are reported to have come from the Atoka formation also, and the general appearance of the associated specimens supports this statement. No Atoka, however, is shown in the vicinity of Ada on the new geologic map of Oklahoma. Therefore, these particular specimens may have come from somewhat younger beds than did the others.

In conclusion, it is interesting to speculate on the significance and origin of this phenomenon of triangular coiling. Aberrances of one sort or another are not uncommon in cephalopods of the phylogerontic type, but the Glyphioceratidae are simple rather than specialized ammonoids. Furthermore, these phylogerontic aberrances in most cases are also phenomena of individual old age, and not of youth, as is the case in the forms described above. In addition, if all cephalopods in their various stages of development recapitulate their ancestry, as certainly most of them do, these peculiar types point to an ancestral stage in which the adults were triangularly coiled. Not only is no such cephalopod known, however, but it is particularly difficult to imagine the existence of such a type prior to Pennsylvanian time. It therefore seems more probable that the cephalopods described in this note are pathological in respect to the manner of coiling of their earlier whorls. If the latter is the case, however, it is not a little remarkable that the same pathological feature should manifest itself in the same general type of cephalopod, at nearly if not quite the same geologic horizon, and in specimens found over a relatively large area, geographically speaking. Supporting the suggestion that the forms described above may be pathologic is the fact that normal nepionic coiling is found in most associated cephalopods. It has not yet been determined satisfactorily, however, whether some individuals of a certain species may be coiled normally and yet others of that species exhibit the triangular nepionic coiling, or whether this type of coiling characterizes all individuals of each species exhibiting this phenomenon.

The writer would appreciate additional records of the occurrence of this type of cephalopod.

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STIMULATORY EFFECTS OF ULTRA-VIOLET RADIATION UPON HIGHER PLANTS

The apparently contradictory results of recent investigators concerning the possible stimulation of the growth of higher plants by ultra-violet radiation led to the work reported briefly here. Chief among these investigators are Eltinge[1] and Sheard and Higgins,[2] who have demonstrated that ultra-violet wave-lengths above the lower solar limit, 290 $\mu\mu$, are beneficial to and seem to stimulate plant growth slightly; and Popp and Brown[3] and Newell and Arthur,[4] who failed to find any stimulation whatsoever in the ultra-violet spectrum.

It appears that these varying results are attributable to differences in methods of irradiation and to other parts of the technique employed by these workers, since similar portions of the spectrum were used in the investigations.

The plants used were tomatoes and cucumbers, reported by Newell and Arthur, and Popp and Brown, respectively, to be unaccelerated in their growth by the radiation from a quartz mercury vapor arc. The experimental groups were the following:

A—Controls.

B—Plants rayed with quartz-lite filter (transmitting to 313 $\mu\mu$) one half minute on the first day, increased by half a minute on each following day.

C—Plants rayed with quartz-lite filter for 9 minutes daily.

D—Plants rayed with vita-glass filter (transmitting to 289 $\mu\mu$), with periods as in set B.

E—Plants rayed with vita-glass filter with periods as in C.

The plants were rayed at 100 inches from the arc through a period of five weeks, with 100 plants in each group. The populations of 100 plants as shown by statistical analysis eliminated the factor of individual variation, which had been neglected by previous workers.

It will be noted that the periods of radiation were adjusted so that at the end of the experiment the incremental and constant period groups would have received equal amounts of radiant energy; hence differences in the reactions of the plants subjected to the two methods are attributable only to the differences in the arrangement of the irradiation periods, not to differences in amounts of energy received.

In general, the results point to definite stimulation where the distance was 100 inches. In a preliminary experiment at 50 inches, when the lamp was screened with the quartz-lite filter, there were no injurious effects and there was apparently a small amount of increased growth. At 100 inches, all rayed sets showed very definitely greater growth than the controls; in both plants, the greatest amount of increase occurred in the vita-glass constant-period group, set E; here, in the tomatoes, the plants at the end of the period showed an increase 33 per cent. greater than

1 Eltinge, *Ann. Mo. Bot. Gard.*, 15: 169–240, 1928.
2 Sheard and Higgins, Science, 65: 282–284, 1927.
3 Popp and Brown, *Amer. Jour. Bot.*, 15: 623, 1928.
4 Newell and Arthur, *Amer. Jour. Bot.*, 16: 338–354, 1929.

that of the controls; in the cucumbers, the percentage of increase over the controls was about 34 per cent. Dry weight percentages of wet weight and ash weight percentages of dry weight were greater in the rayed plants than in the controls, the former as much as 19 per cent. greater in the tomatoes, the latter as much as 13 per cent. greater. Numbers of leaves were greater in the rayed plants.

It is interesting to note that the incremental method induced greater increase in growth than did the constant period method, when the quartz-lite filter was used; with the unscreened arc, the injurious effects were considerably reduced by the former method of treatment. At 50 inches, in some cases, the constant period method seemed actually to retard growth slightly, even when the lamp was screened, whereas the incremental treatment caused the plants to grow somewhat more rapidly than did the controls. The reaction in the case of the incremental method seems to be of a two-fold nature: first, a gradual adjustment to the new environmental factor, then an increased growth rate under the influence of the gradually increasing intensity of that environmental stimulus.

This work was carried out under the direction of Dr. Ernest S. Reynolds. A detailed report is to be published later.

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HETEROTHALLISM IN PUCCINIA CORONATA

THE sporidium of *Puccinia coronata* Corda, on a Rhamnus leaf, germinates by forming a short beak, pierces the outer wall and enters the epidermal cell. The sporidial nucleus usually divides before entry. In the epidermal cell the fungus grows into a primary hypha of 4 to 6 cells, from each of which a branch forms which penetrates to the subepidermal region and develops there into haploid mycelium.

The mycelium spreads between the epidermis and the palisade, forcing the two layers apart and forming a continuous mat or stroma several cells thick. From this stroma hyphae grow down between the palisade cells into the spongy mesophyll. Haustoria may be unbranched or may fork dichotomously once, twice or even three times.

On the subepidermal stroma the pycnia form at fairly even intervals. Later a similar but smaller stroma forms next the lower epidermis and a few pycnia appear on it, which open onto the lower surface of the leaf. In old infections the whole upper stroma with its pycnia may peel off leaving the palisade layer exposed.

Puccinia coronata is at least partly, perhaps wholly, heterothallic. Eight Rhamnus plants bore 1 infection each. They were carefully isolated. Seven of the 8 remained sterile, that is, produced no aeciospores. On another plant bearing 6 infections the pycniospores were well mixed. Five of the 6 produced open aecia.

The sterile infection produces aecia which reach a considerable size but they form no spores. In these sterile aecia, however, there appear at a certain stage of development cells with 2 or 3 nuclei. These cells grow irregularly and their nuclei increase in number, but sooner or later they deteriorate and die. Multinucleate cells are to be found in practically 100 per cent. of all the older sterile aecia. A few of these multinucleate cells survive to a great age. In one sterile infection 62 days old there were living multinucleate cells of monstrous size, highly irregular in form and each containing 15 or 20 nuclei.

In the fertile infection the aecia produce spores regularly. Here are to be found an abundance of cells with 2 nuclei, some with 3, very rarely 1 with 4 or 5, but never the monstrous multinucleate cells so characteristic of sterile aecia.

The point at which the sporophyte is initiated in the fertile infection would seem to be variable. A few binucleate cells have been observed near a pycnium, in the subepidermal stroma, in hyphae between palisade cells, in the mycelium of the spongy mesophyll and above the aecium. Rarely a cell fusion can be seen between hyphal cells at some distance from an aecium. Cell fusions are most frequently found at or near the upper edge of the aecium, several cells above the sporogenous layer. In the majority of cases several cell divisions take place between the initial binucleate cell of a series and the basal cell which will produce the spores. Basal cells and spores are usually binucleate, rarely tri- or quadri-nucleate.

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