SOME ECOLOGICAL EFFECTS OF SUBSTANCES PRODUCED BY THE CHARACEAE

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In the last few years much interest has been taken in substances produced during the metabolism of the lower plants. Chief among these are the antibiotics produced by fungi, with their well-known toxic effects on bacteria.

Among the algae little work has been done on the nature of the substances produced. Chlorellin from *Chlorella* is an antibiotic; and recently a Portugese worker isolated an antibiotic from the desmid *Closterium* (Sampaio, 1946). Many other algae produce external metabolites known to have inhibiting effects on other plants and animals. Most of the literature on this subject has recently been brought together in a paper by Lucas (1947) who coins the name "ectocrine substances" for these metabolites.

In the Characeae it was first suggested by Caballero (1922) that certain species of *Chara* produced substances toxic to mosquito larvae. This suggestion aroused great interest and in the following decade much was done on the problem.

These investigations produced conflicting results. Blow (1927) using species of *Culex, Anopheles* and *Theobaldia* with different species of *Chara,* concluded that the Charophyta do not posses any larvicidal properties and that some other factor or factors must be the cause of absence of mosquito larvae in places where these plants occur.

Macgregor (1924), using two species of *Chara,* could find no positive evidence that *Chara* possessed any toxic properties. Pal (1932) generalized even more, when on the evidence of experiments with one species of *Chara* and two of *Nitella,* he wrote that it was "highly probable. . . . .that the supposed larvicidal properties of Charophyta are nonexistent."

Matheson and Hinman (1928) observed that no mosquito larvae were present in pools containing *Chara vulgaris L.* They noticed that few eggs were laid on the surface of the ponds and the larvae that did hatch out died without reaching maturity. At first they concluded that the *Chara* produced a toxic substance, but in a subsequent paper (1931) they proved rather conclusively that the larvicidal effect was due to minute bubbles of oxygen produced by the plants during active photosynthesis.

Meanwhile, in Australia, Buhot (1926) had uncovered another aspect of the problem. He found that female mosquitoes would lay eggs freely in aquaria not containing *Nitella phauloteles* Groves, but refused to lay them

in adjacent aquaria containing the Charophyte. Buhot also attempted to show that *Culex fatigans* Wiedmann (*C. quinquefasciatus* Say) would not lay eggs upon *Nitella* water under any conditions, but this was denied by Hamlyn-Harris (1929; 1932).

Buhot's work was never followed up and was largely ignored. Groves and Allen (1934) and later Fritsch (1935) in summarizing the situation agreed that there was no foundation for the proposal that the Characeae produced substances that were toxic to mosquito larvae. This statement was evidently correct in the light of Matheson and Hinman's results, but obviously many avenues of investigations were still open.

The author of this paper designed a series of experiments to explore possibilities along the following lines:

(1) Could Buhot's results be repeated?

(2) Was the phenomenon of repulsion to female mosquitoes separate from that of the alleged toxicity to larvae?

(3) Were the ecological effects of different species of the Characeae different and how did different species of mosquitoes react to them?

(4) What effect did varying external conditions have on the phenomena observed?

(5) What substances do the different species of Characeae produce?

(6) Could any of these substances be put to some practical use?

Unfortunately only a few experiments had been completed before the author was forced to abandon them. However the experiments completed, did give some clue to the complexity of the problem and the dangers of generalisation.

In the first experiment three aquaria were used and two species of Characeae; *Chara fragilis* Desv. (*Chara globularis* Thuill.) and a new, as yet undescribed species of *Nitella*. All of the aquaria were filled with water; one was planted with *C. fragilis*, another with *Nitella* n. sp., and the other contained nothing but water and mud. These three aquaria were exposed to numerous females of *Culex quinquefasciatus* Say.

Hundreds of egg-rafts were deposited on the surface of the water in the *Nitella* aquarium and in the vegetation-free aquarium, while only one egg-raft was deposited in the *Chara fragilis* aquarium. This occured despite the fact that the surface area of the *Chara* aquarium was over twice that of the *Nitella* aquarium and that the concentration of the *Nitella* plants was much greater than that of the *Chara* plants.

In a second experiment equal numbers (ten) larvae of approximately the same age were placed in jars containing *Chara* plants, a second series containing *Nitella*, and a third control series containing only water. Deaths of the larvae and emergence of the adults was not significantly different in any of the series.

From these experiments we can deduce several interesting facts.

(1) Gravid females of *Culex quinquefasciatus* avoid water containing *Chara fragilis* when ovipositing, providing other water is available.

(2) *Chara fragilis* produces a substance having an ecological effect on the female mosquitoes. The nature of the substance is unknown.

(3) All species of the Characeae do not produce this substance.

(4) This phenomenon does not appear to be connected with any larvicidal effect.

Whether these observations will prove to be of any practical value is yet to be discovered. It does seem that some aspects are worthy of further investigation.

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