

THE MICHILLINDA (MICHIGAN) SAND DUNES AND THEIR FLORA.

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Nowhere is the struggle for a place in nature by plants more spectacular or more severe than that with the sand dunes. The alignment of the opposing forces is so evident, their activity is so ceaseless, their modes of attack so varied that one wonders that the plants ever succeed in fixing these restless masses of sand. After the classic studies of Cowles upon the Dune flora it would seem that little remains to be said, but to the botanist accustomed to the placid plant life of mesophytic regions the struggle is irresistibly fascinating and, as a rule, he is unable to resist the temptation of a new consideration of some phases of the problem.

The region studied was a short stretch of beach dunes on the east shore of Lake Michigan at a summer resort known as Michillinda, about twenty-five miles north of Muskegon. That the region is exceptionally favorable for such studies is evidenced by the fact that it is the place chosen by Dr. Cowles for his classes when considering the problems presented by the dune flora. The study made was neither systematic nor exhaustive; it was merely a part of a rest of three weeks after a summer school session. No attempt was made to enumerate the constituent members of the flora or to work out all of the factors determining the success or failure of the plant invaders. The paper, therefore, touches only the more evident features of the problem and treats even these in the line of suggestion rather than explanation.

The plants begin their struggle on what Cowles calls the middle beach, a region beaten by the winter waves, but as a rule dry during the summer months. The struggle here is almost hopeless and on the open stretches of the beach the plants are extremely scattered. In the shelter of the drift logs and debris, however, they are more numerous and may maintain a precarious existence for some months. It is probably the area of greatest stress. The fierce winter storms compel an absolute renewal of the struggle each succeeding year, while the summer winds and sun make it possible for only such plants as possess the most marked xerophytic characters to maintain themselves. A severe summer storm may overwhelm the beach,

killing all forms that have obtained a foothold, and the struggle must begin all over. Such a storm swept the Michillinda beach for almost a week during the past summer, blotting out absolutely the middle beach flora. In a week, however, the brave plants began to show themselves again and to renew the apparently hopeless struggle. The most notable member of this flora was the succulent leaved crucifer, *cakile edentula* (Bigel.) Hook. The adaptation in this case is plainly against the dessicating action of wind and sun. The plant also is able to withstand, to a certain extent at least, a sand covering of considerable thickness, forcing its way through it to the surface apparently but little injured by its temporary burial. Its stubborn erectness and unyielding rigidity are characters that at once serve to distinguish it from the other members of this flora.

More numerous upon this stretch of beach is *Cuphorbia polygonifolia* L. This prostrate spurge finds its protection in its close hugging of the sands which are here always damp at a slight depth, whatever may be the sun's heat. A covering of sand does not seem to kill it, unless it is several inches thick, new shoots emerging from the crown, finding their way to the surface in a few days. In spite of these two species, the middle beach strikes one as practically destitute of plants—and the wonder grows as the conditions are studied that the few that do occur have found even a temporary lodgment.

The upper beach and the active dune region present a much more varied and consequently much more interesting flora. The opposing forces here are the fierce rays of the sun, the almost constant winds and the shifting sands. In high winds the mechanical action of the sands is very great, often completely destroying well-established plants. These factors have led to the development of the most pronounced xerophytic characters found in this latitude, and this in spite of the fact that there is no scarcity of water in the soil. Even after the long summer drought, the sand is moist at a slight distance below the surface. The most marked adaptations in this region are those against the covering of the plant with sand, exposure of roots by the shifting of the sand, excessive evaporation because of sun and wind, and the mechanical action of the sand driven by storms. Practically every device against these destructive agencies is here in evidence. They are so well known that they need not be recited in this connection.

Most interesting, perhaps, are the provisions against submergence by the sands. In the case of the poplars, willows and dogwoods, the sprouting habit in connection with the habit of sending out roots from any node in

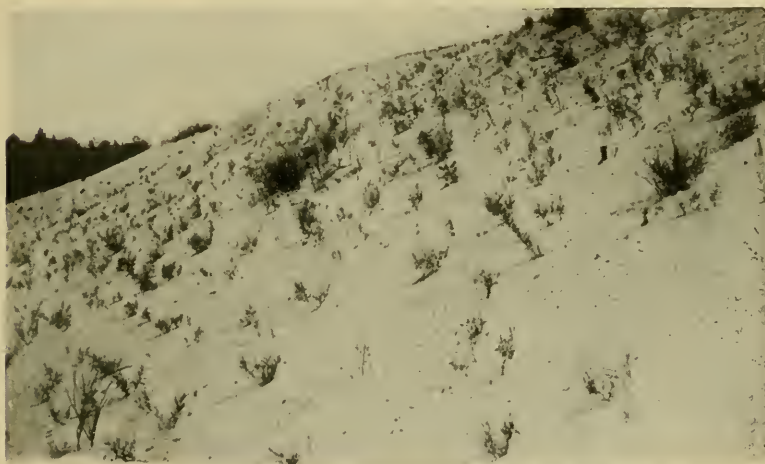
contact with the soil is sufficient protection, save in the most extreme cases. These plants, therefore, while not strongly developed in the upper beach, are rarely wanting on active dunes. The willows commonly found are *S. yuriatilis*, *gloucophylla* and *adenophylla*. The dogwoods are *C. stoloniifera* and *Baileyi*. The poplar is the cottonwood, *P. deltoides*. To the botanist, the adaptation of these plants for such a position are self-evident, but individual cases present continual variations. Nothing could more clearly illustrate the extreme plasticity of these shrubby species than their quick and sure response to these constantly varying factors.



These grasses lead in the attack upon the dunes. These plants all arise from a single root stock.

In the case of the grasses, which are chiefly *Andropogon scoparius*, *Ammophila arenaria*, *Calamovilfa longifolia*, and *Elymus canadensis*, there is a quick setting of roots from the nodes when there is but a partial submergence, while the long, horizontal branching root stock is constantly sending up new stools during the continuance of favorable conditions. The first plants to obtain a foothold upon these shifting sands are usually the grasses. From a single stool through the agency of the root stock there is a rapid spread which covers a very considerable area. In various places upon the most active portion of the dunes some one or more of these grasses obtain a foothold and struggle fiercely to maintain the place they have seized. So far as my personal observations go, the invasion of the dune is

made at its lower stretches, gradually creeping upward, until in a particularly favorable season the whole dune is fairly well covered with plants. The binding together of the soil by the grasses, even for a short time, is sufficient to permit the establishment of other forms, so that in places the flora of the upper beach and active dune may be quite varied. On the upper beach the most common of the plants are *Artemisia caudata* and *A. Canadensis*, while the attractive *Carduus Pitcheri* is scarcely less common. In these plants the strong and long tap-root and dissected leaves serve as an almost perfect protection against excessive evaporation and the mechanical



At the close of a favorable season the whole dune may be fairly well covered with plants.

action of the sand in the case of high winds. In the case of the *Artemisias* it was possible to observe in a considerable area, the perfection of the defense the finely dissected leaves afford against the sand blasts of a storm which lasted for nearly a week. Almost every other species in the area, which lay open to the direct action of the wind-driven sand was completely battered to pieces, while only about 15 per cent. of the *Artemisias* showed any sign of having been subject to a long continued action of a destructive force.

Upon the upper beach, also, is to be found in favored situations the beach pea, *Lathyrus maritimus*, although in no instance was it at all a dominant form. Upon the active dune is often to be found the frost grape,

Vitis cordifolia. Far more common, however, the common milk weed, *Asclepias Syriaca*, the bug-seed, *Corispermum hyssopifolium* and *Puccoon*, *Lithospermum Gmelini*. This last is by far the most common of the groups, consisting in many instances a large proportion of the plants. A golden rod is not at all uncommon in such situations, but I am not certain what species it is. I am, however, confident it is not *S. virgaurea gillmani*, to which it is referred by Dr. Cowles in "The Ecological Relations of the Vegetation of the Sand Dunes of Lake Michigan." In no two cases are the conditions exactly similar, so that in spite of the paucity of species there is



At times the *Artemisias* are dominant plants over considerable areas.

no monotony. Different dominant species, differing proportions of those occurring make each area a special study. If we add to these the varying adaptations of the same species and the fact that at best any victory of the plants is but apparent, we can understand something of the complexity of the problem. The illustration on page 127 shows a large pine dying because of an uncovering of its roots during the storm mentioned above.

The succulent type of annuals was not so strongly marked as I had expected, but dissected leaves, the profile position, inrolling of leaf blades, and coverings of hairs seemed the dominant adaptations against the excessive transpiration and doubtless also against the fierce heat of the sun. Against the wind action the prostrate or trailing habit and great rigidity were the prevailing adaptations among herbaceous plants. Against sand coverings, nodal rooting and branching root stocks are almost universal among the

annuals. Where perennials have obtained a foothold, the long, thick tap-root is usually sufficient to give a new lease of life. Against the mechanical effects of the sand, the prostrate habit, the dissected leaves and at times



Any victory of the plants is but apparent. After years of possession of the soil they may be dislodged by the shifting of the soil under the action of the wind.

an extremely tough and resistant structure. The first two are by far the more common and apparently the more effective.

From the standpoint of the plant no situation can be more pitilessly cruel than the stretches of white, restlessly shifting sand making up the beaches and dunes. In a certain sense, no other situation furnishes ecologi-

cal problems of such apparent simplicity, but even here, as I have tried to show, the problem is really one of extreme complexity. If in any measure this paper serves to indicate how utterly without significance much so-called ecological study really is, and to stimulate to work along these lines that is really analytic, that recognizes the fact that no ecological problem is in reality simple and needs long-continued, oft-repeated observation and reflection before generalizations are made, it will have a distinct value quite apart from the specific subject discussed.