radiomicrometer, and his measurement of the energy radiated from certain stars and planets, are properly acknowledged.

The chapter on optical instruments is excellent. It is followed by one on the eye, which furnishes a satisfactory summary of what is of chief interest in physiological optics to the physicist. This includes a brief discussion of the telestereoscope of Helmholtz, and the more recent double telescope by Zeiss for the perception of a distant object in relief. Interesting developments are the stereo-telemeter, stereo-micrometer and stereo-comparator of Pulfrich. This last instrument finds a new and unexpected field of application to the heavenly bodies. Assume that on two successive evenings photographs of Saturn are taken, using the comparator with camera attachment. During the interval of a day the position of the planet with regard to the stars has changed, as well as the position of the satellites with regard to their primary. Let these two photographs be arranged to form a stereograph and viewed binocularly either with a stereoscope or with the unaided eyes if suitably trained. Against the black background are seen the distant stars. Suspended independently in mid space between foreground and background is the planet. Behind it on one side is a satellite, and on the other side is another satellite just emerging from eclipse. Spatial relations are as distinct as if all were within arm's length. A stereograph of this kind from proofs secured by Wolf at the Heidelberg observatory is one of several that are presented for the reader's scrutiny. The instrument has been applied to the discovery of planetoids, of variable fixed stars, and to the study of such as have considerable proper motion.

The last part of the volume, relating to optical phenomena in the atmosphere, interference of light, diffraction, polarization, double refraction, interference of polarized beams and the turning of the plane of polarization by quartz and other bodies optically active, is well up to the standard of the earlier part. The value of the book is greatly enhanced by the clear cut summaries of important conclusions, and the bibliographic list of references to the literature of the subject with which each chapter is closed.

W. LE CONTE STEVENS.

DISCUSSION AND CORRESPONDENCE.

PALEOZOIC SEED PLANTS.

IN my short note in SCIENCE of July 1 proposing the name *Pteridospermaphyta* for this group of plants, I assumed that all interested in the subject were acquainted with the facts and the literature, and I expressly refrained from entering into details. It seems that I was mistaken in this assumption, otherwise I could hardly have been misunderstood.

When in 1897 Potonié founded the group Cycadofilices,* he based it on the internal structure and classed it under the Pteridophyta with the same rank as the Filices. It included *Nœggerathia,* the Medullosæ, *Cladoxylon, Lyginopteris, Heterangium* and *Protopitys.* Later he worked the same subject over for Engler and Prantl's 'Natürliche Pflanzenfamilien.'† He here says that the groups Sphenopterides, Percopterides and Neuropterides might perhaps be better included in the Cycadofilices, although he continues to class them with the ferns. He now includes *Calamopitys* in this group. M. R. Zeiller in 1900‡ discussed these forms, and although he admitted that the characters then known approached more closely those of cycads than of ferns, he says it would be rash to exclude them from the latter on these characters alone, that they may represent a special type of Filicineæ, provided with secondary wood, and that indications of fructification observed on certain fronds of *Alethopteris, Odontopteris* and *Neuropteris* may be adduced in favor of this hypothesis.

In the first preliminary paper of Drs. Oliver and Scott§ they show that *Lyginodendron,* which Potonié classes in the Lepidodendraceæ,

* 'Lehrbuch der Pflanzenpalaeontologie,' p. 160 (Lief, 2, dated 1897).

† Teil I., Abt. 4, pp. 780–795 (Lief. 213 dated 1902).

‡ 'Eléments de Paléobotanique,' pp. 124 ff., 370.

§ 'On *Lagenostoma Lomaxi,* the seed of *Lyginodendron,*' *Proc. Roy. Soc.,* Vol. LXXI., pp. 477–481.

almost certainly bore the seeds called *Lagenostoma Lomaxi* by Williamson. Toward the close of this paper they make the following significant remark: "It is not likely that *Lyginodendron* stood alone in this; we must now be prepared to find, what has long been recognized as a possibility, that many of the plants grouped under Cycadofilices already possessed seeds, and thus that a considerable proportion of the so-called 'fern-fronds' of the Palæobotanist really belonged to Spermatophyta."

Following quick upon this discovery came that of Mr. Kidston of a specimen of *Neuropteris heterophylla* bearing a rhabdocarpous seed.* The second preliminary paper of Drs. Oliver and Scott† does not mention Kidston's discovery, but deals, like the first, with the seed of *Lagenostoma Lomaxi*. In this paper, however, they say: "There are many indications that other genera, now grouped under Cycadofilices, had likewise become seed-bearing plants. It is proposed to form a distinct class, under the name Pteridospermæ, to embrace those Paleozoic plants with the habit and much of the internal organization of ferns, which were reproduced by means of seeds. At present, the families Lyginodendreæ and Medulloseæ may be placed, with little risk of error, in the new class, Pteridospermæ." Putting this with the remark above quoted from their previous paper, it seems clear that this new class is regarded as belonging to the Spermatophyta as coordinate with the Gymnospermæ and Angiospermæ.

In a paper presented to the Paris Academy of Sciences by M. Grand'Eury on March 7, 1904,‡ he mentions the numerous seeds found associated with the Neuropterideæ and gives his reasons for believing that they were borne by those plants, and he remarks that 'from all this it evidently does not follow that the Neuropterideæ are primitive Cycadineæ, but this solution is the more probable as the stipes of these ferns resemble in a striking manner *Colpoxylon* and *Medullosa*.'

* *Op. cit.*, Vol. LXXII., December 29, 1903, p. 487.

† *Op. cit.*, Vol. LXXIII., pp. 4–5.

‡ *Comptus Rendus*, Vol. CXXXVIII., pp. 607–610.

At the next session of the academy (March 4), M. R. Zeiller made a communication on the mode of fructification of the Cycadofilicineæ. Commenting on the facts set forth by Grand-'Eury and the discoveries of Kidston and Oliver and Scott, he says: "We thus find ourselves in the presence of types manifestly related on the one hand to the ferns, on the other to the Cycadineæ, and we can hardly refuse to see in this group of the Cycadofilicineæ or Pteridospermæ, to use the name proposed by MM. Oliver and Scott, one of the principal steps in the process of evolution which must have led from the one to the other; but we have already to do here with true Gymnosperms, and the establishment of this fact leads to a profound modification in our knowledge of the Carboniferous flora.*

Still more significant are certain statements made by M. B. Renault relative to the Paleozoic flora of Autun in a paper presented to the academy on May 16, 1904. He says: "With the stems of *Calamodendron* and *Arthropitys* and their branches we have met with small cylindrical seeds several millimeters long (Stephanospermum); the proximity of the seeds and branches may permit the assumption of some relationship (*parenté*) between them. * * * From the facts above set forth it seems to follow that the Cryptogams may have had several points of contact with the Phanerogams; the Colpoxylons remind us of the Cycads and Ferns; *Arthropitys* of the Equisetaceæ and the Conifers; and finally the seeds of *Gnetopsis* recall those of the Gnetaceæ.†

M. Grand'Eury returned to this subject in the session of July 4, 1904, and gave reasons for believing that several of the genera formerly regarded as ferns, including *Linopteris*, were seed-bearing, and that the small striate seeds associated with *Neuropteris flexuosa* from the Department of the Gard were borne by that species. He entered somewhat into the discussion of the numerous

* *Comptes Rendus*, Vol. CXXXVIII., p. 664.

† *Comptes Rendus*, Vol. CXXXVIII., p. 1239. This paper was republished in the *Procès-Verbaux de la Société d'Histoire naturelle d'Autun*, Année 1904.

seeds that have been found at St. Etienne and in other parts of France, and the probable connection of a considerable portion of them with these fern-like genera.*

About the last work done by Adolphe Brongniart was the elaboration of the collections of these silicified seeds, the results of which were published posthumously in a large monograph.† In the light of recent discoveries this work assumes special importance. From such an examination as I was able to make in 1900, in company with M. Potonié and under the guidance of M. Grand'Eury, of the beds of St. Etienne, from which most of these seeds were obtained, I conclude that it is doubtful whether any will be found there attached to stems or fronds, but some may be so found, and, as we have seen, they are being so found in other places.

These and other considerations which need not be introduced here have led me to the conclusion that the plants in question should not be classed either as Pteridophyta or as Spermatophyta, but should be regarded as constituting a distinct phylum intermediate between the two, for which I proposed the name Pteridospermaphyta. The three great types to which the Paleozoic seed plants, exclusive of recognized Gymnosperms, either have proved or are likely to prove to be allied are the Ferns, the Calamites and the Lepidophytes. It therefore seems probable that there will need to be recognized three corresponding classes, which should be called, respectively, the Pteridospermæ, the Calamospermæ and the Lepidospermæ. The first of these names has already been appropriately used, unless, as Potonié's classification of *Lyginodendron* in the Lepidodendraceæ would imply, that plant has its closest affinities with the Lepidophytes. In that case it would belong to the class Lepidospermæ. Those having affinities with the Calamarians or Equisetineæ, such as the Stephanosperma, believed to have been borne by *Calamodendron* or *Arthropitys*, would belong to the class Calamospermæ, while those seeds borne by plants having the foliage of ferns, such as *Neuropteris heterophylla*, would belong to the class Pteridospermæ.

If it be said that the existence of seeds necessarily places a plant in the Spermatophyta, the answer is that at the stage in plant development to which those forms belonged it will not probably prove possible to maintain any such sharp line of demarkation. The distinction between microspores and pollen has already practically broken down, and Kidston now regards the spores of *Neuropteris heterophylla* as the male inflorescence. In like manner the distinction between macrospores and seeds is likely to break down, and the attempt to retain plants of such low organization in the Spermatophyta will present grave difficulties. By establishing an intermediate phylum to which all forms may be referred as fast as the appropriate parts are discovered, all these difficulties will be removed. We should then have the following classification of vascular plants:

PHYLA.	CLASSES.
Pteridophyta	Filicineæ.
	Equisetineæ.
	Lycopodineæ.
Pteridospermaphyta	Pteridospermæ.
	Calamospermæ.
	Lepidospermæ.
Spermatophyta	Gymnospermæ.
	Angiospermæ.

LESTER F. WARD.

* *Comptes Rendus*, Vol. CXXXIX., pp. 23–27.

† 'Recherches sur les Graines Fossiles Silicifiées,' par Adolphe Brongniart, Paris, 1881, fol. with 21 plates, many colored.

THE SOUFRIÈRE OF ST. VINCENT IN JULY, 1904.

TO THE EDITOR OF SCIENCE: When the report was circulated in the daily papers of this country that Mont Pelé was in full eruption again, May 8, 1904, the second anniversary of the destruction of St. Pierre, the author wrote to correspondents in Martinique and St. Vincent for particular information as to the condition of the volcanoes which roused so much attention throughout the world two years ago. The data regarding Mont Pelé were published in SCIENCE for July 1, 1904.*

From St. Vincent comes the statement that everything has been quiet at the Soufrière since the great eruptions in the latter part of

* Hovey, 'Mont Pelé from October 20, 1903, to May 20, 1904,' SCIENCE, N. S., Vol. XX., pp. 23–24.