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SPECIALIZATION IN SCIENCE[1]

By Professor FRANCIS RAMALEY

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IN the organic world it is the generalized type which gives rise to higher forms while extreme specialization means an end of progress. To illustrate from the field of botany: the mosses have been called an evolutionary failure for, although they have adopted a thousand forms, these all are too highly specialized to allow of really important advance. In the whole moss class there is a clinging to certain particular features—no freedom to produce or even to suggest anything non-moss like. Mosses have rung changes upon non-essentials but have always kept their own special pattern. The liverworts did not thus specialize but retained their plasticity, varying in many directions and at last giving rise to the remarkable Anthoceros (horned liverwort), which is almost a lycopod. And although the paleontologists may not find the "missing link" which connects liverworts and lycopod there can be no doubt that the generalized liverworts, not the specialized mosses, gave origin to the next plant division.

Among animals, also, specialization stops progress. Neither the intelligent and betrunked elephant tribe, nor the swift-footed, one-toed horse, nor the cunning members of the wolf and dog family with their great body specialization and highly developed sense organs produced the "lords of creation." Rather was it some simple creature with primitive hands and feet and jaws which began that great advance leading by one path to the grinning chimpanzee and ferocious gorilla or, by another turn, past a long series of half-human beasts to present-day man. Here, as always, the specialized types early reached a limit beyond which they could not go while generalized forms retained the

[1] Condensed from the address of the retiring president of the Southwestern Division of the American Association for the Advancement of Science, eleventh annual meeting, Tucson, Arizona, April 23, 1930.

power to advance. Too great specialization may even lead to extinction. The cephalopods of Mesozoic times carried to an extreme their coiling and twisting. Their complicated suturings which rival the most elaborate arabesque ornament may have suggested progress, but with all their marvelously intricate patterns these once important creatures became extinct and only their poor relations, the simple squid and devil-fish, remain. When environmental conditions change the survival chances of specialized types diminish. It needs no argument that a man who could do nothing but make horseshoes, although very much needed in the Victorian period, would have little call for his skill in these days of good King George the Fifth.

It is a fashion just now of newspaper columnists to make fun of the many specialties in medicine; but are these any narrower than the enclosed and cultivated fields in the general sciences? As a botanist I must associate not with other botanists but with plant physiologists, plant ecologists, geneticists, biometricians, phycologists, mycologists and phytopathologists. Perhaps this specialization is not so extreme as it sounds; it may be that these worthy men of science are really broader than they like to appear. But our universities seem not to be working for breadth. Many professors, although themselves broadly trained, permit students to give all their time to a small field of study. I suggest that embryonic and larval scientists be encouraged to cultivate also their "minor" subjects. At the present time there seems to be a lessening in breadth of requirements for graduate degrees. Some schools allow the minor to be taken in the same department as the major or else more honestly state that no minor at all is required. Others, and even supposedly reputable ones, grant the Ph.D. degree to students who are unable to read French and German.

Specialization has come to stay. The family physician, the old-fashioned naturalist and the general student of physical sciences give way to those who confine their work to a particular and narrow field. Should not these specialists, however, have a solid foundation, a broad background, for their individual studies? Should the chemist be merely a chemist or should he have some knowledge of other branches of science? Shall the geologist be a geologist and nothing more? Will the physicist be a better or a poorer physicist if he knows some chemistry? Is it not true that he who neglects broad fundamentals, however proficient in some specialty, may fumble long and never find the key which opens the door of opportunity?

Perhaps it is not altogether the fault of the university professor that his graduates lack the broad training which I claim to be so important. Personally, I find it difficult to make students, whether undergraduates or graduates, elect courses outside their major department. They become acquainted with the general facts of their own science and with the instructors and their methods; they fear to set out upon an unknown road lest they be not able to travel it in safety. These observations refer not so much to the "weak brothers," for they may try a new subject hoping that it will be easy, but they point rather to the so-called "good" students who have done well yet are such timid souls that they shrink from the untried. I find very little zest for intellectual adventure among the "flaming youth" of to-day who like best the familiar scenes and who do not care to seek out that which lies beyond accustomed limits.

Since specialization is necessary, how may the ills of over-specialization be minimized? If workers in different sciences are brought together in one organization each is broadened by contact with others. There may be mutual help for those too narrowly trained, whether employed in a university or an endowed research institution or in an industrial plant. Young persons entering upon a scientific career need to be reminded of this great advantage in working with others. The solitary science worker lacking the stimulating influence of companionship in research has a hard struggle, and especially hard if his interests are greatly circumscribed. The annual gatherings of societies are of high value. We older folk know this from experience but youngsters need to be told. This meeting of the Southwestern Division of the American Association for the Advancement of Science brings before us many problems and achievements of our fellow laborers in other fields. It gives us breadth of vision and keeps us from thinking too highly of ourselves and of our own specialties.

It has been my attempt to show the need of breadth of learning and the danger of one-sidedness. But let me not be misunderstood! I know and you know that the great scientific advances of the future will come from the work of the specialist. Yet it seems reasonable to expect that the specialist with a wide background of scientific knowledge will achieve most. Those of us now in the harness may well urge upon the rising generation a longer scholastic preparation and a more generous grounding in basic science. May these neophytes, as they advance in their studies and in their professional careers, retain a sympathetic interest in all knowledge even while they press forward in their own straight and narrow path!