B, *C*), for instance, where the tin ground is more than sixty feet below the sea-level, whilst the estuarine deposits overlying the forest bed prove that the subsidence was progressive. Also, if the forests were submerged according to the low district hypothesis, they must have flourished under geographical conditions identical with the present, and yet these conditions have proved unfavourable to their growth on the present low lands. On the other hand, it cannot be argued that the submerged forests are mere rafts of drift wood, stranded with vegetable matter borne down by rivers, and finally buried beneath the sea sands. The traces of submerged forests are too numerous and too extensive (1, 7, 8) to be thus accounted for; in several cases, moreover, the roots are said to occur *in sitú* (3, 5, 11, ?6), and the elytra of beetles have been found (1, 6). Mr. Godwin-Austen (Q.J.G.S. vol. vi. p. 93, etc.) says: "It is diminished area and elevation which at present unfit the West of England to produce that growth of oak and gigantic fir which . . . . . seems to have clothed every portion of the region of Dartmoor, and which would still more be unfitted for it when at its lower Pleistocene level. On such low districts, however, and in a climate modified by a surrounding sea, some portion of a previous flora might have been enabled to live on." By substituting the words "at a few feet below its present" for "at its lower Pleistocene," the passage reads in accordance with my ideas.

(*To be concluded in our next Number.*)

NOTICES OF MEMOIRS.

The Plant-World before the Appearance of Man.

M. LE COMTE DE SAPORTA has recently pointed out[1] that life was aquatic before it became amphibious, and amphibious before it became aerial, and that terrestrial life is but the latest expression of the sequence that took its initial point of departure in the ocean. The seas that deposited the Laurentian and Huronian rocks, 50,000 feet in thickness, contain only the Rhizopod *Eozoon*. The Cambrians of Britain and Sweden give but 50 species of primitive types, marine vegetables, a few Sponges, Corals, and Echinoderms, Brachiopods alone representing the Mollusca, which gradually spread from their first birthplace in the Polar Ocean to other basins, no cause formerly operating to limit their extension. In Silurian times Crustacea were alone represented by Trilobites, which occurred in profusion, disappearing suddenly in the Coal-measures, and the order is now only represented by *Limulus*. Similarly, at the close of the Secondary epoch, the Ammonites as suddenly cease to exist.

The most ancient terrestrial Vertebrates show traces of affinities with the Fishes on one side, and the Batrachians on the other, and the Reptilian affinities of *Archæopteryx* are commented on; the

[1] Le Monde des Plantes avant apparition de l'homme. Paris. J. Masson. 1879.

mandibles with teeth found in the American Chalk showing a bird less Reptilian than *Archæopteryx*.

The *Labyrinthodonts* of the Coal-measures were less highly organized than those of the Trias, the ossification of the vertebræ being imperfect, and the disposition of the teeth resembling that of fishes.

The Fern, *Eopteris Morièrei*, Saporta, discovered by Prof. Morière of Caen, is the oldest terrestrial plant known, being derived from the Ardoises of Angers. In the *Cincinnati group* of America, Lesquereux has recorded several vascular Cryptogams and Gymnosperms, a *Sigillaria* (*Protostigma sigillarioides*, Lesq.), Calamites (*Annularia Rœmingeri*, Lesq., and *Sphenophyllum primævum*, Lesq.).

Insects are present in the Devonian, and no less than 30 species occur in the Carboniferous according to Heer. A Myriapod, *Anthraceps*, recently discovered in Illinois, has similar breathing apparatus to that of the order at the present day.

The Scorpion of Bohemia differs but little from the venomous species of the tropics.

From the Infra-Lias of one locality (Argovie) M. Heer records no less than 143 species of insects. Beetles and leaf-eating forms abound; but Butterflies, Bees, Ants, and Flies are still absent.

In the second chapter the author gives a careful analysis of the theory of Evolution, especially as to the facts adduced by Mr. Darwin.

In Chap. III., on ancient climate, it is pointed out that:—

At the foot of the Himalaya, tropical vegetation is maintained up to 1000 mètres; at 2000 Palms and Bananas have disappeared, and are replaced by Oaks and Pines; at 3000 snow falls in winter; at 3500 occurs a zone of Cedars; at 5000 corn is still cultivated, at an elevation about that of the top of Mont Blanc; at 5500 all life disappears.

Since the "Golden Age" of the poets there has always been present a legend of successive changes undergone by the world.

In the Quaternary age M. de Saporta considers the climate was much more humid, and the rivers consequently larger, both in Europe, Asia, and Northern Africa.

He refers to the extension of the glaciers of the Alps not only to the Jura, but from the observations of M. A. Falsan almost to Lyons. He comments on the colossal proportions of the glaciers of Argeles in the Pyrenees worked out by MM. Martins et Collumb, and the former extension of the glaciers of Scandinavia and Spitzbergen, during which the shells of the Arctic Ocean lived in the British Seas, and the plants and mammals of the Far North occupied the plains of Europe. He points out that the species found in the low grounds—to which the excessive size of the glaciers might be supposed to drive both animals and plants—are associated with species indicating warm conditions; thus the mammals of the alluvia of the Seine and Somme, worked out by M. E. Lartet and by M. A. Gaudry, are associated with *Elephas antiquus* near to that of India, and shells of *Cyrena fluminalis*, while the Mosses tell the same story as regards the plants; Vines and Laurels occurring in great abundance, not only in the middle of France, but at Moret, near Paris, and he considers that

the polar forms did not travel far from the glaciers themselves, and that the valleys enjoyed a more humid and temperate climate, and evidences the observations of Haast as to the descent of glaciers in a humid climate in New Zealand.

The mean annual heat of Lyons is now 11° Centigrade; in Quaternary times it was 14° to 15°; in Pliocene times it was 17° to 18°; the flora of the Canaries flourishing on the banks of the Saône.

The author lays great stress on the discoveries of Nordenskjöld, in Southern Spitzbergen, of plants of Carboniferous, Jurassic, Cretaceous, and Tertiary times, and states the labours of Professor Heer show the position of the earth's axis was the same in Tertiary times as at present. To Greenland he assigns a mean temperature of 9·7° Cent. in Miocene times, rising to 22° in Switzerland, the northern limit of Palms traversing the Rhine provinces and Belgium about the 50th parallel, while at the present time (excepting the *Chamærops humilis* at Nice) their limit is the 30th to the 35th parallel.

The Eocene era was marked by the multiplication and extension of Palms, Pandanas, Bananas, and other tropical plants in England and Germany, indicating a mean temperature of 25° Cent.

The Cretaceous flora of Bohemia (Cenomanian) is characterized by the first appearance of Dicotyledonous plants, including the genus *Credneria*, Magnolias, and Laurels; at Toulon, seven degrees further south, these are rare, and Conifers are the dominant forms, especially a fine *Araucaria*, and the author concludes that Dicotyledonous plants travelled from north to south, and that climate in this period first became differentiated. In Jurassic times the same vegetation spread from India, Siberia, and Spitzbergen to Europe.

The author considers in early times the earth was covered with thick fogs, the atmosphere being charged with a diffused light. With Buffon, he believes that life originated at the Poles, and travelled equatorially, and he comments on the fact that the chief Coal deposits occur at the polar sides of the equatorial zone, and that the still older *Eozoon* of the United States and Bohemia are similarly limited in area, and he regards the 50th parallel as the equator of the origin of life. An equal distribution of heat, probably not exceeding 25° or 30° Cent., prevailed throughout the world in the early periods, the contrasts of day and night, summer and winter, being but slightly marked; that light, though diffused, was certainly present, is proved by the existence of the reticulated eye of the Trilobite.

He considers the former tropical heat of the earth to be in no way connected with its central heat, nor does he ascribe the gradual secular cooling of the crust to have influenced the cessation of warm conditions on the surface—no signs of gradual decrease being apparent, as would have been the case, and especially no signs of intense heat, in the indication given by the earliest vegetation; and agrees with M. Burmeister that the earth's crust had so far solidified as to be a considerable thickness before life appeared on its surface, and points out the low conducting power of the rocks forming this crust.

In the second part, the author reviews in succession the Vegetable Periods, which he divides as follows:—

Geological Formations.	*Stages.*	*Phytological Epochs.*	*Phytological Periods.*
Primordial or Protozoic.	Laurentian. Cambrian. Silurian.	Primordial or Eophytic.	Primordial.
Palæozoic.	Devonian. Carboniferous. Permian.	Carboniferous or Palæophytic.	Devonian. Palæanthracitic. Carboniferous. Supracarboniferous. Permian.
Mesozoic or Secondary.	Triassic.	Bunter. Mushelkalk. Keuper.	Secondary or Mesophytic. Triassic.
	Jurassic.	Lias. Oolite.	Infraliassic. Oolitic.
	Cretaceous.	Neocomian. Chloritic Chalk. Rouen Chalk. Upper Chalk.	Wealden. Urgonian. Tertiary or Neophytic. Cenomanian. Supracretaceous.
Neozoic or Tertiary.	Eocene. Miocene. Pliocene.		Palæocene. Eocene. Oligocene. Miocene. Pliocene.

In the first chapter of the second part the author reviews the vegetable contents of the various formations. The earliest traces are marine, the *Bilobites* (*Cruziana*) *rugosa*, D'Orb., being a true Algæ from the Silurian; *Harlania Hallii*, Gœpp., *Chondrites fructiculosus*, Gœpp., *Murchisonites* (*Oldhamia*) *Forbesi*, Gœpp., from the Irish Silurian, and *Spirophyton*, Hall, of America, belonging to the same category. He comments on the plants of the Lower Silurian being purely marine, and figures the oldest terrestrial plant, *Eopteris Morièrei*, Sap., discovered by Prof. Morière in the slates of Angers, in the zone of *Calymene Tristani* (base of Middle Silurian), a Fern near to *Cyclopteris* of the Coal-measures. In America M. Lesquereux, and in Canada Principal Dawson, have recognized *Sphenophyllum* from the Upper Silurian, the species being *S. primævum*, Lqx. Lesquereux has also described *Protostigma sigillarioides*, Lqx., and a Lycopodiaceous plant, *Psilophyton*, has been recognized by Dawson, with affinities leaning towards the Ferns through *Hymenophyllum*, with the Rhizocarps through *Pilularia*, with the Lycopods through *Psilotum*. *Psilophyton* also occurs in the Devonian of Canada, with *Asterophyllites*, *Annularia*, *Calomendendron*, *Lepidodendron*, and ferns.

Before describing the Coal-measure flora, the author notices the formation of modern peat-mosses, and points out the conditions necessary for their production, the most important being an equable temperature, constant humidity, a flat country allowing free access to water supported by an impermeable soil, and a moderate amount of heat, peat-mosses not growing south of the 40th parallel.

The Carboniferous period marks an epoch during which a large continental area was from time to time slightly submerged beneath the water, forming vast shallow lakes, whose shores were tenanted by dense masses of vascular Cryptogams and Phanerogamous Gymnosperms, under a thick atmosphere charged with vapours precipitating rain, with a violence now unknown, producing an equable damp and warm climate. The labours are summarized of Grand'Eury, Renault, Brongniart, of Corda, Gœppert, Geinitz, Goldenberg, Stur in Germany and Austria; Schimper of Strasbourg; Lesquereux, Dawson, Dana, in America; and Williamson and Binney in England.

The Permian flora exhibits transitional and ambiguous characters, the characteristic elements of the Carboniferous being absent—Cycads, Conifers, and some Ferns have the preponderance (*Walchia piniformis, Ginkgophyllum Grasseti*).

In the succeeding Mesophytic, or Secondary epoch, the Triassic flora marks a period of decadence of old types barely replaced by new forms—species and individuals being alike rare. The Conifers are represented by *Voltzia heterophylla,* Schimp., and *Albertia Braunii,* Schimp.; the Ferns by *Danæopsis Marantacea,* Hr., and *Tæniopteris superba,* Sap.

In the Jurassic epoch, though the Carboniferous types of plants are gone, the Angiosperms, which form nine-tenths of the existing flora, have not yet appeared, except some rare Monocotyledons. Cryptogams are represented by Ferns; Gymnosperms by Conifers and Cycads, ranging from the Arctic regions to Hindustan and Europe, from Greenland to Irkutsk. Cycads now live in the Tropics, Florida and Japan marking their northern limit. The Infra-Lias Ferns, *Clathropteris platyphylla,* Gœpp., *Thinfeldia rotundata,* Nath., and Cycads, *Podozamites distans,* Presl., *Pterophyllum Jægeri,* Brogn., and *Pterozamites comptus,* Schimp., indicate a damp and humid locality. Ferns also occur in the Corallian, Bathonian, and Kimmeridgian stages. Amongst the Conifers are some resembling the modern *Araucaria,* others the Cypress.

Europe, at the commencement of the Jurassic period, formed an archipelago of large islands; the central plain, at the end of the Lias, was still separated from the Vendée to the west, and from the Vosges and Alps to the north-east. These islands gradually coalescing formed one Continental mass, at the close of the Oolitic period, when lacustrine and fluviatile conditions set in, over a large part of England and North Germany, expressed by the Wealden, and Urgonian strata of Wernsdorf, in the Carpathians, which latter has much in common with the Greenland Cretaceous flora. Amongst the latter is the Cycad, *Pterophyllum concinnum,* Hr., and *Sequoia ambigua,* Hr.

The author comments on the circumstance that led to the appearance and rapid multiplication of Dicotyledons, at the commencement of the Cenomanian epoch. He describes the Dakota beds of America as ranging through Kansas, Arkansas, Nebraska, Minnesota, and the region of Missouri, up to the Rocky Mountains,

and resting on the Trias. Of similar age are the freshwater bands, with plants, of the Quadersandstein of Bohemia; they occur also in Moravia, the Hartz, and some localities in Saxony, Westphalia, Scania, and the neighbourhood of Aix-la-Chapelle and Toulon, and in Disco and Noursoak in West Greenland.

The most southern locality is that of Beausset, near Toulon, including *Magnolia telonensis*, Sap., *Lomatopteris superstes*, Sap., *Araucaria Poucasi*, Sap.; but other Dicotyledonous genera are rare, and are numerically stronger in the German localities, between 49° and 51° N. lat., which present a mixture of tropical and boreal forms, the genus *Credneria* being an example of the first, *Hymenea* of the second (one of the latter group, *Ceratonia siliqua*, still lives on at Mentone). In the Dakota group, the *Credner*ias are represented by *Protophyllum multinervæ*, Lqx., and *Aspidiophyllum*. M. Lesquereux has also recognized Oaks, Ivy, Beech, Planes, and Chestnuts. The flora of the Middle Chalk (Cenomanian) marks the commencement of the fourth and last vegetable era the author recognizes, specialized by the appearance of Dicotyledons.

This group increases in importance in the succeeding Tertiary epoch. The Monocotyledons, which had gradually been decreasing in number and importance, also become somewhat more salient again, as conditions more favourable to vegetable life come in. Europe had still no winter, and though already to a certain extent continental, the Alps and Pyrennes were only represented by insignificant islets; lakes were scattered over much of the surface, and plants were imbedded in volcanic ashes.

In the Palæocene (Saporta, *Suessonien* d'Orbigny) the flora is little changed. It extends from the N.E. of Paris into Hainault and Liège; in the latter province it has yielded a rich flora at Gelinden, containing Laurels, Cinnamons, Oaks, Vines, and a species of *Thuites*, near to those of Japan, the flora of which resembles the facies to a certain extent. The European Palæocene flora has some affinities with the American lignitic flora, and also with the Greenland Tertiaries, especially that of Atanekerdluk.

The Eocene period was characterized by the existence of the Nummulitic sea, a larger Mediterranean extending from Asia Minor and Arabia to Western Europe, and from Africa to a Gulf including the London, Paris, and Belgian basins; it is present in Persia, India, and China, and forms the summit of the Alps, forming one of the vastest inland seas of geological history, tenanted by similar biological forms.

Washed up on the shores of the Brito-Belgian gulf were seeds of a *Nipa*, of an Indian type, near to that now flourishing on the banks of the Ganges. Near Paris, on the site of the 1867 Exhibition, at the Trocadéro, occurred Palms, Pines, Thujas, and a Dryandra (*Michelotti*), a type now characteristic of the Australian flora. A similar flora occurs in the collection formed by MM. Aymard and Vinay, at Puy, in Velay, including the now African genus *Phœnix* (*P. Aymardi*) allied to the modern Date. To this age belong the sandstones of Beauchamp, the limestones of St. Ouen, the gypsum

of Montmartre, the plant beds of Sarthe (M. Crie), and the neighbourhood of Angers, the Isle of Wight, and the lignite of Skopau in Saxony.

The flora of Aix is somewhat newer; it occurs in an old lacustrine deposit, 20 kilomètres in length, by 15 in width; it exhibits a rich flora, made up partly of European elements, and partly of plants now become purely exotic—Palms, *Flabellaria Lamanonis*, near to those of China, *Dracænæ* near to the Dragon Trees of the Canaries, Bananas near to those of Abyssinia and Africa, with plants of Australian and Madagascan flora affinities. *Acacias* abounded, whose modern representative affords the favourite food of the Giraffe.

Amongst the flora is a *Magnolia* leaf, the corolla of a *Catalpa* near to a Chinese species. Magnificent corollas of *Bombax*, and a Fig, *Ficus venusta*, near to *F. pseudocarica*, Mig., of Upper Egypt. Associated with the tropical types are the temperate forms, Oaks, Beeches, Elms, Poplars, and other temperate forms; these, however, are of rare occurrence, and it is suggested that they lived well above the level of the ancient lake, and experienced a different climate to that prevailing in the lower valleys. The facies of this apparently more temperate flora is rather that now existing in Central Asia than in Northern Europe as regards the Birch and Elm, while the Oaks resemble those of Louisiana, the Poplars those of the Euphrates and River Jordan; and on the whole the flora appears to have resembled that of Central Africa, with some elements in that of Southern Asia and China—conditions which lasted on to the end of the Oligocene, which is, however, characterized by the gradual introduction of Miocene species. Amongst the new types that appeared in Europe were species of Conifers, *Chamæcyparis*, many Sequoias, Taxodium. Amongst the Palms the *Sabal Hæringiana*, *S. major*, and *Flabellaria latifolia;* amongst the *Myricas*, *Comptonia dryandræfolia*, Brogn., most of them plants of an American type requiring either the presence of water or of a humid atmosphere. These plants traversed Northern America, Europe and Asia, and are associated with Oaks, Elms, etc., replacing the plants with African affinities, whose modern representatives require a large precipitation of rain.

The author refers to the presence of tropical types, as Cycads, Ferns, and *Gleichenia*, in the Jurassic and Cretaceous deposits of the Arctic lands, and especially to the number of species and profusion of the genus *Sequoia*, the presence of *Glyptostrobus thuja;* and he comments on the absence of the more purely southern forms, as the Palms, Pandanas, and Dragon Trees. In the succeeding epoch, the Miocene, of the Arctic region, the larger number of species appear for the first time on a horizon about parallel with that of the European Oligocene, which received from the Arctic Ocean the Limes, Chestnuts, Willows, Cedars, Birches, just alluded to, which migrated over the whole of Europe, and occupied the whole of the temperate area. Elevation of Central Europe took place, and the sediment called *Flysch*, or "shales with Fucoids," was thrown down in saturated salt lakes resembling the Caspian and Sea of Aral. These Algæ become extinct in this deposit, though ranging up from the Palæozoic, and

it is suggested that they were preserved unmodified in an inland salt sea. The Alps during this epoch probably formed a plateau, here and there covered by salt lakes; after a time the sea again gained on Europe; this *Tongrien* sea traversed a different direction to the older Nummulitic sea. It occupied anew the Paris basin, united the Isle of Wight, traversed Belgium, Westphalia, penetrated the Gulf of Cassel, fringed the Adriatic, and bordered the Vosges and the Black Forest. From the various localities including them in Alsace and Austria M. Schimper records no less than 800 to 900 species of plants. The general aspect of the vegetation resembles that now living in Australia. Palms (*Sabal major*) as large as the Parasol Palm of the Antilles. *Sequoias*, near to those of California. In the lake a profusion of Nymphacea and Nenuphars existed, now only found in Senegambia, Nubia, and Egypt. At Armissan, near Narbonne, the flora is specially rich, and exhibits characters transitional to the more modern Lower Miocene or Aquitanian.

The Oligocene period terminated with the retreat of the Tongrien Sea, which deposited the Fontainbleau grits, and at the commencement of the Miocene period the Paris basin emerged above the water, and the "Falun Sea" to the west was separated from the "Molasse Sea" of S.E. France by a central dry arm; the Faluns, of the Aquitanian period, mark deposits tranquilly deposited in lakes, gradually diminishing in depth; beds of the same age occur in the Baltic Amber region (54° lat.), at Bovey Tracey, Thorens in Savoy, Coumi in Greece (38° lat.), and Radoboj in Croatia, ranging through 16 degrees of latitude, though the included flora points to an almost absolute identity of climate. The Ferns point to a damp soil and climate. An *Osmunda* (*O. lignitum*) flourished near to the *O. presliana* of Southern Asia, Ceylon, Java, and Southern China. The genus *Lygodium* also now finds its most northern limit, with one species in Florida, and another in Japan, the Aquitanian forms most resembling the American species. The Palms (*Flabellaria* and *Sabal*, etc.) had not yet diminished in Europe. Sequoias still abound, but the Pines are becoming rarer, while the Oaks, Alders, Beeches, and Poplars commenced to exhibit their modern morphological characteristics. In the Baltic amber region Camphor Trees abound, but Palms are absent, but a number of the genus *Smilax* occur there. The limit of Palms passed probably a little north of Bovey Tracey to along the 52nd parallel. The *Sabal major* apparently did not pass north of Bonn, 50° 45′ W. lat., the lignites of which contain many other tropical plants, sensitive Mimosas, many Acacias, Azaleas, etc.

In the Coumi deposits temperate forms are few in species and individuals, and they are characterized by a profusion of tropical species. Palms are, however, rare; but the last Cycad that lingered in Europe occurs in it, the magnificent *Encephalartos Gorceixianus*, Sap., discovered by M. Gorceix.

Succeeding the Aquitanian lacustrine deposits come the Upper Miocene "Molasse Sea," the last that invaded our Continent, and turned Central Europe into a scattered archipelago. To the west the sea of the Faluns occupied the Garonne, but did not communicate

with "the Molasse," which extended from Marseilles north-eastward by Lyons, the Jura, north of the Swiss Alps, to Bavaria, and occupied the whole of the valley of the Danube, the western shores of the Adriatic, Illyria, Thrace, and the S.W. of Greece, to which Prof. Heer has given the name *Pennino-carnienne.* The marine deposits at Carry, near Marseilles, being somewhat older than the inland Molasse beds, serve to show the gradual invasion of the Aquitanian land by the "Molasse Sea" took place from south to north. During this period the steps by which the temperate zone was becoming colder, though continuous, were softened by the heavy rains of summer and the mildness of winter, which still allowed a rich and varied vegetation. At no later period of the world's history did it contain so many species of Poplar, all sections of the group being represented in France, including many types driven southward by the cold, and only now found in North Africa and Southern Asia, as the variable-leaved Poplar, *Populus Euphratica,* which is the modern representative of *P. mutabilis* of Œningen; the former the author considers to be the plant referred to in the Psalm of Jeremiah, commencing, "By the rivers of Babylon," translated Willows, the Weeping Willows introduced from China being unknown in Hebrew times.

Remarking on the fact that for representatives of the Miocene flora we have often to turn to America, a successive immigration from the Pole southwards in all directions is suggested as the explanation of these ancient geographical connections. Amongst the Ferns (*Adiantum* and *Pteris*), we have several ancestors of existing Ferns. A *Salisburia* near to *S. adiantifolia* of Japan, *Sequoia, Taxodium,* and *Glyptostrobus,* occur among the Conifers. *Comptonias* in rich and elegant variety, now only represented by one form in the sandy marshes of Pennsylvania. The Green Oaks of Œningen reproduce the aspect of Mexico and Louisiana. Through the long summers of equal heat and mild winters, the genera *Laurus, Persea, Benzoni, Oreodaphne, Cinnamomum,* and *Camphora,* still lived in the centre of Europe, but in this epoch reached their final limit in this area. Again new types commenced to appear from the north, such as the Limes. An *Aralia* (*Panax circularis,* Hr.) still lived at Œningen, a Magnolia (*M. Ludwigi,* Ett.) at Salzhausen.

The author draws a striking picture of the number and variety of the vegetable forms, and the richness and elegance of the forests of the Molasse epoch, the locality of Œningen, near Schaffhausen, alone, having yielded to M. Heer no less than 475 species of plants, besides numerous Pachyderms, Birds, Reptiles, Fish, Mollusca, Crustacea, and Spiders, and 800 species of Insects. He considers that the climate must have resembled that of Madeira, Malaga, the South of Sicily and Japan, and Georgia, or indicates a mean temperature of 18° to 19° Cent. Broken branches and crushed leaves and flowers testify to violent storms and heavy rains; but the character of the vegetation shows that flowers and fruits persisted throughout the whole year. In these primeval forests lived the great Salamander (*Andrias Scheuchzeri,* Holl.), of which the living type is found in Japan (*H.*

japonicas, Tem.). Amongst other fossiliferous localities are the lignites of Wéteravic (Salzhausen, Roekenberg), Gunzbourg in Bavaria, Bilin in Bohemia, Menat in Auvergne, Mt. Charray in Ardèche, Parschlug and Gleichenberg in Styria, Tokay in Hungary, and the neighbourhood of Vienna.

Reviewing the Tertiary floras, the Count de Saporta points out the vigorous and complete flora of the Palæocene was succeeded by the poorer but more varied flora of the Eocene, containing an assemblage of plants with African and Southern affinities, which persisted on in the rich flora of the Miocene, in which, at the commencement of the Oligocene, an influx of Northern types is observable, which gradually increased in importance, as the influence of winter first appeared in Central Europe; the vegetable zenith was reached in this epoch, and with the succeeding Pliocene a gradual exodus of exotic forms took place, with the definite climatic change which is too marked to have been due simply to alteration of geographical configuration; though the elevation of the Molasse sea-bed into land and the appearance of the Alps probably snow-covered would not be without effect in assisting the general chilling of the atmosphere. But the change was a cosmical phenomena, commencing with the Oligocene, and embracing the earth in its effects. At the commencement of this era the ice at the pole would be sporadic and occasional, gradually becoming permanent, and to give off masses of floating ice to chill the more southern districts, themselves now covered with glaciers in the more mountainous parts. These changes were probably gradual. Resting on the marine Molasse, with *Ostrea crassissima* of Provence, are lacustrine deposits, in which tropical plants still linger. An exotic Fig, *Ficus Colloti*, Sap., and a Bamboo. At Cucuron, at the foot of Mont Léberon, M. Gaudry has discovered a large number of Mammals, and he observes the end of the Miocene is characterized by a great development of Herbivores; this is the case not only in Provence, but at Pikermi, in Greece, and Eppelsheim on the banks of the Rhine. Stags also began to appear. Oxen were still absent.

Mio-pliocene.—Arms of the sea still occupied the valleys of the Rhone, Danube, and the Po, and extended over parts of Belgium, north of the valley of the Thames, in Sicily and Algeria.

In the Vienna basin, resting on the Molasse, is the *Sarmatic* stage, with *Cerithium*, which contains a rich flora, near to that of Œningen. Cinnamons, Camphor Trees, Acacias, and *Sequoias*, and a *Callitris*, in the succeeding deposits, "the zone of *Congeria*,"—all these have disappeared for ever, except the genus *Sequoia*, and the Cinnamons, which still lingered in the floras of Stradella, near Pavia, and of Senigaglia, in the Marches; and in the East a true bamboo, *Phragmites*, still existed. The Sassafras of North America, the Glyptostrobus of China and Japan, the Planera, Platanus, Liquidambars of Southern Asia, are also still represented at Senigaglia; associated with Limes and Oaks, clearly the ancestors of our own European trees, and in beds of similar age (marine molasse of St. Fons, Isère), in the Rhone Valley occurs a Beech with entire curved leaves like

that of our forests—*Fagus sylvatica pliocenica*, affording a valuable index of the existing climatal conditions, requiring, as it does, rain throughout the year.

In the somewhat newer fluviatile beds of Vaquières, explored by Prof. Marion, grew an *Alnus*, between a Syrian and a Japanese species; a *Glyptostrobus*, near to that of Canton; a reed, near to the green reed of the Nile (*Arundo Ægyptia antiqua*, Sap.), covered the sand banks of this ancient river. The calcareous deposits of Meximimiex, discovered by M. Falsan, disclose rich forests, resembling in the character of their vegetation those of the Canaries, joined with Asian, North American, and European facies; but tenanted yet, only by Stags, Mastodons and Tapirs.

To this age belong the lacustrine deposits associated with basaltic overflows of Auvergne; in that overlying the older lava M. B. Rames has found in Cantal the remains of *Dinotherium*, *Mastodon*, *Hipparion*, and *Machairodus*, which places these beds on the horizon of the Upper Miocene of Mont Léberon and Pikermi. Over these come porphyritic basalt, and trachytic conglomerate. The country was broken into ridges and escarpments, the northern and southern aspects of which were covered by a somewhat different vegetation, which also now varied with elevation,—profound forests occupying the hollows of great magnificence, and tenanted by a numerous fauna. New eruptions, first of trachyte, then basalt, then phonolites, then of more modern lavas. These are associated with volcanic tuff and ash beds, containing a numerous Pliocene flora, especially at Puy, in the "Grey marne with tripoli," at Ceyssae (Haute-Loire), examined by MM. Aymard and Haydes, and the Cantal beds examined by Rames, which he correlates with those of Lyons. At Pas de la Mongudo, on the south of the volcanic district, and Saint-Vincent, on the north, occurs a Japanese species of *Acer* (*A. polymorphum*), which has recently been reintroduced into France by the horticulturist. In these flora modern genera and species, Oaks, Elms, Alders, Poplars, etc., multiply in numbers, and preponderate over the few remaining exotic types. The same temperate facies is observable in the littoral deposits of the Val d'Arno, and in the travertines of Lipari, where the Palm, *Chamærops humilis*, still lingered on.

At the commencement of the Pliocene period, favoured by the dampness of the climate and the increasing cold, glaciers gradually descended the flanks of the high mountains to the valleys beneath, and great aqueous precipitation took place. The Norfolk Forest Bed is correlated with the horizon of St. Martial in Herault and the more recent parts of the Val d'Arno series. Mastodons had quitted Europe; Monkeys had emigrated to Africa; but Rhinoceri and Hippopotami had never been more numerous; Stags abounded; but the age was specially characterized by *Elephas meridionalis*, found associated in the sandy marls of Durfort, with the leaves—on which it fed chiefly—of an Oak, of a species still living in Southern Italy. A Laurel lived on in the Rhone Valley, and *Abies montana*, and other northern species, in the Forest Bed; climatal difference of vegetation in the North and South of Europe being first strongly accentuated in this period.

The author closes his work by summing up the seven elements into which the past and present French flora may be divided. The indigenous plants being those, like the Vine, that have never quitted France. Others, though fully developed in the Tertiaries, are now only tropical; others are cosmopolitan; some now live in foreign warm temperate regions, though extinct in France; others inhabit Madagascar and Africa; a small number have American affinities (Sabal Palms, etc.); whilst the Greenland and Arctic flora is well represented by Sequoias and Glyptostrobus of the French Tertiary.

C. E. De Rance.

REVIEWS.

I.—"Dr. W. Waagen On Geographical Distribution of Fossil Organisms in India." (Read at the Imperial Academy of Science, Vienna, December, 1877. Translated in Records Geol. Surv. India, vol. xi. p. 267.)

THIS paper, from the scope of its subject and the largeness of the conclusions put forward, may be called both important and ambitious. Important because, independently of the author's speculations, it contains a well-condensed summary of the geology of India as now known; and ambitious, in that it seeks to present somewhat of the changing scene of the ancient physical geography of this great portion of the earth's surface since early Palæozoic times. It speaks well for the progress of geological knowledge regarding India, that data of so tangible a nature exist to aid the impulse towards speculative inquiry.

No "fear to fall" would seem to prevent our author from climbing, and if we cannot quite go with him to heights within the region of pure conjecture, it must be admitted that his "bold" theoretical sketch wears an aspect of consistency so far as he adduces evidence, and, despite one's doubts of large assumptions, leaves the impression of being, at least to some extent, founded on fact.

The former existence of a continent of which India formed a part ever since Palæozoic times, is not by any means a new idea; this has been suggested or mentioned by many writers;[1] but the definition of its form at various geological periods, as indicated by the distribution of marine fossils, is the special object of the paper under notice; the author dissenting strongly from the supposition of Mr. H. F. Blanford, that this continent was connected with Africa or Australia.

After noticing all the formations of Peninsular-India, the Himalaya, Burmah, the Garrow hills, on the east, and the Suliman ranges to the west, and referring to his neat geological sketch-map, Dr. Waagen concludes from the distribution of "slaty" and sandstone Palæozoic rocks (the word 'slaty' being evidently used as synonymous with 'marine') that there was in Palæozoic times an Indian continent whose northern limits coincided with the foot of the Himalayan chain, and which included the whole of British India to the south.

[1] Hæckel, Hist. Creation. H. F. Blanford, Physical Geography of India, 1873. W. T. Blanford, J. A. Soc. Bengal, 1876. Geol. Mag. Decade II. Vol. III. etc.