The Mammals, however, are by far the most important class for marking geological time, as their changes and the high degree of their specialization furnish the particular characters that are most useful to the geologist in distinguishing definite zones, and the more limited divisions of the strata containing their remains. The few mammals known from the Trias are so peculiar that they can only give us hints of what mammalian life then was, but in the Jurassic the many forms now known offer important testimony as to the different horizons in which their remains are found. This is true also of the known mammals from the Cretaceous; all are of special value as witnesses of the past.

During Tertiary time, however, the enormous development of the class of mammals, their rapid variations, and, most important of all, the highly specialized characters they develop, offer by far the best evidence of even the smaller changes of climate and environment that mark their life-history throughout. The ungulates alone will answer the present purpose as an illustration, and even one group, the horses, will make clear the point I wish to bring before you.

Near the base of the Eocene the genus *Eohippus* is found, representing the oldest known member of the horse tribe. Higher up in the Eocene *Orohippus* occurs, and still higher comes *Epihippus*, near the top of the Eocene. Again through the Miocene more genera of horses, *Mesohippus*, *Miohippus*, and others, follow in succession, and the line still continues in the Pliocene, when the modern genus *Equus* makes its appearance. Throughout this entire series, definite horizons may be marked by the genera, and even by the species of these equine mammals, as there is a change from one stage to the other, both in the teeth and feet, so that every experienced paleontologist can distinguish even fragments of these remains, and thus identify the zones in which they occur.

This is true of every group of mammals, although not to an equal extent, so that in this class we have beyond question the best means of identifying the age of Tertiary strata by their fossil remains.

I have thus briefly pointed out some of the evidence on which a decision may be reached as to the value of the different kinds of fossils, Plants, Invertebrates, and Vertebrates, in determining the age of strata. All evidence of this kind is of value, but it is the comparative value of each group that is the important point I wish to emphasize, and I have brought the matter before this Section of the Association in the hope that a better understanding on this question may be reached among geologists, in the interest of the science to which we are all devoted.

ART. LI.—*On the Families of Sauropodous Dinosauria*;* by O. C. MARSH.

THE subclass Dinosauria as known to-day, I have divided into three orders: the *Theropoda*, or carnivorous forms; the *Sauropoda*, or herbivorous quadrupedal forms; and the *Predentata*, also herbivorous, and including several suborders; namely, the *Stegosauria* and *Ceratopsia*, both quadrupedal, and the *Ornithopoda*, containing bipedal bird-like reptiles.†

The principal characters of the order *Sauropoda*, here discussed, may be briefly stated as follows:

Order SAUROPODA.

External nares at top of skull; premaxillary bones with teeth; crowns of teeth rugose, and more or less spoon-shaped; large antorbital openings; no pineal foramen; alisphenoid bones; brain case ossified; no columellæ; postoccipital bones; no predentary bone; dentary without coronoid process. Cervical ribs coössified with vertebræ; anterior vertebræ opisthocœlian, with neural spines bifid; posterior trunk vertebræ united by diplosphenal articulation; presacral vertebræ hollow; each sacral vertebra supports its own sacral rib, or transverse process; no diapophyses on sacral vertebræ; neural canal much expanded in sacrum; first caudal vertebra biconvex; anterior caudals procœlian. Sternal bones parial; sternal ribs ossified. Ilium expanded in front of acetabulum; pubes projecting in front, and united distally by cartilage; no postpubis. Limb bones solid; fore and hind limbs nearly equal; metacarpals longer than metatarsals; femur longer than tibia; astragalus and calcaneum not fitted to end of tibia; feet plantigrade, ungulate; five digits in manus and pes; second row of carpal and tarsal bones unossified; locomotion quadrupedal.

(1) Family *Atlantosauridæ*. A pituitary canal; large fossa for nasal gland. Distal end of scapula not expanded; coracoid quadrilateral. Sacrum hollow; ischia directed downward, with expanded extremities meeting on median line. Anterior caudal vertebræ short, with lateral cavities; remaining caudals solid; chevrons single.

Genera *Atlantosaurus*, *Apatosaurus*, *Brontosaurus*. Include the largest known land animals. Jurassic, North America.

* Abstract of Communication made to Section D, British Association for the Advancement of Science, Bristol Meeting, September 12, 1898.

† The Dinosaurs of North America, Sixteenth Annual Report, U. S. Geological Survey. 84 plates. Washington, 1896.

(2) Family *Diplodocidæ.* External nares at apex of skull; no depression for nasal gland; two antorbital openings; large pituitary fossa; dentition weak, and in front of jaws only; brain inclined backward; dentary bone narrow in front. Scapula with shaft somewhat enlarged at summit. Ischia with shaft expanded distally, directed downward and backward, with sides meeting on median line. Sacrum hollow, with three coössified vertebræ. Anterior caudal vertebræ procœlian, with sides deeply excavated, and chevrons single; median caudals excavated below, with chevrons double, having both anterior and posterior branches; distal caudals elongate, with rodlike chevrons.

Genera *Diplodocus* and *Barosaurus.* Jurassic, North America.

(3) Family *Morosauridæ.* External nares anterior; large fossa for nasal gland; small pituitary fossa; dentary bone massive in front; teeth very large. Shaft of scapula expanded at distal end; coracoid suboval. Sacral vertebræ four in number, and nearly solid; ischia slender, with twisted shaft directed backward, and sides meeting on median line. Anterior caudals solid; chevrons single.

Genera *Morosaurus*, *Camarasaurus* (?) (Amphicœlias). Jurassic, North America and Europe.

(4) Family *Pleurocœlidæ.* Dentary bone constricted medially; teeth with crowns like those of *Diplodocus.* Cervical vertebræ elongate, centra hollow, with large lateral openings; sacral vertebræ solid, with lateral depressions in centra; caudal vertebræ solid; anterior caudals with flat articular faces, and transversely compressed neural spines; median caudal vertebræ with neural arches on front half of centra. Ischia with compressed distal ends, and sides meeting on median line.

Genera *Pleurocœlus*, *Astrodon* (?). Jurassic, North America and Europe. Include the smallest known *Sauropoda.*

(5) Family *Cardiodontidæ.* Teeth of moderate size. Upper end of scapula expanded; humerus elongate; fore limbs nearly equaling hind limbs in length. Sacrum solid; ischia with wide distal ends, and sides meeting on median line. Caudal vertebræ biconcave; median caudals with double chevrons.

Genera *Cardiodon* (Cetiosaurus), *Bothriospondylus*, *Ornithopsis*, and *Pelorosaurus.* European, and probably all Jurassic.

(6) Family *Titanosauridæ.* Fore limbs elongate; coracoid quadrilateral. Presacral vertebræ opisthocœlian; first caudal vertebræ biconvex; remaining caudals procœlian; chevrons open above.

Genera *Titanosaurus* and *Argyrosaurus.* Cretaceous (?), India and Patagonia.

ART. LII.—*A Biotite-tinguaite Dike from Manchester by the Sea, Essex County, Mass.;* by ARTHUR S. EAKLE.

THE dike described in this paper cuts through the augite-syenite of Gales rocks, 200 yards south of Gales Point, Manchester, and was discovered in July, 1896, by Mr. J. H. Sears, while investigating the rocks of that vicinity. The writer has not seen the dike, and all of the data regarding its occurrence, and the material for the petrographical and chemical study, has been very kindly supplied by Mr. Sears. "The dike is 6 inches wide and is exposed for 20 feet, cutting the augite-syenite in a nearly horizontal position, six feet below the surface of the mass of syenite. It is only exposed at low water, as at high tide the entire mass of syenite is submerged." The occurrence of this ægirine dike in the immediate vicinity of the tinguaite dike at Pickards Point, which was first described by Sears* and lately shown to be an analcite-tinguaite by Washington,† might naturally lead to the supposition that the two dikes would be similar in many respects, yet both macroscopically and microscopically they are quite dissimilar rocks.

The rock has a greenish-gray color and a slightly greasy luster, like tinguaites and rocks rich in nepheline. Small phenocrysts of feldspar are visible in the somewhat compact groundmass, and also much magnetite, mixed with biotite, occurs in brownish-black patches, giving the rock a mottled appearance. The structure is compact, holocrystalline, the rock resembling a phonolite, breaking with an even fracture and weathering to a light gray color.

Under the microscope the principal constituents are seen to be feldspathic laths and plates with much nepheline and less amounts of ægirine, magnetite and biotite. Besides these prominent minerals, hematite, a little sodalite, a few apatite and zircon needles, and minute sections of purple fluorite are present.

The feldspar is the most abundant constituent and predominates in lath-shaped sections, most of which have a broken, ragged appearance, due to frayed-out ends and a fibrous structure. This fibrous appearance is evidently the result of lamellar intergrowths of the soda and potash feldspars, microcline and albite, forming microcline-microperthite. Some of the broader sections show a rather coarse intergrowth of the two feldspars, giving extinctions on different parts corresponding respectively to those of microcline and albite. The character-

* J. H. Sears, Bull. Essex Inst., vol. xxv, 4, 1893.
† This Journal, IV, vol. vi, p. 182, 1898.