problems of life. We must, therefore, recognize the fundamental importance of the research spirit, for education in general as well as for medical training and practice.

C. M. JACKSON

DIVISION OF MEDICAL SCIENCES,
NATIONAL RESEARCH COUNCIL,
WASHINGTON, D. C.

RECENT ACHIEVEMENTS IN PALEOBOTANY

UNTIL within the last few years a sort of forbidding lonesomeness has seemed to attend the student of fossil plants. Paleobotany is in fact the last of the paleobiologic trio to reach accuracy and finality in the methods of research employed. Above and beyond the discovery of new materials, the great need is men. There are far too few workers in definitely recognized paleobotanic positions which make active contribution possible—in all the world a few over twenty. In Germany there is Gothan, Kräusel and R. Potonié; in Sweden, Halle; in France, Carpentier and Paul Bertrand; in Austria, Kubart; in Holland, Jongmans; in Great Britain, Kidston, Lang, Scott, Seward, Benson, Weiss, Stopes, Oliver; in India, Sahni; in the western world, Knowlton, Berry, Noé, White, Jeffrey, Wieland, Goldring, Torrey, Chaney.

Where the workers are so few, contributions uniformly fail of needed criticism, and such comment as does rise to the surface may not have a sufficiently constructive effect. Only in subjects where elaborators are active and their fields somewhat overlap, does criticism become an organic, functioning thing—a force such as can carry the study of ancient plant life to the goal. There is pith in the remark of Dr. Marie Stopes that "paleobotany requires a serene civilization."

Turning to actual discoveries the initial dates may serve. Taking the past thirty-five years, that is, the close of the last century and the opening of the present, the outstanding discoveries and elaborations in the larger fields are: Seed cone of Bennettites Morierei, Lignier, 1894; finding of new localities of American cycads, Macbride, Ward, '93–94; volumes on the status of the Mesozoic floras with initial description of cycadeoids by Ward, '99–'05; cycadeoid collection and discovery of fructification and foliage, Wieland, 1898–99; early Williamsonians, Nathorst, 1902; great development of "coal ball" study by the British group of paleobotanists leading to the publication of great text-books on fossil plants and especially to the determination of the seed ferns by Oliver and Scott, 1903; taxonomy and distribution of American Carboniferous floras by White with codiscovery of seed ferns; the microspore-bearing disk Codonotheca, Sellards, 1903; chemical methods and demonstration of Williamsonians by Nathorst, 1907; sustained investigations of American dicotyledonous floras by Knowlton and Berry; brilliant study of the Kreischerville lignites by new methods, Hollick and Jeffrey, 1909; many Mexican Williamsonians with the latest of the typical Cordaite floras, Wieland, 1916; Rhynia of the lower Old Red of Scotland, the most primitive of vascular plants, Kidston and Lang, 1917; extension of the Hollick and Jeffrey methods to wider studies of lignitic gymnosperms of Cretaceous time, Torrey, 1923; collection and initiation of microscopic study of an immense series of American "coal balls," Noé, 1923; the Gilboa forest plants of the Upper Devonian of New York, Goldring, 1924.

While it is unlikely that any of these events, discoveries and accomplishments will seem to diminish in importance as the years pass by, others not mentioned may be found significant. Other names stand out, such as Zeiller, Grand-Eury, Bertrand, Gothan, Pelourdé. Although when the present century draws to a close some reviewer will surely throw into broader and fuller light as an outstanding event of these earlier years the discovery of the Pennsylvanian "coal balls." There doubtless are calcified parts of coals of extensive occurrence in other horizons than the Carboniferous. But it already appears that if any pre-Cretaceous forests may ever be fully and thoroughly reconstituted from a cosmopolitan record they must be those of the coal swamps. It is improbable that vegetal life of other periods can ever be so extendedly visualized from precise structure. The coal itself, both bituminous and anthracite, has been recently found from polished surfaces etched by flame to have the structures of lignites and of the "coal balls." Only in the latter (petrified parts of coal seams) has nature done the staining and imbedding for the investigator, who merely requires application of the simpler but well-carried-out arts of the lapidary and thin sectioner of rocks.

Just 69 years have passed since Joseph Dalton Hooker and Edward William Binney turned their attention to the seeds of the coal balls, and it appears incredible that Americans should have let all these years pass away without noting or reporting a single coal ball or cutting a single thin section from such, if a few sections of English material cut at Yale be excepted. However, the American coal balls are all at once here from Illinois, Indiana, Kentucky, Texas; and they are the key to a record of imposing extent and importance. What limits may be set to the data these great accessions may be made to yield no one now living may say. As we stand at the threshold of this new era in the study of ancient plants, the question of questions is, What were the ancestors of the Jurassic and lower Cretaceous dicotyls? Are the recent glimpses suggesting intense parallelism and great antiquity of forest types illusory? It seems not.

Professor Noé and one of his students announce the presence of angiospermous and in fact monocotyledonous structure in the materials already sectioned, although their view meets adverse criticism. Correctness or error here must depend on later more elaborate study and should not be too strongly affixed to any initial descriptions. Noé and Hoskins dismissed identity of the stems (or petioles) revealed by their sections with Myeloxylon the petiole of Medullosa, to which especially so great an authority as Seward pointedly objects. How far can objection be sustained? Or, if there is a mere presence of Medullosan structures, are such throughout more gymnospermous than angiospermous? *Possibly they are not.* If each type of tracheid, vessel, stem or flower or finally fossil plant, suggesting the presence of a link in angiosperm descent, is to be summarily cast out because the evidence is incomplete or contrary to old interpretations or on the ground that only a so-called pteridosperm is concerned, the riddle of angiosperm origin can never be solved. Yet no one would maintain that the early angiosperms, letting the word for convenience include the line of descent as far back as flowers may go, those for instance of Permian time, were not numerous.

The Medullosa of Cotta is widely known, and the later study, down to interesting comparisons with Heterangium and Lyginopteris, indicates early gymnospermous features—mainly cycadeous. No more than when Weber about 1880 found that Myeloxylon was the petiole of Medullosa could any one until very recently have suspected the presence of a Medullosan angiospermous relationship or antecedency. But the cycadeoids throw all ancient cycad-like structures under suspicion of relationship to the earlier angiospermous phyla. They were complex of habit, cosmopolitan in distribution and their floral plan was that of the flower of Linnaeus. Moreover, it is not the later cycadeoids but exactly the Triassic Wielandiella that first suggests angiosperm affinity; while the Medullosans as a detached group of highly variant structure may well include members near if not within the line of angiosperm descent. Going back in time, related lines must approach. And while monocots are admittedly more recent than dicots, both appear old and may have arisen at much the same time.

Many of the Medullosans are giant forms, always more or less deceptive. But the woody cylinder in the different types was of a very varied structure, greatly subject to reduction, or, as may equally be said, less giant development and specialization. The secondary wood is soon lost by the leaf traces as they leave the parent stele, and the steles themselves are subject to diminution. Consequently, with the monocot-like bundle features and distribution in the petioles most marked, and the *sheer certainty* that vessels even could develop from the large tracheids, other tracheids becoming reduced, monocot relationships are a possibility.

The Medullosans display a fundamental difference from the cycadeoids, cycads and Lyginopterid seed ferns, in the absence of leaf gaps. The Myeloxylon "petioles" are merely branches, and the breaking up of the steles is due to unknown causes. Such are the unusual features that favored a transition from Myeloxylon-like structures into actual endogenous stems. In fact, Medullosa is at least semi-endogenous. Thus *Medullosa pusilla* of the lower Coal Measures is one of the smallest of all Medullosans, stem and leaf bases being only two centimeters in diameter; while according to Scott the *hypoderma* of the leaf trace is simpler and does not appear to have had any secondary tissue of its own on leaving the stele. And finally, Kubart beautifully figures *Heterangium Sturii* as a typical but primitive type without a secondary xylem cylinder. Such a stem could merge into or be taken as the end result of the loss of the Medullosan secondary wood; for Medullosa is only a polystelic *Heterangium.* And don't forget the sheathed bundles.

The monocotyledons are extreme herbaceous types. It has even been suggested that palms are in their second childhood. There is no enclosing tubular stele. Secondary growth is replaced by peculiar development of strand sclerenchyma. The foliar supply is the great feature tied up with a dense peripheral bundle grouping. This is the antithesis of the dicotyl condition (stem) with progressive elimination of the large medulla and increasing importance of the secondary wood. Hence such a Medullosan stelar equivalent as Heterangium may have supreme importance as an evolutionary turning point, where the protostelic primary wood could easily lose its thin enclosing secondary xylem. The trigonid floral plan must also be old. Trigonocarpus, Seward considers "fairly assigned" to medullosans. (Fossil Plants III, 13.)

That the Medullosans, so to speak, reach the evolutionary parting of the ways has been in the mind of several paleobotanic writers. The Medulloseae or their immediate relatives may well stand near the point where one great race began to use secondary wood in its stem architecture, and another the sheathed bundle.

In the cycad *Encephalartos Barteri* there are in the seedling stem three concentric steles, each like a Medullosan stele, which unroll to form the xylem cylinder. And Miss DeFraine called attention to the fact that by loss of internal tracheids a Medullosan protostele like Sutcliffia could give rise to the cycadean woody cylinder. But the course of change could as easily occur in the reverse. The Medullosan protostelic strands could come to dominate, as the small amount of secondary wood in certain Heterangiums proves. For, as stated, each stele of such a type as *Medullosa Anglica* is the equivalent of the single cylinder of a Heterangium, both as to the primary and secondary wood; while the Heterangium primary wood extends to the stelar center in contrast to the medullated Lyginopteris. Yet in no case is a pith absent, and it is but a step to the Myeloxylon condition, foreshadowing, if not actually representing, early monocotyledonous structure. Again, Noé and his students have found the root structures which accord with these views of change toward the monocotyledons.

That the Medullosans include some of the precursors of later and higher types of flowering plants is a likelihood enhanced by the recent discoveries in the Devonian of the State of New York. The plants of the Gilboa forest are called *Eospermatopteris,* and are referred directly to the seed ferns. If the redintegration of *Eospermatopteris* by Dr. Goldring as based on the small cupulate seeds, microspore-disks, foliage and associated stumps is correct (and I believe it to be essentially so), an early Medullosan type comes into view. In the description of the stems it is said that some of the smaller ones show (well within the outer stereome zone) "toward the center an irregular ring of sclerenchyma tissue, and within this ring and to some extent outside it irregularly scattered strands of sclerenchyma tissue." All which befits a Medullosan, unless secondary to maceration and pressure. But the stumps show excellent preservation, taken as casts. Marked displacement or flotation of the wood or of any of the other tissues during fossilization seems little in evidence and this opinion is given from a huge symmetrical specimen brought from Gilboa by Professor Dunbar, of Yale. Apparently the Medullosan record extends all the way through the lower Carboniferous down into the Devonian, although what was already known of the group, particularly the relation to Heterangium, would have permitted the assumption of this early appearance, even as a giant form.

Going further, the symmetrically lobated microspore-bearing disk Codonotheca has not had the attention it deserves, not even from Kidston and Jongmans when their material demanded comparison. Codonotheca is probably a Neuropterid of Medullosan affinity, and it looks like some cupulate Rhabdocarpus seed attributed to Medullosa. The campanulas are extremely abundant. Split nodules from Mazon Creek no larger than one's hand sometimes bear three or four of the disks, some of which contain quantities of microspores; most singular if these merely drifted from other plants into position along the bundle ridges of the campanula. That is, the evidence, whether Rhabdocarpus and Codonotheca are ever amphisporangiate or not, suggests that some of the Medullosans bore flowers constructed on the cycadeoid and angiospermous plan.

The Medullosans lasted too long in geologic time, were too cosmopolitan, too varied of structure, to be unquestioningly classed as seed ferns or cycadophytes through all their record. If they advanced floristically as did the cycadeoids, and there is much reason to believe they did, the seed fern categories will shortly need revision. "Pteridosperms" have become over-inclusive in fossil plant classifications, more especially those of Seward and Scott. But a few more years will bring determinative discoveries. In the prosecution of science nothing is so unfortunate, nothing so to be feared, as failure to admit the import of new or previously obscure facts which require expression and discussion.

G. R. WIELAND

YALE UNIVERSITY

WHITE INDIANS OF DARIEN

THE story of the Marsh-Darien Expedition, organized and led by Richard O. Marsh, of Brockport, N. Y., has been told in detail in the daily press to the last of March, when it left the first base-camp, at Yavisa, in the lower Chucunaque Valley. During the preceding seven weeks southern Darien had been quite thoroughly explored without finding any blonde Indians, although Mr. Marsh had seen several at Yavisa in the summer of 1923. It is probable that any white Indians residing in that territory had hidden themselves because of the wild reports concerning the purposes of the expedition. But Mr. Marsh remained confident that white Indians would be found in the upper Chucunaque basin or in the Cordillera of northern Darien.

By the end of March, the Chokoi tribe in the lower Chucunaque Basin and the Cunas of the upper Tuyra Basin had been studied by John L. Baer, with skull measurements, and a considerable collection was made of Indian ornaments, utensils and structures. Many thousand feet of motion-picture film was taken by Charles Charlton, the Pathé photographer. Intensive study was made by Charles M. Breder of the lower vertebrates, and large collections secured. A large number of skins of birds and mammals were obtained by J. A. Johnson, the naturalist and taxidermist of the party. Some physiographic and meteorologic data also were obtained by the writer.

The failure to find any blonde Indians in southern Darien, while disappointing to Mr. Marsh, did not shake his confidence that they existed and that they would be found in the north. On March 27 the Ya-