tions in the case of the late fourth and the fifth stage lobsters.

EXPERIMENT VIII.

*Conditions: black background (similar results were seldom obtained on a white background); sunlight bright; 20 late fourth stage lobsters.*

| Test. | Lt. End. | Mid-area. | Dk. End. | Cover. |
|---|---|---|---|---|
| 1 | 9 | 4 | 7 | |
| 2 | 11 | 5 | 4 | Reversed. |
| 3 | 7 | 6 | 7 | |
| 4 | 9 | 3 | 8 | |

EXPERIMENT IX.

*Conditions: black background; medium sunlight; 12 fifth stage lobsters.*

| Test. | Lt. End. | Mid-area. | Dk. End. | Cover. |
|---|---|---|---|---|
| 1 | 2 | 4 | 6 | |
| 2 | 2 | 3 | 7 | |
| 3 | 2 | 2 | 8 | Reversed. |
| 4 | 1 | 3 | 8 | |

The results of these experiments may also explain, to a certain degree, the facts which appear through the observation of large numbers of the larval stages of *Homarus* when confined and exposed to different light conditions, as they may also interpret to some extent the behavior observed in the larval and early adolescent stages of lobsters under natural conditions of environment. The first three larval stages, when confined in the large twelve-foot white canvas bags in which they were observed, manifested at all times a marked tendency to sink toward the bottom—except perchance at night, when more active swimming is observed in all the stages. This tendency during the daytime could not be controlled in any way. At night, however, it was possible to evoke a seemingly positive phototropic reaction from any of the thousands of young larvæ in the large canvas bags. This was accomplished by means of an acetylene light so directed against a certain area of the white field of canvas that large numbers would at once group themselves thickly about the illuminated area, manifesting, in the case of the third and fourth stages, such an effort to come into the light area that they would often throw themselves partially out of water, causing thereby numerous surface ripples. Since, however, similar results could be obtained when a black background was employed with the acetylene rays, and since the results were not so definite when the incident rays struck the water perpendicularly as when they were thrown at an angle, it was assumed that these reactions were not true phototropisms, but were largely due to the effort on the part of the young lobsters to move in the direction of the incident light rays. This phenomenon was better observable in the fourth stage of *Homarus,* when the very definite rheotropic proclivity, first clearly observable in this stage, could be entirely broken up by introducing the incident rays either at right-angles to or in opposition to the direction of the current. The fourth stage lobsters, however, even under the natural conditions of light, swim actively at the surface. It is not until the fifth stage that the bottom-seeking and 'hiding-habit' is fully established.

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## AN ILLUSTRATION OF THE USE OF THE WIRE-BASKET METHOD FOR SOIL TESTING.[1]

THE method of cultures in paraffined wire baskets, for determining the relative agricultural values of soils and for investigating the effects of various fertilizers, which was described in Bulletin No. 23 of this bureau, consists in growing wheat seedlings in the soils to be tested for from two to three weeks, determination being made of the water lost by transpiration and of the green and dry weights of the plants at the end of the period. Where differences between the various treatments are developed it is found that the transpiration varies with the weight, being, therefore, a fair measure of growth.[2] This method, which virtually furnishes a pot the walls of which are composed of soil cemented with paraffin, causes a uniform distribution of roots in the soil and exhibits the effects of

[1] By permission of the Secretary of Agriculture.

[2] See in this regard a paper on the relation of transpiration to growth in wheat, about to appear in the *Botanical Gazette.*

various soils upon growth much more clearly than do cultures in ordinary pots, where most of the roots come to lie between the soil surface and that of the pot.

The soil of the present illustration is of the Orangeburg clay type, from South Carolina. Another sample of the same type from Texas is used for comparison. The soil is generally very fertile in both states. To investigate the effects of fertilizers upon the sample from South Carolina, wheat cultures in paraffined wire baskets were grown for three weeks in this soil with various treatments. By this means the surprising discovery was made that the untreated soil gave an exceedingly poor growth of the wheat plants, and that it was not appreciably benefited by any one of a large number of treatments used. An experiment was then carried out to compare this soil with the Texas sample of the same type and with Takoma lawn soil (see Bulletin No. 23 of this bureau), one of the poorest soils with which the bureau has dealt. Transpiration data from thirty plants for twelve days showed that, considering the transpiration on Takoma soil as 100, that on the South Carolina sample was 41, while that on the Texas sample was 209. On the same basis the green weights of the plant tops grown on the two soils were 35 and 216, respectively. Thus by the basket method it appears that this particular sample from South Carolina is exceedingly unproductive, and that the unproductivity is not corrected by fertilizers.

It seemed possible that the observed sterility might be due to the presence of toxic organic substances in the soil. Such toxic substances have been found to be readily transmitted to the soil extract and to show their characteristic effects therein, and so to determine whether or not such substances were present here wheat seedlings were grown in aqueous extracts of the two soils from South Carolina and Texas. These extracts were prepared as described in Bulletin No. 23, by stirring for three minutes five parts by weight of soil with six parts of water, allowing the mixture to stand twenty minutes and then filtering off the extract through a Pasteur-Chamberland filter tube. The plants of the present experiment showed somewhat better growth in the Texas extract, but the difference was not marked. The transpirations from the two cultures of sixteen seedlings each, grown sixteen days, were, for the South Carolina sample 118.4 g. and 117.1 g., and for the Texas sample 148.8 g. and 129.3 g., respectively. This indicates that the soil to be tested contains no soluble organic substances markedly toxic to the plants and that it does contain sufficient soluble inorganic material for normal plant growth. Its infertility must, therefore, be due either to some physical property of the soil or to too great a concentration of the soluble salts in the soil. The effect of such concentration might be overcome to a very large extent by the much greater dilution of the soil extract.

To determine whether the infertility might be due to too great concentration of soluble matter, the South Carolina sample was leached by passing about an equal volume of water through it, and the leached sample was compared with the Takoma soil by another basket experiment which ran for six days. Considering the transpiration and green weight each as 100 for the Takoma soil, the figures obtained from the leached soil were 196 and 152, respectively. Thus by leaching the soil its power to support plant growth was increased from 41 to 196 by transpiration and from 35 to 152 by green weight. On the same basis, the fertility of the Texas sample is represented by 209 for transpiration and 216 for green weight, so that by leaching the sterile sample it has been improved in fertility so as to be nearly equal to the Texas sample. These results show that the sterility of the South Carolina sample, at least as far as seedling wheat plants are concerned, is probably due to an excess of soluble salts. Chemical analysis of the water extract of the South Carolina sample showed the following amounts of dissolved materials, expressed in parts per million of the air dry soil by weight: $NO_3$, 611; $PO_4$, trace; $SO_4$, trace; K, 100; Ca, 11; and Cl, 175. The large amounts of nitrate, chloride and potassium here found seem to corroborate the conclusion reached by the method of basket cultures.

To test this proposition still further, the baskets of untreated soil used in the first fertilizer test were replanted and the plants allowed to grow three weeks. The result showed the soil to have improved to the extent of about 183 per cent. by transpiration and 86 per cent. by green weight. This observation suggested that possibly the plants of the first planting had absorbed from the soil sufficient salts to reduce the concentration of the soil solution to a considerable degree, although the plants had made but a poor growth, and that in this way the injurious property of the original sample had been largely corrected. At the end of this second culture the soil was again subjected to a chemical analysis of its water extract, with results which showed clearly that the above explanation is the correct one. The following amounts of dissolved materials, expressed as before in parts per million of air dry soil, were found: $NO_3$, 87; $PO_4$, trace; K, 29; Ca, 4; and Cl, 100. It is obvious that a marked decrease in dissolved salts has indeed taken place.

While the last test was in progress basket cultures were carried on with three new samples of this soil from other spots in the same field, these having been obtained in order to determine whether or not the first sample was typical of the whole field. The average growth in the three new samples was very much better than that in the first planting of the original samples, the difference amounting to 322 per cent. by transpiration and 110 per cent. by green weight. Thus it became apparent that the original soil sample was not typical of the field from which it was taken and that in general the field is not unproductive.

It appears then that the particular spot from which the original sample was taken has in some way, possibly by over-fertilization, too high a soluble salt content for good plant growth.

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## OBSERVATIONS ON COLOR PERCEPTION AMONG THE VISAYANS OF LEYTE ISLAND, P. I.

As a United States government teacher in the public schools of Leyte Island, I became interested in the dialect of the Visayans. In this study I found frequently suggested what sort of men the Visayans were when the Spaniards came to their islands. The modified Spanish words in the vocabulary of the present native designate ideas given to the Visayans by the Spaniards. It was not long before I was confronted with the same question that Gladstone encountered in his study of Greek. Gladstone by pointing out that in the Homeric vocabulary there were no words for blue, and by concluding that in the time of Homer the Greeks did not see blue, opened quite a controversy over the evolution of color perception as based upon the nomenclatures of ancient people and savages of the present. Geiger advanced the theory that red was the first color seen by man and after that the other colors in their order as formed by the spectrum. Geiger was supported by Magnus with further philological evidence. This discussion until recently had been considered closed. Havelock Ellis in Vol. 69 of *The Contemporary Review* at page 715 says: "There is no doubt whatever that all races of men, concerning whom any evidence can be obtained, have been acquainted with the same regions of the spectrum we have known." After so strong a statement I was surprised to find Rivers, who had made extensive experiments upon the Papuans of Torres Straits, saying of his work that one of its chief interests 'is that it shows a defect in nomenclature for a color may be associated with defective sensibility for that color and so far lends support to the views of Gladstone and Geiger.'[1] The evidence that I have obtained among the Visayans also supports the views of Gladstone and Geiger. My discovery that the people had no words for the colors higher than yellow was new to me, but I later learned that this fact was known as early as 1869. Words for the higher colors which are used to-day by the natives are bor-

[1] 'Reports of the Cambridge Anthropological Expedition,' Cambridge, 1901, Vol. II., Part I., p. 49.