based on anatomical features are open to suspicion. From the examination of specimens in my own collection, I have no doubt that quite heterogeneous stems are commonly confounded under the name *Lepidophloios fuliginosus*. Some, no doubt, like that originally identified by Messrs. Cash and Lomax¹, really belong to *Lepidophloios*, but others are in all probability referable, like the specimen now described, to species of *Lepidodendron*. Internal structure is presumably of more importance than external configuration, and we may conjecture that the characters of the leaf-bases, on which systematists have been compelled to rely, possess but small taxonomic value.

D. H. SCOTT.

Kew.

LIGNIFICATION OF PHLOEM IN HELIANTHUS.—Some observations on the phloem of the common sunflower were described in a note² published in 1902; the chief points were as follows. In an old stem, collected early in October of the previous year, it was found that lignification of the walls had taken place in a considerable number of sieve-tubes and companion-cells, as well as in many of the phloem-rays, and in the whole of the pericycle; the rather surprising result was also obtained, that the proteid-contents of some sieve-tubes and companion-cells gave lignin-reactions³, especially in the root, where lignification of the walls of these elements was not observed.

These results were based on an examination of two plants only, and required to be supplemented by further observations. For this purpose additional material was collected in 1902 for future investigation, and included eleven plants of *Helianthus annuus*, L., one plant of *H. tuberosus*, L., and stems of *H. laetiflorus*, Pers., and *H. decapetalus*, L. All of these except the specimen of *H. tuberosus* were grown at Kew. The object of the present note is to give the results of the examination of this material.

The lignification previously observed appears to be of general occurrence in old stems of the sunflower, since the walls of a large number of sieve-tubes and other elements of the phloem proved to be lignified in all the specimens of this species; the same was observed in the three other species of *Helianthus* mentioned above. The contents of numerous sieve-tubes and companion-cells were lignified in the root of all the sunflower-plants and in that of *H. tuberosus*⁴. Thus the previous observations are confirmed for the sunflower, and extended to other species of the same genus.

Of the eleven plants of the sunflower, nine were grown close together and at first treated alike, but two of them were transferred to a green-house in August, and from two other plants the different capitula were successively removed before reaching

¹ W. Cash and J. Lomax, On *Lepidophloios* and *Lepidodendron*, Report of the British Association (Leeds), 1890, p. 810.

² Boodle, On lignification in the phloem of *Helianthus annuus*, Annals of Botany, vol. xvi, p. 180.

³ The different reagents used are mentioned on p. 181, loc. cit.

⁴ The roots of *H. laetiflorus* and *H. decapetalus* were not examined.

any considerable size. These two plants were left growing until December 12, their upper leaves, which had remained green, having been killed by a frost a few days previously. The other plants were collected at different times from October 15 to December 6, in each case after the fruiting of the main flower-heads had been completed.

The proportional amount of lignified tissue was found to vary greatly in different plants, and in different parts of the same plant. In most cases lignification of the phloem is more general in the upper part of the stem than near the base (e.g. two inches above the level of the soil), the middle region being intermediate. The pericycle behaves similarly, the whole or the greater part of this tissue being lignified in the upper region of the stem, while at the base usually very little of it had undergone lignification, or sometimes none.

In the plant showing the greatest amount of lignification, there were, at intervals, small groups of elements having cellulose walls and consisting of two or three sieve-tubes with companion-cells, while opposite the primary masses of sclerenchyma similar but rather larger groups were present; apart from these the whole of the phloem and pericycle had become lignified. No cambium remained, so that a transverse section showed a continuous mass of lignified tissue, comprising the xylem and the tissues between the latter and the endodermis¹, and interrupted only by small islands of unaltered phloem.

Lignification of the phloem generally begins immediately on the inner side of the primary groups of sclerenchyma, and proceeds from these towards the xylem. Usually the medullary rays in the phloem undergo gradual lignification from within (i.e. from the limit of the xylem) outwards, and this often begins a little later than in the first phloem-elements. The groups of sclerenchyma may become connected with the xylem by bridges of lignified tissue at a time when there is very little lignified tissue at intermediate points. As a rule lignification of the pericycle begins, often comparatively late, at the sides of the groups of sclerenchyma, and proceeds tangentially. Hence it appears that in all these tissues lignification generally takes place in elements adjacent to previously lignified tissue.

From the data obtained it was not found possible to deduce the cause of lignification of the phloem. The largest plant (stem eight feet high, and 3.8 cm. in diameter at the base) showed the greatest amount of lignification in the basal region, and the smallest plant (stem three feet high, and less than 1 cm. in diameter at the base) showed the least amount, but the remaining plants gave no sort of proportion between the degree of lignification and the size of the stem. Neither was there a regular relation to the age of the plants. Again the two plants, from which the flower-buds were cut off, showed less lignification at the base of the stem than the majority of the other plants, but the distinction was not sufficient to warrant any definite conclusion. Possibly lignification of the walls may set in near the time of the death of the elements, and this may depend on several factors affecting the supply and demand of food-substances.

Lignification of the proteid contents of sieve-tubes was seen in the roots of all

¹ Lignification appears to stop accurately at the endodermis; no cases of lignified cortical cells were observed.

the specimens¹. It was sometimes only to be observed for a short distance from the sieve-plate, but in other cases extended throughout the length of the element. It was found to occur in sieve-tubes where the callus formed a very thick deposit on the sieve-plates, as well as in others where no callus was present. The walls of some few sieve-tubes in the root were slightly lignified (chiefly close to the sieve-plate) in two or three plants, but no general lignification of the phloem in the root was observed.

From the observations described above it appears that the walls of the phloem-elements in the stem, and the contents of the sieve-tubes in the root become normally lignified in the sunflower, and the same phenomena occur in other species of *Helianthus*. The occurrence of lignified contents in the sieve-tubes of the root of *H. tuberosus* shows that this feature is not restricted to annual species.

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GERMINATION OF THE SPORES OF OPHIOGLOSSUM.—During a recent visit to Java, attempts were made by the writer to germinate the spores of several species of *Ophioglossum*. Three species—*O. Moluccanum*, *O. intermedium*, and *O. pendulum*, germinated, and in all of these the earliest stages were observed.

O. Moluccanum germinates very freely and quickly, the first germination stages having been met with within three days. In this species a small amount of chlorophyll was sometimes found, but it was insufficient to enable the young prothallium to develop independently, and the largest ones had but four cells.

Germination in *O. intermedium* was much slower. Only a small amount of this rare species was available, and the observations were necessarily very incomplete. About a month after the spores were sown, the first stages were found. No chlorophyll could be detected, and the prothallia had but three cells.

Spores of *O. pendulum* collected at Hanwella in Ceylon, and at Tjibodas in Java, were sown, and germinations were obtained in both cases. The first stages were not met with until about a month after the spores were sown, but it is quite possible that some may have germinated sooner.

As in *O. intermedium*, no chlorophyll was formed, and the development of the young prothallium, until three cells were formed, was very much the same. But in *O. pendulum* a number of young prothallia were found, in which there was an association with a mycorrhizal fungus, which penetrated the cells of the young prothallium, and caused its further development. In one case a young prothallium of thirteen cells was found. In every case where growth had advanced beyond a three-celled stage, the mycorrhiza was present.

A number of adult prothallia of *O. Moluccanum* were found at Buitenzorg; and at Tjibodas prothallia of *O. pendulum* were collected in the humus between the leaf-bases of *Asplenium nidus*.

DOUGLAS H. CAMPBELL.

SINGAPORE,
June, 1906.

¹ Mr. J. H. Van Stone informed me in 1902 that he had observed lignification of the contents of some of the sieve-tubes in the stem of the perennial sunflower.

Boodle, Leonard Alfred. 1906. "Lignification of phloem in Helianthus." *Annals of botany* 20, 319–321. <https://doi.org/10.1093/oxfordjournals.aob.a089104>.

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