been begun from which it is hoped to obtain enough cross-overs to estimate with some accuracy the intensity of the linkage.

Whatever the quantitative result of these tests may be, the fact is already established by the occurrence of a single cross-over that the genes for short-ear and dilution, although borne in a common chromosome, are *not* at identical loci.

The experiments have been carried out at the Bussey Institution under the direction of Dr. W. E. Castle, to whom the author is greatly indebted for invaluable suggestions and assistance.

Gates, W. H., "Linkage of Short Ear and Density in the House Mouse," *Proc. Nat. Acad. Sci.*, **13**, pp. 575–578, 1927.

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EVIDENCE THAT THE FEMALE IS RESPONSIBLE FOR THE SEX RATIO IN SCIARA (DIPTERA)[1]

BY MILDRED S. MOSES AND CHAS. W. METZ

DEPARTMENT OF GENETICS, CARNEGIE INSTITUTION OF WASHINGTON

COLD SPRING HARBOR, N. Y.

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Species of Sciara, as has already been noted,[2] are of two kinds in respect to sex ratios: (1) those which typically give "unisexual" progenies and (2) those which typically give "bisexual" progenies.[3] In the former, pair matings give offspring entirely or almost entirely of one sex, either males or females. In the latter type, pair matings regularly give offspring of both sexes, but often in ratios deviating widely from 1:1. The present paper is concerned with experiments on species of the former type and deals specifically with only two features: (1) with evidence showing that the sex ratio is determined by the female, not the male[4] and (2) with evidence indicating that in *Sciara coprophila* Lint., the eggs of any one female are fertilized by sperm from only one male. The question of sex determination itself is not considered here, but will be treated in another paper.

In order to determine which sex is responsible for the sex ratio, individual males were tested separately with several females and individual females were tested separately with several males. These experiments were carried out on two different species—*S. coprophila* Lint. and *S. impatiens* Joh., with the same result in both cases. In testing individual males, matings were made in two ways. First, one male and several females were put together in a single culture. The preliminary matings of this type gave the results summarized below.

S. coprophila. Twenty-two progenies were clearly of the "unisexual" type, 6 were doubtful, due to small numbers, and 10 gave the following ratios (female: male): 10:18, 169:116, 32:108, 108:44, 78:14, 56:63, 32:168, 129:68, 92:89, 27+:89.

S. impatiens. Five progenies were "unisexual," the ratios being 1:407, 0:159, 204:0, 133:0 and 0:306. Two progenies were bisexual, giving 95:246 and 297:210, respectively.

These results indicated that the female was responsible for the sex ratios, but in order to obtain more critical tests, a second series of experiments was carried out. Here the females of each lot were separated, after being exposed to a male, and the offspring of each female recorded separately. The results are summarized below.

S. coprophila. Thirty-two successful series of matings were secured.[5] In 10 of these all the females gave progenies of the same sex. In the remaining 22, both types were obtained. Examples of the latter are shown in the following counts taken from the first seven series. The ratios here, as before, are expressed in terms of females: males. (1) 23:0, 0:12; (2) 63:1, 0:82, 31:0; (3) 0:102, 22:0; (4) 12:0, 10:0, 0:38; (5) 0:95, 83:1, 0:42; (6) 0:93, 46:1; (7) 0:27, 67:0, 0:40.

The above results show that a male may give daughters by one female and sons by another, from which it is concluded that the female is responsible for the sex ratio.

This conclusion would be supported by evidence showing that the offspring of individual females are regularly of one sex, even when sired by different males, and two series of experiments were carried out for the purpose of securing data on this point. In the first of these, single females were put with several males. As expected, the progenies were of the "unisexual" type. In the second series, individual females, homozygous for the recessive mutant character truncate, were mated to wild-type and to truncate males. With this type of mating, the exact parentage of each offspring could be determined. Twenty-one such matings were made. In each case the offspring were all normal or all truncate, showing that they came from only one male. It seems probable, therefore, that in this species (*S. coprophila*) the eggs of one female are normally fertilized by sperms from only one male.

In the experiments just mentioned, the progenies were mostly wild-type, suggesting a selection in favor of sperms from wild-type males. To check this and also to find out whether it is the sperms from the first male or the last which function, truncate females were mated first to truncate and then to wild-type males. In the four cases in which the female was observed to mate with the truncate male before the wild-type male was substituted, the offspring were all truncate. Of the six cases in which mating was not observed, three gave truncate and three wild-type

progenies. This would indicate that the eggs are fertilized by sperms from the first male with which the female mates and that the results are not due to a greater effectiveness of sperms from wild-type males.

It should be noted in this connection that in the species of Sciara thus far studied, the eggs all ripen simultaneously and are all laid within a few hours—the female usually living only 3 or 4 days after mating.

[1] This investigation has been aided by a grant from the National Research Council Committee for Research on Problems of Sex.

[2] Metz, C. W., *Amer. Nat.*, **40**, 57–81, 1926. Metz, Moses and Hoppe, *Zeits. ind. Abs. Vererb.*, **42**, 237–270, 1926.

[3] In one species both "unisexual" and "bisexual" strains have been secured. These intercross freely and are being studied at the present time.

[4] A brief statement of these results appeared in abstract form in the *Anatomical Record*, **34**, p. 170, 1926.

[5] Records are included only where two or more females gave progenies of ten or more each.

OBSERVATIONS ON SEX-RATIO DETERMINATION IN SCIARA (DIPTERA)[1]

BY CHAS. W. METZ AND MILDRED S. MOSES

DEPARTMENT OF GENETICS, CARNEGIE INSTITUTION OF WASHINGTON, COLD SPRING HARBOR, N. Y.

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It was shown in the preceding paper,[2] that in species of Sciara giving "unisexual" progenies, the sex-ratio is "determined" by the female, not the male; i.e., certain females are female-producers and others male-producers, regardless of the males with which they mate. The present paper deals with the results thus far obtained in an attempt to analyze the genetic background of sex-ratio determination. As in the preceding paper, the question of sex determination itself is not considered. It apparently involves a separate series of phenomena.

Early in the work it was observed that in female progenies both male-producers and female-producers were usually found. These were not distinguishable morphologically and could only be identified by breeding tests. In order to determine whether both types were found regularly in such progenies and whether or not they were produced in equal numbers, records were made from a large series of matings extending over several generations. In most of these, relatively few sisters were tested in each case, but in a few instances larger numbers were tested individually in order to determine more exactly the ratio of female-producers to male-producers. The following records illustrate the type of results obtained.