

chemist or the geneticist will not understand the ecosystem. Basically he is not directly involved with understanding it. He is studying in detail, devoting all his efforts to some particular problem connected with an organism or with a cell or with a complex molecule, but he is not working with the problem of the synthesis of all these things in this ecosystem context of organisms and environment in the out of doors of which we are speaking here. This is an exceedingly important point because we could support biology very vigorously and very strongly and yet fall flat on our faces from an ecological standpoint and not deal with the external environment in the least.

The ecologist must be trained to synthesize the results of all these other disciplines. This is a very difficult task and demanding. The ecologists need to work as a team and to use all the techniques available, including mathematics and computers and the other sciences, as I mentioned a few moments ago. We need a new breed of ecologists, a new aspect to this discipline, and this is my next point. We need a branch of theoretical ecology. The same thing occurred in physics a half century ago when theoretical physics became very strong and physics advanced incredibly because of this. This put physics on a predictive basis where they could actually predict out of theory certain particles which could not be observed and they were found through experimentation. Ecology cannot do this today. It has relatively little predictive power because of lack of strong theoretical formulation, lack of good mathematical models to work with in order to carry through the complex order of things to the predictive stage.

We are being asked today the consequences of weather modification on the ecosystem or the impact of the highway or a bridge or dam on the surrounding ecosystem. We have difficulty giving answers. We can give some. We can say if you cause a deluge you are going to have a flood or plants are going to grow like crazy in some region, or if you cause rainfall here and drought over here we can say there is going to be a dying off of the plants and a desert, but it doesn't happen that way. It is much more subtle and it is these subtle changes that are slowly going on. Perhaps you have heard of the inadvertent weather modification which man is producing in terms of jet contrails in the atmosphere all over the world. Maybe out of this, we are not sure, we are getting a slow but definite cooling trend of the world's climate. What is the impact of this on our growing of crops? On our natural habitat, on the forests, and the grasslands, and everything else? We don't know; we don't know exactly what will happen. The systems are very complex.

Mr. DADDARIO. There are those that say it has no effect whatsoever.

Dr. GATES. I don't think it can be told at the present time.

Mr. DADDARIO. Your idea is that certainly something ought to be examined because we don't have the capability of developing any real forecasting about the effect of jet transportation. Jet transportation will be increasing at a remarkable rate in the years to come and it could start a chain of natural circumstances which would be dangerous to us all?

Dr. GATES. Yes. What I am speaking of here is not so much the question of the cause there, which is another subject in atmospheric physics, but the result, the consequence, of that event on the biota of your surface.