



UNIVERSITY OF LONDON, UNIVERSITY COLLEGE

GOWER STREET, LONDON, W.C.1

Telephone : Museum 7389

GALTON LABORATORY

20 April 1934.

Dear Diver,

Many thanks for the new grouse locust, which arrived in good health, though lacking one leg. I will arrange for her marriage.

In classifying some snail broods today, I found one giving apparently about 20% of crossing over. The double heterozygote was a brown bandless from Sutton ^{id} ~~Co~~field, and the double recessive from Port Isaac, Cornwall, whence I have also had bandless browns. The demonstration of crossing-over is not perfect, as the previous history of the parents is not fully known, but in the previous year the recessive had been with another brown bandless from Cornwall and the eight young had shown 3 of the 4 types to be expected if linkage was incomplete.

It is, therefore, difficult to imagine any system of previous matings which would ^{mimic} ~~make~~ the effects of ~~the~~ crossing-over in the way the 1933 brood has done, and I should much like to know if anything of the same kind has come to your knowledge in Nemoralis, - also if you have any data which show that in this species these factors are in other cases closely linked.

Yours sincerely,

R.A. Fisher

40 Pembroke Square,
Kensington, W. 8.

22 April 1934.

Dear Fisher,

I am glad the lady arrived safely, she was without her leg when I first met her.

Stelfox' experiments with brown in nemoralis are none of them very clear. I will look up the data when I get the chance and let you know the results. As far as my memory goes, I think I was forced to decide that brown was not allelomorphic to yellow and pink but something different. Looking through hastily for examples from natural populations in nemoralis I find two Worcestershire populations that give

	Browns	Pinks & yellows	Browns	P & Ys
CCCCC	9	8	13	-
Banded	-	351	-	59

In hortensis there are quite a number of small population samples that are in the same sense. An example from Leeds gives

	B	Y
C	34	-
Bd	9	387

added to this there were 5 whites of which 2 were unbanded and 3 had the usual hyaline bands. Another from Wilts

	B	Y
C	20	3
Bd	-	75

and one white with hyaline bands

If one or both of the parents were carrying old sperm and if the sperm can be held from one season to another you might get the four types. I was faced with similar difficulties in one or two of Stelfox' crosses. V. C. N.



UNIVERSITY OF LONDON, UNIVERSITY COLLEGE

GOWER STREET, LONDON, W.C.1

Telephone : Museum 7389

GALTON LABORATORY

24 April 1934.

Dear Diver,

Many thanks for your ^{letter} ~~labour~~, which shows that the samples from wild populations have, in some cases, browns tightly linked with bandlessness, for even low cross-over frequencies should, in time, equalise the proportions. As to previous matings, we are only concerned with the double recessive, since previous matings of the double heterozygote could not produce the cross-over types, without upsetting the gene ratios. These are quite normal, as you will see from a letter to Nature that I have drafted and to which you might care to suggest any amendments that might occur to you.

My double recessive shared a cage, in a previous year, with another brown banded, and they produced a very small brood, only 8 being classified, but showing 3 of the 4 types. In the light of the 1933 brood, I should guess that here, also, there was crossing-over in 3 cases out of 8, and that the first brown bandless was also a double heterozygote in coupling, but ^{at first} I could not rely on this, as they had only been isolated a few months. The 1933 brood is thus on fairly strong ground, which is not weakened by previous experience, but is not absolutely

critical. I have at once put up two pairs of brown
bandless in repulsion, bred in my cages, back-crossed to
banded yellow, but I may not get any confirmation for 2 years,
so, I think I ought to put the current result on record.

Would you care to add your wild ^{population} ~~computation~~ data
and make a joint letter?

Yours sincerely,

R. A. Fisher

40 Pembroke Square,
Kensington, W. 8.

2 May 1934.

Dear Fisher,

I attach two small amendments to your wording and a proposed form for the last new para. I attach considerable importance to leaving out the word "wild" as the word is definitely misleading - all the genes concerned are wild.

In the last para, I have adhered to your first draft except for quite small changes. It does not, I think, lengthen the original letter unduly. I have given the ~~xxx~~ reference to my 1933 note as that ~~xxx~~ sets out briefly the facts about natural populations. If we included the actual figures for the Bundoran samples that I found they would require several sentences of explanation and I do not think much would be gained.

Yours sincerely,

CD .

I don't know whether you are asking for reprint of this note, but I should like to see it.

W

Proposed Amendments to the Note

"Crossing-over in the Land Snail Cepaea nemoralis L.

Page 1, line 5:

Leave out "wild" and insert "normal".

line 16:

Leave out "I have" and insert "one of us (R.A.F.) has".

Page 2, at end add new para:

"The occurrence of close linkage between a number of genes in natural populations of Cepaea has long been recognised

Footnote:- Diver, C.(1933) Proc. Sixth International
Cong: Gen: Vol 2, p. 236.

though the actual data have not yet been published. ~~An~~
~~examination of~~ The unpublished genetic results of A.W.Stelfox,
kindly placed at the disposal of one of us (C.D.), ^{include} shows a
similar back-cross between pink bandless and yellow banded
which gave 13 pink bandless and 11 yellow banded, followed
by a brood from bandless pinks of 16 pink bandless and 10
yellow banded. Neither of these progenies show recombination
and they are inconsistent with the occurrence of so much as
20 per cent. It seems likely that the pinks used in the
two sets of experiments were genetically different, and that
the one is more closely linked with bandless while the other
shows appreciable recombination. The alternative that the
same genes may show ^{variable} ~~different~~ linkage in different strains is,
however, ^{not} ~~by no means~~ excluded.

C.DIVER.

40 Pimlico Square W.8

2 May 1934.

i Delhi

AW Ruffin has made a number of experiments with this species and he has kindly placed his results at our disposal. It is one of these ~~a strong tendency~~ than a poor evidence for a strong tendency between the same two species of genus but it is not the possibility is not excluded that the pits used in the two cases were not the products of the same genus. In ~~the~~ crosses involving other genera his results show that some crosses are true plants.

$$\begin{array}{r} 138 \\ 45 \\ \hline 183 \end{array}$$

$$\begin{array}{r} 179 \\ 14 \\ \hline 193 \end{array}$$

Anders

0

Pit

183

yellow

193.

PI

127.

25

41.

20

309

57

Eloff.

Genetica.

1932. Vol XIV.
parts 1-2

a detailed collection
of crosses known to
appear among them

38/23-

0

Blue

2

Pit

3

yellow

—

W.

—

29

33

The occurrence of close linkage between a number of genes
between a number of genes is (Lefsky has long been recognized) through
the extensive population studies through the

1. Diver 1922

though the ~~actual~~ data have not yet been published. An examination
of the ~~published~~ data of the unpublished genetic ~~data~~ results obtained by
A.W. S. Fisher and himself found at the disposal of me of us (C.A.) shows the
following ~~between~~ ~~and~~ ~~from~~ pink banded x yellow banded
a banded between

which gave 13 pink banded and 11 yellow banded, followed by a and
for banded pink of 16 pink banded and 10 yellow banded.

Data of these progenies show no recombination and are consistent
with the occurrence of a recombination of 20%.

It seems likely that the pink and in the two sets of experiments were genetically different
and that while one is now closely linked with banded the other shows
appreciable recombination.

The alternative that the same genes
may show variable linkage in different strains, however, is not excluded.

Although the general occurrence of down birdings is before has been long
recognized, published evidence is lacking. One of us (C.D.) has the ~~honor~~ of examining
the unpublished data of A.W. Silliman on Nevada's has found ~~from the best~~ ~~best~~ ~~best~~
~~and on 72 fragments~~ ~~minerals with an amount 20% over the following~~ ~~best~~ ~~best~~ ~~best~~

13 Pink sandstone

11 Yellow sandstone

followed by on 72 from the sandstone further going

15 Pink sandstone

10 Yellow sandstone

Both of these fragments ~~minerals with an amount 20% over the following~~ ~~best~~ ~~best~~ ~~best~~
with the occurrence of so much as 20%. It is to be pointed out that the fossils were
as generally different, and that while one is more closely related with another, the other shows a different
relationship. The ^{alternatives} ~~alternatives~~ that the same genus shows variable changes in different localities is, however,
by no means excluded.

the Land Snail, *Cepea*
CROSSING - OVER IN *CEPEA* *Memoralis*

hanel

A genetic situation of particular interest from the point of view of the evolutionary modification of genetic phenomena occurs, not only among fishes (*Lebistes*), but among insects (Orthoptera) and land snails (*Cepea*), in all of which a number of variant genes, completely dominant to their ~~wild~~ allelomorph, are found to be closely linked in the same linkage group. In the ^{grouse} grass locusts the linkage was at first regarded as absolute and the variant forms supposed to belong to a single allelomorphic series. The occurrence of crossing-over was demonstrated by Haldane in the extensive data published by Nabours. Nabours has since shown that in one American species of ^{grouse} grass locust (*Acrydium arenosum*) a similar series of pattern factors occurs, showing only relatively loose linkage. In the course of experiments designed to test quite other consequences of natural selection, ~~I~~ have recently obtained a brood of *Cepea memoralis* showing *apparently* 20-25% recombination between the factor for brown ~~versus~~ yellow and that for bandless. The brood of about 60 young appeared in the summer of 1933, the parents having been taken in nature about 15 and 28 months previously. The brown bandless double heterozygote was evidently in the coupling phase, for there survived to be classified in April of this year 17 bandless brown, 18

On of us (RAF) has

11
banded yellow or 35 of the parental combinations,
making 9 combinations together with 4 banded brown and 5 bandless yellow,
evidently due to crossing-over.

2/29
The above has since shown that in one American species of grass locust (*Asrydus gramineus*) a similar series of factors occurs, showing only relatively loose linkage. In the course of experiments designed to test the consequences of natural selection, I have recently obtained a brood of *Asrydus gramineus* showing 20-25% recombination between the factor for brown versus yellow and that for bandless. The brood of about 80 young appeared in the summer of 1933, the parents having been taken in nature about 12 and 14 months previously. The brown bandless double heterozygote was evidently in the coupling phase, for there survived to be classified in April of this year 17 bandless brown, 18 classified in April of this year as bandless brown,