be built up from the investigations of a number of observers. Dr. Garrison closes his very interesting account by saying: "But no one ever thought of mosquitoes in relation to yellow fever before the time of Finlay and Walter Reed." Dr. Reed and his associates proved the theory, which was the all-important event, but it may not be amiss to call attention to an article published by Dr. Josiah C. Nott in 1848. He was evidently a learned physician of wide experience, a keen observer and reasoner, and in addition had a profound knowledge of the literature of zoology, particularly entomology. To what extent he anticipated present knowledge of the mosquito transmission of yellow fever may be somewhat a matter of opinion. The article is a most interesting one and will well repay perusal. It should be read in its entirety to get the proper conception of it and realize to what a remarkable degree the man was ahead of his day. The title is "Yellow Fever contrasted with Bilious Fever—Reasons for believing it a disease sui generis—Its mode of Propagation—Remote cause—Probable insect or animalcular origin, etc., by Josiah C. Nott, M.D., Mobile, Alabama. New Orleans Medical and Surgical Journal, IV., pp. 563–601, 1848." A few extracts may prove interesting, as this journal is not accessible to many persons.

I propose to now show, from facts presented during the various Epidemics in Mobile that the morbific cause of Yellow Fever is not amenable to any laws of gases, vapors, emanations, &c., but has an inherent power of propagation independent of motions of the atmosphere, and which accords in many respects with the peculiar habits and instincts of insects. . . . There are even perfectly authenticated instances where one side or end of a ship has suffered severely from this disease, whilst the other was entirely free from it! We can readily believe, that certain insects which are endowed with unaccountable instincts and habits might attack a part of a ship, or a tree, of a wheat or cotton field; but we can not imagine how a gas could be turned loose on one side of the cabin of a vessel and not extend to the other. . . . Yellow Fever can not be explained by the malarial[1] theory, and it must remain with the reader to determine whether the chain of analogies offered, render the Insect theory more probable. . . . With these facts before us, how much more easily may we account for the spread of yellow fever from a focus, by the insect, than by the malarial[1] hypothesis—here is something tangible and comprehensible.

[1] Used in the sense of bad air.

In regard to cholera he says: "The history of these great epidemics which sweep over the surface of the globe affords very strong support to the Insect theory." Dr. Nott's remarks on vessel quarantine are in absolute accord with the knowledge and practise of today.

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Does Excessive Light Limit Tropical Plankton?

To the Editor of Science: Among the numerous explanations of the richness of polar seas in plankton and the poverty of tropical waters, I fail to see any mention of the lethal effect of excessive light, yet this effect is so well known that we make daily use of sunlight to destroy pathogenic organisms, all of which flourish in the dark only. The tropics are rich in all land forms, but in every case there is some provision by which the protoplasm is protected from excessive light, and, as a matter of fact, the ordinary bacteria of northern latitudes do not flourish in the tropics. In the waters, on the other hand, unpigmented forms have nowhere to hide, as in caves, crevices, under rocks or under the shade of pigmented ones, except as parasites in the bodies of multicellular organisms, and must perish through this disinfecting power of the sun's rays. The same phenomenon has been found by the metropolitan sewage commission in the waters of New York harbor, where the winter flora derived from sewage is far richer than the summer.

The vernal increase of phyto-plankton in northern waters is the same phenomenon as the vernal increase of land plants—due to the return of the sun with non-lethal amounts of light which are utilized in the decomposition of carbon dioxide by the chlorophyl. To be sure, the increased temperature of the air is the main reason for renewed protoplasmic ac-

tivity of land forms in spring, but Herdman says[1] that "the temperature of the sea-water, however, appears to have little or no effect in determining the great vernal maximum of phyto-plankton." From this it is presumed that the richness decreases in the summer in spite of the warmer water, because the light becomes more or less destructive. It must be remembered that at 70° of north latitude the midday sun is just as strong on June 22 as it is at the tropic of cancer December 22.

There seems to be great confusion in literature on the effects of light, due to failure to distinguish between these two entirely distinct phenomena—(1) the stimulating or actinic effect on the living protoplasm and (2) the use of the energy of the rays to break up carbon dioxide in the chlorophyl-bearing cells. Plant-cells, as a matter of fact, like bacteria, function in absolute darkness, under the bark or in the roots, and do not need the slightest stimulation of light, indeed are killed by it, as a rule. Light is only used to build up the carbon food, and the cells engaged in this duty are also protected by the green pigment, hairs, etc., but even they are killed by two much light, as the botanists show—each species having its own danger limit which in the shade-loving plants is a very low one. Indeed, in botanical literature there are increasing numbers of references to the fact that the effect of light on plant protoplasm is to retard growth; while the effect on the chlorophyl is to supply carbon food for the cells under the bark.

It is quite evident, then, that the return of light in the spring starts the phyto-plankton to grow and multiply by furnishing more nutrition, but when the light gets so intense that it can penetrate in harmful degree to the protoplasm, growth is checked.

Dr. C. Stuart Gager's experiments with radium[2] are reported to show that in minimal amounts these powerful rays do not penetrate sufficiently to have any effect on the plant protoplasm, but above this minimum and up to an optimum they stimulate all functions. Beyond the optimum and up to the maximum their effect is a retardation or distortion of function, and beyond the maximum it is lethal. This is precisely the conclusion from the innumerable observations and experiments of the effects of light and ultra-violet on protoplasm of animals adjusted to a life in the light—man particularly—though as a matter of fact the stimulation of small amounts of light is not a vital necessity, as shown by the animals which have taken up residence in the deep sea or dark caves or have developed a nocturnal habit.

Curiously enough, though there are innumerable observations on the effects of minimal, optimal and maximal amounts of light on the plant as a whole, there are none which differentiate between the effects on the chlorophyl activity and the effects on the protoplasm. The radium rays have no known effect on the synthesis of the carbon compounds—the only rays effective there are small bands in the red or blue or both, and varying with different species. The radium effects are solely due to their influence upon the protoplasm under the bark. On the other hand, the well-known nocturnal growth of plants exposed to electric light is solely due to the increased food synthesis in the leaf, for it is not possible for these rays to penetrate the bark to effect the other cells which constitute the plant and construct its materials. It is so manifestly difficult or impossible to get light to penetrate bark evolved for the very purpose of excluding it, that we probably never shall know exactly how the various intensities of light affect the protoplasm of the higher plants, beyond the one undoubted fact that in amounts sufficient to penetrate thin skins it invariably retards growth or kills. In the case of unprotected unicellular plants, the case is different, and it is known that some species are injured by light in any amount, others seem to thrive best in dim light, while all are injured and killed by an excess, which varies with the species.

The behavior of phyto-plankton then according to the light of climate, latitude and season seems to follow all other forms of

[1] SCIENCE, November 26, 1909.

[2] *Memoirs of the N. Y. Bot. Garden*, Vol. IV., 1908.

protoplasm. Indeed it ought to be safe to predict that the vernal increase in northern waters will continue throughout the summer wherever there is much cloudiness to temper the lethal effects of the midday sun. Perhaps this fully accounts for the wonderful fisheries in northern cloudy, misty, foggy latitudes, rich phyto-plankton serving as food to minute animals, these as food for larger, and so on up to those edible varieties upon which so many millions of people subsist.

It is to be hoped that there will be renewed activity in studying the effects of light on plant protoplasm regardless of its effect on the leaf activities. There is opportunity for valuable deductions applicable to man, for we are finding that the effects of excessive light on unprotected migrant types are much more profound than we formerly believed possible, and there is room for improvement in daily hygiene in the interests of the preservation and eugenic development of these types. The fact that plants depend upon light to enable them to get their carbon food has concealed the fact that it is a lethal agent to naked protoplasm. The medical profession is slowly realizing the dangers of excess, but to place the matter on a sounder and more exact basis, we need more investigations, particularly on plants such as the plankton and the land forms of the lower orders.

The matter is becoming of great economic importance, not only from the fact that life insurance companies are finding less expectancy of life in northern Europe ethnic types too greatly out of adjustment to American climates, but Retzius, in a recent address to the British Anthropological Institute, has called renewed attention to the long-known fact that the northern blond type is unfit for modern industrial life which is being carried on by the brunet races. It has also long been known that the blond types evolved for survival in northern outdoor employments in the cloudy northwest corner of Europe, are so injured by city life, that even as far north as Glasgow, Scotland, they are being rapidly replaced by the brunets, who in some way are better guarded against factors fatal to the others. The disappearance of the blond type, which Retzius predicts, is of course a baseless absurdity. Indeed their numbers are constantly increasing in Europe where they can live, and immigration keeps up the proportion here in spite of their higher death rate. It is possible to lengthen their average life here, if we will only realize what injures them. The premature death of such great men as the late Governor Johnson of Minnesota has a lesson which American anthropologists should heed now that Retzius and Beddoe have led the way. But nothing can be done as long as we consider man so supernatural that he is the only species of living thing whose characters, such as pigmentation, are meaningless freaks of no survival value—an absurd view for which the pre-Darwinian anthropologists are responsible—a view also derived from the old theory that all present-day types are degenerate forms of prehistoric perfect adamites.

So it is of much importance that all vital phenomena in any way related to light intensity should be investigated and explained. The profusion of plankton in northern climates and particularly in the cloudy and foggy places, such as the North Sea and Banks of Newfoundland, is therefore a more interesting and important phenomenon than our biologists seem to realize. In "The Effects of Tropical Light on White Man," published in 1905, I collected all available data then found, but in the succeeding five years much more have been published which show that all racial characters have survival value and some of them are so important as to fit a type for a very limited environment. Pigmentation is of this nature, and so important that its absence is a bar to survival if the type migrates to a very light country. In every known case of survival of the migrated blond race, it is found to be due to the fact that it is in the cloudy mountains such as the Alps, or in northern Italy and Spain, even though it be found by the side of brunets. It is not then such a far cry from the northern richness of phyto-plankton to the existence of large numbers of the sea-faring, Baltic type of man.

Chas. E. Woodruff