

## THE RECLAMATION OF SOIL BY VEGETATION.

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An exceptional opportunity afforded itself to make a study of the reclamation of soil by vegetation on a small scale, as will be set forth in this paper. In most cases of this kind the original conditions either are not known or one is so situated that he is unable to follow the progress of the revegetation of a given area. However, some cases are on record where the observer is not hampered by the above mentioned adverse conditions.

An extensive and admirable study of revegetation has been made by R. F. Griggs<sup>1</sup>, who investigated the encroachment of plant life on the materials thrown out by volcanoes. Instances of this and other kinds of revegetation are also mentioned by Schimper<sup>2</sup>. That seeds of plants may be carried long distances by both air and water is well known. The proper elucidation, however, of many of the conditions involved in such dissemination has been especially well studied and reported by Schimper who observed that seeds may be carried long distances not only in the above ways, but also may they withstand adverse conditions during such carriage.

Traub<sup>3</sup> has also proved that spores and seeds can be carried long distances, at least 20 nautical miles, for he found the spores of 11 ferns and the seeds of two species of Compositae that distance inland on Krakatoa. Wallace<sup>4</sup> mentions instances of seed distribution and revegetation. Numerous instances could be recounted illustrating the capability of plants to obtain a new locality and grow and finally take possession of a given area.

That many plants will gain a foot-hold and grow in unfavorable conditions is in some instances well known. One such case the writer observed on the slopes of Mount Vesuvius, when a few years after an eruption, certain small trees and other plant life were growing on and among the cooled lava and ashes, on a surprisingly unsuitable surface. These plant forms were, of course, carried almost entirely by the agency of the wind and some of them for considerable distances. The vegetation here decreased rapidly from the base of Vesuvius upward until finally conditions were such that no plant growth was possible.

But one does not always find it necessary to study such a problem at a distance or over a large area in order to see the same factors at work, even if on an infinitesimally smaller scale. One of the difficulties is to find an area where complete plant denudation has been effected. The re-establishment of the plant forms in a very small area, as in large ones, can be seen in most cases to be extremely irregular in its

<sup>1</sup> Griggs, R. F. The Valley of 10000 Smokes. National Geographic Magazine, Vol. 31, 1917, pp. 13-68, and literature there quoted.

<sup>2</sup> Schimper, A. F. W. Pflanzen Geographie auf Physiologischer Grundlage, 1898, pp. 33, 200, etc., and the literature quoted in this work.

<sup>3</sup> Traub, M., in Schimper's Pflanzen Geographie auf Physiologischer Grundlage, 1898, p. 200.

<sup>4</sup> Wallace, A. R. Island Life, 1892, p. 77.

advance—only the hardiest ones being able to gain a foothold and survive. Even many of these will be seen to start to grow for a time and then die, since some of the conditions in the new territory are too adverse to allow them to continue growth. After a time other individuals survive the soil conditions and reach maturity, at first probably not producing quite as vigorous specimens as those growing on distant territory.

It is interesting to see how soon the various forms of plant life will gain and become thoroughly established in the new territory. Some forms begin to grow in a short time, others only after a considerable period of time and some are later crowded out by the stronger forms in the general struggle to survive.

One plant that could not be overcome by the other species in the area to be discussed was the common *Ipomoea purpurea*. This plant, although it had no support at first, was heavily crowded by stronger forms which appeared after it had grown to a considerable size. Despite this hindrance it grew rather vigorously and almost as large, on the average, as other specimens in the open and under favorable conditions. It was interesting to compare on the other hand, a number of small and somewhat delicate forms, such as *Lobelia spicata*, which were crowded out. Other rather small and delicate forms persisted and completed their growth before the stronger forms came on.

The piece of ground to be considered was an area of 200 square feet. It was composed of heavy and rather damp clay and before this experiment began, was covered by a dense growth, mostly of *Poa pratensis*. It slopes gently to the east but more strongly to the south except for an artificial swale about the center of the tract. The ground to the west and north of the area is rich soil and heavily overgrown with *Poa pratensis*. In the directions just mentioned the grass was kept closely cut and free of all weeds to a distance of 75 to 100 feet. The same is true of the east and south although here less space intervened.

After a time it was noticed that some patches of *Rumex acetosella* put in their appearance, the seed having been introduced, in all probability with hay which had been strewn rather densely over the ground some time before these observations. This troublesome weed requires the application of quick and drastic methods if it is to be eradicated. The surest and one of the best ways to destroy *Rumex acetosella* is by the use of common salt, as experiment has sometimes shown. It is often necessary by this method, to sacrifice the surrounding vegetation, but however much it may be desired to spare other plants in the direct vicinity, it is generally time and money saved in the end to use salt in abundance and to leave everything else out of the consideration but the destruction of the *Rumex acetosella*. This plant has a tendency to grow in patches, due to its underground habit, and therefore it lends itself somewhat more readily to the above mentioned treatment than if growing more scattered. The *Rumex acetosella* was present on the ground here under consideration and was given two heavy treatments with common salt. This completely and permanently destroyed every vestige of these plants. A light application of the salt is very likely not to kill

*Rumex acetosella* as it may not reach the root stocks which are at varying distances below the surface. The soil recovers from the effect of the salt in a comparatively short time or if plowed up and cultivated in the spring after being treated with salt in the fall, vegetation of the desired kind when planted will grow uninterruptedly.

Subsequently to the treatment with salt on the ground here referred to—this plot was spaded and some time later was covered with clay. This clay was removed from under a large building which had stood over it for 19 years. Tests made on this clay soil showed that it contained no seeds of plants that would grow. The clay was deposited in April on the ground above mentioned, in a few places two feet deep, but in most places much less. The greatest depth of two feet happened to be over the southeast portion toward which drainage was most active. The swale above mentioned was preserved so as to provide drainage to the southeast as the slope of the land in general required.

All plants having been killed by the salt treatment, the forms to be enumerated later, which after a time appeared on this area, were carried in by various agencies, especially the wind. Some put in their appearance early, others not until considerably later, and most of them when once started grew fairly well from the first. One thing that favored the new in-coming forms of plants in this area was the rather perfect retention of the moisture in this clay soil. In dryer parts of the season this was particularly noticeable, especially when a comparison was made with other plants of the same kind in the same vicinity growing on soil which was more quickly deprived of its water by more thorough drainage.

Other forms appearing in this area plainly showed that the conditions were unsuited to their welfare since their growth was abnormal. Some of the larger plants gained entrance through the agency of water or animals, as in the case of *Zea Mays*.

The drainage was in the direction of this area for more than 100 feet above it, a circumstance which caused a considerable amount of water to cross this area to the southeast during heavy rains, and to spread out over it in the lower parts. As usual, many of the plants whose seeds were light and carried by the wind did not grow close to the area, but were to be found some distance away.

Plants started about the center of the area in question, showing that they had not simply broken through the thinner new soil at the edges, even if the former plants had not previously been killed with the salt application above mentioned. The spading of the area had turned the old soil with its salted surface deeply under. The only opportunity for plants to again grow on this area was for those forms which are generally disseminated by the usual agencies to find their way to the surface of the new soil. An area near this which was treated heavily with salt the preceding season and later plowed under, raised the following season a heavy crop of *Zea Mays* and other plants.

Woods<sup>5</sup> mentions the fact that common salt is of value when applied

<sup>5</sup> Woods, Alfred F. The Relation of Nutrition to the Health of Plants, Yearbook of the Department of Agriculture, 1901, p. 165.

to certain soils. This fact has been familiar for many years. The further mention of the use of this substance by English farmers to the extent of "two to three hundredweight per acre" shows its value in the soils concerned. Storer<sup>6</sup> and others have made valuable contributions on this point.

The observations of this study were carried on for two summers on the area here in question. During the first summer the introduction of the forms that appeared was slower than during the second season. At first the plants that grew were few in number and kind. However, it was easy to see that this state of affairs changed rapidly as the first season advanced and new plants appeared more and more quickly.

This was increased during the second year to such an extent that at the expiration of the second season the whole area was densely covered with plant forms, for the most part grasses of several kinds. The grasses covered the area so completely that this tract of land was cut over three times before the close of the second year.

In the meantime the other forms, especially coarse and large weeds were, for the most part, removed as their period of anthesis closed, to prevent them from seeding, and also to record those that might disappear.

By the end of the first season 41 different forms had put in an appearance on this area and reached maturity at or about the usual time, as was determined by observing other plants of the same species in the same locality. This, however, was not always the case, since some of the same plants which were observed as controls near this area, grew under more favorable soil conditions. *Ulmus Americana* put in an appearance early. This was readily accounted for since some elm trees of considerable size stood to the south of the area and about 75 feet away so that the winged seeds were easily carried by the wind. This form grew vigorously and in some number, but not more so than on the soil immediately surrounding this area. One specimen of *Juglans nigra* was found which was evidently carried in through the agency of some animal. Also two specimens of *Carya ovata* appeared the second season. This, however, is easily accounted for by the presence of a large tree of this species a few feet away from this area, so that a falling nut was readily transferred to this tract of land from this short distance.

Of all the forms that appeared on this area in the time noted the representatives of the Gramineae were the most numerous. These and other forms that grew here showed that wind, as would of course be expected, was the most important disseminator of the plants recorded. Of the 120 forms that were recorded by the writer and that appeared in this area in the two years' observation almost 30 belonged to the Gramineae. Not only did this family contain the greatest number of forms, but also the greatest number of individuals. By the end of the second year practically no difference could be ascertained a short distance away between this area and one that had been seeded for grass for a much longer time.

<sup>6</sup> Storer, cited by Woods, Alfred F., in the Yearbook of the Department of Agriculture, 1901, p. 165.

Various families of plants were never represented by more than one species, as the Juncaceae by *Juncus tenuis* and the Liliaceae by *Asparagus officinalis*, and the Portulacaceae by *Portulaca oleracea*. Other families, on the other hand, were represented by several representatives, such as the Cruciferae, the Leguminosae, the Euphorbiaceae, whose representatives have grown especially well and numerous in the last summer of 1921, as well as the Solanaceae and others. *Oxybaphus nyctagineus* was brought by me from Harrodsburg, Indiana, more than 20 years ago and planted in my garden. Since then it has spread at times more or less, but in such soil never in large numbers. It showed, however, a tendency to spread. Early in the second year of these observations it traveled to this new area about 100 feet away.

Next to the Gramineae the Compositae had during the two years of observations the greatest number of species represented in this area. Some of the genera were represented by numerous individuals, as would be expected of the genus *Taraxacum*. The 120 different species that were found on this area during the two years of observation were represented among other species of plants in the same vicinity. Especially was this true of some vacant land to the south of the area here discussed. This vacant land had for two years been in part plowed and used for gardens, but in a very poor and unsuccessful fashion. This land was weedy before plowing, particularly with *Vernonia altissima* and *Ambrosia artemisiifolia*. Afterward this land was entirely neglected and thus soon became a veritable pest-house for weeds. As this tract lay just to the south across a road and about 70 feet away, it thus became a very important source of weed infection of the area I have discussed above.

Barring its dense covering of weeds one especially was very conspicuous and numerous, namely *Lactuca canadensis* while *Vernonia altissima* above mentioned was at this time represented by only a few individuals and even these were, due to crowding and shading, by no means as robust as when this land was an open meadow.

The plants given in the following list for the area above discussed are arranged for the most part according to the 7th Edition of Gray's New Manual of Botany.

*Zea Mays*, *Setaria glauca*, *S. verticillata*, *Sorghum halepense*, *Digitaria filiformis*, *D. sanguinalis*, *Paspalum setaceum*, *Panicum Gattingeri*, *P. Capillare*, *P. virgatum*, *P. microcarpon*, *P. huachucae*, *Axonopus furcatus*, *Phalaris canariensis*, *Phleum pratense*, *Sporobolus uniflorus*, *Agrostis alba*, *Avena sativa*, *Danthonia spicata*, *Bromus sccalinus*, *Cynodon Dactylon*, *Eragrostis capillaris*, *Briza media*, *Dactylis glomerata*, *Poa pratensis*, *Festuca ovina*, *Hordeum sativum*, *Triticum sativum*, *Secale cereale*, *Juncus tenuis*, *Sisyrinchium angustifolium*, *Asparagus officinalis*, *Juglans nigra*, *Carya ovata*, *Ulmus americana*, *Cannabis sativa*, *Rumex crispus*, *Polygonum Hydropiper*, *Fagopyrum esculentum*, *Chenopodium album*, *Amaranthus retroflexus*, *Celosia argentea*, *Phytolacca decandra*, *Oxybaphus nyctagineus*, *Anychia polygonoides*, *Stellaria media*, *Cerastium vicosium*, *Saponaria officinalis*, *Portulaca oleracea*, *Sassafras variifolium*, *Draba verna*, *Capsella bursa-pastoris*, *Raphanus Raphanistrum*,

*Brassica nigra*, *Sisymbrium officinale*, *Agrimonia parviflora*, *Rubus villosus*, *R. allegheniensis*, *Trifolium pratense*, *T. incarnatum*, *T. repens*, *Melilotus alba*, *Medicago sativa*, *M. lupulina*, *Oxalis Acetosella*, *Euphorbia maculata*, *E. marginata*, *E. humistrata*, *Acalpha virginica*, *Acer saccharinum*, *Vitis cordifolia*, *Sida spinosa*, *Malva rotundifolia*, *Viola pedata*, *Oenothera biennis*, *Erigeron bulbosus*, *Pastinaca sativa*, *Daucus Carota*, *Vinca minor*, *Apocynum cannabinum*, *Aselepias syriaca*, *Gonolobus laevis*, *Convolvulus sepium*, *Ipomoea Batatas*, *I. purpurea*, *Prunella vulgaris*, *Solanum nigrum*, *Lycium halmifolium*, *Datura Stramonium*, *Physalis subglabrata*, *Verbascum Blattaria*, *Linaria vulgaris*, *Conobia multifida*, *Verbascum Thapsus*, *Veronica officinalis*, *Plantago major*, *P. lanceolata*, *Galium Aparine*, *Sambucus canadensis*, *Cucurbita Pepo*, *Lobelia siphilitica*, *L. spicata*, *Vernonia altissima*, *Solidago canadensis*, *Aster Shortii*, *A. ericoides*, *Erigeron annuus*, *Xanthium canadense*, *Rudbeckia hirta*, *Helianthus annuus*, *Bidens frondosus*, *Achillea Millifolium*, *Anthemis Cotula*, *Chrysanthemum Leucanthemum*, *Articum Lappa*, *Cirsium lanceolatum*, *Taraxacum officinale*, *Sonchus oleraceus* *Lactuca canadensis*.

## MIDSUMMER GROWTH.

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In the year 1893 the writer's father transplanted a two year old specimen of *Liriodendron tulipiferu*. This tree was cut down on account of some street work the present year (1923). It had attained a height of 21 meters and a diameter of 33 cm., one dm. above the ground, in the 30 years. When standing it presented a beautiful spectacle with its towering slender shaft-like trunk and admirably balanced top.

Within the recollection of the writer it has been defoliated on three occasions, twice in one year, and once during a later year. When it was felled the writer started an investigation to ascertain how distinctly the above mentioned defoliations had impressed their results in the formation of the annual rings. Accordingly a disc 2.5 cm. in length was cut from the trunk of the tree one dm. above the ground and exactly at right angles to the trunk by means of a guide which the writer has invented. The accuracy of this simple arrangement may be judged by the performance, since with a one-man cross-cut saw a variation of only a few mm. was shown in the above mentioned diameter cut of 33 cm. We have therefore in such cases, where proper care is used, a very commendable approach in a large scale, comparatively speaking, to the accuracy of an ordinary mitre box.

The disc cut as above described was next passed over a "jointer" which decidedly helped the visibility of the annual rings. The distinctness of the rings was further enhanced by sand-papering one side of the disc with a sanding block which was adjustable by means of a pintle. This last operation brought out the annual rings with much greater distinctness. The treatment above outlined made it possible to study the annual rings minutely. The section showed distinctly the