BIOLOGY

Coding of the Colour Preference of the Gull Chick

GULL chicks (*Larus atricilla*) peck at their parent's red bill, an act which elicits regurgitation from the parent. In an investigation reported elsewhere[1], it was found that chicks peck preferentially in response to long and short wave-lengths of visible light (that is, they prefer red and blue to green and yellow). The following hypothesis attempts to account for this wave-length preference.

The bird's retina contains minute coloured oil droplets, a single droplet being contained in a single cone. Most avian species have three distinct colours[2]; the gull chick's eye appears to contain only red and yellow droplets[1]. The droplets are situated at the base of the outer segment of the cone, and thus filter incoming light before it strikes the visual pigment. The bleaching effect of the filtered light, and hence the response of the cone (C), for any given wave-length may be expressed as:

$$C = k_1 \log IOP \tag{1}$$

where I is the intensity of the unfiltered light, O, the percentage transmission by the oil droplet, P, the percentage absorption of the visual pigment, and k_1, a constant of proportionality the value of which depends on the measurement of the cone response. The logarithmic transformation appears to be characteristic of visual receptors[3].

Assume that the red droplet-bearing cone is excitatory and the yellow one inhibitory. If inhibition is subtractive (as in lateral inhibition of the *Limulus* eye[3]), the pecking rate (R) at any given wave-length would be determined by:

$$R = k_2(C_r - C_y) = k_2 (\log IO_rP_r - \log IO_yP_y) \tag{2}$$

which reduces to:

$$R = k_2 \log \frac{IO_rP_r}{IO_yP_y} \tag{3}$$

where C_r and C_y are the responses of the red- and yellow-droplet-bearing cones, respectively, O_r and O_y are the transmissions of the droplets, P_r and P_y are the absorptions of the visual pigments, and k_2 is a proportionality constant.

Muntz[4] has suggested in another context that the interaction of visual receptors in wave-length coding is multiplicative (without logarithmic transformations), in this case:

$$R = k_3 \frac{IO_rP_r}{IO_yP_y} \tag{4}$$

If the gull chick's eye contains but a single photopic pigment (as is probably true for the chicken[5] and the pigeon[6]), the P's cancel from equations (3) and (4), as must the I values, which are identical for a single wave-length. The pecking rate is thus proportional to the ratio of the transmissions of the oil droplets, or the logarithm of this ratio.

The chick's response rates were recorded automatically on a transilluminated pecking key for stimuli of selected wave-lengths between 450 and 650 mμ. The wave-length bands were obtained with interference filters, the energy transmissions of which were equated with a variable diaphragm using a thermopile and deflexion galvanometer. (The discrepancy between equal energy and the physiologically meaningful number of quanta at various wave-lengths thus introduces a small error.) Transmission spectra of the oil droplets were obtained using Strother's[1,2] method in his laboratory. The O_r/O_y ratios were computed for wave-lengths in the spectrum between 450 and 650 mμ, and are compared with the mean pecking rates in Fig. 1. Theoretical results from both forms of the hypothesis are in close agreement with the behavioural data.
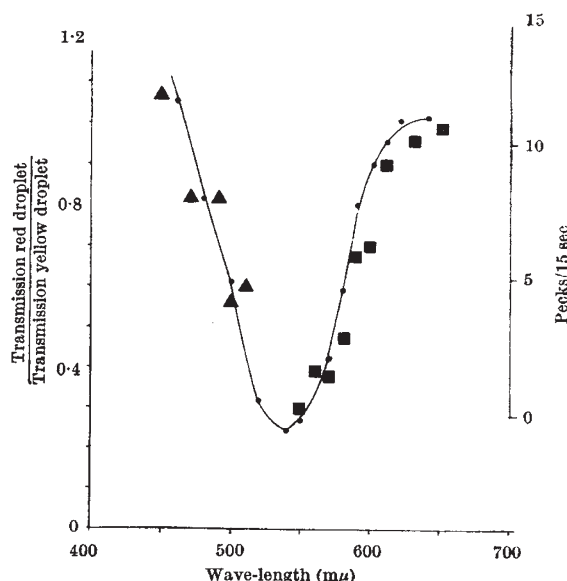

Fig. 1. The line and small dots represent calculated transmission ratios of the two oil droplet colours. The large triangles and the large squares represent mean pecking rates from groups of twelve and ten newly hatched *Larus atricilla* chicks, respectively

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ENTOMOLOGY

Methyl Linolenate as an Essential Nutrient for the Cabbage Looper, *Trichoplusia ni* (Hübner)

A DIETARY requirement for polyunsaturated fatty acids has been demonstrated in several lepidopterous and orthopterous species. The most common expression of fatty acid deficiency was a slower larval growth-rate or faulty adult emergence with resulting wing deformity, or both[1-5]. In the lepidopterous species examined the requirement was fulfilled with either linoleic or linolenic acids[2,3,5]. In the genus *Ephestia*, the flour moths, linoleic or linolenic acids promoted larval growth and normal wing development[3]. Arachidonic acid improved the growth-rate of *Ephestia*, but had no positive effect on wing development[6]. Linoleic acid allowed normal wing development of the pink bollworm, *Pectinophora gossypiella* (Saund.), but, because lower levels were active, linolenic acid was considered more effective[5]. Normal wing development of the greater wax moth, *Galleria mellonella* (L.), was promoted with linoleic or linolenic acids, but not with arachidonic acid[2].

This communication reports on the fatty acid requirements of the cabbage looper, *Trichoplusia ni* (Hübner). A satisfactory meridic diet, a modification of that described for the bollworm, *Heliothis zea* (Boddie)[7], containing wheat germ (oil and solids) as the only plant