chief beneficiary, through the beating activities, the providing of scraps, and the providing of parasites and even flesh of its own body by the animal accompanied. Another series in this category is the pilfering or robbing of one species by another.

In flocks in which numerous species of birds keep together, many of the factors involved in the simpler cases mentioned above are discernible, and it is probable that several may work together, reinforcing each other. Protection from predation by flocking is probably of no great importance.

Data are given to show the extreme acuity of birds in seizing on small elements in their environment that provide food benefits. They show that such occasional benefits may lead to new habits; that new habits are still arising; and that simple or occasional associations in some species are more complex or regular in other species.

It is possible to see how complex behaviour patterns evolved if psychological processes of a low order are postulated, satisfaction or benefits being associated with the presence of certain conditions such as variability among the birds to recognize such associations and the selection of certain favourable variations until they become a part of the normal behaviour pattern.

The rapidity with which new patterns develop, and similar patterns that evolve in unrelated birds, indicate that these behaviour patterns are not necessarily phylogenetic. Despite this, these patterns indicate the stages through which complex behaviour probably passed and how it originated.

Some mixed bird parties increase competition between species, offsetting some at least of the mutual aid of the associations.

MICROSEISMS

THE name microseisms was given in 1870 by Father T. Bertelli to the ground unrest of wave period from about 1 sec. to 10 sec. and variable amplitude (about 5 μ) registered by seismographs. This movement is now studied because of its intrinsic interest and also pragmatically because of its meteorological associations. A symposium on the subject, organized by Dr. R. C. Gibbs, was held at Arden House, Harriman, New York, during September 4–6, 1952, under the sponsorship of the Office of Naval Research and the Geophysical Research Division of the United States Air Force*. It was attended by more than thirty specialists in the field (one each from the Netherlands and Sweden, two from Great Britain and the remainder from the United States), and the report has just been received. It contains the following eight papers together with the discussions on them: sketch of the history of microseismology, by J. B. Macelware, *S.J.*; tripartite stations and the direction of approach of microseisms, by J. E. Ramirez, *S.J.*; amplitude distribution of storm microseisms, by Marion H. Gilmore; microseismic period spectra and related problems in the Scandinavian area, by Marcus Båth; Can sea waves cause microseisms ?, by M. S. Longuet-Higgins; storm and surf microseisms, by F. W. van Straten; the ocean as an acoustic system, by Frank Press and Maurice Ewing; on theories of the origin of microseisms, by J. G. Scholte.

* Symposium on Microseisms. (Publication 306.) Edited by James T. Wilson and Frank Press. Pp. vii+125. (Washington, D.C.: National Academy of Sciences, National Research Council, 1953.) 1 dollar.

It appears to be generally accepted that microseisms, more frequent in winter than in summer, are elastic waves travelling at about 100 miles/min. over the surface of the earth and not body waves through the earth. They appear to be largely Rayleigh waves together with some Love waves, and to be of different wave forms as well as of different periods. Those of period 2 sec. and less may be due to local winds or may be man-made. Group microseisms of period 3–10 sec., exhibiting beats, appear to be almost always of marine origin, and those of period 1 min. or more to occur at the time of frost near stations. The symposium was mostly concerned with problems about the group microseisms of period 3–10 sec.

Historically, it was suggested by Wiechert that these may be due to the beating of surf on a rocky coast, and later by others that they were formed near the centre of a storm at sea. Tripartite stations were used by J. J. Shaw in England (1918–22) and more accurately by Gilmore, among others, in the Caribbean (1944) to get cross-bearings, in an attempt to track the centres of microseismic disturbances. This method has not proved entirely satisfactory, supposedly because of geological barriers such as deep-seated faults, and the irregular passage and attenuation of waves by geological formations. Gilmore is now attempting to detect microseismic centres when they begin; to follow the centres once they have formed; and to get an idea of the energy at all points in the path, by empirical amplitude relationships.

The intimate connexion between events in air (such as microbarometric pulsations, gustiness, barometric gradients and cold fronts), events in the sea (waves, standing waves, surf pressure) and microseisms is not fully understood, but good progress is being made at some points. It has been shown by Deacon and Longuet-Higgins, following work by Miche, that second-order terms in the equations of the pressure field produced by standing waves at sea integrated over a sufficiently large area could quantitatively account for microseisms of half the period of the standing waves; and such microseisms have been shown to exist at Kew. Ocean waves of period 16 sec. produced 8-sec. microseisms at Kew, just as $\frac{1}{2}$-sec. waves in an experimental tank produced $\frac{1}{4}$-sec. microseisms in the bottom of the tank.

Standing waves in the ocean could conceivably be produced by interference caused by a fast-moving low air pressure area, or by coastal reflexion of ocean waves; but this does not seem to be the whole picture since, on the western side of the Atlantic Ocean, Frank Press and Maurice Ewing (Columbia University) conclude from their observations that "(1) Frontal microseisms are generated very soon (often abruptly) after a cold front passes seaward from land, with no obvious correlation to prior wind and sea conditions. (2) A relatively narrow spectrum of periods appears to be generated by a front, cyclone, or hurricane at a given time when the disturbance is over an area of uniform water depth. Characteristic periods of microseisms can be related to generating areas in the ocean. (3) As a front recedes from shore, the spectrum gradually shifts to longer periods, and becomes fairly constant after deep water is reached. (4) Cold fronts and air masses following them can generate microseisms whereas warm air masses preceding the cold fronts fail to generate microseisms even when strong onshore winds are present. (5) In many cases there are no obvious correlations between swell and surf conditions and microseisms. (6) Micro-

seismic energy is dissipated by a profound crustal discontinuity at the edge of the continental shelf. Hurricanes crossing the edge suddenly generate larger microseisms".

Observations are still being made at observatories throughout the world, in conformity with the microseismic research project of the Section of Seismology of the International Geodetic and Geophysical Union, which was initiated in 1952, and detailed observations have yet to be made of the energy of the gusts of wind at sea likely to be associated with microseisms, and also the pressures and variations of pressure at great depths on the bottom of the ocean likely to be associated with microseisms. It is hoped that, with further observations and consideration, more progress will be made, particularly with the air–sea energy transfer.

ERNEST TILLOTSON

BASIC RESEARCH ON ODOUR

TO say that the sense of smell has been neglected as an object of study, because of the formidable experimental difficulties involved, particularly when examining the peripheral aspects of the sense, is of course to state a platitude. It would appear that the newer techniques of measuring minute quantities of substances might, however, prove rewarding when applied to the investigation of olfaction, and might be the means of stimulating renewed interest, especially in these neglected peripheral phases. It was possibly with such thoughts in mind that a conference was organized in April 1953, jointly by the New York Academy of Sciences and the American Society of Heating and Ventilating Engineers, for although practically every aspect of olfaction was then reviewed, greatest emphasis was placed on the peripheral phases. The edited versions of the papers read at the conference have now been published in the *Annals of the New York Academy of Sciences**. No doubt because of the participation of the latter Society, papers on technological problems occupy a prominent place, more prominent than would probably be the case at a similar conference in Britain. The whole report, therefore, provides an up-to-date review, and a short guide to the literature, of both technical and laboratory work carried out recently on odours and olfaction.

A major object of any conference such as this is to throw up ideas, and a reasonable degree of speculation is not altogether undesirable. However, this can be overdone, and unfortunately several of the participants did not resist the temptation to explain how, on theoretical grounds, odours might be converted into nerve impulses. While reading some of the papers, one was reminded of Homer Smith's comment, made when he was reviewing the earlier concepts of renal function, that the history of science has been one of rival over-simplified theories, to which fault has been added that of insufficient experimental work. Parts of the report on this conference show that our grandfathers may have been no worse than ourselves.

The first part of the conference was concerned with the problem of odour in industry; the papers were, in fact, devoted to the practical problems of how to prevent food, tobacco, paper and the interiors of buildings from being contaminated by odoriferous substances. As there is so little basic knowledge available as to either the behaviour of the odoriferous substances, or the absorbent properties of the contaminated materials, the problems are attacked along empirical lines. The cause is traced, and if it cannot be removed then various odour neutralizers or modifiers are tried until the one which is most satisfactory in the circumstances has been found.

The next major section of the conference was entitled "Problems of Odour Research from the Viewpoint of the Scientist", with contributions from a physiologist, a psychologist, a physicist and a chemist. J. Greenspan outlines some of the newer physical methods for measuring concentrations as low as parts per million; but later in the conference, R. L. Kuehner reports that such methods are still not as satisfactory as would be desired, and he suggests the use of other methods which depend upon subjective threshold sensations, or upon chemical absorption of the odorant. L. M. Beidler, the physiologist, points out, too, that by analogy with the investigations on taste a method of measuring concentrations in the air, and of controlling such concentrations, would not necessarily enable the ultimate nature of the stimulus to be understood, for the nature of the receptor is so important. J. B. Sumner, at least, is aware that the generally accepted view of odours being transmitted by volatile particles in the atmosphere is no more than a hypothesis, although undoubtedly a much more satisfactory one than others depending upon such an alternative as infra-red radiation.

The third section was concerned with the status of our present knowledge of the olfactory nervous system, and contained papers of rather uneven quality. There was in one paper a tabulated list of the functions of the turbinate bones; while another paper, which offered yet a further hypothesis of olfaction, based upon information theory this time, opened with a quotation followed by the comment, "In these words, Titus Lucretius Carus developed the first atomistic theory of olfaction in about 47 B.C. This year of 1953 marks the two-thousandth anniversary of this theory". On the other hand, K. H. Pribram and L. Kruger's review of the "Olfactory Brain" is particularly satisfying, and, at the risk of appearing invidious to the writers of other equally satisfactory articles, one may regard it as one of the most important papers of the conference and suggest that it is not to be overlooked. Their final conclusion justifies quoting: ". . . the 'olfactory brain', as defined, is not primarily olfactory, though parts of it serve olfactory functions. Nor is the current conception of a 'visceral brain' more tenable though viscero-autonomic functions are also served. It is clear that the formations in this portion of the brain, though they share several characteristics, are not, at this time, usefully thought of as *a* brain serving any *one* function. Since at least three distinct systems can be delineated, each might profitably be investigated before an attempt is made to define what functions they have in common". In the third section also, M. M. Mozell and C. Pfaffman contribute a review of the afferent neural processes, largely concerned naturally with Dr. E. D. Adrian's recent work, while V. G. Dethier has a most interesting paper on the physiology of olfaction in insects.

The rest of the conference was mainly devoted to techniques of measuring and identifying odours, with a consideration of some of the results obtained. This section might preferably have been placed earlier in

* "Basic Odour Research Correlation", by A. R. Behnke and 38 other specialists. *Ann. N.Y. Acad. Sci.*, **58**, Art. 2, 13–260 (1954). 3.50 dollars.