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FRANCIS BERTODY SUMNER

1874–1945

BY

CHARLES MANNING CHILD

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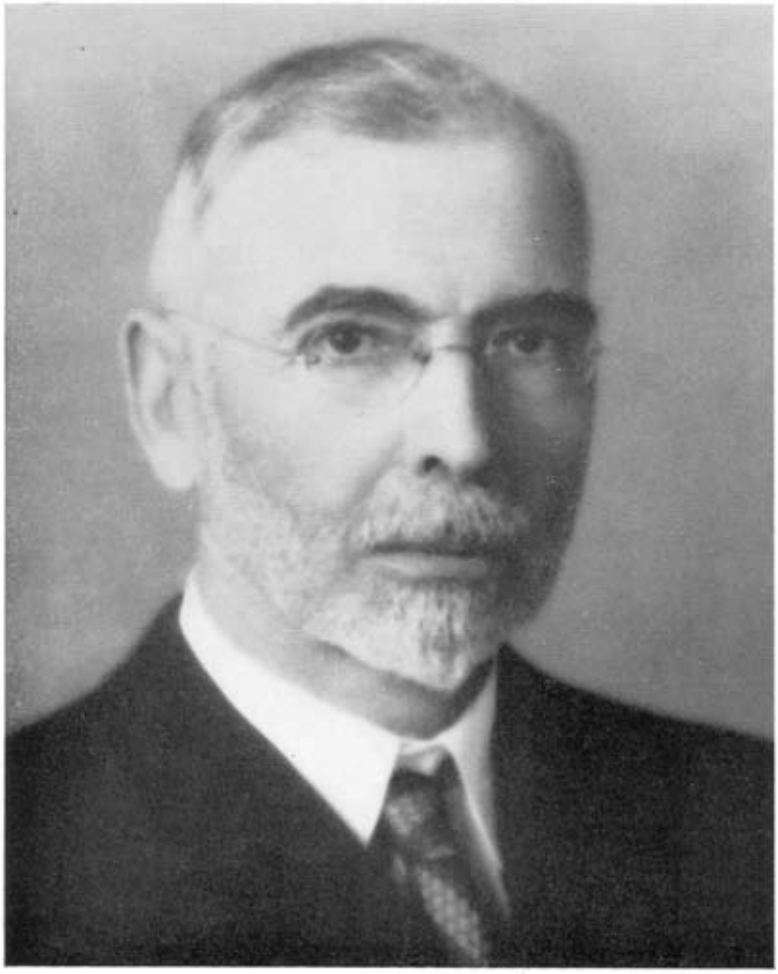

Francis B. Sumner

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No one who knew Francis Sumner could fail to be impressed by an outstanding characteristic of the man, his intellectual honesty, not only in regard to his particular fields of research, but in his wide general interest in human relations and problems, including those of his own personality. It is impossible to read his "Life History of an American Naturalist" without realizing that the self-analysis and self-criticism, perhaps the most interesting features of the book, are expressions of this characteristic. Not all men could have viewed themselves as objectively and have criticized themselves as frankly as he has done. If he has erred it is not in the direction of overestimation. This cannot be said of all autobiographies.[1]

Francis Bertody Sumner was born August 1, 1874, in Pomfret, Connecticut. His parents were Arthur and Mary Augusta (Upton) Sumner. His father's ancestry was predominantly English, but in the "Life History" he speaks of an interesting family tradition that an Italian, Bertoldi by name, an official at Ispahan, Persia (Iran), married a Persian. Their son served as a physician to the king of France, but later, during the period of the French Revolution emigrated to the United States and married a great-grandmother of Sumner in the paternal line. Sumner's face was regarded by E. W. Scripps, one of the founders of the Scripps Institution, as showing evidence of this Iranian ancestry. This seems to be something more than a mere family tradition. Mrs. Sumner possesses Francois Bertoldi's snuff box, also a copy of his appointment as physician to "Monsieur," later king of France, and the citation for an honorary degree at the University of Padua. Moreover, Dr. Sumner's middle name, "Bertody," is apparently derived from Bertoldi. His mother's ancestry was English. She had

[1] Acknowledgment is due to the Roland Press Co. of New York, present holders of the copyright, for permission to quote from "The Life History of an American Naturalist." The source of each quotation from the book is indicated.

taught in a school in Charleston, directed by his father. His father retired early from the teaching position and a few months after Sumner's birth the family went west and lived for about ten years on a somewhat isolated place at the foot of the hills back of Oakland, California. Here Sumner and his older brother ranged the hills and made collections of various sorts, kept insect larvae and learned about their metamorphoses and about the life histories of amphibians. Toads and snakes were Sumner's special pets. A real interest in living things, encouraged by his father, developed in this environment with the aid of a few elementary books on natural history and a small compound microscope.

During the Oakland period he did not attend school but was taught by his father. When he was ten years old the family began a reverse migration eastward, living in Colorado Springs for three years. There Sumner entered school, a private school, for the first time and found himself in advance of children his age, but not well adjusted as regarded social relations, since he was not accustomed to boys in large numbers. Here also he roamed the Garden of the Gods and nearby canyons and collected minerals and fossils, developing still further his interest in nature. Having been given a set of chemical reagents with directions for use he became interested during this period in "rather planless messing with chemicals" and decided to become a naturalist and chemist.

The next stop in the family migration eastward was Minneapolis where Sumner spent three years in schools and four (1890-1894) in the University of Minnesota. His chief interest was zoology and he regarded Dr. H. F. Nachtrieb as largely responsible for his final choice of zoology as a lifework. During two summers of this college period he was a member of field parties sent out from the university to collect biological material, particularly fishes, from the region about Minneapolis, which was then largely wild country with numerous lakes. These trips involved camp life, often much discomfort, particularly from mosquitoes, but during them he acquired extensive knowledge of field zoology and developed the interest in fishes which led later to some of his most interesting work.

A very considerable interest in psychology and philosophy was aroused during the college period and persisted throughout life. He has expressed himself as believing that with a broader outlook and more stimulation and enthusiasm on the part of his instructor, philosophy rather than zoology might have become his field of endeavor.

He was elected to Phi Beta Kappa, received the Bachelor of Science degree at the age of twenty, and was granted a graduate fellowship which, however, was not used because he was advised to delay further studies on account of his health.

Although Sumner has dealt in the "Life History" more at length than is possible here with his childhood, school and college periods this brief review of those parts of his life has seemed essential to an understanding of his later scientific career. His interest in nature from early childhood, encouraged, rather than ignored or discouraged by his father, became the foundation on which his lifework was built. To what extent that interest resulted from the relative isolation from social contact in his earlier life or from a certain type of reaction system he does not, and no one else can, attempt to decide. However, it appears that the environment was by no means unfavorable as a background for development of a biologist, though if he had reacted differently to it his later life might have been entirely changed.

After his graduation Sumner joined his family, then living in Westminster, Maryland, made various attempts to obtain some sort of position and saw Dr. Osler of Johns Hopkins, who suggested first rest, then a trip to South America on a sailing ship, which was accomplished with considerable discomfort and much of interest. On his return another physician advised his return to university work and in the autumn of 1895 he entered Columbia University as a graduate student with zoology as a major and physiology and psychology as minors. In zoology he came into contact with E. B. Wilson, Bashford Dean, and H. F. Osborn. During his first year at Columbia he was somewhat repelled by the amount of routine drudgery involved in various fields of zoological research, could not become interested in "cell lineage," considered at one time beginning a medical course, but with encouragement by Bashford Dean returned to the fishes

and undertook work in fish embryology. The entire development of a fish proved to be too extensive a field, for his thesis, entitled "Kupffer's Vesicle and its Relation to Gastrulation and Concrescence," was concerned only with certain features of development which, however, had a definite bearing on the general problem of formation of the fish embryo.

In psychology he came under the influence of Dr. Cattell, prepared a questionnaire on certain aspects of belief, treated the answers statistically and became particularly interested in Cattell's application of quantitative methods to the treatment of individual differences. This he regarded as influencing his use of essentially the same technique in his later work on animal variability. During this period he became impressed by reports on so-called psychical research, had an interview with William James and visited several "mediums."

Following an unsuccessful expedition by Reid Hunt and N. R. Harrington to the Egyptian Sudan in 1898 to obtain developmental stages of the lungfish, *Polypterus,* which were expected to throw light on the evolution of the land-living vertebrates, funds were provided for a second expedition to the Sudan in 1899. This consisted of Hunt, Harrington, and Sumner. After a brief stop at the Naples Zoological Station, Hunt and Sumner joined Harrington in Africa and the search for the desired material began but was unsuccessful. Hunt and Harrington developed fever almost at once and the expedition ended with Harrington's death and Sumner's illness. Another brief stay at the Naples Station in the autumn of 1899 after leaving Africa was ended by the notice of Sumner's appointment to the Natural History Department of the College of the City of New York. There he found conditions unbelievably primitive but held the position until 1906 with two-years' leave of absence. It was scientifically an unsatisfactory period, both because he felt himself ill adapted to teaching elementary biology with little evidence of interest on the part of students and because of the very limited possibilities for research. In consequence of this appointment he was unable to complete requirements for the degree of Doctor of Philosophy at Columbia until 1901. During the years as a graduate student at Columbia and as teacher at the College

of the City of New York most of the summers were spent in research at Woods Hole with one summer at the Naples Station and one at Cold Spring Harbor.

In 1903 he married Margaret Elizabeth Clark, daughter of the Reverend and Mrs. James Starr Clark, of English ancestry. Her father conducted a boys' school at Tivoli on the Hudson River where she was born. She was a graduate of Barnard College. Dr. Sumner and she met first while both were students at Columbia University, but two summers spent by her as a student at the Marine Biological Laboratory at Woods Hole played no small part in the outcome. The Woods Hole Laboratory has often been regarded as a highly successful matrimonial bureau for biologists; in this case, though not entirely responsible, it was an important factor in furthering the acquaintance and interest. In the "Life History" Sumner wrote: "The lapse of more than forty years finds me still married, and to the same woman." This, he thinks, may require some explanation in view of the present day trend away from permanent marriage and of his own highly individualistic character. The explanation is that she had been an exceptional partner. "Simple justice," he wrote, "requires an acknowledgment of the devoted help which she has rendered me throughout our life together," not in scientific collaboration but in "keeping a constant watch over my needs, mental and physical, and sparing my energies in every way. Any ambition which she may have had for self-expression on her own account she has largely submerged for the sake of my undertakings, which may all, to this extent, be regarded as our joint undertakings." She and three children, all married, survive him.

Also in 1903 he was appointed director of the laboratory of the United States Bureau of Fisheries at Woods Hole, a three months' summer appointment, renewable yearly. Three years later he resigned his teaching position and with his wife and child lived at Woods Hole continuously for the following five years, except for six months at the Naples Zoological Station in 1910. The change was made possible by creation of a temporary all-year position for him at the Bureau of Fisheries

laboratory in connection with the undertaking of a biological survey of the Woods Hole region.

Following the return from Naples in 1910 there was more than a year of uncertainty and anxiety as regarded the future, but appointment as naturalist on the Bureau of Fisheries exploring vessel, "Albatross," provided at least temporary respite. This appointment took Sumner back to California with the expectation of making long exploring trips. However, because of the condition of the ship and lack of funds for reconditioning, exploration was limited to a biological survey of San Francisco Bay. This position offered little promise for the future but it did bring him into association with the biologists of the University of California. After two years a suggestion by Dr. C. A. Kofoid led to correspondence and a meeting with Dr. W. E. Ritter, director of the then recently established Scripps Institution for Biological Research at La Jolla, California. The result of this meeting was acceptance by a committee, consisting of Dr. Ritter and other members of the biological faculty of the University of California of a project presented by Sumner for field and laboratory study of certain rodents and his appointment in 1913 as a permanent member of the staff of the Scripps Institution, where he remained until his death.

Turning to a survey and evaluation of Sumner's scientific work, it must be emphasized first that he was a tireless worker who found his greatest pleasure in research and that, as his publications indicate, the range of his interests was very wide. He said of himself that his mental attitude was that of a dilettante, turning from one problem to another as his interest changed. Probably very few besides himself would regard him as a dilettante.

His thesis was a descriptive study of certain aspects of fish embryology concerned with the problem of embryo formation. It was soon followed by a paper concerning the cell movements involved in fish embryo formation. This paper was his only contribution to experimental embryology. The experiments consisted in interfering with, or preventing, the cell movements occurring in certain regions in the course of development by inserting small glass needles through the cellular layers into the

yolk beneath them. The resulting modifications of development permitted certain conclusions. Effects on development of destruction of various areas were also determined and it was found that when the region in which the embryo normally appeared was destroyed another region could give rise to an embryo. This experimental study was carried on during his directorship of the Fisheries laboratory. These two papers played a very considerable role in modifying views concerning the method of formation of the vertebrate embryo.

At that time the question of Lamarckism versus Darwinism was still a subject of active discussion. This is the question, familiar to all biologists, whether characteristics acquired during the life of the individual are inherited and environment is directly concerned in determining the course of evolution, or whether environment is concerned only indirectly through natural selection of genetic, and therefore, inheritable, "chance" variations, that is, by survival of the "fittest" for particular environments? One result of Sumner's interest in this problem was an attempt to determine whether certain fish species showed any measurable differences which might be of selective value between survivors and non-survivors when subjected to various external toxic or lethal agents. With hundreds of measurements no definite differences were discovered, but much later one of Sumner's students did obtain more definite results. One of the agents used by Sumner with marine fishes was fresh water and questions of the osmotic relations of fishes to the aquatic medium, changes in internal salt content and the role of the gills and the external body surface in these relations led to extended investigations continuing through several years of the Woods Hole period and to several papers of very considerable interest.

Another line of investigation concerned with the problem of evolution, and particularly with the inheritance of acquired characters, was an attempt to determine whether keeping white mice at different temperatures from birth would produce heritable effects. This study was undertaken as incidental spare-time work during the Woods Hole biological survey but was continued for a number of years. It also involved a large number of measurements. The early results seemed to show positive inherited

effects of the different temperature environments, but later data were not entirely consistent and the work ended in uncertainty. In the "Life History" Sumner has pointed out the inadequacy of the technique of these experiments as regards control of the character and past history of the stocks of mice and of nutrition and has stated his belief, based on his later work with the deer mouse, *Peromyscus,* that it appears highly improbable that heredity played any part in the differences in the generation born of parents kept at high and at low temperatures. The chief result of these experiments involving thousands of measurements on some twenty-three hundred mice was, he believed, a valuable addition to his own experience.

As regards time and labor involved, the chief work of the Woods Hole years was the biological survey of the Woods Hole region with several coworkers and the preparation of the two-volume report. The survey, covering some four hundred and fifty "stations," involved an enormous amount of pure routine work and drudgery, dredging, taking bottom samples, recording temperature and salinity at each station, identifying the species taken or sending the material to specialists, and preparing distribution maps for the different species. Correlation of the data and the generalizations from them were undertaken by Sumner. Probably the most important result of the survey was the evidence that closely related species, differing only slightly morphologically show definite differences in distribution, which can often be clearly correlated with environmental differences. It appears that the morphological differences may themselves be of little or no significance, but are associated with, or are to be regarded as expressions of, physiological differences which determine the distribution.

The later biological survey of San Francisco Bay was essentially similar in character but the biological material was turned over to specialists and the data were published by them in separate papers. Sumner reported on the physical conditions in the bay. In discussing these two surveys and the resulting reports in the biographical sketch prepared for the National Academy of Sciences, to which he was elected in 1937, he has characterized them as yielding "relatively low grade ore," al-

though the work was not carelessly done and the methods, while not up to the standard of later oceanographic surveys, were fairly accurate.

The visit to the Naples Station in 1910 led to a study of the color changes in certain fishes, particularly in small flatfish, in relation to environment. He supplied these fishes with a variety of environments, some natural, some artificial, differing not only in color, but in pattern, that is, in distribution of different colors or shades, and kept photographic records of the resulting changes in color and pattern of the fishes. He found that they altered not only their color but the pattern of distribution of the pigment in relation to different environments with the general result that they became less visible. The alterations of pattern consisted in change in distribution of lighter and darker areas, not in copying of definite outlines or figures in the environment. This study ranks high among the various lines of investigation undertaken by Sumner and was so regarded by him. The published results aroused much interest, both scientific and unscientific and gave rise to some bizarre speculations by certain biologists and others. The work also provided a basis for highly interesting further research on color in fishes in relation to environment, begun some twenty years later.

The next important step in Sumner's career after the two years as naturalist on the "Albatross" was his appointment to the staff of the Scripps Institution and the beginning of seventeen years' study of the geographic races of the deer mouse, *Peromyscus,* in their relation to environment. These races occur in widely different habitats all over the United States and beyond its boundaries and show great differences in color and other characteristics. The differences in color of the different races were found in general such as to decrease the visibility of the animals in the environment in which they lived. Those living in light colored environments, such as many desert regions, or on white sand, are pale or virtually white; those living in regions of relatively high humidity with much vegetation and dark soil are dark in color. Collections by trapping of living animals were made on field trips, not only from many California localities, but from other states, even as far away as Florida. Some of his

amusing experiences during these collecting trips are recounted in the "Life History." Some observers of his trapping activities, finding that he was a member of the University of California were indignant that the state should permit such foolishness at the expense of the taxpayers. Others raised the question so often asked of the collecting biologist: "What is the use of all this?" One, an intelligent Hopi Indian, on whose ranch Sumner was trapping, inquired what he intended to do with the mice, and when informed that they were to be taken to California asked, "Why, ain't they got no mice in California?" Sumner found it no more and no less difficult to explain to him, than to the average white man, in some measure the purpose for which the mice were collected. The mice were brought to the Scripps Institution at La Jolla and bred there for many generations. Many thousands of measurements of color, length, area and weight were made. Results of this study published in numerous papers gave Sumner still wider scientific recognition. Only a few of the more important points can be mentioned here.

The different races bred in La Jolla environment did not show increasing resemblance to each other in successive generations. No evidence of inherited direct effects of environment appeared. According to Sumner, the different races appear to have arisen through accumulation of small differences, not essentially different from those between individuals of the same race. As regards color, this accumulation has probably occurred by natural selection of characteristics aiding in concealment of the animals. Many differences, for example, differences in proportions of the body and length of appendages, have no evident adaptive value but they may be morphological expressions of significant physiological differences. High humidity has been regarded by some biologists as directly favoring development of dark pigmentation in the individual. Sumner was at first inclined to accept this view but later became convinced that aerial humidity and soil moisture are chiefly effective only indirectly on the colors of the mouse races by their influence on soil color. The bare, or mostly bare, soil of arid regions is in general pale in color and the light colored animals are less visible there; in

damp regions the soil is darker and dark colored animals are less visible.

Also during the earlier years of the mouse studies Sumner thought that the Mendelian theory of inheritance was not adequate to account for the blending of characteristics when two races were crossed but came finally to accept the concepts of modern genetics, though, as he has admitted, somewhat reluctantly, partly because particulate theories, such as the gene theory, were repugnant to him as they are to some other biologists, and partly because he disliked what he viewed as attempts to get on the bandwagon of Mendelian theory. Chapter XVIII of the "Life History," dealing with the mouse research, is particularly interesting reading, both for biologists and others. One point as regards procedure in such investigations is worth noting. Measurements, particularly biological measurements, which are usually not exact in the physical sense and in which the personal equation is relatively large should not, Sumner believed, be left to assistants, with the investigator considering only the significant results which appear, but should be largely or entirely made by the investigator himself, both in the interests of greater accuracy and in order that he may realize more clearly just what his data mean.

One paragraph from Chapter XVIII of the "Life History," calling attention to some of the unsolved problems of evolution with particular reference to the *Peromyscus* study deserves quotation in full. "Of a certainty, we still know very little about the process of evolution in its details, however sure we may be (and have a right to be) of its actuality. With all our faith in the 'survival of the fittest,' we are rarely able to point out the particular elements of 'fitness' that have enabled a particular type to survive. Nor do we know precisely the hazards which they survive. Why, for example, is one species of *Peromyscus* restricted to three of our southeastern states, while another is so widely distributed that 'it is probable that a line, or several lines, could be drawn from Labrador to Alaska and thence to southern Mexico throughout which not a single square mile is not inhabited by some form of this species' (Osgood)? Why are some species of races restricted to woodland, others to open

country, others to bare rocks, etc.? Because they are especially 'adapted' to these various habitats, we say. Of course, but has anyone taken the trouble to find out what this 'adaptedness' consists in? Presumably we shall be able, in time, to answer some of these questions, but until then much of our discussion of adaptation must remain airy speculation."

The *Peromyscus* researches would undoubtedly have continued throughout Sumner's life if the change in purpose and title of the Scripps Institution for Biological Research into the Scripps Institution of Oceanography had not made abandonment of the entire program virtually obligatory after three years of support by the Carnegie Institution. The abandonment of this research program was deeply regretted by Sumner and was regarded by his biological colleagues as a very great mistake, "a colossal blunder," as one of them has put it. Sumner had made the field his own, had attained results of very great interest and importance as regards inheritance and evolution and there was every promise of further results of no less interest and value. However, in spite of his deep disappointment no time was lost in bemoaning fate. He turned again to the problems of color and its changes in fishes and continued work in that field until his death, this line of investigation being regarded by the directors of the Scripps Institution as within the scope of its function.

He discovered that in addition to the relatively rapid and readily reversible changes of color and pigment pattern in relation to environment, which are due to altered distribution of pigment granules already present in cells of the integument, the total amount of pigment present may undergo increase or decrease more slowly, also in relation to environment and also with the result of decreasing visibility of the fish. These studies involved chemical determinations of amounts of pigment and were carried on with the aid of coworkers. The determinations demonstrated that the dark pigment, melanin, increased in certain fish species kept on increasingly dark backgrounds with uniform intensity of illumination. In the same species the white pigment, guanin, increased in amount when the fishes were kept on increasingly light backgrounds with uniform

illumination. These experiments appear to have established beyond doubt that the factor effective in determining the reaction is the albedo, that is, the ratio between the light reflected from the surface of the background and the incident light by which it is illuminated. Sumner has pointed out that this type of reaction seems to have something in common with the ability of the human being to recognize shades correctly under different lighting conditions. However, neither in the fish nor in man is anything known concerning the mechanism of such reactions.

The conclusion that so-called protective coloration actually protects has been disputed in recent years by various biologists, but Sumner's researches have demonstrated conclusively by actual experiment that protective color does protect. Fishes so pigmented that they were less distinctively visible to the human eye in a given environment were less frequently taken by predatory birds and also by larger predatory fishes than other individuals of the same species so pigmented that they were more clearly visible.

Studies of fish metabolism in relation to temperature were also carried on with coworkers. Sumner was interested in the adaptation or acclimation to high temperatures, in nature, to life in warm springs at temperatures which are lethal to unacclimated individuals. Data of interest concerning the differences in oxygen consumption at the different temperatures and the changes during acclimation were obtained.

In a discussion of "The Naturalist as a Social Phenomenon" at a symposium some years ago (American Naturalist, 74, 1940) Sumner raised the interesting question whether he himself or others would continue research if there were no possibility of publication or other method of communication of the results. He believed that the answer would be an almost unanimous negative, including his own. Moreover, he maintained that even with anonymous publication there would be comparatively little interest in research. This attitude of mind he regarded, not as evidence of selfishness or due to personal vanity but rather as indicating that even the scientific man is a gregarious animal and obtains satisfaction "from the approbation and sympathetic understanding" of his colleagues.

He believed that all science, even the "purest," is completely justified by its value to human life, quite apart from any practical application. No matter how small the contribution of the individual may be, he is heading in the right direction. "But we must recognize the existence of various standards of value other than economic or practical ones. I merely insist upon applying to science the same standards as those which we apply to music, literature, art or religion, namely, their contribution to the life of the whole man, taken in the broadest possible sense. * * * Science is not the handmaid of industry, nor is it a mere intellectual pastime. It is a quest for the facts and principles upon which to erect a true philosophy of life" (Life History, p. 262). Many of the so-called benefits of science, particularly those which have made it possible for larger numbers of human beings to live in a given restricted area he regarded as something other than unmixed benefits to man. One does not know his reaction to the military applications of atomic research.

Mention of some of his many interests outside the fields of his researches serves to throw further light on his personality. He had a deep appreciation of, and love for, undespoiled scenic nature and was particularly attracted to the so-called desert regions of Southern California, Arizona, and New Mexico. The writer shared his feeling and was privileged to be his companion on various trips into these regions. No better companion could be desired. He was an ardent conservationist, was a member of various conservation organizations and wrote and spoke in support of his views. He deeply deplored the waste of natural resources and the substitution of ugliness for natural beauty. The "booster" type was anathema to him. However, he has pointed out that the efforts of conservationists are largely futile. They, like other "reformers," are amateurs. "Their opponents are professionals. How can a few zoologists, botanists and nature-lovers, innocent of the game of politics, make any headway against such eminently practical people as lumbermen, real-estate promoters, cattle and sheep raisers, water-power magnates, sportsmen and ammunition dealers—groups united in the common enterprise of destroying our wild life and our scenic beauty?" (Life History, pp. 225-6).

Closely associated with his views concerning conservation was his firm belief in the necessity of birth control. He held that the United States as well as the world in general is overpopulated and that, without restriction of increase, life must become less worth living. He was no less active against the antivivisectionists, but considered the medical defense of vivisection unjustified or actually disingenuous. He wrote in the "Life History": "Every biologist knows that a large part of the work conducted in our laboratories of physiology and experimental biology has only the remotest relation to questions of health and disease. They (?) relate to fundamental problems or animal life or plant life, and the investigators themselves are seldom thinking of any practical applications of their discoveries. Why must we tell the voters that medical progress is the real object of all such work? Why not try to give them a glimpse into the amazing world of life processes which has been revealed during the past hundred years and point out to them—though this would hardly be necessary—that these things could only have been discovered through the study of living animals, *while living.*" For several years he was a member of the Advisory Board of the Society for the Legalization of Euthanasia. That he stood for freedom of speech and civil liberties goes without saying. Various titles in his bibliography indicate the wide range of his interests. Some time before his death he had a part in establishing a discussion club at La Jolla, including not only members of the Scripps Institution staff but others in the town who were interested. Since his death this has been named the Sumner Club in his memory.

His discussion of "that great welter of contradictory thoughts and emotions which is suggested by the word 'religion'" in Chapter XXIII of the "Life History" reveals his independence of thought and his intellectual honesty as clearly, perhaps, as anything he has ever written. It seems to the present writer a remarkably fine example of straight thinking in a highly confused and controversial field. Concerning his own views, only the following sentences need be quoted. He wrote: "I have long been intrigued by the notion of a creative principle which is itself undergoing evolution. This great chaotic universe,

wasteful, cruel and imperfect in countless ways, is so because both it and its maker are in the process of making. Creation is a vast process of trial and error, and the creator itself cannot foresee a result prior to any experience of this. Such a view divests the creative agent of some of its omnipotence, to be sure, but it seems to me the only alternative to a view which makes cruelty and injustice basic in the organization of the universe."

Sumner's serious concern with many problems of science and social life was balanced by a deeply, though quietly humorous vein which often found expression in the most unexpected ways and was much appreciated by those who knew him. It is evident in his discussions of P. D., the Personal Demon, which he, like most of us, sometimes felt was responsible when things consistently "went wrong," not only in the ordinary concerns of life, but in experimental science. A paper in the Scientific Monthly, entitled, "The Philosophical Basis of Pediatrics," is concerned, not with pediatrics in the usual sense, but with P. D., the Personal Demon. Referring to P. D. on page 292 of the "Life History," he says: "I shall leave to my philosophically minded readers the task of identifying this Personal Demon (The 'P. D.', as some of us familiarly call him in our laboratory) with the famed 'Uncertainty Principle' of Heisenberg and his legion of followers. I am disposed to feel that my discovery, which surely antedates Heisenberg's by several decades, entitles me to full priority in the matter! All that Heisenberg seems to have added is the mathematical garnishing."

Some of Sumner's colleagues have been inclined to regard him as a pessimist. However, what may have seemed to them to be pessimism was evidently nothing more than the dislike of one as honest as he was for much that he saw in the world, even the scientific world, about him. That dislike very commonly expressed itself humorously rather than in bitterness or discouragement. His interest and activity in relation to conservation and other social problems is a sufficient answer to those who considered him pessimistic. Moreover, no thoroughgoing pessimist would or could have devoted himself so whole-heartedly and tirelessly to research in "pure" science as he did. His absolute

scientific integrity has influenced and helped many younger workers, both at the Scripps Institution and elsewhere. The writer of this memoir knew him, not only as a zoologist, but as a good companion and, since his death on September 6, 1945, has felt keenly the loss of a highly valued friend with an extremely interesting mind.

KEY TO ABBREVIATIONS USED IN BIBLIOGRAPHY

Amer. Fish Cult. = American Fish Culturist.

Amer. Jour. Physiol. = American Journal of Physiology.

Amer. Nat. = American Naturalist.

Anat. Anz. = Anatomischer Anzeiger.

Arch. f. Ent. Mech. = Archiv für Entwickelungsmechanik.

Biol. Bull. = Biological Bulletin.

Bull. Bur. Fish. = Bulletin, Bureau of Fisheries.

Bull. Scripps Inst. = Bulletin, Scripps Institution.

Jour. Exper. Zool. = Journal of Experimental Zoology.

Jour. Hered. = Journal of Heredity.

Jour. Mammal. = Journal of Mammalogy.

Jour. Phil. Psychol. Sci. Methods = Journal of Philosophy, Psychology and Scientific Methods.

Mem. N. Y. Acad. Sci. = Memoirs, New York Academy of Sciences.

Physiol. Zool. = Physiological Zoology.

Proc. Nat. Acad. Sci. = Proceedings, National Academy of Sciences.

Psychol. Rev. = Psychological Review.

Sci. Mo. = Scientific Monthly.

Trans. Amer. Fish. Soc. = Transactions, American Fisheries Society.

Trans. N. Y. Acad. Sci. = Transactions, New York Academy of Sciences.

Trans. San Diego Soc. Nat. Hist. = Transactions, San Diego Society of Natural History.

Univ. Calif. Publ. Zool. = University of California Publications in Zoology.

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