THE GEOTROPIC REACTION OF RODLESS MICE IN LIGHT AND IN DARKNESS.

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I.

It has been shown that it is possible to formulate precisely the geotropic orientation and movement of rats (Crozier and Pincus, 1926–27 (3, *c*); Pincus, 1926–27 (4)), mice (Crozier and Oxnard, 1927–28 (7)) and certain invertebrates (Wolf, 1926–27 (5); Crozier and Stier, 1927–28 (6)) through their behavior on an inclined plane. The present paper records preliminary results of a more complete physiological study of the development of sense organs in the rodless mouse employing this method.

II.

The apparatus used was similar to that employed by Crozier and his collaborators, consisting of a plane $2\frac{1}{2}$ feet square overlaid with black screen wire upon which is painted a grid, 5 cm. between intersections. An inverted protractor, to which was attached a weighted thread, measured the angle of inclination of the plane (α). A large celluloid protractor was constructed to measure the angle of orientation upward from the horizontal (θ) (*cf.* Fig. 1, in Crozier and Pincus, 1926–27 (3, *a*)).

A litter of six rodless mice of an inbred "black—short ears—kinky tail—rodless" stock about 25 days of age was tested, together with an "albino—short ears—kinky tail—rodless" of similar age. A litter of two of an inbred "non-agouti—pink eyed—dilute—brown" stock of about 20 days served as controls.

Active adult animals with senses well developed do not orient on the inclined plane, naturally, but must be stimulated, and this stimulation must be given carefully and precisely. The mouse is placed nose upward upon the incline and the tail gently pressed to the screen wire with a forefinger. The animal pulls hard to get loose. When the pressure is gradually increased the mouse pulls very hard. When the finger is suddenly released, the mouse runs forward quickly, taking the line of "least resistance" which determines the measured angel θ. A straight edge is placed between two marked points in the mouse's path and the angle measured with the transparent protractor.

III.

Six observations of θ were made in the dark for the rodless animals for $\alpha = 20°, 30°, 50°, 70°$ and for the controls at 15°, 30°, 50°, and 70°.

TABLE I.

Values of	15°	20°	30°	50°	70°
Black rodless *A*		51.2	62	70	74
" " *B*		50.4	61	71	77.8
" " *C*		52.8	61.4	72.4	79.4
" " *D*		51	59.2	71.4	78.6
" " *E*		52.4	62.8	73.4	80
" " *F*		50	62.2	74.4	80.6
Albino "		52.2	61.6	72.6	79.6
Control *A*	39.5		64	80	78.2
" *B*	44.4		55.5	68.4	80.4

TABLE II.

Values of	15°	20°	30°	50°	70°
Average θ, rodless		51.4	62.4	72.1	78.6
" θ, controls	41.9		59.7	76.2	79.3

The averages of the six observations for each animal are shown in Table I.

The averages for the rodless individual and for the controls are again averaged and these grand averages are given in Table II.

A 50 watt 115 volt white frosted Mazda light was then placed at the top of the plane and the animals were again tested at the previously recorded angles.

The averages of six observations for each rodless animal are given in Table III, together with their grand average.

When, however, the controls were tested in the presence of light, they utterly refused to mount the plane but turned quickly and moved away from the source of illumination. Thus no records could be obtained for them.

After about 5 minutes in the light to become adapted to the light, they were forced to walk up the plane facing the light and their tails were then pinched. I finally succeeded in getting the scattered

TABLE III.

Values of	20°	30°	50°	70°
Black rodless *A*	51.2	64	71.8	77.2
" " *B*	54.8	62	71.8	80.4
" " *C*	53.6	63	72.6	79.4
" " *D*	54.6	61.4	71.6	80.4
" " *E*	52.8	60.2	70.4	77.4
" " *F*	51.6	58.8	68	78.8
Albino "	49.2	60.8	71.6	79.8
Average	52.5	61.4	71.1	79.1

TABLE IV.

	20°	30°	50°	70°
Control *A*	42.8		63.2	58
" *B*	38.2	39.2	58.2	55.5

figures shown in Table IV. At 30° Control *A* refused entirely to mount the plane and the average for Control *B* at this angle is based upon only 4 observations.

IV.

It has been shown (Crozier and Pincus, 1926–27 (3, *c*)) that the behavior of young rats on an inclined plane in darkness is such that when θ is plotted against $\log \sin \alpha$ the curve tends to approach a straight line.

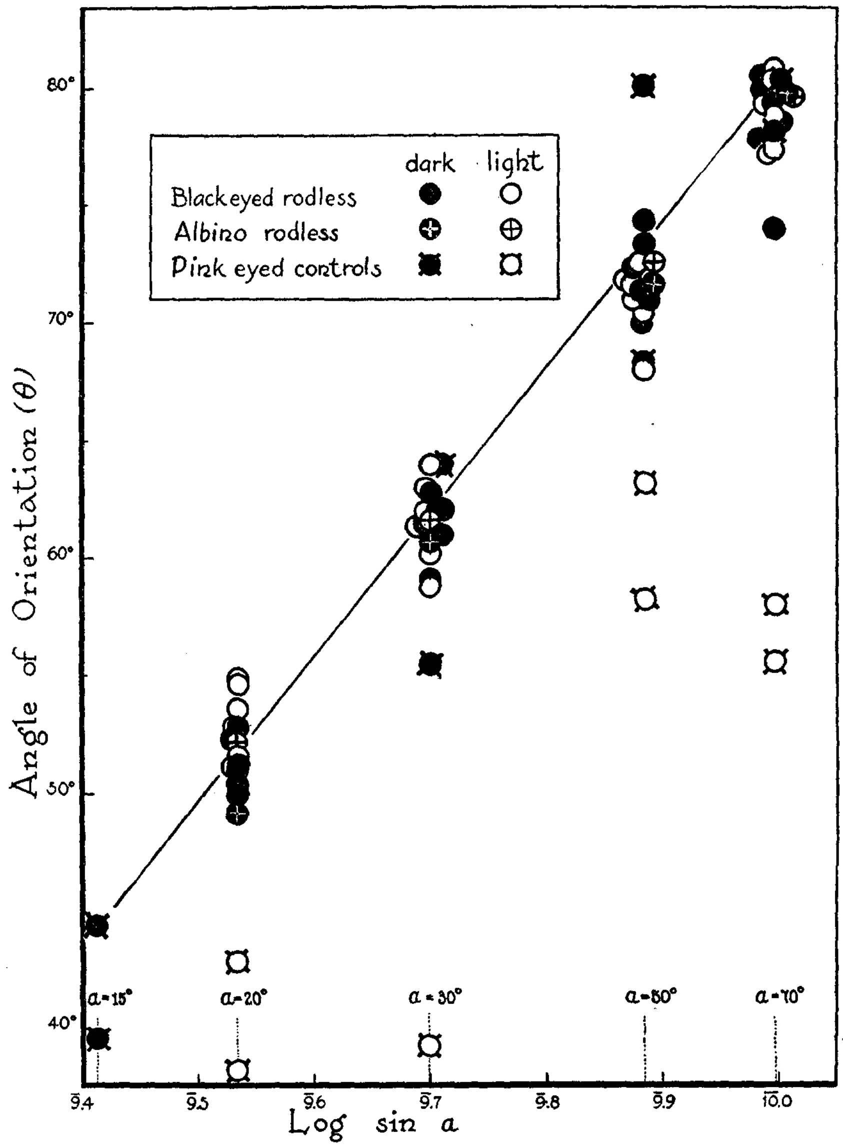

FIG. 1. The amounts of upward geotropic orientation of (θ) "rodless" mice are the same in darkness or in light. Mice with normal retina orient well in darkness, but in light their orientation is erratic. The plotted points are average measurements of the orientations of single individuals.

In Fig. 1 are plotted values of θ against the corresponding log sin α for the individual averages, as well as the scattered inaccurate values for the controls in the light (data of Tables I, II, III).

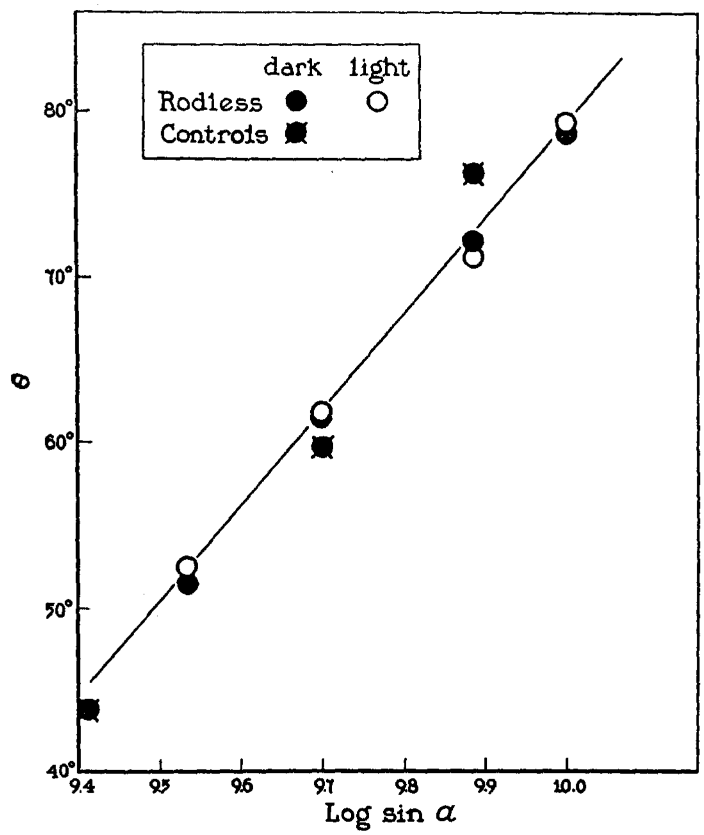

FIG. 2. Mean values for the amount of geotropic orientation (θ) of rodless and control mice in darkness or in light (rodless) is to a sufficient approximation a rectilinear function of the logarithm of the gravitational component in the plane of creeping (log sin α).

A line drawn through the general groups of points is such that when arbitrary values for points upon this line are substituted in the general relation,

$$\theta = K \log \sin \alpha - C$$
$$K = -62$$
$$C = 539.3$$

When a similar plot (Fig. 2) is made for the averages of (1) all rodless in the dark (Table II), (2) all rodless in the light (Table III), and (3) all controls in the dark (Table II), the result is even more striking. The geometric means are of a slant differing very little from that seen in Fig. 1.

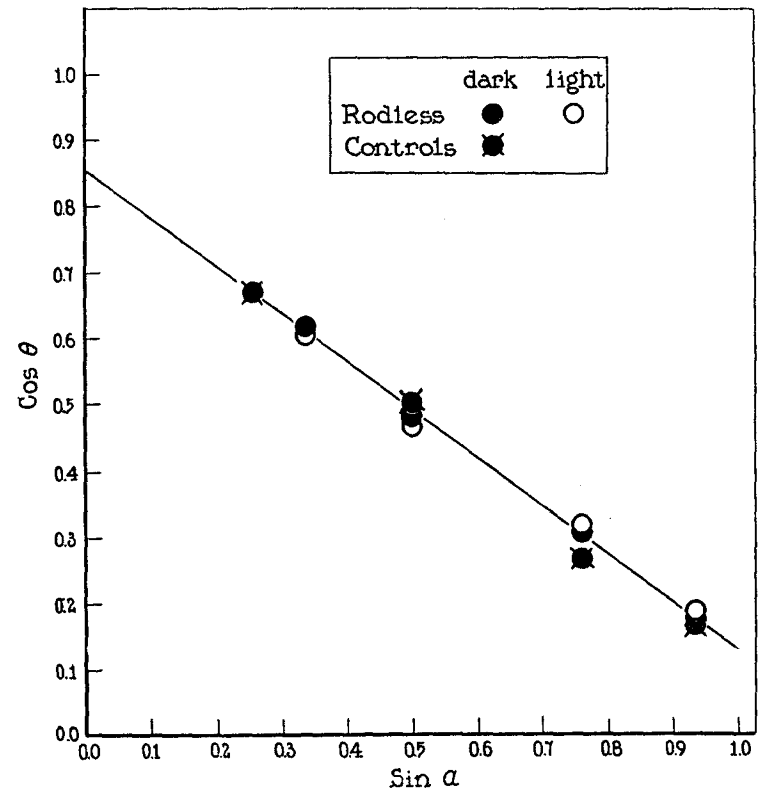

FIG. 3. A more exact relationship between the angle of upward orientation on the plane of creeping inclined at angle α to the horizontal is given by the rectilinear connection between cos θ and sin α.

Such geotropic orientation in the absence of other stimuli may be plotted with cos θ against sin α, in which case the curve should more nearly approach a straight line (Crozier and Pincus, 1926–27 (3, *c*)). Fig. 3 shows such a plot of the data recorded in Fig. 2.

DISCUSSION.

All three methods of handling our data show (1) greater variation of reaction for the controls in the dark, (2) very close agreement of reactions in the rodless animals in both light and darkness.

It has been shown (Crozier, 1925–28 (2)) that the photic orientation of certain animals, including young rats, is at an angle at which photic excitation upon the two sides are equal. It has been further demonstrated (Crozier and Pincus, 1926–27 (3, *a*)) that young rats with their eyes opened seek a darkened place in the field when light is introduced. The same workers (Crozier and Pincus, 1926–27 (3, *b*)) opposed phototropism to geotropism in the young rat, and found that the logarithm of the intensity necessary to counterbalance geotropic orientation bears a constant ratio to the logarithm of the angle of inclination $\frac{\log I}{\log \sin \alpha} = K$.

If the rodless animals are affected by the light, we should expect to see the values of θ observed in the light to be lower than those in the dark, which is not the case. Further experiments employing light of different intensities and wave-lengths are planned.

SUMMARY.

"Black—short ears—kinky tail—rodless" mice, controlled by "pink eyed—dilute—brown" mice, were tested on an inclined plane in order to determine if they are photically sensitive, and, if so, to get a quantitative expression for their visual receptivity. Rodless and control animals were tested in the dark to obtain an expression for normal geotropic orientation. Light was then introduced to modify these reactions if possible. Under light, the controls failed to orient, whereas the rodless gave reactions almost identical with those in the dark.

This test has failed in this experiment to suggest sight in the rodless mouse.

CITATIONS.

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