36	28
.101-.110	15	28	22	26	12	--	8	10	8	6
.111-.120	7	30	22	10	14	--	4	3	4	4
.121-.130	1	16	24	4	2	--	--	--	--	--
.131-.140	--	--	10	4	--	--	--	--	--	--
.141-.150	1	--	--	--	2	--	--	--	--	--

from ships and planes. Furthermore, breeding requirements of the two appear to be similar. In order to determine the potentiality of domestica survival in Egypt, pupae from a laboratory colony were obtained from G. Sacca of the Istituto Superiore di Sanità in Rome.

It is almost impossible to distinguish females of the two forms, but males differ in frons width; domestica males have a wide frons and vicina a narrow one. This differentiating character, however, is subject to quantitative variation.

Several methods of measuring the relation between frons width and other parts of the head have been used. Patton (1933) used the relation between frons and the width of the eye. In domestica the frons is approximately half the width of the eye, but in vicina it is approximately one-third. Van Emden (1939) used the relation between the frons and the third antennal segment. In domestica the frons of the male at the narrowest point is about three times as wide as the third antennal segment; in vicina it is less than three times as wide. Sabrosky (correspondence) suggested that it would be preferable to compare the narrowest width of the frons to the widest head width. He pointed out that the antennae are often curled or shrunken and easily knocked off. Furthermore, unless high magnification is used, one would be comparing

measures of only a few units, and errors would be greater. In crosses reported herein the ratio of frons to head width has been used.

Rearing of all flies in these tests was done in CSMA media composed of bran and alfalfa meal to which yeast, malt, and water were added. Egg batches laid by various females were counted, and each egg was allowed 1.5 grams of mixed media in rearing containers. Flies not needed for further mating tests were allowed to die in the rearing jars, and then collected, pinned, and placed in an insect box for measurements.

Series of vicina and domestica specimens were measured to obtain the range of each type. Crosses of the two types of flies were made, the eggs were planted, and the progeny collected and measured. First-generation hybrids were also crossed. Backcrosses to vicina and domestica were also made.

Results

The distribution of the ratio of frons to head width of males in various crosses is shown in table 8. Typical vicina and domestica males fall into two distinct groups with very little overlapping. When the two forms were crossed, most of the progeny fell in almost the same group

TABLE 8

Percent distribution of ratios of frons to head width of males in laboratory strains of vicina (Mv), domestica (Md), crosses between the two, the F₂ generation and backcrosses.

Ratio	: Mv x : : Mv	Md x : Md	Mv x : Md	x : F ₂	Backcross : to Mv	Backcross to Md
.041-.050	--	--	1	--	--	--
.051-.060	--	--	--	1	--	--
.061-.070	2	--	2	1	1	--
.071-.080	15	--	4	4	3	--
.081-.090	29	--	13	21	17	--
.091-.100	34	--	28	25	43	4
.101-.110	15	--	21	24	24	12
.111-.120	3	1	19	15	7	48
.121-.130	1	7	8	6	3	16
.131-.140	1	17	3	4	1	16
.141-.150	--	18	--	--	--	4
.151-.160	--	17	--	--	--	--
.161-.170	--	17	--	--	--	--
.171-.180	--	12	--	--	--	--
.181-.190	--	6	--	--	--	--
.191-.200	--	4	--	--	--	--
No. of flies	147	208	277	140	144	25
Mean	.091	.154	.101	.101	.097	.119
S.D.	.012	.019	.016	.015	.011	.011

as typical vicina. In a backcross to typical domestica, a trend to wider frons (i.e., domestica) was shown.

The distribution of these ratios indicates that the narrow frons character of vicina is dominant over wide frons of domestica. If a pair of these two types were to mate in nature, as these strains did under experimental conditions, the progeny would likely appear to be vicina. Furthermore, when these F_1 flies mated in nature in Egypt, where only vicina occurs, chances are great that F_2 progeny would appear to be vicina, not domestica.

It appears that the reason domestica as such has not become established in Egypt is that it loses its identity when breeding with native flies--i.e., the narrow frons of vicina is a character dominant over the wide frons of domestica.

Ratios of frons to head width of female progeny in these crosses were also calculated (table 9). Even though there is a slight tendency for domestica females to have a wider frons than vicina females, the difference is so small that this character is of no value in differentiating the two types of females.

SUMMARY

Laboratory studies of crossing and sexual isolation between some forms in the Musca domestica complex were

TABLE 9

Percent distribution of ratios of frons to head width of females in laboratory strains of vicina (Mv), domestica (Md), crosses between the two, the F_2 generation and backcrosses.

Ratio	: :	Mv x Mv	Md x Md	Mv x Md	: :	x F_2	: :	Backcross to Mv	: :	Backcross to Md
.261-.270	--		1	--	--	--	--	--	--	--
.271-.280	10	--		2	--	--	--	--	--	--
.281-.290	12		2	--	1	2		4		
.291-.300	34		4	12	10	13		16		
.301-.310	22	23	42	16	30	44		20		
.311-.320	18	30	24	32	46					
.321-.330	4	28	19	26	7	16				
.331-.340	--	11	1	13	2	--		--		--
.341-.350	--	1	--	2	--	--		--		--
.351-.360	--	1	--	--	--	--		--		--
.361-.370	--	1	--	--	--	--		--		--
No. of flies	50	252	116	92	46	25				
Mean	.299	.317	.310	.317	.310	.308				
S.D.	.013	.013	.011	.013	.009	.010				

made in an attempt to clarify some of the existing confusion in this complex in Egypt. Characters used to differentiate vicina and cuthbertsoni were the ratio of first to fourth dorsocentral bristle in both sexes and the ratio of frons width to head width in males. Laboratory strains of these two forms readily interbred and produced fertile offspring. Ratios of differentiating characters of progeny fell between those of the two parent forms, but tended to be closer to vicina than cuthbertsoni. The ratio in progeny from backcrosses fell into the range of the type to which the backcross had been made. Results indicated that vicina characteristics are dominant over those of cuthbertsoni.

Sexual-isolation tests were run between the two strains of second, third, and fourth generations from wild fertilized females. In male-multiple-choice tests these two strains were sexually isolated in the second and third generations; by the fourth generation, though isolation was still evident, it was much reduced. The degree of isolation was due largely to the greater amount of mating by vicina and to the greater attraction of vicina males for vicina females.

The mating propensity of laboratory strains of those two subspecies was about equal. Wild strains, only two or three generations removed from the field, did not

mate so readily as laboratory strains. This lack of mating propensity was marked in cuthbertsoni. After several laboratory generations cuthbertsoni manifested a greater mating propensity. The mating propensity of vicina changed little during the first seven laboratory generations. Biological tests with those forms should utilize flies fresh from the field.

Vicina-like siblings in the cuthbertsoni strain mated more readily than did siblings that appeared to be cuthbertsoni.

Without constant selection of parents, the short-bristled character of cuthbertsoni was dominated by long-bristledness of vicina. This tendency also carried over into the frons-head width ratios. Thus it may not always be possible to identify field-collected specimens to the correct form.

Male vicina and domestica were differentiated on the basis of frons-width and head-width ratios. When laboratory strains of the two were crossed, ratios of the progeny were almost those of typical vicina. In other crosses (F_1 and backcrosses) the same tendency was shown. Characteristics of vicina are therefore considered dominant over those of domestica. This fact may largely explain why domestica has never become established in Egypt.

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AUTOBIOGRAPHY

I, Robert Luther Peffly, was born in Saginaw, Michigan, October 13, 1911. I received my secondary school education in the public schools of the city of Lima, Ohio. My undergraduate training was obtained at Capital University, Columbus, Ohio, where I received the degrees, Bachelor of Science in 1937 and Bachelor of Science in Education in 1938. I taught science courses from 1937 to 1940 in the New Washington, Ohio public school. From the Ohio State University, I received the degree Master of Science in 1941. I acted in the capacity of assistant to Dr. L. L. Huber at the Ohio Agricultural Experiment Station from June, 1941 to May, 1942. From June, 1942 until September, 1943, I was shift supervisor chemist at the Plum Brook Ordnance works, Sandusky, Ohio. In September, 1943, I received an appointment as research assistant in the Research Foundation at the Ohio State University where I remained until 1947. During this period I completed the requirements for the degree Doctor of Philosophy. From 1947 until the present, I have been employed as an entomologist by the United States Department of Agriculture, working for two years in Orlando, Florida and for five years in Cairo, Egypt.