be good grounds for believing that they were idols; but had I been left without help to interpret for myself I should not have guessed them to be net-sinkers, but rather children's playthings—the ancient representatives of modern dolls. To show how little pains are sometimes taken in the preparation of net-sinkers, I may mention that a few months ago, while walking along the banks of the River Bann, I saw a fisherman cutting the tough sward into pieces about two inches by three or four, which, in answer to my inquiry, he informed me were intended for net-sinkers. I asked him why he did not use stone or lead, and he replied that turf sinkers were much superior, as in using them the nets never became entangled in the bottom of the river. I wonder if this custom is a recent invention or a survival from earlier times.

I was struck by the close resemblance which several other objects in the Schliemann collection bore to Irish antiquities. I have noted several tool-stones with the usual hollowed marks on the sides, especially those bearing the double numbers 26 and 1578, 26 and 1478, 26 and 1522, 45 and 1499, and also a stone celt or hatchet with marks on the sides like those on the tool-stones, and hammered at the edge, numbered 13 and 1505, all of which I could match from my own collection. Several whorls are marked in my notes as being similar to others found in Ireland, and an object bearing the numbers 6 and 1636 as being almost identical with double stone beads in my collection. I have also a large series of rubbing or polishing stones similar to others in Dr. Schliemann's collection. Hammer-stones numbered 6 and 7268, 26 and 1529, 26 and 1566, 13 and 1570 are perfect duplicates of some of those found by myself, with flint and bone implements, &c., at Portstewart and Ballintoy. The ornamentation on a few of the stone and glass whorls and beads in my collection have a sort of resemblance to that on some of the terra-cotta whorls exhibited by Dr. Schliemann.

Cullybackey, Belfast, February 10 W. J. KNOWLES

Selenium

THE use of selenium for the automatic registry of star transits, proposed by me in a letter which you were good enough to publish in NATURE, vol. xxiii. p. 218, leads to the idea of applying it in a somewhat similar way for photometric purposes, in order to improve the existing scale of star magnitudes, and to watch any variations therein. W. M. C.

Bombay, February 5

A CHAPTER IN THE HISTORY OF THE CONIFERÆ

THE Sequoias form the third genus of the Taxodieæ in the "Genera Plantarum." The only existing species are the Wellingtonia and the Red-wood of California, both of which are confined to the south-west coast regions of the United States. Their nearest living allies are Taxodium and Glyptostrobus; but these were as completely differentiated in the Eocene as at present, and they all appear, like the Ginkgo, to be survivals from more ancient floras; Sequoia especially had formerly a far wider range than it has at the present day.

The Sequoias are monœcious, and have obtusely ovate ligneous solitary and terminal cones one to two inches in length, which are persistent and gaping after shedding the seed. The scales are spirally disposed, sixteen to twenty in number, wedge-shaped, with an orbicular or transversely oblong nail-like head, depressed, wrinkled, and mucronate in the centre, sharing thus to some extent the ornamentation which seems a characteristic of the Taxodieæ. The foliage is distichous and yew-like in *Sequoia sempervirens*, and spiral and imbricated in *S. gigantea*, but both occasionally foliate in the opposite way. The former, or red-wood, occupies the Coast Range, a sandy rock rising to 2000 feet, of supposed Cretaceous age, and forms dense forests twenty to thirty miles in width, from a little south of Santa Cruz to the southern borders of Oregon, following the coast line for some 350 to 500 miles, its distribution depending, according to Prof. Bolander, upon the sandstone and oceanic fogs. The *S. gigantea* extends at intervals along the western slope of the Sierra Nevada for nearly 200 miles, and at elevations of 5000 to 8000 feet. "Towards the north the trees occur as very small, isolated, remote groves of a few hundreds each, most of them old and interspersed amongst gigantic pines, spruces, and firs, which appear as if encroaching upon them; such are the groves visited by tourists (Calaveras, Mariposa, &c.). To the south, on the contrary, the Big-trees form a colossal forest forty miles long and three to ten broad, whose continuity is broken only by the deep sheer-walled cañons that intersect the mountains; here they displace all other trees, and are described as rearing to the sky their massive crowns; whilst seen from a distance the forest presents the appearance of green waves of vegetation, gracefully following the complicated topography of the ridges and river-basins which it clothes."[1] The leaves are scale-formed, rounded dorsally, concave on the inner face and closely inlaid, regularly imbricated on the branchlets, longer and looser on the branches. In young trees they are much larger and freer, with long and awl-shaped leaves at an acute angle to the stem. No trees under cultivation in this country seem yet to have completely assumed the small imbricated foliage characteristic of the giant trees of California.

Although the types of foliage in the two existing species appear to be perfectly distinct, they are not really entirely so; for *S. sempervirens* preserves the spiral scale-like leaves for a short distance at the base of each branchlet, and *S. gigantea* sometimes assumes the distichous arrangement. Besides, the foliage of the former is not in two rows as it is in Taxodium, being spirally arranged round the stem; but the leaflets, where they are flat and comparatively expanded, have a strong tendency to crowd into two marginal rows, so that every surface becomes exposed to light and moisture. The leaflets take a half twist near their base, and then diverge upward or downwards towards the sides of the branchlet, an additional row frequently lying centrally along the branch.

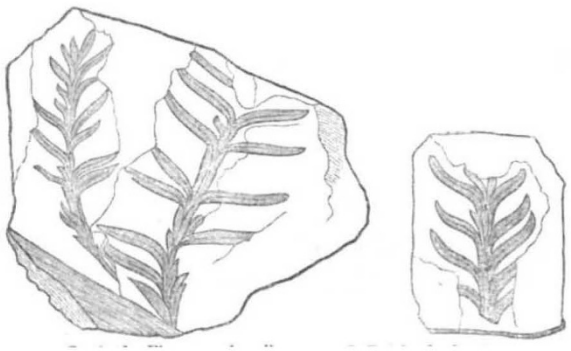
The earliest-known Sequoias are Cretaceous, and were described by Carruthers, one as *S. Woodwardii* from Blackdown, and others as *S. Gardneri* and *S. ovalis* from the Folkestone Gault. The foliage from the latter has falcate leaves like Araucaria, and it is only inferred that it and the cones belonged to the same trees. It is not impossible that the cones may have been brought down from some high ground, and the foliage been shed by trees nearer the sea-level. Although Sequoia itself cannot be traced farther back than the Cretaceous, Schimper speculates on its probable derivation from some much older Araucarian form, and believes its position to be between the Cupressineæ and the Abietineæ.

Saporta regards the Chalk period as the age of Sequoias, and our principal knowledge of them is derived from Heer's "Flora fossilis arctica," where a large number are figured. Saporta speaks of Pattorfik as a Sequoia wood carpeted with ferns, and Ekkorfat as a forest composed of cycads, sequoias, and firs. *S. Reichenbachii* is the chief form, and occurs in the Cretaceous of Kome, Spitzbergen, and doubtfully at Atane. The foliage resembles the larger foliage of *S. gigantea*, being spiral, awl-shaped, set at an acute angle to the stem, and with the points overlapping. It differs in being less regularly spiral, and often combines an approach to the more distichous *S. sempervirens* type, being called in such cases, *S. Smittiana*. In several of the figured specimens from the Komeschichten the branchlets of the two forms are almost united, and a very slight degree more care in collecting would, it seems, have placed the reality of the union beyond the possibility of doubt. One instance is reproduced from plate xx., and a fragment from the same plate determined as *S. Reichenbachii*, to show that even apart from the frequent association of the two species on the same slabs, their distinctness cannot be maintained if the

[1] Lecture before Royal Institution, April 12, 1878, by Sir J. Hooker.

plates are faithfully drawn. The separation of another species, *S. rigida* from *S. Smittiana*, seems even less warranted; but *S. ambigua* has somewhat smaller foliage and cones, and *S. gracilis* still smaller foliage, approaching *S. Couttsiæ*, yet compared, for no obvious reason, with *S. Gardneri*.

Spitzbergen has no Cretaceous species peculiar to it, but the Upper Cretaceous of Atanekerdluk possesses, besides two of the Komeschichten species, *S. fastigiata*, Sternb., and *S. subulata*, Heer. These two bear the

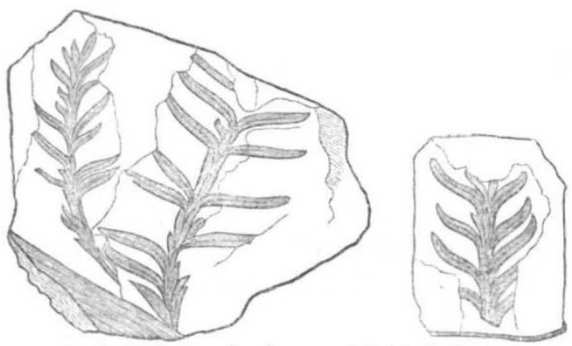


a, *b*, *S. Reichenbachii*; *c*, *S. Smittiana*, Fig. 7, pl. xx. vol. iii. "Flora foss. Arctica."

same relationship to each other that we have seen between *S. Reichenbachii* and *S. Smittiana*, only they are both considerably smaller, and were, as in the other case, doubtless the same tree.

S. Reichenbachii is said to be met with in other Cretaceous deposits in Bohemia, Saxony, Moravia, Belgium, &c., and *S. fastigiata* over the same, but a more restricted area; their wide distribution being held by Saporta to evidence a former universal equality in temperature.

It is of course useless, without further material, to seek



S. rigida, Fig. 11*a*, pl. xxii. *S. Reichenbachii*, Fig. 8, pl. xx.

to unite the whole of the above species, since they have been described as distinct by Heer; but it seems perfectly certain that had collecting been systematically carried on, a small proportion only of the specific distinctions could have been maintained. The excessive subdivision is to be regretted, since it has given undue prominence to the Arctic Sequoias of this age as a group, and will otherwise lead to inconvenience. Their chief and most interesting characteristics have been overlooked by Heer. These are first the union in one plant of the now almost completely differentiated *S. sempervirens* and *S. gigantea* types; and second, that the foliage, which then approached to the distichous *S. sempervirens* form, was produced, if the plates are correctly drawn, by the shortening almost to abortion of the upper and under leaves, and not to their being narrowed at the base and twisted, as at present, towards the sides of the branchlets.

The Arctic Tertiaries have yielded no foliage of the spiral, needle-leaved *S. gigantea* type, except that which has been referred to *S. Couttsiæ*. The large Araucaria-like foliage of *S. Sternbergi* does not seem at that time to have existed much farther north than Iceland, while the *S. sempervirens* type seems to have been abundant. *Sequoia Lagnsdorfii* is in fact the prevailing fossil in Greenland, scarcely any stone with leaf impressions being without some remains of it. The branchlets are generally simple and single, rarely forking, and seem thus to have had a short season of growth and been quickly shed, an adaptation probably to the long Arctic winter. Flowers, fruits, and seeds have been collected. It is hardly less abundant at Spitzbergen, Mackenzie River, and other localities near the Arctic circle and in Iceland. The cones are said to be somewhat larger, and with more scales, and the leaves less pointed than in the existing species. The more decidedly imbricated character of the fruit-bearing branchlets implies a closer affinity with the Cretaceous forms. Heer makes six duly-named varieties out of the Spitzbergen species, being probably unaware of the extent to which foliage on the same tree may vary at the present day. *S. brevifolia*, again, is at best a variety, and *S. disticha* has leaves in opposite pairs, and while unlike in this respect, has nothing besides to support its reference to Sequoia. *S. Langsdorfii* next appears in the Miocene Baltic and in the Aquitanian and Mayencian stages in Switzerland, Germany, Austria, and France, but does not seem to appear in any Upper Miocene beds except as far south as Italy, where it occurs in several localities. This distribution is important, as well as the fact that branchlets from beds of Central Europe are more compound than those from the far north. Another Spitzbergen species, extremely abundant where first found, is *S. Nordenskiöldi*, said to be distinguishable by smaller and softer foliage, narrower leaflets scarcely tapering at the base and at more acute angles to the stem, the last being the chief distinctive character. None seem to have been met with in the 1872 expedition, only *S. Langsdorfii* being illustrated. in the fourth volume of the "Flora fossilis arctica."

Another species belonging to the same group, described by Saporta as *S. Tournalii*, is found in the Miocenes of Manosque, Armissan, and Kumi. It is principally characterised by the clustered, rarely solitary cones, and while the foliage resembles generally that of the existing species, the branchlets bearing fruit were much more imbricated, and in this respect resembled those of *S. Langsdorfii* of the Arctic floras.

Most of these types have also been met with in America —where Lesquereux, following Heer, has over-subdivided the fragments into species.

The *S. gigantea* type had by far the more restricted distribution of the two in the Tertiaries. Much of this form of foliage from the Lower and Middle Eocenes of England and France has been referred to Araucaria; but elsewhere, in the Oligocenes especially, almost the whole of it is referred to a single species of Sequoia, *S. Sternbergi*. It agrees with that of young plants of *S. gigantea*, the leaflets being less falcate, longer, and at a more acute angle to the stem than in the nearest existing Araucaria. On the other hand, however, no nearer approach to the ordinary adult foliage of *S. gigantea* is ever associated with them. The characteristic cones of Sequoia, which are small and numerous, and very persistent on the branches after the seed is shed, remain attached in several fossil species, as *S. Couttsiæ*, wherever

they are met with: but are rarely associated with the foliage figured as *S. Sternbergi*, none having been found at such important localities as Sotzka, Häring, Monte Promina, and Bilin, where foliage abounds. This absence of cones is very strong negative evidence against their foliage in the above localities at least being Sequoia, and in favour of their being Araucaria. The cones of Araucaria are few and large, shaken to pieces by the wind almost as as soon as ripe, and when carried by water the flotation of the winged seeds and of the foliage would differ enough to lead to their being separately imbedded. The foliage was described for years as *Araucarites*, and a well-defined immature cone of Araucaria was found in the deposit at Häring and figured by Sternberg [1] and by Goeppert [2] as *Araucarites Goepperti*, and afterwards considered by Unger and Ettingshausen [3] to belong to *A. Sternbergi*. Another small Araucaria-like cone is figured by Massalongo from Chiavon,[4] which was found associated with foliage identical with that from Bournemouth. Similar foliage, but still nearer to Araucaria, is found at many places in France, and in England at Sheppey, Bournemouth, Bracklesham, the Isle of Wight, &c., but also always without any Sequoia cones, although I have found an Araucaria cone at Sheppey.

Against all this evidence we have to set the fact that a branch with compressed cones attached has been found in the Upper Miocene near Turin, and that Sequoia cones are found in the same strata with somewhat similar foliage in Iceland. In both these instances however the foliage differs materially from the typical *S. Sternbergi* of Sotzka. If we consider that foliage of existing species of Araucaria, Sequoia, Cryptomeria, and Arthrotaxis can with difficulty be distinguished, and that species which have died out may have approached each other still more closely, the evidence upon which Heer has changed the determination of all the Austrian and German specimens must appear insufficient. The possibly accidental similarity, not identity, of foliage occurring in deposits far apart and of widely different age, does not, I hold, outweigh the other facts I have advanced.

This type of foliage, whether it belong to one or many genera, has not been found of Tertiary age north of Iceland, nor in the newer Miocenes of Central Europe, if we set aside two more than doubtful fragments from Oeningen. It abounds however in England, France, Germany, and Austria in Eocenes and Oligocenes, and recurs, as an Upper Miocene form, in Italy only.

The British Eocenes have been credited with several Sequoias, as *S. Sternbergi* and *S. Bowerbankii* from Sheppey, *S. Langsdorfii* from Alum Bay and Bournemouth, *S. du Noyeri* from Antrim, &c., &c. There is, I believe, no good evidence yet of the presence of any Sequoia except *S. Couttsiæ*, confined to Bovey, Hempstead, and perhaps Bournemouth, in any Tertiary rock of Great Britain. This question however cannot here be profitably discussed. *S. Couttsiæ* was originally described by Heer from Bovey Tracey, where it literally abounded. The foliage resembles that of *S. gigantea*, though smaller and more delicate, and must have been very graceful; but Heer's restoration of it, since copied into other works, is very stiff and unnatural. The foliage in the "Flora fossilis arctica" is much coarser, and should not have been referred to the same species. Saporta describes a beautiful variety "*Polymorpha*" from Armissan, in which the ultimate branchlets take on the *sempervirens* character. *S. Couttsiæ* seems to have been capable of supporting considerably greater heat than any of the other species, if we may judge from the associated plants.

The leading facts known to us respecting the past history of the Sequoias may be summed up thus. They are not known to be older than the Cretaceous, when they were principally a northern form. The differentiation of the existing types has progressed from that period to the present, being slight in the Cretaceous (*e.g. S. Reichenbachii*); more pronounced in the Eocene (*e.g. S. Couttsiæ v. polymorpha*); yet more so in the Oligocene and Miocene (*S. Langsdorfii*), and most so at the present day, though even now there is a tendency to approach each other. The number of fossil species should be considerably reduced, and much of the supposed Sequoia foliage transferred to other genera. The genus is known to have ranged as far south as Central Europe during the Cretaceous, seems to have retreated north during the Lower and Lower Middle Eocenes, re-occupied its former habitats in the Upper Middle Eocene and Oligocene, first through *S. Couttsiæ*, and then through *S. Langsdorfii*, and ranged into Italy during the Upper Miocene. It was well-nigh exterminated during the Glacial epoch, and has been strangely preserved in two isolated spots, perhaps beyond its original range, where the moderating influence of the Pacific enabled it to survive on, or occupy at a remote period lofty mountain spurs between the sites of ancient glaciers. Fixed on exceptionably favourable stations with congenial soil, the existing species may have slowly adapted themselves to a temperature far more genial than that supported by their polar ancestors, and, in adapting themselves to an always increasing mildness, have acquired that stupendous habit of growth which makes them the giants of vegetation.[1]

The moral to be drawn from the history of the Sequoias is that we should not place implicit credence in the minimum temperature of the so-called Miocene Greenland, Spitzbergen, Vancouver's Isle, Sitka, and Arctic America and Asia, as settled by Heer. Such bald argument, as for instance that because Sequoia now requires such and such a temperature, therefore former but different species must have required the same, is entitled to but little deference; yet Heer's facts and opinions are quoted as axioms by a wide range of workers. When examined they are seen to be disputable, whether taken as physiological, geological, palæontological, or any other data. Provisionally they were of use, but the questions depending on the accuracy of the data are so important and the evidence so intricate that they should not be deemed settled until some greater amount of care has been bestowed on them.

J. STARKIE GARDNER

[1] "Verst.," vol. ii. p. 204, Pl. 39, Fig. 4.
[2] "Monogr. foss. Conif.," 1850, Haarlem *Trans.*, p. 237, Pl. 44, Fig 2.
[3] "Flora von Häring," p. 36. [4] "Specim. Photogr.," pl. xxi.

GEOMETRICAL TEACHING[2]

WE are glad to see that the Association for the Improvement of Geometrical Teaching has been by no means idle, though no report has been issued since January, 1878, but that there has been a good deal of silent work going on in the way of sub-committee discussions upon the several syllabuses of solid geometry, of higher plane geometry, and of geometrical conics. All who know the president will heartily sympathise with him in his bereavement, and will understand how unfitted he must have been for any other work than that which his position at Harrow imperatively required of him. He has now thrown himself with much energy into the cause, and proof of his interest in the labours of the Association is manifest throughout the interesting address which is printed on pp. 12-17 of this Report. It is well known that he has long advocated an extension of the scope of the Association, and in this address he takes the opportunity of putting his views well forward.

"It was doubtless well at the outset of our work to concentrate our attention and confine our efforts to the definite field, in which perhaps the need for improvement

[1] If we can really trace back the history of *S. gigantea* to fossil forms, it becomes curious to notice that it is only now approaching *S. Couttsiæ*, the type which there is reason to believe formerly supported the highest temperature of any Tertiary Sequoia.
[2] Association for the Improvement of Geometrical Teaching. Seventh General Report, January, 1881.