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Environment as a Factor in the Growth and Distribution of Plants

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individuals, simlar to a few that I encountered. Fabre also came to the same conclusons as Reinhard at first, but later found other colonies of wasps which would violate their instinct by carrying in the prey without stopping as described in my experiments. Yet with exactly this data in mind, Fabre writes:

"There are picked tribes, strong-minded families which, after a few disappointments, see through the experimenter's wiles and know how to baffle them."

This sounds like a candid admission of their ability to modify conduct according to conditions, but he is apparently not so to be understood. Four pages further on he adds: "Nature has endowed her with only those faculties called for in ordinary circumstances ... . and as these blind faculties which cannot be modified by experience, are sufficient for the preservation of the race, the insect is unable to go beyond them."

That is to say, an insect can see through an experimenter's tricks (though they are entirely new to it) and learn how to overcome them, while utterly unable to modify its blind faculties by experience! But I leave it to the reader to draw his own conclusions.

Roy L. Abbott.

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ENVIRONMENT AS A FACTOR IN THE GROWTH AND DISTRIBUTION OF PLANTS

Biology

The form and appearance of plants and the activities which they carry on are due in large part to the inherited characteristics of their ancestors. The influence which heredity exerts should be clearly and forcefully presented to students. At the same time the expression of the hereditary traits may be greatly modified by the conditions under which the plants grow. Plants, on the whole, are quite well adapted to their environment. This is so well recognized that we commonly associate certain types of vegetation with certain combinations of environmental conditions. The relations of plants to the habitat factors, both animate and inanimate, are quite complex and yet much can be learned from comparatively simple studies.

A field trip to the woods will acquaint the students with one type of habitat and the plants characteristic of it. The upper story or layer is composed of the crowns of the larger trees which shut out a considerable part of the light from the plants beneath. Next comes a layer of smaller trees such as the ironwood (Ostrya), choke cherry (Prunus) and the hawthorns (Crataegus). These trees are tolerant of shade and can thrive in the reduced light. Below them is a third layer composed of shrubs, of which the gooseberries (Ribes), prickly ash (Xanthoxylum) and the dogwoods (Cornus) are common examples. The ground layer will be found to be composed of herbaceous species which trive in the moist, fertile soil and deep shade. We regularly associate hepatica (Hepatica), bloodroot (Sanguinaria), spring beauty (Claytonia), trilliums (Trillium), wild ginger (Asarum), adders-tongue (Erythronium) and Dutchman's breeches (Bicuculla) with such conditions. Along with these flowering plants we expect to find mosses, ferns and fungi of many kinds and, in the wetter situations, liverworts. The layering of vegetation in a typical forest is an interesting study of the relation of plants to light. The relation of the blooming of the plants in the ground layer to the leafing out of the trees will illustrate one method by which survival is possible.

In various situations and types of soils the species of the principal trees will be quite different. On rich, moist soils the sugar maple (Acer), basswood (Tilia), red and white oak (Quercus),

walnut and butternut (Juglans) and shagbark hickory (Hicoria) are the principal species. On drier soils the elms (Ulmus), bur and black oak (Quercus) and hackberry (Celtis) are common. Along stream courses in all parts of the state will be found willows (Salix), cottonwood (Populus), silver maple and boxelder (Acer). In open spaces and along the margins of the woods will be found largetooth and trembling aspens (Populus). These are intolerant species which cannot endure deep shade.

Large areas of virgin prairie are not common now but sometimes small areas can be found; often along railroads fairly typical prairie vegetation can be found. Common prairie grasses are the big and little bluestems (Andropogon), goldstem (Andropogon), panic grasses (Panicum), June grass (Koeleria) and porcupine-grass (Stipa). On drier soils are found rush grass (Sporobolus), tall grama grass (Atheropogon) and mesquite grass (Bouteloua). With the grasses are found various species of legumes such as the purple and white prairie clovers (Petalostemum), bush clover (Lespedeza), wild indigo (Baptisia), vetches (Vicia) and psoraleas (Psoralea). Rattlensakemaster (Eryngium), shooting star (Dodocatheon), whorled milkweed (Asclepias), leatherflower (Viorna) and ruellia (Ruellia) are also quite common. During the late summer and fall the composites become very conspicuous. Among them brown-eyed susan (Rudbeckia), purple coneflower (Echinacea), gray-headed coneflower (Ratibida), tickseed (Coreopsis), rough oxeye (Heliopsis), compass plant (Silphium), fever-few (Parthenium) and the button-snakeroots (Lacinaria) are common. In low places where the moisture content of the soil is higher there may be found some plants such as the iris (Iris) or the marsh marigold (Caltha) which represent an earlier stage in succession. In favorable location shrubs may be found illustrating the stage which will succeed the prairie vegetation in time.

A trip to a pond or low marshy situation will permit the study of vegetation of a different type. If there is open water there will be found floating on the surface different kinds of algae and duckweeds (Lemna, Wolfia and others). Growing completely submerged are the waterweed (Elodea) and the hornwort (Ceratophyllum). Rooted in the mud near the margin but with their leaves floating on the surface, or slightly elevated if the plants are crowded, are water lilies of various species (Nymphaea and Castalia) and the water plantain (Alisma). Comprising a zone around the margin are cat-tails (Typha), irises (Iris), sedges (Carex, Cyperus, etc.), bur reeds (Sparganium) and similar plants. Other zones are composed of grasses and trees. This zonation of plants illustrates the influence of water content upon the character of vegetation.

It is desirable to correlate the differences in the vegetation of different situations with the habitat factors. The most important of these factors are water supply and temperature of the soil, humidity and temperature of the air and light intensity. The importance of these conditions in the growth and development of plants should be studied. The field work can be accompanied by class discussions on the flora of Iowa; the distribution of plants, the relation of plants to animals and similar topics which have to do with the environment of plants.

The fall is an excellent time to study the dissemination of fruits and seeds. Such plants as burdock (Arctium), cocklebur (Xanthium), sandbur (Cenchrus), tick-trefoil (Meibomia), beggar's ticks (Bidens), stickseed (Lappula), black snakeroot (Sanicula) and sweet-cicely (Washingtonia) have fruits fitted for dissemination by animals. Fleshy fruits, such as are found on hawthorns (Crataegus), nannyberry

(Viburnum), the cherries (Prunus) and wild grape (Vitis), are also devices by which the seeds may be scattered by birds or other animals which eat the pulp. Nuts and acorns are commonly scattered and planted by squirrels. Milkweeds (Asclepias), thistles (Cirsium), dandelions (Taraxacum), wild lettuce (Lactuca), willows (Salix) and poplars (Populus) are examples of plants with fruits or seeds equipped with hairs for dissemination by the wind. Maples (Acer), elms (Ulmus), ashes (Fraxinus), pines (Pinus) and catalpa (Catalpa) have winged fruits and seeds while the ground cherries (Physalis) and the ironwood (Ostrya) have envelopes which contain air. Russian thistle (Salsola), witch grass (Panicum) and other "tumbleweeds" also have their seeds distributed by the wind. One or more field trips as well as class discussions can profitably be devoted to the problems of how plants are distributed.

A study of the common weeds, including identification and recognition, their relation to the growth of other plants and their effect upon erosion and soil building, can well be taken up during the fall and is of considerable importance. The sources from which they have entered this country and how they have spread would be worth discussing. Seeds can be collected during the fall and then, during the winter, attemtps can be made to germinate them. It will be found that many of them will not grow due to some characteristic of the seed coat or the condition of the embryo. During the winter months studies can be made of bulbs, tubers and other underground structures which carry the plant species over the winter. Attempts can be made to break the dormant period by different treatments with hot water or ether as suggested for the twigs of trees. In the spring a record of the dates of blooming for the common flowers and trees will provide material for interesting studies. The relation of the blooming of different species to conditions of the advancing season will give the students some idea of our continually changing floral aspects.

Simple laboratory experiments can be devised to illustrate the influence of environmental conditions upon plants. The effect of light can be demonstrated by plants in the window or by placing seedlings in a box with only one small opening through which light may enter. The turning of the seedlings toward the light will take place within a short time. The influence of light upon the development of chlorophyll and the character of growth can be shown by comparing the color and height of seedlings grown in the dark with normal seedlings grown in the light. The influence of water upon the growth of plants can be shown by growing seedlings in a series, varying the water content of the soil from a point, in the first container, barely sufficient to maintain life, to saturated soil at the other extreme. By means of another series of seedlings, some at room temperature, others in a temperature as low as it is possible to maintain, and others at a high temperature, the effect of temperature can be illustrated. The influence of gravity upon the direction of growth in stems can be demonstrated by fastening seedlings of corn or bean in different positions in a chamber in which the air is kept moist. Some of the seedlings can be placed with the primary root growing in the normal position, others can be placed with the root in a horizontal position and others with the root pointing upward. By marking the roots with India ink the region of curvature can be located. Other simple demonstrations can be devised and performed as time permits.

By means of these field and laboratory studies the students should acquire some knowledge concerning the important factors of plant habitats and their influence upon growth, development and distribution.

O. R. Clark.