

ON THE SIMULATION OF BACKGROUND COLOURS BY THE DESERT LOCUST, *SCHISTOCERCA GREGARIA* (FORSKÅL) [ORTHOPTERA, ACRIDIDAE]: EXPERIMENTS WITH PAINTED BOXES.

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I. INTRODUCTION.

The known types of colour variations in the Desert Locust, *Schistocerca gregaria* (Forskål) are: (i) The phase variations (Uvarov, 1923, 1928; and others). In overtone the *gregaria* adults are deep pink when immature and yellowish when mature, as was shown long ago by Künckel d'Herculais (1892) who was, however, unaware of phase differences; the *solitaria* adults are usually bluish grey. *Gregaria* hoppers have a black pattern, while *solitaria* ones are usually green (Johnston, 1926; and others). (ii) In the *solitaria* phase, again, two colour-types occur, thus (Roonwal, 1945a, 1946a): The majority (about 91%) of the adults are blue-grey and the remainder fawn; similarly, the majority of the hoppers are green and a small percentage fawn. Other types of variations, e.g., regarding eye-stripes, etc., are also known (Roonwal, 1936 *et seq.*).

Adaptation to background colours in the field has often been reported in Acridid grasshoppers (*vide* Cott, 1940). Rao (1937, pp. 24-25) has observed partial adaptation in the Desert Locust. In recent years Faure (1932) and Hertz and Imms (1937) have studied this phenomenon experimentally by rearing locusts of the genera *Locusta* and *Locustana* in variously coloured boxes. Here I shall present the results of some preliminary experiments, carried out several years ago on the Baluchistan Coast, on rearing hoppers of the Desert Locust in uniformly coloured boxes.¹

II. EXPERIMENTS.

Hoppers were reared singly in small, rectangular, wooden boxes (12 × 9.5 × 8.5 cm.) having the inner walls and floor painted with ordinary commercial oil paints in the following different colours: Lemon yellow, prussian blue, mahogany, black, dark green, signal red and white; unpainted boxes were used for a pale ochre background. The boxes were closed on all sides except the top which was of unpainted, grey-coloured wire-gauze. They were kept in the bright, diffuse daylight of the

¹ For a brief report of these experiments *vide* Roonwal, 1937, pp. 148-149.

verandah and were not exposed to direct sunlight. For food, the hoppers were supplied twice or thrice daily with fresh twigs of *Heliotropium undulatum* Vohl. (= *ramosissimum* Sib.) (Baluchi name: 'marrand'), Nat. Ord. Boraginaceae. This shrub grows commonly in the sandy areas on the Baluchistan Coast, and is the favourite food-plant of the Desert Locust (phase *solitaria*) in nature, in both the hopper and adult stages. Green (*solitaria*) first stage hoppers were utilised. The colour of the hoppers was noted at the start of each experiment and, subsequently, at intervals of 2-3 days. Out of 64 experiments which were started, 19 reached a sufficiently advanced stage for reliable deductions to be made; in the remainder, the hoppers died in the first two stages. The following experiments were performed for each type of background, the results of the successful experiments being summarised in Table 1:—

1. *Lemon yellow*.—Nine experiments were started. In five the hoppers died in the first stage, and in two in the second. In the remaining two, one hopper reached the fourth stage and the other the adult.

2. *Prussian blue*.—Nine experiments were started. In six the hoppers died in the first stage, and in one in the second. In the remaining two, the adult stage was reached.

3. *Mahogany*.—Nine experiments were started. In five the hoppers died in the first stage, and in two in the second. In the remaining two, one hopper reached the third stage and the other the adult.

4. *Black*.—Seven experiments were started. In four the hoppers died in the first stage. In the remaining three, one reached the fourth stage and two the adult.

5. *Dark green*.—Eight experiments were started. In five the hoppers died in the first stage, and in one in the second. In the remaining two, one reached the third stage and the other the adult.

6. *Signal red*.—Nine experiments were started. In seven the hoppers died in the first stage. In the remaining two, the adult stage was reached.

7. *White*.—Ten experiments were started. In six the hoppers died in the first stage. In the remaining four, two hoppers reached the fourth stage, one the fifth and one the adult.

8. *Pale ochre*.—Three experiments were started. In one the hopper died in the first stage; in the second the hopper reached the fourth stage, and in the third the adult.

III. DISCUSSION AND CONCLUSIONS.

In S. Africa, Faure (1932), who reared hoppers of *Locusta migratoria migratorioides* (R. and F.) and *Locustana pardalina* (Walk.) in boxes painted in different colours on the inside, found 'good' or 'fair' resemblance on white, black, grey, yellow and brown backgrounds, and no clear resemblance on green, pink and blue backgrounds. He also noticed that green hoppers were produced not as a result of green background but only under high humidity with an abundance of fresh and succulent food. Hertz and Imms (1937), working on *Locusta migratoria migratorioides* in England, confirmed the dependence of green colour in hoppers on the presence of a moist atmosphere. They further elucidated the phenomenon of partial colour adaptation in terms of wave-length of light reflected from the coloured background. They found that, except upon a black background, no complete colour adaptation was observed, but the effects of different backgrounds were clearly defined—the background only influences the amount and proportion of the orange-yellow and black produced. Yellow reflected rays (5500–6000A) stimulate the production of orange and yellow; their absence, and the presence, instead, of rays shorter than 5000A, produce colourless, pale grey or dark grey hoppers.

TABLE 1.

Results of experiments on rearing Desert Locust hoppers in painted boxes.

Inside colour of rearing box.	Resulting colour of insects.	
	Old hoppers (III-V stages).	Adults.
1. Lemon yellow.	Bright yellowish green.	Light green.
2. Prussian blue.	Fawn or green base with black markings.	Brownish or pinkish grey.
3. Mahogany.	Ditto.	Ditto.
4. Black.	Dark green or dirty fawn base with black markings.	Smoky brown or ash-coloured.
5. Dark green.	Bright green.	Light green.
6. Signal red.	Dirty green or orange.	Grey with violet tinge, specially on hind-legs.
7. White.	Greenish white.	Whitish fawn.
8. Pale ochre (unpainted wood).	Pale green with or without yellowish tinge.	Dull brown.

The results of the present experiments on the Desert Locust showed (Table 1) that among hoppers the background colours which were more or less simulated were lemon yellow, black (?), dark green and white, while others, *viz.*, prussian blue and signal red, were not; the results for mahogany and pale ochre were indefinite. The fawn hoppers, as observed on black, prussian blue and mahogany backgrounds, would seem to represent the fawn colour-type (Roonwal, 1945*a*, 1946*a*) produced independently of the background in the *solitaria* phase. Among adults the results were less clear, but some simulation was observable on black, dark green and white backgrounds.

IV. SUMMARY.

1. To study adaptation to background colours in the Desert Locust, hoppers were reared singly in boxes painted uniformly in different colours on the inside. Nineteen hoppers reached a sufficiently advanced stage to permit of some deductions being made.

2. Among hoppers, more or less marked colour adaptation was observed on lemon yellow, black (?), dark green and white backgrounds; no adaptation was observed on prussian blue and signal red. Among adults, the results were less clear, but some degree of adaptation was observable on black, dark green and white backgrounds.

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