types in succession; often a dune phase is interposed in this series, immediately after the beach.

2. Hydrophytic to Mesophytic. Hydrophytic areas are common in young regions and are either drained or undrained. Undrained lakes and swamps are very common at first, but are very rapidly filled by vegetation, so that one formation rapidly follows another from the lake to the forest; zonal arrangement is usually found in these places. Drained swamps and rivers often increase as a region grows older; progressive development is best seen on the flood plains, where the order of succession is commonly well marked and rapid, culminating in the very highest type of mesophytic forest. There are often hydrophytic shores along the lakes, usually in the less exposed places; their history is much like that of a swamp.

B. Retrogressive Development of Plant Formations. Retrogression is commonly local or evanescent. It is best seen along lake or river bluffs, where constant erosion causes the destruction of mesophytic formations. When erosion ceases, progressive movements begin, culminating again in mesophytic floras. Retrogressive movements may also be caused by crustal movements, changes in climate, or through the action of man.

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II.

THE RELATIONS OF THE NORTH AMERICAN FLORA TO THAT OF SOUTH AMERICA.

IN my paper on 'The Relation of the Flora of the Lower Sonoran Zone in North America to the Arid Zones of Chile and Argentine,' attention was called especially to discussions by Gray and Hooker and by Engler on the presence of North American or boreal floral elements in South America. The species considered in the two citations were chiefly alpine and mountain xerophilous plants of the Rocky Mountain Region and the arid Southwest (the latter especially by Engler) which occur in the Mexican Cordilleras and in the boreal altitudes of the tropical Andes, becoming more generally distributed in the extra-tropical Andes and the higher plains of Chile and Argentine. My own paper attempted to show that a very significant number of the genera representing the most extremely xerophilous elements of the enclosed desert plateaus and valleys of the Lower Sonoran Zone, reappear in correspondingly arid regions far south of the equator, and that the intervening territory contains these rarely or not at all. It further discussed the problems of distribution between the two regions, going in some detail into a discussion of certain species which illustrate the case especially well.

In this paper the purpose will be to point out the generally known and accepted facts of relationship between the floras of North and South America as illustrated in all the floral elements represented in both, emphasizing more particularly the elements which I have studied in some detail which furnish additional evidence for conclusions already suggested rather than offer a new solution to the more difficult problems of distribution.

It may be said as an elementary observation, that if we consider only the present aspects of plant life, and conceive the floral zones of North and South America to be due to and lie coincident with zones of latitude, we should have in the two Americas only the tropical zone in common, shading off into the north and south zones of lower temperature, in which the likelihood of a mixture of boreal and austral elements of any two corresponding boreal or austral zones would grow less with increasing proximity to the poles. The question of distribution would be chiefly one of distance which might or might not be overcome by

any of the various agencies operating now. In other words, we should expect endemism to increase with latitude and a consequent minimum of forms common to two corresponding zones. As a matter of fact, however, these simple conditions are wholly changed because of the existence of north-south zones of elevation, shading off vertically from tropical to Arctic Alpine, and cutting through the tropical and sub-tropical latitudinal zones at right angles, and so approximating a connecting bridge between boreal and austral zones. Here, again, if we take any given era in the history of vegetation and assume the north-south zones to be continuous, the results of distribution could be fairly predicted.

But in considering the relations of the floras of the two continents, no fact stands forth more prominently than this, namely, that we have to deal largely with the geological and climatic changes which have taken place during the time since the flora of the earth began to assume its present aspect, and to possess its present specific content. For many elements of vegetation which still persist we could reasonably go back as far as the Eocene Tertiary, although much of what are called *Peculiar West American Elements* must have developed at a very much later period. Assuming, however, the Eocene Tertiary as the starting point, some very important conditions and changes in the relations of the two continents may be pointed out, which would influence the development and the distribution of plant life most profoundly. These are to be borne in mind when we seek to explain the floral relations of North and South America. Such, for example, are the following:

1. At the beginning of the Tertiary period, a large part of Western North America was at sea level. The Rocky and the Sierra Nevada Mountains ranged from 3,000 to 5,000 feet in elevation. West America was separated from Atlantic America by a wide sea. By the end of the Tertiary Period the elevation of West America was tripled, bringing the mountains to at least their present height and elevating the plains and Great Basin region.

2. During the Eocene and Miocene eras, Central America was submerged, thus separating the two continents.

3. With the beginning of the Tertiary Period, the Andes stood but little above sea level. A Cretaceous sea had extended along their eastern front from Venezuela to Argentine, separating the Brazilian region from the Andean. By the close of the Tertiary, the Andes had emerged as much as 20,000 feet on their east front, and the region at their eastern base stood emerged from the sea.

4. During some portion of the late Tertiary upheaval, or subsequently, South America was joined to Cuba and probably to Florida. There is reason to believe that at a similar period the land masses of Mexico and the Californian region included the now isolated islands lying to the westward, thus making a broad highway for distribution between the American continents.

5. The climate of the Eocene and Miocene eras in North America was mild, and permitted an extension of warm-temperate flora as far north as Alaska.

6. In the Pleiocene era the climate became cooler. Subsequently in the Glacial Pleistocene, the encroaching ice-sheet drove all plant life far southward. As the Andes were at their present height approximately, and as the Central American highlands in common with the Mexican Cordilleras and the Rocky Mountains were in a period of upheaval, probably greater than the present, a highway was opened to the south for Alpine and Arctic-Alpine elements, as well as for the southward migrating warm temperate flora.

7. The sequence of upheavals which

brought the Great Basin and the arid Southwest from sea level or submergence to their present elevation, also witnessed the development of a vigorous flora which has continued to occupy these regions, containing many of the peculiarly West-American groups. The same sequence of upheavals may have opened up similar areas southward at the east of the Andes upon which this flora could also extend, though subsequently excluded by tropical conditions more like the present.

A vegetation developing under such conditions as those cited above, would have had a most varied, not to say precarious history, now reaching far northward in luxuriance, now driven back by the encroaching ice-sheet; now, a species distributed over a wide area, and again only the remnants of it in widely separated areas. Here, a terrain covered with a varied vegetation which with the next change of conditions becomes a sea or an arid basin. Not only were these tremendous changes going on in the make-up of the two continents and their relations to each other, but conditions existed which related each to other land masses, whereby floral elements were received which were to play a part in the subsequent development of the floral history. Such was the contact of the North American region with Europe and Asia, and of South America through the Antarctic Continent with Australia, New Zealand and probably South Africa.

In taking up a more specific analysis of the floral elements common to both Americas, we must therefore bear in mind certain physical conditions involving not only those which prevail at the present time, but also the varying conditions, which have prevailed since at least the middle Tertiary period.

First, the north-south zones of elevation have interruptions of distances great enough to offer a very efficient check to north-south distribution, greater in the case of Arctic Alpine conditions, less in the transition zone and greatest of all in the case of extreme xerophilous elements of enclosed desert basins and valleys.

Second, we must allow for fluctuations in elevation and depression of the continental axis, especially in the region of juncture of the two continents, and consequent changes in relation of the two land masses. These fluctuations would extend back over a period in which the flora of the earth was undergoing tremendous changes, migrations and adjustments, all of which would be influential in the final setting.

Third, as to the sources of elements which might be brought into the field of influence, we must allow for the intimate relation of North America to the Eur-Asian continent whereby floral elements were shared in common, and for the early isolation of the South American continent from Antarctic land masses, although the Antarctic flora of South America does show a community of elements with South Africa, Australia, New Zealand and Antarctic islands.

Fourth, the prevalent southward pressure of elements is to be associated with glacial influences which may well have been most powerful in driving so great a boreal element southward. This would be all the more notable in the case of the warm temperate xerophilous elements, which have shown such vigor of development and encroachment, constituting the most characteristic and unique elements of the New World flora.

The relationship of the floras of North and South America will be discussed under the following heads: 1st, The Gulf Zone Neo Tropical, 2nd, The Alpine and Arctic-Alpine, and 3rd, the Warm-temperate and Semi-tropical xerophilous elements embracing (*a*) high plateau and mountain forms of the Transition and Upper Sonoran Zones; (*b*) enclosed basin and valley forms of the

Lower Sonoran Zone; (c) semi-tropical xerophilous forms of Gulf Zone distribution.

. THE GULF ZONE NEO-TROPICAL ELEMENT.

The territory embraced within the Gulf Zone includes those regions which have had a common history in the development of their flora during the fluctuating geological conditions of the Gulf area. While this zone is but a part of the greater Neotropical, its association with a common sequence of geological changes has, as Engler* thinks, given it a degree of distinctness from the Brazilian region. The regions so associated are: The coast lands, plains and sub-Andean parts of Guiana, Colombia and Venezuela; the Central American region except the tierra templada, the tierra frias of Guatemala and the isolated elevations (above 8,000 feet) in Nicaragua and Costa Rica; the tierra caliénté of Mexico which on the west reaches northward to include the lower Colorado Valley in California and Arizona, and embraces the point of the lower California peninsula, and on the east coast is a narrow belt extending northward to the lower Rio Grande Valley in Texas, the lower third of Florida and the greater and Lesser Antilles. On the west, the tropical elements pass vertically rather gradually into the vegetation of the tierra templada of Mexico and Guatemala, and at the north a semitropical Gulf strip from the mouth of the Rio Grande to and including upper Florida, marks the transition to the subtropical flora of the Gulf States which, though distinctly a part of the Atlantic Coast Plain or Austro-riparian flora, has numerous elements of tropical extraction, as, for example, the *Palmæ*, the *Tillandsias*, some *Euphorbiaceæ* as *Argithamnia*, *Acalypha*, *Sebastiana*, *Stillingia* and *Hippomane*; *Bignonia*, *Phoradendron*, *Persea* and many others.

At the west, the northward extension of tropical flora is checked by xerophytic conditions, so that a very meager tropical element reaches the United States in that quarter. On the other hand, the free northward extension to the Florida province, whose physical conditions favor a purely tropical flora, has been retarded by interruptions in the continuity of land masses, so that while the flora of South Florida is not a part of the Austro-riparian and sub-tropical, it is comparatively meager in South American species. It has, however, many elements in common with the Antilles. The sharp distinction between South Florida and the remaining Gulf States and North Florida, is shown in the following data compiled by Drude* from *Chapman's Flora*. "There are 360 species in Florida which do not extend north of the 29th parallel; of these 169 belong to 132 genera which have no distribution further northward, or 16 families reach a northern limit in this peninsula."

It is interesting to note that some of the genera cited above and others, as marking the transition from tropical to sub-tropical United States, also extend into extra-tropical South America, namely, to Argentine. Those cited by Engler† are *Argithamnia*, *Bignonia*, *Lippia*, *Chaptalia* and *Galphimia*, to which may be added many *Amaranths* and others. But as this element consists so largely of xerophytic and halophytic species, I have discussed it under the head of semi-tropical xerophilous forms of Gulf zone distribution.

2. ALPINE AND ARCTIC-ALPINE FLORAL ELEMENTS IN SOUTH AMERICA.

As previously stated, the extension of an elevated continental axis from Alaska to Cape Horn makes an approximately continuous boreal zone across the equatorial regions. This continuity has fluctuated

* Entwickelungsgeschichte der Pflanzenwelt, II., p. 197.

* Pflanzengeographie, 511.

† Entwickelungsgeschichte II., p. 189.

greatly during the period of development of the plant life of the present era, and with profound effect in molding the present conditions. As a highway for north-south distribution of the boreal elements, its efficiency has of course varied. As at present constituted, it is interrupted by a stretch of moist tropical conditions for a distance of some 10 degrees of latitude, namely, from the southern downfall of the Guatemala highland, 15° N., to the Colombian Andes, 5° N., at an altitude of some 12,000 feet. Practically, however, one must allow for a degree of continuity even over this stretch as offered by the highest peaks of Costa Rica, Nicaragua and even in the Panama district. An analysis of the floral elements of this north-south Arctic and Arctic-Alpine zone shows the following interesting phenomena:

First, that the flora of the Rocky and Sierra Nevada Mountains above the Transition zone, the Mexican Cordilleras in the tierra frias (from 8,000 to 12,000 feet), of the Guatemalan tierra frias and of the tropical Andes above 12,500 feet, and the extra-tropical Andes and highlands, is one of Northern extraction, abounding in genera associated with the colder zones of North America and Eur-Asia. Such, for example, are: *Ranunculus*, *Anemone*, *Berberis*, *Geranium*, *Spiræa*, *Geum*, *Rubus*, *Ribes*, *Saxifraga*, *Hydrocotyle*, *Gaultheria*, *Vaccinium*, *Veronica*, *Eritrichium*, *Gentiana*, *Polemonium*, *Hieracium*, etc.

Second, that while possessing very many genera in common, by far the greater per cent. of species in the Mexican Cordilleras are endemic, as are those of the Alpine Andes. This points to a long continued and effective isolation of the Mexican and South American Andes from each other and from the Rocky Mountains.

Third, that of Arctic-Alpine genera those are most common which belong to the element common to the Himalayan and East-Asiatic regions and the Rocky Mountains from Alaska to Colorado; that such genera occur sparingly in the Mexican and tropical Andes, and then with endemic species; that there is an increase of this element in the extra-tropical Andes toward the Straits of Magellan. Here is to be noted that certain species of the Rocky Mountain Arctic-Alpine region reappear in the extra-tropical Andes toward the southern extremity of South America, being, so far as known, absent from the Mexican and Tropical Andes. Among these are: *Gentiana prostrata*, *Trisetum subspicatum*, *Primula farinosa* and var. *magellanica*; *Draba incana* = *Draba magellanica*; *Alopecurus Alpinus* = *A. antarcticus*; *Saxifraga cespitosa* = *S. cordillerarum*; *Polemonium micranthum* = *P. antarcticum*; *Collomia gracilis*.*

3. WARM TEMPERATE AND SUB-TROPICAL XEROPHILOUS ELEMENTS COMMON TO NORTH AND SOUTH AMERICA.

These elements of flora common to both Americas deserve special emphasis. They embrace for the most part, the flora of the arid regions of the western and southwestern states and North Mexico. This flora occupies the mountain slopes of the transition zone, the plains and plateaus of the Upper Sonoran and the hot deserts of the Lower Sonoran zones. This area has been the field of development of many groups peculiarly American. It is the region of xerophytic composites, *Nyctaginaceæ*, *Polygonaceæ-Eriogoneæ*, *Onagraceæ*, *Amaranthaceæ-Gomphreneæ*, *Malvaceæ*, *Borraginaceæ-Eritrichiaeæ*, Gilias, the Yucca and Agave kinships and the *Cactaceæ*.

When this peculiar flora was in the vigor of its development and occupation of new territory, the climatic conditions seem to have exerted a pressure to the southward which geological conditions favored, with

* This list is taken mostly from Engler's Entwickelungsgeschichte, II., p. 256.

the consequence of carrying a great richness of forms into the South American region.

There has also apparently, been an encroachment of elements developed in South America northward, as shown in the *Loasaceæ* (Mentzelias) and species of *Prosopis*, whose great development occurs in the Chilean and Argentine regions respectively.

Greater details of distribution may be discussed as follows: (1) The mountain forms; (2) Forms of the arid basins and valleys of the Lower Sonoran Zone; (3) Subtropical xerophilous forms of Gulf Zone distribution.

(1) *The Mountain Xerophilous Sonoran Elements.*

In North America this element occupies the arid mountain slopes and high plateaus of the Transition and Upper Sonoran zones, extending also into the deserts of the Lower Sonoran. Its southward distribution has been favored by the existence of an arid zone comprising the moistureless west slopes and enclosed plateaus of the Mexican and Tropical Andes, lying mostly below the altitudes of Alpine conditions. Both the aridity and continuity of this zone have varied with the changes in elevation, and in all probability a north-south distribution of xerophilous mountain elements was much easier at some earlier period than at present. The facts of endemism are much the same for the North American, Mexican and Andean regions as in the case of Alpine forms.

Illustrations of this element include Xerophilous ferns of the genera *Gymnogramme, Pellæa*, § *Eupellæa* and § *Cincinalis*, *Nothol*æ*na* and *Cheilanthes*, many of which range from West Texas, New Mexico, Arizona, etc., to Mexico, Guatemala and in the South American Andes to Chile; of the *Leguminosæ: Astragalus, Dalea, Lupinus, Trifolium, Vicia* and *Lathyrus; Rosaceæ-Quillajeæ, Onagraceæ: Œnothera, Gayophytum, Chammissonia, Lavauxia, Godetia*, and *Boisduvallia; Artemisia, Perezia* and *Astereæ-Soladigineæ* of the *Compositæ;* many *Cactaceæ; Borraginaceæ-Eritricheæ; Gilia* and many others.

(2) *Lower Sonoran Elements.*

These forms are of special interest because they include the most extreme xerophytes and halophytes occupying the most arid deserts of both North and South America *in the extra-tropical regions*, and mostly unrepresented in the long stretch of moist, tropical and high mountain areas between. Such are the *mimoseæ, Prosopis*, § *Strombocarpa* with 3 species in Argentine, and 3 Lower Sonoran species of west Texas, north Mexico and westward; § *Algarobia* with 19 species mostly Argentine; *Polygonaceæ-Eriogoneæ* with eleven Lower Sonoran genera (except some Eriogonums) and the peculiar subgenus *Chorizanthopsis* of the *Chorizanthes*, endemic in Chile, and three species common to both zones; namely, *Oxytheca dendroidea, Chorizanthe commissuralis* and *Lastarriæa chilensis*, all originally from the Californian region; *Frankeniaceæ*, with the very distinct *Frankenia jamesii* of the west Texas region, *F. Palmeri* of the southern California region, *F. triandra* of the Puna region six nearly allied Chilean species, one of which is in California and Arizona and *Nederleinia juniperoides* of the Argentine Salt Steppes, more nearly related to the Lower Sonoran than to the Chilean species. These, apparently, constitute remnants of a previously widespread development.

The *Zygophyllace* also present an excellent illustration of the phenomena of distribution here considered. Perhaps no plant is more prominent as an indicator of the Lower Sonoran Zone than *Larrea mexicana* which is exceedingly abundant and widespread over this zone. No representatives of this genus occur between the southern limits of the Lower Sonoran in Mexico, and the Andes and Salt Steppes of Cardoba and

Mendoza southward to the Rio Colorado in South America, where three species occur which are sharply distinct from each other and especially from *Larrea Mexicana*. One of these South American species, *L. divaricata*, is described as covering great areas of Cordoba and Mendoza as *L. Mexicana* covers areas in Texas, Arizona and Northern Mexico.

From these and other illustrations, it is necessary to conclude that we are here dealing with forms which were connected by a remote ancestry, which flourished at a time and under conditions which permitted a more general distribution. We may possibly ascribe these condition to a certain stage in the elevation of land masses along the continental axis. At any rate, the fluctuations in climatic and geological conditions since the Tertiary Period would have very different conditions of distribution and relationship from those we observe now.

On the other hand, that the same species may occur in both these widely separated areas, and nowhere between, indicates the energy of certain agencies acting now and in spite of climatic and geological barriers, *e. g.*, *Fagonia cretica*, *Frankenia grandiflora*, *Munroa squarrosa* and the three previously cited species of *Polygonaceæ-eriogoneæ*.

(3) *The Semi-tropical xerophilous forms of Gulf Zone Distribution.*

In discussing the Neo-tropical and semi-tropical elements, attention was called to a Gulf Zone distribution between extra-tropical regions. The forms involved here are the less extremely xerophytic species of the warmer and less arid portions of the Lower Sonoran Zone; *e. g.*, the Rio Grande Plain in Texas and Mexico below Eagle Pass. Such species occur also in the xerophytic areas of Colombia, Venezuela, Guiana, Brazil, Uruguay, Paraguay and Argentine, and in similar areas of the Antilles. Some are undoubtedly sea-coast species. The following are illustrations:

Sida leprosa: Uruguay, Patagonia, Argentine, Cuba, Lower Sonoran Zone (even north to Washington).

Sida hastata: Argentine, Uruguay, Mexico, Texas, Arizona.

Sida Anomala: Mattogrosso, Uruguay, Argentine, Bolivia, Cuba, Florida, Texas, Mexico.

Cienfugosia sulphurea: Southwest Texas, Mexico, South Brazil, Paraguay.

Spergularia plattensis: Texas to California, South Brazil.

Polygala paludosa: Brazil, Paraguay, Louisiana and Texas.

The *Amaranth-Gomphreneæ* are prevailingly of the Gulf Zone distribution, especially *Frœlichia*, *Alternanthera* and *Gomphrena*, but in the last case, mention should be made of the massing of species in Southern Brazil and Argentine, and their comparative absence northward until the Mexican plateau is reached, where, again, are many species, mostly distinct from the South American forms. This fact would suggest the propriety of including *Gomphrena* in the category of genera like *Larrea*, *Frankenia*, *Spirostachys*, *Malvastrum*, *Chorizanthe*, and others, in which the present conditions of distribution and kinship point to them as remnants of a previous general distribution over territory not now adapted to their needs.

SUMMARY.

Reviewing the floral relations of North and South America as illustrated in the foregoing instances, we may say that the phenomena of distribution agree fairly with the record of physical conditions which have succeeded each other and those which still exist, and upon which we might almost *à priori* have predicted an analogous set of distribution phenomena. In this relationship we may distinguish three categories of distribution:

(1) Those due to the conditions of hu-

man civilization, commerce, etc. This has resulted in placing the same species in similar regions of both continents, as, for example, *Fagonia cretica* in Lower California and Chile; *Munroa squarrosa*, western plains of North America, plains of Argentine and high plateaus of Chile and Bolivia; *Frankenia grandiflora*, Southern California and Arizona, coast lands of Chile; *Oxytheca dendroidea*, *Lastarriæa chilensis*, and *Chorizanthe commissuralis*, all in Southern California and Western Chile.

(2) Those due to the operation of natural causes acting under present conditions of climate, geology, etc. Under this head may be cited such species as *sida leprosa*, *hastata*, *anomala*, *Cienfugosia sulphurea*, *Spergularia plattensis* and, in general, elements of Gulf zone distribution; also certain elements which still find a pathway along the continental axis, including some alpine and mountain xerophilous genera.

(3) The third category of distribution would include those phenomena due to geological and climatic changes acting through long periods. Under this head are included the elements of greatest significance in the relationsip of the North and South America floras. The endemic boreal flora of the Andes, the equally endemic boreal flora of the Mexican Cordilleras, and genera with sharply distinct species or sub-genera in the arid extra-tropical regions of both continents, which may be called remnant elements.

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NAMES OF ANIMALS PUBLISHED BY OSBECK IN 1765.

In 1757, Peter Osbeck, a pupil of Linné published in Stockholm a work entitled: 'Dagbok öfver en Ostindisk resa aren 1750–1752.' The work* was subsequently translated into several languages, with dates of publication as follows: in German, 1765 (Rostock), and 1772 (Leipzig), two editions; in French 1771; in English, 1771. Of these translations I have examined the German, 1765, and the English. The latter translation is not from the original, as we learn from its editor, but from the German, the latter having had the advantage of revision by Osbeck, who, we are told, made some additions to it.

* The German translation is entitled: Reise nach Ostindien und China.

On comparison of Osbeck's proposed names for the various species of animals discovered with the tenth and twelfth editions of Linné's *Systema Naturæ*, one is struck by the number which are not referred to in those works; and, as far as I can learn, these omissions have not been included in later works in most instances. It is for the purpose of bringing them to the attention of naturalists that I offer the present notes.

Such of Osbeck's names which are tenable should date from the 1765 translation which follows the tenth edition of Linné. The pagination noted herein refers to that volume.

MAMMALIA.

Cervus javanicus. Page 357. Java.

This is, probably, the *Tragulus* (= *Moschus*) *javanicus* Gmelin, 1788. The synonymy should be *Tragulus javanicus* (Osbeck), 1765, = *Moschus javanicus* Gmelin, 1788.

AVES.

Sitta chinensis. Page 326. China.

The *British Museum Catalogue of Birds* gives as a synonym of *Sitta cæsia*, a *Sitta chinensis* Viellot, 1819, but on reference to the *Nouv. Dict.*, v. XXXI, p. 332, it will be seen that Viellot gives Osbeck as authority for the name. Therefore *Sitta chinensis* Osbeck, 1765 and 1771, has priority over *Sitta cæsia* M. and W., 1810.