the thickness of the layer which would be produced by the corrugations resulting, and found it far short of that which the existing inequalities would form if levelled down. The discovery of a level of no strain within the crust by Mr. Mellard Reade and Dr. Davison further reduced the possible amount of corrugation. Even a substratum of liquid magma holding water gas in solution would not account for it, and he therefore argued that the substratum was affected by convection currents, which, ascending beneath the oceans, flowed horizontally towards and beneath the continents.

Mr. J. J. H. Teall discussed the petrological aspect of the general question, and divided the effects of movements upon rocks into two classes, easily separable, namely, local and regional. The former were confined to the immediate areas of dislocation, while the latter extended over tens or hundreds of square miles.

Local movements were characterised by fault breccias and mylonites, these being close grained, compact rocks formed by the crushing down of original rocks as in a mill. In some cases there was no crushing, the dykes being converted into foliated schists. In respect of regional effects, we have slaty cleavage due to mechanical deformation of extensive tracts of country. Foliation might be due to the original form of crystallisation or to earth movements after consolidation.

Prof. T. McKenny Hughes thought that lateral pressure, not necessarily horizontal, had produced almost every feature, and that faults were due to compression occasioned by such pressure rather than by extension.

The folding skin of an apple due to shrinkage of the interior was not wholly comparable to earth folding, for, in the case of the earth, many complex circumstances had to be taken into account. Time was one important point, as well as such forces as molecular deformation, temperature changes, volume and force of crystallisation, and transference of material from one region to another.

Prof. W. J. Sollas said that the belts of folding could usually be correlated with the margins of preexisting oceans, and those belts of folding which were comparatively superficial must be accounted for by deep-seated causes. The inequality of the present earth was the best guide to former folding. Inequality at the meeting places of oceans and continents, together with sedimentary deposits on the ocean floor, altered the isothermal lines—flattening them out—and so produced stresses and thrusts, which resulted in pushing part of the material seawards. Thus there was a redistribution of pressure, and this produced fluid magmas, with earthquakes and volcanoes resulting. He thought that all this, however, would hardly suffice for the results produced. There must be another cause. The earth was more pear-shaped in the past than it now is by reason of its relation to the moon. Constant deformation towards its present shape produced contraction of the two hemispheres, and thus the American and Australian beltings or folds were, he thought, accounted for. Deformation of this character produced the same effects as contraction, and the two causes together, he considered, might be enough to account for the existing phenomena produced by earth movements.

Sir John Evans remarked that thirty years ago he had argued that if a globe with a fluid nucleus and a solid crust were postulated, deposition or other causes would result in the solid crust moving over the nucleus, and this disturbance would produce a change in the position of the pole. There was evidence of such a change in the fossil fauna and flora of the Arctic and Antarctic regions. This might be an additional aid beyond those due to cooling.

Prof. Blake thought that, in speaking of thrusts, Dr. Horne had only given the description, and not the cause. In the north of Scotland, where did the force come from? He suggested that if mountains expanded upwards by lateral or upward pressure, a sufficient cause for such thrusts would be found. He had never, he said, seen a true isoclinal fold, and he considered it mathematically impossible for one to exist; the nearest to it in nature was a pleisioclinal fold.

Prof. Rothpletz, of Munich, referred to overthrusts he had observed in Saxony twenty-five years ago. The Scotch overthrusts were older than those of the Alps. In the Alps the plane of the overthrust got steeper and steeper as it approached Vienna. When the folding was a shortening of the earth's crust, the overthrust was a shortening too, in another direction. The matter was more difficult of observation in Scotland, as the overthrusts ended in the sea.

Prof. Boyd Dawkins referred to a case in the Derwent Valley where folding had taken place over level beds, and thought they were not necessarily formed at the root below mountains.

Prof. J. Milne submitted that the seismologist required a world like that of the physicist, one as rigid as cast iron. Earthquake waves traverse chords of the earth at 11 or 12 km. a second, *i.e.* twice as rapid as through steel. This indicates a world very rigid and uniform in the interior. He thought that if it were liquid with convection currents, as urged by Mr. Fisher, the velocity of tremors would not be uniform.

Dr. Knott advised caution in accepting the abrupt change from solid to liquid as supposed by Prof. Sollas. The changes from solid to liquid would probably be through a viscous condition.

Prof. Kendall, in winding up the discussion, pointed out that the special feature of continental margins was deposition. Deposits, acting as imperfectly conducting blankets, would cause the isotherms and the critical zone to rise, and the weakest spot would give way. Given stiff rocks above the critical zone and plastic rocks below, puckering must take place. He considered that in thrust planes the rocks were not forced over horsts, but the horst was wedged underneath them. While areas of sedimentation were weak, other and thinner rocks were stationary under deforming stresses.

Following the discussion, Prof. Kendall read a paper on the evidence in the Secondary rocks of persistent movement in the Charnian Range, in which he gave specific examples of the movements which had been discussed by previous speakers. He referred to the speculations of Godwin Austen, who stated that all recent anticlines are built on older anticlines.

The Charnwood rocks showed evidence of folding in a N.E. to S.W. direction even before Cambrian times. These movements were continued in pre-Carboniferous, Carboniferous, and Permian times, and grounds existed for the belief that they were repeated at intervals during the Jurassic and Cretaceous periods. The Charnian axis, he believes, constitutes the boundary of two important coal fields which extend under the Secondary rocks far to the south.

J. LOMAS.

RECENT STUDIES OF DISEASE ORGANISMS.

AT the recent Cambridge meeting of the British Association, the results of several investigations of organisms associated with various diseases were described before the section of zoology, and are here summarised separately from the general report of the proceedings of the section, which will appear in another issue of NATURE.

Mr. A. E. Shipley, F.R.S., on behalf of Dr. Elliot Smith, gave a brief account of Looss's observations on *Ankylostoma duodenale* (miner's worm), and directed attention to the series of preparations sent by Prof. Looss from Cairo illustrative of his recent work. The male and female of this worm are found hanging in numbers to the intestinal walls of the man affected, and produce enormous numbers of eggs, which are discharged from the body. These give rise to small active worm-like larvæ which live in mud, and enter the body of man either along with food or through the skin, which they can penetrate without causing any visible lesion of the part. They then enter the lymph- and blood-vessels, are swept into the circulation, and eventually reach the lungs, where they pass from the blood-vessels into the air cavities. From the time the larvæ perforate the skin until they reach the lungs they remain the same size, but as soon as they reach the air vesicle they begin to grow rapidly. They pass into the bronchioles, up the bronchi and trachea, and, emerging through the glottis, pass down the œsophagus to the duodenum, where they become sexually mature. The bare-footed races of the tropics and subtropics, both in the Old World and America, are widely and generally infected with this worm, which produces severe anæmia, often ending in the death of the host.

Mr. G. P. Bidder pointed out the great economic importance of Looss's researches. He stated that experts now believed the majority of cases in the Cornish tin mines were due to infection of the bare shoulders, arms and hands, through coming into contact with some polluted surface in the mine. Against such infection, cleanliness in feeding, which has been recommended as the principal precaution, is of no avail. The question is a serious one, as the disease is grave, and there are half a million men working in our coal mines. Though as many as 80 per cent. of the men were affected in some Continental mines, the disease does not at present exist in British collieries; but in many of these there are those conditions of temperature and humidity which would be favourable to its propagation.

Prof. Simmers (Cairo) commented on the paper from an experience of thousands of cases. Nothing resembling the "miners' bunches" which have been described as occurring in Cornwall has been met with in Cairo. Looss's experiments on puppies point to a definite toxic effect on the tissues penetrated by the larvæ. A remarkable feature about the adult parasite is the absence of any wounds or bleeding on the intestinal wall to which it adheres. The muscular mouth of the worm appears to draw up the tissues into a sort of bell, and at the same time to secrete into the blood some substance which has the power of breaking up the constituents of the blood, so causing the peculiar anæmia.

Prof. G. N. Calkins gave to the section an account of his work on *Cytoryctes variolae*, Guarnieri, the organism of small-pox. After the inoculation of a rabbit's cornea with vaccine virus, Guarnieri (1892) found in the cells peculiar homogeneous structures of diverse form and size, and regarded them as Protozoa. Pathologists, however, do not accept this conclusion, as the "Guarnieri bodies" have no apparent structure, and cannot be cultivated on artificial media. Prof. Calkins considered these objections were dispelled by the experiments of Wasielewsky (1901), who vaccinated a rabbit with a small quantity of virus; from this a second rabbit was vaccinated, from the latter a third, and so on until forty-seven had been successfully inoculated. In all the rabbits the "Guarnieri bodies" were found, and Prof. Calkins believes they had undergone growth and multiplication—the attributes of a living organism. In 1902 Councilman discovered, in addition to the usual bodies in the cytoplasm, peculiar and definite bodies in the nuclei of skin-cells infected with small-pox. Prof. Calkins has worked over this material (from fifty-five cases), and has formulated a life-history. The first appearance of the organism in the human skin is a minute homogeneous spherule which enlarges and differentiates into two substances, one destined to give rise to the multiplication elements, the other forming an enveloping matrix. The organism increases in size until it is larger than the cell nucleus. The gemmules repeat the cycle again and again, thus giving rise to auto-infection of the vaccinia type. In later stages the gemmules enter the nucleus, where they develop into two kinds of structures, possibly male and female gametocytes. From the latter a sporoblast stage arises, the sporoblasts increase in size, and ultimately give rise to spores. Meantime, the nuclear membrane has been ruptured and the sporoblasts liberated. The spores are hollow spherules 0·5μ in diameter. Spores may be found scattered in the cytoplasm and in the nucleus, but it is only in the latter that they can develop further.

After Mr. J. J. Lister, F.R.S., had commented on the apparent absence of a definite nucleus, Dr. S. Monckton Copeman, F.R.S., mentioned that in a paper by Dr. Gustav Mann and himself (1898–9) practically all the features described by Prof. Calkins are shown, but that their interpretations are entirely different. They regarded the "Guarnieri bodies" as masses of nucleo-proteid material which have been extruded into the perinuclear space as the result of specific irritation, and it is noteworthy that these bodies are all found, in cases of inoculated variola or vaccinia, on the side of the nucleus *remote* from the point of inoculation, whereas the reverse might be expected if they were Protozoa. Similar appearances have been described by Pfeiffer and others in carcinoma, sarcoma, chicken-pox, and various vesicular skin diseases, all of which diseases cannot be due to the same specific agent. The specific zymotic disease which in all respects—period of inoculation, progress, affection of the skin and mucous membranes, production of immunity, &c.—most closely resembles small-pox, viz. enteric or typhoid fever, is now acknowledged to be a bacillary disease, and there would seem to be reason for believing small-pox to be due to an invasion of the system by a similar organism. Dr. Copeman considers that the small bacillus, which he demonstrated at the Liverpool meeting, which stains with great difficulty and cannot be grown on any of the ordinary laboratory media, represents the specific virus of small-pox and vaccinia.

Dr. J. A. Murray, of the Imperial Cancer Research Fund, read to the section a paper on the biological significance of certain aspects of the general pathology of cancer. He stated that both benign and malignant new growths increase their characteristic parenchyma entirely from their own resources, and there is no evidence of the transformation of the original tissue into malignant tissue, although the latter may be indistinguishable histologically from that among which it takes its origin. The cells increase by division; amitosis does occur, but mitotic division is much more common in fully developed tumours. Multipolar mitoses are common. The active growth and extension of the malignant tissue as manifested at the growing surfaces of a malignant new growth, are effected by cell divisions which, so far as they are mitotic, conform to the ordinary type met with in early development. The number of chromosomes entering the equatorial plate is constant in each species, and they undergo the usual longitudinal splitting. Passing from the growing margin towards the older parts of the growth, it is seen that some of the mitoses are characterised by the presence of bivalent chromosomes (heterotype), in number half that found in the younger parts. These heterotypes must be regarded as occurring late in the life-history of the cells in which they are present. The analogy of spermatogenesis suggests that the heterotype initiates a terminal phase in the life-history of the cancer cell as in the spermatocyte. While studying the changes which occur immediately after transplantation in a tumour of the mouse, nuclear changes were observed which presented a close similarity to a conjugation process. Subsequent observations (on more than 1000 tumours of all ages from three different primary sources) have tended to confirm this interpretation. Numerous secondary centres of growth are always found around the periphery of older tumours, and these secondary masses may in time outgrow that which preceded them. It is suggested that the cells which conjugate are those which have passed through a reducing division, but until the complete cycle is elucidated this must remain only a working hypothesis.

THE EVOLUTION OF THE HORSE.[1]

PROF. H. F. OSBORN referred to the three independent lines of research being carried on by Profs. Ewart, Ridgeway, and himself, and hoped that they would be able to bridge the interval which at present existed between the fossil, the historic, and the recent races of horses. He gave an account of the explorations, begun three years ago, of the American Museum, which were rendered possible by a liberal gift from the Hon. W. C. Whitney. The object of this research into the fossil history of the horse was to connect all the links between the Lower Eocene five-toed and the Lower Pleistocene one-toed horses, and to ascertain the relations of the latter to the horses, asses, and zebras of Eurasia and Africa. The first result obtained is the proof of the multiple nature of the evolution of the horse during the American Oligocene and Miocene periods. Instead of a single series, as formerly supposed, there are five—one leading to Neohipparion, the most specialised antelope-like horse which has ever been found; a second, of intermediate form, probably leading through Protohippus to Equus, as Leidy and Marsh supposed; a third leading to the Upper Miocene Hypohippus, a persistently primitive, probably forest- or swamp-living horse, with short-crowned teeth adapted to browsing rather than grazing, and with three spreading toes; this horse has recently also been found in China. A fourth and fifth line of Oligocene-Miocene horses became early extinct. This polyphyletic or multiple law is

[1] Abstracts of three addresses given in Section D of the British Association on August 23.