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Observations on the habitat of certain ferns

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In the course of geological field-work in the Appalachian Mountains the writer has often found ferns which are usually regarded as characteristic of calcareous rocks growing on rocks such as granite, sandstone, and schist, which are as a rule very low in lime. In order to ascertain whether the presence or absence of lime in a rock has anything to do with the growth of the ferns upon it, a series of chemical analyses has been made, with the results herein described.¹

For the first subject the walking fern, *Camptosorus rhizophyllus*, was selected, and samples of the rocks and the soils on which it was growing were collected at twenty stations in Pennsylvania, Maryland, Virginia, and West Virginia,² ten different rocks being represented.³ The percentage of lime in each rock was first determined, and, as had been expected, was found to vary widely; one pure limestone proved to contain over 53% of lime, but there was less than 5% in many of the rocks, and mere traces in several of them. The fern is, therefore, by no means limited to calcareous rocks; it must get lime from some source, however, for analysis of the ash obtained by burning its leaves showed the presence of 30% or more of this constituent. So examination of the soil in which its roots were imbedded seemed desirable.

¹ The detailed results of the analyses have been published in Journ. Wash. Acad. Sci., Vol. 6, 1916, pages 672-679.

² These stations were located with the kind aid of the following local botanists of the several regions, to whom the writer herewith expresses his thanks: Mr. Harold W. Pretz, of Allentown, Pa.; Prof. Glenn V. Brown and Prof. N. F. Davis, of Bucknell University, Lewisburg, Pa.; and Dr. T. C. Stotler and Prof. H. T. McDonald, of Harper's Ferry, West Virginia.

³ These comprised limestone, dolomite-limestone, limestone-pebble conglomerate, argillaceous limestone, mica-schist, granite, granitic gneiss, shale, sandstone, and quartzite; there were also two occurrences on hemlock trees.

The total amount of lime in the several samples of soil was found to vary from 1.2 to 10.5%, the average being 4.4%. When it is considered that the field soils of the same regions contain on the average only 0.8% of lime the highly calcareous character of the soils supporting the growth of this fern is evident. Determination of the amounts of water-soluble lime gave a similar result, the fern soils yielding 0.08%, the field soils only 0.01%.

These data clearly indicate that *Camptosorus* is a lime-loving plant; so the problem resolves itself into accounting for the presence of a soil containing 4 or 5% of total lime in the crevices of a rock which may carry only traces of this substance. The explanation is not difficult to find;⁴ the soil supporting the growth of the fern is in most cases a black, powdery material consisting chiefly of bits of leaves, stems, etc., in various stages of decay, and containing only minor amounts of rock fragments derived from the adjacent ledges. Such vegetable matter contains even in its fresh state 2 or 3% of lime; and upon its decomposition organic substances are volatilized, resulting in a gradual concentration of this lime. Some of this substance may be carried away by rain water,⁵ but enough remains to render the soil calcareous, and to satisfy the lime-requirement of the fern.

In addition to *Camptosorus* several other rock ferns have been studied from the same viewpoint, with similar results. They comprise: *Asplenium ebenoides*, *A. montanum*, *A. pinnatifidum*, *A. ruta-muraria*, *A. trichomanes*; *Cheilanthes lanosa*, and *Pellaea atropurpurea*. In

⁴ It has been fully treated by Mr. Frederick V. Coville, in "The formation of leafmold," Journ. Wash. Acad. Sci., Vol. 3, 1913, p. 77; Annual Rept. Smithsonian Inst., 1913, p. 333.

⁵ The soils over limestone are in fact often poorer in lime than those over other rocks, owing to the comparatively great solubility of limestone in rain water.

all cases the soils in which the roots were imbedded proved to be highly calcareous, even though the adjoining rocks were not.

In view of the above results it seems obvious that in the study of the habitats of plants, such as these ferns, the mere superficial recording of the kind of rock is inadequate, and may lead to erroneous conclusions. The nature of the soil upon the rock is the important factor, and this should always be examined to find out whether, instead of being derived from the rock, it may not consist essentially of decayed vegetable matter. In the latter case, lime-loving plants may be enabled to thrive even though the underlying rock is wholly non-calcareous.

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Cheilanthes lanosa and Isoetes in Indiana

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The only record for *Cheilanthes lanosa* (Michx.) Watt for Indiana is contained in a list of the "Plants of the Lower Wabash Valley" by Dr. J. Schneck. This list was published by the Indiana Geological Survey in 1876. The area included in the title "Lower Wabash Valley" is that below the confluence of White River of Indiana. The Indiana territory included was parts of Gibson and Posey Counties. The habitat of *Cheilanthes lanosa* is given as rocky ledges. In Gibson and Posey Counties there are no rocky ledges, except a few low sand-stone ledges on the "Gordon Hills" in Gibson County, and a few low limestone ledges along the Wabash River below New Harmony. The writer has searched all of these and has failed to find the fern referred to, although the pressure of forty years of civil-

⁶ Since this paper was written transferred to the Bureau of Chemistry.