PHOTOTROPISM OF DIXIPPUS MOROSUS.

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(Accepted for publication, September 18, 1927.)

Axenfeld (1899) found that there is a local difference between the upper and under part of an eye in the effect of stimulation by light. Since his experiment Loeb (1918), Garrey (1917), Mast (1911) and other authors have mentioned the same phenomena regarding different orders of insects. So far as I have found, the local difference in the effect of light is considered to be a matter of upper and lower regions, or of anterior and posterior of the eye. The writer used a walking-stick (*Dixippus morosus*) to study these local differences in a compound eye, and for measurements of phototropism.

The compound eyes are parallel, side by side of the genæ, making no perceptible angle between the planes of the eyes. So we can infer that an angle of orientation made by the body corresponds to the angle at the base of the eye. When the right eye is illuminated after covering the lower half of the left eye, the insect orients toward the *right*, making a circuitous movement. If the light comes from above, the insect orients toward the *left* with a circuitous movement. The latter orientation is also shown when the illumination is from underneath the body, either from the front or the back.

I have found that if the peripheral part of the right eye is covered with lamp black, and the insect is placed in a room which is lighted with either the usual daylight or diffuse artificial light, that it will orient toward the *right* side as it does under the illumination at a right angle from the side. But the insect orients toward the *left* side when the central part of the eye remains uncovered.

From these investigations we conclude that the local differentiation for reception of light is apparent when the eye is uniformly acted upon by light evenly distributed; the facets at the peripheral part of the

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eye of *Dixippus* appear to be of equal significance for reaction to light. Such local difference may be related to the life of this insect, which rests upon the stem of the plant being lighted from above and beneath, or from front and behind the body.

Experiments with Dixippus Placed upon a Vertical Surface.

Dixippus walks directly up a vertical surface or rests with the body axis in a vertical line unless stimulated by light from one side. When the insect is illuminated from one side of the body it no longer walks vertically but veers off at an angle toward the source of the light. The lower limit of non-effective intensity of the light is about 0.7 foot candle. The angles of inclination of the body, at rest, toward six different intensities were observed in the dark room on five individuals. Five measurements of an angle of orientation toward each intensity of light were made on each individual.

TABLE I.

Mean Angle of Orientation (θ) at Different Intensities of Light (Foot Candles); the Probable Error of Each Angle (P.E.); and the Coefficient of Variation of θ (C.V.).

Intensity of light	log I	θ	P.E.	*C.V.*
foot candles				*per cent*
1.2	0.0792	88.1°	±0.2209°	1.95
1.7	0.2304	73.16°	±0.2379°	2.95
2.9	0.4624	63.84°	±0.2304°	3.60
4.7	0.6721	53.64°	±0.2804°	5.15
8.6	0.9345	43.84°	±0.2456°	6.41
17.0	1.2304	35.2°	±0.2428°	6.60

The results summarized in Table I are averages of twenty-five tests at each intensity of light upon the vertical plane. The experiments tell us that the angle of orientation toward the light varies inversely with the intensity of the light when the insect is illuminated from one side upon a vertical plane.

It can be shown that the cotangent of the angle θ (Fig. 1) is proportional to the logarithm of the intensity of the light. In terms of the theory of orientation under such conditions (Wolf and Crozier, 1927–28) the position of orientation should be predicted by the force diagram in Fig. 1. Since adaptation of *Dixippus* to light is slow, the angle θ may be studied as a function of the intensity of the acting light, I. The linear form of the body of the insect makes it particularly suitable for such measurements, which are further facilitated by the maintenance of a position of orientation without creeping. If, as is commonly

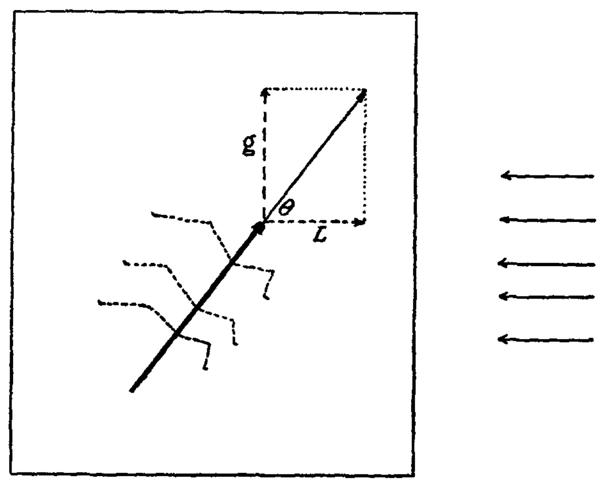

FIG. 1. Position of orientation assumed by *Dixippus* on a vertical surface (covered with black cloth, giving a firm hold for creeping), when illuminated from the right side. The posture of the legs is determined by differences in extensor tonus comparable to those seen in *Ranatra* (Crozier and Federighi, 1924–25). The angle θ is determined by the relation

$$\cot \theta = \frac{L}{g},$$

where L = the phototropic vector, g the geotropic. Since g is assumed constant (the plane being vertical), and L is taken as proportional to $\log I$, it should follow that $\cot \theta$ is a linear function of $\log I$ (see Fig. 2).

the case, photic excitation should be proportional to the logarithm of the intensity (over an intermediate range), then from Fig. 1

$$\Delta \text{ cotan } \theta / \Delta \log I = \textit{constant},$$

since the geotropic stimulation is constant. The graph in Fig. 2 gives a picture of this relationship, which is satisfactorily obeyed. The variability of θ as measured increases in the same way as θ decreases.

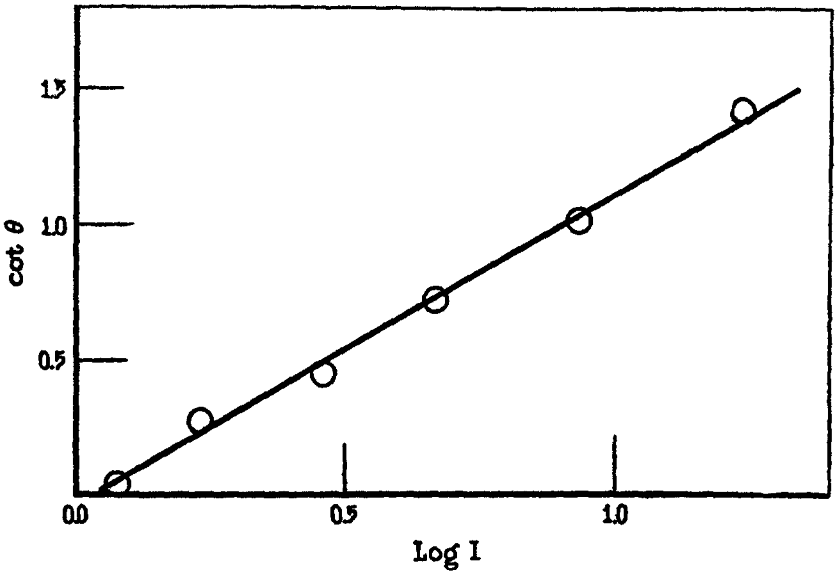

FIG. 2. The cotangent of the angle of inclination of the body of *Dixippus*, on a vertical surface with illumination from one side, is a linear function of the logarithm of the light intensity.

SUMMARY.

1. Local differences in the effects of stimulation of parts of the eye by light are expressed in *Dixippus morosus* by differential circus movements.

2. The angle of inclination of the body axis toward one source of light when the animal is on a vertical plane with light from one side is inversely proportional to the logarithm of the intensity of the light.

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