the solubility of the hemialbumose in water, nor that of the globulins in 10 per cent. NaCl solution, but it renders the protoplasmic matrix of the cells quite insoluble in dilute alkaline solutions. These facts were established by experiments with grains which had been in alcohol for three months.

I have detected the presence of hemialbumose in the seeds of vetches and of the hemp and flax plants, and I propose to study the mode of its occurrence in the seeds of these and other plants, as I have already done in the case of the blue lupin, and further, to determine what is its exact significance in the process of germination.

VIII. "Report on Phyto-Palæontological Investigations generally and on those relating to the Eocene Flora of Great Britain in particular." By Dr. Constantin Baron Ettingshausen, Professor in the University of Graz, Austria. Communicated by Professor Huxley, Sec. R.S. Received December 12, 1878.

When, about thirty years ago, I began to direct my attention to the study of the fossil Flora, the knowledge of fossil forms of plants was confined almost exclusively to forms of the Palæozoic formations. Of the Tertiary Flora there existed at that time a very imperfect conception; but few beds of Tertiary plants were known, and these had been only superficially examined. Leaf-skeletons had not been examined, and consequently the characteristic marks upon them were not available for the purpose of instituting a comparison with the fossil leaves. The fossils themselves were only obtained from stones which had been exposed to the air, and were easily split asunder, and it was thus impossible to arrive at any accurate knowledge of the nature of the old world plants. In fact, parts of one and the same plant were often regarded as plants of different genera. Thus on making a closer and more careful investigation into the Coal Flora of Bohemia, I was able to show that the *Asterophyllites* are the branches, and the *Volkmanniæ* the fruits of the Calamites.

It appeared to me, therefore, necessary that I should devote myself to the study of the so-much-neglected Flora of the Cainozoic formations. With this object in view, I determined:—

Firstly, to collect fossil plants as completely as possible, in order that my investigation should produce results on which I might entirely rely.

Secondly, to improve the method of investigation, especially with regard to the working out of the skeletons of the leaves of living plants, so as in that way to acquire sure standpoints from which to determine the species of the fossil leaves.

Thirdly, not to confine the scope of the inquiry within the limits of

mere palæontological interest, but above all to extend it to the unveiling of the history of the development of the whole vegetable kingdom.

As in studying the Eocene Flora of Great Britain I shall follow the path of the inquiry which I originally took, I must begin by giving an account of my method of investigating fossil plants, and I shall then explain the results which I have obtained.

I.—*The Method of obtaining Fossil Plants.*

It has been usual to collect fossil plants by splitting the pieces of rocks with a hammer. The more a stone has been exposed to the action of the weather, the easier it is to break it and lay bare what is within. But fossil plants found under such circumstances are no longer in good preservation: they have suffered greatly from exposure to the weather, and generally only the outlines are visible; their structure and the finest veins of the leaf-skeleton are lost. Stone when it has not been exposed to the air is not easily split; the more compact it is the more difficult it will be found to obtain the fossils in this way. Under favourable circumstances only fragments of the fossils are obtained. By the forcible splitting of pieces of rocks with a hammer it is only possible to succeed very imperfectly in obtaining fossil plants, besides which it must always be a lucky chance that the hammer strikes that part of the stone in which the plants lie concealed, and that it has not been injured by the blow, for a large number of fossils are lost in this way, or remain undiscovered in the stone. I have found a method by which fossil plants can be satisfactorily got out of the most compact rocks without using a hammer.

The pieces of rocks are for a considerable time subjected to a thorough soaking under the pressure of two or three atmospheres. In an iron vessel full of water brought into connexion with a stand-pipe the stones are left lying for half a year (most advantageously in summer-time). In those places where there is a fossil in the stone the material of the stone is not continuous. Thus numerous, often microscopically small, splits and other hollow spaces are found along the fossil plants. These hollow spaces get filled little by little with water. Then the stones which have been treated in this manner are exposed to an intense cold, $-15°$ to $20°$ C. The water in the hollow spaces is turned into ice, and by this means the stones are burst asunder on the spot where there are petrifactions. The stones open of themselves, and show what they contain. The more compact the stone the surer and more complete by this method is the successful acquisition of the fossil plants. They show the original state in which they were preserved. With very hard stones the soaking and the subsequent freezing must be frequently repeated. On the first action of the frost the splits and hollow spaces are widened by the formation of ice within them to the surface of the stone. These must be quite filled again with

water; the stone will thus be raised to a higher temperature and again exposed to the soaking process. The ice formation and the soaking being thus employed alternately, the widening of the splits increases, till at last the stone opens of itself exactly along the enclosed fossil, which then comes to the light of day uninjured and in the best state of preservation.

This method offers not only the advantage of securing for investigation the most complete and well preserved fossil plants, but it yields also a much larger amount of material than could be obtained by the old method of forcibly splitting with a hammer. In this way no fossil can be lost. All the fossil plants in the stones are uninjured. Luck and chance are excluded. To obtain an abundant supply of useful material for investigation is of the greatest importance for the study of Phyto-Palæontology and must lead to better and surer results.

II.—*Method of Investigating Fossil Plants.*

Phyto-Palæontologists have hitherto made too many species. Unfortunately authors have been too readily disposed to adopt as a new species every slightly differing form. Consequently not only is science encumbered by a useless burden, but it is itself brought into a discredit which has occasioned serious injury to the progress of this branch of science. The most important way of remedying this evil, lies in procuring abundant material for investigation, showing a series of forms, and thus causing the false species to disappear. A collection of fossil plants acquired by careful study must therefore contain not only rare specimens, but as large a number as possible of a series of forms of common fossils. These series should be divided into two groups, the series of the contemporaneous, and of the non-contemporaneous (genetic) forms. The first is obtained by the bringing together the forms of a fossil out of the extension of one and the same layer (horizontal extension), the second in the searching for a fossil in different horizons (vertical extension). The latter series supplies the material for the phylogeny of the species, the complete elucidation of which is of the highest importance for the history of the development of the vegetable world.

A second way of removing the above-mentioned unsatisfactory state of things would be to put aside certain obsolete notions and prejudices. People are prone to admit mere differences of stratigraphical position as sufficient ground for the acceptance of a particular species, when indeed there appears to be no substantial reason arising out of its distinctive character. Only too often an insignificant difference of form, then regarded as important, is held to justify the acceptance of a species, if the fossil belongs to another horizon or another formation. My experience, however, has led me to the conclusion, that, in many cases, one species passes through many horizons and indeed through greater periods,

and that the number of the species is reduced all the more rapidly the more remote the Flora is from that of the present world. But of this more later on.

The method of investigating fossil plants must, above all things, be directed to their exact classification, and consequently to a knowledge of the facts on which the history of the development of the vegetable kingdom is supported. This however is only made possible by most carefully comparing fossil plants with living ones. Unfortunately, in this respect, so many faults and mistakes have been committed, that the greater part of the determinations as yet arrived at require revision and correction. Hitherto the fossils have not been compared accurately enough with the recent vegetable world. It may be frankly said, that most phyto-palæontologists possess too little botanical knowledge; how can it be expected of a novice in botany, that he should classify fossil plants correctly, if he do not thoroughly know the living ones?

The most frequent difficulties arise in classifying the fossil leaves which form by far the greatest number of fossil plant remains. The leaf skeleton which offers the most important marks for their classification must first be studied with this object, for the systematic botanists have barely regarded this matter at all. I may indeed point out, as a very fortunate circumstance, that exactly at the time I was much occupied with this work, Nature Printing was invented in the State Printing Office, at Vienna (1852), an operation by which the leaves of living plants with all the details of their finest veins were printed off in the most accurate manner.

I was permitted to publish a series of works on the leaf-skeleton together with illustrations in nature printing with the object of comparing them with fossil plants. The marks on the leaf-skeleton were examined and arranged, and at present all the families of living plants which are of importance in relation to the fossil Flora have been already brought into scientific order according to their leaf-skeletons.

III.—*Object and Plan of the Investigation of Fossil Plants.*

Fossil plants are often examined only for palæontological or geological purposes, but in the opinion of the author it is also necessary to consider the interests of botany. We must in this always take our departure from the known to discover the unknown. We proceed, therefore, from the Flora of the present world, step by step, to the primæval, and thus have first to investigate the Cainozoic Flora. Only when these have been fully examined and their connexion with the living Flora completely ascertained, can the Mezozoic Flora be so worked out that the genetic connexion of the Cainozoic Flora with the latter will be determined. The final object of these labours will be the investigation of the Palæozoic Flora,

and through them the question of the origin of the vegetable kingdom will receive such an answer as is open to human inquiry.

How is it possible to discover the genetic connexion of Floras following each other in immediate succession?

The successive Floras of different ages are not sharply distinguished from each other, but there are the most manifold transitions between them. These transitions are to be found in the common species. It is therefore desirable closely to examine, in the above-mentioned method, the species most frequently met with, and specially to select from the different varieties the progressive and retrogressive forms. By placing together these with other varieties discovered, in a vertical direction (that is, crossing the horizons lying over each other), the Phylogenetic series are obtained, and therewith also the required connecting links of the Floras.

As examples of the Phylogenetic series, only those of the *Castanea atavia* and of the *Pinus palæo-strobus**), found by me, are at present known. Other Phylogenetic series which I have discovered will be published at a future time.

IV.—*Results relating generally to the Tertiary Flora.*

My method of procuring fossil plants, and the improved method of investigation on the one part, and on the other the direction of the inquiry which I adopted, have led me to results which are very little in harmony with those obtained by the old method. I can only describe most of the previously determined species as being some of them incorrect, and the others of no value, inasmuch as the knowledge respecting them has been derived from insufficient materials. I shall probably, however, not be in a position to adduce special proof of this, and so correctly to determine which the false species are. On account of much new work, I must be satisfied to refer to it generally, and leave it to future specialists to relieve science from the mistakes which have been made.

I have found:—

Firstly, that all the Floras of the earth stand in genetic connexion with the Tertiary Flora. These contain the original species of the recent Flora and plant forms of all parts of the globe. The mixing together of forms of plants is clearly shown, especially in the Miocene Flora, as I at first pointed out in the Tertiary Flora of Austria.

Secondly, that in each of the recent Floras are to be perceived the elements of their common original Flora. They have, however, been more or less changed, and appear frequently altered into manifold forms. I have given the name of "Florenglieder" (members of a Flora) to these extensively-developed Flora elements. The character of a Flora

* "Beiträge zur Erforschung der Phylogenie der Pflanzenarten," "Denkschriften der Wiener Akademie der Wissenschaften," Band xxxviii.

has formed itself through the greater development of one element which has become the "Haupt-Florenglied" (principal member of a Flora); such as, for instance, has occurred in the Flora of Australia,* and of the Cape.† The rest of the genetic members have remained rudimentary. The Endemic species of European, Asiatic, and East Indian genera are, in the above-mentioned Floras, the representatives of these "Nebenglieder" (secondary members).

Thirdly, that the species of fossil plants inclined much more to the formation of varieties than those of living plants, and that the varieties of the fossil species, for the most part, correspond with the species of existing Flora. I have proved this in the case the *Pinus palœo-strobus,* the varieties of which so entirely correspond with many of the recent Pinus species, that the former must be recognised as the original forms of the latter. At some future time, I hope to publish a demonstration of the genetic connexion of the varieties of many other Tertiary plants with species of plants in the living world.

V.—*Results relating to the Eocene Flora of Great Britain.*

The very extensive materials which I have had under examination were principally those of the collections of the British Museum and that of Mr. John S. Gardner, and I have here to express to Mr. H. Woodward and Mr. Carruthers, as well as to Mr. Gardner, my most grateful thanks for their willing aid. I desire, also, especially to acknowledge my deep obligation to the Royal Society, from which I have received a grant for the investigation of the Eocene Flora of Great Britain. Mr. Gardner has gained for himself well deserved acknowledgments for the important services he has rendered in discovering and obtaining a vast collection of the Eocene Flora of Great Britain, and it has given me great satisfaction to have been associated with him in the study of this fossil Flora.

As the geology of the localities of the Eocene Flora of Great Britain has been already published by Mr. Gardner, I proceed at once to those results which the investigation of this Flora have, up to the present time, produced. These results can only be partially indicated now, as the comparing of the fossil Flora of Great Britain with other Floras will not be published until the investigations are completed. For the present, the monographic work of the *Filices* is finished in manuscript.

The Eocene Flora of Great Britain is distinguished by a series of tropical forms of ferns. Of these are especially to be named the peculiar genera of *Podoloma* and *Glossochlamys*, which connect themselves mostly with tropical forms of *Polypodium;* then the peculiar genus *Menyphyllum* most nearly related to the tropical *Aspidiaceœ.*

* Ettingshausen, "Die genetische Gliederung der Flora Australiens," "Denkschriften der Wiener Akademie der Wissenschaften," Band xxxvii.

† Ettingshausen, "Die genetische Gliederung der Cap-Flora," "Sitzungsber. der Wiener Akademie der Wissenschaften," Band lxxi.

In addition may be mentioned forms of *Chrysodium* and *Lygodium*. The appearance of the genus *Gleichenia* reminds us of the fern Flora of the Cretaceous period, while some species of *Pteris* and *Phegopteris* are related to species of the Miocene Flora. One fern, *Asplenites allusoroides* Ung, as yet only known in the Fossil Flora of Sotzka, has also here found its predecessor.

The species of the Eocene Flora of Great Britain are enumerated as follows:—

Filices of the Eocene Flora of Great Britain.

Names of Species.	Localities.	Formation.
ORD. POLYPODIACEÆ.		
a. Acrostichaceæ.		
Chrysodium Lanzæanum. *Vis sp.* ..	Studland, Bournemouth.	Lower and Middle Eocene.
b. Polypodieæ.		
Podoloma polypodioides. *Ett. et Gard.* ..	Bournemouth ..	Middle Eocene.
,, affine. *Ett. et Gard.* ..	,, ..	,, ,,
Glossochlamys transmutans. *Ett. et Gard.*	,, ..	,, ,,
Polypodium sp., near to P.	,, ..	,, ,,
,, lepidotum. *Willd.* ..	,, ..	,, ,,
c. Pterideæ.		
Adiantum Carruthersii. *Ett. et Gard.* ..	,, ..	,, ,,
Pteris eocenica. *Ett. et Gard.*	,, ..	,, ,,
,, Bournemouthiana. *Ett. et Gard.* ..	,, ..	,, ,,
,, pseudo-pennæformis. *Lesq.* ..	Counter Hill ..	Lower Eocene.
d. Aspleniaceæ.		
Asplenites præ-allusoroides. *Ett. et Gard.*	Bournemouth ..	Middle Eocene.
e. Aspidiaceæ.		
Menyphyllum elegans. *Ett. et Gard.* ..	,, ..	,, ,,
Phegopteris præ-cuspidata. *Ett. et Gard*	,, ..	,, ,,
Phegopteris Bunburii. *Heer*	Bovey Tracey ..	,, ,,
	Bournemouth ..	,, ,,
ORD. GLEICHENIACEÆ.		
Gleichenia hantonensis. *Wanklyn sp.* ..	Bournemouth ..	,, ,,
ORD. SCHIZÆACEÆ.		
Lygodium Kaulfussi. *Heer*	,, ..	,, ,,
ORD. OSMUNDACEÆ.		
Osmunda subcretacea. *Saporta* ..	,, ..	,, ,,
,, lignitum. *Gieb. sp.*	Bovey Tracey ..	,, ,,
	Bournemouth ..	,, ,,

The Society then adjourned over the Christmas Recess to Thursday, January 9, 1879.

Presents, December 5, 1878.

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