ments was due to a deficiency of some of the above-mentioned elements so long overlooked. An illustration with regard to boron will serve as an example.

In a series of experiments dealing with certain potassium relations of the tomato plant, it was found impossible to obtain anything that even approximated normal growth in water cultures without the addition of a small quantity of boron. This circumstance was especially interesting since no attempt had been made to purify the ordinary C. P. chemicals used in the solutions. These observations led to a series of experiments dealing with the relation of boron to the growth of the tomato plant. It is believed that some of the results obtained are interesting enough to warrant this brief preliminary paper. Both the appearance of the plants as well as actual measurements and analyses clearly showed boron to be absolutely essential.

Most of these experiments were carried out in the division of plant nutrition at the University of California, with the variety Santa Clara Canner. Some of the experiments have been repeated at the University of Maryland with this same variety and with Marglobe. Boron was supplied as boric acid in a concentration of 0.5 p. p. m. Plants grown in nutrient solution containing this concentration of boron grew normally and produced blossoms. Plants grown in the boron deficient solutions ceased to grow at the end of three or four weeks. In the Maryland experiments the first signs of injury were noticed after nine days. One of the early visible symptoms of boron deficiency is the blackened appearance at the growing point of the stem. New leaves and branches often start growing just below this dead portion and give to the plant a short bushy appearance. Often the leaves grow in length, but not in width. Chemical analysis in the case of the Berkeley experiments showed approximately twice as much total sugars in the leaves of the boron deficient plants as in those from normal plants grown in a similar manner, but in solutions containing boron. The leaves from the boron deficient plants also contain more starch than those from the normal plants. On the other hand, the quantity of total sugars in the stems of the boron deficient plants is only about two thirds of that in the stems of normal plants. The leaves of the boron deficient plants at College Park developed, after 13 days, a distinct purple color, probably anthocyan, which is frequently associated with an excess sugar accumulation. Another very striking characteristic of the boron deficient plants is the extreme brittleness of the leaf petioles. This brittleness is not that characteristic of turgid stems, which break with more or less snap, but it is one that may best be described as similar to the breaking of a piece of cheese.

Both the chemical analysis and later observations on an entirely different variety indicate a failure on the part of the boron deficient plants to remove sugar from their leaves. This seems to be related to a breaking down of the conducting tissues. Microscopic examinations of the petioles and stems made by Professor J. H. Priestley on a few of our plants seem to bear out this view. In the boron deficient plants the phloem was broken down and apparently gave a much more acid reaction than the corresponding regions of the normal plants.

These general conclusions are in agreement with the anatomical studies of Warington[2] on *Vicia Faba* (broad bean) grown in boron deficient solutions. She states, "The vascular bundles in particular are affected, the xylem often appearing unusually remote from the phloem or even broken up into small groups of elements . . . an unusual development of the cambium is chiefly responsible for this abnormal appearance." The phloem is described as becoming compressed or displaced and the xylem itself may degenerate. Frequently the lumen of the tracheides become completely blocked. These conditions of the broad bean seem to be very similar to those occurring in the tomato when grown in boron deficient solutions.

EARL S. JOHNSTON,
UNIVERSITY OF MARYLAND
W. H. DORE
UNIVERSITY OF CALIFORNIA

TRIASSIC VERTEBRATE FOSSILS FROM WYOMING

DURING the past summer the writers, with the able and enthusiastic assistance of Mr. N. H. Brown and his son, Newton, of Lander, Wyoming, added materially to the University of Missouri collections of vertebrate fossils from the Triassic of Wyoming. All the fossils came from the Popo Agie beds of the Chugwater formation, but from several scattered localities. Chief of these are the quarries on Bull Lake Creek and Sage Creek, Fremont County.

The collections include both reptilian and amphibian remains, the latter in much the greater abundance. Among the amphibian materials are two nearly perfect skulls similar in many respects to the specimen from Texas described by Case as *Buttneria perfecta*.[1] There is in addition a considerable part of four other skulls; at least two distinct types of clavicular girdles,

[2] Warington, Katherine, "The Changes induced in the Anatomical Structure of *Vicia Faba* by the Absence of Boron from the Nutrient Solution," *Ann. Bot. 40*: 27–42. 1926.

[1] E. C. Case, "New Reptiles and Stegocephalians from the Upper Triassic of western Texas," Carnegie Inst. Wash. Publication No. 321, pp. 13–25, 1922.

each represented by several specimens, some of which appear to be complete; several mandibles, and numerous limb bones and vertebrae. Lower jaws, limb bones and clavicles were found rather closely associated with two of the skulls.

The reptilian remains consist of several imperfect phytosaur skulls, isolated limb bones, vertebrae of several types, teeth not yet identified, and several footprints of such a nature that the stride can be determined. It is thought that the phytosaur material will clear up some of the doubtful points in two little known genera, *Palaeorhinus* Williston and *Angistorhinus* Mehl. In two of the quarries a large amount of bone remains to be excavated.

The study of this new material has progressed little beyond the point of raising again the entire question of Triassic correlations. It appears to the present writers, who have been in intimate contact with Triassic problems in one capacity or another for many years, that in correlations much stress has been placed on paleontological evidence of a very unsatisfactory nature, particularly in the use of the vertebrates. Attempts have been made to designate various horizons as Lower, Middle or Upper Triassic on the basis of "primitive" or "advanced" forms. One of the more recent of such attempts is that by Huene.[2] Here, as in an earlier and more elaborate correlation table,[3] a rather meager list of "primitive" forms, genera for the most part inadequately known and of very limited geographic range, serves to place much of the bone bearing western Triassic as equivalent to the European Muschelkalk or even lower.

In time these assumptions may prove to be well founded, but at present they seem little better than guesses without particular merit. The writers place little confidence in such long range correlations based on present vertebrate evidence and they are not entirely enthusiastic over future possibilities, the abundance of recent additions to the collections notwithstanding. In the first place, while there seems to be no great difficulty in determining primitive and advanced forms, except that the individual is often a peculiar combination of the old and the new, there is no assurance that one can differentiate between earlier and later forms by this means. On the other hand, there is evidence that during Triassic times primitive and highly specialized forms were often contemporaneous. *Acompsosaurus* Mehl, listed by Huene with the Middle Triassic forms from New Mexico and Arizona, was based on a pelvic girdle with peculiarly down-turned pubes, a character scarcely to be designated as primitive. In this particular, *Acompsosaurus* resembles Huene's phytosaur genus *Angistorhinopsis* except that in the former the down-turning is much more pronounced. *Angistorhinopsis* is found only in the uppermost Keuper.

The insecure foundations of present Triassic correlation are further evidenced by the difficulties encountered in placing the members of a single formation in a limited area. The Chugwater formation of central and southern Wyoming illustrates the point. The Jelm of southern Wyoming is commonly correlated with the Popo Agie beds of central Wyoming, apparently because both members contain vertebrate remains and because of the assumption that both are of the Upper Chugwater. So far as the writers know, dependable fossil evidence has not been found in the Jelm. During June of the past year Branson examined the Jelm with the view of obtaining identifiable fossils, but found only scraps. The Popo Agie beds are the source of the recognizable Triassic vertebrates throughout central Wyoming. As recently emphasized by Branson,[4] these beds do not form the upper part of the Chugwater of this region, but are near the middle. The Popo Agie and the Jelm are both near-shore or actual land phases of the Chugwater. The conditions recorded by these members undoubtedly existed over limited areas from time to time throughout the Chugwater, and are not evidence of contemporaneity.

The point the writers wish to emphasize is that vertebrate fossil evidence must be used with the greatest caution in Triassic correlations and that present vertebrate summaries do not lend themselves to such usage. It is the intention of the writers to publish a series of papers describing the Triassic vertebrate remains in the University of Missouri collections. At present they are preparing descriptions and summaries of the amphibians from the Triassic of Wyoming. Later, amphibian materials from New Mexico and Arizona will be included. It is hoped to present in a similar way the Triassic reptiles. As a start in this direction Mehl is preparing descriptions of the new or little known phytosaurs represented in the collections.

E. B. BRANSON
M. G. MEHL
THE UNIVERSITY OF MISSOURI

[2] F. R. von Huene, "Notes on the Age of the Continental Triassic Beds in North America with remarks on some Fossil Vertebrates," *Proc.* U. S. Nat. Mus., Vol. LXIX, pp. 1–10.

[3] "Neue Beiträge zur Kenntnis der Parasuchier," *Jahrbuch der Preussischen Geologischen Landesanstalt*, Band XLII, Heft 1, pp. 59–160, 1921.

[4] E. B. Branson, "Triassic-Jurassic 'Red Beds' of the Rocky Mountain Region," *Jour. Geol.*, Vol. XXXV, pp. 607–630, 1927.