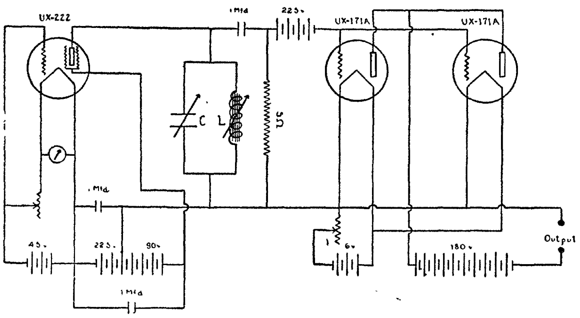

FIG. 1.

inductances and capacities. The frequency in cycles per second is approximately given by the relation: $f = \frac{1}{2\pi\sqrt{LC}}$ where L is the inductance in henries and C is the capacity in farads. A convenient arrangement, if not too great variations of frequency are desired, is one using a constant inductance such as that supplied by the primary of an audio-frequency transformer and variable capacity supplied by a battery of fixed and variable condensers joined in parallel by appropriate keys. A gross change in range may be effected by tapping the inductance or increasing the original amount. If greater accuracy is desired a coil of three or four henries may be wound and substituted for the transformer. Since the frequency of the oscillating circuit is not independent of the voltage supplied to the filament of the screen grid tube it is well to insert a voltmeter in the filament circuit. Maximum efficiency is achieved by operating the filament at the rated 3.3 volts.

The power to run the clock motor is secured from a series of UX-171A tubes in parallel, two being sufficient to take care of small motor loads. Most synchronous clock motors draw about 2 watts; this makes possible the use of dry cell batteries as sources of power. The A and B voltages of the power stage and oscillator have been taken from separate sources, though this is doubtless an unnecessary refinement. With the usual modifications of the circuit, operation would probably be quite satisfactory with A.C. for filament voltage and rectified A.C. for B and C supply. In order to operate the clock motor it is necessary to allow the D.C. as well as the A.C. output of the tubes to flow through the stator windings.

As is necessary in the operation of all synchronous motors, the clock motor is started by spinning the shaft until the motor falls into synchronism at either of two fractions of the impressed frequency, the one being twice the other. These are not difficult to discriminate, since they depend upon the starting torque. In our arrangement the primary shaft has been made to turn at speeds varying from 250 to above 700 r.p.m. without running at multiples. A greater range would be entirely possible, though this is sufficient for most purposes, since gross changes may be effected by gearing the shaft up or down.

Calibration of the oscillator is best effected by substituting an electric clock for the motor in the output circuit. If this is allowed to run ten minutes, for example, with the oscillator at one setting and its rate of motion, as indicated by the hands, be compared with that of an ordinary timepiece, the frequency of the oscillator can be computed with great accuracy.

The apparatus described was developed for use in an experiment on the critical frequency of flicker, where the speed of rotation of a sectored disc must be changed by exactly known amounts. Other uses are apparent. As just described, the method is an excellent one for determining frequency. The rotating disc could be supplied with a contact to interrupt a circuit at definitely variable intervals. The frequency of a second oscillator could be calibrated over a range much higher than the first by connecting the second oscillator to a neon bulb and making it produce a stroboscopic pattern on a disc rotated by the first.

ROLAND C. DAVIS
FRANK A. GELDARD
PSYCHOLOGICAL LABORATORY,
UNIVERSITY OF VIRGINIA

SPECIAL ARTICLES

A FLOWERING CYCADEOID FROM THE ISLE OF WIGHT

FOLLOWING the notes on the petrified "cycad" trunks of the Isle of Portland given by Dr. Buckland with the advice of the famous botanist, Robert Brown, a hundred years ago, the definitive knowledge of the cycadeoids or flowering cycads begins with Carruthers' description of *"Bennettites Gibsonianus"* from Luccomb Chine on the southeast shore of the Isle of Wight, in 1870. Just when these stem-bearing mature cones were first seen is not so sure. In Wilkins' "Geology and Antiquities of the Isle of Wight" of 1859, there is mentioned as coming from Sandown (a Wealden shore), "an interesting specimen in a nodule with a fracture across it, exposing its fructification with seed vessels, discovered by my friend T. F. Gibson Esq." This is likely the Carruthers type, despite any discrepancy as to locality or horizon;

[2] C. E. Worthen, *Gen. Rad. Experimenter*, 1930, 4, No. 12, 1–4.

although such a specimen does not seem to have been seen as early as the year 1850. Then Robert Brown had remarked that so far as known to him "all the cycad stems from the Isle of Wight differed from those of the Isle of Portland in having a bud in the axilla of each leaf."

Cycadeous stems with a full complement of axillary structures such as Brown seems to have seen are not clearly in evidence in the recorded material from the shores of the Isle of Wight, whether from either the Wealden or the Greensand. Nor have any such since appeared at the Isle of Portland. Albeit, the Chine at Luccomb must ever remain the classic locality of unusual stems, as again proven by a fortunate long hoped for supplementary *find* made by Alfred J. Mew, Esq., of Shanklin, I. W. The "chines" (from the old French and Anglo-Saxon, meaning a cut), are those deep, rugged and picturesque gorges cut back from the shore into either end of the "Undercliffe," a remarkable talus of yet higher rocks stretching along the south shore of the Island for some miles. The Luccomb chine is the first to the east of the Undercliffe, and there, on the beach at the right entrance wall, Mr. Mew made his find about seventeen years ago.

Mr. Mew as a lover of science had long held the very laudable desire of seeing a compact museum unit in his town of Shanklin. But this project seeming to fail of realization, his Luccomb specimen with other material remained by the side until recently. Then, on the occasion of my visit to the Isle of Wight following attendance at the recent International Botanical Congress at Cambridge, through a cordial introduction from a neighbor, Mr. H. F. Poole, after some discussion the suggestion was made and followed to turn the fine specimen over to the Yale collections. Both these gentlemen were fully aware of its interest and promise as one of the handsomest single gifts ever made to Yale. Mr. Poole had also made an important find of a fragment of a trunk still remaining *in situ* in the lower Greensand at a point near by, and about four feet above high tide.

The Mew cycad reached Yale safely, and I have sawn through it longitudinally and transversely, with some lesser cutting, and the smoothing down of the significant tangent surfaces as well, bringing to view the main vegetative and reproductive features in an essential completeness. The stem is a medium sized one bearing its fructifications sparsely, for about the first time. It is 25 cm high by 24 cm on the flat, and 17 cm through on the compressed diameter. The form is distinctly pear-shape due to the thick mass of old frond bases above, amongst which are imbedded young ovulate, and several staminate flower-buds, and at the summit in armor and ramentum 8 to 9 cm deep a splendid crown of fifteen well grown and but slightly emergent young fronds revealing in the transverse section the full pinnule series and structure. The medulla is 10 cm in diameter, the wood and cortex thin. As a specimen this is hence a virtually perfect one, and being quite uneroded it must have been found by Mr. Mew very shortly after rolling down from its matrix onto the upper beach. It even carries on one side a large patch of the lower Greensand rock which, taken with Mr. Poole's *in situ* find, settles at last the position of the most important cycad horizon of the Greensand.

Calcite is the main petrifying material in these petrifactions of the Greensand as more or less associated with stems of conifers. Here and there, though chiefly in the outer armor, are pyritized patches with residual plant carbon. In addition there are in places numerous small pyrite crystals which easily tear out and scratch the surfaces in course of preparation for closer study. There is little direct evidence of siliceous content. But just as some of the darker carbon-containing silicified cycads like *Raumeria* may be etched by hydrofluoric acid and studied by the Walton gelatine-pull method, so here hydrochloric acid is effective. Also, coloration is such as to yield much detail and fine photographs on all smoothed surfaces. Whether the stem is to be referred specifically to *Cycadeoidea* (Bennettites) *Gibsonianus* is not yet quite certain, but probably it is so referable.

This is the first instance of a European cycad bearing a full crown of fronds comparable to those seen in various American specimens. Small fronds found on a very tiny trunk or branch of indeterminate locality yielded to Dr. Stopes excellent histologic details. Also I found on an Isle of Portland *Cycadeoidea microphylla* very young fronds with the bundle series alone indicated. These three instances are thus the only ones in which the fronds have been seen at all in the European petrified series. Therefore, with the three European and six American species of *Cycadeoidea* in which leaves occur, there are in the world nine known species with foliage. All agree in the presence of a varyingly dense mat of hairs borne not alone on the rachis but all over the under surface of the pinnules as first noted by Dr. Stopes, and overlooked by me in the initial instances studied.

The ovulate cones of the Mew cycad, of which there may be a half dozen, are about a scant half centimeter in diameter, by a centimeter long and very prettily calcified. Of the complete flowerbuds two are fairly seen; but as the petalo-staminate disk is much pyritized the features are not so fully preserved as in *Raumeria* and the American specimens. No less, they are unmistakable. The disk includes eight staminate fronds, the lowest number thus far seen in cycadeoids; and it is so furrowed on its outer side as to indicate the probable number of the fused petals to be sixteen. The disk diameters are 9 and 19 mm due to compression. Inside the disk the medium-sized synangia are here and there nicely indicated by their outer palisade layer as seen even under a hand lens on smoothed surfaces. This is therefore the second European specimen in which the complete flowers are seen, the third with the preserved synangia. Those I found in *Cycadeoidea etrusca,* though overlooked by Capellini and Solms, were the first, those of *Raumeria* the second recorded.

The foregoing features emphasize the fact that the Mew cycad must rank as the fourth finest European specimen yet discovered, even if it does not stand alone. The record begins with the Dresden *Raumeria,* found or first noted in 1753. This stem bears the large specialized flowers with sixteen stamens like those of the Black Hills, but is held distinct generically because of the wood structure. The second great specimen is the *Cycadeoidea* (Bennettites) *Gibsonianus,* found as noted above about 1850, and twenty years later in the hands of William Carruthers revealing a seed cone organization strangely and unexpectedly different from that of all previously known cycads or other gymnosperms existent or extinct. The third is the *Cycadeoidea etrusca* of the necropolis and nearby Etruscan temple of 4,300 years ago at Marzabotto, and thus the oldest petrifaction of record ever handled by man. Refound in 1878, this stem yielded the first young seed cones with associated pollen grains, indicating the possibility of an amphisporangiate fructification; although Capellini and Solms overlooked the presence of the distinctly chalcedonized synangia, as I found on later examination of the type at Bologna. As the fourth of the European series showing the critical structures, the Mew cycad is therefore the equal of any, in fact the most complete of all in what it shows. As in the great *Cycadeoidea ingens* of the Black Hills, the first event in its fossilization occurred in the springtime. As in the magnolias the flowers appeared early, and then the fronds; although the sparse flowers and cones of this rather young stem seem once more to indicate the presence of monecism in the cycadeoids, rather than the uniformly complete floral type. These features need closer scanning. But as so well recognized the general organization had long departed from the ancient lines, and was specialized in its own way in form and foliage, especially in the increased size and diminished number of the flowers.

The next great find of the Isle of Wight collector, whether in the Greensand or at the "log raft" in the Wealden at Brook (= Como), must be one of those trunks bearing floral buds in all the axillae of the fronds, as seen by Robert Brown. Such, since the assemblage of the splendid series of trunks from the Navajo Country with their full complement of small flowers, must be regarded as the more primitive cycadeoid type.

The aid that has been given from European and other sources in the freest use of priceless and historic specimens of the petrified cycadeoids for comparison in the study of the American material has had a profound meaning and value. It has come in the first instances from Capellini at Bologna, Lignier at Caen, the custodians of the Zwinger Museum at Dresden, and from Britain. It proves that in the foremost countries the collector and the student is free in laboratory and field, and unhampered by legal or other restrictions; while fossil botany is to its devotees a world subject. It shows that eventually some concerted plan must be adopted making the unrivaled American cycadeoid collections a source of material for direct university use and demonstration *per se* of these, the most singular and instructive of all extinct flowering gymnosperms.

G. R. WIELAND

CARNEGIE INSTITUTION,
YALE UNIVERSITY

THE NEURO-MUSCULAR MECHANISM CONTROLLING FLASHING IN THE LAMPYRID FIREFLIES

BY the use of a photoelectric cell and amplifier in connection with the string galvanometer,[1] it has been possible to record curves of the flashes of *Photuris Pennsylvanica.* Records of spontaneous flashes and records of electrically stimulated flashes were obtained under normal conditions, under various oxygen tensions, and under various conditions of pressure and other factors. Fig. 1 is an illustration of the curve from a typical normal spontaneous flash.

Analysis of the curves of normal flashes shows that there are two independent mechanisms governing the amount of light in any flash. One is evident through a factor, which, when it varies, affects only the height of the intensity-time curve; it does not affect the ratio of the development and decay portions of the curve, and does not affect the duration of the flash. The other factor affects primarily the duration of the flash; it also affects the height and to some extent the relationships of the development and decay portions of the curve. These findings lend support to the observation, made first by Lund,[2] that either few or many discrete and definite individual areas of a luminous organ may be involved in any flash. The

[1] E. N. Harvey and P. A. Snell, Proc. Amer. Philos. Soc., 69, 303, 1930; *J. Gen. Physiol.,* March, 1931.
[2] E. J. Lund, *J. Exp. Zool.,* 11, 415, 1911.