revision has been introduced, largely the result of recent work by the Assam Oil Company.

As in previous editions, the stratigraphical sections are followed by chapters on the physiography and on the economic geology of the country, thus affording the student a complete account of Indian geology; while a coloured geological map on the scale of 96 miles to 1 in. is given in a pocket at the end. Prepared by the Geological Survey of India in 1949, it is an up-to-date map in which separate colour indexes have been used for the peninsular and extra-peninsular regions.

The Indian sub-continent provides a fine example of a stable continental shield lying adjacent to one of the earth's great mobile belts, with the attendant problems of crustal structure, gravity anomalies and earthquake phenomena. It is the birthplace of the hypothesis of isostasy, of the theory of earthquake wave motion, and of the conception of a great southern continent, Gondwanaland, with its *Glossop-teris* flora; also, the Siwalik hills bordering the Himalaya were the home of a rich mammalian fauna, the fossils of which adorn the museums of the world. All these matters receive adequate attention (within the compass of a text-book) in this volume. Written in a fluent style, it has been an inspiration to generations of Indian students, and a standard work consulted by foreign geologists. In this latest edition the publishers have produced a well-printed volume; but it is unfortunate that the price has been doubled, for it must now be beyond the reach of many who would wish to own it.

W. D. WEST

BEE BEHAVIOUR

The Behaviour and Social Life of Honeybees

By C. R. Ribbands. Pp. 352+9 plates. (London: Bee Research Association, Ltd., 1953.) 21s.

AMONG the social insects only the bees, and in particular *Apis mellifera*, have come into close contact with man; and while man's primary interests were honey and wax and nowadays extend to pollination, the doings of the bees have since time immemorial attracted curiosity and imagination.

Mr. C. R. Ribbands is almost entirely concerned with facts, and consequently the chapters of his book lead the reader from the origins of scientific observation through the past hundred and eighty years to the latest stage of each problem in our experimental era. In collecting his information from many languages and blending it with his own experiences, he has written a well-balanced book which by its simplicity of language, beauty of photographs and many diagrams is a joy to read.

The book has four sections, the first of which deals with the roots of behaviour (sense perception, glandular development and caste differences) and is followed by a section on the individual behaviour in the field (flying, foraging, mating, time sense, etc.). The third section deals with communication between the bees (recruitment to crops, selection of a home, recognition of companions and defence of the community), and this part also contains a practically interesting discussion of the methods for directing bees to particular crops. The fourth section—the longest—describes food sharing, clustering, building and brood-rearing, as well as those activities which

are concerned in the propagation of the individual and the colony. Its main conclusion is that the evolution of the social insects can be understood in terms of a series of adaptive responses to food supplies and that the honey bee, in particular, owes much to the habit of food sharing; parts of this discussion are polemical and will perhaps not be generally accepted.

The book, primarily written for students of bee behaviour, will nevertheless be appreciated by many people interested in certain wider aspects of comparative physiology, communication and group behaviour. This may be illustrated by the discussion of a few topics. Von Frisch, utilizing the social habit of foraging, showed several years ago that bees can orientate themselves in relation to polarized light; since then this faculty has been discovered in many solitary insects and crustaceans which do not collect food and are thus more difficult to train. Thus a faculty which is probably common to all arthropods having compound eyes has been discovered by its attachment—in the course of evolution—to more complex patterns of behaviour.

The astonishing fact, that worker bees can be directed to a crop by another bee's dancing, is also based on simpler potentialities of wide occurrence. It is perhaps easiest understood as an imitation by the recruited bees of the intentional movements of the discoverer of a new source of food (that is, its dance), before it flies out again. In this dance four features of orientational value are incorporated, namely, the odour, abundance, distance and direction of the crop. The odour is simply that of the nectar or pollen, clinging to the body of the dancer; the abundance of food is indicated by the duration of the dance, which one may take to be proportional to some sort of 'excitement'; while the distance of the crop, expressed by the frequency and duration of tail-wagging, similarly indicates the anticipated 'effort' for the next foray. The last feature in this 'language without words', namely, the expression of direction, is based on an equivalence of geotropism and phototropism, common among plants, animals and man: a bee dancing on a vertical comb deviates by the same angle from the zenith as the direction of its horizontal flight to the crop deviates from the direction of the sun; this rather reminds one of the convention that 'up' in a map indicates north, or the fact that twelve o'clock on the dial of a clock points upwards.

Communication of all this information is effected when an unemployed worker on the comb, alerted by the dancer, imitates the peculiarities of the former's dancing movements and then leaves the hive to search for the crop.

Students of group behaviour will perhaps find a description of observations by Lindauer of even greater interest. This concerns what can only be called communal decisions by swarming bees. A figure summarizing five days of observations on a cluster indicates how scouts flew out in various directions and how each on its return danced in the direction which it had found suitable for a new home. Sometimes one party grew stronger, and sometimes another. But only after all dancers pointed in the same direction did the swarm finally take off.

Observations like these seem to hold some promise of further discoveries, and the first step towards making them might be to read Mr. Ribbands's book.

H. KALMUS