ratio of root to top being 1:7. On the other hand, the dry weight of roots produced by cosmos under these intervals greatly exceeded that of the tops, the proportion being 1: .3–.4. Under the other exposures the ratio of root to tops remained nearly constant and was about the same for both plants, namely, 1: 3.0–4.0. The combined dry weight of root and tops of cosmos was the same for all alternations of light and darkness and slightly less than half of that produced under continuous illumination. With the soybeans this relation did not hold, the combined dry weight produced under continuous illumination being only slightly greater than that under the 12-hour and 1-hour alternations while the combined weight under the 1-minute alternations was relatively quite small. The effect on the growth and nutrition of the plant, at least in some particulars, suggests that commonly produced by weak light, although the leaf injury possibly could be considered as indicating excess illumination. There seems to be no feature resembling the typical short-day effect except possibly that on root growth in cosmos. These tests are being further elaborated and it will be of interest to study the effects of various other alternations with both equal and unequal durations of the light and darkness intervals.

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## IRON ORGANISMS

DURING the last two years we have endeavored to investigate iron organisms of the Gallionella group (Toxothrix, Spirophyllum, etc.).

In the course of the work it became clear that a medium consisting of tap water (pH = 7.6) and iron filings was beneficial to their growth.

The air carries, as spores or cysts, many iron organisms. This was demonstrated by sucking outside air through sterile culture flasks. Within five days cultures appeared, among which the curious Toxothrix, described by Molisch[1] from Japan, was conspicuous.

The natural occurrence of iron organisms around Stanford University seems to be related to aeration of deep waters, either through cracks in a reservoir dam or from deep wells and springs. In the former case aeration of the hydrotroilite black mud, containing large amounts of $(FeS)_x$ $(H_2O)_y$ causes a formation of $H_2S$, while the oxidation of ferrous iron goes parallel with a noticeable acidification of the aerated water (pH changes from 7.6 – 6.8).

[1] Molisch, H., Rep. Imp. Tohoku. Univ. Japan Series I. 2, 1925.

The reactions involved are either

$$4FeCO_3 + 6H_2O + O_2 = 4Fe(OH)_3 + 4CO_2$$
$$4Fe(HCO_3)_2 + 2H_2O + O_2 = 4Fe(OH)_3 + 8CO_2$$

As soon as the pH drops below 7 the black suspended hydrated pyritite will begin to decompose.

It was at first thought that this fairly acid medium constituted the normal environment for the organisms. This view seemed to derive support from the observation that $Fe^{+++}$ becomes soluble at pH $<5$ while $Fe^{++}$ becomes soluble around pH $<6.2$. This fact was checked with various organic and inorganic salts with fairly consistent results. The availability of $Fe^{++}$ for the alleged autotrophonts would be of course greater at a lower pH.

However, cultures were very successful up to pH = 9.2 with an optimum activity around pH = 8.6. Here less than one part of $Fe^{++}$ in $5 \times 10^6$ water was present, as checked by colorimetric determination. Therefore, if the organism is able to use iron in its metabolism, it has to lower the pH locally so as to make it soluble.

A series of experiments was carried out in which the increase in weight of infected and sterile iron media (c.p. iron filings, Cu-free, in tapwater) was established. It appeared that no acceleration of the oxidation in the infected media could be observed in an eighteen-day run, although cultures developed normally. Our microscopic findings check Cholodny's work.[2] We observed, however, that the terminal organism may swarm, sometimes over a rather large area. It will settle down and begin to form a new stalk, which may be independent or become attached to the old stalk when the excreted mass increases. The terminal organisms are very small ($.8 \times .5\,\mu$). Directly below the terminal cell the stalk is non-incrustated. Incrustation starts in patches, hardly ever gradual.

Both Molisch and Cholodny deny the presence of a core in the sheath and claim that the entire Gallionella is soluble in "dilute" acids. Unfortunately, the $H^+$ concentration of their solutions is not mentioned in their papers.

It was soon found that by using various acids of a pH close to 5 (acetic, lactic, citric, butyric, tartaric) the sheath will dissolve, leaving a thin glistening core. We believe that Cholodny's comparison of the Gallionella group with certain flagellates (Anthophysa, Phalansterium, Spongomonas, Rhipidodendron) is a significant one.

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[2] Cholodny, N., Die Eisenbakterien. Jena. Gustav Fischer, 1925.