

(2) An evaluation of primary and lesser factors influencing the inter-relationships; and

(3) A greatly improved ability to predict the results of planned, imposed, or uncontrolled variations in the overall operation of the ecosystem.

The implications for better resource management seem to fully justify this effort.

B. Program on aerobiology

This program proposes to correlate ongoing work and to promote needed investigations into passively air-borne microorganisms, and to relate these investigations to similar work in other countries and continents. The promise involved seems to be the acquisition of greater knowledge of such pathogenic organisms as attack wheat, rice, and other crops, such pests as locusts and sucking insects; bacteria, viruses, air-borne allergens, and insect vectors of human diseases. The primary concern of this program is to advance knowledge of methods of lofting, air transport, and deposition of these organisms. Implications seem to lead to:

- (1) Better predictive techniques of the spread of crop diseases and pests.
- (2) Probable identity of more vulnerable periods in the life cycles of pests and microorganisms leading to improved methods of control.
- (3) Better predictive techniques on the spread of bacterial, viral and fungal diseases.

C. Program on phenology

This program proposes to more explicitly describe the seasonal development of organisms and from these descriptions to better understand, interpret and predict biological events. A. D. Hopkins from 1905 to 1920 was very successful in working out the planting dates for winter wheat so that the seedlings developed after the last date for egg laying by the hessian fly (*Phytophaga destructor*). The larvae attack the stems of wheat and barley and are one of the most destructive pests in the raising of wheat. Hopkins utilized about 40,000 records of winter wheat planting and harvest dates in working out his fly free dates (based upon the life cycle of the insect and growth rates of wheat) for various parts of the country. From these charts one could predict the average best date for wheat planting to within a 10-day range. Hopkins developed bioclimatic laws and maps to predict the seasonal development of organisms across the country. Unfortunately this work has not been continued.

The work of Hopkins using insect and plant phenology and climatic records, enabled the U. S. to increase wheat production during World War I by a wiser selection of fall planting dates. The same principle has had other uses:

- (1) In predicting dates and intensity in outbreaks of wheat stem rust (*Puccinia graminis*) from Mexico to Canada.
- (2) Aiding in the determination of forest fire hazard based upon the dryness of the herbaceous layer and moisture content of tree leaves.
- (3) Determining the carrying capacity of range lands and the length of time stock can be permitted to graze based upon plant development, and
- (4) Studies on codling moth and chinch bug development in relation to temperature.

The determination of egg hatching and adult emergence in relation to climatic conditions permits better estimates of when the insects will be more troublesome.

It is hoped that more intensive studies, conducted in a variety of locations in this country and others will better enable man to understand and predict seasonal activity of key organisms. Some of the kinds of phenologic data that would be most useful include:

- (1) Predicting the time and intensity of fall bird migration, especially geese and ducks in relation to hunting season. The time of migration as well as the species that overwinter in a given location is largely controlled by fall weather patterns and intensity.
- (2) Some zoonotic diseases are carried north in the spring by birds migrating from the tropics. An accurate network to predict spring migration would enable man to better control diseases carried by these birds.
- (3) Some insects develop in the south and are then carried north and east by summer winds. A phenologic network which studied the rate of insect development in the south and the rate of insect spread from such areas would have great value.