

SUMMARY BY THE CHAIRMAN

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In trying to summarize what has been learned today I face the problem that all instant summarizers face—it's hard to be correct and harder to be brief, but hardest to be both correct and brief.

We have heard a lot about wide-scale studies. Some of these studies are being carried out, though perhaps in very preliminary stages. Others are being considered and planned; others are being considered, and still others have not got this far even: they are being proposed, discussed or just dreamed about.

But all of these levels are perfectly natural stages in the development of research, and in fact they occur in the reverse order to what I have listed.

Jerome Namias' work at the moment is at almost the largest possible scale—a hemisphere. He is one of the few who are really trying to do large-scale comparisons and fitting together of atmospheric phenomena. What he is asking for is not a larger scale so much as a more intensive and continuous array of data. And we can see how it will soon be possible to help him by giving him closer arrays and more nearly continuous time series. Our techniques are improving and though they have not reached the ultimate they are much better than 10 years ago.

Harris Stewart has talked about some data collections which are going on now in a systematic way, and will be expanded, and can contribute to many fields of ocean research. The ocean is being covered by research vessels now, more than ever before, and we must learn to use them all.

It seems likely that the most rapid increase in data coverage through national and international cooperative efforts will be in the meteorological field. There is an obvious need for such material and the weather people seem to recognize now that the conditions over the ocean cannot be neglected if they really want to understand even the land weather. Such meteorological observations at sea will also include sea water temperatures at the surface, and all of these measurements can be considered now as standard observations, with no really new techniques required if all they want is an increase in coverage of the older forms. Any ship at sea can be considered as a weather ship: the equipment required for the ordinary observations is not expensive and the training of the crews is a simple job. Conscientiousness in such measurements is quite a different affair but a continuing, vigorous program can develop it.

With buoys the problem is not one of conscientiousness in old techniques but ability to devise, fund and employ new ones. It really seems that we ought to be able to do this.

Hugh McLellan has given us a list of four experiments which might be carried out with present ideas and a better array of data. Each of these, and the

various others which might be proposed, require careful consideration. Any experiment of this scale must be judged in advance in terms of the quality of the ideas behind it and exactly what it might tell us, our ability to carry it out with present equipment, and how much scientific manpower and how much money would be expended which might be used in other programs. This sort of judgement is not easy and it should not be made lightly, since failure in one large, expensive effort might inhibit further opportunity to experiment. On the other hand too great a fear of failure can do just as much damage, and with a greater certainty.

But other ocean-wide studies, particularly the biological ones, have endured two major disadvantages. One has been a narrower base of support. A Kansas farmer may care about studying weather but he may not be enthusiastic about spending money to study fish. This disadvantage is slowly being overcome, since the world may really require things from the ocean—such as protein—that the Kansas farmer cannot provide for the same price.

The other disadvantage which the biological studies have endured may stem from the first. With limited support truly oceanic studies of the biomass had not been possible until recently, and the techniques developed by individual researchers for particular areas and biological forms had not produced any acceptable standard for ocean-wide use. Progress has certainly been made upon this. The various attempts to standardize net hauls and productivity measurements made on the last few international cooperative expeditions are steps leading toward a rational solution of this problem.

Tim Parsons has given us some examples of what sort of analysis can be made from the data of Station "P" and the various expeditions into the Northeastern Pacific. He has discussed time-variations of the population and the growth rate of certain organisms in terms of the critical depth (a function of light intensity) and the depth of the mixed layer of the ocean. He and Mr. LeBrasseur have had a considerable success in relating these quantities. The depth of the mixed layer is fairly well known in their area, collections of the organisms have been made in various seasons, and the continuous records at Station "P" have made it possible to handle the light-intensity variations in a rational manner over the rest of the area. Though far from being all they could ask, the data are sufficient for Parsons and LeBrasseur to form a reasonable hypothesis about the different seasonal growth-rates between the Northeastern Pacific and the Northeastern Atlantic oceans.

To improve this sort of study these two investigators require better information about layer depth,

radiation, extinction coefficients, and the organisms. Some of this may come from satellites or aircraft, but other parts require, at least at this stage, work by surface vessels.

Dr. Ahlstrom has pointed out once again that many species of fish have very wide distributions in the ocean and that our knowledge of the limits of these distributions can be extended considerably by wide-scale collections of eggs and larvae. In effect this is an indictment of the work of many of our expeditions for not having made net hauls. If such net hauls had been made regularly, there might already exist a col-

lection of plankton that could help to answer some of the questions Dr. Ahlstrom posed. It is a point well worth remembering when any large expedition is being planned.

In the title of this Symposium and in the titles of the various papers there is an implicit question: are oceanographers interested in carrying out wide-scale studies of the ocean? Though all of the speakers have been prudent enough to point out the difficulties of such work, there is no doubt that all of them believe that we do stand to gain tremendously from a wide-scale application of ideas and techniques now at hand.

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