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of muscular contraction and other mechanisms where the immediate process is an anærobic one.

Mr. L. C. Beadle.—*Osmotic regulation in some brackish water invertebrates* (10.30).

Experiments with several brackish water animals (*Gunda ulvæ*, *Nereis diversicolor*, *Nereis virens* and *Arenicola marina*) have shown that the weight changes undergone on transference from normal to dilute sea-water are essentially similar in all these forms. A rapid rise in weight due to uptake of water is checked at a maximum considerably lower than would be expected if osmotic equilibrium were established. There follows a fall to an equilibrium value above the original weight. The general activity may fall during this process, but is ultimately regained. A typical marine invertebrate such as *Nereis cultrifera*, when subjected to these conditions, will take up water continuously until osmotic equilibrium is reached. The nature of the water control in the above brackish water forms is under investigation. Experiments indicate (1) that different species and individuals of the same species at different seasons differ in their powers of control; (2) that the water enters the body through the skin; (3) that the rate of entrance and consequently the power of control is influenced by temperature and by the calcium content of the sea-water; (4) that the water content of the body is not primarily controlled by the excretory organs, but that the animal is able to regulate the rate of inflow through the skin.

Symposium on *The herring problem* (11.0):—

Mr. E. Ford.—*The nature, extent and significance of vertebral variation in the herring with reference to the 'race' problem* (11.0).

Dr. W. C. Hodgson.—*Recent additions to the knowledge of the herrings of the southern North Sea* (11.30).

Since it became possible to forecast the general characteristics of the main fishery of the southern North Sea, attention has been directed to the study of factors which have an influence on the swimming of the herrings.

Besides phytoplankton concentrations, it appears that wind, either before or during the fishery, has a considerable effect on the catches of the drifters, and a detailed study of the variation in the amount of fish landed in relation to the direction of the wind is at present being carried out.

Further, lunar influence on the catches of herrings, especially in the southern part of the North Sea, is considerable, and the characteristics of the fishery vary according to the date of the October full moon.

It is also evident that there is a connection between the relative strength of year-classes and the temperature of the water in January in the Channel, which is the main spawning ground of the herrings of the southern area.

Prof. A. C. Hardy.—*The herring in relation to the plankton* (12.0).

Earlier work on the planktonic food of the herring is reviewed and reference made to the work of Pearcey, Savage and Hardy on the influence of phytoplankton on the herring. Recent work carried out with Dr. G. T. D. Henderson, Mr. C. E. Lucas and Mr. J. H. Fraser from the University College of Hull is described. The distribution of the herring in relation to that of the plankton is studied by experiments with an instrument, the plankton indicator, used on herring drifters during 1930–1934. Positive correlations between the number of herring caught and their food *Calanus* and negative correlations with phytoplankton have been demonstrated. Other correlations are suggested. The instrument is now used commercially. The progress made with a wide survey of the plankton by means of continuous plankton recorders towed by steamships crossing the North Sea is briefly described, and a general review made of the distribution of the herring fisheries in relation to the plankton. The continuous recorder survey is being conducted in close association with the Fisheries Department of the Ministry of Agriculture and Fisheries, who are making a more detailed study of the plankton in relation to the herring in certain areas of the North Sea.

Mr. R. S. Wimpenny.—*The plankton communities of the North Sea and their relation to the herring fishery.* (A résumé of work done by Lowestoft Planktologists) (12.30).

It has already been shown that the phytoplankton forms at times such dense patches that the movements and shoaling of the herring are interfered with. In this contribution the development and movements of these patches are considered for the past twelve years, but with especial reference to 1933 and 1934.

1933 produced the most luxuriant and dense growth of *Rhizosolenia styliformis* yet observed and also an unusually high salinity in the area of its occurrence. This was difficult to account for, and the possibility of its having been caused by the photosynthetic activity of the diatom itself is discussed.

In both 1933 and 1934 there was a tendency for the autumn herring shoals (as revealed by the charted catches) to mass against the edge of a diatom patch. A similar orientation was observed when some of the zooplankton organisms caught by the Hensen net were charted. Zooplankton are not absent even in dense phytoplankton patches, but in these areas the community consists of a greater proportion of young forms. It is possible that the phytoplankton patches may be nursery grounds and there may be a physiological gradient for the zooplankton between the edge and centre of a patch. Similarly herring that shoal prior to spawning may be taking up a position in relation to the phytoplankton patch that has a connection with the physiology of reproduction.

Afternoon.

Centenary of the Landing of Darwin on the Galapagos Islands, and of the Birth of the Hypothesis of the 'Origin of Species.'

Prof. Sir E. B. Poulton, F.R.S.—*Introduction* (2.15).

Prof. J. H. Ashworth, F.R.S.—*Charles Darwin in Edinburgh, October 1825 to April 1827* (2.45).

Information obtained chiefly from a notebook of observations made by Darwin and from the minute book of the Plinian Society of the University of Edinburgh, a biological society of which Darwin was a member from November 28, 1826, until he left Edinburgh in April 1827.

Prof. G. D. HALE CARPENTER.—*Charles Darwin and entomology* (3.10).

Galapagos insects. Similar habits of ant-lions in Australia and Europe suggest unity of creation in 1836 : by 1845 view-point changed. Colouration of insects formerly ascribed to need for concealment : bright colours resembled flowers. Unpleasant odours repelled enemies : no one correlated this with conspicuousness and peculiar habits. Bates in 1862 described resemblances of butterflies to others, not nearly related, conspicuous and avoided by enemies, as ' Mimetic Analogies ' produced by Natural Selection. Reason for conspicuousness explained in 1867 by Wallace for brightly coloured caterpillars on appeal by Darwin. Natural selection explains (1) association of conspicuous colouration with habits displaying it, toughness, and repugnant qualities ; (2) acquisition of conspicuousness by a form lacking the other qualities ; (3) why mimicry deceives the artist and not the anatomist, and (4) production of mimetic effect by different means. Coincidence, affinity, or similarity of environment cannot explain niceties of geographical distribution of model and mimic.

Observations and experiments on insectivorous vertebrates show preferential feeding according to demands of theory.

Darwin stressed insects as exemplifying sexual selection, but elaborate scent-producing apparatus in males, acrobatic performances, and presentation of gifts to females provide little evidence of preferential choice by female of one particular male.

Modification of whole groups of insects and flowers for mutual benefit strong argument for natural selection.

Prof. E. W. MACBRIDE, F.R.S.—*Darwin and the problem of the population of the Galapagos Islands* (3.30).

Darwin's reputation as a naturalist and a great observer would be secure if it rested on his description of the Galapagos Islands alone. In a masterly chapter in *The Voyage of the Beagle* he makes these islands live before our eyes. We see their arid burnt surfaces of lava studded with innumerable cones ; the great tortoises and the hard beaten paths which they pursue in their search for water ; the two peculiar lizards obviously nearly related and unlike the Iguanas, but one clearly adapted for life in water and the other for life on land ; we recognise the curious fact that the main islands, so closely similar in their physical features, are inhabited by species of birds and insects closely allied but nevertheless differing in the different islands.

In *The Voyage of the Beagle* he speculates on the mystery of these remote islands having been centres of so much creative activity, but in *The Origin of Species* he puts forward as an explanation ' Natural Selection.' At another meeting of this section I have maintained that this explanation really resolves itself into falling back on ' chance ' as a cause, and such a course I regard as unscientific. But the only alternative course is to suggest reaction to the environment as the cause of specific characters, and it might be asked how environment differs in such similar islands. Darwin suggests the existence of different proportions of enemies, but this is in the highest degree unlikely. A precisely similar phenomenon was described by Kammerer in his description of the varieties of lizards inhabiting the rocky islets of the Adriatic. He shows that in one islet the male has a rosy flush on the breast in the breeding season, and in another during the whole of the year, and yet there are no natural enemies as far as Kammerer could discover. One islet is more washed by spray than the other, that is all the difference that could be discovered between them.

An animal is not a piece of clockwork, but as Macdougal has pointed out, a centre of active striving. It rises up to meet the environment, and its effort alters its growth in every character.

Mr. H. W. PARKER.—*The herpetological fauna of the Galapagos Archipelago* (3.50).

A century ago it was the reptiles which gave ' the most striking character to the zoology of these islands.' It was not the multiplicity of species, but the enormous numbers of individuals and the fact that ' the different islands . . . are inhabited by a different set of beings ' (Darwin, *Journal of Researches*) which most impressed Darwin, and the combination of these two features, the one implying competition and the other change, first suggested the idea of cause and effect—selection and the origin of species.

This fauna has, in the last hundred years, been decimated ; many of the larger species have been completely exterminated, and others have been so reduced in numbers that to-day not a dozen specimens exist on islands which formerly supported thousands. These larger forms, Giant-Tortoises and Iguanid Lizards, have a commercial value, and their destruction is due to direct human action. But the smaller lizards and snakes which are of no economic importance have also been seriously affected by the commensal animals accidentally or deliberately introduced by man.

The future of this fauna, so full of historical interest and possibilities for research, is bleak indeed ; irreparable damage has already been done and only immediate and drastic action can hope to save any fragment of it for posterity.

Dr. P. R. LOWE.—*The finches of the Galapagos Islands in relation to Darwin's conception of species* (4.10).

No attempt is made to give a general description of the birds of the Galapagos. The very peculiar and interesting condition which exists in connection with one group, viz. the *Geospizids*, or finches. They are the dominant group, and the diversity presented by their colouration, colour-pattern and external structure far surpasses anything found elsewhere in the world either on islands or the mainland masses.

When Darwin came to work out his collection of birds from the Galapagos he was struck with the diversity existing among the finches from the various islands and thought that each island had its own peculiar variant. These finches are therefore historical in that they inspired Darwin with his ideas on the subject of the effects of environment, natural selection, etc., in the origin of species.

But a very different condition exists. There are some twenty islands in the Galapagos group, on all of which these finches are found, and on the different forms of which no less than sixty-seven specific, or subspecific, names have been bestowed by systematists. The most conservative admit forty, and their distribution is very remarkable, for some of the islands, as for example, James, Charles, and Indefatigable, have as many as ten or eleven different forms comprised within their limits ; while the little Wenman, seventy-eight miles from the nearest point of Albemarle, has six (referred by systematists to three genera). Duncan Island, again, with an area of only ten square miles, has no less than ten different forms (comprised in five genera) herded together.

Compared with other insular groups such a condition of things is phenomenal. It seems clear too, from descriptions published of the various islands, that the environmental conditions existing cannot be regarded as satisfactory factors which have caused this extraordinary diversity.

To what then can it be ascribed ?

(1) Is it due to hybridisation ?
(2) Were the segregates of a cross between ancestral forms distributed over a large insulated area which was subsequently broken up by subsidences or upthrusts leading to the present disposition of the islands ?
(3) Is it due to the fact that the natural tendency to vary resident in all organisms has been uncontrolled by any selective action ?

No attempt is made to answer these and other questions. The Galapagos problem can only be solved by establishing a biological station on the spot where experiments in genetics can be conducted.

Monday, September 9.

DISCUSSION on '*The species problem*' *based on the Presidential Address* (10.0).

Prof. E. W. MACBRIDE, F.R.S.

Even if he could not agree with everything the President said, the speaker recognised that the President had the true zoological point of view. For the species problem was *the* zoological problem ; as Lankester said at the meeting of the Association in York in 1906, there was this in common between the Church and zoological science, that both had set their hearts not on the present but on the distant future. The course of evolution was the problem which distinguished zoology from its allied sciences of comparative physiology and histology. Prof. MacBride agreed with the President that the theory of natural selection did not account for the evolution of all species. In his opinion it accounted for the evolution of no species. It was simply a dishonest truism and signified merely that 'the survivors survived.' It covertly assumed that small heritable variations in all directions were constantly occurring 'by chance' and the chance correspondence of one of these 'random variations' with the needs of the environment determined the survival of the individual. This, so far as modern research went, was simply not true. He thought that the President was right in stressing the unbroken passage from biological races to sub-species and eventually species. But the President should not be distressed by the fact that we could not see within our lifetime the inheritance of environmentally produced differences of structure. The 'engraining' of environmental effects was a very slow process. Woltereck examining lakes in South Bavaria found no peculiar species of Daphnid Crustacea in them, but only peculiar sub-species. These lakes were morainic lakes left behind by the recession of the great Alpine glacier of the Ice Age, and could not be less than 10,000 years old.

The President was also worried because he could not see the utility of certain 'characters.' Let him remind the President that characters were abstraction. What lived and survived was not the character but the animal. A character was a peculiarity of growth, and the growth of the animal in all its parts was a response to the demands of the environment. Certain zoologists finding colour variations in parts of gastropod shells which were covered by the mantle and therefore invisible, must be due to chance. One of our brilliant younger naturalists had shown that in one gastropod at least these colour varieties were correlated with different kinds of food.

Lastly, many naturalists had emphasised the difficulty of seeing how one structure presumably derived from another could have been evolved, except by chance mutations. He would remind them where, as in lineage series, the actual course of evolution was known, the functional nature of the slow gradual changes was evident. Let what we know not be shaken by what we do not know.

Dr. R. GURNEY.

The distribution of fresh-water Entomostraca shows, in many cases, precise association of species with particular environments which can only be accounted for by almost unlimited means of dispersal and selective destruction. The trivial structural differences between pairs of species cannot have survival value, but must be accompanied by physiological differences which cannot be estimated. Evidence can be given of structural changes directly caused by change of environment, but these changes are so small that the direct influence of environment cannot be one of the main factors in evolution.

Prof. H. L. HAWKINS.

Palæontology shows the history of the relation between organisms and environment. Most fossil evidence that is reasonably consecutive is found in marine organisms ; and even there no genetic relationships can be proved.

Given a constant environment, the tendency of the struggle for existence is to prevent the origin of species ; but the histories of the Micrasters and Gryphæas show that progressive change proceeds in defiance of this tendency. Such evolutional changes affect characters that are only incidentally connected with physiological efficiency, although they may prove fatal when carried too far. Such cases imply the existence of a directional momentum of change that is wholly intrinsic.

Changing environment may cause migration or extinction ; but it cannot be proved to produce direct adaptive change. The correlation between organisms and their environments is most easily explained by the influence of habitat on structure ; but in many cases this leaves the 'choice' of environment as a problem. Any effect caused by environment is limited by the potentials of the organism, and is subordinate to the course of intrinsic change.

Dr. W. K. SPENCER, F.R.S.

The species clusters are those arranged around evolving lines of starfish found in the chalk of Western Europe. Here there was fairly uniform physical conditions existing over a wide area for a very considerable time. Evolution was gradual and in definite directions. The changes involved are increase in diameter, in depth of body, and in modifications of shape and of ornament of marginalia. These modifications are parallel in several independent lines. The ornament characters could have had little functional importance. They are definitely related to the age of the lines and may be indices of physiological changes in the race. Branches from lines, giving new genera and species, seem to owe their new character in part because of acceleration in their racial history giving earlier maturity and premature senility.

There is no evidence of suppression of lines by competition. Lines which have become rare and then disappear are those which have had a