

# PHYSIOLOGY AND PHYSIOLOGISTS A SWAN SONG

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Tradition is a good thing. Our Society needs more of it. One tradition is for the Past-President to 'sing a swan song' at this time. He is supposed to 'view with alarm', 'point with pride', and 'preach from on high'. He must be witty, whimsical, philosophical and oblique. His chidings must give no offense. My predecessors have exceeded our expectations in all these qualities. Their wisdom was obvious, their wit amusing, their words arresting, their sermons wholly worthy and welcome. In fact, they have said everything which needed saying—they have even presented every good pun and joke! There is nothing left for me. Were I wise, I would now sit down. But tradition must be upheld! So you must put up with me, bearing in mind that I have neither the profundity nor the fluency to compete with them.

During the three-year tour of duty in the top command of the Society, it is natural that one's thoughts turn to the broad aspects of physiology, biology, science, teaching and research. Like my predecessors have, and my successors will, I too have thought a great deal about these matters—and I would like to use this occasion to tell you about a few of my conclusions. Instinctively, I prefer to deal with broad principles and philosophies rather than with commonplace matters such as programs, publications and types of meetings.

We are physiologists and belong to a Society of physiologists. Have we thought through what physiology is? As I see it, it is dynamic biology—the study of living things in action and the mechanisms by which such actions are accomplished. Our Society limits itself primarily to animal physiology, both normal and abnormal. Regrettably we are dominated by medical physiology and have given less prominence to general physiology and biophysics. Physiologists from university departments of biology and from colleges do not feel entirely at home among us. This needs to be remedied since they have much to contribute to us and much to learn from us. Animal physiology is not a dichotomy; it is a unity of all aspects of animal life. Its application to medicine is only one limited area of its activity—though an important one. Biophysicists, of whatever type, and general physiologists, ecologists and geneticists must be brought into our midst, if physiology is to continue to flourish. I am happy that positive steps are now being taken by our Society in this direction. I hope they will continue.

There is—as I see it—too much emphasis on organ system physiology and, as a consequence, the broad aspects of physiology are being

somewhat pushed to one side. This is doubtlessly due—among other things—to the mass of detail being published, to the development of a language of short-hand symbolism by each group of organ-system specialists—which others, unfortunately, can understand only with great effort—and to the complicated instrumentation which has grown up in the exploration of the mysteries of organ system functions. Ours is an age of super-specialization. One wonders sometimes whether the plethora of tiny bits of information which is causing such a diarrhea of words is not leading to a constipation of thought!

What we need in physiology are broad unifying concepts, not so much detail. We need laws that apply to all cells, laws that unravel the mysteries of cell integration, laws that reveal the manner of growth, development and heredity, laws that make clear the influence of environment on living things. Too few of us are concerned with these broad aspects. This is where the general physiologists and the biophysicists can be of help—unless they too become too concerned with detail, polemic and trivia.

It is my firm conviction that the future of dynamic biology lies in two divergent areas. The first is the study of cellular physiology which should reveal how all types of cells operate biologically as far as cell membrane, cell cytoplasm, nuclei, chromosomes, mitochondria, etc., are concerned. This path ultimately should get down to first causes, the physiology of molecules in organic compounds and of molecules organized into cells. Were I a young man, this is the area I would enter.

The second is the field of biological regulation. This involves, first of all, the role of hormones and the central nervous system in integrating bodily function in organisms of various complexity, ranging from the lowly invertebrates up to man. It also deals with genetics and ecology, the interplay of organisms and their environment—the influence of climate and of radiation on living things, and the like. The importance of all this is obvious in our modern age where no clime is sacred to man from the torrid tropics to the icy polar areas, and from the depths of the sea and mines to the limits of our atmosphere and beyond. It is clear that biology, not physics nor chemistry, will cause the bottlenecks in the conquest of these new horizons of man's exploration and settlement.

As I have thought about other broad aspects of physiology in this philosophical vein, I have become concerned about the interrelationship between teaching and research.

Our Society has constantly emphasized research. The quality—and quantity—of publications is a measure of a candidate's acceptability as a member. Our meetings are primarily for the purpose of presenting results of research, and so are our publications. Only latterly have we become concerned about the teaching of physiology and the recruitment of new physiologists. Physiologists have a major role to play in the teaching of physiology, and this aspect of our activities must grow in extent as an affirmed Society endeavor.

It is necessary to train many persons in biology who will never be investigators nor even biology teachers. Science is becoming a more and more important aspect of our civilization. All citizens, consequently,

must be properly indoctrinated in the philosophy of science and its broad perspectives. A proper and early understanding of life processes is essential. This understanding must begin in the high school and continue in the college. To meet this goal, more teachers trained in the philosophy and substance of dynamic biology, rather than more of those trained in home economics or physical education, must be turned out for this purpose. The mood of our communities must be turned away somewhat from vocational training, from the substitution of the school for the home, and from the over-emphasis on the methodology of teaching. Instead, the mood must favor substantive teaching by well-informed and inspired, and—incidentally—well-paid, teachers of biology. Our communities must also favor the diligent and brilliant student rather than the slacker and stupid one—or even the average one. Learning must be accepted in our communities and looked up to, as in other civilizations, and not just tolerated or even viewed with suspicion. An evil inherent in democracy is the intolerance of the unusual person, of anyone that is different. This evil must be faced squarely and anti-intellectualism must be eliminated. Democracy can, if it will, develop in this direction! Great advances, after all, come from the unusual person and not from the ordinary one.

Scientists should get out of the ivory tower and enter into community life—especially on the local scene. We must explain our role as scientists to our community, accept our obligations and responsibility to our community, and help to establish the environmental climate by which scientific discoveries will be used for good and not for evil. Being, by and large, rational and not emotional persons, and understanding the rigid rules of good research, we scientists are in an excellent position to mold our neighbors into a mood of reasonableness, tolerance, and freedom from irrational prejudice. These things we must do. For as Pericles (1) in the golden age of Athens said, according to Thucydides, "The private citizen, while engaged in professional business, has competent knowledge on public affairs; for we stand alone in regarding the man who keeps aloof from these latter, not as harmless but as useless."

We biologists must act as citizens not only as individuals, but as a group. In this connection, I favor a public relations program on the part of biologists. Among other things this will help with our recruitment program. It will assist in getting the message across to the public as to what biology really is. Physiological endeavors and discoveries are too often labeled medical, surgical, chemical, physical, etc. because the public knows about these other areas, while physiology is less widely appreciated. How many ordinary citizens in the United States or Canada know what physiology is?

The low state of our biologists—and other scientists—compared to industry, labor, agriculture, politics, engineering and medicine is dependent on a lack of information on the part of the public. The ultimate responsibility for this rests with the public. To act, the public must know. To know, it must be informed. Public relations is a profession which serves to inform the public. We biologists through our special societies must see that the public is informed through a dignified public relations program. After all, we physiologists are the servants of the public, just like every other group, and this is one of our civic duties.

The question next arises as to how this can be best accomplished. Obviously, it must be through an organization of biologists. I doubt if

the Physiological Society is that organization. What we need is an 'umbrella' organization for all biologists, for all who deal with the life sciences—for this broad purpose and others like it. I mean an organization like the 'umbrella' organization of the physicists, of the chemists or of the psychologists. Perhaps, as a first step, we will need to establish three 'umbrella' societies—one for general biologists, one for basic medical biologists and one for clinical biologists. Once these subsidiary 'umbrella' groups are organized, they could unite to form an overall organization to speak on public matters for all biologists. If such an organization structure is accomplished, it will help to neutralize the centrifugal forces which split up biologists, and help bring about the idea of a unity among all biologists regardless of which speck of the biological universe they are concerned with.

Many biologists, I know, are uninterested in this movement and others are so 'isolationist' and 'stand-pattish' as to be opposed to it. They may say: These activities are undignified and unrelated to our scientific and academic role in our communities. But I put it to you that one cannot escape from the realities of life by letting others uphold our position, maintain our opportunities, and take over our moral obligations. Perhaps we have become too dependent upon others—we scientists; too ready to let 'George do it'—George being our Dean, our University President, our University governing bodies, and our other friends and neighbors. This I believe is unrealistic—no one can explain things biological better than we ourselves. So for everyone's good—the public's as well as our own—we must assert ourselves in an orderly fashion.

As I said earlier, one of the chief results which will come from this diversion of our activity into the public domain is to recruit new biologists who can become the teachers and investigators of the future. We are all keenly aware that the mysteries of biology will not be solved in our lifetime. Surely, it will take many generations before the life processes are completely solved. This being so, it follows that our undue concentration on research with the resulting neglect of good teaching is short-sighted. Not every good investigator is necessarily an inspiring teacher; nor, contrarily, is every good teacher a brilliant investigator. When both qualities are combined in one person, the result is ideal in inspiring young talent. But such a combination occurs much too seldom to enable us to use only investigators as teachers to help fill the ranks of future research scientists, let alone enable adequate teaching of the applied scientists, technicians and general public. We must, therefore, have many teachers whose research talent is of a lower order, provided they teach well and are inspiring.

It follows from what I have just said that the teaching of biology must be upgraded and teaching must be placed on a par with research. Regrettably, this is not true at present. One way to accomplish this equalization, I believe, is to establish some prestige for teaching as such by means of awards and special recognition, in much the same way as is now done in research—including the title and extra privileges of a class to be known as career teachers for those in the first rank. The selection of such persons will not be as easy as the selection of career investigators but this is no reason to drop the idea. Is not the task of glorifying the teaching of physiology, difficult though it is, a most important one?

My own life, these last 40 years, has been concentrated upon research—and only incidentally upon the training of scientific apprentices. The evolution of research in these four decades has been startling to me not only in terms of scientific advances attained but in the evolution of biological research from a field dominated by 'rugged individualism' to the trend for it now to become "big business". With this evolution has come a greater emphasis on teams rather than individuals, on big buildings and elaborate equipment rather than magnificent ideas! One gets the feeling that the role of creative minds today is being placed somewhat in the background. I need not tell you—for you know—that it is brains that we need today more than all else. Sir William Osler (2), the great physician, aptly put it this way in 'Aequanimitas': "The great possession of any University is its great names. It is not the 'pride, pomp and circumstance' of an institution which brings honor, nor its wealth, nor the number of its schools, nor the students who throng its halls, but the men who have trodden in its service the thorny road through toil . . . to the serene abode of Fame".

Research has had a great impact upon medicine. This was predicted by Claude Bernard (3), the father of physiology, who wrote: "During its advance through the centuries . . . medicine has always been driven into action and from numberless ventures in the realm of empiricism has gained useful information. Though furrowed and overturned by all manner of systems . . . it has none the less carried on research, acquired ideas and piled up precious materials which in due time will find their place and meaning in scientific medicine. . . . Thanks to the great development and powerful support of the physicochemical sciences, study of the phenomena of life, both normal and pathological, has made progress which continues with surprising rapidity".

Claude Bernard was clear also in his views on the role of instruments, for he said: "Only within very narrow boundaries can man observe the phenomena which surround him; most of them naturally escape his senses, and mere observation is not enough. To extend his knowledge, he has had to increase the power of his organs by means of special appliances; at the same time he has equipped himself with various instruments enabling him to penetrate inside of bodies, to dissociate them and to study their hidden parts. . . . Investigation, now simple, again equipped and perfected, is therefore destined to make us discover and note the more or less hidden phenomena which surround us".

He summed up the difference between observation of nature and experiment in one pithy sentence (4): "In the philosophic sense, observation shows, and experiment teaches".

Today there is too little appreciation of the continuity of research—of the dependence of our work upon that of our predecessors. The life stream of research was clearly recognized as far back as three centuries ago by Harvey, the father of experimental medicine, whose Tercentenary was celebrated last year. In the first English edition of his classical work, published in 1653 (5), he appended a communication to one of his critics which showed his appreciation of the continuity of research. I quote: "There is no science which has not its beginning from foregoing knowledge".

Too often we lose sight of such old sayings, and of the scientific contributions of our predecessors—even those of the present century. Too many facts are rediscovered. Literally, there is too much re-research! Too often, also, we become the slaves of tools, instead of their masters. Organization, buildings and elaborate equipment are taken too often as the *sine qua non* of research, and it is forgotten that it is creative minds that we need—not just elaborate cybernetic machinery. With the recent increase in opportunities for full-time positions in universities and elsewhere, the feeling has grown that all persons in full-time positions should do research. Production in research is becoming one of the most common measures of a man's ability to advance up the academic ladder. Sometimes this measure is actually weighed merely by the number of papers written, without regard to their quality. Governing boards, benefactors and the public are impressed by such output. Does it not lead to bigger institutions, larger budgets and increased endowments? Bigness in research is becoming confused with goodness.

One result of all this is a plethora of publications, meetings, conferences, symposia, abstracts and reviews in which the few shining pearls of great wisdom are buried in masses of clinging mud. How can any serious student, even in a restricted area of scientific knowledge, hope to keep his head above this deluge of unimportant facts? And the flood has not yet crested! What can we do about it? In this continent of ours, we tend to discourage speculation and scholarly synthesis of thought in physiology. This trend must be reversed. We must strive to have each communication be a major opus. Minor bits of trivial progress notes must be discouraged.

Research today, worse still, is carried out in a fish bowl. Reports are plucked up by the mass media—the lay press, radio, television and magazines—sometimes even before the results are presented to a scientific body or printed in a scientific journal! It is tempting, of course, to 'hit the headlines', and regrettably some succumb. More often, the scientists are helpless victims of publicity because of the misguided activity of institutional or voluntary agency press releases. This is a natural result deriving from the millions of dollars being invested in research by governmental and private agencies. The product being sold by the misguided effort of such publicity stunts is the serious work of the defenseless investigators.

Research is a dignified profession to be pursued only by the consecrated and inspired, in quietude, at a leisurely pace, and away from prying eyes. It cannot be placed on a business footing where one new fact is to be turned out for each quantum of dollars invested. Great discoveries are not produced on the assembly line. Only duplicates can be so manufactured. The original must come about through the activity of a creative mind, and a creative mind works best away from artifices and prodding. Great discoveries evolve—they are not delivered on call.

One of the hazards of expanding knowledge is specialization in research. More and more becomes known by each investigator about an ever-constricting field of knowledge. Ultimately, the horizon becomes so constricted that the perspective is lost. There is need of interdisciplinary cross-fertilization to overcome this trend. Departmental

barriers should be easily passed. A serious research should be followed wheresoever it leads, regardless of the disciplines or the tools employed.

Research, I believe, should either advance a fundamental concept, or have an obvious practical value and early applicability. It should not be gadgeteering per se, nor need it follow the fashion of research of the moment.

The background of all great advances, whether planned or arising from serendipity, is basic research. This can start anywhere, in the strangest and most exotic places—not necessarily, as too many of us imply, only in a university department. This is so because unusual minds create, and not all such minds are in the universities. At present too much of our effort is in research which seems to offer immediate answers. This is short-sighted. Great advances do not come so obviously. If we knew the methods of getting answers quickly, the important problems would have been solved a long time ago. Since we do not know how to get useful and practical answers, it is our task to encourage the most creative minds to undertake research, and to do their work in any area which intrigues them. It is not the place or field that counts in research, as much as it is the perspective. It is the original creative mind asking a question and designing an experiment that counts. Obviously, research should not be pebble-picking—it should be the building of magnificent castles.

These thoughts on research have been troubling me for some years. There have been other occasions when I have expressed similar views in addresses and writings (cf.6). I have taken the liberty of re-expressing them here since they are problems we must face constantly.

It is now time to close. I have imposed on your patience long enough. If in this address I have accomplished only one thing, I shall be satisfied—and that is to convince you that biologists should plan—and in a big way. It is in the broad vistas that investigators, like artists, get their greatest pleasure. There is beauty in truth, and the large panoramas of truth are the ones that are most exhilarating. This is perhaps best expressed in a re-arrangement of the words of Christopher La Farge (7), who toward the end of his book, Beauty for Ashes says:

"So fly up now, up . . . above, above, high . . .  
 Soon from on high . . . see it differently, the topographical pattern . . .  
 laid out below . . . distant . . .  
 Seen from this height, down looking, steep, you fit them to the pattern . . .  
 that's your geography . . .  
 Remember them . . . but not as ants that crawled painfully and small . . .  
 down infinite steeps of grass, not as the germs that brilliance and clever glasses made manifest, but as the echo . . . of the thing you lent when, in participation, you descended to witness and to know".

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