ALGAE: A CAUSE OF INHALANT ALLERGY IN CHILDREN

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Algae are chlorophyll-containing plants included among the lowest divisions of the vegetable kingdom. They grow in salt water, in fresh water, or in the soil, and range in structure from single-cell types to the complex marine types known as kelps which are among the largest living plants (attaining dimensions of more than 300 feet). Studies by Professor H. C. Bold et al.,1-4 as well as unpublished data obtained from Bolds' laboratories, indicate that soil algae are ubiquitous and their populations often extremely large. In an attempt to find the method of dispersal of soil algae, air-sampling studies were undertaken which demonstrated great numbers of algae present in the air, especially on windy days. Among techniques employed were exposure of inorganic nutrient agar plates and exposure of air-filtration sampling discs. The higher the wind velocity, the greater the number of algal colonies obtained on plates and filters. Sampling techniques require the use of an inorganic culture medium (modified Bristol's solution—Bold, 1949) and two or more weeks of culturing before algal impactions become visible. If culture media which incorporate organic substrates are used, fungi usually overgrow the plates and render the algae unobservable. This explains the reason they have not often been observed in routine pollen and mold surveys.

Since algae are known to contain high concentrations of protein and have been shown to be air contaminants, an investigation was undertaken in order to determine whether they might be a contributing cause of inhalant allergic sensitivity.

While numerous representatives of various algal divisions have been obtained by air sampling, the uni-algal and bacteria-free cultures used in this study are green algae (Chlorophyta). Algae are autotrophic (photosynthetic) organisms which may be unicellular, colonial, filamentous or multicellular. The cultures used for this study were of unicellular and filamentous species.

We elected to use four strains of green algae: Neochloris sp. (Hawaii); Chlorosarcinopsis sp. (South Dakota); Bracteacoccus sp. (Texas) and Hornidium sp. (Texas). These algae were extracted by standard techniques and PNU determinations were done by the micro-Kjeldahl method. The three unicellular species range in diameter from 9 to 20 microns and the cells of Hornidium are about 6 microns in diameter. (Figs. 1-4).

1. Doctor Bold and Mr. Brown are on the staff of The Plant Research Institute, University of Texas, Austin.
To ascertain if algae are capable of inducing sensitivity, 140 children were tested—20 nonallergic and 120 known to have definite pollen and/or other inhalant sensitivities. Each of these patients had an exacerbation of symptoms if exposed to a blowing wind, regardless of any specific pollen season. One wonders whether these exacerbations of allergic symptoms are due to an increase in pollen or mold exposure, to primary irritating or drying
Fig. 3. (Above) Chlorosarcinopsis sp. 450×. Note aggregations of cells in packets.
Fig. 4. (Below) Hormidium sp. 970×. Note parietal chloroplast and tendency of filaments to dissociate.

effects of an increase in wind velocity, to associated changes in temperature or barometric pressure, or possibly to other heretofore unrecognized airborne inhalant sensitizers that increase during periods of increased wind velocity.

Intracutaneous skin tests were performed separately with 1,000 PNU per cc concentrations of the four strains of algae, with common known
inhalant allergens and with controls of buffered saline. In that none of the nonallergic group showed reaction to any of the four algal extracts and as this was the case in 22 of the highly sensitive patients, one may conclude that these algal extracts were not primarily irritants. Several patients were also tested with concentrations of 4,000 PNU per cc of the algal extracts without evidence of primary irritation.

Of the 120 allergic patients tested, 98 showed definite positive reactions to intracutaneous tests with one or more of the four test-strains of algae. However, 22 patients showed no reaction to the four test-strains. Twenty patients reacted to one strain; 34 to two strains; 34 to three and 10 subjects reacted to all four strains. It is possible, of course, that a degree of cross-antigenicity may exist and be responsible for at least part of these findings. *Bracteacoccus* and *Neochloris* appeared to be the most antigenic. To date, we have not performed inhalation or conjunctival tests because of paucity of test material. We do, however, plan to utilize these clinical techniques along with passive transfer when sufficient material is recovered. If sufficient antigen can be harvested in bacteria-free culture, we shall attempt to set up an experimental model in laboratory animals using a hemagglutination technique with human sera of sensitive and control patients.

In many of the patients, reactions to algal extracts were greater than to inhalant allergens known to be producing definite clinical symptoms. The youngest child to show a definite positive reaction was four years of age. This suggests that prolonged exposure might be required before measurable sensitization by skin testing develops.

**DISCUSSION**

Investigation of other potential allergenic air contaminants may explain the persistence of allergic symptoms in some patients who have received so-called "optimal" therapy under current standards.

The finding of greatly increased numbers of airborne algae during periods of increased wind velocity and the observation that allergic patients often have an exacerbation of their allergic symptoms after such exposure suggest a possible correlation, at least if no distinct correlation, and the possibility that algae play some role in initiating an allergic response.

In these studies only green algae were used because of the difficulty of obtaining the ubiquitous blue-green algae in bacteria-free culture—a real problem when dealing with these organisms.

However, this will not preclude further study of algae as sensitizing agents since numerous other strains have been isolated from air samples and active work on their growth in bacteria-free culture is being carried out. We plan to begin studies with several other strains to determine if they too are capable of sensitization; and quantitative analyses are being done to determine the relative prevalence of these algae in the air. Animal experiments are also in progress to help determine relative antigenicity of the
various algal species. A review of the medical literature reveals this to be the first reported study showing airborne algae to be a cause of inhalant allergic sensitivity. Drinking of water contaminated by blue-green algae, "Waterbloom," long has been known to cause poisoning in cattle, dogs, horses, fish and man.\textsuperscript{5-8} Also, certain marine algae have been shown to cause a swimmer's dermatitis.\textsuperscript{9-14} Algae previously have been reported to cause urticaria, conjunctivitis and hay fever-like symptoms in patients who swim in water contaminated by blue-green algae.\textsuperscript{15,16} Heise describes testing patients with extracts of blue-green algae (Myxophyceae) and obtaining strongly positive skin reactions of immediate wheal and flare type. He was also able to transfer passively this sensitivity (Prausnitz-Kustner method) and to hyposensitize effectively with algal extracts.

**SUMMARY**

Inasmuch as algae have been shown to be air contaminants, we isolated, cultured and extracted four strains of green algae from air samples. These algal extracts were employed as skin-test antigens in 120 patients who suffered from respiratory allergic diseases. Of these patients, 98 showed definite positive reactions to intradermal tests with one or more extracts of these green algae. This finding suggests that air-borne algae, which heretofore have been unrecognized as a cause of inhalant allergic sensitivity, might well be allergenic. To achieve certainty, these data should necessarily be followed by further investigation.

**REFERENCES**