Professor Owen in the subsequent memoir. From the basin of Fort Beaufort to near the southern foot of the Winterberg range (which is about 90 miles inland) the same beds appear to be continuous, but they are interstratified with beds of greenstone which also occasionally intersect them.

The Winterberg peak (between 5,000 and 6,000 feet high) is a flat tabular mass of basalt. Several hundred miles to the westward of the peak a region extends of horizontal sandstone capped on the eminences by basalt and intersected by numerous basaltic dykes. A similar region extends to the north of the peak. Here again reptilian fossils have been discovered, and they have also been brought from the country far to the north beyond the Orange River. Ammonites have been found at the summit of the Compass-berg 150 miles N.W. of the Winterberg.

The author does not venture to decide on the geological age of the formations he thus describes, but proceeds in conclusion to allude to some overlying deposits found near the southern coast of Albany, one of which is a red sandstone conglomerate, entirely without fossils and resting unconformably on the supposed carboniferous sandstone: others are distinctly tertiary, and abound in shells resembling those of animals still living on the South African coast. A thick diluvial deposit is found near Fort Beaufort, and from the plains far to the northward beyond the Orange river the fossil skull of a kind of buffalo has been obtained.

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2. *Description of certain Fossil Crania, discovered by* A. G. Bain, Esq., *in Sandstone Rocks at the South-eastern Extremity of Africa, referable to different Species of an extinct Genus of Reptilia* (Dicynodon), *and indicative of a new Tribe or Sub-order of* Sauria. By Richard Owen, Esq., F.R.S., F.G.S., &c.*

The most remarkable character in these fossils is the presence of two long curved and sharp-pointed tusks, which, like those of the Walrus, descend one from each superior maxillary bone, and pass on the outside of the fore part of the lower jaw, a character rare even in Mammals, and hitherto only met with in that class; but in these specimens combined with a structure of the cranium, proving that the animals belonged to the class Reptilia, but were members neither of the Crocodilian nor Chelonian orders. The Lacertine Sauria offer characters for comparison, but the minor deviations from the ordinary Lacertian structure are so numerous, the mode in which Crocodilian and Chelonian characters are interwoven upon an essentially Lacertian base is so interesting, and the individual and distinctive characters of the Dicynodons so striking and peculiar as to require a detailed osteological description for their complete illustration.

* Transactions of the Geological Society of London, 2d series, vol. vii. p. 59.

In these animals, the Crocodilian structure is chiefly manifested in the occipital region of the skull, and gives place to the Lacertian characters in the upper and fore part ; but in regard to these deviations it must be remembered, that the distinctive features of the Crocodilian type are most broadly manifested in the existing representatives of the order, and are modified and rendered less salient in the more numerous and varied extinct members.

It is necessary to bear in mind this tendency to the amalgamation of Crocodilian and Lacertian characters in the older Loricata, in order to form a right estimate of the value of those correspondences with the cranial peculiarities of the existing Lacertians.

Nevertheless, various characters justify the conclusion, that the general type of cranial organisation manifested by modern lizards was that in which the peculiar modifications of the Dicynodon have been superinduced. It is not, however, amongst the modern lizards that we find the nearest approximation to the Dicynodon. For this we must go as far back into the period of Reptilian life on this planet as the epoch of the new red sandstone, when the *Rhynchosaurus* manifested the Lacertian type of skull, combined with toothless jaws, which were most probably sheathed with horn. What concerns us most in the present inquiry is the anomalous edentulous sharp edge of the upper and lower jaws in the ancient Rhynchosaur, and the Chelonian form of the deep lower jaw, the same anomaly having been repeated in the extinct African lizard of apparently as remote a period, with the superaddition of Mammalian canine tusks. For the rest, much difference of form is manifested in the two extinct genera; but it is interesting to remark the same peculiar contraction of the cranial cavity, indicating an arrested developement of brain in both of them. The dental peculiarity of the African Saurian forms its chief distinction from the Rhynchosaurus, as from all other Sauria : but with the strange superaddition of its two canine tusks, we must bear in mind that the affinities linking the Dicynodon to Crocodilians and Chelonians are much more strongly manifested than they are in the Rhynchosaurus.

The author, in concluding his account of the Dicynodon, adverts to the analogy of structure, which radiates from this genus in the direction of the Ophidian division of existing Reptilia, although it is unsupported by any other concordances of cranial or dental organisation than those about to be cited. In the poisonous serpents, the rattle-snakes for example, the intermaxillary bone is single and edentulous; the maxillary bone supports a long, curved, pointed tooth, which, when advanced, descends outside the lower jaw. Apart from all the other peculiarities of the maxillary and dental systems of the poison-snakes, they alone, of all existing Reptilia, repeat, in the above-cited structures, the characters of the Dicynodon. But, in addition to the two large maxillary teeth, the rattle-snake has smaller

teeth in rows upon the palatine, pterygoid and mandibular bones. To complete the resemblance between the tusks of the Dicynodon and the venom fangs of the snake, you must deeply groove their fore-part, or bore a canal through their centre; you must remove those strong columns of bone which converge to, abut against, and strengthen the fixed socket of the tusk, and you must suspend the maxillary bone by a moveable pedicle to the pre-frontal and malar bones. Besides, the perforated tusk of the poisonous serpent is always followed by one or more similar teeth, in various stages of growth, ready to supply its place, according to the general law of the maintenance in serviceable state of the dental armature of the jaws throughout the Reptilian class.

The canine tusk of the Dicynodon consists of a simple body of compact unvascular dentine, with a very thin outer coat of enamel, which may be traced into the alveolus for a short distance. Rather more than one-third of the tusk is lodged in the socket, the basal conical pulp-cavity is continued from the base about one-half down the implanted part of the tusk, and a linear continuation extends along the centre of the rest of the tusk, from which the dentinal tubes of the solid body of the tusk radiate. They present gentle parallel secondary curves or undulations throughout their course, divide dichotomously twice or thrice near their beginnings, and send off numerous small lateral branches, chiefly, but not exclusively, from the side next the apex.

The principal difference in the microscopic texture of the tusks of the Dicynodon, as compared with the teeth of the crocodile, consists in the closer and more compact arrangement of the calcigerous tubes of the dentine; by which character it makes a closer approach to the intimate texture of that tissue in the canine teeth of the carnivorous Mammalia.

In the other Reptilia, recent or extinct, which most nearly approach the Mammalia in the structure of their teeth, the difference characteristic of the inferior and cold-blooded class is manifested in the shape, and in the system of shedding and succession of the teeth. The dental armature of the jaws is kept in serviceable order by uninterrupted change and succession; but the matrix of the individual tooth is soon exhausted, and the life of the tooth itself may be said to be comparatively short. Evidence of this low organised dental condition, common to fishes, has been obtained in every reptile, in which the implanted base of the teeth has been examined by the author.

The existing Lacertians superadd to this endless shedding and succession of teeth, the ichthyic character of anchylosis of the base of the teeth in use to the osseous substance of the jaw; so that in the *Rhynchocephalus* and other acrodont lizards, the teeth appear like small enamelled processes of the alveolar border. The Dicynodons not only manifest the higher type of free implantation of the base of the tooth in a deep and complete socket, common to Crocodilians, Megalosaurs, and Thecodonts, but make an additional

and much more important step towards the Mammalian type of dentition by maintaining the serviceable state of the tusk by virtue of constant renovation of the substance of one and the same matrix, according to the principle manifested in the long-lived and ever-growing tusks and scalpriform incisors of the Mammalia. This endowment of the teeth of a reptile is far more remarkable and unexpected than the more obvious character of the size and shape of the long exserted tusks themselves, superadded as they are, and in such strange combination, with the otherwise edentulous jaws of a bird or turtle. Yet if we consider the fact in its relations to the exigencies and convenience of the living animal, the wisdom and beneficence of the principle is apparent, and the departure from the ordinary rule manifests a power transcending the trammels of scientific system. The teeth of the Dicynodon being but two in number, and their use to the animal indicated by their unusual size to be of unusual importance, the inconvenience and detriment that must have ensued from frequent shedding and replacement is very obvious; we may readily conceive it to have been incompatible with their functions, and therefore abrogated in favour of another mode of renovation which is abnormal in reptiles, simply, perhaps, because the form, proportions, and function of such tusks were unique, and are now no longer manifested in a cold-blooded class.

Some observations may be naturally expected in reference to the probable use of the tusks to the Dicynodons, and the mode of life of those ancient and most remarkable saurians. In the Mammalian class, where alone we now find the analogous instruments, tusks are usually given as weapons of offence and defence, — an office exemplified in the hornless musk-deer, the boar, and in the large canine teeth of the Carnivora. The elephants use their tusks chiefly, though not exclusively, as lethal weapons: the Walrus is said to apply his tusks to aid in clambering over icebergs, as well as in combat and defence: the Dugong is supposed to wear the exserted points of the tusks in detaching fuci for food. Such an office at first suggests itself as a very probable one in regard to tusks descending, like those of the Dugong, from the upper jaw, and combined with edentulous and probably horny mandibles like those of a fucivorous turtle.

On inspecting the remains and the impressions of the tusks in the fossils under consideration, and especially in the almost entire skull of one species, the *Dicynodon lacerticeps*, we perceive that these weapons are sharp-pointed, and present no trace of that obliquely bevelled or chisel-shaped extremity which is produced by habitual application in acts of obtaining daily food, as, for example, in the protruded extremities of the tusks of the Dugong and the incisors of the Rodents. The tusks of the Dicynodon, though similar, in their origin from maxillary bones and downward direction, to the tusks of the Walrus, are so much shorter, at least in the single specimen in which their entire length is shown, that they could not be available in locomotion. I conclude therefore from their shape, pro-

portional length, sharp points and dense texture, that the tusks of the Dicynodon were applied by the living animal either for the purpose of killing its prey, or of defending itself from its foes, or in both acts; and that they were offensive and defensive arms.

A further insight into the habits and mode of life of the Dicynodons may reasonably be expected to follow the examination of the skeleton of the trunk and the organs of locomotion. This will form the subject of a subsequent memoir; but the vertebræ of the Dicynodon present the sub-biconcave structure common to most of the older extinct saurians, which structure, in comparison with the ball and socket vertebræ of the modern species, indicates a more aquatic and perhaps marine theatre of life for the amphibia which swarmed in such plenitude of development and diversity of forms during the ancient secondary periods of the geological history of this planet.

January 22. 1845.

David Walter, Esq., of Colchester, was elected a Fellow of this Society.

The following communications were read:—

1. *On the Newer Coal Formation of the Eastern Part of* Nova Scotia. By John Dawson, Esq.

In some notes communicated last year to the Geological Society, I stated the results of observations on the gypsiferous formation of Nova Scotia, tending to confirm the views of Mr. Lyell respecting the age of that series of rocks. In introducing those notes, it was stated that the carboniferous strata of this province may be included in three groups; first, the gypsiferous or mountain limestone formation; secondly, the older coal formation; and thirdly, the newer coal formation: of these the two former have almost exclusively attracted the attention of geologists, the latter having been in a great measure neglected. In connection with the Pictou coal field, however, and probably also in other parts of this and the neighbouring colonies, the newer coal formation is an extensively distributed deposit, often attaining considerable thickness, and, though not containing valuable beds of coal, ironstone, or gypsum, yet so associated with the rocks including these minerals, that a knowledge of its structure and relations is essential to their satisfactory investigation. In a palæontological point of view also it possesses considerable interest; as its fossils show the continuance of the coal flora during the deposition of a series of red sandstones newer than the great coal measures; and also the co-existence of that flora with terrestrial vertebrated animals.

The coal measures of the Albion mines, on the banks of the