SOME STUDIES IN HUMAN MATE SELECTION AND HEREDITY IN MICE

Thesis for the Degree of M. S.

DOROTHY PERMAR

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Heredity

Zoologi

SOME STUDIES IN

HUMAN FATE SELECTION

AND

LIABILITY IN MICE

T H E S I S

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PART I

MATE SELECTION

Mate Selection

The purpose of this investigation was to determine what kinds of people marry each other; whether people of similar types tend to marry, or whether marriage is more frequent between dissimilar individuals. It was here possible to consider only a few characters, but it should be recognized that there are innumerable characters which may influence mate selection, provided it can be shown that there is any definite selection exercised.

"Who marries who" is a question worthy of consideration. Does a man choose for a wife a woman possessing his own traits in a similar degree? Does a woman prefer a husband who is much like herself? Or do men and women marry persons of entirely different types? There are many age old theories concerning this question, but few efforts to prove or disprove these theories. And yet it is important to know whether genius marries genius, or whether a person of genius more often marries one of entire lack of ability. Do persons of superior health select for mates persons possessing this same attribute, or do they marry persons inferior to themselves in this respect? Do those of superior mentality marry each other, or do they choose one of lesser mind for a mate? And if extreme types do marry, are the offspring like one or the other of the parents, or do they compose an "in between" group? To state the question more generally, is there a tendency toward the equalization of the human race, toward the intermingling of the extreme classes of all

or some of the traits of this race to produce one intermediate class of these traits; or is there a tendency to produce classes which are more extreme than those we have, eliminating gradation?

In this paper an attempt is made to answer a few of these questions. To do this, it is necessary to consider what factors may influence mate selection, and then, from the data at hand, to determine whether or not these factors do influence selection, and if so, to what extent.

It is undoubtedly true that these factors are somewhat different in different countries and localities; but we will consider those which might most frequently influence this choice in any locality where a considerable degree of choice is permitted.

One factor which should be considered is the social status of the individuals marrying. In some European countries this factor is undoubtedly effective; in this country there may be some question as to its potency. Another possible influence is that of family customs, such as religion and occupation. Personal traits and talents, as for example, artistic ability and literary interests, may be determining factors. Physical traits of the individual, as the degree of pigmentation, size, and health, should be considered as possible operative elements. Or such circumstances as the age and education of the persons marrying may be characteristics by which selection is determined. There are innumerable factors which may possible be influential, and which should be recognized.

From the data obtainable in the present investigation, however, only a few of these factors may be studied.

The work was done at the Eugenics Record Office, located at Cold Spring Harbor, Long Island, New York, under a grant of money made by the Eugenics Research Association of the Carnegie Institute of Washington. Appreciation is expressed for the use of their archives, and for the many courtesies and suggestions which made the work possible.

The data were found in the Records of Family Traits. These Records are printed blank forms which ask for certain definite information concerning various members of a family. The individuals to be described in the blank include child number 1,2,3,4, etc., the father and mother of these children, the father's father, the father's mother, the mother's father, and the mother's mother. There is also space for information concerning the uncles and aunts of the children. The blank is made out mostly in tabular form, so that it is perfectly clear what information is wanted.

Some of the questions for the father are stated as follows:

Full name _____
Date of birth_____
Birthplace: town _____State or Country____
Education _____
Residences, principal _____
Age at marriage _____
Occupations at successive ages _____
If dead, cause of death and age at death _____

Questions pertaining to personal traits were listed in the form of a table. A part of one table is as follows:

	Father	Mother
Age at which description is given		
Adult or present height in inches (without shoes)		
Color of hair (before graying) a.(albino) f.(flaxen), etc.		

Most of these records were filled out by college men and women, or by other persons interested in eugenics; and they have been collected from all parts of the United States. About eight thousand records were examined, and data were used from the 2300 records which appeared to be written up most completely and carefully. No other selection was made.

In most cases the person who had filled out the record held the place in that record as one of the children (child number 1, 2, or 3, etc.); in a few cases he held the place of "Father"or "Mother". In this study the married persons used for comparison of traits were those described in the record as "Father" and "Mother"; so that in the majority of cases the individuals had been described by one of their children, and in a few cases by one of the persons themselves. For this reason, the data given should be accurate, at least in those instances where the trait considered is an easily measurable one, as age and height.

Date were collected for the following characteristics: age, education, height, hair color, eye color, mental ability, musical ability, drawing ability, mechanical ability, general bodily energy, condition of sight (at time of marriage), and condition of hearing.

Some of these characters may be easily measure, and should give a fairly accurate indication of their importance in mate selection. This is true of age and height, particularly, as they may be measured in years and inches without question. Education may be slightly more difficult, since the actual number of years spent in school, or the grade which the individual finally reached, is not always indicative of the amount of his education. However, when nearly 2000 cases are considered, the results should be of some value, for in the majority of cases the college man or woman is better educated than the man or woman whose schooling ended with the eighth grade of grammer school, or perhaps earlier. Hair color and eye color are difficult to measure without a color chart, and there were undoubtedly many different ideas of blue and brown eyes put into the records. There is one fact which should not be overlooked, however; this is a comparison of two individuals; and since the two individuals concerned were, in all cases, described by the same person, only one person's classification of degrees of color enters into any one comparison, so that any difference indicated between individuals is probably real. This is true also of the very poorly measured traits of mental, musical, drawing, and mechanical abilities. The conditions of sight and hearing were probably classified with reasonable accuracy, and will be discussed later.

Age

An effort was made to determine whether or not age influenced mate selection, and if so, how much. Do men and women of about the same age most frequently marry, or is a man of twenty-one as apt to marry a woman of thirty or thirty-five as he is a woman of twenty or twenty-one?

In the blanks to be filled out in the Records of Family Traits, the information was asked for as follows: under "Father" the question was put "Age at marriage"; under "Mother" it was "Date of marriage". The date of birth was given in both cases. The age of marriage of the mother was found by subtracting "Date of birth" from "Date of marriage". The accuracy of the dates was checked by subtracting the "Date of birth" of the father from the "Date of marriage" of the mother, and comparing it with the given "Age of marriage" of the father.

The age at which the two individuals were married was given in 2212 cases. In tabulating the data the individuals were classified as follows: those married at sixteen years of age and under, those married at seventeen, eighteen, nineteen, etc., years, up to thirty-eight years, this latter group including those married at thirty-eight years and over. Table I.

The coefficient of correlation between the ages of the men and women married is $r = \sqrt{1 - \frac{S_y^2}{\sigma_y^2}}$ equals .57 ± .0097.

YEARS	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
16			3	1	2	5	7	6	1	2	1	4	3	1	2	1			1				
17	1	2	2	2	3	17	10	4	12	5	9	4	3	1	1	2	1			1			
18				5	14	23	12	21	6	16	10	3	4	5	5	4	3	1	1			1	2
19			3	5	8	20	17	13	28	12	12	8	6	7	5	2	2	3		3	1		3
20			2	3	11	28	27	19	25	28	12	13	11	13	7	9	1	4	2				3
21			1	1	7	17	14	22	23	26	26	16	12	9	5	8	4	4	2	1	3		5
22			3	2	2	12	26	32	30	31	19	16	17	11	8	7	6	8	2	2	5	1	6
23				4	1	9	13	26	25	31	30	21	15	11	6	4	3	2	4	1	3		2
24					1	3	8	12	24	31	22	20	12	10	19	3	5	7	2	5	3	4	6
25						1	5	9	9	35	27	31	21	15	17	7	3	4	4	4	2	1	5
26				1		3	2	2	3	14	25	19	11	11	9	11	3	4	2	3	3	2	3
27							3	1	4	8	7	15	10	9	9	3	3	4	3	4	2	2	2
28							3	2	2	13	2	6	10	5	5	4	9	5	2	2	1		6
29							1	1	2	2	8	6	7	14	10	4	3		3	4			7
30								2		1		2	5	5	2	2	5		2	6	2	1	9
31									2		2	1	1	2	5	3	2	1	1	3		1	5
32												1	1				5	1	1	4	3	1	6
33							1	2		1					1		1		1	3	2	1	4
34							2		1							1	1						8
35										1				2		1	1		2		1		3
36																					1		2
37																							4
38					1					1					1					1	2		3

The coefficient of correlation is 58 times its probable error, and is significant. It may be concluded that men and women near the same age more frequently marry than men and women of widely different ages. Age seems to play an important part in the selection of a mate, which is what would, after all, be expected.

Height

The measurement of height is quite as easily made as that of age. In this case, the men were classified in groups as sixty inches, and under, sixty-one inches, sixty-two inches, sixty-three inches, up to seventy-eight inches. The women were classified from fifty-eight inches and under, up to seventy-two inches. Table II.

The heights of persons marrying were given in 1450 cases. The coefficient of correlation is .48 ± .013. The coefficient of correlation is 37 times its probable error, and is significant. Men and women of similar heights more frequently marry than those of opposite extreme heights, and therefore height may be considered as a factor in mate selection.

The correlation here is greater than that obtained by Pearson. In his study of 200 cases, he found $r = .0931 \pm .0473$. His conclusion is that "although the probable error is about half the coefficient of correlation, it is unlikely that the latter can really be zero.... we are justified in considering that there is a definite amount of assortive mating with regard to height going

TABLE 11

AGE

	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78
58	3	1	1			1	2		2		2		2		1				
59		1					2	1	1	1	1	2	1						
60	3		2		3	7	4	8	8	11	14	5	4	1					
61			3	2	1	4	11	15	15	9	15	8	4	1	1				
62			4	2	8	8	23	19	25	17	22	14	8	3	8				
63			1	6	10	17	20	22	28	15	15	17	17	2	5	1			
64			1	4	7	15	24	25	26	43	33	24	25	8	3	2			
65				1	4	19	22	28	41	22	23	28	15	3	3	2			
66			1	1	4	8	17	28	32	25	22	24	11	3	2	3	1		1
67				1	2	2	2	12	23	12	13	13	7	3	2	5			
68					1	1	1	8	17	13	11	18	3	3	3		1		
69					1			1	4	4	5	6	4	5					
70			1		1					2	1	3	3	1	2				
71												1	1						
72											1								

on in the middle class."

Education

It is perhaps to be expected that the amount of education of individuals will affect mate selection. The data given in these Records of Family Traits may throw some light on the question. The amount of education of both parents was definitely stated in 1988 cases. Certain grouping of individuals was necessary, as different kinds of schools may, in the end, turn out persons of essentially the same degree of learning.

The types of schools were grouped as follows:

Common school plus high school = high school
Common school plus business college = high school
Common school plus normal school = high school
High school plus normal school = college
High school plus college = college

The records which for "Education" gave only normal school, business college, etc. without designating common school or high school as preceding this, were not included, for there was no way of determining whether or not the individual had attended high school. Table III.

Table III. Amount of Education.

	None	Common school	High school	College	Total
None	10	14	1	4	29
Common school	16	639	164	99	918
High school	4	185	283	226	698
College	0	44	54	245	343
Total	30	882	502	574	1988

The coefficient of contingency, $C = \sqrt{\frac{S - N}{S}}$, is found to be .671. The greatest possible value for C for a symmetrical 4 x 4 fold table is .866. (See footnote).

The coefficient of correlation is .53 ± .107.

Education, then, is indicated as being influencial in mate selection.

The nest question is, just how much effect does this factor have within each class of persons? It will be necessary to consider each class separately.

Upon a closer examination of the table it will be noticed that there is an extraordinarily large number of college and high school persons, much larger than is found in a random sample of the population of the United States. It will be recalled that the Records of Family Traits from which these data were collected were filled out by college men and women and by other persons interested in eugenics, and that the individuals here compared are, in most cases, the parents of the recorder. This will explain the reason for the large percent of well educated persons found here; for it is reasonable to assume that in a group of parents of college students, there are more high school and college graduates than in the parents of all the people of the country between the ages of eighteen and twenty-two.

Footnote: This and all of the following values were obtained from G. Udney Yule - Introduction to the Theory of Statistics, 7th edition, pp. 65, 66.

It is impossible to tell from the data here given, how much this unfortunate selection affects our conclusions. It is probable, however, that the mate selection found here is strongly indicative of the selection for the entire population.

Uneducated men:

We will begin with the group of uneducated men -- that is, men with no school training -- and see from which classes they have selected their wives; which will tell also, of course, which classes of women have selected this type of man.

There are 1988 women in the entire population studied; 29 of them are without education, which is 1.46% of 1988. (Table III). If there are 1.46% uneducated women in the total population, and if marriage takes place at random, one would expect to find 1.46% of uneducated women among the wives of uneducated men. There are 30 uneducated men, and of the 30 wives of these men, 10 are uneducated, or 33.33%. The probable errors of these percents, the difference, and the probable error of the difference are as follows:

Observed percent of uneducated women among the wives of uneducated men:	33.33% ± 5.80%
Expected percent of uneducated women among the wives of uneducated men:	1.46% ± .18%
Difference	31,87% ± 5.80%

The difference is five and one-half times its probable error, and is therefore significant. And we

have found that there are 31.87% ± 5.80% more uneducated women among the wives of uneducated men than was expected. The selection here is positive and rather extensive.

Secondly, how frequently do uneducated men marry women of common school education? Of the entire female population of 1988, there are 918 having a common school education, or 46.17%. With random marriage there should be 46.17% of the wives of the 30 uneducated men with a common school education. There are 16 such wives, which is 53.33% of 30.

Observed percent of women of common school education among wives of uneducated men:	53.33% ± 6.14%
Expected percent of women of common school education among wives of uneducated men:	46.17% ± .76%
Difference	7.16% ± 6.18%

The difference is not significant. There is about the expected number, assuming random marriage, of women of common school education among the wives of uneducated men.

Thirdly, do women of high school education number largely among the wives of this group of men? There are 698 women of high school education in the total population of 1988, which is 35.11%. Four of them are wives of uneducated men. Then only 13.33% of the wives of uneducated men are of high school education.

Expected percent of high school women among the wives of uneducated men:	35.11% ± .72%
Observed percent of high school women among the wives of uneducated men:	13.33% ± 4.18%
Difference	21.78% ± 4.24%

The difference is 21.78% ± 4.24% and is significant. High school women are evidently selected against by uneducated men, or vice versa.

The fact that no college women have married uneducated men is conspicuous. Since 17.26% of the total population of women are of college education, the same percent, in random marriage, should be the wives of uneducated men. But we obviously do not have random marriage. We find that the 17.26% of expected college women, and the 21.78% of the expected high school women, who are missing among the wives of uneducated men, are replaced by the 31.87% of uneducated and the 7.16% of common school women who are in excess of the expected percents from these two latter groups.

Common School Men:

The second group of men to be considered is that of men of common school education. How frequently do men of common school education marry women having no education? As noted above, in any group of men we would expect to find 1.46% of their wives uneducated if there were random marriage. There are 882 men of common school education, and of their wives, 14 are uneducated. This is 1.59%.

Observed percent of uneducated women among wives of common school men:	1.59% ± .28%
Expected percent of uneducated women among wives of common school men:	1.46% ± .18%
Difference	.13% ± .33%

The difference is very small, and is not significant. We may conclude, then, that uneducated women are selected neither for nor against by men of common school education.

How frequently do men of common school education marry women of common school education? We would expect 46.17% of the wives of men of common school education to have this same degree of education. Actually there are 72.45% of such wives.

Observed percent of common school women among wives of common school men:	72.45% ± 1.01%
Expected percent of common school women among wives of common school men:	46.17% ± .76%
Difference	26.28% ± 1.26%

The difference is large, and is significant. There are many more women of common school education among the wives of men of common school education than would be expected in random marriage.

The number of women of high school education marrying men of common school education gives a different result. Among the wives of this group of men we may expect 35.11% to be of high school education if we have random marriage. Instead of this, we find only 20.97%.

Expected percent of high school women among wives of common school men:	35.11% ± .72%
Observed percent of high school women among wives of common school men:	20.97% ± .88%
Difference	14.14% ± 1.14%

The difference, 14.14%, is significant, being thirteen times its probable error. There are fewer wives having high school education than are expected.

If there were random marriage, we should find among the wives of common school men 17.26% of college education. Actually we find only 4.99%.

Expected percent of college women among wives of common school men:	17.26%	± .57%
Observed percent of college women among wives of common school men:	4.99%	± .49%
Difference	12.27%	± .75%

The difference is sixteen times its probable error and is significant.

It is evident that men of common school education select women of similar education for wives, rather than women of superior learning.

High School Men:

Such selection is also carried out by men of the high school group. There are, in the population studied, 502 men of high school education, one of whom has married an uneducated woman.

Expected percent of uneducated women among wives of high school men:	1.46%	± .18%
Observed percent of uneducated women among wives of high school men:	.20%	± .13%
Difference	1.26%	± .22%

The difference is 5.7 times its probable error, and is significant. High school men tend to select against uneducated women for wives.

The expected number of women of common school education among the wives of high school men surpasses the actual number:

Expected percent of common school women among wives of high school men:	46.17% ± .76%
Observed percent of common school women among wives of high school men:	32.67% ± 1.35%
Difference	13.50% ± 1.54%

The difference is significant, being nine times its probable error. High school men select against women of lesser education.

But high school men more frequently marry high school women.

Observed percent of high school women among wives of high school men:	56.37% ± 1.48%
Expected percent of high school women among wives of high school men:	35.11% ± .72%
Difference	21.26% ± 1.64%

The difference is twelve times its probable error and is significant. The selection is positive, and quite extensive.

The selection is seen to be negative for the marriage of high school men with college women.

Expected percent of college women among wives of high school men:	17.26% ± .57%
Observed percent of college women among wives of high school men:	10.75% ± .94%
Difference	6.51% ± 1.09%

The difference is nearly six times its probable error and is significant.

It may be concluded that high school men select for wives women of their own educational class rather than those of classes above or below it.

College Men:

The last group is that of men having a college education. Do men of college education marry women who are uneducated? The date here give results which are unexpected in the light of what has just been found to be true of all the other groups. The expected percent of uneducated wives in this group if there were random marriage is 1.46%. There are found to be four such wives, which is .7%.

Expected percent of uneducated women among wives of college men:	1.46% ± .18%
Observed percent of uneducated women among wives of college men:	.69% ± .24%
Difference	.77% ± .30%

While this observed percent is smaller than the expected, the difference is less than three times its probable error, and is not significant. The date do not show the expected significant selection against uneducated women by college men. The writer finds nothing in the data to account for this circumstance.

The selection by these men against women of common school education is about what would be anticipated.

Expected percent of common school women among wives of college men:	46.17% +- .76%
Observed percent of common school women among wives of college men:	17.25% ± 1.08%
Difference	28.92% ± 1.32%

The difference is significant.

High school women number more frequently as the wives of college men.

Observed percent of high school women among wives of college men:	39.38% ± 1.35%
Expected percent of high school women among wives of college men:	35.11% ± .72%
Difference	4.27% ± 1.53%

The difference is positive, showing more than the expected number, and is nearly three times its probable error. The deficiency of uneducated and common school women found in the wives of college men is partly made up by the excess of high school women.

The difference between the expected and observed percents of college women among the wives of this group of men makes up the remainder of the preceding deficiencies.

Observed percent of college women among wives of college men:	42.68% ± 1.42%
Expected percent of college women among wives of college men:	17.26% ± .57%
Difference	25.42% ± 1.53%

The difference is eighteen times its probable error and is significant. College men frequently select college women for wives.

Conclusion:

Education is a very effective factor in mate selection. It affects all classes of persons similarly. Men and women tend to choose for mates persons of their own educational class rather than persons of a widely different degree of schooling.

Hair Color

Does hair color in any way influence mate selection? The color of the hair, before graying, was given for 2074 sets of married persons. In the Records of Family Traits the question was stated,

Color of hair (before graying). a.(albino,white),f.(flaxen), y.br.(yellow-brown), l.br.(light brown), m.br.(medium-brown), d.br.(dark brown), bl.(black), cl.r.(clear red), d.r.(dark red), d.br.r.(dark brown red).

For purpose of this work, these classes were grouped as follows:

f., y.br. = blond
l.br., m.br. = brown
d.br., bl. + black
cl.r., d.r., d.br.r. = red

The main purpose of this grouping was to attain greater accuracy in classification. It is obvious that data collected in this manner will not be uniform for such characters as color of hair and eyes. It was believed that by thus grouping the data, the smaller variations in the opinions of different shades of color might be eliminated. For instance, one person might classify a man's hair as light brown, while another person might put the same man's hair under the class of medium brown. However, it is not likely that is a hundred persons classified this particular hair any of them would make the gross error of calling it flaxen, or black, or red; at least, such cases would probably be so few as to make little difference in so large a group.

Another factor which greatly decreases the inaccuracy of the classification of this character is that stated above: the two individuals compared were, in all cases, described by the same person, and so only one person's ideas of degrees of color enters into any one comparison.

While the data have not been collected in an entirely satisfactory manner, the results should give some fair indication of how important hair color is in mate selection.

Table IV. Hair Color

WOMEN \ MEN	Blond	Brown	Black	Red	Total
Blond	7	27	67	3	104
Brown	20	217	417	13	667
Black	59	371	742	42	1214
Red	5	19	63	2	89
Total	91	634	1289	60	2074

The coefficient of contingency is 0.081, the highest possible value being 0.866. Table IV.

In this case C is so low that there is no indication that hair color is effective in mate selection.

When these data are treated as those given above for education, it is found that in only one case is there a significant difference between the observed number and the number expected in any one group assuming that hair color does not affect mate selection, and that marriage is at random. That is, the difference betweenthe observed and the expected is in all but one case considerably less than three times its probable error. There are 10.19% ± 2.9% fewer brown haired women among the wives of blond

men than is expected in random marriage.

Conclusion.

It may be concluded that the color of hair has very little to do with determining "who marries who"; it is not an effective factor in mate selection.

Eye Color

The color of the eyes of the married persons was given for 1941 marriages. In the records eye color was classified in seven groups: p.bl.(pale blue), d.bl.(dark blue), bl.br.(blue with brown spots), l.br.(light brown), d.br.(dark brown), bl.(black), y.bl.(yellow-blue,gray or green), r.br.(reddish brown).

Since it is difficult to distinguish between such colors as pale blue and dark blue, and black and dark brown, the classes were grouped as follows:

Table V. Eye Color

	Blue	Brown	Black	Total
Blue	657	112	259	1028
Brown	158	56	55	269
Black	374	68	202	644
Total	1189	236	516	1941

p.bl., d.bl., y.bl. = blue
bl.br., l.br., r.br.= brown
d.br., bl. = black

The coefficient of contingency is o.127, and the highest possible value for C for 3 x 3 fold table is 0.816. (See Footnote). Eye color apparently has little

Note: G. Udney Yule - Introduction to the Theory of Statistics.

effect in mate selection.

The data may be treated in the same manner as those given above for education. We may find the expected percent of any type of woman in each group, assuming that for this factor marriage takes place at random, and then find the actual percent. If the difference between these two percents is more than three times its probable error it may be considered significant.

Group I. Blue eyed men:

Observed percent of blue eyed women among wives of blue eyed men:	55.26% ± .94%
Expected percent of blue eyed women among wives of blue eyed men:	52.96% ± .77%
Difference	2.30% ± 1.21%
	Not significant.
Expected percent of brown eyed women among wives of blue eyed men:	13.85% ± .53%
Observed percent of brown eyed women among wives of blue eyed men:	13.29% ± .68%
Difference	Not significant.
Expected percent of black eyed women among wives of blue eyed men:	33.18% ± .74%
Observed percent of black eyed women among wives of blue eyed men:	31.45% ± .88%
Difference	1.73% ± 1.15%
	Not significant.

Group II. Brown eyed men:

Expected percent of blue eyed women among wives of brown eyed men:	52.96% ± .77%
Observed percent of blue eyed women among wives of brown eyed men:	47.46% ± 2.16%
Difference	5.50% ± 2.29%
	Not significant.

Observed percent of brown eyed women among wives of brown eyed men:	23.73% ± 1.88%
Expected percent of brown eyed women among wives of brown eyed men:	13.85% ± .53%
Difference	9.88% ± 1.94%

The difference is five times its probable error, and is significant.

Expected percent of black eyed women among wives of brown eyed men:	33.18% ± .74%
Observed percent of black eyed women among wives of brown eyed men:	28.81% ± 1.96%
Difference	4.37% ± 2.09%
	Not significant.

Group III. Black eyed men:

Expected percent of blue eyed women among wives of black eyed men:	52.96% ± .77%
Observed percent of blue eyed women among wives of black eyed men:	50.19% ± 1.48%
Difference	2.77% ± 1.67%
	Not significant.
Expected percent of brown eyed women among wives of black eyed men:	13.85% ± .53%
Observed percent of brown eyed women among wives of black eyed men:	10.66% ± .94%
Difference	3.19% ± 1.08%
	Not significant.
Observed percent of black eyed women among wives of black eyed men:	39.14% ± 1.42%
Expected percent of black eyed women among wives of black eyed men:	33.18% ± .74%
Difference	5.96% ± 1.60%

The difference is 3.7 times its probable error, and is significant.

The difference is three or more times its probable error in only two cases: that for marriages of brown eyed men with brown eyed women, and that for marriages of black eyed men with black eyed women. In both of these cases there are more than the expected number of such marriages. In the case of the marriage of blue eyed men with blue eyed women, we find more than the expected number of blue eyed women among wives of blue eyed men, but the difference between the observed and expected is not significant. In all other cases -- that is, in all cases except those of the marriage of similar types with each other -- we find that the observed number is less than the expected. In none of these cases, however, is the difference significant.

Conclusion:

The data above given do not prove that marriage takes place at random so far as the eye color of the persons marrying is concerned; neither do they prove conclusively that matings are definitely determined by eye color in many cases. However, it indicates that eye color may possibly influence mate selection to a limited degree.

This is in accordance with Pearson's conclusion of the effect of eye color in Mate Selection. "The correlation between husband and wife for two very divirgent characters" (referring to height and hair color) "is thus shown to be about .1, or is 25 percent greater than is required between first cousins° by the law of ancest-

° Roy. Soc. Proc., Vol. 62, p. 410."

ral heredity."

General Bodily Energy

In the Record of Family Traits the degrees of enerty, or activity, were classified as follows:

General bodily energy. 1. (very inactive). 2.(ordinary). 3. (exceptionally energetic). Table VI.

Table VI. General Bodily Energy

	1	2	3	Total
1	7	14	9	30
2	14	612	392	1018
3	21	458	656	1135
Total	42	1084	1057	2183

This is a very difficult character to classify, and the accuracy of the data is questionable. However, it is interesting to see whether or not there is any indication of selection for this character in the data obtained.

The actual percent of group 1 women found among the wives of group 1 men exceeds the percent expected in random selection by 15.29% ± 3.85%. The difference is significant.

The difference between the expected and the observed percents of group 2 women among the wives of group 1 men is not significant.

Group 3 women number among the wives of group 1 men about as expected in random selection.

There is apparently no selection for or against

women of group 1 by group 2 men.

The observed percent of group 2 women among the wives of group 2 men exceeds the expected by 9.83% ± 1.23%. This is significant.

The selection of group 3 women by group 2 men is negative. The difference is 9.64% ± 1.23% and is significant. The expected is greater than the observed.

The marriage of group 1 women and group 3 men seems to be random:

Expected group 1 women among wives of group 3 men:	1.37% ±.17%
Observed percent group 1 women among wives of group 3 men:	.85% ±.18%
Difference	.52% ± .25%

The difference is not significant. In view of the seeming selection in the other groups, we might well expect selection here.

Group 3 men seem to select against group 2 women; the expected percent of group 2 women among the wives of group 3 men exceeds the observed by 9.55% ± 1.23%.

A positive selection is seen for the marriage of group 3 women and group 3 men. The observed exceeds the expected by 10.07% ± 1.23%.

The coefficient of contingency is .26, the highest possible value being .816.

The coefficient of correlation is .194 ± .014.

The data indicate the marriage of similar types to be slightly more general than the marriage of extreme types, but the nature of the data does not warrant any

definite conclusion concerning the effect of the character of general bodily energy in mate selection.

Mental Ability.

The Records of Family Traits gave data concerning the general mental ability of the individuals married. The data, however, are far from being satisfactory. It is extremely difficult to accurately measure mental ability by the most carefully arranged mental tests; but far less desirable are data obtained from the estimate of the mental ability of any set of parents by the children of those parents. It is readily admitted that the present data can do no more, at best, than give a very rough estimation of whether unusually capable and quick individuals tend to marry persons who are also of active mind, or whether marriage much more frequently takes place between persons of widely different ability.

The degrees of ability were classified in the Records as follows:

General Mental Ability. 1. (poor; failure to advance at school). 2. (medium to good). 3. (exceptionally good).

Table VII. Mental Ability

	1	2	3	Total
1	4	8	2	14
2	12	837	467	1316
3	4	226	595	825
Total	20	1071	1064	2155

The coefficient of contingency is .393. The highest possible value is .816.

The coefficient of correlation is .36 ± .012.

Assuming that marriage takes place at random and that this character does not influence selection, we may find here certain expected numbers of individuals for each group. These numbers may be compared with the actual number found in each group, as has previously been done for the other characters.

Observed percent of 1 women among the wives of 1 men:	20.00% ± 6.00%
Expected percent of 1 women among the wives of 1 men:	.65% ± .11%
Difference	19.35% ± 6.00%

The difference is more than three times its probable error and is significant; but the numbers are very small; there are only 20 group 1 men to consider.

Expected percent of 2 women among the wives of 1 men:	61.06% ± .74%
Observed percent of 2 women among the wives of 1 men:	60.00% ± 2.22%
Difference	1.06% ± 2.32%
	Not significant.
Expected percent of 3 women among the wives of 1 men:	38.28% ± .69%
Observed percent of 3 women among the wives of 1 men:	20.00% ± 6.00%
Difference	18.28% ± 6.03%

The difference is three times it probable error and is significant.

Observed percent of 1 women among the wives of 2 men:	.74% ± 1.74%
Expected percent of 1 women among the wives of 2 men:	.65% ± .11%
Difference	.09% ± 1.70%
	Not significant.

Observed percent of 2 women among the wives of 2 men:	78.15% ± .71%
Expected percent of 2 women among the wives of 2 men:	61.06% ± .74%
Difference	17.09% ± 1.01%

The difference is 16 times its probable error and is significant.

Expected percent of 3 women among the wives of 2 men:	38.28% ± .69%
Observed percent of 3 women among the wives of 3 men:	21.1% ± .81%
Difference	17.18% ± 1.06%

The difference is sixteen times its probable error and is significant.

Expected percent of 1 women among the wives of 3 men:	.65% ± .11%
Observed percent of 1 women among the wives of 3 men:	.19% ± .08%
Difference	.46% ± .14%

The difference is 3.4 times its probable error and is significant.

Expected percent of 2 women among the wives of 3 men:	61.06% ± .74%
Observed percent of 2 women among the wives of 3 men:	43.89% ± 1.01%
Difference	17.17% ± 1.25%

The difference is 13 times its probable error and is significant.

Observed percent of 3 women among the wives of 3 men:	55.92% ± 1.01%
Expected percent of 3 women among the wives of 3 men:	38.28% ± .69%
Difference	17.64% ± 1.22%

The difference is 14 times its probable error and is significant.

There is a significant excess of group 1 women among the wives of group 1 men, of group 2 women among the wives of group 2 men, and of group 3 women among the wives of group 3 men.

There is a significant lack of group 3 women among the wives of group 2 men, of group 1 women among the wives of group 3 men, of group 2 women among the wives of group 3 men, and of group 3 women among the wives of group 1 men.

The other differences are not significant.

The data indicate the marriage of similar individuals to be more frequent than of dissimilar individuals, but, as previously pointed out, any definite conclusions based on these data would be unsound, as the data are not sufficiently accurate.

Musical Ability

Ability in vocal music was classified as follows: 1. (poor), 2. (Medium to good), 3. (exceptionally good). Estimates of such ability were given in this manner for 1992 marriages. No tests were given; the classification was purely an estimate.

Table VIII. Musical Ability MEN

WOMEN	1	2	3	Total
1	322	232	32	586
2	415	625	105	1145
3	109	102	50	261
Total	846	959	187	1992

The coefficient of contingency is .232, the highest possible value being .816.

For the marriage of group 1 women and group 1 men the observed number exceeds the number expected in case of random marriage by 8.64% ± 1.24%, which is significant, indicating the selection of similar types.

The the marriage of group 2 women with group 1 men, the expected exceeds the observed by 8.43% ± 1.37%. The difference is significant, indicating that group 1 men select against group 2 women for wives, or vice versa.

The expected number of group 3 women among the wives of group 1 men exceeds the observed by .23% ± .84%. The difference is not significant.

Group 2 men select against group 1 women. The observed percent is 5.23% ± 1.16% less than the expected. The difference is significant.

Group 2 men select more frequently group 2 women for wives. The observed percent of such wives exceeds the expected by 7.69% ± 1.25%. The difference is significant.

The expected number of group 3 women among the wives of group 2 men exceeds the observed by 2.47% ± .83%. The difference is a little less than three times its probable error, but may possibly be considered significant.

Group 3 men select against group 1 women, the ex-

pected number exceeding the observed by 12.3% ± 2.02%. The difference is significant.

The expected percent of group 2 women among the wives of group 3 men exceeds the observed by 1.33% ± 2.21%. This is not significant.

Group 3 women number largely among the wives of group 3 men, the observed exceeding the expected by 13.63% ± 2.20%, and is significant.

The coefficient of correlation is .15 ± .012.

The data indicate that persons of similar ability in vocal music tend to marry a little more frequently than persons of dissimilar ability, but the nature of the data permits no definite conclusion to be drawn. In spite of the unsatisfactory data, it is probable that musical talent and interest do play some part in mate selection.

Drawing and Coloring

Ability in drawing and coloring was classified 1. (poor), 2. (medium to good), 3. (exceptionally good). Again there were no tests given, and the value of the data is questionable due to the probable inaccuracy of classification in a number of cases. However, the data should serve to indicate whether or not persons of great interest and activity in such art tend to marry each other more frequently than they marry persons entirely lacking in such interest and ability.

Table IX.

Table IX. Drawing and Coloring

	1	2	3	total
1	646	245	63	954
2	272	325	53	650
3	74	72	42	188
Total	992	642	158	1792

The coefficient of contingency is .29, the highest possible value being .816.

The coefficient of correlation is .255 ± .015.

The observed group 1 women found among the wives of group 1 men exceeds those expected in case of random marriage for this character by 11.89% ± 1.3%. The difference is significant.

The expected group 2 women among the wives of group 1 men exceeds the observed by 8.85% ± 1.2%. The difference is significant.

The expected group 3 women among the wives of group 1 men exceeds the observed by 3.04% ± .74%. The difference is significant.

The expected group 1 women among the wives of group 2 men exceeds the observed by 15.07% ± 1.5%. The difference is significant.

The observed group 2 women among the wives of group 2 men exceeds the expected by 14.35% ± 1.5%. The difference is significant.

The observed group 3 women among the wives of group 2 men exceeds the expected by .72% ± .94%. The difference is not significant.

The expected group 1 women among the wives of group 3 men exceeds the observed by 13.36% ± 2.7 %. The difference is significant.

The expected group 2 women among the wives of group 3 men exceeds the observed by 2.73% ± 2.6%. The difference is not significant.

The observed group 3 women among the wives of group 3 men exceeds the expected by 16.08% ± 2.3%. The difference is significant.

The date might seem to indicate that mate selection is influenced by interest and ability in drawing and coloring, but this cannot be considered conclusive, due to the inaccurate nature of the data.

Mechanical Ability.

This character was listed simply as "mechanical skill", to be classified in the same manner as musical ability: 1. (poor), 2. (Medium to good), 3. (Exceptionally good).

There were 1698 marriages so classified. The coefficient of contingency is .186, the highest possible value being .816.

The coefficient of correlation is .13 ± .016.

Following are listed the significant differences found between the percents of any group of women among the wives of any group of men expected in random marriage, and the percents actually observed:

Group 1 women among the wives of group 1 men:

Observed	70.67% ± 1.48%
Expected	57.48% ± .81%
Difference	13.19% ± 1.68%

The difference is 8 times its probable error, and is significant.

Group 2 women among the wives of group 1 men:

Expected	36.16% ± .74%
Observed	22.44% ± 1.35%
Difference	13.72% ± 1.54%

The difference is 9 times its probable error, and is significant.

Group 2 women among the wives of group 2 men:

Observed	40.82% ± 1.15%
Expected	36.16% ± .74%
Difference	4.66% ± 1.36%

The difference is 3 times its probable error, and is significant.

Group 1 women among the wives of group 3 men:

Expected	57.48% ± .81%
Observed	49.66% ± 1.62%
Difference	7.82% ± 1.81%

The difference is 4 times its probable error, and is significant.

The other differences were small and less than three times their probable error. The data indicate that mechanical ability may have a slight influence in mate selection; that persons of similar ability marry more often than would be expected in random marriage. But the un-

satisfactory classification of individuals prevents any conclusions being drawn when the selection is no more decisive than it is in this case.

Sight and Hearing

The condition of sight was classified in three groups: 1. (blind), 2. (imperfect;wears glasses), 3. (strong).

The condition of hearing was classified in three groups: 1. (deaf), 2. (defective), 3. (strong).

Only those cases were used where the age at which the defect, if any, was acquired was given; and if the defect occured after the time of marriage, the case was not used unless the condition before that time was given. This necessary selection of cases has ruled out many of group 1 in both sight and hearing; for in many cases a person was classified as blind or deaf after the age of marriage, but no statement was made as to whether or not there was a defect in the sight or hearing before marriage.

The date here given may be relied upon as being accurate, for this is not an estimate of slight degrees of a condition, such as the estimate of hair color, for instance. If a man's hearing is imperfect enough for him to be classified in group 2, it is probably imperfect enough to affect mate selection is imperfect hearing does affect it.

Those persons who were blind in only one eye, or deaf in only one ear were here placed in group 2.

TABLE X. Condition of Sight.

WOMEN	MEN 1	2	3	Total
1	0	0	0	0
2	0	69	177	246
3	1	167	1403	1571
Total	1	236	1580	1817

Data for condition of sight:

Observed % group 2 women among wives of group 2 men: 29.23% ± 2.02%

Expected % group 2 women among wives of group 2 men: 13.53% ± .53%

Difference 15.70% ± 2.1 %

The difference is 7 times its probable error, and is significant.

Expected % group 3 women among wives of group 2 men: 86.46% ± .53%

Observed % group 3 women among wives of group 2 men: 70.76% ± 2.02%

Difference 15.70% ± 2.1 %

The difference is 7 times its probable error, and is significant.

Expected % group 2 women among wives of group 3 men: 13.53% ± .53%

Observed % group 2 women among wives of group 3 men: 11.2 % ± .53%

Difference 2.33% ± .75%

The difference is 3 times its probable error, and is significant.

Observed % group 3 women among wives of group 3 men:	88.79% ± .53%
Expected % group 3 women among wives of group 3 men:	86.46% ± .53%
Difference	2.33% ± .75%

The difference is 3 times its probable error, and is significant.

It is indicated by the data that the condition of sight does affect mate selection: a person having defective sight is more apt to marry someone whose sight is also defective than he is to marry someone whose sight is normal.

Table XI. Condition of Hearing MEN

WOMEN	1	2	3	Total
1	2	1	0	3
2	0	0	50	50
3	3	68	1872	1943
Total	5	69	1922	1996

A comparison of the observed percents with those expected in random marriage for the condition of hearing gives no significant differences. There are too few defectives among data collected in the manner in which this was collected - from among the parents of college students, for the most part - to give a true sample of the population for such characters.

Conclusions.

Since these Records of Family Traits were made out largely by college students, or by other persons sufficiently weel educated to be interested in the field of eugenics, and concern, in the majority of cases, the family of the recorder, any conclusions reached or any condition indicated can be said to be true only of what is often called the "upper strata" of our civilization. Whether or not these same indications apply to persons of a group inferior mentally and physically to this one we are not in a position to say.

The data have given definite proof that mate selection is affected by at least three characters, age, height, and education, the first and third having, perhaps, a greater effect than the second.

Persons of about the same age much more frequently marry than persons of widely different ages.

Persons of similar heights tend to marry each other somewhat more frequently than persons of widely different heights.

A person of extensive education usually selects for a mate someone possessing an education nearly equal to his own, rather than a person of limited education.

Some other characters have been indicated as affecting or not affecting mate selection, but the accuracy of the data is not sufficiently satisfactory to permit any positive conclusions.

Hair color does not appear to have any influence in mate selection. It appears that persons of similar eye color somewhat more frequently marry than persons of dissimilar eye color. Similarly energetic and active persons tend to marry each other. Persons of about the same degrees of mental ability are apt to marry each other. It is indicated that musical ability and interest is effective in selection. Drawing and coloring apparently have some influence. Mechanical skill seems to have nothing to do with mate selection. The condition of sight is apparently effective. But as pointed out above, the data for these characters are not entirely satisfactory, and the evidence of selection cannot be considered decisive.

It should be noted that in no case is there an indication that types dissimilar for any character tend to marry. In many cases there is an indication that similar types of individuals tend to marry each other, and in the study of three characters it has been shown with reasonable certainty that there is assortative mating.

The ultimate effect of such selection cannot be prophesied. Are we heading toward a better civilization, or is there danger of more widely different groups of people than we already have - groups that will constantly struggle for supremacy? And would such a struggle help to make a better civilization?

ACKNOWLEDGEMENTS

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PART II

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The Genetic Character of Flexed Tail in Mice History

The first flexed tailed mice appeared in the winter of 1927 in the rodent colony of Michigan State College. Two albino male mice having this peculiarity were discovered by Dr. H. R. Hunt among animals descended from stock supplied by Dr. W. E. Castle.

The first such mouse had an S shaped tail which was directed first anteriorly over the back of the mouse, and then posteriorly. Figure 1 was not drawn directly from the mouse, but illustrates the approximate shape of the tail. There is no record of the type of flexure found in the second mouse.

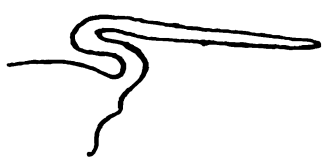


Fig. 1

These two mice were bred with females from albino stocks, and the F_1's were inbred; the result was the production of more flexed tailed mice. The problem of determining the genetic character of this type of tail was undertaken in the fall of 1927.

Description of Flexed Tail

Figure 1 and plates 1, 2, 3, etc. illustrate the appearance of the flexed tail in the adult. The tail is found to be very stiff at the point of bending, and also, in some cases, in places where the tail is not visibly bent. There seems to be no constant form or

forms of flexure; the tail may bend in any direction any number of times; the flexures may be very angular, or they may be curvilinear; or the tail may take the form of a spiral. In some animals the tail appears to be of normal length; in others it is conspicuously short. A number of adult animals were found in which there was no visible flexure in the tail, but upon passing the tail between the fore-finger and thumb, and bending it slightly at the same time, there could be detected an unquestionable stiffness not found in normal mice. In some cases this stiffness was well marked; in others it was uncertain.

Abnormalities of other sorts were frequently noticed. A defective eye was found among some of the general stock of the colony, and frequently appeared in the flexed animals. Several flexed tailed animals were observed to have dorsal enlargements of the head in front of the ears, suggesting a hydrocephalic condition. These animals never lived to maturity. In newborn litters of F_2's nearly all of the flexed tailed mice, and occasionally a mouse that appeared to have a normal tail, exhibited a distinct paleness of color, suggesting anemia.

In very young flexed tailed mice, the tail usually does not have sharp bends, but rather several waves. The tails of adult mice frequently are bent very sharply. It would be an interesting problem to study the change of form of the tail from birth to maturity. The flexed tail apparently does not change shape appreciably after the mouse is fully grown.

Dr. Ernst Blank, in his paper of "Die Knickschwänze der Mäuse",° describes a tail abnormality which he calls "broken tail". He found tails of different degrees of bending, some bent to the extreme of a right angle, others visibly straight but more or less stiff when run through the fingers. Investigation showed this to be due not to a true break, but to a fusion of the vertebrae. The bone regions of two adjacent vertebrae approached each other on one side of the tail, pushing the growth zone and entire intervertebral apparatus in the opposite direction. This condition produced a bend in the tail.

Microscopic centions of different ages embryos of our own flexed tailed mice have, so far, revealed nothing of these processes, but it seems probable that the cause of the flexure is the same as that described by Dr. Blank. Out own microscopic investigations are insufficient to confirm or to contradict Blank's conclusions.

Procedure

The flexed tailed mice used in these experiments were mostly F_2's and F_3's from the original flexed mice. They were crossed with straight tailed mice from the regular stock cages. The straight tailed mice used did not, so far as we knew, carry flexed tail - that is, no flexed tailed animals had been observed in the stock.

The F_1's obtained were mated together. In some cases two or three females were placed in the same cage

°Archiv für Entwicklungsmechanik der Organismen. Vol. 42, 1916-'17, pp. 333-406.

with one male, and when this was done the females were isolated before the birth of a litter. In most cases only one female and one male were placed in a cage, and in these crosses in the earlier part of the work the female was not always isolated when pregnant, but the litter was born in the cage with the male. In all of the later experiments all pregnant females were isolated.

In the majority of the crosses of F_1 x F_1, the young were counted at the time of weaning - between three and four weeks after birth. The animals should, of course, be counted promptly at the time of birth. It is usually, but not always, possible to distinguish straight and flexed tails when the animals are very young. The policy of counting the animals within 48 hours after birth has been followed in all of the crosses of flexed x flexed, the condition of the tail being checked at the time of weaning.

Flexed mice were mated with flexed mice to determine whether or not the character bred true. Diagrams of the tail of the parents were made at the time of mating, and later compared with diagrams of the tails of their progeny to determine if the type of flexure of the parents appeared to be transmitted to the offspring, or if one type seemed to dominate another.

Results

Crosses of flexed x straight to obtain F_1's:

From crosses of flexed x straight tailed animals

142 F_1's were obtained. All of these F_1's were straight tailed. (Table 1). The flexed tailed here behaved as though it might be a Mendelian recessive.

Crosses of F_1 x F_1 to obtain F_2's:

In most cases the F_1's crosses were from the same parents, and frequently from the same litter. F_2 young were obtained from 30 crosses of F_1 x F_1. (Table 2). A total of 1065 F_2's was obtained, 936 of which were straight tailed and 129 flexed, a ratio of 7.26 : 1.00.°

Crosses of Flexed x Flexed:

From 16 crosses of flexed x flexed 137 young were obtained, all of which had a flexed tail. It should be noticed that in crosses 101 and 102 (Table 3) one parent was classified as having a stiff tail rather than a flexed tail, but that all of the young were flexed tailed, indicating that this stiffness is genetically similar to the flexed condition.

The following plates give diagrams drawn from some of the parents and their progeny. Plates 1, 2, 3, 4 and 5.

° Dr. H. R. Hunt, working with mice from the same stock, obtained a ratio of 6.8 : 1.0 from 1141 F_2's counted. From a back-cross of flexed tailed parent x F_1 generation, he obtained a ratio of 1.4 straight to 1.0 flexed in 266 young. The back-cross shows the same deficiency of flex-tailed animals as the crosses of F_1 x F_1. This is in accordance with the findings given above.

Table 1. Flexed x Straight to Obtain F_1's	
Cross	Number of Animals
3	6
6	36
7	2
12	7
13 ♀ 60	18
13 ♀ 61	21
18	10
19	14
56	8
58	6
64	3
72	4
67	7
Total	142 all Straight Tailed

Table 2. F_1 x F_1 to Obtain F_2's:

Cross no. F_1 x F_1	Straight F_2's	Flexed F_2's	Total F_2's
20	31	3	34
21	45	7	52
22	24	2	26
23	16	3	19
24	78	13	91
25	54	14	68
27	27	2	29
28	45	4	49
30	31	2	33
31	32	10	42
32	37	3	40
34	31	4	35
35	5	2	7
36	26	4	30
37	45	2	47
38	51	7	58
39	37	5	42
43	42	6	48
44	49	6	55
45	32	3	35
47	38	6	44
48	28	4	32
57	18	0	18
58	17	2	19
60	26	3	29
61	12	3	15
62	15	1	16
63	14	5	19
65	16	0	16
66	14	3	17
Total	936	129	1065

Table 3. Flexed x Flexed

Cross	Number of Young	
10	5	
11	8	
14	7	
74	12	
80	10	
81	19	
86	8	
87	3	
93	10	
94	3	
95	16	
96	3	
100	13	
101	5	(stiff x flexed parents)
102	5	(stiff x flexed parents)
103	10	
Total	137	(All young flexed tailed)

Interpretation of Data

In the F_1 generation. obtained from crossing a flexed tailed animal with a straight tailed animal, the flexed character behaves as a Mendelian recessive - it does not appear in F_1.

When flexed is crossed with flexed the character again acts as a Mendelian recessive - it breeds true. The fact that a flexed tailed animal, when crossed with a stiff tailed animal, gives all flexed tailed progeny (crosses 101 and 102, table 3) supports the assumption that a stiff tailed animal is genetically similar to a flexed animal, and such animals are counted as flexed in counting the F_2's.

The ratio in F_2 is yet to be explained. It is neither 3 : 1 nor 15 : 1, but is between the two, 7.26

straight : 1.00 flexed.

If this character were a simple Mendelian recessive caused by a single factor we would expect to find a ratio of 3 : 1, or 798.7 straight to 266.3 flexed. Instead, we get 936 straight to 129 flexed, a ratio of 7.26 : 1.00. The deviation is 137.3 ± 9.5. The numbers obtained are not in a simple 3 : 1 ratio.

If this character were caused by two recessive factors acting together the expected ratio would be 15 : 1 or 998.4 : 66.6. The deviation is 62.4 ± 5.3. We are not dealing with a 15 : 1 ratio.

The ratio obviously does not approximate 9 : 7.

If we consider that there are three pairs of factors concerned, and assume a modified 27:9:9:9:3:3:3:1 ratio, the theory still does not fit; for by grouping 27:9:9:9 and 3:3:3:1, the ratio is 54 : 10, or 5.4 : 1.0, the expected numbers being 898.6 straight to 166.4 flexed. The deviation is 37.4 ± 7.9.

Let us assume the presence of two factors, one of which acts as an inhibitor to the appearance of the flexed condition.

A - straight (dominant) B - inhibitor
a - flexed (recessive) b - non-inhibitor

The zygotes formed in F_1 are:

1AABB + 2AABb + 2AaBB + 4AaBa + 1AAbb + 2Aabb + 1aaBB + 2aaBb + 1aabb. Now if B inhibits the flexure entirely, the ratio is 15:1. We do not have a 15:1 ratio. If BB inhibits the appearance of the flexure entirely and Bb permits it to appear only as a slight flexure, and

bb permits sharp flexure in the presence of aa, the ratio would be 13 : 3, or 4.3 : 1.0. The deviation from this in our count is 72 ± 8.6. The deviation is more than three times its probable error indicating that this is not a ratio of 4.3 : 1.

No satisfactory explanation for our ratio has been found. We may have a character influenced by more modifying factors. There is also another possibility of differential mortality, either pre-natal or post-natal. As observed above, there are numerous abnormalities in the stock, and the flexed young are frequently of anemic appearance at birth. Before any definite conclusions as to the cause of the 7.26 : 1.00 ratio may be reached, a study must be made of both pre-natal and post-natal mortality. The young must be counted at birth, and at weaning, and the pre-natal mortality must be determined, perhaps by counting corpora lutea.

To turn now to the study of the inheritance of flexure type, it will be helpful to consult the diagrams made of the tails of two flexed parents and their offspring. This is not the ideal way to study inheritance of type, since two types are introduced into the cross, one from eigher parent; but it was undertaken along with the endeavor to determine if the character bred true.

In cross 10 (Plate 1) it will be noticed that the flexure in the parents was not extreme. Four out of the five offspring have a very extreme bend at the base of the tail in about the same direction; the fifth resembles the parents.

Cross 11 displays very little similarity in the offspring, although the parent types are not widely different.

In cross 14 young 1, 2, 3, 4, 6 and 7, seem to resemble the male parent, while number 5 is more like the female parent.

Very little resemblance is noticed among the young, or between the young and the parents in cross 81. The same is true of the other crosses here shown. While some resemblances are present, they are neither numerous, nor striking. The similarity observed in some of the crosses, however, suggests that flexure type may be inherited.

Conclusions

The conclusion to be drawn from the data collected are:

A cross of flexed x straight gives, in F_1, all straight tailed animals, which is what would be expected if flexed tail is a Mendelian recessive.

A cross of flexed x flexed gives all flexed animals, which is also in accordance with the idea that flexed tail is a Mendelian recessive.

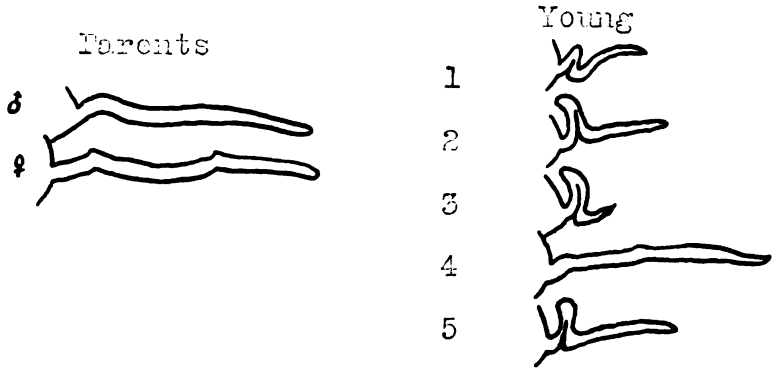
Mice having stiff tails which do not show bending bred as flexed tailed animals, giving all flexed progeny in a cross of stiff x flexed. Stiff tail is genetically similar to flexed tail.

Crosses of flexed x straight give in F_2 a ratio of 7.26 : 1.00. This cannot be explained by a single factor, the flexed condition being recessive to normal; nor by modified ratios produced by the operation of two factors. The explanation for the 7.26 : 1.00 ratio may have numerous modifying factors, or a differential pre-natal or post-natal mortality.

Types of flexure may possibly be inherited, but no such conclusion can be drawn from the data at hand.

Plate I

Cross 10



Cross 11

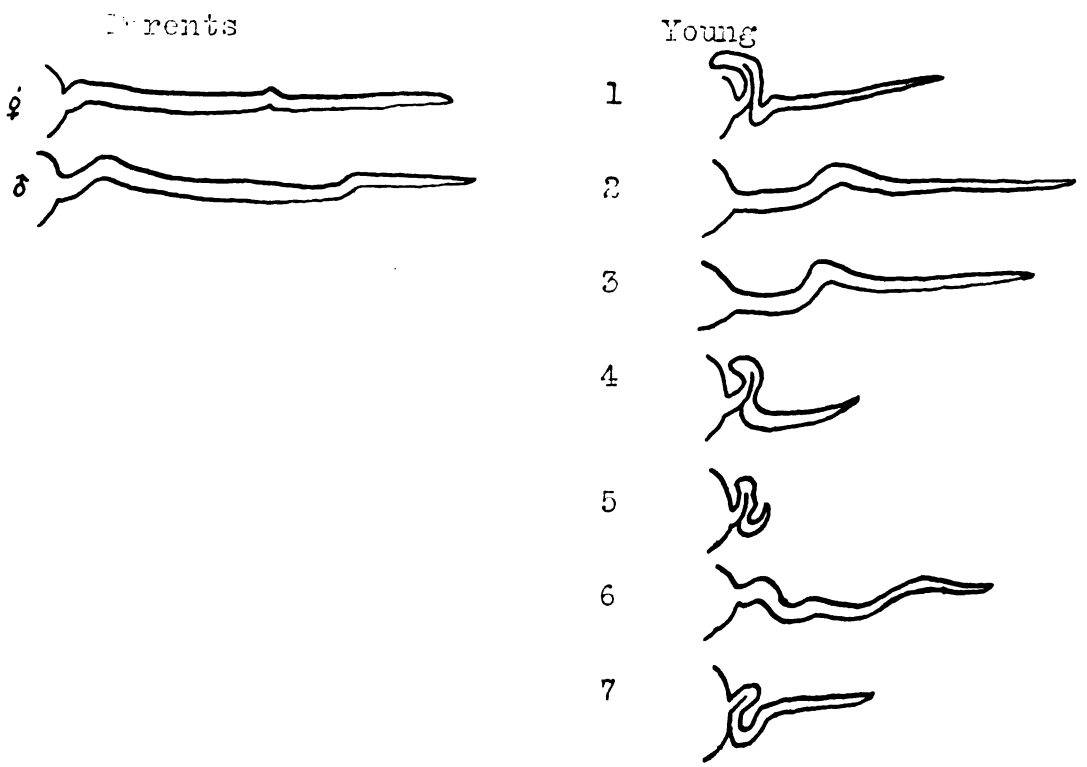
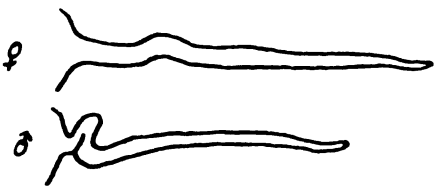


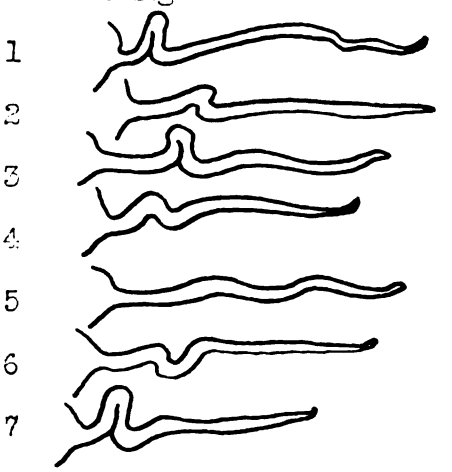
Plate II

Cross 14

Parents

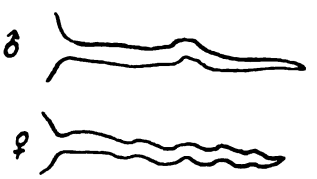


Young



Cross 81

Parents



Young

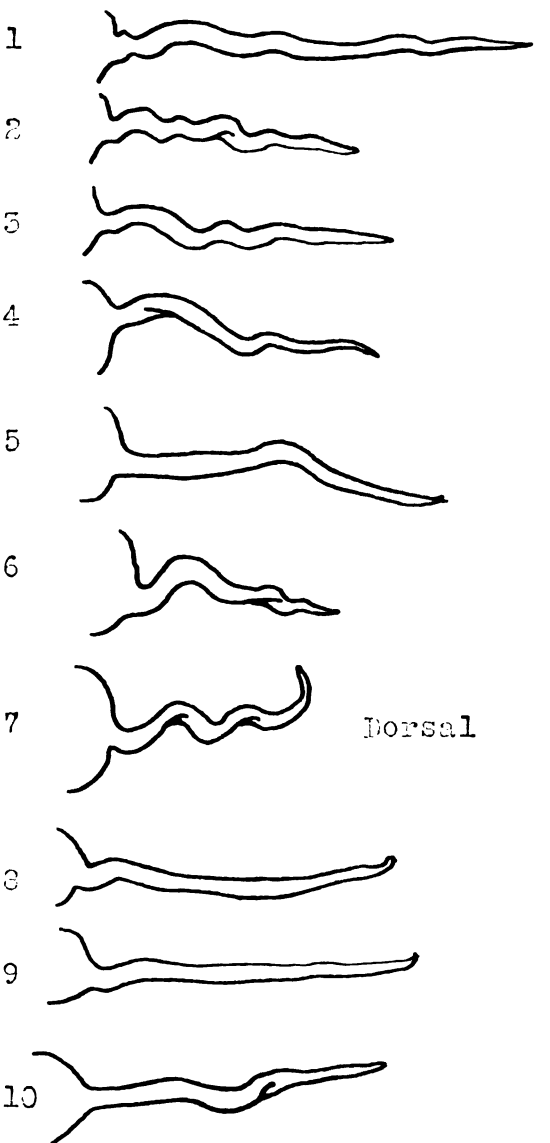


Plate III

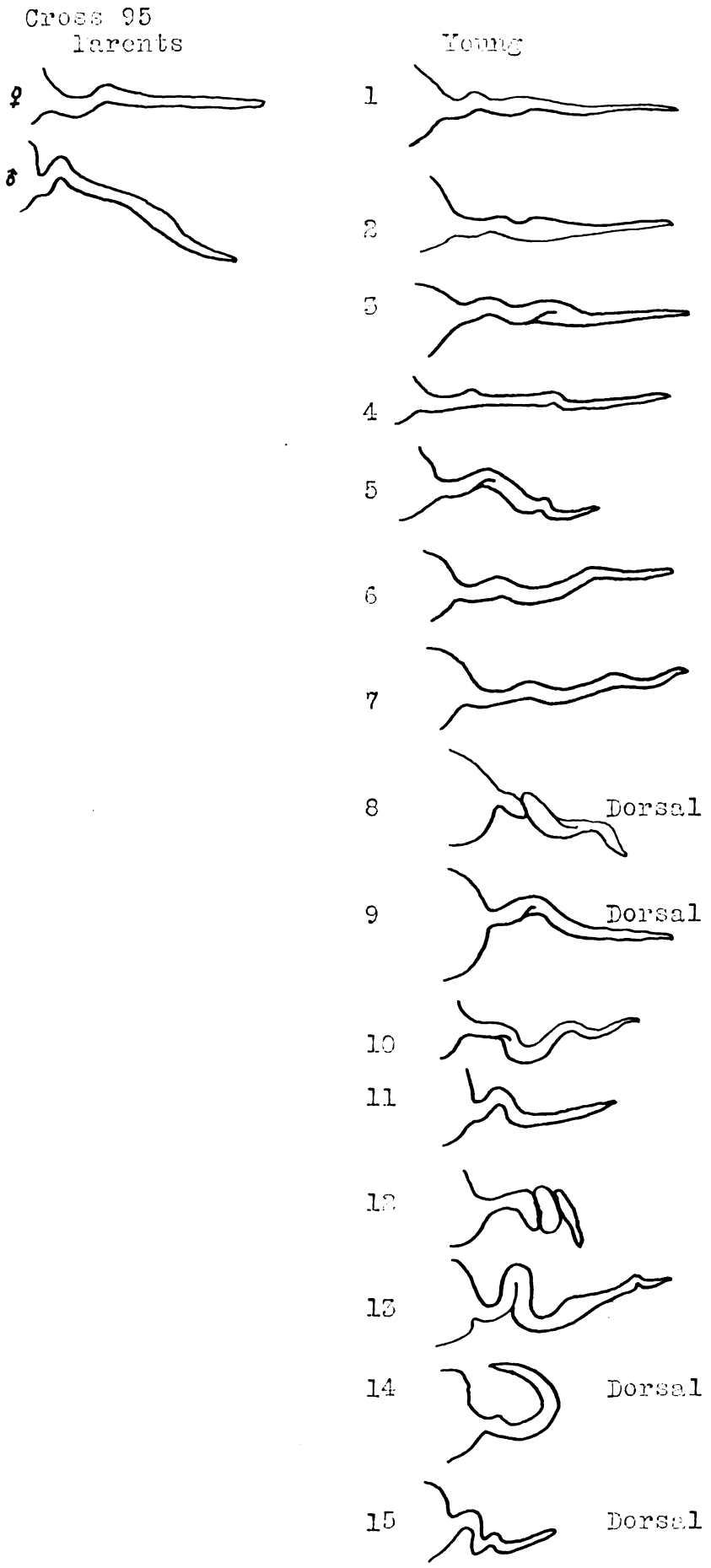
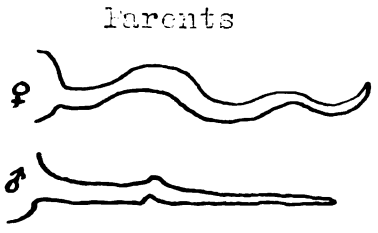

Cross 95
Parents
♀
♂
Young
1
2
3
4
5
6
7
8
Dorsal
9
Dorsal
10
11
12
13
14
Dorsal
15
Dorsal

Plate IV

Cross 100



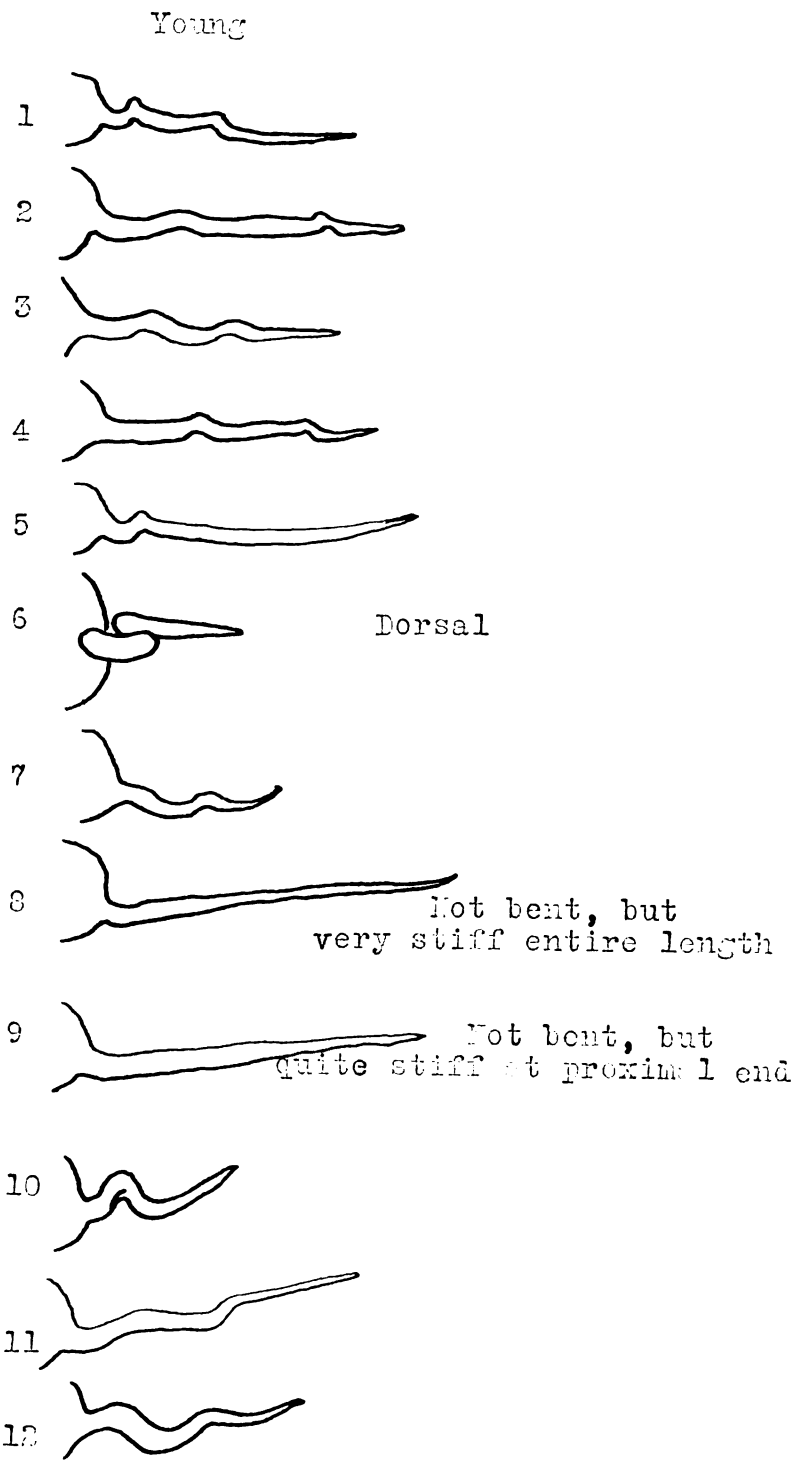


Plate V

Cross 103
Parents

Young

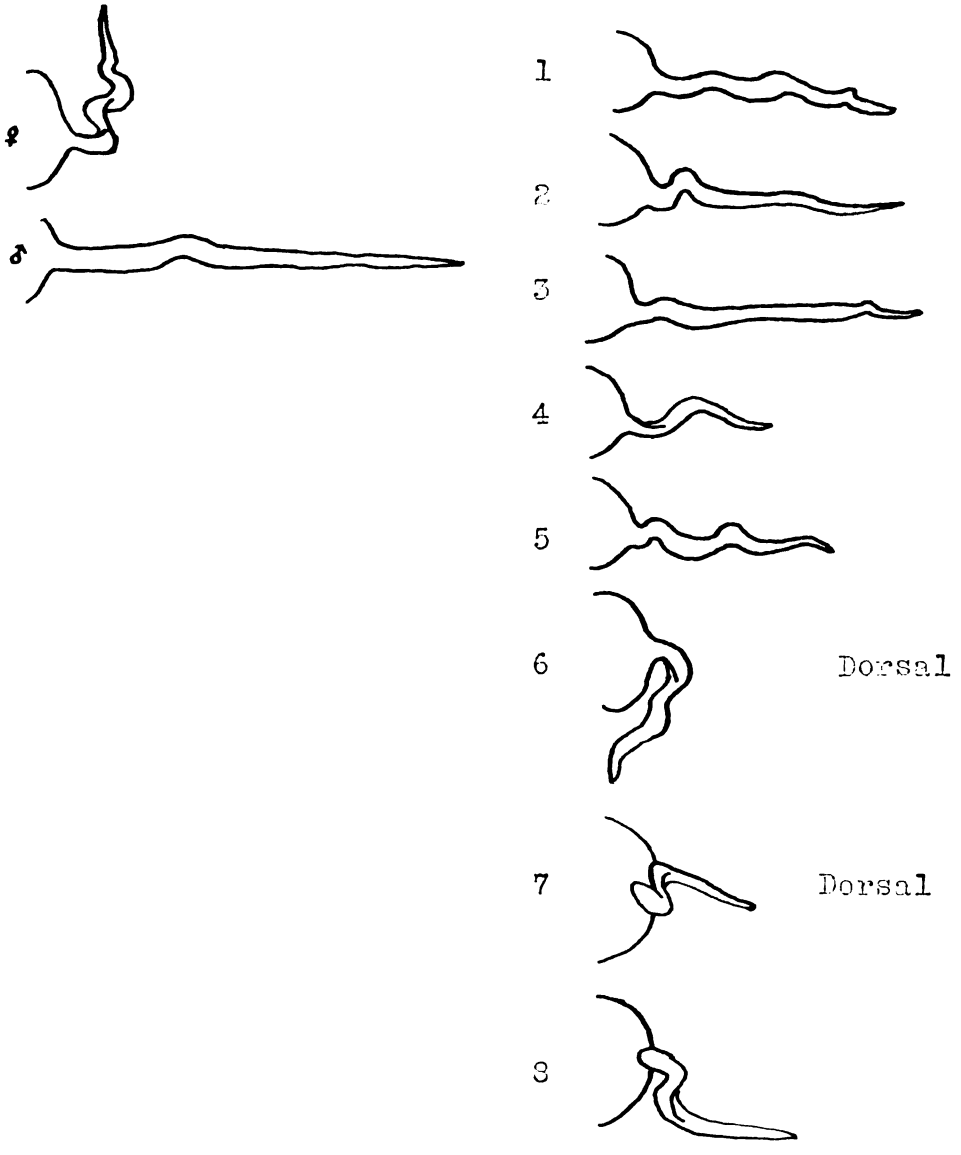
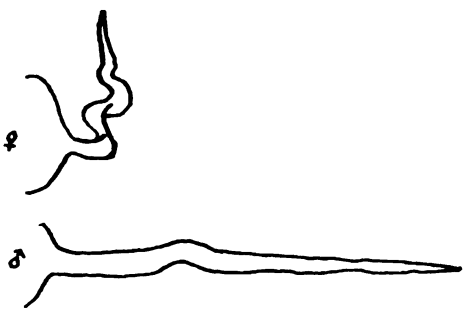
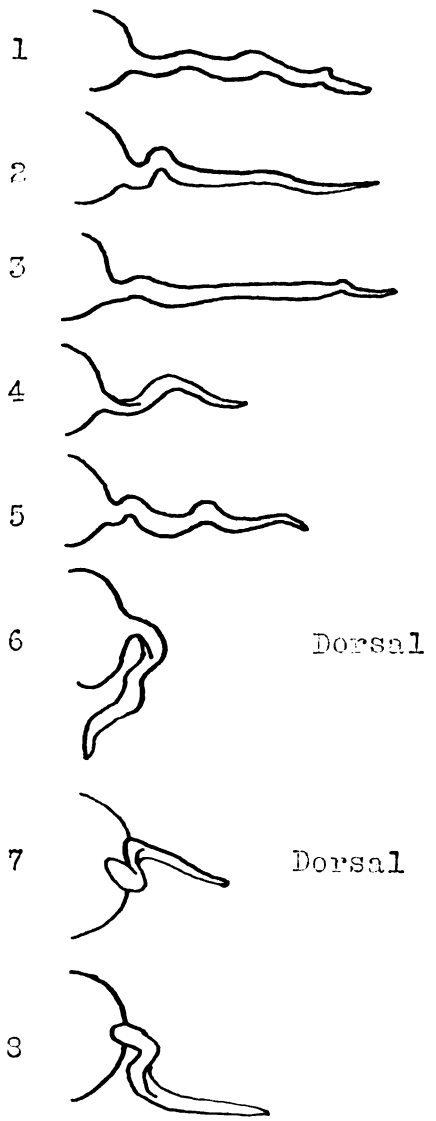


Plate V

Cross 103
Parents

Young





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