the society, which by this time had built its own house at 36 George Street, Manchester, where some of the rooms were placed at the disposal of Dalton. Dalton continued to work in these rooms up to the time of his death in 1844, and it was here that the atomic theory was born. Dalton's classical essay on color-blindness, a defect from which he suffered, was communicated to the society in the year of his election. Dalton served as president of the Manchester Literary and Philosophical Society from 1817 to 1844, and at his death, his manuscripts, apparatus and personal belongings (including his spectacles, walking stick and numerous medals) were presented to the society.

Two years before Dalton's death, James Prescott Joule was elected to membership, and served as president for several terms of office during the next forty years. A tradition in experimental physics was thereby established in Manchester, which was continued by Sturgeon, Rutherford and Bragg up to the present day.

DONAL SHEEHAN

DEPARTMENT OF ANATOMY,
COLLEGE OF MEDICINE,
NEW YORK UNIVERSITY

THE AGE OF SAUROPOD DINOSAURS

AN article entitled "The Age of Jurassic Dinosaurs," by Dr. Edward W. Berry, appeared in SCIENCE, n.s., Vol. 93, No. 2416, Friday, April 18, 1941, page 374. The last paragraph of this article read as follows: "All this leads into the question of the age of the Morrison. I have expressed my opinion long ago, and wish merely to raise the question in the present connection, that if a Jurassic dinosaur (vertebrate chronology) makes footprints at a horizon near the middle of the marine Lower Cretaceous (invertebrate chronology) where do we go from here?" This article calls for elucidation.

Since the first notice was published of *Apatosaurus* (*Brontosaurus*), *Diplodocus* and other types of sauropod dinosaurs from the Morrison formation of Colorado and Wyoming, much has been written about the age of the Morrison and its fauna. At present, I believe, most vertebrate paleontologists are agreed that the Morrison fauna is of Jurassic age, but a great many discoveries relating to sauropod dinosaurs have been accumulated of late years, and much of this information has not yet been published.

In the exposures south of the Black Hills the lowest Cretaceous strata are represented by the Fuson and Lakota formations and there is a definite break between these Lower Cretaceous beds and the Jurassic below, although the vertebrate faunas in these two formations are not well known in this area.

In Montana, surrounding the Big Horn and Pryor Mountains, the Cloverly formation which is contemporaneous, probably with the combined Fuson and Lakota of the Black Hills, carries a distinct early Cretaceous vertebrate fauna whose affinity is with the late Cretaceous faunas elsewhere. American Museum expeditions worked in this region for several years continuously from 1931 to 1934 and secured a large series of skeletons of typical Cretaceous dinosaurs, Trachodonts, Nodosaurs and a new type of Iguanodont not yet described from the Cloverly formation. No sauropod skeletons were found, but a great many sauropod limb bones were seen in these beds. The same fauna was found and collected in the Cloverly formation near Harlowton, Montana, and in a few instances sauropod bones were recognized by our parties in the typical Kootenai beds near Great Falls. Some vertebrae were collected that are apparently those of *Diplodocus* although the exact generic and specific identification is hazardous. In the Big Horn region *Barosaurus* and *Morosaurus* are abundant in the Jurassic strata where there is a distinct break between the Jurassic and Lower Cretaceous beds and it is certain that sauropod dinosaurs extended through into the Lower Cretaceous, but we are not sure that they are the same genera as those found in the Jurassic strata. It is certain, however, that the abundant Lower Cretaceous dinosaur forms are not found in the Jurassic beds below.

Until recently it had been my opinion that the sauropod dinosaurs of Jurassic age died out sometime before the varied and rich fauna of Upper Cretaceous times came into existence. This opinion, however, has been altered by the results of the National Museum expeditions which have discovered sauropod dinosaurs, *Alamosaurus,* and a yet undescribed genus of sauropods in the Upper Cretaceous beds of Utah.

In the Big Bend region of Brewster County, Texas, the Chisos Mountains are surrounded by a series of alternating sands and clays that have been named the Aguja formation (Rattlesnake fm.). These beds are rich in Cretaceous dinosaur remains, for the most part disassociated and badly broken, but occasionally with identifiable specimens. The American Museum expedition of 1940 secured a fairly large collection from these beds in which there are typical Trachodont, Ceratopsian, Ankylosaurian and crocodilian remains. The genera, for the most part, are recognizable, but the species are new and the faunal facies is comparable to that of the Mesaverde and Judith River formations farther north. The area is extensive and no sauropod remains were found in this formation.

Above the Aguja and so far as could be seen conformably overlying it are the Tornillo clays. This is a series predominantly of clays 1600+ or − feet in thickness in which none of the Trachodont, Ceratopsian or

Ankylosaurian dinosaurs are to be seen, but several remains of sauropods were found—some of gigantic size. Now as the Mesaverde and Judith River formations are fairly high up in the Cretaceous series it is determined that in the south, at least, climatic conditions of Jurassic times persisted well up into the upper part of the Cretaceous age, so that sauropods definitely extended through the Morrison Jurassic well up into Cretaceous times. It is our opinion that they did not exist to the very close of the Cretaceous as represented by Lance and Hell Creek times.

There is no doubt that the Glen Rose formation of Texas is Lower Cretaceous in age and in this formation we have found the first sauropod dinosaur footprints known. These tracks, of which there are several hundred, show distinctly that there were no claws on the front feet but they were unquestionably made by sauropod dinosaurs, probably an unnamed species, some of which are as large and larger than *Brontosaurus*. Similar tracks of the same character were found in Bandera County, Texas, and they have been found also in the Panhandle of Oklahoma. It is unfortunate that the article describing these tracks infers that they were made by a *Brontosaurus*. One of the characters distinguishing the genus *Apatosaurus* (*Brontosaurus*) is a single large claw on the first digit of the front feet. No tracks of *Brontosaurus* are known, but the Glen Rose tracks were definitely made by a sauropod dinosaur closely related to and of the same size as the mounted *Brontosaurus* in the American Museum and it is proposed to place a series of these tracks under the mounted skeleton in order to show the size and stride of the feet of a similar living animal.

BARNUM BROWN
THE AMERICAN MUSEUM OF NATURAL HISTORY

WESTWARD SPREAD OF EASTERN TYPE EQUINE ENCEPHALOMYELITIS VIRUS

ON the North American continent, two types of immunologically distinct viruses of equine encephalomyelitis have been recognized, Eastern type and Western type. The areas in which these virus types have been isolated have had a sharp line of demarcation defining their boundaries in the Appalachian chain of mountains. Until 1939, these limits were without exception, but in that year a few cases of both types were isolated in the state of Alabama.

On April 29, 1941, portions of a horse brain from a civilian owned animal were received by the Veterinary School, Army Medical Center, Washington, D. C., from Colonel Clifford O. Whitney, V.C., of Fort Brown, Brownsville, Texas. The specimen originated from that area southeast of Brownsville, Texas, bordering on the Gulf of Mexico and known as the "Boca Chica flats." Sixty horses had recently been reported in this area as having died of suspected encephalomyelitis.

Accordingly, 0.1 cc of a 1–500 dilution of an emulsion of portions of the cerebrum and hippocampus from the specimen were inoculated intracerebrally into 3 normal guinea pigs. Within 72 hours all three had developed typical symptoms of encephalomyelitis, one died and two were destroyed while moribund in order to recover their brains.

A 1–500 dilution of an emulsion of portions of these 2 brains was then inoculated intracerebrally in 0.1 cc amounts into 3 groups of guinea pigs, one group immunized against the Western type virus, the second group immunized against the Eastern type and a third group of normal control animals.

The animals belonging to the Western immune type and the normal controls succumbed within less than 72 hours with typical encephalomyelitis symptoms, while the animals of the Eastern immune type remained normal.

Since the Western immune type guinea pigs were affected while the Eastern remained normal, this combined with the short incubation period (3 days instead of the usual 4 days for Western type virus) are certainly indicative of an Eastern type of encephalomyelitis virus.

From the foregoing, it would seem that the geographical limitation of the virus entities has now been broken down.

RAYMOND RANDALL
ERVIN A. EICHHORN

ARMY VETERINARY SCHOOL,
ARMY MEDICAL CENTER,
WASHINGTON, D. C.

THE "MEANING" OF SCIENCE

IT is well for every worker in science to sometimes attempt to set up for himself his concept of the broad field of his interest. I was stimulated to such inquiry by the recent statement of L. K. Frank that there is need for definition of the "meaning" of science.

Subjectively, and from the point of view of the intension of the term: Science is the data of the relations between things; between states; and between events: and of the relations between things, states and events.

Inherent in the term "things" are qualities. Inherent in the term "states" are modes and conditions of being. Inherent in the term "events" are those happenings which occupy a restricted portion of four-dimensional space-time.

There is no need to introduce the term "ordered" as a qualifier of relations since the sense of order is inherent in relation.

If by "meaning" one wishes to mean intent, pur-