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CHARLES MANNING CHILD

1869—1954

A Biographical Memoir by

LIBBIE H. HYMAN

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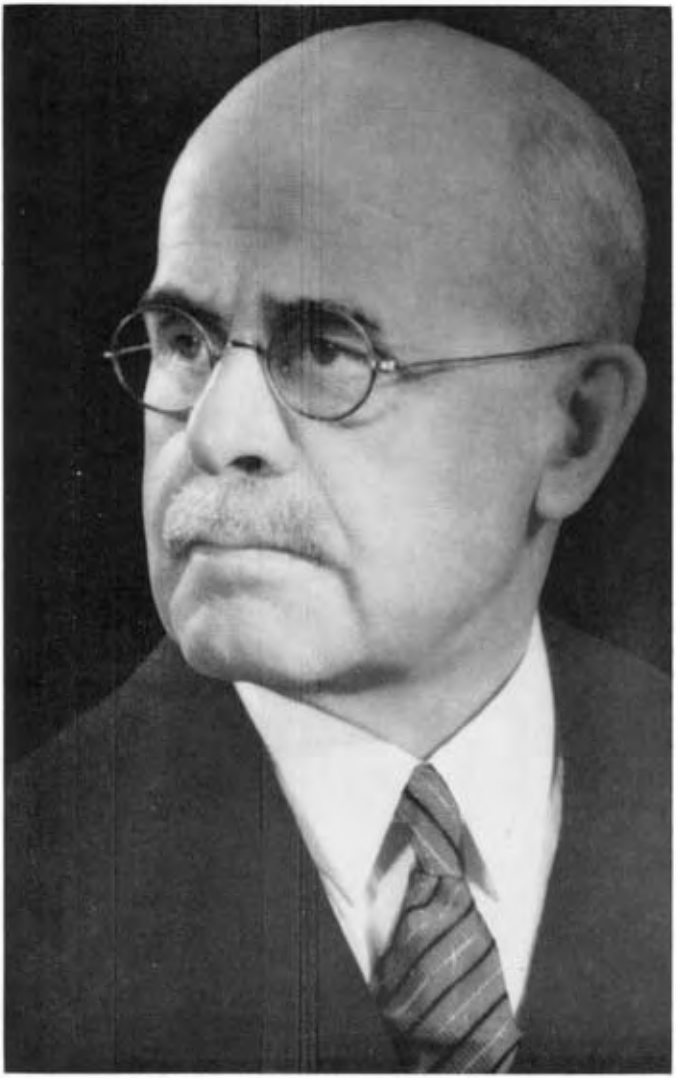

C. M. Child

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CHARLES MANNING CHILD was descended on both sides from sound New England stock. His mother, Mary Elizabeth Manning, belonged to the famous Manning family of New England founded by William Manning, who about 1634 migrated from England to Massachusetts, eventually settling at Cambridge where he left a large number of descendants. Mary Elizabeth's father, William Manning, an eighth-generation descendant of the original William, was a physician of a roving tendency, who practiced during the later years of his life in various towns in Michigan. Mary Elizabeth seems to have had some leaning toward biology, for she attended Mrs. Louis Agassiz's school and Louis Agassiz himself selected a little microscope for her. The Mannings had a manor house in Cambridge, and one of Child's earliest recollections is of being lost in the garden of his great-grandmother's house in Cambridge. The house is part of the Harvard campus now and Coolidge dormitory is built around three sides of it; it was Burgoyne's headquarters during the Revolutionary War.

Mary Elizabeth married Charles Chauncey Child of Higganum, Connecticut, where the Child family had lived for several generations. The family was founded there by James Child, who in 1762 came from Rhode Island and established a shipbuilding business at Higganum. The business was continued by his son James Kelly Child and his two grandsons, Chauncey and Ezekiah Child. In her book *Connecticut River,* Marguerite Allis refers to "the great

ship-building dynasty of Child—three generations of kingpins." During this period the Connecticut River teemed with the building of small wooden sailing ships and there was great rivalry among the various firms. With the fourth generation, that of Child's father, son of Chauncey Child, ships with sails had begun to be supplanted by ships operated by machinery and shipbuilding died out in the region. At the time of Child's birth the Child shipyard had ceased to exist, but the family continued to live in one of the three Child houses with their lawns sloping down to the Connecticut River where the old shipyard had been. Child's father kept a small New England farm that had been owned by the family for several generations; this served merely as a source of food and was not profitable.

Child was born February 2, 1869, at Ypsilanti, Michigan, because his mother desired to be under the care of her physician father, then practicing at Ypsilanti. When the baby was twenty days old she returned with him to Higganum, which was Child's home until the death of his parents. Higganum is a small village on the Connecticut River, the inhabitants of which at the time of Child's boyhood were largely of old New England stock and rather strict in many respects, although some degree of relaxation of the earlier puritanic rigidity was taking place.

Child was the last and only survivor of five sons and hence was reared as an old child and subjected to the most solicitous materal care. His mother, further, was strongly religious and raised the boy according to strict orthodox ideas, including rigorous observance of Sunday, regular attendance at church, and the like. His father, who before his marriage had roughed it to some extent in the Lake Superior country at the time of the discovery of copper there, was not interested in religion but did not interfere with his wife's rearing of the boy.

The home had a considerable library of books and complete files of magazines such as *Scribner's* and *Harper's; Youth's Companion* and *St. Nicholas* were taken for the benefit of the boy.

Child's parents read much, usually spending the evenings in reading, and Child early acquired the habit, reading and rereading the files of the magazines. At an early age he became aware of the beauty of nature and this remained a ruling passion throughout his life. Until he was nine years of age he was taught by his mother, who often talked about Louis Agassiz and awoke in Child a great respect for him. He was encouraged to use the compound microscope selected for his mother by Agassiz, but preceding his high school years did not realize its possibilities. He had few youthful companions and had to invent most of his amusements for himself. His first really active interest in natural science came at about the age of ten through a collection of minerals that his father had accumulated. His father told him all he knew about them and their origins. The granite hills about his home had many pockets of crystalline minerals and several quarries and Child became an ardent collector of minerals.

Child attended the district school at Higganum from 1878 to 1882 and the high school at Middletown, Connecticut, from 1882 to 1886, graduating at the head of his class. During this period of schooling he added the study of systematic botany to the study of minerals. He began to analyze plants and to acquire a herbarium that in the course of time comprised almost a thousand species. With minerals and plants as incentive he explored the whole region about his home, so far as time permitted, often starting out at daylight and returning some three or four hours later. An interest in birds was soon added and he came to know almost all the resident and migrating species by sight and sound. He desired to study and collect insects also but could not afford the books that seemed necessary. During his high school days, D. S. Johnson, later Professor of Botany at Johns Hopkins, whose home was near his, and Lewis Westgate, later Professor of Geology at Ohio Wesleyan, were his companions on many walking and collecting trips. At about twelve years of age he became a member of the Agassiz Association sponsored by *St. Nicholas Magazine,* and after entering high school

became an active member of the chapter there with Westgate and Edward Rice, later Professor of Zoology at Ohio Wesleyan. Thus during high school years Child was particularly interested in natural science and had little interest in Latin and Greek except as he began to see something of the relation of these languages to English. Mathematics was not difficult for him and he was somewhat impressed by geometry but not keenly interested. During these years he lived at home, making the ten-mile trip to and from school daily by railroad. At home he assisted about the place when not studying and spent most of his vacations in miscellaneous work with his father. During the summer he usually took a camping trip down the river to Long Island Sound and a trip to New York on a steamboat whose captain was a neighbor. On the New York trips he was wont to visit the zoo and the American Museum of Natural History.

Child entered Wesleyan University at Middletown in the autumn of 1886. During his college years he had to live at home and go to classes daily by train because his father had become somewhat disabled by a slight cerebral hemorrhage about the time that Charles entered college; he also had to look after the farm, milking the cows night and morning and doing anything else that was possible in the intervals of study and during week ends. He scarcely knew most of his classmates and had no college life. During his college years he was greatly interested in chemistry and found it difficult to decide whether chemistry or zoology attracted him most strongly, but he eventually decided on zoology. He held the Seney scholarship for high standing during his sophomore, junior, and senior years and was elected to Phi Beta Kappa. He graduated from Wesleyan with the Ph.B. degree in 1890 and took the M.S. degree there in 1892, having served as graduate assistant in biology at Wesleyan from 1890 to 1892.

By this time his parents had died and Child, then 23, sold the old home to a friend and betook himself to the University of Leipzig; there he remained until 1894, living the genial life of a German

university student of those golden days, attending concerts, operas, and plays as well as classes. During his college years he had become greatly interested in the nervous system, and his first piece of original work, published in the *American Naturalist* in 1892, concerned the functions of the nervous system of the Myriapoda. His interest in the nervous system led to a considerable inclination toward psychology. Consequently, soon after arriving in Leipzig, he worked for a semester in Wundt's laboratory of experimental psychology; but feeling somewhat disappointed in his experience there, he returned permanently to the zoological laboratory, then headed by Rudolph Leuckart, under whom he took the Ph.D. degree in 1894. His doctor's thesis was, rather surprisingly, purely morphological, dealing with the histology and innervation of a sense organ on the antennae of lower Diptera. This piece of work, published in the leading German journal of zoology, still remains a standard reference in entomological works. Following the completion of his doctorate, Child immediately began independent research in experimental zoology while he held the Agassiz table at the Naples Zoological Station.

Returning to the United States, Child became a member of the zoological staff, being organized by C. O. Whitman, of the new University of Chicago, and remained with that institution throughout his active academic life. He was zoological assistant there from 1895 to 1896, associate from 1896 to 1898, instructor from 1898 to 1905, assistant professor from 1905 to 1909, associate professor from 1909 to 1916, and professor from 1916 until he reached the retiring age in 1934, when he became professor emeritus.

At the University of Chicago, Child gave an outstanding undergraduate course in invertebrate zoology that was far more comprehensive than the usual university course in this subject. He also conducted seminars for graduate students in subjects that interested him and in which he was well informed. Although he was an able lecturer, he was primarily an experimentalist and in his early years at the University he spent his summers at the Marine Biological

Laboratory at Woods Hole, Massachusetts, engaging in research and teaching as instructor in embryology in 1895-1896. During this period he studied the problem of cell lineage, that is, the tracing of the fate of each cell of the early embryo, using as material the annelid *Arenicola.* Cell lineage was at that time occuping the attention of a group of men including C. O. Whitman, E. G. Conklin, and F. R. Lillie, all of whom worked at Woods Hole, and with Child came to be ranked among the most distinguished zoologists of the United States. Their articles on cell lineage remain among the outstanding contributions to zoology emanating from this country, and Child's work, published in 1900, was of the same high order of merit as that of the others in the group. However, even at this early date Child already revealed his trend toward organicism by recognizing with Whitman the inadequacy of the purely cellular theory of development derived from the studies of cell lineage.

It was while teaching at Woods Hole in 1895 that Child met, as a member of his class, Lydia Van Meter, the charming and cultured daughter of John Van Meter who was for a long period dean and acting president of Goucher College, Baltimore. Child and Miss Van Meter were married in 1899. This was a very fortunate and happy example of married devotion and mutual understanding. The union produced one daughter, Jeannette Manning Child, now Mrs. Alexander Findlay, who resides in Washington with her husband and three children.

About 1900 Child began the long series of experiments on the regeneration of coelenterates and flatworms that was to continue through much of his career. These experiments were conducted mainly at the University of Chicago but in part at Naples, where he held the Smithsonian table in 1902 to 1903, and in part on the coast of California. Although for some years Child went to Woods Hole occasionally during the summer he much preferred the marine stations of the Pacific coast, partly because more suitable material for his researches was obtainable at them. During the decade from 1900 to 1910 Child published around forty articles on regeneration

in leading American and German journals. He constantly sought for some governing factor in regeneration and for some years believed the transformation of a piece into a normal whole resulted from tensions and activities, eventually from its acting functionally like the missing parts, or, broadly conceived, that the organism is constructed by functioning. About 1910 he began to perceive that the unity of the organism is a matter of correlation; his search for the mechanism of correlation led to the gradient theory which emerged about 1911 and with which his name will always be associated. The numerous researches he conducted on the regeneration of planarians from 1910 to 1915 led him to the concept of the existence in such simple axiate organisms of a gradation in rate of physiological processes along the axis. In this gradient Child believed he had found the mechanism of correlation by which the mass of cells that constitutes an animal is maintained as a unified whole of definite form and construction. The chief factor in correlation is antero-posterior dominance, i.e., each level dominates the region behind and is dominated by that in front.

By 1911 Child had become so well known as a leader in the study of morphogenesis that he was invited by W. Roux to participate in a series he was editing called *Vorträge und Aufsätze über Entwicklungsmechanik*. Child's contribution to this series was a small volume of 157 pages entitled *Die physiologische Isolation von Teilen des Organismus als Auslösungsfaktor der Bildung neuer Lebewesen und der Restitution*. In this he developed his concept of antero-posterior dominance with special reference to distance diminution of the dominance, permitting parts sufficiently distant from the dominant anterior end to escape from that dominance and establish themselves as new individualities, buds, zoids, and the like. He termed such escape from dominance physiological isolation and brought forward a wealth of supporting facts. Much the same ground was covered in an outstanding book, *Individuality in Organisms,* published at Chicago in 1915. Here he clearly pointed out that the characteristics of the organic individual—definite size,

form, structural pattern, and correlation of activities—are maintained by transmission of dynamic change along the axis. Such a gradient in transmission of excitation represents the simplest expression of unity and order in protoplasm and is the simplest axis of polarity and symmetry; along such a gradient a relation of dominance and subordination exists because the most active region dominates the others. Regeneration is fundamentally the same as embryonic development, consisting in the formation of the apical dominant region first and then the appearance of other parts in correlation with this.

In 1915 also appeared the volume *Senescence and Rejuvenescence* in which the foregoing concepts and experiments based upon them were applied to phenomena of aging and rejuvenescence. Other books growing out of the fundamental idea of a transmissive gradient as the basis of various properties of the organism were *The Origin and Development of the Nervous System from a Physiological Viewpoint,* Chicago, 1921, and *Physiological Foundations of Behavior,* Chicago, 1924.

From about 1915 Child devoted his researches to the demonstration of the existence of physiological gradients in a great variety of materials, plant and animal, adult and embryonic. The method consisted in placing the organism in a lethal solution and observing the progress of death and disintegration, which were found to correlate definitely with the axes of the organism. Originally Child employed potassium cyanide as a disintegrative agent because this substance was known to inhibit oxidative processes; hence, Child reasoned, the most active parts of the organism must be most susceptible to it, the least active the least susceptible. Thus the organism when placed in suitable concentrations of cyanide displays a susceptibility gradient, not dying all at once, but each level dying in correlation with its preceding rate of metabolic activity. Later Child found that a great variety of agents and conditions would give evidence of the existence of a quantitative gradation of rate of activity along the main axis of axiate organisms. Additional evi-

dence to the same effect was obtained by exposure to various dyes which were found to stain the organism differentially with respect to the axis.

Out of this experimental work grew various subsidiary ideas, notably the concepts of differential recovery and differential inhibition. Regions of highest activity are the most susceptible to lethal concentrations of agents but they also have the greatest power of recovery in non-lethal concentrations; or concentrations may be found that inhibit active regions to a greater extent than less active ones. By applying agents to embryonic and regenerating materials, many modifications resulted that were interpretable as expressions of differential inhibition or differential recovery and that attested to the morphogenetic importance of the physiological gradients. Especially striking was the wide range of embryonic forms obtainable by these methods applied to echinoderm embryos and the like.

In the late twenties Child began to feel the need of a journal for the publication of researches of the type he was engaged upon and with the cooperation of the University of Chicago Press he founded the journal *Physiological Zoology,* of which the first number appeared in 1928. Child was editor of this journal until it was taken over by the assistant editor, W. C. Allee, during Child's absence in Japan. The journal became an outlet for many of his later researches and has attained status as a leading publication in experimental zoology.

Child's bold and original ideas did not fail to attract international attention and he was frequently invited to teach and lecture at other institutions. He was visiting professor at Duke University in 1930 and visiting professor of the Rockefeller Foundation at Tohoku University, Sendai, Japan, in 1930-1931. He and Mrs. Child never forgot this year in Japan where they were delighted with the courtesy and kindness of the Japanese people, the artistic productions of the country, and the beauty of the landscapes. Here Child became acquainted with Y. Watanabe who assisted him in researches in Japan and later came to the United States as his research assistant.

In 1934 Child reached the age of retirement at the University of Chicago but was asked to remain for a few years as chairman of the department. In 1937 he retired with Mrs. Child to California where they eventually settled in Palo Alto, acquiring a home there. Child then became a welcome and highly esteemed guest in the Zoology Department of Stanford University and a familiar figure on its campus. He frequently attended the biology seminars and reported at them from time to time. He participated in many classes as guest lecturer, especially in invertebrate zoology, parasitology, and experimental embryology, and in the last course gave a series of lectures annually on the gradient theory. He enjoyed the sunny and pleasant room that had been provided for his use on the mezzanine of Jordan Hall and there he was usually to be found experimenting or typing. The writer visited him there in February, 1953, and found him peering into finger bowls of embryonic specimens.

His first years at Stanford were largely spent in writing his last book, a large volume entitled *Patterns and Problems of Development* published in 1941 by the University of Chicago Press. This was a summary of his lifework, giving the accumulated evidence for the existence of physiological gradients, the means of demonstrating them, and their role in development and regeneration. This outstanding volume with its wealth of references forms an indispensable guide to Child's philosophy of the organism.

Experimental work was continued whenever possible. The proximity of Stanford University to the marine station at Pacific Grove permitted Child to obtain ample material of echinoderm and other eggs and to pursue his researches on the modification of development by various agents, especially agents of oxidation and reduction in which he had become particularly interested in his later years. He often went to the marine station to experiment there or would carry material and sea water back with him to Palo Alto. In his last years at Stanford arrangements were made for material to be sent to him from Pacific Grove or brought up by individuals driving back from the station. At Stanford also an abundance of

material was made available to him by other members of the staff, as fruit fly ovaries, salamander embryos, and eggs of fish and seaweeds. Publication on the results of these researches was continued up to the last year of his life; hence he remained to the end an experimenter whose curiosity and interest were inexhaustible.

In December, 1953, Child wrote to a friend that he was working on a general paper that was to cover in condensed form the same ground considered in the book *Patterns and Problems of Development,* which by then had gone out of print. He wanted in this article to emphasize the main points that he thought might have become lost in the mass of data in the book. In April, 1954, he wrote that the article had become a small book into which he was gathering the material of his more important papers of the last 60 years, together with the work of his students and assistants, emphasizing the high lights of his ideas. The book was to be called *Physiological Factors in Organization and Reorganization.* In September, 1954, he again wrote to the same friend that he was working on the figures for the book and on December 2 that he was very weak but still hoped to complete the book. However, this was not to be and the book was left incomplete at his death, lacking the placing of, and captions for, the figures.

Child's scientific career may be summed up by saying that he concentrated on a courageous frontal attack on the central problem of biology, that of organization, how in the organism, structurally composed of a mass of cells of various sorts, there is achieved pattern, order, unity, and correlation of activities. His solution of this problem, that of a gradation in rate of physiological processes, resulting in a relation of dominance and subordination, may not stand, but at least he saw clearly, as did few zoologists of his time, the nature of the problem. The validity of the great mass of facts he assembled cannot be questioned and these facts must contribute permanently to zoological theory and interpretation.

Child was a member of the American Society of Zoologists, the American Association of Anatomists, the American Society of Nat-

uralists, the American Physiological Society, the Western Society of Naturalists, the Society of Experimental Biology and Medicine, and the Marine Biological Association, Woods Hole. He was a fellow of the American Association for the Advancement of Science and in 1929 served as vice-president of section F (Zoology) of this Association. He was president of the American Society of Zoologists in 1919 and was elected to the National Academy of Sciences in 1935. He was also a foreign member of the Linnaean Society of London and an honorary member of the Société Royale Zoologique de Belgique. He was honored by his alma mater, Wesleyan University, on the occasion of the dedication of its new biological laboratory on October 12, 1928. This Shanklin Memorial Laboratory of Biology had been erected by the family and friends of the former president of Wesleyan, William Shanklin. On this occasion Child delivered the dedicatory address, "The Individual as a Biological Problem," and received the honorary degree of Doctor of Science. Following his final departure from Chicago, Child was honored by the dedication of a commemorative number (April, 1938) of the journal that he had founded, *Physiological Zoology*. This number was made up of research articles by his former students and also contained an annotated bibliography of his publications to 1937 compiled by the writer with the assistance of C. D. Van Cleave.

As natural to a boy brought up along a great river, Child was an adept swimmer, skater, and handler of sailboats, and enjoyed these recreations whenever opportunity afforded. At Chicago he was accustomed to skate in winter on the lagoon of Jackson Park, not far from the University. A ruling passion of his life, however, second only to his passion for biological investigation, was a love of nature. He has recorded among his earliest recollections watching the fall of snow, the ripples of the river, and the reflections in it of hills and clouds. After moving from the New England area he found his greatest pleasure in walking in the country. He was a big man of strength and endurance and easily capable of hiking twenty-five to thirty miles a day. At Chicago he regularly walked in the forest

preserves of Cook County and in the sand dune area of Indiana on week ends, and during summer vacations usually went with a male friend to the national parks of the United States and Canada where he generally took the trails leading away from the frequented areas, carrying a sixty-pound pack of camping equipment that permitted him to camp out for days. He was an ardent lover of mountain scenery. Shortly before leaving Chicago he became interested in photography and began accumulating photographs of the scenes he knew well and loved so well. These photographs were beautifully composed and beautifully executed from a technical standpoint. Long before moving to California, Child had become familiar with the Sierra Nevada range of that state, and after he took up residence in Palo Alto he enjoyed regular excursions into these mountains. He introduced many of the members of the zoology staff at Stanford to the beauties of the Sierras, and greatly enjoyed analyzing the geology of the formations and studying the movements of the clouds on the peaks. He would drive his car into the foothills, then start out climbing, walking eight to ten miles. He continued to climb mountains up to a few years before his death. In September, 1947, at the age of 78, he wrote in a letter that he had been out for four days, going over Sonora Pass, hiking in Owens Valley, and ascending to 10,000 feet. He thought he would be able to climb Mt. Whitney. This was about his last trip to the high country. After this he began complaining that his knees could not stand mountain climbing any longer, although in 1951 at the age of 82 he was still able to walk four or five miles on level ground. He now began to enjoy the photographs of places to which he could no longer go; in fact, in his younger days he jokingly said he was accumulating these photographs for his old age. All his life he had enjoyed reading books about travels and mountaineering in places which he had been unable to visit. He loved to recall and reminisce about his visits to mountains in various parts of the world.

In November, 1952, he began to suffer from a bony tumor on the left collarbone shown by biopsy to be caused by a metastasis

from a primary cancer of the left kidney. This tumor was removed in February, 1953, and he made a good recovery. These circumstances unfortunately spoiled a surprise party that had been planned for his eighty-fourth birthday by the Zoology Department at Stanford. Contact had been made with a host of friends, colleagues, and former students and these had been asked to send in congratulatory letters. A book bound in soft red leather and composed of blank vellum sheets to which the letters were to be attached had been prepared for the occasion, but because of the operation all festivities were canceled. Child, however, was very pleased with the book and letters. The cancerous kidney was considered inoperable but Child felt quite well after the operation and continued to experiment and to write up his researches for some time; but in June, 1954, the cancer again manifested itself in a soft mass on the right shoulder. Child continued to work desperately on the small book already mentioned that he still hoped to finish. The operation, performed October 24, 1954, was very severe and extensive and a huge mass of tissue was removed. Following the operation Child weakened steadily and passed away at the hospital on December 19, 1954, at the age of 85. The body was cremated without services and the ashes were sent to the Van Meter family lot in Green Mount Cemetery, Baltimore.

Child was a man of great natural reserve and dignity and hence not easy of acquaintanceship. However, once convinced of the worth of the other person, he formed firm and enduring friendships and suffered much by the death of men friends through the years, especially those who had often accompanied him on camping trips in the mountains. He adhered to the highest ideals both in his personal life and in his scientific work. His devotion to science was of the purest sort and was unmarred by personal ambition or striving for fame and position. He conducted his life and his scientific work on the same high plane as the mountains he so passionately loved.

KEY TO ABBREVIATIONS

Am. J. Bot. = American Journal of Botany
Am. J. Physiol. = American Journal of Physiology
Am. J. Psychol. = American Journal of Psychology
Am. Nat. = American Naturalist
Anat. Anz. = Anatomischer Anzeiger
Anat. Rec. = Anatomical Record
Ann. Clin. Med. = Annals of Clinical Medicine
Ann. Mag. Nat. Hist. = Annals and Magazine of Natural History
Annot. Zool. Japon. = Annotationes Zoologicae Japonenses
Arch. Ent. Mech. Organ. = Archiv für Entwicklungsmechanik der Organismen
Arch. Int. Med. = Archives of Internal Medicine
Arch. Neurol. Psychiat. = Archives of Neurology and Psychiatry
Biol. Bull. = Biological Bulletin
Biol. Centralbl. = Biologisches Zentralblatt
Biol. Gen. = Biologia Generalis
Biol. Lec. Marine Biol. Lab. Woods Hole = Biological Lectures of the Marine Biological Laboratory, Woods Hole, Mass.
Bot. Gaz. = Botanical Gazette
Bull. N. Y. Acad. Med. = Bulletin, New York Academy of Medicine
Int. Congr. Zool. = International Congress of Zoologists
J. Am. Med. Assn. = Journal of the American Medical Association
J. Comp. Neurol. = Journal of Comparative Neurology
J. Exp. Zool. = Journal of Experimental Zoology
J. Morph. = Journal of Morphology
Nat. Acad. Sci. Biogr. Mem. = National Academy of Sciences Biographical Memoirs.
Peking Nat. Hist. Bull. = Peking Natural History Bulletin
Physiol. Zool. = Physiological Zoology
Proc. Am. Phil. Soc. = Proceedings, American Philosophical Society
Proc. Nat. Acad. Sci. = Proceedings, National Academy of Sciences
Proc. Roy. Soc. London = Proceedings, Royal Society of London.
Proc. Soc. Exper. Biol. Med. = Proceedings, Society for Experimental Biology and Medicine.
Pub. Am. Assn. Adv. Sci. = Publications of the American Association for the Advancement of Science
Pub. Am. Sociol. Soc. = Publications of the American Sociological Society
Pub. Puget Sound Biol. Sta. = Publications, Puget Sound Biological Station
Sci. Rept. Tohoku Univ. = Science Reports, Tohoku University
Smithson. Misc. Coll. = Smithsonian Miscellaneous Collections
Trans. N. Y. Acad. Sci. = Transactions, New York Academy of Sciences

Zeit. Wiss. Zool. = Zeitschrift für Wissenschaftliche Zoologie
Zool. Anz. = Zoologischer Anzeiger
Zool. Bull. = Zoological Bulletin

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