group as a whole evolved was discussed by Dr. J. D. Robertson (University of Glasgow). A widely held view, due mainly to Homer Smith and Marshall, is that certain features of these mechanisms, especially the presence of the peculiar glomerular kidney, point to a freshwater origin for the vertebrates. Robertson challenged this view. He showed that the palæontological evidence indicates that the earliest vertebrates, the Ostracoderms and the Acanthodians, lived in the coastal waters of the sea, and their remains, found in the rocks of the Ordovician and Silurian periods, are mostly associated with known marine invertebrates. At the same time, geochemical evidence suggests that the seas in Ordovician times were probably almost as saline as they are to-day. Robertson claimed that the inferences which could be drawn from the physiological features of present-day vertebrates are not opposed to this view. He brought forward the fact that all non-vertebrate chordates are marine and their blood composition, where known, is similar to that of sea water. Although the salt content of the blood of almost all the aquatic vertebrates is much less than that of sea water, the blood of the myxinoid cyclostomes—a very primitive vertebrate group—is not dissimilar, and this may be a primary feature. Finally, he suggested that the glomerular kidney is not necessarily a freshwater adaptation. It may well have existed in marine protovertebrates as it does to-day in the marine elasmobranchs and myxinoids. In these marine animals the glomerular filtration surface may be practically as large as that of the freshwater teleosts.

There seems little to be gained by pursuing this question further until new facts have come to light. On the physiological side, many more studies on the quantitative aspects of renal function in the cyclostomes and fishes would do much to increase our knowledge on this fundamental issue.

A quantitative approach to the problems of salt balance was adopted by Dr. J. Shaw (King's College, Newcastle), who described an analysis of sodium uptake by the freshwater crayfish, *Astacus pallipes*. A steady state is achieved when the normal sodium loss is balanced by an equal uptake of sodium from the environment. The rate of sodium uptake can be conveniently measured by the use of a radioactive sodium isotope. The rate of sodium uptake depends on the external sodium concentration and a maximum rate is approached at concentrations as low as 1 m.mole/l. Above a certain minimum value balance can be achieved at any external concentration, since the uptake-rate is also regulated by the internal sodium concentration. A fall in the blood sodium concentration of 10 per cent or less may increase the rate of uptake by as much as five times. The system is a self-regulating one and results in the maintenance of the blood sodium concentration despite changes in the sodium content of the environment or the presence of other factors which may affect the sodium uptake-rate.

J. Shaw

AQUATIC AND AIR POLLUTION

A SYMPOSIUM on "The Effects of Pollution on Living Material", organized by the Institute of Biology, was held at the rooms of the Royal Geographical Society on September 25 and 26. The general and scientific interest in various aspects of this subject may be gauged from the fact that 380 registrations were received, more than a hundred of which were from industrial organizations, public authorities and similar bodies. The symposium was divided into four sessions, each dealing with one separate aspect of the problem: these were river, estuarine and air pollution, and pollution by radioactive substances.

In the field of air pollution the immediate need is clearly to study its effect on man, but there was evidence at this symposium that other aspects of the problem are not being neglected. Recent studies by Gorham[1] suggest that air pollution is increasing the concentrations of sulphuric acid in atmospheric precipitation in the Lake District and "will presumably hasten deterioration of already heavily leached Lake District soils". Moorland and high tarn communities may well be affected. Changes of this sort brought about by air pollution, though difficult to study except in local areas and special habitats, may be widespread.

Before about 1945 the biologist studying water pollution was primarily interested in the effects of polluting discharges on river and estuarine communities. The change in community structure often gave a useful measure of the severity of the pollution. The mode of action of the pollutants which resulted in such changes was rarely studied and, with the exception of organic pollution associated with low oxygen concentrations, practically no information was gathered on how these selective forces operated at organismic level. This state of affairs is generally true to-day, although a recent advance has been made concerning the chemical factors important in the distribution and deaths of fish in a sewage effluent channel[2].

Since the end of the Second World War, however, there has been an increasing interest in the effects of organisms on the polluted environment. In pollution by radioactive wastes, although there is no evidence of changes in community structure, the activity of organisms in accumulating and afterwards releasing radioisotopes is of the utmost importance in determining permissible discharges. In the field of 'conventional' water pollution similar trends are evident, and it seems likely, from the papers presented, that in the near future it will be possible to make estimates of some of the effects which organisms have on their environment.

The first speaker in the session concerning river pollution, Mr. F. T. K. Pentelow (Ministry of Agriculture, Fisheries and Food), began by admitting the difficulty of defining pollution. It could be said, however, that water is polluted when it becomes unfit for some use to which it could be put in its natural state. Mr. Pentelow directed attention to the many improvements which have occurred in British rivers over the past thirty years at a time of great industrial and urban expansion in spite of a major slump, rearmament, war, and a series of financial crises. Pollution, though now perhaps more widespread, is not nearly so intense as at the beginning of this period. Mr. Pentelow considered that an important factor leading to further improvement has

been the recent formation of river boards and their endowment with statutory powers of control.

Mr. H. B. N. Hynes (University of Liverpool), discussing the biological effects of water pollution, suggested that the effects vary with the age of the phenomenon which the pollution produces. Man-made types of pollution, such as the discharge of poisons, which have no counterparts in natural ecological systems, result in an elimination of species, whereas other types, such as organic and thermal pollution, result in the development of replacement communities adapted to the peculiar ecological conditions. These observations seem to provide a useful basis for an ecological classification of pollutional effects. Dr. Hynes suggested that a controlled introduction of selected organisms tolerant of the somewhat higher temperatures found near discharges of cooling water from power stations might be considered. There are severe objections to such introductions, however, some of which were raised by the delegates present.

Mr. D. F. Westlake (Freshwater Biological Association) described recent studies made to assess some of the effects which plants and invertebrates have on stream conditions. It was shown that these organisms have quite large effects on the oxygen regime of organically polluted streams where high densities of bottom-living invertebrates and often large growths of macrophytic vegetation, especially *Cladophora*, occur. Estimates of these changes in the concentration of dissolved oxygen based on field observations were presented, together with descriptions of experimental studies of the effects of some invertebrates on bottom deposits. Physical effects of plant growth in streams were also discussed.

In the discussion which followed this session, Mr. F. W. Roberts (Luton Sewage Works) described his experiments on the effects of detergents on aquatic plants and reported that when grown in concentrations of 2·5 p.p.m. of anionic detergents, certain plants, such as *Ranunculus* and *Apium*, showed browning and loss of leaves. A non-ionic detergent did not have the same adverse effects. The tolerances of different plant species to detergents reflected their natural distribution in the river system with which he was concerned.

The second session, dealing with estuarine pollution, was introduced by Dr. B. A. Southgate (director, Water Pollution Research Laboratory), who said that British estuaries were generally in a worse condition than the rivers. He attributed this principally to differences in legislation and to past over-assessment of the capacity of estuaries to deal with pollution.

The first two speakers in this session, Mr. A. B. Wheatland and Mr. A. L. H. Gameson (Water Pollution Research Laboratory), discussed some aspects of the carbon, nitrogen and sulphur cycles in the Thames estuary. Mr. Wheatland described his investigations on denitrification and particularly the influence of low concentrations of dissolved oxygen and organic matter on this process. Some of the factors affecting the formation and oxidation of hydrogen sulphide were also described. Mr. Gameson discussed the importance of the biochemical reduction of nitrate and sulphate, and photosynthesis by phytoplankton, in contributing oxygen to the Thames Estuary. The reduction of nitrate produced about 140 tons of oxygen daily, that is, roughly one-quarter of that supplied by absorption from the atmosphere. Sulphate reduction and photosynthesis would seem to play a minor part in the oxygen balance of this estuary.

The final speaker on the first day, Prof. G. E. Newell (Queen Mary College, London), confining his remarks to lower estuaries, described the eutrofication resulting from organic pollution and its enrichment of the fauna and microflora. It was shown how hydrographic characteristics of estuarine basins and condition of the deposits may influence these pollutional effects.

In the discussion which followed, Mr. R. Bassindale (University of Bristol) showed how difficult it was to decide, in any given case, how far pollution was responsible for the reduction in fauna in the middle reaches of an estuary, for fluctuations in salinity in these areas result in a similar faunal reduction, and pollutional effects are generally superimposed on natural salinity effects.

The morning of September 26 was devoted to a series of papers on air pollution. The first speaker, Dr. E. T. Wilkins (Fuel Research Station), described the methods of measurement of deposited matter, sulphur dioxide, and smoke, and commented upon the value of the instruments employed for this purpose—now almost 3,000 in Great Britain—in monitoring suspected sources of excessive pollution and assessing local and national trends. Dr. Wilkins described measurements of toxic constituents of motor-vehicle exhausts, the most harmful of which appears to be carbon monoxide, which reaches concentrations of 50 p.p.m. at breathing height in London streets congested with traffic. The general conclusions of smog studies were outlined and possible synergistic effects of smoke, sulphuric acid and other complexes were discussed. The possibility of neutralizing acid gases in smog by the controlled addition of ammonia is being explored.

Dr. J. K. A. Bleasdale (National Vegetable Research Station) described his studies of the deleterious effects of air pollution on plant growth, these being particularly severe on winter annuals, which grow at a time when air pollution is at its worst. Dr. Bleasdale discussed the toxic effects of pollution on plants and soils and the effect of smoke haze in reducing light available for photosynthesis. The one redeeming feature in this otherwise gloomy picture is the notable freedom from certain fungal infections of plants growing in polluted air.

Dr. P. J. Lawther (Medical Research Council) pointed out that while acute air pollution is manifestly injurious and even fatal to old people and respiratory cripples, less dramatic consequences such as the hastening of the development of chronic bronchitis must not be overlooked. The chronic pollution suffered by town-dwellers is also suspected as an etiological factor in the production of chronic bronchitis and lung cancer, though in the case of the latter disease air pollution can play only a small part in the alarming increase in its prevalence.

Dr. R. Allcroft (Ministry of Agriculture, Fisheries and Food), reading a paper entitled "Fluorosis in Farm Animals", briefly surveyed the areas of occurrence and the industries with which it is associated. In Britain, fluorosis results exclusively from the aerial contamination of herbage by the emission of gases and dusts containing fluorine. The symptoms of fluorosis in cattle and other farm animals were described and shown on film, and the effects of dental changes and lameness, associated with fluorosis, on the quality of stock were discussed. Adverse environmental factors and physiological stresses greatly

influence the severity of the toxic effect and it seems difficult to define damaging pasture concentrations, but a tolerance-level of between 30 and 50 p.p.m. in the food was given.

Mr. R. H. Burns (Atomic Energy Research Establishment), the first speaker in the final session, devoted to pollution by radioactive wastes, outlined the main differences between radioactive and other waste materials, the most important being our inability to destroy the harmful properties of the former by chemical means. Methods of dealing with wastes, disposal and storage, were described. There is an increasing demand for some of the fission products, particularly radiocæsium and radiostrontium, in industry and medicine, and storage of liquid wastes, though expensive, costing £200 per cubic metre, is being used on an increasing scale. Mr. Burns demonstrated by his paper how carefully such factors as the proper siting of effluent pipes and the fixing of permissible levels of discharge are considered in relation to the disposal of radioactive wastes.

Mr. W. L. Templeton (U.K. Atomic Energy Authority) directed attention to the greater hazards that may arise from accumulation of radioactive isotopes from the diluting medium by food-organisms than by direct radiation from the environment. The value of the observational and experimental approaches in the measurement of accumulation factors was outlined and their findings surveyed. Mr. Templeton felt, however, that series of planned experimental discharges, each of several months duration, would be of the greatest value in determining long-term variations and build-up of activity.

Dr. H. J. M. Bowen (Wantage Radiation Laboratory), discussing the uptake of fission products by plants, outlined recent advances in our knowledge of their absorption by various plant structures and their translocation in plant tissues. Dr. Bowen described his work with accumulator plants, that is, plants which concentrate large quantities of specific elements. He found that radiostrontium, the most dangerous fission product, was accumulated particularly by certain species of *Fucus* and *Laminaria*. It would seem that one important gap in our knowledge is that of the relation of rainfall and soil-type to the accumulation of fission products by plants.

In the last paper of the symposium, entitled "Genetic Hazards of Radioactive Pollution", Dr. T. C. Carter (Medical Research Council) suggested that recent work casts doubt on assumptions made by experimental geneticists, based principally on the radiation effects on gene mutation in *Drosophila* sperms. It is on these questionable assumptions that radiation effects are calculated. Dr. Carter stressed the need for an investigation of the relation between rates of mutation and accumulated radiation doses in mammals, particularly in the low-dosage range relevant to man. All present-day assessments of genetic hazards of radiation assume a linear relation. A figure of about £200,000 was quoted as the total outlay necessary for such an investigation. This is surely a small price to pay for such basic and vital information, especially when man's future well-being is at stake. R. W. Edwards

[1] Gorham, E., *Trans. Roy. Soc.*, B, **241**, 147 (1958).
[2] Allan, I. R. H., Herbert, D. W. M., and Alabaster, J. S., *Fish. Invest.*, **6**, No. 2 (1958).

THE UNIVERSITY GRANTS COMMITTEE

RETURNS FOR 1956–57

THE annual returns from universities and university colleges in receipt of Treasury grants for the academic year 1956–57, published by the University Grants Committee*, records a further increase of 4,672 in the number of full-time students, which now stands at 89,866, compared with 81,705 in 1954–55, and it is expected that the number in 1957–58 will show a greater increase since the number of full-time students in the autumn term of 1957 was 5,899 greater than in the autumn term of 1955. There were 6,115 full-time and 2,016 part-time students from overseas within the British Commonwealth and 3,792 full-time and 1,756 part-time students from foreign countries; for 1955–56 the corresponding figures were 5,536 and 2,068 for the Commonwealth and 3,750 and 1,756 for foreign countries. Distribution of full-time students among the faculties showed no significant change, but the proportion in pure science increased from 21·3 to 22·2 per cent, in technology from 13·3 to 13·9 per cent, and that in medicine decreased from 15·7 to 14·4 per cent. Full-time advanced students of pure science numbered 3,675 (35 per cent); of technology 1,650 (15·7 per cent); and medicine and dentistry 1,041 (9·9 per cent); 2,870 students were working for the teacher's diploma. Of the full-time students, 71,713 were reading for a first degree, 3,969 for a first diploma, and 13,379 engaged in research or other advanced work, the corresponding figures for 1955–56 being 67,850, 4,021 and 12,668.

The proportion of assisted students was 75·7 per cent compared with 74·9 per cent in 1955–56 and 71·9 per cent in 1953–54, ranging from 90·4 per cent in Wales, 83·8 per cent for English universities and university colleges, excluding Oxford, Cambridge and London, to 61·7 per cent for Scotland. Of the recurrent income of £41,635,609 (an increase of £3,338,958 on 1955–56), £29,082,526 was from parliamentary grants (69·8 per cent). Income from fees decreased from 11·2 to 10·8 per cent, local authority grants increased from 2·9 to 3·1 per cent, payments for research from 6·0 to 6·5 per cent, gifts and subscriptions from 1·0 to 1·2 per cent, and endowments were again 4·0 per cent. Full-time teaching staff increased to 10,485, compared with 10,202 in 1955–56 and 9,810 in 1954–55.

The proportion of full-time students residing in colleges and halls of residence was 27·4 per cent, compared with 27·5 in 1955–56, but the total, 24,652, was higher. The proportion of men in residence was 23·2 per cent and of women 39·9 per cent; whereas 41,291 (46·0 per cent) were in lodgings and 23,923 (26·6 per cent) at home, compared with 44·7 per cent

* University Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant, Academic Year 1956–1957. Pp. 50. (Cmnd. 477.) (London: H.M. Stationery Office, 1958.) 4s. net.