LINKAGE BETWEEN FIDGET AND AGOUTI IN THE HOUSE MOUSE

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INTRODUCTION

THE recessive gene fidget in the mouse (symbol fi; Grüneberg, 1943) influences behaviour (head shaking, circling), the cornea and the skeleton (polydactylism and some other effects not yet described). Linkage tests of fi with tan, a^t, albinism, c, and blue dilution, d, all gave negative results; there was no close linkage, but the possibility of loose linkage could not be excluded.

During 1949 further breeding records led us independently to suspect loose linkage between fi and a^t. The combined results, which are presented in this paper, establish its existence; recombination is about 33·5 per cent. Work is now proceeding to determine the position of fi with respect to that of pallid, pa, which is also linked to a^t (Roberts and Quisenberry, 1935).

MATERIAL AND DATA

Two types of mating were used, namely repulsion intercrosses $a+/a^tfi \times a+/a^tfi$ and coupling intercrosses $A+/a^tfi \times A+/a^tfi$; but the progeny of one set of matings of the latter type were divided into three phenotypes with respect to the agouti locus, based on the appearance of the belly (light versus dark) as well as the back (agouti versus black).

The data are shown in table 1, which also reproduces those published previously (Grüneberg, 1943).

Several other mutants were also present in some of the matings; they were brown, b, albinism, c, luxate, lx, pinkeyed dilution, p, and macrocytic anæmia, W^v. It was not possible to classify fully for pinkeyed dilution, owing to the simultaneous segregation of albinism; nor was it possible to put any confidence in the classification of luxate, since the double heterozygote $+fi+lx$ was found to resemble the homozygote $lxlx$ and the heterozygote $+lx$ often shows polydactyly similar to that seen in many fidgets. The segregations of fi with b, c, p and W^v are shown in table 3.

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TABLE I

Segregation of fi and a^t

Author and date	Mating*	Phenotypes and numbers of progeny						Total	Segregation of fi†					Segregation of a^t†‡				
									D	I	χ^2	DF	P	D	I	χ^2	DF	P
Edinburgh :—																		
Falconer, new data	I.R.	a^t+ 21	$a^t fi$ 10	$a+$ 16	$a fi$ ...			47	−9·3	250·6	0·348	...	...	−22·6	150·6	2·050	...	...
Carter, new data	I.R.	a^t+ 34	$a^t fi$ 13	$a+$ 16	$a fi$ 3			66	−2·6	352·0	0·020	...	...	−13·3	352·0	0·505	...	...
Carter, new data	I.C.	$AA+$ 16	$AA fi$ 2	Aa^t+ 45	$Aa^t fi$ 13	$a^t a^t+$ 16	$a^t a^t fi$ 10	102	−2·6	544·0	0·013	...	...	+32·0	816·0	1·255	...	...
Sum										1146·6	0·381	...	...		1418·6	3·810	...	...
Deviation									−14·6		0·215	1	>0·5	−4·0		0·011	1	>0·9
Heterogeneity											0·166	2	>0·9			3·799	2	>0·1
London :—																		
Grüneberg, new data	I.R.	a^t+ 226	$a^t fi$ 75	$a+$ 105	$a fi$ 6			412	−117·3	2197·3	6·265	...	...	−42·6	2197·3	0·828	...	...
Grüneberg, 1943	I.C.	$A+$ 53	$A fi$ 11	a^t+ 21	$a^t fi$ 7			92	−26·6	490·6	1·449	...	...	+13·3	490·6	0·362	...	...
Sum										2688·0	7·714	...	...		2688·0	1·191	...	...
Deviation									−144·0		7·714	1	<0·01	−28·3		0·299	1	>0·5
Heterogeneity											0·000	1	>0·9			0·892	1	>0·3

* In the column headed "mating," C = coupling, I = intercross, R = repulsion.

† In the segregation analyses, D = discrepancy in the equation of estimation, DF= degrees of freedom, I = amount of information, P = probability.

‡ In all cases a^t entered with fi ; the signs have, therefore, been taken in the sense required to test the segregation of a^t from its allele, whether a^t was playing the dominant or recessive role.

ANALYSIS OF THE DATA

The data have been analysed by the methods described by Mather (1935, 1937), which are special applications of the maximum likelihood method of estimation (Fisher, 1925). In the linkage analysis, however, we have adopted the sign convention used by Fisher (1946), whereby linkage closer than the trial value is indicated by a positive instead of a negative score.

The single-factor segregation analyses (table 1) show a deficiency of fidgets, significant at the 1 per cent. level, in the London data ;

TABLE 2

Linkage of fi *and* a^t

Author and date	Mating	Analysis of linkage					
		D_{33}	D_{34}	I	χ^2	DF	P
Edinburgh :—							
Falconer, new data .	I.R.	+12·685	+13·241	55·613	2·893	...	...
Carter, new data .	I.R.	−7·343	−6·278	106·554	0·506	...	...
,, ,, .	I.C.	−9·672	−6·552	311·996	0·300	...	...
London :—							
Grüneberg, new data	I.R.	+26·266	+30·463	419·738	1·644	...	...
,, , 1943 .	I.C.	−27·912	−24·904	300·726	2·591	...	...
Sum . . .	...	...	...	...	7·934	...	...
Deviation . .	...	−5·976	+5·970	1194·628	0·030	1	>0·9
Heterogeneity .	...	...	...	...	7·904	4	>0·05

Recombination fraction $p = 33\cdot5 \pm 2\cdot9$ per cent. (standard error).

TABLE 3

Segregation of fi *with* b, c, p, W^v

Author	Mates	Phenotypes and numbers of progeny						
				+ +	+fi	b +	bfi	Total
Grüneberg	$b+/+fi \times b+/bfi$	...	...	23	5	33	8	69
,,	$b+/+fi \times b+/+fi$	...	...	84	29	30	7	150
				+ +	+fi	c +	cfi	Total
Falconer	$cfi/++ \times cfi/cfi$	...	...	19	3	16	10	48
,,	$cfi/++ \times cfi/++$	...	...	85	22	26	8	141
,,	$cfi/++ \times cfi/c+$	...	...	6	2	5	3	16
Grüneberg, new data	$+cfi/p++ \times +cfi/p++$	...	...	33*1*	82	116	29	558
				112*	35*			
		$W^vW^v +$	W^vW^vfi	$W^v+ +$	W^v+fi	+ + +	++fi	Total
Falconer	$W^v+/+fi \times ++/+fi$	...	...	11	2	11	4	28
Carter	$W^v+/+fi \times W^v+/+fi$	8	...	20	5	14	5	52

* Figures in italics show the numbers of pinkeyed progeny within the non-albino classes.

the deficiency of a^t in the London data is not significant and the Edinburgh data show good segregations at both loci.

In analysing the linkage we assume that the deficiency of fidgets was entirely due to inviability of the homozygotes and that this

inviability was not dependent upon the genotype at the agouti locus. When these assumptions are made, the estimate of the recombination fraction is independent of the viability of the fidgets : the amount of statistical information available about the estimate is still measured by the rate of change of the discrepancy in the equation of estimation.

The linkage analysis is shown in table 2 : the five bodies of data are homogeneous and indicate linkage with a recombination fraction $33 \cdot 5 \pm 2 \cdot 9$ per cent. (standard error).

The data of table 3, which gives the segregations of fi with b, c, p and W^v, do not show any significant departures from free segregation.

SUMMARY

Fidget, fi, in the house mouse is linked to tan, a^t ; recombination is estimated at $33 \cdot 5 \pm 2 \cdot 9$ per cent. Its position with respect to pallid, pa, is not yet known.

Note added 2nd January 1950.—We are grateful to Professor Fisher for pointing out, since this paper was written, that the linkage analysis of some of our data (the four class segregations) could have been facilitated by the use of table XIV$_1$, in the 1948 edition of Fisher and Yates' *Statistical Tables for Biological, Agricultural and Medical Research* (Edinburgh, Oliver and Boyd).

REFERENCES

FISHER, R. A. 1925. *Camb. Phil. Soc. Proc.*, 22, 700-725.
FISHER, R. A. 1946. *Amer. Nat.*, 80, 568-578.
GRÜNEBERG, H. 1943. *J. Genet.*, 45, 22-28.
MATHER, K. 1935. *Ann. Eugen.*, 6, 399-410.
MATHER, K. 1937. *Ann. Eugen.*, 8, 95-105.
ROBERTS, E., AND QUISENBERRY, J. H. 1935. *Amer. Nat.*, 69, 181-185.