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BIOLOGICAL RESEARCH AFTER A CENTURY OF DENTISTRY¹

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PHYSICIANS who do not practice medicine, but devote all their working time to research and teaching in a field of medical science, are numerous enough nowadays to be taken for granted. Dentists in parallel circumstances, however, are still extraordinary. Research on problems of disease of the mouth and teeth is still a neglected field; and in view of the prevalence of such disease and its great economic importance our ignorance of it is even more extraordinary. This year marks the centennial of the establishment of the first dental school and the first dental journal, which signaled the emergence of dentistry as a profession. After one hundred years the dental profession points

with justified pride to its many noteworthy contributions to human welfare and comfort, but these achievements do not include very much positive advancement in knowledge of the diseases which determine dentistry's existence. Physicians and dentists generally appreciate this fact, and many feel capable of offering an explanation of it, often to the discredit of dentistry. Since I am one of the rare birds alluded to—a dentist who devotes all his time to research and teaching—my opinion on this subject may be of interest. For 12 years, working in the environment of a large medical school which is an active center of medical research, I have given all my research time to problems of dental disease. During much of this period I have taught one of the basic sciences and its

¹ Prepared by invitation of the American Dental Association's Committee for the Dental Centenary Celebration, 1940.

dental applications to the students of the associated dental school and aided in the teaching of medical and graduate students. From the beginning I have been keenly interested in the comparisons which these circumstances have continually presented to me, of the medical with the dental—students, faculties, research workers, facilities, and what may be called the respective intellectual and scientific climates. These comparisons form the basis of what follows.

At the outset, curiously, it seems necessary to argue that the problems of dental research are important. The importance of research is estimated variously in various circumstances. Most research workers, as I know them, are guided in their choice of problems (when they are free to choose) primarily by the sort of feeling that prompts them to read the detective stories of a particular author, or to seek the image of a particular movie queen: it is a matter of what they like, or of what others like. Of course their choice is influenced by their knowledge and skill, and by the assistance and physical equipment at their command. It is likely to be modified by the funds available, whether because some problems are inherently more or less expensive or because money on hand is earmarked for some special purpose. Sometimes a problem is chosen directly because of its public importance or because it deals with or is likely to illuminate a broad and fundamental principle; and sometimes one is chosen because it seems certain to yield a publication with little effort and in a short time. But primarily the problem is selected because it quickens the research worker's curiosity and interest; he likes it, and this is as it should be. Now it happens that I like dental problems. If others fail to admire my taste, I can sometimes return the compliment.

The importance of research problems is probably more objectively evaluated by those outside research or at all events from their collective point of view. Here problems become important in proportion as they deal with fundamental principles or directly or indirectly influence human welfare. Dental problems have not seemed important with respect to fundamentals. The problem of dental caries, for example, is in several respects unique. Knowledge of other diseases has been of little aid in solving it, and its own solution is unlikely to throw much light on disease elsewhere. But if this is true of dental caries, it is less true of other dental problems. For example, the work of Schour and his collaborators on the growth and development of the teeth is not only rapidly increasing knowledge of that limited field, but is likewise aiding in the development of methods of wide applicability and in the formulation of laws governing the whole process of growth and development. Again, exploration of the bacterial flora of the mouth, on which, despite sporadic researches over many years, only a bare beginning

has as yet been made, will not only clarify many questions of disease of the mouth, but seems likely also to help explain the origin and character of certain extra-oral diseases (such as the "fuso-spirochetal" group). What may be more fundamental, the collateral study of mouth infection of low virulence may also be expected to provide a fruitful approach to the whole question of natural resistance.

As for their influence on human welfare in general, there can be little valid question of the importance of dental problems. Poliomyelitis is more dramatic than pyorrhea; one seems terrible, the other commonplace. Yet I think a man from Mars, apprised of all the facts of distribution, of mass damage and of ultimate effects, would have no hesitation in choosing pyorrhea as the more important. And dental caries, by the same standard, is more important than pyorrhea. In recent years there has indeed been an awakening appreciation of dental problems in medical circles. Perhaps recent dental research is having a stimulating effect, and possibly also the realization is growing that dental problems can be as "likable" as any others. Nevertheless, the public importance of problems of dental disease has been very inadequately appreciated; and as one consequence only a disproportionately small share of the funds allocated to research on disease in general has gone to support dental problems.

Although I admit that dental research is still a neglected field, it is not as though it were completely unexplored. Even in the 1880's, when medical research received the impetus that eventuated in its modern phase, W. D. Miller and G. V. Black, both dental practitioners, published researches on fundamental dental problems whose influence is as strongly felt to-day as that of many medical classics of the same period. And since that time there have always been a few workers, here and abroad, some of whose contributions have solid and durable value. It may be significant that some of the best among them, as witness I. J. Kligler and A. T. Henrici, went on to greener pastures, presumably because the opportunities in the field of dental research in their time were not attractive enough to hold them.

That was about twenty-five years ago, and it may be said that the first three quarters of the period now being celebrated by dentistry saw individual dental researches of merit, but no organized or wide-spread research activity. Since that time there has been an appreciable expansion, due in part to improving pre-dental education, in part to the frank statement of deficiency embodied in the Carnegie Foundation's Bulletin No. 19, prepared by W. J. Gies and published in 1926, and no doubt in part to accumulating awareness within dental educational circles themselves that sound scholarship, in dentistry as elsewhere, can not exist without the spirit of research. To Gies, in addition,

goes the credit for establishing the *Journal of Dental Research* in 1919, and the International Association for Dental Research in 1920. The latter, now affiliated with the American Association for the Advancement of Science, has acquired about 500 members, conducts regular sectional meetings in many parts of this country and abroad and a two-day annual meeting of which no scientist need feel ashamed. And the *Journal of Dental Research*, now owned and controlled by the I.A.D.R., can hold up its head in the best medical company, and is finally approaching actual financial stability!

In more recent years additional stimulation of research on dental problems has come in the form of grants in support of research or dental graduate teaching or both, from such agencies as the Rockefeller Foundation, the Commonwealth Fund and the Carnegie Corporation. The last named is currently pursuing the far-sighted policy, of establishing dental graduate fellowships leading to research and teaching positions on dental faculties, which is certain to have salutary effects. To-day most large dental schools and some small ones have a research program of some kind; the Public Health Service is sponsoring fundamental research on dental problems; and the fellowships for graduate training of dentists now being offered at several centers—thanks largely to the Carnegie Corporation—are coming to be eagerly sought after.

Things are looking up. Yet the field is still not what it should be. It remains true that in most dental schools research, however much the word may sometimes be glorified, proceeds under severe handicaps or not at all. Opportunities for recent dental graduates leading toward careers in research and teaching in dental schools have only begun to appear, and there is still no satisfactory basis upon which young men of promise and outstanding ability might be encouraged to prepare themselves for a life work independent of dental practice. It is still true that there is not enough incisive dental research going on to do more than scratch the surface of the major problems of dental disease. In these respects dental research differs conspicuously from medical research, and it is my purpose to inquire into them more particularly.

The major dental problems are not simple ones. From the little we know of dental caries and pyorrhea and of the various common forms of gingivitis and stomatitis, for example, it is clear that none is a simple infection, a simple dietary deficiency disease, the result of any simple or single cause. It is becoming plain that their effective solution will not be achieved without full recognition of the peculiar characteristics of the teeth and their surrounding structures, that is, without the knowledge which is part

of the dentist's special training. There is plenty of room in the field of dental research for physicians and for those whose primary training is in one of the basic sciences; but the development of broad concepts, the true interpretation of groups of data, the synthesis of isolated researches, calls for the special knowledge of the dentist. Dentists, in other words, or those whose primary training is in dentistry, ought to lead the field of dental research. Their special knowledge, moreover, is better calculated than the lack of it to stimulate a genuine interest in dental problems, to motivate the drive without which research never amounts to much.

The dental student to-day shows abundant promise of aptitude and capacity for research, comparing very favorably with the medical student. The great majority in both groups, of course, could not and should not be diverted from practice. But only occasional and exceptional medical students go on to careers in research. Similar occasional and exceptional dental students appear in full measure, particularly in response to the stimulus of increasing awareness of the problems awaiting solution in their field. Dental students have changed appreciably in this respect even in my own comparatively short period of experience with them. Improving pre-professional education has doubtlessly contributed toward keener appreciation of dental problems; increasing research activity itself has had an autocatalytic effect: a little has induced more. And, of course, changing economic conditions have done their share. The future in practice does not seem quite so rosy to the student to-day as it did fifteen years ago. He is much more ready to accept unpaid or poorly paid internships to improve his clinical training, or the graduate fellowships which are becoming available, to prepare for clinical teaching or research. But opportunities for such graduate training are still far too limited; and more distant prospects—opportunities on dental faculties, for lifetime careers in research and teaching positions—are still so meager that most of the qualified students prefer the lesser insecurity of practice. The seeds of a healthy dental research plant, in short, are ready to germinate; but the soil is not yet ready to receive them.

The soil is the dental school, and its infertility is its own retarded scientific development. I think this fact will not be seriously disputed; but I also think that the blame for it does not rest solely on the dental schools themselves. Medical schools must shoulder a full measure of it. Two interrelated circumstances seem to me to be responsible for the slow scientific development of dental schools. The first is that instruction of dental students in the basic science subjects is given, as a rule, by associated medical schools,

which often overlook the dental applications of these subjects; the second is that clinicians, by and large, are not research-minded.

We should expect research activity to be stimulated by example in dental schools that are closely associated with medical schools in which research is active. Yet most of the research in such medical schools is done in the basic science departments; these departments include among their functions the instruction of dental students; yet they usually overlook dentistry in their research programs. There are, of course, subsidiary circumstances which underlie this one. Lack of adequate understanding of research or of interest in it on the part of dental faculties may be one of them, and if so, is linked to the second major circumstance to be considered later. More pertinent seems the fact that instruction of dental students in the basic sciences does not usually have, and is not expected to have, a dental orientation. Commonly the course for dental students is an abridgment of that for medical students. The instructor in charge, as a result of his own training or by example from his department at large, has a medical orientation, and sees no need or perhaps no opportunity to adapt his course to the special requirements of dental students. This is likely to be exactly what the dental faculty itself requests or at least sanctions. I need not raise the question whether this practice is good or bad in its general effects, but that it militates against a healthy development of dental research can hardly be questioned. Research and teaching are both at their best when each interacts with and stimulates the other. The conscientious teacher utilizes past and current research to breathe life into his courses, and in so doing attains the most favorable position to discover the gaps and uncertainties in his subject that call for investigation. The teacher of a basic science subject who ignores its ramifications into the dentist's special field is unlikely to become aware of the problems that exist there, still less to be stimulated to explore them.

It is not my intention to argue that, for any reason, instruction of dental students in the basic sciences should be completely separated from that of medical students, or even that the dental courses should be altered in any radical way. It seems to me self-evident that instruction in general principles should be the same for both groups. But all courses include application of the principles, and it is here that substitutions might be made. Material of special interest to the physician can be displaced by subject-matter better suited to the needs of the dentist. In biological chemistry, for example, a little less time might be devoted to urine and milk, a little more to saliva; a little less to muscle and other tissues as such, a little more to the special problems of the composition and calcification of bone and teeth. The biochemist may

find little on these substitute topics in text-books, precisely for the reason that they are generally given no more than a passing glance in the medical courses for which the books are written. If he takes the trouble to dig for it, however, he will find enough to vitalize his whole course for dental students. At the same time he may discover that there are fascinating research problems dealing with the mouth and teeth which lie wholly within his own proper field. From my own experience I know, moreover, that dental students, who may sometimes evince a certain detachment, even verging on apathy, toward a subject whose bearing on their own field is imperceptible, come to life when they see the application plain. Not only does their own curiosity and interest stimulate investigation by their teacher; the students themselves willingly grasp any opportunity to participate in such investigation. If more basic science courses were presented to dental students with the sort of dental orientation here suggested, and the spirit of research conveyed to them not as something beyond their reach, but as an atmosphere surrounding the answers to their own questions, some among the students would ultimately help to contribute answers to those questions. Meanwhile, more dental research would be done in medical schools.

I submit, furthermore, that these suggested alterations looking toward a more dental orientation of basic science courses ought to be initiated by the instructor in charge of dental students, without waiting for the suggestion to come from superiors or dental faculties. The instructor should strive to do the best job he can, and this is a means toward that end. On the other hand, it would probably do no harm if dental faculties went at least as far as to encourage him by seeming interested.

This brings us to the second major circumstance which in my view has held back the growth of research in dental schools: the lack of due appreciation of research among dental faculties. This is a matter of great importance; yet rather than join the chorus of the supercilious whose confidential remarks imply an inherent and unalterable defect of the dental mind, I propose, being a dentist myself, to condone it by explaining it. We may, indeed, dismiss the clinician as such, with a few outstanding exceptions, as all but hopeless in this regard. But be it noted well! as I know him the dental practitioner, by and large, is no worse than his medical brother under the skin, except as the accumulated pressure of accomplished medical research has forced the physician to recognize its value. May I recall that Sydenham, peerless among clinicians of his time, is now charged in certain quarters with having delayed the development of epidemiology by nearly two centuries, and that Pasteur had certain difficulties with physicians? For the most part the dental clinician is a hard-headed practical fellow

by necessity. The patient is his problem; research is of value to him only in its final stage. He can not afford the detachment that research demands before that final stage is reached, and we who do research can not expect him to support us until we have proved our worth in terms of practical usefulness to him. In short, dental research must get its support from other sources first, and hope that clinicians will ultimately come over, as physicians have done increasingly, when they see their own advantage in doing so.

Nevertheless, whereas medical schools maintain their research-conscious basic science departments as the backbone of their scientific framework, the associated dental schools, sharing the same basic science departments, are thereby largely deprived of backbone: for the remaining members of dental faculties are nearly all clinicians. There is, on the other hand, a smaller group of dental faculty members who are not clinicians or whose position on the faculty, at all events, is not clinical. These include the teachers of applied phases of those basic science subjects in which special dental requirements are generally recognized—*anatomy, histology and pathology*. It may be said that these teachers should shoulder the greatest measure of responsibility for research in dental schools. Many of them do so, and some of them do so very effectively: the group includes some of the foremost dental investigators. Others, unfortunately, either give no indication of research activity at all or, what may be worse, attempt investigative work, and even publish voluminously, while giving every evidence of an utter lack of appreciation of the meaning of research. This type of teacher has of course not become extinct as yet even in medical schools, and is well known in medical as well as in general scientific history. The name of Pouchet occurs to me as a conspicuous example. In dental schools I have been told that they are still numerous. Some of them are said to have an inhibitory effect on research in their environments analogous to the effects of the theories they promulgate. These latter, being deductive and plausible, lacking either experimental background or any feasible avenue of verification, presented with scholastic authority, still—seventy years after Claude Bernard!—satisfy the student's curiosity instead of stimulating it, or provoke only feeble and futile attempts "to prove" their theories. And I am told that investigations which tend the other way are still fraught in some quarters with unpleasant consequences for the investigator. The true spirit of research has never prospered in such an atmosphere.

Nor do I see any immediate prospect of a cure for this particular manifestation of the chronic deficiency disease which currently afflicts dental research. Medical research was in a somewhat similar position sixty years ago, before the experimental method achieved its

present respectability; but there is a double-barrelled difference. Medical research *has* gone on, during the interval, and become virtually a profession or group of professions in its own right. Dental research now has both a living example for emulation which medicine lacked during its own adolescence and a grown-up cousin who usurps the spotlight and covers his smaller relative with a magnificent shadow. Medical schools have assumed part of the responsibility for training dental students. I think the real cure of dwarfism in dental research is likely to come only as the research departments of medical schools take that responsibility more seriously. Time will eliminate the unscientific and pseudo-scientific teachers of science in dental schools only in proportion as younger men with better basic training emerge to take their places and as additional places are created for them to take. Medical schools must carry a large part of the burden of training those younger men. At the same time, the subject will grow if they undertake their own share of research on dental problems, and a better research environment will thereby arise by direct example in the associated dental schools.

The field of dental research to-day shows some of the awkward features of retarded development which will disappear of themselves, I think, as maturity approaches. There is too much spirit and not enough substance in our literature. There is a great deal of foolish competition and not enough cooperation among research workers. Among investigators of dental caries, for instance, each one, apparently hoping to achieve fame as the sole discoverer of the cause, blows his own horn lustily and airily ignores his neighbor. The total effect is a glorious cacophony. Again, not only is self-criticism poorly developed in general, but the ability to give and take criticism in true cooperative spirit is often altogether lacking. But these are merely symptoms of the condition described. We need more healthy young blood, a greater infusion of the sort of interest in dental problems, based on adequate training, which will be deep and sound enough to transcend the legitimate interest of the individual in his own material advancement. One approach to that goal should be to make material advancement less precarious.

From the inside, then, one hundred years of dental research in retrospect provide little basis for self-congratulation. Dental research is still the weakest link in the chain of dental achievements to be celebrated this year. During the same period medical research, building upon developments in chemistry and biology in the decades before 1840, emerged as a group of organized activities in the 1880's and later, and has since achieved adult stature. Dental research has lagged behind, entering upon an analogous phase of organized expansion only in recent years, so that at

the moment it presents the stigmata of a somewhat retarded adolescence. Good dental research is now being done, but not enough to crack the major problems of disease that constitute its field. These problems are complex, in that probably no single basic science will provide the answer to any of them, and peculiar, in that the development, structure, chemistry and pathology of the dental tissues are distinctive. The special training of the dentist should help to solve them. Improving predental and dental education is now producing students able and eager to work along these lines, but opportunities for them to do so are far too limited. Research activity in dental schools remains at a low level, first because dental schools usually lack research-conscious basic science departments, which are shared with medical schools and there oriented away from dentistry, secondly because clinical

dental faculties and many teachers of applied dental sciences are undeveloped or poorly developed as investigators. Since medical schools, with their own well-developed research programs, largely control the basic science departments of dental schools, the medical schools ought to take their responsibility toward dentistry more seriously. By giving their courses for dental students more of a dental orientation the instructors in charge may be stimulated to explore the dental field. The dental student may then in turn find greater opportunity to help. The cumulative effect of awakening dental interest and activity in medical schools may finally open the field for further study and research by dental graduates, and thus provide both the material and the impetus for the changes in dental faculties which are most necessary for the maturation of dental research.

SCIENTIFIC EVENTS

THE NEW TELESCOPE OF THE OAK RIDGE STATION OF THE HARVARD ASTRONOMICAL OBSERVATORY

A NEW telescope was the center of considerable attention on September 14, when delegates of the American Astronomical Association at the sixty-fourth meeting at Wellesley College, paid a visit of inspection to the Oak Ridge Station of the Harvard Astronomical Observatory.

The telescope, shortly to be in operation, will be named the Jewett Memorial Telescope for James R. Jewett, professor of Arabic, emeritus, and his late wife, Margaret Weyerhaeuser Jewett. A substantial gift from Professor Jewett has made possible the construction of the instrument at this time.

A unique feature of this new Jewett Reflector telescope is to be found in the manner in which it is housed; the entire building revolving on a special concrete base. Usually only a top of a turret or dome rotates on tracks supported by a non-rotating building. The Jewett Reflector rotating building is twelve-sided and is insulated with homosote. Construction was under the direct supervision of Dr. George Z. Dimitroff, superintendent of the Oak Ridge Station.

The optical parts of the telescope have been completed. They consist of a 33-inch spherical mirror, and correcting plate of 24 inches diameter. This important type of telescope was invented about ten years ago by Bernard Schmidt, of Hamburg, and to date the Jewett telescope is the largest to be put into operation. Construction of larger telescopes of this type was recently started for the Boyden Station of Harvard Observatory at Bloemfontein, South Africa, and at the Palomar Observatory of the California Institute of Technology.

This new type reflector combines the advantages of the reflecting telescope and of the large-field photographic refractor. It both refracts and reflects. Ordinary reflecting telescopes cover satisfactorily only a fraction of one square degree of the sky at a time, but the new Jewett Reflector can cover from ten to a hundred square degrees, depending on the properties chosen for optical parts and mechanical parts. It is particularly effective for surveys of the distribution of galaxies and stars, variations of stars and other problems where a large coverage and high speed are essential.

The mounting for the telescope is of the two-pier type, but the special nature of the Schmidt-type reflector has made it necessary to include several unusual features. Construction is being superintended by Herbert E. Hanson of the observatory staff. Except for the polar axis and counterweights, the mounting is of Dowmetal—probably the first telescope mounting ever made of this specially light and strong magnesium alloy. The Dow Chemical Company, of Midland, Mich., cooperated in providing the difficult castings necessary for both the telescope tube and mounting.

The new Jewett Reflector is considered one of the three or four most important telescopes of the twenty-five in regular use at the Harvard Observatory, and is in some ways, because of its unusual adaptability, the most important. It will greatly extend the survey of external galaxies in the northern hemisphere and it is believed that perhaps a million galaxies will be within its range.

THE DEDICATION OF THE ADMINISTRATION BUILDING OF BELLEVUE HOSPITAL

THE new administration building of Bellevue Hos-