ECOLOGY

Grass-Roots Science

Canadian Botanist Is Digging Deeply Into Problem Of Erosion and Weeds and Rooting Out the Solution

By DR. FRANK THONE

ROOTS look large to our natural consciousness nowadays. Floods, soil erosion, and the looming threat of choking storms swirling out of the West's "dust bowl" have made even city folk apostles of the plant-more-grass movement. We all want to see the myriad cords of roots holding fast the slipping soil that is riches if it stays where it belongs, ruin downstream and downwind if it does not. As a people, we are becoming rooters for roots.

Yet, paradoxically, we know very little about this subject that has become so important to us. About the tops of plants we know plenty. They are easy to get at, agreeable to see, and are the sources of most of the plant products we use. So botanical scientists of all kinds and degrees have for centuries centered their studies on the overground parts of plants, and have left roots in muddy darkness.

This neglect of roots has been a serious error. It is almost as bad in its way as it would be for a zoologist to make careful study of the lungs and other breathing apparatus of an animal and pay no attention to its digestive system. Roots do an important and indispensable share of every higher plant's life work: They get the all-necessary water, along with the all-necessary mineral nutrients from the soil, and they anchor the plant in place. Sometimes also they store food.

Important Function

It is important to know about how the roots of every important economic plant (whether food plant or weed) function as water- and mineral-gatherers if we are to understand and control their activities, whether as crops or crop pests. It is important to know how deeply and thoroughly roots take hold in the soil if we are to choose intelligently when we come to plant soil-binding vegetation to check erosion. We cannot afford any longer to be ignorant about roots.

Out on the Canadian prairies, at the University of Saskatchewan, there is a plant scientist who is actively doing something about it. He knows more about where roots actually go than any man who has ever lived, for he is the first man who has ever taken the trouble to remove all the soil from a whole root system, grain by grain, and chart the roots, inch by inch, as he has come to them. He is a real grass-roots botanist.

His name is T. K. Pavlychenko. He is a native of Ukrainia, but he has for several years been a Canadian citizen. He is attached to the faculty of the University of Saskatchewan, at Saskatoon, in the capacity of "weed experimentalist." He did work primarily on weed problems when he first came there, but his researches have branched out since, to include range, forage, and grain crops as well. But Mr. Pavlychenko is a highly practical kind of botanist, and will not take time to dig up and examine the root systems of non-economic wild plants. "Too much to do at present with economic species," he says. "May get round to the wild stuff later on."

Because of Weeds

The whole thing started because of weeds. Farmers on the fertile plains of Saskatchewan were increasingly troubled with several particularly persistent and pestiferous weed species. The authorities at the experiment station of the province, located at Saskatoon, decided to attack the advancing enemy with all the weapons of science.

One of the most self-evident facts about the weed situation was that the weeds were not crowding out the useful plants in the same way that they do in the moister agricultural areas of the East. Where there is plenty of moisture in the soil, the dominant weed tactics consist in crowding down the crop plants and thrusting their leaves forward to "hog up" all the necessary sunlight.

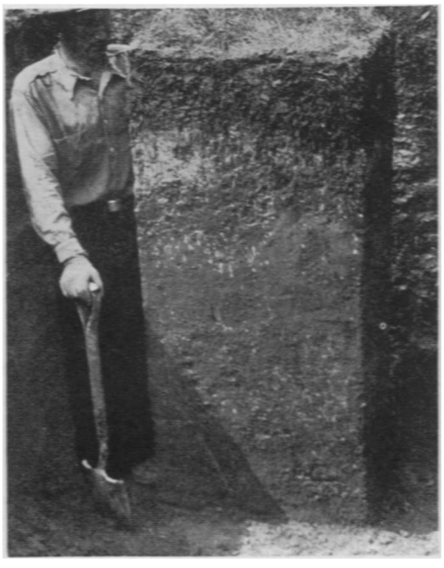
But on the drier lands of the West, the competition does not go on above ground. The tops do not crowd each other for a place in the sun. The deadly, silent battle is fought beneath the surface of the soil. There roots compete with roots for the smaller supplies of moisture and for the dissolved mineral nutrients in the water. In the East, the winner is the plant with the lustiest top, in the West, the victor is the plant with the deepest, bushiest root system.

Among the most troublesome weeds of the Saskatchewan plains were several species of wild mustard, and even worse than these, wild oats. (Yes, there really is a wild oats plant. It looks like real oats but its grain is light and worthless. The great classical botanist Linnaeus, who evidently had a sense of humor, gave it a scientific name that means "fools' oats" — *Avena fatua*.) These weeds, in turn, can be routed by two or three species of range grass, especially one brought in from western Asia, known as crested wheat grass. These fighting grasses can beat the weeds at their own deadly game of root competition.

Thorough

To Weed Experimentalist Pavlychenko fell the task of finding out exactly how the roots of each weed and crop plant behaved, both when grown alone with plenty of space both above and under ground and when grown side by side with a competing plant.

He went about the job thoroughly. He planted seeds of each kind, both separately and within competing range of other plants. At four different times during the first growing season, and with perennial plants twice more during the following year, he took out a sample plant of each kind, lifting with each



MAN-SIZED

This block of soil, 12x30x60, has been carved out to study the root system of the sod of crested wheat grass at its top.

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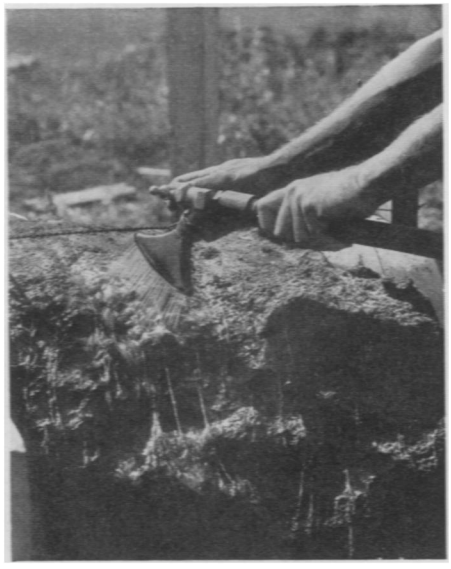


WASHING

Using this specially built spray nozzle, the earth is carefully cleared away from the roots with a "brush" of fine water jets. Washing the soil away from the roots starts at the bottom of the column of soil and works toward the top.

plant a solid block of soil containing its entire root system. With a "brush" of fine water-jets he removed every particle of soil, charting the position of every root as he did so. Later, in flat tanks in the laboratory, he measured every inch of every root. How laborious this job was may be guessed from the fact that some of the root systems of full-grown plants had main roots and branches summing up to two and three hundred miles! When he showed one of his "extricated" root systems before the meeting of the American Association for the Advancement of Science, and later before audiences of botanists in Washington, D. C., Toronto, and Winnipeg, his fellow-scientists regarded the specimen with something like awe.

Takes Hard Digging

To get out a root system involves a great deal of hard labor, but the procedure is so straightforward and simple that anybody can understand it. It is not much more complicated than standing an egg on end—though it takes rather longer to do.

First, Mr. Pavlychenko digs a trench clear around the plant he is going to study, leaving a block of soil big enough to hold all the roots. If it is a big clump of crested wheat grass, for example, the block is four feet square and seven or eight feet deep. One side of the trench is sloped off into a kind of steep ramp. This preliminary spade-work takes about a week, and leaves the soil block standing up like a short, thick, square pillar, with the plant's overground part standing on top of it.

The next step is to enclose the pillar in a sectional case or framework, made of stout two-inch lumber and steel rods. Once securely encased, the soil mass is loosened at the bottom and tilted slowly over on its side. That is where the widening of one side of the trench into a ramp comes into the picture.

Then block and tackle is rigged to the prostrate lifting case, and a couple of husky-backed young assistants heave away at the falls until the whole massive block (it may weigh as much as two tons) has been brought up to the surface. Here it is slid onto a platform mounted on trailer wheels, and removable sides are set up around it. Bolted tight, they form an oblong watertight tank. This is filled, and the soil mass is left to soak until it is soft through—perhaps a couple of days.

With this heavy-labor part of the job finished, the real work is ready to begin. All that earth has to be removed from around and among those infinite interwebbed roots, and yet not the smallest branch may be broken. No trowel, not even a toothpick, could meet those exacting requirements.

A Brush of Water

The only safe working tool is water; water, in fine, brush-like streams. Mr. Pavlychenko has devised such a water-brush, a flat spray-nozzle with a valve to control the force of its fine streams. With it he can wash clear every speck of soil, and even remove the occasional stone that one finds in the fine loam of the Saskatchewan prairies.

Beginning at the bottom, working slowly toward the top, the water-brush does its work. Inch by inch it discloses the webwork of the roots, and inch by inch, as they appear, the scientist charts them on a big sheet of graph paper. At the end, he has a complete map of the whole intricate root system, spread out on his cross-ruled paper like a surveyor's map of a river system. (Except that in the river system of a plant's roots the water runs uphill!) Washing and charting a big root mass is a two-week job.

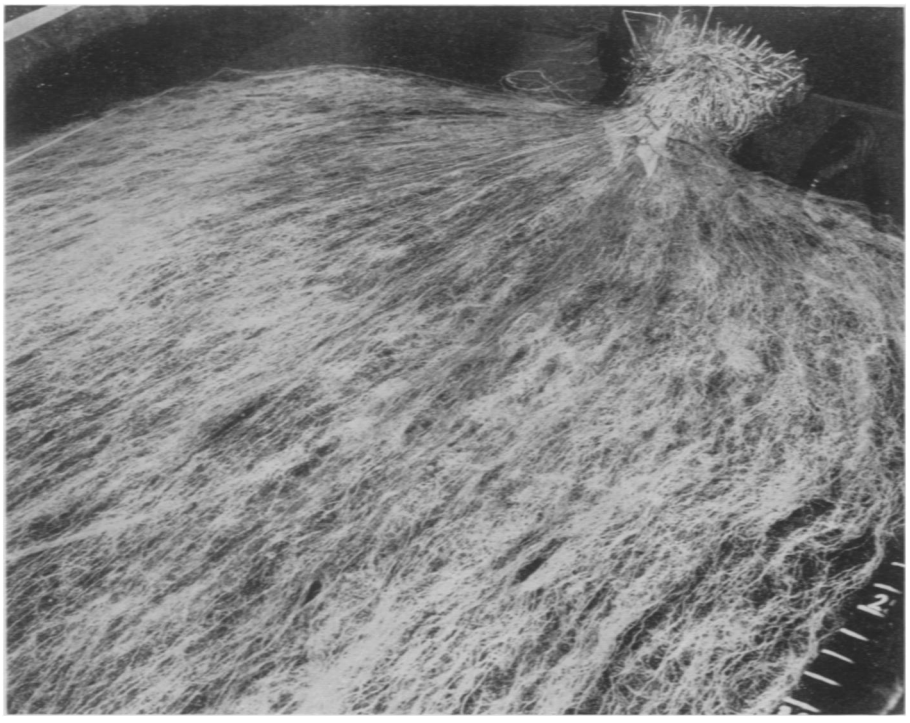
Once the root system is clear of all foreign matter, it can be rolled up and packed away in a container of preservative, to be taken out for further study when the long Saskatchewan winter comes, and not even the most enthusiastic grass-roots botanist can dig in the frozen soil. Little plants with small root systems get pickled in ordinary glass fruit jars. Big plants with huge root systems are stored in special tanks with lids. The preservative is three or four per cent formalin.

Winter Occupation

The job of measuring up a big root system may take a month of winter laboratory time. The roots are laid out in natural position in a flat, shallow tank, painted black inside to set off the white of the roots to best advantage and strongly illuminated with a battery of eight 250-watt electric lamps. Tedious as the task is, Mr. Pavlychenko and his young assistants hold themselves to it day after day. The "inchage" of some root systems reaches incredible figures—runs into millions. It becomes more convenient to reduce the measurements to miles. Thus, the root system of the crested wheat grass plant which Mr. Pavlychenko took along on his recent trip East had a thousand main roots, each with hundreds of branches, and the whole measuring up to a total of 319 miles!

To take a big root system travelling, Mr. Pavlychenko has devised an ingenious traveling tank. It is as long as the root system is wide—some forty inches. It has a tightly fitting lid, which can be sealed on. The root system is first laid out flat in its tank, with a wide sheet of oiled paper beneath it. The water is slowly drained away, letting the roots settle flat on the paper. Preservative solution is sprayed or sprinkled on. Then the paper is rolled up, roots and all, beginning at the bottom. The roll is gently lowered into the tank, which has a bulge built into its bottom, to accommodate the thick clump where roots and stems come together—the "crown," botanists call it. Thus Mr. Pavlychenko's favorite crested wheat grass specimen traveled many hundreds of miles.

Mr. Pavlychenko is enthusiastic about crested wheat grass, as a plant for the Canadian West and for the northern Great Plains of this country. It has practically all weeds licked from the first gong. It grows more roots, deeper roots, and grows them faster, than any grass he has experimented with. It holds soil. Livestock like it. It grows freely in most soils typical of the West, and its water requirements are not exacting. It is a perennial grass, but a relatively short-lived one, and since it depends on seed rather than underground runners for propagation it is not likely to become a



JUST ONE

A single crown root of a wild oat plant 80 days old. Total length of roots shown here measures more than 300 miles.

troublesome weed as its relative, quack grass, has done. In general, Mr. Pavlychenko holds, it is a most desirable type of plant immigrant.

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A series of English books for Chinese readers is being prepared in China, using 850 common English words.

Drinking through straws is an idea as old as 1400 B. C., for people in Syria drank beverages that might contain dregs by inserting a copper tube with holes in it in the clay drinking jar and putting a long bent reed inside that.

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MEDICINE

Much Spring Hay Fever Due to Plantain Pollen

SPRING hay fever has been thought of largely as grass hay fever, and doctors have been treating it with grass pollen extract.

Now come Drs. George I. Blumstein and Louis Tuft of the allergy clinic at Temple University, Philadelphia, with the news that 20 per cent. of the spring sneezers may attribute their trouble not to the grasses but to plantain.

By mixing some plantain pollen with the grass pollen extract, physicians and their hay fever patients may both be happier over the results, an article in *the Journal of the American Medical Association,* (May 1) states.

English or narrow-leaved plantain is a worse culprit than the common or broad-leaved plantain, because it is more abundant. As a pollen producer it ranks right along with the best of the grasses.

Plantain pollination begins about May 15 and continues until early September, but after July 1 the amounts are small.

The pollen grains on the plantain flower are hung in such a fashion that the slightest jar shakes them off and they float out into the air.

These Philadelphia physicians studied a group of 150 sufferers from all types of hay fever and found that only 7.7 per cent. of them were sensitive to plantain pollen.

When they took a group of 70 patients with spring hay fever, however, they learned that plantain was a factor in 20 per cent. of the cases.

Timothy and ragweed pollens bear no relationship to those of plantain, it was found.

Use of the dry pollen nasal test is an invaluable aid in arriving at a correct diagnosis of plantain hay fever, especially when grass hay fever exists in the same individual, these investigators learned.

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ANTHROPOLOGY

Expedition Seeks Mummies Threatened By Foxes

RESCUING ancient mummies from hungry foxes is one aim of a Smithsonian Institution expedition now preparing to start for Alaska.

The expedition, led by Dr. Ales Hrdlicka, noted anthropologist, will return to the Aleutian Islands, off Alaska, where last year they found some of the elusive mummy caves that were once scenes of strange Aleutian Island burials.

Salvaging the mummy bundles is of great interest, scientifically, because they shed light on physical type and cultural possessions of little-known early inhabitants of America, in the far north. Danger to the mummies is becoming acute, because fox farms are established on the islands. Famished foxes find the mummy caves, and devour the hides that wrap the mummies, gnawing and scattering the bones. Souvenir hunters have also risked their necks to land on the craggy islands to plunder the old burials.

Dr. Hrdlicka is seeking evidence particularly on migration routes taken by early people who entered America from Asia. Bering Strait was the main crossing point, but the Aleutian Islands, which swing like stepping stones across from Asiatic waters toward Alaska, may have been a secondary route, according to one theory.

Dr. Hrdlicka, assisted by volunteer college students, will explore two large ancient towns in the Aleutian Islands, never visited by white men, so far as is known. In ruins of these towns, which lie in the western part of the island chain, he may find new evidence to solve the old migration riddle.

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