by 24. Economic advice was given by the Department of Zoology on the protection and control of elephants in Africa; the control of the musk-rat; occurrences of parasitic worms in man and animals in Nyasaland, Morocco, Algiers, the Sudan and East Africa; and the ravages of shipworm at Haifa and Rangoon. In the entomological department work was done in relation to insects causing or transmitting disease, pests of stored products, boring insects and farm and garden pests.

THE Illinois State Department of Health at Springfield has issued a statement in which it is noted that the circumstance that fatalities from diarrhea and enteritis jumped from 1,306 in 1929 to 1,531 in 1930, a very significant reversal in the recent trend of mortality from these causes. It is pointed out that fatal intestinal infections, especially in children, nearly always reflect errors in diet. Either the food is not wholesome or the wrong kinds of foods are consumed. Economic distress has doubtless led many families to modify radically their food supplies. Frequently, this has cut out from the diet of children, or reduced beyond the point of safety, such indispensable foods as milk and eggs. No medicinal or specially prepared vitamin products can take the place of milk and eggs in the food supply of children. Over 90 per cent. of the mortality from diarrhea and enteritis occurs among children under 2 years old. A sharp decline in milk and egg sales during 1930, as compared with 1929, indicates that the difficulty is associated closely with the economic situation. From a health standpoint, the statement says, it appears that a serious disturbance of the family food supply should be the last matter affected by a retrenchment program. Wisely expended, a very small *per capita* outlay will provide a well-balanced diet at prevailing food prices.

THE Hungarian correspondent of the *Journal* of the American Medical Association reports that Count Kuno Klebelsberg, Hungarian minister of public instruction, recently announced in the National Assembly that the American Rockefeller Foundation had entered into cooperation with the University of Sciences in Szeged and the Biological Research Institute in Tihany, and had granted 1,018,000 pengö for the two institutes. According to the accepted plan the Szeged University will devote from this sum 678,300 pengö to the equipment of natural history and theoretical medical scientific institutes, and to cover the current expenses of scientific investigations the foundation allows 200,000 pengö, about $40,000. For the erection of a glasshouse at the biological institute in Tihany, on the bank of the Danube, the foundation allowed 70,000 pengö, and for covering the current expenses of the next five years it gave 50,000 pengö. During this period also the Hungarian state will contribute a large sum to the budgets of these institutions. The correspondent of the *Journal* writes: "The Hungarian public received this report with immense enthusiasm; not only is the princely sum which was donated appreciated, but still more so the moral achievement. The foremost and richest scientific institution of the world gave a helping hand to two Hungarian scientific institutions from which they obviously expect results on behalf of the entire human family. With this act the Rockefeller Foundation not only obliged the Hungarian state and community, but it made a great service also to the universal natural sciences and to the search for truth. The minister, when expressing gratitude at the sitting of the National Assembly, spoke, in fact, from the heart of the whole Hungarian nation."

ERRATUM: In the issue of SCIENCE for August 14, on page 171, the bequest of Dr. Richard Alexander Fullerton Penrose, Jr., was incorrectly stated owing to a line having been misplaced after the pages had been made up. The residue of Dr. Penrose's estate, valued at $1,000,000, is divided equally between the American Philosophical Society and the Geological Society of America.

DISCUSSION

WHY THE ANGIOSPERMS ARE OLD

A CONSISTENT course of leaf change from Carboniferous times down, easily leading into trident (Sassafras), bladed (Magnolia), and other angiospermous leaf types through a gradually developed net venation, or especially through invasion of a marginal net, has been outlined with reference to type fossils elsewhere. It is believed this view of a wide-spread and gradual development of the foliar features of modern forest types taken in general is a valid one, though unlikely to at once appeal to those unfamiliar with the manner in which fossil leaf evidence bulks up in the field. No less, there should be some further recourse of proof. Does not such come into view when the classification of vascular plants is enough simplified?

Now in the first instance (as indicated by Jeffrey), all stem structures fall into two great series or lists, the lycopsida and the pteropsida. From the former might be separated the sphenopsida. Be this as it may, what is held here is that neither the sphenopsids nor the lycopsids include true floral antecedents, and that fructification in the lycopods and in selaginella is non-zonate and therefore has never had anything to do with the origin of the cones of conifers or the flowers of angiosperms, while in the second instance the pteropsida include the great lines of seed plants, probably all going back beyond the Carboniferous as follows:

	I. *Metastrobile* (inflorescent)	Cordaites Ginkgos Conifers
ARCHAEOSTROBILE (The protospermatophyta, primitively amphisporangiate).	II. *Anthostrobile* (floral)	Gnetales Angiosperms Cycadeoids
	III. *Neostrobile* (carpellary)	Cycads Lyginopterans Medullosans

This scheme portrays a unit view of cone, or of primitive strobilar and floral structure. It could be called the view or theory of *monomorphy*. It suggests, if it does not even emphasize conformity in a course of variation which throughout all the lines of seed plants extends back to, and takes its beginnings in amphisporangiate primitives just above the algae. That for instance searching anatomical study of angiospermous floral structures does not confirm the claim for the presence of "polymorphy" or complexity in emplacement of floral parts (*Cf.* Eames), is a strong supporting point. That the cycadeoid floral origin and history runs parallel to that of the angiosperms must also be believed. The primitive form would alike be a zonate and amphisporangiate spiral. It need not be supposed that in this the gnetaleans varied. Nor is it likely that the cones of conifers had an entirely separate origin.

That the Cordaites are not better known is perhaps the greatest tragedy of present-day fossil botany. Evidently much more will be learned about this exceedingly varied group. It seems at present to be a fundamentally inflorescent group with the male flowers and the female very much alike if the stamens may be considered analogous to carpels and those of course to modified leaves. The group is evidently dioecious or monoecious. Could it have been derived from an amphisporangiate ancestry which through branching developed the reproductive axis of limited growth and then monoecism? With regard to the dioecious Ginkgo, except for advance in wood structure the features are Cordaitean; while if the stalk bearing the two ovules is an axillary shoot as seems likely, a cone homology with the cycads also exists. As to the conifers, they are now and have long been a homogeneous group, the most specialized of all gymnosperms. Did they ever include, or were they derived from a primitive amphisporangiate type which after branching became monoecious, then partly dioecious? Such might be defined as a hemiconifer. In conifers the stamens are still simple; but the seed scales are axillary and utterly modified. Hence it is not so sure that the basal and zonate spirals of stamens in abnormal amphisporangiate axes have no reminiscent meaning.

Turning again to Group II of the scheme it is noted that in view of the pine-like character of the *Gnetum* wood, and the fact that the amphisporangiate flower of *Welwitschia mirabilis* may even be primitive for all Gnetaleans, the question whether such floral unit was in some like manner antecedent in pines and Cordaites can not be called absurd. In any case an extreme antiquity is suggested for all of these types and groups. Unfortunately amongst the cycadeoids where it might most be hoped to answer questions of antiquity, evidence still fails. Notwithstanding the certainty of a long and cosmopolitan history the flowers are not seen beyond the Triassic, by which time despite a general simplicity of structure, modernity of type and form had already been reached. The supposed affinities with the cycads and seed ferns afford little aid in picturing the antecedent forms. Though, however the cognate facts and inferences may all fall, can the angiosperms in turn have had any other than a very remote and always amphisporangiate ancestry? It is held not. Only polyphyly explains.

In Group III the cycads could at least be derivatives of monoecious forms, while the sporophylls are of course analogous to stamens and carpels in angiosperms. The difficulty of deriving the angiosperms from within this complex, at least as homogeneous as either of the preceding, rests in the absolute lack of evidence for the presence within it of amphisporangiate axes of limited growth. The numbers are now few, giantism is intense, and apparently fertile recessiveness in the cones never occurs. Nor is much of suggestion here afforded by the seed ferns because their microphyllous variants and antecedents are not seen, and are as difficult to picture as any other hypothetic types. The medullosans are really the aberrant pteridosperms on which aside from the isolated and odd Caytonia must rest the first possibility of angiosperm affinity. Their mimicry of monocot stems was long overlooked. The tracheids are of a form which could easily give rise to vessels. The branching is peculiar.

The great evolutionary fact is that whereas in dicots and cycadeoids stem branching supports the reproductive axis of limited growth, free branching in monocots is confined to the flowering shoots. The shoots have a remote analogy to inflorescent cones. The simple cone (as seen in cycads), the flower, the inflorescent cone or strobilus of conifers, cauline branching of dicots and conifers, and the reproductive branching of the endogenous and columnar monocot, mark out the great ways of higher seed plant evolution. And when these ways are followed back with due attention to the most logical grouping of the seed plants and the fossil record, it is seen that flowers must go so far back that it is reasonable to hypothesize archaic forms above the algae leading into plants little else than a stalk bearing a few leaves followed above by micro- and then megasporophylls. According to such conceptions, in the subsequent course of phytologic evolution foliage leaf advance often tended to be thrown back into the megasporophyll, while flowers always tended to remain small, cones always to reach giantism. Whence as in the above classification, it seems reasonable to consider the flowering types as the older line and to place them between the simple cone types (cycads) on the one hand and the inflorescent strobilar types (conifers) on the other.

In looking over present day plants, and back through time, nothing is so deceptive as megaphylly and giantism, unless perhaps the mixed cones of selaginella and those of lepidodendron. It is too much to expect directly from fossils the fuller history of flower and cone. The sporophyll, cataphyll and stipules, the rôle of branching, of monoecism and dioecism, must all be considered *per se*. Only through analysis aided by diagram is it seen that the flower has always been just an emplacement of sporophylls at first spiral, then whorled and cyclic. And then only does unity in the classification—accord in structure and origin begin to appear.

Moreover, botanists have not sufficiently emphasized the fundamentally significant fact that precisely the forms concerned in plant descent throughout the ages, therefore the relatively extinct forms, should not be expected to occur as left-overs in surviving floras. Mainly the specialized types, or those of peculiar environments are the ones seen as fossils. The assumption that the visible fossil antecedents are numerous is an utter fallacy. It too easily leads to the thought that the dint of a hard analysis and approach to the problems of seed plant origin from every possible view-point may be escaped.

G. R. WIELAND

CARNEGIE INSTITUTION

THE OCCURRENCE OF PHYLLOERYTHRIN IN THE DIGESTIVE SYSTEM OF HERBIVOROUS ANIMALS

IN 1903 Marchlewski[1] described a compound obtained from the fresh excrement of a cow fed entirely on grass and gave to this compound the name of phylloerythrin. In the same year Loebisch and Fischler[2] isolated bilipurpurin from ox-bile. Marchlewski later showed that bilipurpurin and phylloerythrin were identical compounds and that they were the decomposition products of chlorophyll formed by the herbivorous animal. H. Fischer and O. Süs[3] used phaeophorbide *a* to prepare phaeoporphyrin a_6 and a_5 and from these compounds they succeeded in preparing phylloerythrin, thus proving chemically that phylloerythrin originates from chlorophyll.[4]

The presence of such a chlorophyllous product as phylloerythrin in the bile and the feces of herbivorous animals is of considerable interest; and since, in so far as we are aware, no one has determined the place or mode of origin of this substance in the body, the present work was undertaken with these objects in view.

We have demonstrated that phylloerythrin occurs in the third stomach (omasum) of cows and sheep which were fed on a normal winter diet containing chlorophyll. The stomach contents were collected at the slaughter house about fifteen minutes after the animals were killed and the material taken to the laboratory and extracted with a chloroform-pyridine mixture. An ether solution of the extracted pigments was fractionated with hydrochloric acid and the eight to nine per cent. fraction gave an absorption spectrum in pyridine-ether identical with phylloerythrin. This latter substance was crystallized from pyridine-alcohol. At the present time a sufficient quantity for a combustion analysis has not been obtained, but this will be done later. Using the same procedure as that used for the third stomach, we demonstrated spectroscopically that traces of phylloerythrin occur in the first stomach (rumen) of the cow and the sheep. The third stomach contents of a calf on a milk diet gave no trace of phylloerythrin.

Further work on the physiological formation of phylloerythrin outside the animal body is now in progress. The experimental details and a complete summary of the literature pertaining to this work will be published elsewhere a little later.

O. L. INMAN
PAUL ROTHEMUND

C. F. KETTERING FOUNDATION FOR THE STUDY OF CHLOROPHYLL AND PHOTOSYNTHESIS, ANTIOCH COLLEGE

[1] *Bull. int. de L'Académie Polonaise des Sciences et des Lettres.* Série A, p. 638–642, 1903.

[2] *Monatsch. f. Chemie.*, pp. 335–350, 1903.

[3] Ann. vol. 482, p. 225–232, 1930.

[4] H. Fischer, O. Moldenhauer and O. Süs, Ann. 486: 107–177, 1931, have shown that phaeoporphyrin a_6 and a_5 are identical.