and by the corrosive properties of sea-water. About forty projects were displayed as exhibits by the engineering section both as instruments and by working drawings, out of some 120 designed in the past sixteen years. Some of the more recent instruments have been briefly referred to here. The stabilized narrow-beam transducer is at present being used in the R.R.S. *Discovery*; this is part of a 36-kc/s underwater acoustic echo-ranger used for work on fish-detection problems and marine geological investigations. The axis of the acoustic beam is perpendicular to the fore-and-aft line of the ship and may be rotated from the horizontal to the downward vertical. Gyro stabilization is provided against the roll of the ship; beam width and side lobe patterns are adjustable. The range is about 800 yd. and scanning is achieved by steering the ship past the features to be investigated. A more recent project is the towed vehicle, which houses a transducer array for the long-range geological slanting sonar briefly mentioned here as being intended for use in deep water, which will work at a much lower frequency and will necessarily be larger than the sonar used in shallow water. It is intended that the vehicle will be towed at a depth of about 400 ft. and, in order to obtain adequate signal levels for the sound scattered back by the sea-floor, each of the 144 transducer elements will transmit 400 W of acoustic power. In connexion with the thermistor chain a helical traversing capstan is being developed as the traction member of a deep-sea hoist for handling faired electric cables. The capstan is so constructed that the cable advances across its surface with a purely rolling action, free of slipping or sideplay; there are no unbalanced forces to cause the path to be altered.

Yet another stated object of the Royal Charter was to collect and maintain an oceanographic library and, starting in 1953 with the welcome nuclei of earlier collections, the National Institute of Oceanography Library has now grown to be one of the major oceanographic libraries, containing about 3,500 text-books, 25,000 reprints and 7,000 unpublished reports all cross-indexed for easy reference, together with an annual intake of about 400 periodicals. There is a specialized collection of charts and atlases and a fine collection of scientific reports of oceanographic expeditions. The publications of the Institute, the *Collected Reprints* and *Discovery Reports*, are distributed on a world-wide basis, preferably with an exchange arrangement. In a year the library lends some 3,000 publications, about 2,500 to scientists at the Institute and the others to many outside libraries.

The work of the Institute over the past 16 years was represented by these exhibits; the general line for the future was discussed at the press conference. It was reassuring to hear from Mr. Prentice that both the growth and continuity of the present work of the Institute would be maintained under the Natural Environment Research Council and encouraging to hear Prof. Lighthill comment on the fact that, although little money had been spent on the National Institute of Oceanography, yet the return had been good value; the amount of money spent on research is not necessarily in direct proportion to the results.

MARY SWALLOW

INSECT BEHAVIOUR

THE Royal Entomological Society of London continued its series of biennial symposia by organizing a meeting on "Insect Behaviour" which was held at the Imperial College of Science and Technology, London, during September 23–24, 1965. The meeting was opened by Mr. E. O. Pearson, the president of the Society, who pointed out that the objective of this series of symposia was to provide authoritative surveys of recent work in the chosen field for the information of entomologists generally, and the very high attendance at this meeting emphasized that these symposia fulfil a real need.

Prof. Birukow (Göttingen) spoke on orientation behaviour and factors which influence it. This particular aspect of insect behaviour is engaging the attention of several German entomologists, and Prof. Birukow was able to indicate the way in which past attempts at the systematization of the subject contrasted with more recent approaches such as those of Jander. He described the capacities and physiological mechanisms of lower levels of orientation behaviour (the so-called baso-taxes) and pointed out that higher orientation behaviour may have evolved from these. The variability noted in orientation behaviour results principally from adaptive variability which ensures that an animal can never become 'a slave to its own orientation mechanisms'. Insect orientation behaviour can be adjusted by the interaction of innate and learned patterns, but in complex behaviour it is rarely possible to discriminate between these two sources. Prof. Birukow gave details of his interesting work on light orientation in *Calandra granaria*, which is affected by biological rhythms and meteorological factors.

Dr. P. S. Corbet (Ottawa) gave an account of the role of rhythms in insect behaviour, and from this wide field took as his main theme the factors which influence field periodicities. Particularly valuable were his clear definitions of the terms used to describe periodic behaviour and his elucidation of the relationships between them. He pointed out that the causal analysis of field periodicities in terms of their endogenous and exogenous components had been neglected because integration of field and laboratory work on periodic behaviour had seldom been attempted. He underlined the need for investigations of the periodicity of single processes in the laboratory under controlled conditions and also in Nature, preferably in several situations. He particularly emphasized the need for entomologists to recognize the pervasiveness of rhythmicity as an experimental variable. He instanced the response to sex pheromones, the amount of body protein and the intensity of virus transmission as processes under control of circadian rhythms which, therefore, show different values at different times of day and night. He suggested that a description of any such process should properly include an account of its periodicity, particularly when this affects its measurement or detection.

Dr. P. T. Haskell (London) discussed flight behaviour, first mentioning factors inhibiting or limiting to insect flight, particularly the effect of wind on height of flight and orientation. He went on to outline the general aspects of flight behaviour in respect of food-seeking, homing and territorial flight, defence and predator avoidance, courtship and mating, oviposition and migration and dispersal. He pointed out that there seem to be certain basic patterns which are utilized in different types of behaviour such as, for example, food-seeking and oviposition, which pose the same fundamental problem to the insect, that of homing on a target. He described recent work on mechanisms involved in anemotactic behaviour released by olfactory stimuli, which are important in relation to mating, food and oviposition behaviour, and queried theoretical deductions which supposedly rule out tropotactic orientation to an odour source.

Prof. V. G. Dethier (Pennsylvania) dealt with feeding behaviour and pointed out that in the past decades the emphasis in this field of investigation had altered from description to an investigation of mechanisms. He examined the present-day controversies as to whether

insect relationship to food plants is dictated by token or nutrient stimuli, whether oligophagy is based on attraction or repulsion and whether taste or smell is more important. Behavioural, and particularly physiological, experiments seem to indicate that all these factors are involved. The inflow of data to the central nervous system relating to stimulation by food plant substances is complex, and hence neither the mechanism of discrimination nor the basis of preference can be a simple one. Prof. Dethier pointed out that the regulation of the initiation, termination and frequency of feeding had received less attention than the problem of selection. In some insects, for example the fly, the process is driven by sensory input and is terminated by sensory adaptation, while the frequency of feeding is controlled by an as yet unknown mechanism; on the other hand, in other insects such as the locust, endogenous central activity appears to influence the initiation of feeding.

Dr. A. Manning (Edinburgh) described sexual behaviour and defined it as "specialized behaviour patterns which form the normal preliminaries to mating". He pointed out that elaborate sexual behaviour occurs in some insects but not in others and raised the problem of 'female coyness'. He considered three possible functions of courtship: appeasement and synchronization, physiological maturation, and sexual isolation, and concluded that various combinations of the foregoing functions must have been involved in the evolution of 'female coyness'. He felt that a direct origin of the movements used in courtship from modified pre-copulation movements was often plausible, and pointed out that the ritualism of insect sexual behaviour had followed a course very similar to that found in vertebrates. As to the organization of sexual behaviour, he emphasized that the data were so meagre that little generalization could be made, but that sexual behaviour seems to depend more on the sex of the brain than on that of the lower centres.

Dr. J. D. Carthy (London) spoke on insect communication, which could be said to occur whenever a sensory signal caused a change in the behaviour of an animal. He pointed out that in most cases the receiver is informed of the physiological state, the sex, the species and often the position of the sender, that the language is often private to the species and that dialects may occur which are specific to a group of individuals in a neighbourhood. He examined the range and type of visual, acoustic, tactile and chemical communication and brought forward examples showing how these may be combined to increase the total sum of information passed.

Prof. E. O. Wilson (Harvard), in dealing with the behaviour of social insects, deliberately minimized the functional aspects of this behaviour in order to pay close attention to theoretical considerations of its evolution. In examining its origin, he supported the view of Hamilton that true sociality, mostly limited to the Hymenoptera, had arisen because of the haplo-diploidy prevalent in that order, which, since it resulted in greater genetic similarity between siblings than between parents and offspring, favoured the development of altruistic behaviour. Sociality in the termites, he felt, was associated with obligatory protozoan symbiosis, thus taking the view that true sociality was made possible through pre-adaptations which themselves had nothing to do with sociality. Prof. Wilson went on to examine fitness in insect societies and indicated, for example, that worker inefficiency, including mass behaviour that is the opposite of social facilitation, is widespread in the social insects and yet makes a positive contribution to colony fitness. On balance, however, he concluded that the question of altruism above the individual level remains open.

The final paper was given by Dr. J. S. Kennedy (Cambridge) and the arrangements for this were of an experimental nature in that Dr. Kennedy was asked to talk on "Some Outstanding Questions in Insect Behaviour", drawing largely on points raised by the preceding speakers and thus promoting wide-ranging general discussion to end the symposium. Dr. Kennedy treated four main topics: the origin of social behaviour, communication and 'female coyness', orientation behaviour, and the control of responsiveness. As regards the origins of social behaviour Dr. Kennedy disagreed with Prof. Wilson and suggested that the long-standing theory of parental care as the basis of social behaviour was still adequate. The ensuing lively discussion touched on the value of parental care, the influence of food-sharing, the significance of symbiosis and the evolution of altruistic and selfish behaviour. On balance, while it was conceded that the phenomena of haplo-diploidy and symbiosis may have played some part, parental care won the day as being likely to afford a sufficient basis for the evolution of sociality.

As regards 'female coyness', Dr. Kennedy asked if this was widespread and enquired whether 'male coyness' was also involved, and whether in any case the term was not a misinterpretation of the delaying function of the behaviour which may be necessary so that both males and females can complete internal processes essential to mating. The discussion emphasized the paucity of data on the subject, although the interesting suggestion was made that there was selective value to the behaviour if it was considered as an extension to normal pre-copulatory communication which establishes specific recognition.

On orientation, Dr. Kennedy asked whether the system of Jander did in fact correspond to the 'natural structure' of the behaviour; the discussion did not elucidate this point and served to emphasize the continuing lack of any adequate structure for the classification of insect behaviour.

The final problem discussed by Dr. Kennedy was the control of responsiveness in insects in various behavioural situations, and raised the important issue of the separation of endogenous activity, or 'drive', from reflex activity—the stimulus-response system. The general tenor of the discussion was that the past approach to this problem, based on an 'either–or' choice of these two concepts, had been misleading; the actual system probably involved characteristics of both.

All the papers and the ensuing discussions are to be published shortly in a fully bound volume by the Royal Entomological Society.

P. T. Haskell

FOREST NURSERIES

Forest nurseries became important in British forest practice with the introduction of exotic conifers in the latter part of the eighteenth century for large-scale reforestation work on private estates. But they assumed even greater importance after the creation of the Forestry Commission in 1919 with its declared policy of afforestation. At the present time the plant requirements of the State forest service and of private estates and commercial enterprises are enormous and nursery practice has become a scientific matter. This has developed greatly in the past twenty years. Before that, nurseries were mainly the agricultural type where fertility was maintained by farmyard manure in some cases but mainly by ploughing-in green crops and the use of fallows and rotational practice. However, it was found that the best conditions were not being obtained for growing coniferous seedlings. These were required in greater quantities than ever and in less time than the usual 3–4 years to produce a plant suitable for afforestation purposes. Some experimental work had been done by the Forestry Commission, but in 1944 it