fishery investigations consist of an account, by Prof. Meek, of the migrations of the grey gurnard. The eggs and pelagic larvæ of this fish drift passively inshore towards the Northumberland coast with the general set of the current, and with increasing size they then move offshore. The migrations are correlated with the direction of the movements of the water, but it is more probable that the seasonal variation of temperature is a more important factor. Study of the general direction and the annual shifting of the isotherms would bring out this relationship. Prof. Meek also writes on the migrations of the dab. Mr. Storrow has accounts of the age and rate of growth of herrings and pilchards taken off the coast of Northumberland. The herring investigations form part of the general scheme of biometric research carried on by the Board of Agriculture and Fisheries, but only data referring to the age of the fishes, as determined by a study of the scale-markings, are discussed in this report.

Mr. J. H. Paul contributes an interesting account of the phenomena of autotomy in the Decapod Crustacea, with reference mainly to the lobster and crab. It is well known that injury to, or forcible retention of, a limb leads to the breaking of the latter. Escape is suggested as the object of autotomy on the part of the lobster, but more often a limb is thrown off by the crab as the result of injury and as a means of arresting hæmorrhage. Mr. Paul has studied the anatomy of the parts affected, and has also made experiments on the actions of the muscles and nerves involved. His figures are rather difficult to follow, but he shows that autotomy of a limb always occurs by a fracture in the exoskeleton running partially round a "breaking-groove" in the third segment of the limb. The fracture is a pluri-segmental reflex, and it is effected as the result of antagonistic muscles. It occurs, in the lobster, in about four seconds after nocuous stimulation. J. J.

## *JAMES GEIKIE'S RESEARCHES IN GLACIAL GEOLOGY.*

AT the meeting of the Royal Society of Edinburgh on November 1, Dr. J. Horne, F.R.S., president of the society, delivered an address on "The Influence of James Geikie's Researches on the Development of Glacial Geology." At the outset reference was made to the appointment by the council of a committee to conduct investigations in connection with submarines, aeroplanes, asphyxiating gas, and high explosives. The experimental work had been carried out with the financial aid of an anonymous donor, whose generosity and patriotic spirit had been highly appreciated by the council.

The subject of the address had been chosen because James Geikie's researches in Glacial geology were the most striking feature in his scientific career. They stimulated inquiry and at the same time aroused keen opposition. Brief allusion was made to the state of research in this country when he began his investigations, how glacial phenomena were erroneously attributed to the action of icebergs, and how the clue to the correct interpretation was furnished by Agassiz during his visit to Scotland in 1840. From the evidence which he obtained in the midland valley and in the Highlands he inferred that glaciers formerly existed there in post-Tertiary time.

The land-ice theory of Agassiz was adopted and confirmed by Buckland, Ramsay, Archibald Geikie, and Jamieson, but nearly a quarter of a century elapsed before the accuracy of this interpretation was adequately recognised. As James Geikie's field work in the Geological Survey proceeded he evolved certain ideas regarding changes of climate in Pleistocene time, based on the succession of boulder-clays with intercalations of sand, gravel, and peat, and on the cave deposits and Palæolithic gravels in the south of England, which he afterwards published in 1874 in his volume "The Great Ice Age." He therein gave an account of the Glacial and post-Glacial deposits of the United Kingdom, Scandinavia, Switzerland, and North America. Through the whole description runs the principle, which he believed to be fundamental, that the Glacial epoch was not one continuous age of ice, but consisted of a series of cold and genial periods. In his discussion of the question of the age of the Palæolithic gravels and cave deposits in the south of England, he opposed the view held by many that they were post-Glacial, and referred them to inter-Glacial or pre-Glacial times. As regards the commingling of northern and southern mammals in these deposits, he combated the theory that this assemblage was due to seasonal migrations. He contended that the phenomena pointed to changes of climate.

These were the essential points in James Geikie's teaching which he never discarded. They encountered persistent opposition from the monoglacialists, who maintain the unity of the Glacial epoch, and ascribe the intercalated deposits to local movements of recession of the ice within one period of glaciation. Attention was next directed to his elaborate classification of European deposits, comprising six Glacial epochs separated by five genial periods. It was suggested that the fifth and sixth cold phases were not sufficiently severe to entitle them to be ranked as distinct Glacial epochs. If we eliminate the two last cold phases, his classification agrees with that of Penck and Brückner in the Alps. The evidence furnished by the Eemian clays, the Hötting breccia, the Dürnten lignite, the Don Valley section near Toronto regarding climatic changes in inter-Glacial time was reviewed. The opinion was expressed that sufficient evidence had been obtained to establish the general principle of oscillations of climate in the Glacial epoch, though the number of inter-Glacial periods may remain a subject of controversy.

## *ZOOLOGY AT THE BRITISH ASSOCIATION.*

AT its first meeting Section D heard with profound regret that owing to serious illness the President of the Section, Prof. E. A. Minchin, was unable to be present. The presidential address, his last work, was read by Mr. Heron-Allen, and a telegram was then sent to Prof. Minchin conveying to him the sympathy of the section and thanking him for his able address. The following is a summary of the communications presented to the Section.

### *The Relation of Chromosomes to Heredity.*

In opening a discussion on this subject Prof. MacBride said that there seemed to be no escape from the position that the chromatin, viewed as a whole, is the bearer of the hereditary tendencies, for the influence of the father in determining the character of the offspring is as potent as that of the mother. The head of the spermatozoon, which is the only part of the father which enters into the constitution of the progeny, appears to consist practically exclusively of chromatin. The formation of the organs of an embryo is known in many cases to be due to substances localised in the cytoplasm, but the formation of these substances can be shown to be due to chromatic emission from the nucleus of the unripe egg. Prof. MacBride then considered the difficult

question whether individual chromosomes are the bearers of different characters or groups of characters. The experiments of E. B. Wilson and his school on Drosophila and other insects suggest that they are. The best instance is the so-called sex-chromosome, which is supposed to carry the determiner of sex and of the qualities which are sex-limited. In some cases the female nucleus possesses one more chromosome than the male, and there are two kinds of spermatozoon, one with one more chromosome than the other. Hence it is assumed that sex is fixed by the spermatozoon. But when two species are crossed, differing in a secondary sexual character, the distribution of this character in the hybrid and in the $F_2$ generation shows that it cannot possibly be carried by the sex-chromosome. Moreover, in other cases (Abraxas) the inheritance of characters in a cross between two varieties indicates that there are two kinds of egg and one kind of sperm, and yet no constant chromosomal difference between the two kinds can be detected (Doncaster); in other words, the odd chromosome may not be the cause of sex-difference, but in itself the result of that sex-difference. Prof. MacBride pointed out that the phenomena of meiosis, and their agreement in form with the sort of segregation of qualities postulated by the Mendelian hypothesis, suggest that determiners of various characters are situated in definite pairs of chromatin units which become separated from one another at the meiotic division. Since, however, the number of allelomorphic characters can in many cases be proved to be much larger than the number of chromosomes, the individual chromosomes cannot represent these determiners, though they may perhaps represent groups of determiners.

Prof. Dendy pointed out that the present controversy on the subject of heredity is to a large extent a revival of the old quarrel over epigenesis and preformation. The preformationists are represented at the present day by that large body of biologists who consider that separately heritable, individual characters are represented in the germ-cells by definite material constituents—determinants, "factors," etc. The phenomena of mitosis indicate clearly the great importance of the chromatin substance of the nucleus, and are in complete accordance with the view that this chromatin contains the invisible factors or determinants. But perhaps the strongest evidence of the correctness of this conception is Gates's demonstration of the correlation between abnormal distribution of the chromosomes in the reduction division of the nucleus and the phenomena of mutation as exemplified in Œnothera. Prof. Dendy stated that there appeared to be no justification for the assumption that the entire organism is made up of separately heritable "unit characters," for ontogeny is essentially an epigenetic process. After referring to the influence of the environment on the organism and to the dependence of progressive evolution on the continuance of environmental change from generation to generation, Prof. Dendy directed attention to the great complications introduced by the sexual process, or amphimixis, whereby slightly different samples of germ-plasm are mingled in ever-increasing complexity from generation to generation. Through the oft-repeated process of amphimixis the chromatin of the nucleus comes to contain a great and varied collection of samples of ancestral germ-plasm. Mendelian phenomena are of secondary importance, and result from the permutations and combinations of these different samples of germ-plasm, or of the so-called factors contained therein, in the process of amphimixis.

Prof. Hickson said that the evidence that the chromosomes are the sole bearers of hereditary characters is not proved, and for many reasons is not probable. That the cytoplasm is the sole bearer of such characters is also not proved, and is still more improbable. The only proposition that is proved is that the hereditary characters are transmitted by the sexual cells as a whole, and that the characters are formed by the interaction of nucleoplasm and cytoplasm. He held that there is very strong evidence for the belief that the act of fertilisation involves a conjugation of nucleoplasm with nucleoplasm and cytoplasm with cytoplasm, and that the mixing of both these plasms is essential for the process.

Prof. M. Hartog, in referring to the statement that the sperm introduced only chromoplasm into the egg, pointed out that Vejdovsky had shown in the clearest way in Rhynchelmis, which by the size of the plasmatic elements concerned afforded the best material for such study, that the middle piece of the sperm was not merely a centrosome, for on entrance into the egg it enlarges enormously into a mass of reticulate cytoplasm. This mass sends out radiating strands, which feed on the yolk-granules, and so nourish the enlarging mass within which the centrosome is formed about the centriole.

In reply Prof. MacBride said it was true, as Prof. Dendy had remarked, that the fate of a germ-cell depended not only on its nature but on its environment. But when the environment was altered a new type was not produced, but merely a modified edition of the old type. He could not accept Prof. Hartog's view that the middle piece of the spermatozoon constituted an important addition to the cytoplasm of the egg, for if that were so, when a cross was made between two distinct species, the paternal characters should appear in the earliest stage of development, which was not the case.

*Material Collected in Australia or en route thereto.*

The greater portion of the meeting on the Friday morning was devoted to four papers dealing with material collected in or *en route* to Australia last year. Prof. Herdman gave a short account of work by himself and Mr. Andrew Scott on the plankton collected during traverses of the great oceans. The material was collected by letting the sea-water, which is pumped continuously into the ship, flow out from a bath- or other tap through a fine-meshed silk net. The net was changed morning and evening, so that each sample obtained represented a twelve hours' catch. The amount of plankton per haul dropped markedly in passing from coastal to oceanic waters. Prof. Herdman referred to a number of the more interesting organisms obtained. He remarked that on the day after leaving the Cape the sea was blood-red in colour, and highly luminous at night. The gatherings then taken were found to contain large numbers of a small red Peridinean, which was probably the cause of both the colour and the luminosity.

Dr. J. H. Ashworth described larvæ of Lingula and Pelagodiscus (Discinisca), which were collected by the method above-named. The seventeen larvæ of Lingula obtained in the southern portion of the Red Sea and off Ceylon varied in diameter from 0·5 to 1·6 mm. In the smallest there was no trace of peduncle, but in the largest this organ was well formed, glandular at its tip, and ready to be extended to fix the animal to the substratum. The shell-valves of all the specimens were transparent, and in the case of the youngest specimens were still connected together posteriorly by a thin film of chitinoid substance forming a hinge. The cirri, alimentary canal, statocysts, and cœlomoducts were briefly described. Six larvæ of Pelagodiscus were taken a few miles west of Cape Comorin, and were examined alive. They were all about the

same stage, having four pairs of cirri. The chief anatomical features were demonstrated, and attention was directed to the fact that the stalk of these two Brachiopods develops as an outgrowth from the ventral mantle, whereas that of cardinate Brachiopods (*e.g.* Terebratulina) is formed at a much earlier stage from the entire posterior region of the larva.

Prof. Dendy exhibited and commented upon a series of specimens collected in Australia, among which were certain rare sponges, land planarians, land nemerteans, and three species of Peripatus. The sponge fauna of Tasmania in particular proved to be extremely rich.

Prof. Poulton exhibited a Buprestid beetle, and seven species of bees taken on Eucalyptus. The bees represented five genera but were closely similar in appearance.

*The Discession of the Chromosomes.*

Prof. M. Hartog has re-investigated the discession of the chromosomes in cell-division, and described a series of physical experiments illustrating the path of the chromosomes. Their motion is in accordance with the theory that the chromosomes behave as "flexible inductors" in the cell-field, which is not a uniform field, as it is traversed by the spindle-fibres, stretching from pole to pole along the lines of force, the distribution of which they modify.

*Purpose and Intelligence in the Protozoa.*

Mr. Heron-Allen sought to make clear the position which he has taken up in regard to the theory and phenomena of purpose and intelligence in the Protozoa, as illustrated by selection and behaviour in the Foraminifera. He held (1) that every living organism, having an independent existence, is endowed with that measure and quality of the faculties of purpose and intelligence which are adapted to and called forth by the individual needs of that organism; (2) that these faculties are illustrated by the utilisation by the Foraminifera of foreign substances selected by the animal from a heterogeneous mass of environmental material, and utilised in such a manner as to provide the animal with means of adaptation to its special environment and defence against its special enemies; (3) that it is not competent for a consistent evolutionist to postulate a break in the evolutionary cycle for the introduction at some arbitrary point of an influence of unknown origin, to which he gives the name of intelligence, upon which purpose depends; and (4) that the phenomena under discussion are not to be confounded with adaptations or tropisms.

*Recent Work on Pennatulacea.*

Prof. Hickson gave a short account of some of the results of his investigation of the rich collection, amounting to 550 specimens, of Pennatulacea made by the *Siboga* Expedition in the Malay Archipelago. This area has proved to be extraordinarily rich in sea-pens, no fewer than seventeen of the thirty-two recognised genera being represented in the collection. Of particular interest is the presence of Gyrophyllum, hitherto found only in deep water in the Atlantic, and of Chunella, hitherto found only off the coast of East Africa.

*The Metamorphosis of Bilharzia.*

Lieut.-Col. R. T. Leiper communicated some results of his recent work in Egypt on Bilharzia, a Trematode parasitic in man, and found when adult in pairs in the portal vein and neighbouring abdominal veins. He pointed out that the predominant theory regarding the transmission and metamorphosis of this worm is that put forward by Looss in 1894. Looss believed that there was no intermediate host; that the freshly-hatched larva (miracidium) entered man only through the skin, undergoing metamorphosis in the liver; and that the vesical and intestinal lesions caused respectively by terminal and laterally spined eggs were caused by the same species, the lateral-spined eggs being parthenogenetically produced. Dr. Leiper has succeeded in producing heavy infections of rats, mice, guinea-pigs, and monkeys with cercariæ discharged from *Planorbis boissyi*, one of the commonest of Egyptian fresh-water molluscs. The miracidium enters this Planorbis and undergoes metamorphosis in the liver, forming primary and secondary sporocysts, which give rise to bifid-tailed cercariæ. Infection was found to take place through the skin, and also through the mucous membrane of the mouth and œsophagus when water containing large numbers of cercariæ was drunk. Lateral-spined eggs were produced by paired worms, and there was some evidence, not yet fully examined, that the vesical and intestinal lesions were caused by distinct varieties or species of Bilharzia.

*The Relation of the Phylogeny of the Parasite to that of the Host.*

Mr. L. Harrison advanced the proposition that, in the case of total obligate parasites, closely related parasites will be found to occur upon phyletically-connected hosts without regard to other œcological conditions. As the state of evolution of the parasite will be less advanced than that of the host, it follows as a corollary that a study of such parasites may give valuable indications as to host phylogeny. He based his arguments largely upon his study of conditions in the Mallophaga, which are found among and feed upon the feathers of birds. Mr. Harrison finds that, in general, the Mallophaga parasitic on any avian order are recognisable at sight, and in many cases it is possible to state definitely that a parasite has come from a particular family of birds. Thus *Philopterus lari* occurs upon all gulls, *Lipeurus anatis* upon all ducks, *L. columbae* upon all pigeons, and species of Tetrophthalmus occur on all pelicans, in the gular pouch, and are all similarly modified in their treacheal system in accordance with the conditions. The only reasonable explanation is that the parasites have had common origin. If this be the case, the Mallophaga may afford valuable evidence as to the relationships of birds, and Mr. Harrison brought forward strong circumstantial evidence from the Mallophaga to indicate that Apteryx is not a Ratite related to the ostrich, rhea, etc., but is a Ralline bird.

Dr. Gadow remarked that on anatomical grounds the rails were believed to be the nearest relatives of Apteryx, and that in this case he agreed with Mr. Harrison's conclusions, but he could not accept Mr. Harrison's suggestions in regard to other relationships, *e.g.* of the penguins and pigeons.

*The Genus Eronia.*

Dr. F. A. Dixey said that the Eronia, a genus of Old World Pierine butterflies, might be divided into three subgenera: (1) Nepheronia, from Asia and Mayalan islands; the females have a likeness to various species of Danainæ. (2) Leuceronia, from Africa and Arabia; three of the species have polymorphic females which copy some other butterfly belonging to the Pierine subfamily, but of no close affinity with Leuceronia. (3) Eronia proper, two species from Africa; in both species the underside is coloured like a dead leaf. The likenesses noticed in the first and second groups can scarcely be due to affinity, and since some of the forms resembled by the Eronias are known experimentally (and others are believed on good grounds) to be more or less distasteful to insectivorous animals, Dr. Dixey considered

that the theory of mimicry appeared to offer the most feasible interpretation of the conditions obtaining in this genus.

*Geological Changes and the Distribution of Fish.*

Prof. A. Meek exhibited lantern slides of maps illustrating Tertiary changes and their relation to the distribution of fish. He said that from geological evidence it was known that during the Tertiary era the northern hemisphere was the scene of important changes affecting the sea and the land. A consideration of the distribution of marine and fresh-water fish bears out this evidence, indicates the refuge regions of the Glacial epoch, and shows that the reaction of changing conditions has during the era led to the formation of many species (*e.g.* those of Acipenser) and even of genera (*e.g.* Caspiomyzon). The fish of the Antarctic seas appear to be northern in origin, but the fresh-water fish-fauna of the southern hemisphere is characterised by the presence of primitive types, which appear to have survived from the period of Gondwanaland and the spread of the Glossopteris flora.

*Regeneration of the Tail in the Lizard.*

Dr. C. Powell White gave an account of the regeneration of the tail of *Lacerta vivipara*. Autotomy of the tail takes place through the middle of a vertebra; there is no special autotomy site as in the legs of crabs, but apparently any vertebra may be involved. After autotomy the wound is quickly covered with new skin, beneath which is a mass of spindle cells, originating in the connective-tissue, which acts as a growing point to the new tail, and from it the cartilage, fat, muscles, and vessels are developed and differentiated. All the nerves are derived from the last three pairs of nerve-roots in the stump of the tail. The main trunks of the sympathetic accompany the aorta some distance into the regenerated tail and send branches to the different blood-vessels. In the centre of the tail is an unsegmented tube of cartilage (perforated by blood-vessels which pass to the interior) continuous with the body and neural arch of the vertebra through which the fracture took place. This cartilage surrounds an epithelial tube continuous with the central canal of the spinal cord. Regeneration may continue until the regenerated tail is as long as the original one.

*The Vermiform Appendix.*

Dr. W. C. Mackenzie demonstrated a fine series of specimens of the appendix vermiformis in Monotremes and Marsupials. He drew attention to the fact that Ornithorhynchus has a cæcum, while Echidna has a true vermiform appendix, comparable macroscopically and histologically to that of man, ape, and wombat, the three mammals regarded as having a true vermiform appendix. In Phascolomys the appendix has reached a much more advanced degree of degeneration than that of man, even to complete disappearance by incorporation in the wall of the ileum (various grades of this were shown), a condition suggestive of the mode of further evolution of the appendix in man.

*An Explanation of Secondary Sex Characters.*

Mr. F. W. Ash suggested that male secondary characters are characters of abandoned function suppressed in the young in favour of more essential growth (of organs still fully functional), and in the adult female because, with her, nutritive surplus is more directly diverted to the purposes of reproduction. Hence such characters usually find opportunity for full expression in adult males. Secondary sex exaggerations may significantly parallel enlargements due to accidental loss of function, *e.g.* the tusk of the male babirussa may be compared with occasional circular overgrowth in the tusk of the hippopotamus. The dependence of the development of the secondary character on the presence of the active male gonad may perhaps be explained by reference to the phenomena of periodicity.

*History of Comparative Anatomy.*

Prof. F. J. Cole and Miss N. B. Eales presented materials for a graphic history of comparative anatomy based on an examination of 6304 papers on the anatomy of animals published between 1543 and 1860. The graphs exhibited show that before the year 1650 only intermittent research was carried on, but in the next fifty years there was considerable activity, culminating at about 1683, and thereafter subsiding. This sudden revival was due almost exclusively to Academia Naturæ Curiosorum (founded 1652), the Royal Society of London (1660), the French Academy of Science (1666), and, to a less extent, the Collegium Anatomicum of Amsterdam (1665). From 1700 to 1750 work was steadily maintained, and a second revival began in 1750, gradually increasing to 1800, and suddenly reaching a high maximum between 1835 and 1840, finally declining somewhat to 1860, where the investigation ceases. The second revival was initiated by France, followed closely by Germany, and at some distance by England, but the last country reached her maximum first, then Germany, and finally France. Holland and Denmark took a distinct part in the seventeenth-century revival, and Italy was undoubtedly concerned in initiating the similar movement in the nineteenth century. The seventeenth-century revival related chiefly to mammals, but concerned to a less extent birds, fishes, and arthropods, and to a slight extent reptiles and molluscs. In the nineteenth-century revival, mammals, arthropods, fishes, and organography play the leading part, followed by birds, molluscs and reptiles.

Dr. J. Stuart Thomson gave an account of the morphology of the telencephalon of Spinax as a type of Elasmobranch fore-brain, and detailed the various grey masses and fibre-tracts which he had recognised. He has not obtained any satisfactory evidence of the existence of a *corpus callosum*.

Dr. A. E. Cameron described the insect community of a local environmental complex. A soil-insect census of two different grasslands in the association, differing in their soil-types and vegetational covering, showed that in any given locality the soil-insect fauna of grassland is not likely to vary to any great extent. In the absence of the illustrations these two communications cannot be adequately summarised.

On the Thursday afternoon the members of the Section were received by Prof. and Mrs. Hickson in the Zoological Laboratories, where there was an interesting and extensive exhibit of specimens by members of the staff and by visiting zoologists.

J. H. ASHWORTH.

## *EDUCATION AT THE BRITISH ASSOCIATION.*

AS women are playing an ever-increasing part in the national work of education, it was an eminently reasonable departure from precedent for the council of the Association to elect Mrs. Sidgwick to the presidency of Section L. The full text of her address has already appeared in NATURE, and need not, therefore, detain us here, except in so far as it gave an opportunity to Lord Bryce to dot the "i's" and cross the "t's" of what was, in fact an extremely sane pronouncement. Those who heard him will not