Proceedings of the Iowa Academy of Science

Volume 26 | Annual Issue Article 45

1919

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AN ILLUSTRATION OF THE WEDGE-WORK OF ROOTS

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The wedge-work of roots is a powerful and effective agent of weathering and performs an important part in breaking up solid rock. Since the indurated rocks, as a rule, are covered by mantle rock of considerable thickness the actual penetration of their seams, joints, and crevices by roots is concealed. In some cases, too, the mantle rock is of so great thickness that even the longest roots fail to reach the solid rock below. On bare rocky cliffs where there is sufficient moisture, trees, in some cases of large size, grow from crevices and joints where their seeds have sprouted. As they grow their roots penetrate the openings and wedge their sides apart sometimes prying off unstable rock masses and toppling them over—the final overthrow occurring oftentimes during a windstorm which may blow down the trees.

Not only does the wedge-work of roots shove the rocks apart but the enlarged crevices, becoming the repositories for soil and debris blown in by the wind or washed in by the rain, are further widened when the water and soil thus admitted freeze. Furthermore, when the tree eventually dies the decaying roots form passageways which water readily enters and assisted by the acids of decay may further disintegrate the rock by solution. Even the living roots secrete acids which have a very great effect on the undecomposed minerals or rocky materials.

The wedge-work of roots as a mechanical action is not of the same strength in all plants though all roots possess the power to some degree. In some of the tropical and subtropical parts of the world man makes use of the prickly pear cactus in preparing soil on stony land. The roots of this plant have a remarkable power of penetrating and wedging rock apart and especially in converting fresh lava rock in this manner into soil. Ordinary weathering requires a century to accomplish on such lava what the cactus can do in a few years.[1] Everyone is familiar with the wedging power of roots in heaving walks, in cracking walls of masonry, and in breaking, entering, and even clogging sewer and drain tile. This force,

[1]McConnell, P., Elements of Agricultural Geology, London, 1902, page 48.

expended by growing plants and their roots, is almost incredibly strong. A recent textbook[2] gives an illustration of a millstone ten and one-half inches thick cracked in two by an elm tree in thirteen years after it had sprouted through the central opening.

Some idea of the shoving power in growing plants may be had from a few illustrations of cell pressure. "The root of the garden pea, for instance, has a wedging force equal to 200 or 300 pounds a square inch."[3] I am informed by Dr. R. B. Wylie, of our State University, that the osmotic pressure of the plant cell of a sugar beet is as high as twenty-four atmospheres. Concerning the action of roots Doctor Stockbridge, a careful student of their effect upon rocks and soils, says, "roots permeate the rock-mass wherever the slightest crevice offers an entrance; and then, by the expansive force of the growing tissue, the most tenacious of rocks are rent and torn asunder, no power in nature being able to withstand the force of this slow-working but resistless expansive action." And again, speaking of the power of the root system in forcing the soil-water upward, he says, "the pressure exerted by a birch-root severed from its connection with the tree was equal to a column of water 85 feet in height; and that of a squash-plant eight weeks old, soft, open in its texture, and very tender, exerted a force equal to a column of water 45.5 feet high."[4]

During the winters in our latitude living tree trunks contract at times of very low temperatures and expand again as the thermometer rises. At times frost cracks appear and disappear in some trunks under these conditions. The actual volumetric decrement or increment is of low amplitude but the force is inexorable and no doubt plays a small part in the wedge-work of the larger roots near the surface and of the base of the trunk when the latter is obstructed. The reader is referred to some interesting observations on "The Coefficient of Expansion of Living Tree Trunks" which appeared in a late number of Science.[5]

In discussing the agents of weathering textbooks of physiography and general geology in many cases give illustrations of rocks or boulders which have been cleft by the wedge-work of roots—the cuts usually showing a tree growing out of the cleft. Boulders, however, exhibiting this feature are not common. In spite of the fact that glacial boulders are numerous and widely distributed in

[2]Ries and Watson, Engineering Geology, New York, 1914, Pl. XXXIII, fig. 2.
[3]Cleland, H. F., Physical Geology, Chicago, 1916, page 33.
[4]Stockbridge, H. E., Rocks and Soils, 2nd Edit., New York, 1906, pp. 111, 112, and 184.
[5]Trowbridge and Weil, Science, new series, Vol. XLVIII, Oct. 4, 1918, pp. 348-350.

Iowa it was not until recently that the writer's attention was called to a tree-split boulder in our state. Mr. Harold Corey, a member of the writer's physiography class at the University a few years ago, produced a photograph which he had taken of such a boulder which he modestly contended was as good an example as his textbook illus-

FIG. 120.—A granite boulder at Nashua, Iowa, which has been split in two by an elm tree growing from a crevice in the stone. Photo by Harold Corey.

tration "taken," as he said, "from some other state." Mr. Corey's boulder is located within the corporate limits of the town of Nashua in Chickasaw county. It is situated in a cultivated field on the Greeley estate in the northwest part of the town about one-fourth mile west of the Catholic church. The field is in the southwest quarter of section 18, township 94 north, range 14 west.

The stone is a coarse-grained feldspathic granite, somewhat decayed and of the type that is very common on the surface in Chickasaw and Floyd counties. It measures approximately 11x17x5 feet above the ground. The cleft divides the stone into two unequal parts; the smaller part, which is approximately 10x7x5 feet in maximum dimensions, has sustained all the movement since it rests on top of the ground while the larger part penetrates the soil to an unknown depth. The faces formerly in apposition and now separated by the trunk are readily distinguished. The original cleft in which the sapling sprouted was at an angle of about 45 degrees. The effect of starting its growth in this unnatural position is still apparent in the trunk whose lower part is permanently bent. As the tree grew the smaller part of the stone was not only shoved over but was also rotated through an angle of over 45 degrees since the face against which the trunk shoves is now vertical or slightly beyond that position. The volume of the smaller part, according to the dimensions cited above, is 350 cubic feet. Dividing this by two to allow for the irregularities of the stone, its weight, at 175 pounds per cubic foot, would be over fifteen tons. This figure gives some conception of the shoving power which this particular tree has exerted during its growth. Many of the larger roots of the tree have grown out of one end of the cleft and thence into the earth to avoid the main mass of the stone which extends not only directly under the tree but also into the earth beneath the smaller part of the stone.

The tree is a thrifty elm, *Ulmus americana,* about fifty feet high. The trunk within the cleft and for some distance above the stone is rounded-flattened or oval in cross-section and its dimensions at the top of the boulder are four and one-half by two and one-half feet.

This example of a split boulder, possibly the only one illustrating this feature in Iowa, compares favorably with those illustrated in current textbooks. It is hoped that the good citizens of Nashua and vicinity may long preserve it from injury. Students of natural phenomena for decades to come will marvel at the power of the seedling elm which has rent the massive boulder in twain.

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