extracts the substrate, which is redissolved in water after the alcohol is evaporated off. Table 1 gives the oxygen uptake in c.mm. of the various combinations of enzyme, substrate and vanadium after half an hour at pH 6.7 and 37° C. 0.5 cc enzyme suspension and about 10 per cent. of the amount of substrate present in one guinea pig liver was used in a total volume of 2.0 cc in the Warburg vessels.

TABLE 1

	O_2 uptake c.mm.
Enzyme	0
Enzyme + vanadate	0
Vanadate + substrate	0
Enzyme + substrate	12
Enzyme + vanadate + substrate	119

Work on the chemical identification of the substrate is now proceeding. Experiments have shown that it is probably not an amino acid, amine, simple alcohol or aldehyde, purine, low fatty acid, choline, succinate, cholic acid, citrate, lactate, pyruvate, glucose or ascorbic acid. It is probably a phospholipid.

As vanadium is found in small traces in all tissues these results raise the question whether it has a normal catalytic function in the body and whether it is an essential element.

FREDERICK BERNHEIM
MARY L. C. BERNHEIM
DUKE UNIVERSITY MEDICAL SCHOOL

A COMPARATIVE STUDY OF THE SUBTERRANEAN MEMBERS OF THREE FIELD GRASSES

A COMPARATIVE study was made of the roots and root hairs in upper soil levels for oats, winter-rye and Kentucky bluegrass. Soil samples 3 inches in diameter and 6 inches deep (42 cubic inches) were taken from the fields by means of a cutting tube, and measurements made of the included subterranean plant parts. Total lengths of both roots and root hairs were used in computing the extent and surface exposed by the underground members. In Tables 1 and 2 the values given are the average of the three soil samples surveyed for each species.

TABLE 1
ROOTS*

	Total number of roots	Total length of roots (ft.)	Total root surface (sq. in.)
Oats	4,700	150	50
Rye	6,400	210	78
Bluegrass	84,500	1,260	330

* Per soil sample (42 cubic inches).

In a comparison of the cultivated rye plants grown in competition with a non-competing greenhouse rye plant, previously surveyed,[1] it was found that the field rye had approximately 5 times the number of root hairs per unit of root length as the non-competing greenhouse plant. However, the indoor plant had far more and longer roots, and consequently a greater total number of root hairs.

TABLE 2
ROOT HAIRS*

	Total number of root hairs (in millions)	Total length of root hairs (miles)	Total root hair surface (sq. ft.)
Oats	6.3	4.9	3.7
Rye	12.5	10.0	8.2
Bluegrass	51.6	32.0	16.9

* Per soil sample (42 cubic inches).

Assuming that roots and root hairs were evenly distributed throughout the samples, one cubic inch of soil from this oats field would have approximately 110 roots and 150,000 root hairs, with a combined length of about 630 feet and a surface area of 15 square inches. A similar cube of soil from a field of winter rye would have approximately 150 roots and 300,000 root hairs with a combined length of 1,300 feet and a surface of about 30 square inches. Kentucky bluegrass would have, per cubic inch of soil, approximately 2,000 roots and 1,000,000 root hairs, with a combined length of over 4,000 feet and a surface area of about 65 square inches. When it is considered that these grasses have from 150,000 to 1,000,000 root hairs per cubic inch of soil their importance in the physics of the soil is obvious. From the standpoint of their usefulness as soil binders oats would be least efficient, rye intermediate and bluegrass far superior to either of the others in retarding erosion.

HOWARD J. DITTMER
DEPARTMENT OF BOTANY,
STATE UNIVERSITY OF IOWA

[1] H. J. Dittmer, *Am. Jour. Bot.*, 24: 417–420, 1937.

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