obvious advantage of being of much lower specific gravity, in addition to being of a non-metallic material.

In the accompanying line cut, illustrating the instrument in vertical section, "D" indicates the fritted glass filter disc cemented into the bottom wall of the chamber "A." A wide opening is provided at the top of the chamber for insertion of the test object (not shown) and filling with the glass beads (also not shown). After having been thus filled, the dilatometer chamber is closed by the hollow ground glass stopper "B" which is held in place, against the pressure developed in the chamber, by strong rubber bands wound around the projecting hooks "C" on the stopper and on the outside chamber wall. The dilatometer is then immersed in the solution the swelling effect of which on the test object is to be determined, above the level of the orifice "E" but below that of the hooks "C" on the outside chamber wall, to avoid immersion of the rubber bands in the solution. As the test object in the dilatometer chamber swells, glass beads are extruded from the chamber through the orifice "E"—the number or volume of the beads extruded serving as an indication of the increase in size of the test object in the chamber.

It should be noted here that the volume occupied by a quantity of shot, sand or glass beads is not constant, but will vary somewhat with the packing of the particles.[1]

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SPECIAL ARTICLES

LAND TYPES OF THE TRINITY BEDS

THE Trinity beds are a conspicuous feature in the geology of the state of Texas. There they extend as a broad belt thirty or so miles wide for a distance of 300 miles from the Red River valley across Wise, Palopinto, Erath, Comanche and other counties, south-southwesterly to Fredericksburg (seventy miles due west of Austin). Along its eastern edge the Trinity overlaps the Pennsylvanian, and then south and west the beds run under several later horizons. The series consists in flotation sands, finer conglomerates and thin shelly, limy layers of fresh to brackish and fluvial marine origin, in all 500 feet thick. The invertebrates found in abundance at many points in thin interfingerings of limy rock are fairly well known. Also, R. T. Hill early used for the Trinity series the very good common name of "dinosaur beds" as further noted for their petrified forests, and somewhat later for three isolated and rare petrified cycads.

Occasional finds of land forms in the Trinity long gave little indication of wealth or variety of type; but other and fine discoveries have been accumulating for several years. Through the interest of Mr. Jene W. Wagner, of Burkburnett, Texas, and Mr. Bart Johnson, of Comanche, a splendid cycadeoid trunk from just east of the latter town was some years ago presented to the U. S. National Museum. This specimen I have sawn and studied in detail. Later, another handsome specimen from the neighborhood of Fredericksburg was turned over to Dr. Sellards, of the Texas survey; and I have since cut this stem, which bears young fronds. While, on visiting the general locality with Professor Plummer, of the University of Texas, early this year, we collected additional specimens as associated with the conifers. Again, Mr. Ross R. Wolfe, of Stephenville (Erath County), through persistent inquiry and effort has assembled a varied and most important series of the cycadeoid stems from the Stephenville country. Of these he has donated representative forms to Yale.

During a visit to Stephenville last March and April, aided by Mr. Wolfe and other friends, I was enabled to see why the land types of the Trinity beds and the general facts relating to them have appeared to view rather slowly. In that grassed and forested country fossil hunting is not easy. But the cycads can be found, and it is not too much to say that, considering their wide extent, the Trinity beds must be ranked as one of the five great cycad-yielding terranes of North America—the other four being the Arundel of Maryland, the Lakota of the Black Hills region, the Como of the Black and Freeze Out Hills, and the Mesaverde of the Chuska Mountain region of New Mexico and Arizona.

On inquiry, it was learned that some ten miles from Stephenville along the Paluxy River various portions of a reptilian had been noted. A visit to the locality resulted in the assemblage of a large part of the skeleton of a dinosaurian standing about six feet high at the hips, and thus one of the few lower Cretaceous dinosaurs from North America. Accurate determination of the form and species is greatly to be desired. It was found, too, that the general locality yields small Testudinates. In addition, large serial three-toed dinosaur tracks were pointed out as they occurred. A single track of yet larger form had been found; and cutting across a stream bed three miles from Glen Rose, another and splendid bipedal series of lesser three-toed tracks was seen. These latter tracks could have pertained to the skeletal type of the Paluxy.

[1] Smith, Foote and Busang, *Physical Review*, 34: 1271–1274, 1929.

Regarding the associated conifer forests it may be added that the amount of petrified wood is enormous. The conservation is not favorable to study, but the general types can no doubt be determined with sufficient accuracy. The trees are seldom large, not much if at all exceeding two feet in diameter. The wood has been much gathered for more or less ornamental use in rock gardens at various points about the country of the Trinity terranes. Especially at Glen Rose and in several other villages a type of fossil bungalow (!) may be seen, in which the short lengths of petrified wood are freely used to face cement construction. The result is really ornate. Inside, the fireplace may also be built of the wood (!), which is sold in quantity at a low price for such building. The wood is thus definitely a commodity, the use of which might well be encouraged, so long as it does not go to the extreme of putting specimens of direct value to science into inappropriate places.

Five species of silicified cycadeoids are recognizable in the general series from the Trinity beds, which has finally reached importance, and should have further or preliminary mention now. The types and their localities may be listed as follows:

(1) *Cycadeoidea Boeseana* (Wieland, 1921). This type was found in the basal Trinity beds near Bridgeport, Wise County, by Dr. Emilio Boese in July, 1915, being the first petrified cycadeoid ever reported from this horizon in the state of Texas; although the *Cycadeoidea munita* (Cragin, 1889) from near Sharon in southern Kansas must come from beds of about the same age. The Boese type because of isolation and lack of fruits or leaves could only be named arbitrarily. Taken as a young stem it differs little from either the Arundel or the Lakota forms.

(2) *Cycadeoidea Barti.* A fine new type, the tallest yet found in the Trinity, from about one half mile east of Comanche, and named after Mr. Bart Johnson of that town, who donated it to the U. S. National Museum. The second specimen reported from the Trinity. The trunk has been freely cut and bears various young cones with elongate receptacular cushions. As more fully described (in MS) it appears in all its features to be very nearly related to several of the Black Hills types of the Lakota. This seems to be the type mainly occurring about Fredericksburg. A University of Texas trunk from there, which I have also cut, bears a few young fronds and is considered the same.

(3) *Cycadeoidea Wolfei.* A columnar type with scant ramentum and rather characteristic leaf base spirals, occurring about Stephenville. Again, resemblance to Black Hills types (*C. Stilwelli*) is seen. The species appears validly new as several examples have been secured by Mr. Wolfe, one of which he has kindly turned over to the Yale Collections. It is justly named for him.

(4) *Cycadeoidea Dyeri.* Slender, characteristically branched stems with drooping and much excised frond bases. An uncommonly handsome new species because of a habitus exactly intermediate between the robustly branched cycadeoids of the Lakota, and Williamsonia. The specimen selected as the type bifurcates near the base, and the longer axis then gives off two lesser branches, the height being 30 centimeters with a diameter above the basal branch of 11 centimeters. From near Tolar, Texas, and about Stephenville. Named for Miss Mamie Dyer of Tolar.

(5) *Cycadeoidea Johnstoni.* A nearly globular type, usually compressed during fossilization. Trunks complete, of large size, up to a foot and a half diameter, with nearly mature seed cones, and crowns of fronds up to 30 in number and forming a ring of large diameter about the crown of very numerous scale (?) leaves. Pinnules of the fronds as many as fifty in the lateral row (100 in all). Apparently never branched. Occurrence about Stephenville, but appears to recur in the Black Hills, since the seed cones are the same as those figured as *Cycadeoidea* sp. on Plate XXXII of my American Fossil Cycads, Vol. I. The present new type reopens the earlier question as to identity.

Many facts could be recited about the landscapes and types of the Trinity. The *Cycadeoidea Dyeri* is a new species of note. Originally the type was found a few miles out from Tolar, Hood County, Texas, and then later solidly set in mortar along with other fossils on the wall at the entrance of the post office there. But on the occasion of my visit, the amiable postmistress, Miss Mamie Dyer, concurred in the view that such a stem was of value to science. Only on removal from the wall did its fuller interest become apparent. And then Miss Dyer presented the fine specimen for the collection of cycads at Yale. It is well named for her. Other examples varying somewhat in form but with the branching feature always distinct occur; and, accompanied by Mrs. S. F. Davis (wife of Professor Davis, of the John Tarleton College), I had the fortune to find a second stem on the Harris farm near Stephenville. A terminal bud of a much larger and heavier cycad also found associated by Mrs. Davis belongs to the species *Cycadeoidea Johnstoni.*

Cycadeoidea Johnstoni is the best represented species of the Trinity beds as collections now stand, named after General Albert Sidney Johnston, the heroic figure of Shiloh. Celebrated in the annals of the Southwest of ninety years ago, a lover of nature and deeply interested in the physical sciences, he led an unresting life; he knew the petrified forests, and he carried often his treasured copy of Sir Charles Lyell in his saddle pockets. The type locality is on the Stone farm, ten miles from Stephenville, about the side of a low, flatly conical hilltop where beside fragments at least three large and complete specimens have been recovered. Considerable petrified

wood, mostly fragmentary, is also present. During a visit made with Mr. Wolfe and a large party late in March last, further armor fragments of the cycads were found. The conditions indicate that the general specimen level is undisturbed for some distance along the slope, and that more good material must be present. The exact position of this level measured in feet above the more basal of the "pack sands" can not long remain in doubt if this noteworthy cycadeoid locality, the finest so far known in the Trinity beds, is marked with care. A simple, tasteful, appropriately inscribed monument should here be set up. It would be doubly commemorative of discovery and distribution in the case of such a splendid fossil type, as again seen with such a near certainty in the Black Hills 900 miles north.

Taking the foregoing species and collections from the Trinity beds in fuller view, a group resemblance to the cycadeoids of the lower Lakota is at once discerned. The parallel extends to both simple stemmed and branched species—is, in fact, so close as to become outstanding for all North America. Whatever similarity the Maryland types may have is less evident, as little is known of their fruiting, and branching does not occur. So far as inference may rest on the cycadeoids, by now a most imposing group, the lower Greensand of the Isle of Wight, the lower portion at least of the Lakota carrying the great group of specimens at the Cycad National Monument in the southern Black Hills, and the Trinity beds, are all of quite the same age. It may still be asked whether the Arundel is recent as the Trinity, or old as the Como taken as the equivalent of the Wealden. The Trinity was a flat, subsident, river and bayou, cycad-dinosaur-conifer, forest land, swept by the shallow edges of the sea.

Most of the Trinity cycadeoids are not nearly so well petrified as the Lakota and Como specimens. Finer details of structure are seldom clear. Yet the series as a whole has the finest beauty and value, and often affords singularly handsome polished surfaces. The *Cycadeoidea Barti*, as found at Comanche and at Fredericksburg, has an appearance suggesting original calcification in whole or in part, with subsequent siliceous replacement.

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EFFECT OF H-ION CONCENTRATION ON THE DIVISION RATE OF PARAMECIUM AURELIA

EXPERIMENTS on the effect of hydrogen-ion concentration on the division rate of *Paramecium aurelia* have been performed, feeding the animals on a pure line of bacteria instead of the "mixed culture" of bacteria heretofore used in such experiments. The *Paramecium* used were from Professor Woodruff's pedigreed strain. The bacterium used was a strain of *Erythrobacillus prodigiosis* which has been kept for several years in the Department of Bacteriology of Yale University. The medium consisted of 1.493 gr. of powdered, desiccated lettuce leaves in 1.0 liter of distilled water. To this was added in the first group of experiments KH_2PO_4 buffer salt to form a M/600 solution. In the second group M/300 buffer was used. The animals were kept in isolation in depression slides, and changed daily under sterile conditions. No bacterial contamination was observed at the end of the experiments, but a very few yeast cells were observed at the end of one experiment. The temperature was controlled by a thermostat.

The lines were carried for ten days each at several different H-ion concentrations, produced by titrating with HCl or NaOH, with the following results:

GROUP 1. M/600 KH_2PO_4. Temperature 28° ± 0.5° C.

pH	No. of lines	Average division rate per 10 days
5.9	6	21.7
6.9	6	18.8
7.2	6	20.0

GROUP 2. M/300 KH_2PO_4. Temperature 26.5° ± 0.8° C.

pH	No. of lines	Average division rate per 10 days
7.0	6	14.0
7.7	6	14.0

It will be seen from the above that the division rate is practically unaffected by change in pH between the limits of pH 5.9 and 7.7. This is in striking contradiction to the very thorough work of Darby ('29),[1] who found a very marked variation in division rate with pH, using the same strain of *Paramecium aurelia*. The author believes that the discrepancy in results lies in the fact that Darby used a mixed strain of bacteria as food for the *Paramecium* as opposed to the pure line of bacteria used in the present work. It has been shown Hargitt and Fray ('17)[2] that over 30 species of bacteria may be represented in ordinary hay infusion. It has also been shown that these species differ greatly in their value as food for *Protozoa* (Hargitt and Fray,[2] Phillips,[3] etc.). It is well established that many of the common bacteria are stenionic and are greatly influenced in their growth

[1] H. H. Darby, *Arch. f. Protistenk.*, 65: 1, 1929.
[2] G. T. Hargitt and W. W. Fray, *Journ. Exp. Zool.*, 22: 421, 1917.
[3] R. L. Phillips, *Journ. Exp. Zool.*, 36: 135, 1922.