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CERTAIN ASPECTS OF THE H-ION CONCENTRATION OF THE SOILS OF A CENTRAL INDIANA RIVER BLUFF

By STANLEY A. CAIN AND RAY C. FRIESNER

In a recent paper, Cain and Friesner (3) found that there was a relation between topography and the hydrogen-ion concentration of the soil. This work was done on certain hills in the Sycamore creek region, Morgan county, Indiana, where it was found that the acidity was greater on the hilltops and less in the intervening ravines, so that curves representing the degree of acidity of the soil at different points on a line crossing the hills were roughly parallel with the topography. The average acidity on three ridge tops was pH 5.3, while the adjacent ravine bottoms were practically neutral, averaging pH 6.9. The consistently greater acidity of the ridge tops and upper slopes seems to play a significant part in the distribution of certain plants found only in such situations, viz., *Vaccinium vacillans*, *Gaylussacia baccata*, *Polypodium juniperinum*, etc. Since these ridges studied in the Sycamore creek region were only about one hundred feet high, it was thought desirable to investigate some river hills which rise about 250 feet above their immediate bases.

The work reported in this paper was also made in Morgan county, Indiana, at a point on White river known as Blue Bluffs. The soil samples for the pH investigation were taken in connection with a transect study of the vegetation, Cain, *et al.* (4). Surface and subsoil samples were taken at twenty-five-foot intervals, starting at the bank of the river in a line running 650 feet directly to the top of a hill known locally as Rock Hill. The steepest part of the slope is near the summit of the hill. At the top of the hill the line on which the samples were taken turned 45 degrees to the west and descended into a ravine, where it continued westward to the top of Blue Bluffs. The total length of the line was 1,925 feet, and the soil samples consisted of seventy-seven sets, each set comprising a surface sample and one taken at a depth of six inches. It has seemed advisable to arrange the results in six groups, on a basis of the altitude above the river level of the place where each soil sample was taken. Thus the lowest group of soil samples, from the river level to fifteen feet above the river, included the region of the flood

plain species. Similarly, the last group of samples, from 200 to 285 feet above the river, was in the region of what may be called the "hill-top" species.

Weaver and Clements (6), in their new ecology text, remark that, "It is frequently desirable to know just how vegetation varies with changing environment, such as caused by slope, exposure or other irregularities in topography or soil." In completely wooded river bluffs like the ones here considered, differences in evaporation are probably not great between the tops and bottoms of the hills. Edaphic factors are undoubtedly of greater importance in effect on the vegetation. Soil moisture conditions and the physical and chemical nature of the soil seem to be quite different and need to be investigated. It is the opinion of the present writers that many of the more commonplace and obvious ecological situations need quantitative investigation, if not for substantiation of our preconceived ideas, at least for classroom work. The following results of our pH determinations are a step in that direction.

RESULTS

The results of 477 tests of the pH of the soils are summarized in Table I.

TABLE I

AVERAGE pH OF SOIL SAMPLES TAKEN AT DIFFERENT ALTITUDES ON ROCK HILL AND BLUE BLUFFS

Altitude Class	Surface Soils		Subsoil Samples	
	No. of Samples	pH	No. of Samples	pH
200-285 ft. (Hilltop).....	10	5.89	10	5.13
150-200 ft.	13	5.76	13	4.73
100-150 ft.	18	5.65*	18	4.93*
50-100 ft.	20	5.79*	20	4.94*
15- 50 ft.	8	5.9	8	5.0
1- 15 ft. (Flood plain).....	8	6.5	8	5.8

*These averages were obtained by omitting three soil samples which were involved in a local land-slump, where the surface and subsoil were mixed up.

Wherry (7) has recently called attention to the necessity of realizing the logarithmic nature of the pH numbers when they are averaged, since the direct averaging of them may result in considerable error. If the H-ion concentration is not to be expressed in terms of "active acidity," it is necessary to average them on that basis and change them back to the more familiar pH numbers afterwards. This has been done in preparing the averages in Table I.

This investigation does not reveal as close an adherence of the pH to the topography as was found in our earlier work in the Sycamore creek region, yet the slopes are more acid than the flood plain. These figures can be taken as a certain additional substantiation of the general fact of leaching out of upland soils and the subsequent increase in the acidity, Salisbury (5). In these soils the acidity is conspicuously greater at a depth of six inches than immediately beneath the surface litter. This situation is undoubtedly due to the chemical nature of the parent material of the subsoil, although no analyses or geological study have been made as yet of the region from this point of view. It seems that a more widespread condition is that where the surface soils are more acid than the subsoils, Salisbury (5), Cain (1) (2), Cain and Friesner (3), etc. This condition is ordinarily a result of the accumulation of organic material yielding humus acids at the surface and the leaching out of bases which are not replenished as are the acids.

It has been the policy in our work to date to make three tests of the hydrogen-ion concentration of each soil sample. The Youden portable apparatus, permitting rapid determinations of the e.m.f. of the soil solutions, has been used for the tests. It was found that the average deviation of the three tests made on each sample was approximately 0.1 pH. The deviations are condensed on a basis of the degree of the acidity in Table II.

TABLE II
AVERAGE DEVIATIONS FROM THE MEAN OF THREE TESTS ON EACH SOIL SAMPLE

pH Range	Deviation from Mean	Number of Samples	Number of Tests
pH 7 range.....	0.0935	6	18
pH 6 range.....	0.1253	28	84
pH 5 range.....	0.1302	59	177
pH 4 range.....	0.0995	49	147
Grand average	0.117	142	426

There seems to be no special correlation between the degree of deviation of three tests on a sample and the degree of the acidity. The greatest deviation from the mean of three tests was found in surface soil No. 111, with a range from pH 5.306 to 5.969, and in subsoil No. 118, ranging from pH 5.867 to 6.615, or 0.33 and 0.37 respectively.

SUMMARY AND CONCLUSIONS

1. A total of 477 tests were made of the hydrogen-ion concentration of the soils on a line running 1,925 feet over two river hills, Blue Bluffs and Rock Hill.

2. There were 79 sets of surface and subsoil samples, 77 of which were on the line mentioned above.

3. In 90 per cent, or 71 of the 79 sets (three tests per sample), the subsoil was more acid than the surface soil by an average of approximately 0.8. Most of the eight exceptions were connected with a landslide which would account for the disturbance of the normal stratification.

4. For all the sets of surface and subsoils the range was from pH 4.4 to 7.7, and from pH 4.3 to 7.4 respectively.

5. For all samples the average reaction of the surface soil was pH 5.9 and the subsoil pH 5.1.

6. The greatest difference between the reaction of the surface soil and the subsoil of any one set was from pH 4.7 (subsoil) to pH 7.5 (surface soil). The least difference was from pH 4.45 to 4.47.

7. The average deviation from the mean of three tests on a soil sample was approximately 0.1, a factor sufficiently small to obviate the necessity of duplicate tests on individual soil samples. It is apparent, however, that numerous soil samples must be read in order to gain any accurate idea of the characteristic reaction of the soil of a particular situation or vegetation type.

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