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.

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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.

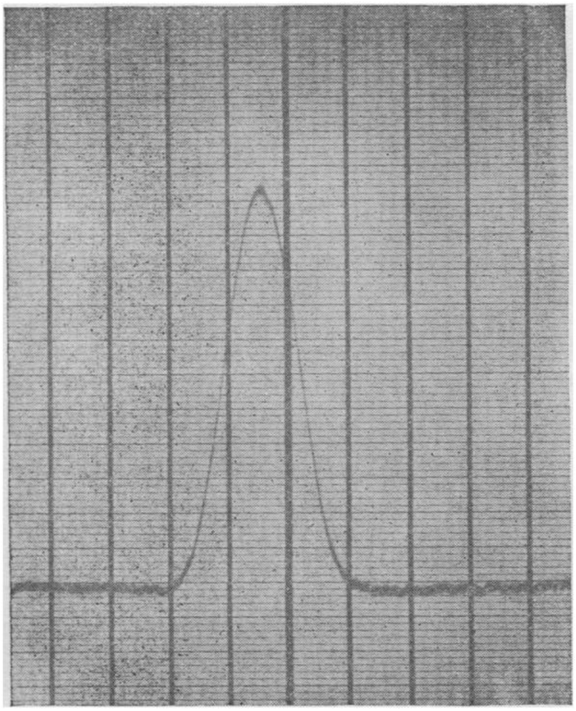

FIG. 1. Normal Spontaneous Flash. Unmounted ♂. Vertical lines indicate .04 second.

factor affecting the height of the curves but not the duration is the expression of the number of units of the luminous organ in action in that flash; the factor affecting primarily the duration is an expression of the activity of the controlling mechanism of these individual areas.

The normal flash shows a large range of intensity due to the two variable factors just described. The duration range is on the contrary comparatively narrow, with very few exceptions lying outside this range which are probably not normal flashes; the duration varies between 0.09 and 0.16 second, with the majority about 0.12 second.

It was found that all the characteristics of a spontaneous flash could be duplicated by the flash of a specimen from which the head and thorax had been dissected, when the abdomen remaining was stimulated in certain ways by singly induced shocks. The strength of current necessary to produce stimulation of all parts of the luminous organ produces injury to the specimen, and these preparations could therefore not be used for experiments requiring a series of observations and records. The analogy of such a preparation with the well-known nerve-muscle preparation is striking. The intensity-duration curve of the flash is similar in nature to the height-duration curve of a muscle contraction.

Reducing the pressure and oxygen tension by vacuum has the same qualitative and quantitative effect on the flash as reducing the tension only by means of oxygen-nitrogen gas mixtures. Normal flashing will take place in oxygen tensions above 20 mm of mercury. Below this point the controlling mechanism is rapidly injured so that it ceases to function, luminescence becomes continuous, and its intensity varies with the oxygen tension. Complete functional recovery takes place if the low oxygen tension is not maintained too long.

These experiments indicate that the mechanism controlling the flashing is responsive to nervous and to direct electrical stimulation, that it effects the control by regulating the admission of oxygen to the cells containing the photogenic substances, and that variation in the character of the flash is brought about by variation either of the number of units stimulated or of the amount of stimulation and response (admission of oxygen to the cells) in the unit involved. The tracheal end cell, which has for a long time been considered by histological investigators to be responsible for the control of luminescence,[3] is certainly the responsive mechanism in this control. Its anatomical features, together with these physiological observations, lead directly to this conclusion.

This work is part of a program of studies on bioluminescence carried out under the direction of Professor E. N. Harvey in the Physiological Laboratory, Princeton, New Jersey.

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SOME OBSERVATIONS ON THE CORTICO-ADRENAL HORMONE

IN a recent short article[1] it was shown that extracts of the adrenal cortex prepared in this laboratory according to the method of Swingle and Pfiffner[2] were remarkably effective in maintaining adrenalectomized cats in apparently normal health and in abolishing the severe symptoms of adrenal insufficiency. Confirmation was given, therefore, of the observations of the Princeton investigators.

To avoid the considerable labor of scraping out the medulla, we have used whole adrenal glands in making our extracts. At the abattoir the glands are exsected from the still warm carcasses and immediately frozen. Shipment is made to the laboratory in carbon dioxide snow, and the glands are finely ground while still in a frozen state and placed in 95 per cent. ethyl alcohol. In the process of preparation of the cortico-adrenal extract, the adrenalin originally present in the whole glands seems to a large extent to disappear. Only traces of adrenalin are left in the crude extract, the

[3] U. Dahlgren, *J. Franklin Inst.*, 1917.

[1] S. W. Britton and Herbert Silvette, SCIENCE, 73: p. 322, March 20, 1931.

[2] W. W. Swingle and J. J. Pfiffner, *Amer. J. Physiol.*, 96: 153, 1931.