

others, and they may have some difficulty in deciding which of the copious references should be selected for further reading. This, however, does not detract from the value of the book to the specialist, both as a concise and up-to-date survey of the subject and as a useful compilation of relevant literature. T. MANN

## FORMALIZATION OF CONSTRUCTIVE CONCEPTS

### Constructivity in Mathematics

Proceedings of the Colloquium held at Amsterdam, 1957. Edited by Prof. A. Heyting. (Studies in Logic and the Foundations of Mathematics.) Pp. viii+297. (Amsterdam: North-Holland Publishing Company, 1959.) 60s.

THIS volume consists of 25 articles by 23 authors. The central themes are intuitionism and inductive definitions. The two fundamental steps in the background are Heyting's formal systems to embody Brouwer's ideas on logic and mathematics, and a classical formalization of the concept of effectively calculable functions by general recursive functions. As a result of these steps, a more formal treatment, congenial to the logician, of intuitionism and constructive mathematics in general becomes possible. Much of the book is devoted precisely to questions arising from such a treatment. Since in classical mathematics we are concerned with not only natural numbers but also real numbers and real functions, a major problem is to extend the notion of recursive functions to those of objects of higher type, that is, to define computable or constructive functionals. Kleene's paper on countable functionals, the papers by Davis, and by Kreisel-Lacombe-Shoenfield deal with this problem. In addition, Kreisel and Kleene each gives an interpretation of intuitionistic analysis by applying constructive functionals.

Another problem is to 'reconstruct' classical mathematics by restricting arbitrary functions to constructive ones. This leads to the study of constructive, in particular, recursive, analysis and topology. The articles by Goodstein, Grzegorzczak, Lacombe and Specker are taken up by this. The three papers by Rasiowa and Sikorski are concerned with formal considerations on Heyting's calculus of intuitionistic logic.

Fitch gives a consistent formal system which contains the theory of combinators and "extended basic logic". Myhill proves theorems on "finitely representable functions" which appear to be essentially the same as the Herbrand recursive functions reported in Gödel's lectures of 1934. Hermes and Wette study certain problems about the "operative" logic and mathematics.

The remaining nine articles are of a more general or a more philosophical character. Heyting makes some familiar but pertinent remarks on intuitionism; Beth comments on his own formal treatment of the intuitionistic logic. Kalmár argues against the hypothesis that every effectively calculable function is general recursive; Péter disputes that every general recursive function is indeed effectively calculable. Löb tries to formalize concepts such as event, brain, subject, mental occurrence of a subject, perception, in terms of constructive ideas. Nelson considers the meaning of falsity in empirical characterizations of truth, as well as the situation that classical logic

identifies certain constructively distinct entities. Lorenzen stresses the importance of inductive definitions for constructive mathematics. Mostowski discourses on various degrees of constructivism. Bernays gives a free-variable, complete formal system as a natural extension of the calculus of relations.

If we summarize the concepts and methods of foundational studies under the five headings of anthropologism (strict finitism), finitism, intuitionism, predicativism (inductivism), and platonism, the book is mainly concerned with intuitionism and a part of predicativism. This is perhaps not surprising since platonism falls outside the domain of constructivity, while the principles of anthropologism and finitism are not yet sufficiently clarified to admit a direct mathematical handling. HAO WANG

## BIRDS OF PREY

### Pirates and Predators

The Piratical and Predatory Habits of Birds. By Colonel R. Meinertzhagen. Pp. ix+230+44 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1959.) 70s. net.

THE author of this handsome volume emphasizes that it is a contribution and not a monograph. The value indeed lies in the record of original observations made in the course of long experience in Europe, Africa and Asia. Economical of words, the writer has a happy knack of conveying a vivid impression of what he has seen. His touch is less sure when he cites the records of other observers, but in any event he disclaims an exhaustive representation of the literature.

An opening chapter deals with various general points, such as the food preferences of individual members of a predatory species, the regular beats and hunting territories of some, relative size of the usual victims, methods of killing and of preparation for eating, and the reactions of other birds to predators. Throughout, particular attention is paid to the occurrence of 'piracy', that is to say one species robbing another of its prey, occasionally in some instances and regularly in others. The habits of mammals and reptiles receive frequent mention.

Group by group, Colonel Meinertzhagen then briefly reviews predatory and piratical habits among the birds which he rather whimsically classes as 'amateurs', those outside the Falconiformes and Strigiformes. Species by species he next deals with many of the 'professionals', the true diurnal and nocturnal birds of prey in which he is especially interested. This is the longest section of the book and covers examples of hunting for many types of prey—insects, molluscs, fish, reptiles, birds and mammals—some species being highly specialized in this respect and others more versatile. Flying prey may be secured by level pursuit or by 'stooping' from above: prey on the ground may be located from flight (quartering, soaring, hovering), from a perch or from the ground itself (secretary-bird); then there are the fishing hawks, the eaters of carrion and the partly vegetarian palm-nut vulture. One would have welcomed some sort of general review of these topics, in addition to the piecemeal presentation.

Finally, there is a chapter on what the author terms 'autolycism', that is to say, making use of other animals (including man) but not as victims. There