TABLE 1

CORN GROWN WITH NITRATE SUPPLIED IN THE LIGHT AND IN THE DARK

When nitrate supplied	Average oven-dry weight per two plants		Ratio of roots / tops	Nitrogen in dry substance of		Nitrogen in two plants	Relative quantities nitrogen absorbed
	tops	roots		tops	roots		
	gm	gm		Per cent.	Per cent.	gm	gm
None at any time	.34 ± .02	.20	.59	1.64	1.19	.0079	0
Both in light and in dark	.62 ± .02	.19	.31	4.49	3.74	.0348	100
In dark only	.63 ± .04	.23	.36	4.21	3.01	.0335	95
In light only	.61 ± .03	.22	.36	3.57	2.68	.0275	73

* Each lot consisted of 6 similarly treated flasks containing two plants each. Data reported are for the average flask of two plants.

light. Further, the root-to-top ratios indicate that the nitrogen requirement was satisfied almost as well by part-time as by continuous exposure to nitrate, for it has been observed that an unfavorable condition for absorbing an essential ion usually produces an increase in the root-to-top ratio.[1] The somewhat smaller quantity of nitrogen assimilated by plants receiving nitrate only in the light, as compared with the quantity taken up by plants receiving nitrate only in the dark, may be due to the comparatively short duration of the light period, 7 hours as compared with the 17 hours of darkness.

Since the plant appears able to take up practically all the nitrogen it needs in complete darkness, it seems that investigations dealing with the influence of light of different intensities and wave-lengths on nitrate absorption are more or less beside the point.[2] Evidently, the effect of light on ion absorption is indirect, the direct effect of light being on carbohydrate synthesis or on changes in organic matter which in turn control ion absorption. This is indicated by experiments of other investigators who found that seedlings and cuttings maintained continuously in the dark absorbed nitrate only in proportion to their carbohydrate or sugar reserves.[3,4,5] Hoagland's[6] experiments with *Nitella*, which took up bromine only in the light, are not necessarily contradictory, since his experimental conditions did not preclude the possibility that bromine absorption was dependent on changes in organic matter that take place only in the light.

That the absorption of an ion may take place in the dark, lagging behind processes which take place in the light, is in harmony with the delayed absorption of ions that necessarily takes place when plants are grown in "fractionated" solutions; that is, grown alternately in different incomplete solutions. Gericke[7] has claimed that plants may grow even better when alternated between a complete solution and a phosphorus-free than when grown continuously in a complete solution.

Whether plants grown under ordinary field conditions usually take up nitrate chiefly in the light or in the dark can be answered certainly only by further experiments. But if the preceding explanation is correct—that nitrate absorption is dependent on synthesis or changes in carbohydrates in the light—it seems that most of the nitrate would be taken up in the light. A lesser part, however, would be taken up in the dark, since the last quantity of organic matter changed in the light would presumably exert a "pull" on nitrates in the dark. The optimum condition for growth would obviously be when nitrates are available both in the light and dark, as shown in the above experiment.

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PERMO-CARBONIFEROUS COAL SERIES RELATED TO SOUTHERN HEMISPHERE GLACIATION

DURING the early Carboniferous (Early Mississippian) there were broad clear inland seas in various parts of the world in which thick masses of limestone accumulated. On top of these limestones is found a series of rocks extending up into the Permian which are of a very different character. These consist of numerous alternations between coarse terrestrial sediments, such as sandstone, arkose and conglomerate, and marine sediments, such as shale and limestone. Such alternations have been called sedimentary cycles. Between the coarse clastic formations and the fine sea deposits are found most of the great coal formations which supply the markets of the world with this type of fuel.

It happens that there is abundant evidence of the existence of huge glaciers in the southern hemisphere during the very times when these curious alternations of deposits were being formed.[1] A relation between these continental glaciers and the sedimentary cycles has been proposed recently by the writers.[2] It is well known that the growth of these various great glaciers of the Pleistocene ice age was accompanied by raising and lowering of the sea level hundreds of feet and by world-wide climatic alternations. Many geologists believe the Permo-Carboniferous glaciers were more extensive than those of the recent ice age, and certainly the glacial conditions persisted over a much greater span of time than the recent ice age. They were probably accompanied by the same waxing and waning of the ice masses. The resulting changes of sea level and of world climate may have caused the alternating types of sediment which go to make up the coal series.

To see how these conditions would have operated, let us start with the formation of the first great glaciers. As the glaciers grew, more and more water would have been withdrawn from the shallow seas which were previously spread over much of the continental surfaces. As the seas withdrew the climate would have grown colder as an accompaniment of the advancing glacial conditions, and greater aridity may have resulted from the decrease of evaporating surfaces from which the atmosphere derived its moisture. The net result would have been the killing of vegetation on the slopes of the mountainous lands which were supplying the inland basins with sediment. Since most semi-arid regions now have periodic heavy rains, it is likely that these barren mountain slopes would have been subjected to violent storms with accelerated erosion, and coarse debris would have been spread as great fans over the emergent lowlands. At this time and in subsequent glacial epochs the coarse continental sediments of the cycles would have accumulated.

With the warming of the climate which led to the melting of the glaciers and the rise in sea level, the slopes would have again become cloaked with vegetation and the streams would have ceased contributing the coarse sediment which had been due to rapid slope wash. As the ground water was raised on the plains and profuse vegetation began to grow, swampy conditions would have developed and in these swamps the peat which later formed coal could have accumulated. The upward growth of the great tangles of vegetation may have held back the advancing seas till large accumulations had been formed in many places.

When the rising seas finally overwhelmed the swamps the marine phases of the cycle set in and an accumulation of muddy sediments formed a cover over the peat beds causing the peat to turn gradually into coal. After the sea level had risen sufficiently to drown the lower courses of the land valleys the muds which had been washed into the open seas would be deposited in the resulting bays and the seas would have cleared and allowed the deposition of limestone. Return of the glacial climates would have led to a repetition of the cycle and of the special sequence of formations already described.

The explanation which has been outlined does not attempt to account for all the phenomena observed in connection with these sedimentary formations. The sequence of formations has been generalized and is actually more complex due to varying local conditions, to the distance of different areas from the sources of sediment, and perhaps to the oscillatory character of the advancing and retreating seas. The explanation has been proposed as a substitute to the hypothesis that the cycles were due to alternate uplift and sinking of the basins of sedimentation and of a much greater, but contemporaneous, uplift and sinking of the source areas. There are mechanical difficulties in such an explanation, especially in view of the wide-spread recognition of the cyclic phenomena during these periods. On the other hand, earth movements probably had an important effect on the sedimentation, but it seems likely that these movements were largely of the order of slow progressive sinking of the basins in which the sediments were accumulating and slow rising of the mountainous tracts which were the source areas of the sediment.

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