Geology of Cephalonia

In answer to the inquiry of your correspondent in the last number of NATURE (p. 173) I beg to inform him that the shells of the Pliocene formation in the Morea have been long since investigated, as is shown by the great and well-known work of Hörnes. And Dr. Fischer has published a list of the fossil shells from the same formation at Rhodes. These subapennine beds extend over the whole of the south of Europe. For many of those species which are still living I have given the localities of the Morea and Rhodes as fossil in the *Proceedings of the Zoological Society*. J. GWYN JEFFREYS

June 25

On the Chemical Characters of the Venom of Serpents

DR. WEIR MITCHELL calls my attention to an error in the brief notice which I wrote in NATURE recently (vol. xxviii. p. 114), on the researches into the chemical characters of snake poison conducted by him and Dr. Reichart. It is that instead of "They are unable to confirm the statement of Gautier of Paris that an alkaloid resembling a ptomaine exists in cobra poison; *or that of Prof. Wolcott Gibbs, that the poison of Crotalus yields an alkaloid*," it should be, "Prof. Wolcott Gibbs was unable to find an alkaloid." J. FAYRER

53, Wimpole Street, W., June 26

Earthquake in South-West England

I HAVE just felt and heard the shock of an earthquake. The trembling of the earth was very great and the accompanying noise very loud, comparing it with one or two other slight shocks which I have before experienced in this district. I found the time to be 1.38 p.m. The time it lasted was several seconds. It was longer and louder than an ordinary clap of thunder when the lightning is not far off. A man reports that the slates of the cow-house were made to rattle.

As I now write (2.7 p.m.) a second shock has been felt, a little less severe. The weather is very calm, sky cloudy. This place is close to Dartmoor, on the westward side, about 500 feet above the sea-level. W. F. COLLIER

Woodtown, Horrabridge, S. Devon, June 25

I BEG to inform you of the occurrence of two slight earthquake shocks here to-day, one shortly before 2 p.m., the other near half an hour later. The direction of progress seemed to be from north-west to south-east—that is along the line of the deep and narrow valley. The tremor was sufficient to cause jangling of glass and earthenware, and of the slates covering the house. The usual rumbling noise accompanied the shocks.

SAMUEL DREW

Penalla Terrace, Boscastle, Cornwall, June 25

ON WHALES, PAST AND PRESENT, AND THEIR PROBABLE ORIGIN[1]

FEW natural groups present so many remarkable, very obvious, and easily appreciated illustrations of several of the most important general laws which appear to have determined the structure of animal bodies, as those selected for my lecture this evening. We shall find the effects of the two opposing forces—that of heredity or conformation to ancestral characters, and that of adaptation to changed environment, whether brought about by the method of natural selection or otherwise—distinctly written in almost every part of their structure. Scarcely anywhere in the animal kingdom do we see so many cases of the persistence of rudimentary and apparently useless organs, those marvellous and suggestive phenomena which at one time seemed hopeless enigmas, causing despair to those who tried to unravel their meaning, looked upon as mere will-of-the-wisps, but now eagerly welcomed as beacons of true light, casting illuminating beams upon the dark and otherwise impenetrable paths through which the organism has travelled on its way to reach the goal of its present condition of existence.

[1] Lecture delivered at the Royal Institution on the evening of Friday, May 25, 1883, by Prof. Flower, LL.D., F.R.S., P.Z.S., &c.

It is chiefly to these rudimentary organs of the Cetacea and to what we may learn from them that I propose to call your attention. In each case the question may well be asked, granted that they are, as they appear to be, useless, or nearly so, to their present possessors, insignificant, imperfect, in fact *rudimentary*, as compared with the corresponding or homologous parts of other animals, are they survivals, remnants of a past condition, become useless owing to change of circumstances and environment, and undergoing the process of gradual degeneration, preparatory to their final removal from an organism to which they are only, in however small a degree, an incumbrance, or are they incipient structures, beginnings of what may in future become functional and important parts of the economy? These questions will call for an attempt at least at solution in each case as we proceed.

Before entering upon details, it will be necessary to give some general idea of the position, limits, and principal modifications of the group of animals from which the special illustrations will be drawn. The term "whale" is commonly but vaguely applied to all the larger and middle-sized Cetacea, and though such smaller species as the dolphins and porpoises are not usually spoken of as whales, they may to all intents and purposes of zoological science be included in the term, and will come within the range of the present subject. Taken all together the *Cetacea* constitute a perfectly distinct and natural order of mammals, characterised by their purely aquatic mode of life and external fishlike form. The body is fusiform, passing anteriorly into the head without any distinct constriction or neck, and posteriorly tapering off gradually towards the extremity of the tail, which is provided with a pair of lateral pointed expansions of skin supported by dense fibrous tissue, called "flukes," forming together a horizontally-placed, triangular propelling organ. The forelimbs are reduced to the condition of flattened ovoid paddles, incased in a continuous integument, showing no external sign of division into arm, forearm, and hand, or of separate digits, and without any trace of nails. There are no vestiges of hind-limbs visible externally. The general surface of the body is smooth and glistening, and devoid of hair. In nearly all species a compressed median dorsal fin is present. The nostrils open separately or by a single crescentic valvular aperture, not at the extremity of the snout, but near the vertex.

Animals of the order *Cetacea* abound in all known seas, and some species are inhabitants of the larger rivers of South America and Asia. Their organisation necessitates their life being passed entirely in the water, as on the land they are absolutely helpless; but they have to rise very frequently to the surface for the purpose of respiration. They are all predaceous, subsisting on living animal food of some kind. One genus alone (*Orca*) eats other warm-blooded animals, as seals and even members of its own order, both large and small. Some feed on fish, others on small floating crustacea, pteropods, and medusæ, while the staple food of many is constituted of the various species of Cephalopods, chiefly *Loligo* and other *Teuthidæ*, which must abound in some seas in vast numbers, as they form almost the entire support of some of the largest members of the order. With some exceptions the Cetacea generally are timid, inoffensive animals, active in their movements, sociable and gregarious in their habits.

Among the existing members of the order there are two very distinct types—the Toothed Whales, or *Odontoceti*, and the Baleen Whales, or *Mystacoceti*, which present throughout their organisation most markedly distinct structural characters, and have in the existing state of nature no transitional forms. The extinct *Zeuglodon*, so far as its characters are known, does not fall into either of these groups as now constituted, but is in some respects intermediate, and in others more resembles the generalised mammalian type.

The important and interesting problem of the origin of the Cetacea and their relations to other forms of life is at present involved in the greatest obscurity. They present no more signs of affinity with any of the lower classes of vertebrated animals than do many of the members of their own class. Indeed in all that essentially distinguishes a mammal from one of the oviparous vertebrates, whether in the osseous, nervous, vascular, or reproductive systems, they are as truly mammalian as any, even the highest, members of the class. Any supposed signs of inferiority are, as we shall see, simply modifications in adaptation to their peculiar mode of life. Similar modifications are met with in another quite distinct group of mammalia, the *Sirenia*, and also, though in a less complete degree, in the aquatic Carnivora or seals. But these do not indicate any community of origin between these groups and the Cetacea. In fact, in the present state of our knowledge, the Cetacea are absolutely isolated, and little satisfactory reason has ever been given for deriving them from any one of the existing divisions of the class more than from any other. The question has indeed often been mooted whether they have been derived from land mammals at all, or whether they may not be the survivors of a primitive aquatic form which was the ancestor not only of the whales, but of all the other members of the class. The materials for—I will not say solving—but for throwing some light upon this problem, must be sought for in two regions—in the structure of the existing members of the order, and in its past history, as revealed by the discovery of fossil remains. In the present state of science it is chiefly on the former that we have to rely, and this therefore will first occupy our attention.

One of the most obvious external characteristics by which the mammalia are distinguished from other classes of vertebrates is the more or less complete clothing of the surface by the peculiar modification of epidermic tissue called hair. The Cetacea alone appear to be exceptions to this generalisation. Their smooth, glistening exterior is, in the greater number of species, at all events in adult life, absolutely bare, though the want of a hairy covering is compensated for functionally by peculiar modifications of the structure of the skin itself, the epidermis being greatly thickened, and a remarkable layer of dense fat closely incorporated with the tissue of the derm or true skin; modifications admirably adapted for retaining the warmth of the body, without any roughness of surface which might occasion friction and so interfere with perfect facility of gliding through the water. Close examination, however, shows that the mammalian character of hairiness is not entirely wanting in the Cetacea, although it is reduced to a most rudimentary and apparently functionless condition. Scattered, small, and generally delicate hairs have been detected in many species, both of the toothed and of the whalebone whales, but never in any situation but on the face, either in a row along the upper lip, around the blowholes or on the chin, apparently representing the large, stiff "vibrissæ" or "whiskers" found in corresponding situations in many land mammals. In some cases these seem to persist throughout the life of the animal; more often they are only found in the young or even the fœtal state. In some species they have not been detected at any age.

Eschricht and Reinhardt counted in a new-born Greenland Right Whale (*Balæna mysticetus*) sixty-six hairs near the extremity of the upper jaw, and about fifty on each side of the lower lip, as well as a few around the blowholes, where they have also been seen in *Megaptera longimana* and *Balænoptera rostrata*. In a large Rorqual (*Balænoptera musculus*), quite adult and sixty-seven feet in length, stranded in Pevensey Bay in 1865, there were twenty-five white, straight, stiff hairs about half an inch in length, scattered somewhat irregularly on each side of the vertical ridge in which the chin terminated, extending over a space of nine inches in height and two and a half inches in breadth. The existence of these rudimentary hairs must have some significance beyond any possible utility they may be to the animal. Perhaps some better explanation may ultimately be found for them, but it must be admitted that they are extremely suggestive that we have here a case of heredity or conformation to a type of ancestor with a full hairy clothing, just on the point of yielding to complete adaptation to the conditions in which whales now dwell.

In the organs of the senses the Cetacea exhibit some remarkable adaptive modifications of structures essentially formed on the Mammalian type, and not on that characteristic of the truly aquatic Vertebrates, the fishes, which, if function were the only factor in the production of structure, they might be supposed to resemble.

The modifications of the organs of sight do not so much affect the eyeball as the accessory apparatus. To an animal whose surface is always bathed with fluid, the complex arrangement which mammals generally possess for keeping the surface of the transparent cornea moist and protected, the movable lids, the nictitating membrane, the lacrymal gland, and the arrangements for collecting and removing the superfluous tears when they have served their function cannot be needed, and hence we find these parts in a most rudimentary condition or altogether absent. In the same way the organ of hearing in its essential structure is entirely mammalian, having not only the sacculi and semicircular canals common to all but the lowest vertebrates, but the cochlea, and tympanic cavity with its ossicles and membrane, all, however, buried deep in the solid substance of the head; while the parts specially belonging to terrestrial mammals, those which collect the vibrations of the sound travelling through air, the pinna and the tube which conveys it to the sentient structures within are entirely or practically wanting. Of the pinna or external ear there is no trace. The meatus auditorius is certainly there, reduced to a minute aperture in the skin like a hole made by the prick of a pin, and leading to a tube so fine and long that it cannot be a passage for either air or water, and therefore can have no appreciable function in connection with the organ of hearing, and must be classed with the other numerous rudimentary structures that whales exhibit.

The organ of smell, when it exists, offers still more remarkable evidence of the origin of the Cetacea. In fishes this organ is specially adapted for the perception of odorous substances permeating the water; the terminations of the olfactory nerves are spread over a cavity near the front part of the nose, to which the fluid in which the animals swim has free access, although it is quite unconnected with the respiratory passages. Mammals, on the other hand, smell substances with which the atmosphere they breathe is impregnated; their olfactory nerve is distributed over the more or less complex foldings of the lining of a cavity placed in the head, in immediate relation to the passages through which air is continually driven to and fro on its way to the lungs in respiration, and therefore in a most favourable position for receiving impressions from substances floating in that air. The whalebone whales have an organ of smell exactly on the mammalian type, but in a rudimentray condition. The perception of odorous substances diffused in the air, upon which many land mammals depend so much for obtaining their food, or for protection from danger, can be of little importance to them. In the more completely modified Odontocetes the olfactory apparatus, as well as that part of the brain specially related to the function of smell is entirely wanting, but in both groups there is not the slightest trace of the specially aquatic olfactory organ of fishes. Its complete absence and the vestiges of the aërial organ of land mammals found in the Mystacocetes are the clearest possible indications of the origin of the Cetacea from air-breathing and air-smelling terrestrial

mammalia. With their adaptation to an aquatic mode of existence, organs fitted only for smelling in air became useless, and so have dwindled or completely disappeared. Time and circumstances have not permitted the acquisition of anything analogous to the special aquatic smelling apparatus of fishes, the result being that whales are practically deprived of whatever advantage this sense may be to other animals.

It is characteristic of the greater number of mammalia to have their jaws furnished with teeth having a definite structure and mode of development. In all the most typical forms these teeth are limited in number, not exceeding eleven on each side of each jaw, or forty-four in all, and are differentiated in shape in different parts of the series, being more simple in front, broader and more complex behind. Such a dentition is described as "heterodont." In most cases also there are two distinct sets of teeth during the lifetime of the animal, constituting a condition technically called "diphyodont."

All the Cetacea present some traces of teeth, which in structure and mode of development resemble those of mammals, and not those of the lower vertebrated classes, but they are always found in a more or less imperfect state. In the first place, at all events in existing species, they are never truly heterodont, all the teeth of the series resembling each other more or less or belonging to the condition called "homodont," and not obeying the usual numerical rule, often falling short of, but in many cases greatly exceeding it. The most typical Odontocetes, or toothed whales, have a large number of similar, simple, conical, recurved, pointed teeth, alike on both sides and in the upper and under jaws, admirably adapted for catching slippery, living prey, such as fish, which are swallowed whole without mastication. In one genus (*Pontoporia*) there may be as many as sixty of such teeth on each side of each jaw, making 240 in all. The more usual number is from twenty to thirty. These teeth are never changed, being "monophyodont" and they are, moreover, less firmly implanted in the jaws than in land mammals, having never more than one root, which is set in an alveolar socket which is generally wide and loosely fitting, though perfectly sufficient for the simple purpose which the teeth have to serve.

Most singular modifications of this condition of dentition are met with in different genera of toothed whales, chiefly the result of suppression, sometimes of suppression of the greater number, combined with excessive development of a single pair. In one large group, the Ziphioids, although minute rudimentary teeth are occasionally found in young individuals, and sometimes throughout life, in both jaws, in the adults the upper teeth are usually entirely absent, and those of the lower jaw reduced to two, which may be very large and projecting like tusks from the mouth, as in *Mesoplodon*, or minute and entirely concealed beneath the gums, as in *Hyperoodon*,—an animal which is for all practical purposes toothless, yet in which a pair of perfectly formed though buried teeth remain throughout life, wonderful examples of the persistence of rudimentary and to all appearance absolutely useless organs. Among the *Delphinidæ* similar cases are met with. In the genus *Grampus* the teeth are entirely absent in the upper, and few and early deciduous in the lower jaw. But the Narwhal exceeds all other Cetaceans, perhaps all other vertebrated animals, in the specialisation of its dentition. Besides some irregular rudimentary teeth found in the young state, the entire dentition is reduced to a single pair, which lie horizontally in the upper jaw, and both of which in the female remain permanently concealed within the bone, so that this sex is practically toothless, while in the male the right tooth usually remains similarly concealed and abortive, and the left is immensely developed, attaining a length equal to more than half that of the entire animal, projecting horizontally from the head in the form of a cylindrical or slightly tapering pointed tusk, with the surface marked by spiral grooves or ridges.

The meaning and utility of some of these strange modifications it is impossible, in the imperfect state of our knowledge of the habits of the Cetacea, to explain, but the fact that in almost every case a more full number of rudimentary teeth is present in early stages of existence, which either disappear, or remain as concealed and functionless organs, points to the present condition in the aberrant and specialised forms as being one derived from the more generalised type, in which the teeth were numerous and equal.

The Mystacocetes, or Whalebone Whales, are distinguished by entire absence of teeth, at all events after birth. But it is a remarkable fact, first demonstrated by Geoffrey St. Hilaire, and since amply confirmed by Cuvier, Eschricht, Julin, and others, that in the fœtal state they have numerous minute calcified teeth lying in the dental groove of both upper and lower jaws. These attain their fullest development about the middle of fœtal life, after which period they are absorbed, no trace of them remaining at the time of birth. Their structure and mode of development has been shown to be exactly that characteristic of ordinary mammalian teeth, and it has also been observed that those at the posterior part of the series are larger, and have a bilobed form of crown, while those in front are simple and conical, a fact of considerable interest in connection with speculations as to the history of the group.

It is not until after the disappearance of these teeth that the baleen, or whalebone, makes its appearance. This remarkable structure, though, as will be presently shown, only a modification of a part existing in all mammals, is, in its specially developed condition as baleen, peculiar to one group of whales. It is therefore perfectly in accord with what might have been expected, that it is comparatively late in making its appearance. Characters that are common to a large number of species appear early, those that are special to a few, at a late period; alike both in the history of the race and of the individual.

Baleen consists of a series of flattened, horny plates, several hundred in number, on each side of the palate, separated by a bare interval along the middle line. They are placed transversely to the long axis of the palate, with very short spaces between them. Each plate or blade is somewhat triangular in form, with the base attached to the palate, and the apex hanging downwards. The outer edge of the blade is hard and smooth, but the inner edge and apex fray out into long, bristly fibres, so that the roof of the whale's mouth looks as if covered with hair, as described by Aristotle. The blades are longer near the middle of the series, and gradually diminish near the front and back of the mouth. The horny plates grow from a dense fibrous and highly vascular matrix, which covers the palatal surface of the maxillæ, and which sends out lamellar processes, one of which penetrates the base of each blade. Moreover, the free edge of these processes is covered with very long vascular thread-like papillæ, one of which forms the central axis of each of the hair-like epidermic fibres of which the blade is mainly composed. A transverse section of fresh whalebone shows that it is made up of numbers of these soft vascular papillæ, circular in outline, each surrounded by concentrically arranged epidermic cells, the whole bound together by other epidermic cells, which constitute the smooth cortical (so-called "enamel") surface of the blade, and which, disintegrating at the free edge, allows the individual fibres to become loose and to assume the hair-like appearance spoken of before These fibres differ from hairs in not being formed in depressed follicles in the enderon, but rather resemble those of which the horn of the rhinoceros is composed. The blades are supported and bound together for a certain

distance from their base, by a mass of less hardened epithelium, secreted by the surface of the palatal membrane or matrix of the whalebone in the intervals of the lamellar processes. This is the "intermediate substance" of Hunter, the "gum" of the whalers.

The function of the whalebone is to strain the water from the small marine mollusks, crustaceans, or fish upon which the whales subsist. In feeding they fill the immense mouth with water containing shoals of these small creatures, and then, on their closing the jaws and raising the tongue, so as to diminish the cavity of the mouth, the water streams out through the narrow intervals between the hairy fringe of the whalebone blades, and escapes through the lips, leaving the living prey to be swallowed. Almost all the other structures to which I am specially directing your attention, are, as I have mentioned, in a more or less rudimentary state in the Cetacea ; the baleen, on the other hand, is an example of an exactly contrary condition, but an equally instructive one, as illustrating the mode in which nature works in producing the infinite variety we see in animal structures. Although appearing at first sight an entirely distinct and special formation, it evidently consists of nothing more than the highly modified papillæ of the lining membrane of the mouth, with an excessive and cornified epithelial development.

The bony palate of all mammals is covered with a closely-adhering layer of fibrovascular tissue, the surface of which is protected by a coating of non-vascular epithelium, the former exactly corresponding to the derm or true skin, and the latter to the epiderm of the external surface of the body. Sometimes this membrane is perfectly smooth, but it is more often raised into ridges, which run in a direction transverse to the axis of the head, and are curved with the concavity backwards ; the ridges moreover do not extend across the middle line, being interrupted by a median depression or *raphé*. Indications of these ridges are clearly seen in the human palate, but they attain their greatest development in the Ungulata. In oxen, and especially in the giraffe, they form distinct laminæ, and their free edges develope a row of papillæ, giving them a pectinated appearance. Their epithelium is thick, hard, and white, though not horny. Although the interval between the structure of the ridges in the giraffe's palate and the most rudimentary form of baleen at present known is great, there is no difficulty in seeing that the latter is essentially a modification of the former, just as the hoof of the horse, with its basis of highly developed vascular laminæ and papillæ, and the resultant complex arrangement of the epidermic cells, is a modification of the simple nail or claw of other mammals, or as the horn of the rhinoceros is only a modification of the ordinary derm and epiderm covering the animal's body differentiated by a local exuberance of growth.

(*To be continued.*)

THE PERAK TIN-MINES[1]

THIS interesting memoir, which forms part of the *Archives des Missions scientifiques et littéraires*, série iii. vol. ix., gives the result of a seven months' exploration of the Malay State of Perak, made by the author, who was sent by the French Government upon a mission of scientific inquiry into the Malay Archipelago in 1881. Perak, although an insignificant unit among even the smallest States of the world, its extreme dimensions being only 95×50 miles, or an area of less than 5000 square miles, has long been known as a tin-producing country, being mentioned in the narratives of Tavernier, and the Dutch and Portuguese navigators of the seventeenth century ; but it is only since the large influx of Chinese miners, consequent upon the suppression of the Taeping rebellion, that it has become of first-rate importance. The success attained by the first-comers led to a rapid increase of the Chinese population, who arrived in such numbers as to be soon beyond the control of the feeble Malay Government, and the mining being carried on without any regulations as to boundaries, the miners became divided into two parties, who made war upon each other with varying success, the Sultan looking on impartially during the contest, but siding with the winners. The defeated party in 1872 having taken to piracy at sea, was suppressed by English gunboats, and a resident was appointed for the purpose of keeping order ; but the Malays having revolted in 1875, when the resident was murdered, the country has since been placed under a British protectorate, with a native rajah, under the title of Regent. This has been attended with the happiest results, the country having made great progress during the last six years, under the vigorous and enlightened management of the resident, Hugh Low, Esq., C.M.G., and now bids fair, according to the author, to become the most considerable producer of tin in the world.

The mines worked up to the present are entirely alluvial or stream works, the watercourses being filled with sand and gravel deposits to a depth of 20 or 30 feet, resting upon a floor of pure china clay, apparently derived from the decomposition of the granitic rocks forming the numerous parallel ridges which traverse the country from north to south. The geological description is necessarily imperfect owing to the dense tropical vegetation which covers the entire county ; but the author has been able to establish the presence of numerous quartz veins traversing the granites which are coarsely porphyritic in the centre and largely charged with tourmaline at the edges of the masses, in fact reproducing the phenomena observed in the north-western tin districts of Cornwall. No mines have as yet been opened in any of these veins, but the author speaks of blocks of tin ore weighing more than 1 cwt. as having been found in the immediate vicinity of the hills, which are evidently not far removed from their original position. The bulk of the production is, however, derived from smaller rounded crystalline masses and grains contained in the lower part of the alluvial gravel, the workable thickness ranging from 7 to 10 feet, and the proportion of clean ore or "black tin" from about 1 to 4½ per cent. by weight. This is remarkable for its purity, being almost entirely free from wolfram, arsenic, and other foreign substances, which are so troublesome to the Cornish tin-miner. The methods of working, mechanical preparations, and smelting of the ore are of the simplest possible kind, the work, with the exception of a few centrifugal steam-pumps, and of Chinese chain-pumps driven by water-wheels, being entirely carried out by manual labour, with furnaces and other appliances of the most primitive types. This simplicity adds considerably to the interest of the author's detailed and carefully illustrated description, which enables the reader to realise in imagination the conditions prevailing in our western districts in the days when the Phœnicians traded with the Cornish miners for tin at St. Michael's Mount. Under the new British rule, the country has made rapid progress, the output of tin having risen from 2059 tons in 1876 to 5994 tons in 1881, the whole of which is exported through Penang. As at the latter date the cost of production, including revenue charges of about 17*l.*, was estimated at about 61*l.* per ton, while the local selling price was 88*l.*, showing a profit of 45 per cent., the popularity of the business is sufficiently explained. It is not probable, however, that such large profits will continue to be realised after the more productive deposits have been exhausted. It does not appear from the narrative that European labour of any kind is employed, the workpeople belonging to three races, namely, Malay aborigines, Klings or coolies from Madras and the Malabar coast, and Chinese, the latter supplying the whole of the miners, smelters

[1] "Les Mines d'Étain de Perak." Par J. Errington de la Croix. 8vo. Paris, 1882.)