

not know whether the animals to which the teeth belonged had a compound lower jaw or a simple one; in other words, whether the mammalian tooth development took place in a reptilian or in a mammalian jaw. The Tritylodontids show that the former was actually realized in the Ictidosauria.

Another question which now arises is whether we may expect even pantotherian teeth in the Rhaetio-Lias. At the moment we do not possess such a tooth and we are still at liberty to build sequences of 'grades' or phylogenies and similar schemes without being encumbered by it.

One may still assert that *Morganucodon* gave rise to the Pantotheria, and that the Symmetrodonta arose independently. One might assert that the co-existence of 'Triconodonts' (in order to make *Morganucodon* a triconodont one has anyhow to widen the diagnostic borders of the order Triconodonts) and Symmetrodonts in the Rhaetio-Lias is a logical demand of the Cope-Osborn theory, and the fact of this co-existence would be a criterion for its correctness. In that event, however, *Morganucodon* could not be regarded as a pre-pantothere.

For the solution of these problems we require a much more extensive mammalian fauna from the Mesozoic than we at present possess. This need is further emphasized by the existence of the tooth described above.

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<sup>1</sup> Kühne, W. G., *Proc. Zool. Soc. Lond.*, 119, Pt. II, 345 (1948).  
<sup>2</sup> Simpson, G. G., *Amer. J. Sci.*, 87 (Aug. 1926).

### Order of Genes in the Fifth Linkage Group of the House Mouse

WORK carried out in this Department during the past two years on the fifth linkage group in *Mus musculus* has established the order circle (*kr*), agouti (*A*), undulated (*un*), wellhaarig (*we*) and pallid (*pa*)<sup>1</sup>. Recent work also suggests that a gene (*pl*) modifying the frequency of manifestation of polydactyly is located in this region, possibly between *A* and *pa*. Mrs. Wallace<sup>2</sup>, also working in this Department, determined a linkage of the order of 25 per cent recombination between fidget (*fi*) and Danforth's short tail (*Sd*). About the same time, Carter and Grüneberg<sup>3</sup> ascertained a linkage of about 33.5 per cent recombination between fidget and agouti. Earlier work, both at Cambridge and at the Jackson Memorial Laboratory, Bar Harbor, showed indications of a loose linkage (about 40 per cent recombination) between *A* and *Sd*. Thus there was clear evidence of a second series of loci in the order *A-fi-Sd*.

The relation between these two series was, however, still in doubt. To determine the order of the loci *A*, *pa* and *Sd*, as one of four projects concerning the fifth chromosome and using stock available in this Department, I set up triple backcrosses of the types

$$Sd A +/+ a^t pa = + a^t pa/+ a^t pa, \quad (1)$$

$$Sd a^t +/+ A^y pa = + a^t pa/+ a^t pa, \quad (2)$$

the heterozygous parent being male in sixteen of the matings and female in two.

The offspring must fall into four (double) phenotypic classes, for example, in case (1) (genotypes written vertically)

$$\begin{array}{cccc} \text{I} & \text{II} & \text{III} & \text{IV} \\ Sd + & + Sd & Sd + & Sd + \\ A a^t & A a^t & A a^t & A a^t \\ + pa & + pa & + pa & + pa \end{array}$$

Kosambi's theory of recombination<sup>4</sup> (using provisional recombination values, *Sd-A* 42 per cent and *A-pa* 15 per cent) gives two sets of expected frequencies for these classes, depending on the orders

$$(a) Sd-A-pa \text{ or } (b) Sd-pa-A.$$

Out of a total of 277 mice bred from both types of mating, the observed and expected class numbers were

	I	II	III	IV
Obs.	135	96	16	30
Exp. a	134.9999	100.4501	25.6601	15.8899
Exp. b	148.0617	87.3883	12.5983	28.9517

To compare the goodness of fit of the rival hypotheses,  $\chi^2$ , calculated on three degrees of freedom, comes to

	$\chi^2$	P.
Hyp. (a)	16.36	< 0.01
Hyp. (b)	2.96	0.5-0.3

These observations are therefore in good agreement with the order

$$Sd-pa-A,$$

and in strong disagreement with the alternative order. This makes the order of these seven factors:

$$kr-A-un-we-pa-fi-Sd.$$

A fuller account of this work will be published later in *Heredity*.

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<sup>1</sup> Fisher, R. A., *Heredity*, 3 (2), 229 (1949).  
<sup>2</sup> Wallace, M. E., *Nature*, [166, 407 (1950)].  
<sup>3</sup> Carter, T. C., and Grüneberg, H., *Heredity* (in the press).  
<sup>4</sup> Kosambi, D. D., *Ann. Eugen.*, 12 (3), 172 (1944).

### Effect of Moisture on the Frictional Properties of Jute Fibre

IN connexion with the measurement of frictional characters of jute fibre (a full report of which will be published elsewhere) by allowing a fibre pad on a metal block to slide over another the inclination of which could be increased gradually, the following results on the effect of relative humidity on the coefficient of friction ( $\mu$ )—fibres sliding parallel to one another—were obtained:

Sample A		Sample B	
Relat. humidity (per cent)	$\mu$	Relat. humidity (per cent)	$\mu$
78	0.54	80	0.56
58	0.46	62	0.48
46	0.41	43	0.37

The samples were conditioned in desiccators over appropriate solutions for seven days or more, and were tested for friction when the room conditions were at about the corresponding relative humidities. As in the case of other textile materials<sup>1,2</sup>, between 40 and 80 per cent relative humidity, the coefficient of friction of jute fibre appears to increase approximately linearly with relative humidity.

In order to see the change beyond the above range of humidities, particularly when jute contains more