in addition was required to perform the rough groundwork of reviving the Division of Mineral Technology. Without guidance, he set up a plan of organization for the development of these varied collections, but the implied necessity of implementing the organization with additional staff brought it an unenthusiastic reception. The plan recognized the threefold substance of the work: the custodial, or preservation of government-owned relics as required by law; the exhibition for public education and information (as well as for Institutional advertisement and public relations); and, in his mind most important, the development of record study collections of authenticated specimens of all of the industrial raw materials and foods. He included in the last the study collections of models and machines representing important inventions. Applied to his very broad field, the plan imposed a large task on him. With several sections of it in able hands, still too much was left for one man. That he did so well with all of it is a tribute to his skill and industry.

World War II shifted the emphasis from the development of the collections to the immediate and effective use of the collections and the expert skills of the staff. The Department performed creditable service in an almost incredible variety of ways. Practically every collection was consulted for solutions of problems and ideas on materials and processes to wage the war effectively. Wasteful reinvention of older ideas was frequently made unnecessary by the existence of an example of the old item, or the time for development was shortened if an old idea was found to be a solution.

Since the cessation of hostilities the Department's work is returning to normal. Collections have been returned from protective storage, and staff members are returning from service. The objective for the future is a department of national significance, with staff and sections adequate to the purpose of establishing the National Museum of Engineering and Industry.

A Century of Progress in Smithsonian Biology

Remington Kellogg
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THE SMITHSONIAN INSTITUTION from the very first was specifically charged with the responsibility for maintaining a museum. In December 1850 Assistant Secretary Baird submitted to Secretary Henry a detailed program of museum activities, which included provisions for the stimulation of scientific research and for scientific and educational publications. As specified in the original endowment, the Institution was founded "for the increase and diffusion of knowledge among men." Since the financing of "explorations in descriptive natural history" was the sole biological objective listed by Secretary Henry in the fall of 1847, when he presented the plan for the organization of the Institution under the terms of the Smithson bequest, the sponsored research was naturally in accord with this directive. To increase the existing knowledge of animal and plant life, various steps were taken to stimulate the collection of such materials and to encourage original investigations by competent workers. To diffuse the knowledge that resulted from studies on these collections, the Institution made provision for assistance in the preparation of illustrations and for the publication of monographs, revisions, and preliminary papers.

The descriptive zoologist or botanist is concerned primarily with establishing the diagnostic characters that differentiate living forms. By assembling for minute comparative study large series of specimens, all uniformly prepared or preserved, from all possible localities, taxonomists have been enabled constantly to advance human knowledge. Consequently, the descriptive phase of natural history is by no means static, since the relative importance of characters selected as having diagnostic significance is continually being scrutinized.

The accumulated studies on the collections thus provide a means of measuring the progress made in this branch of biology during the past 100 years under the sponsorship of the Smithsonian Institution. The natural-history collections assembled under the auspices of the Smithsonian were originally largely North American, but in the course of time expeditions were sent to all parts of the world. Study of these materials, as here described, has helped to elucidate the floras and faunas of these regions. Since these contributions to natural history have resulted from investigations made by staff members, collaborators, and others aided by the Institution, it will be convenient to review the progress in the 10 divisions whose curators have had the responsibility for the improvement and care of the collections.

Mammals

Shortly after entering on his duties as assistant secretary in 1850, Spencer F. Baird brought his private collection to Washington, from Carlisle, Pennsylvania, and about the same time the Smithsonian Institution appro-

priated a small amount for activities related to natural history. Baird was able also to have surgeons and field naturalists assigned to the various government explorations and surveys that preceded the construction of the first transcontinental railroads, and from them, as well as from other expeditions to which the Institution contributed financial support, voluminous collections were received. To these two sources were added in 1858 by transfer from the Patent Office the mammalian materials collected by the U. S. Exploring Expedition (Wilkes, 1838–42), and other early government collections were received in 1861–62, when the National Institute was dissolved. Baird utilized these combined collections in the preparation of his "North American Mammals" (1857), which for more than 30 years constituted a standard reference work.

To increase the knowledge of natural history Baird obtained the cooperation of most of the competent American naturalists of that time, including Harrison Allen, who in 1864 published his monograph on North American bats. In the early 1860's, when Theodore N. Gill, eminent as an ichthyologist, was young and ambitious, he commenced the preparation of a series of synoptic reports on the vertebrates. Although this work was never completed, Gill did publish reports on the seals (1866), sperm whales (1871), and insectivores (1875). The most comprehensive of these studies was his arrangement of the families of mammals (1872).

An examination of the Annual Reports of the Institution shows that no one was directly in charge of the collection of mammals prior to 1879 and that they were probably cared for personally by Baird. During that year the U. S. National Museum was organized by G. Brown Goode in accordance with instructions from Baird, and Elliott Coues was designated as curator of Mammals without compensation. Coues had previously written an account of the fur-bearing mammals (1877) and in coauthorship with J. A. Allen a quarto tome entitled "Monographs of North American Rodentia" (1877).

In 1881, Frederick W. True, librarian of the National Museum, became acting curator of Mammals, a post he held until 1908. He had been designated head curator of Biology on 1 July 1897, and had charge of the library and exchanges as assistant secretary of the Smithsonian Institution from 31 May 1911 until his death on 25 June 1914. True achieved world-wide recognition for his cetacean researches, of which the most notable were the reviews of the dolphins and smaller-toothed whales of the family Delphinidae (1889), the whalebone whales of the western North Atlantic (1904), and the beaked whales of the family Ziphiidae (1910).

Gerrit S. Miller, Jr., came to the National Museum in 1898 from the Bureau of Biological Survey and until his retirement at the end of 1940 had the actual responsibility of caring for the mammal collection. During those 42 years Miller took a leading part in the general advance of mammalogy. He was the author of nearly 400 publications, dealing for the most part with mammals and including "The families and genera of bats" (1907), "Mammals of Western Europe" (1912), "North American Recent mammals" (1924), and with Glover M. Allen the "American bats of the genera Myotis and Pizonyx" (1928).

Leonhard Stejneger was a member of the commissions that investigated for the U. S. Government the fur-seal herds of the North Pacific in 1895, 1896, and 1897. In 1922, at the request of the Department of Commerce, he visited again the northern fur-seal rookeries to determine the changes that had taken place since the international agreement of 1911.

Other important contributions[1] were made by Marcus Ward Lyon, Jr., who was appointed aid in the Division of Mammals in 1898 and resigned as assistant curator in 1912. While a member of the staff Lyon completed for publication the "Classification of the hares and their allies" (1904) and the "Treeshrews: an account of the mammalian family Tupaiidae" (1913). Ned Hollister transferred to the division from the Bureau of Biological Survey in 1910, but in 1916 he became superintendent of the National Zoological Park, a position he held until his death in 1924. Hollister's capacity for straight thinking is best shown in his taxonomic revisions of the muskrats, minks, grasshopper mice, and prairie dogs. His major contribution is generally considered to be "East African mammals in the United States National Museum" (1918–23).

For his explorations in the Malay Archipelago and elsewhere between 1888 and 1923, William L. Abbott will be classed among the most interested and generous benefactors of the Smithsonian Institution, and although he did not engage in taxonomic studies, large collections of natural-history specimens were made available by his efforts to those who were so interested. Edgar Alexander Mearns, who was associated with the Institution for many years as a collaborator, not only was the collector of large numbers of mammals and birds but also published one volume on "Mammals of the Mexican boundary of the United States" (1907).

Birds

For many years, during the formative period of American ornithology, the center of systematic studies on North American birds was located at the Smithsonian, where through the efforts of Baird the first large North American bird collection was assembled. Included among the older publications on birds that had considerable influence in stimulating and advancing the study of ornithology were "Birds of North America" (1858), by Baird, and the revised edition (1860) under the same title but published under the joint authorship of Baird, John Cassin, and George N. Lawrence.

A considerable number of bird students were given facilities for study by Baird, and one of these was Elliott Coues, an accurate worker noted for fluency and versatility in writing and the author of "Key to North

[1] Remington Kellogg, author of this article, came from the Bureau of Biological Survey to the Division of Mammals in 1928 as assistant curator, succeeding to full curatorship at the retirement of Mr. Miller in 1940. Dr. Kellogg's principal contributions to mammalogy have been concerned with marine mammals, both fossil and Recent. Also, he has participated in several international conferences on the regulation of whaling.—Editor.

American birds'' (1874), which subsequently passed through five editions. The bird biographies prepared by Coues for his ''Birds of the Northwest'' (1874) are still considered to be among the best.

After serving an apprenticeship from 1867 to 1869 as zoologist with the Geological Survey of the 40th Parallel under Clarence King, Robert Ridgway became a regular member of the Smithsonian staff. At first Ridgway was given the exacting task of preparing the technical descriptive material and certain of the illustrations for the treatise entitled ''History of North American birds'' (1874–84), which appeared under the co-authorship of Baird, T. M. Brewer, and Ridgway. Subsequently, ''A manual of North American birds'' (1887) was published by Ridgway, and a few years later he commenced work on the monumental ''Birds of North and Middle America'' (8 vols., 1901–19), which, however, was not completed during his lifetime. Dissatisfied with the inadequacy of the color terminology employed in technical descriptions of birds, Ridgway devised a plan for standardization of the named colors. The first edition was issued under the title ''A nomenclature of colors for naturalists'' (1886) and a second, more comprehensive edition, ''Color standards and color nomenclature'' (1912), was underwritten by the author aided by his friend José C. Zeledón, of Costa Rica.

During the early years of his association with the National Museum, Leonhard Stejneger devoted considerable time to avian studies. In addition to those dealing with the Japanese and Hawaiian avifauna, Stejneger made important contributions to ornithology in ''Outlines of a monograph of the Cygninae (swans)'' (1882), ''Results of ornithological explorations in the Commander Islands and in Kamtschatka'' (1885), and ''Natural history of birds'' in the Standard Natural History (1885).

Charles W. Richmond successively advanced from aid to curator in the interval between 1893 and 1932. Most of his life was devoted to bibliographic research. Aside from an unpublished card index of avian scientific names, which currently is widely used as a research tool, Richmond will be remembered for several installments of ''Generic names applied to birds'' (1902–27).

Extensive contributions to our knowledge of the birds of Eastern Asia, Malaya, the East Indies, and the Philippines have been made by members of this Division. Joseph H. Riley, who joined the staff as aid in 1896 and subsequently was promoted to assistant and associate curator, worked first with West Indian birds and then became a specialist on far eastern birds, particularly those of Mongolia, China, Siam, Malay Peninsula, northern Celebes, and islands off Sumatra and Borneo. Charles W. Richmond and Harry C. Oberholser, of the Bureau of Biological Survey, published a number of reports on the large collections of birds made by W. L. Abbott in the Dutch East Indies. Collections made by Abbott also formed the basis for ''The bird fauna of the West Sumatran Islands'' (1944) by S. Dillon Ripley. With firsthand information gained from two years' experience in the field (1935–37), Herbert G. Deignan, associate curator of Birds, wrote ''The birds of northern Thailand'' (1945). Edgar Alexander Mearns, associate in zoology, summarized the results of his field experience in eight papers on Philippine birds (1905–16).

The most comprehensive studies on the birds of some of the larger West Indian islands have been made here. Alexander Wetmore, secretary of the Smithsonian Institution, has reviewed the avifauna of two of these islands in ''Birds of Porto Rico'' (1927–28) and in joint authorship with B. H. Swales, ''The birds of Haiti and the Dominican Republic'' (1931). While a staff member of the Bureau of Biological Survey, Wetmore obtained the field data for his ''Observations on the birds of Argentina, Paraguay, Uruguay, and Chile,'' published by the Museum in 1926. Numerous contributions to the paleoornithology of North America have also been made by Wetmore.

Herbert Friedmann, who accepted the curatorship of Birds in 1929, has published reports on the birds of Ethiopia and of Kenya Colony (1930, 1937), and since the death of Ridgway has continued the publication of ''Birds of North and Middle America.''

During September 1883, Charles Emil Bendire accepted Baird's invitation to organize the collection of bird eggs, a task he continued to perform as honorary curator of the Department of Oology until his death in 1897. Bendire collated all available data in ''Life histories of North American birds, with special reference to their breeding habits and eggs'' (1892–95). On the death of Bendire, William L. Ralph was appointed custodian of the egg collection, and following the latter's death in 1907 these duties were assumed by the curator of Birds. More recently, Arthur Cleveland Bent, collaborator, has attracted wide notice for his comprehensive ''Life histories of North American birds,'' of which 14 volumes have now been published by the National Museum.

Reptiles and Amphibians

In the decade notable for exploration, large numbers of reptiles and amphibians were received from the field naturalists of the various government parties surveying the United States and Mexican Boundary and the parallels for a transcontinental railway. Consequently, work was begun without delay by Baird and Charles Girard on the herpetological collections, and by 1853 the ''Catalogue of North American reptiles in the Museum of Smithsonian Institution'' was published. Girard subsequently (1858) published the volume on herpetology for the U. S. Exploring Expedition (Wilkes, 1838–42), while Baird was the author of the ''Reptiles'' of the United States and Mexican Boundary Survey (1859).

Edward Drinker Cope, the master naturalist in the estimation of Henry Fairfield Osborn, began his studies on the herpetological collections of the Institution in 1860, and for many years thereafter incoming collections were sent to him for study and report. As a result of this collaboration, the Smithsonian Institution published for Cope ''The Batrachia of North America'' (1889) and ''The crocodilians, lizards and snakes of North America'' (1900).

When the National Museum was organized in 1878, Henry Crecy Yarrow, an Army surgeon whose time was largely taken up by official duties at the Army Medical Library, was induced by Baird to serve as honorary curator of Herpetology, a post he felt impelled to relinquish in March 1889. Prior to this, Yarrow had prepared two reports on herpetological collections made while detailed as surgeon and naturalist to the U. S. Geographical and Geological Explorations and Surveys west of the 100th meridian. The main task undertaken by Yarrow at the Museum was the preparation of the "Check list of North American Reptilia and Batrachia, with catalogue of specimens in the U. S. National Museum" (1883).

From March 1889 until February 1943, the Division of Reptiles and Batrachians was supervised by Leonhard Stejneger. Among the sound and carefully considered contributions to that branch of zoology, which made Stejneger one of the world's foremost authorities, were "The poisonous snakes of North America" (1895), "The herpetology of Porto Rico" (1904), and "Herpetology of Japan and adjacent territory" (1907). Although his scientific investigations were curtailed somewhat by administrative responsibilities after 1911, when he succeeded F. W. True as head curator of Biology, Stejneger was engaged for many years in the preparation of a general revision of North American turtles, but only one section of this study, entitled "Notes on the American soft-shell turtles with special reference to *Amyda agassizii*" (1944), was completed for publication. Because of his wide knowledge of systematic zoology and his ability as a linguist, Stejneger took a prominent part in the formulation of the code of zoological nomenclature, beginning with the Fifth International Zoological Congress, held at Berlin in 1901.

Doris M. Cochran became aid to Stejneger in 1919 and in the ensuing years was promoted through the grades to associate curator in charge, Reptiles and Batrachians, in March 1943. In addition to a number of shorter articles, she is the author of "The herpetology of Hispaniola" (1941).

Fishes

After having shown marked aptitude for scientific work as a student and as assistant of Louis Agassiz, in the fall of 1850 Charles Girard began his association with the Smithsonian, where for 10 years he was Baird's principal assistant, preparing reports on the cold-blooded vertebrates received from government sources. Girard was the author of 42 papers on fishes, including a study of North American minnows (Cyprinidae) and a monograph of the sculpins (cottoids), and was accorded high rank among the descriptive zoologists of that period.

Through Baird's influence, Theodore Nicholas Gill was included in 1859 in the group who were being paid for the preparation of zoological reports for the Northwestern Boundary Survey, and the following year he was working on the fish report for the North Pacific Exploring Expedition. Gill became a member of the Smithsonian staff in 1861. Between 1865 and 1874 he was in charge of the Smithsonian library deposited in the Library of Congress. For almost 40 years after 1874 Gill was a volunteer worker in the Institution. As an analytical taxonomist, he possessed an unrivaled knowledge of the scientific literature, and his scholarly treatises on fishes reveal a keener understanding of the significance of structure in classification than that shown by most of his contemporaries. Gill published 388 papers on fishes, of which the most outstanding contribution was the arrangement of the families and the diagnostic analyses of the genera included in certain families. His papers on parental care and other phases of the natural history of fishes were particularly noteworthy.

Having spent two summers on the coast of New Jersey and subsequent seasons at Woods Hole, Massachusetts, and Eastport, Maine, Baird was so impressed with the importance of a thorough investigation of the factors responsible for the decrease of food fishes along the North American coasts that he assisted a senatorial friend in drafting a bill for such an inquiry. This resulted in the creation by Congress of the U. S. Fish Commission in 1871, and Assistant Secretary Baird was appointed to serve without salary as commissioner.

George Brown Goode was brought by Baird to Washington in 1877, and was given increasing responsibilities in the direction of the National Museum and the Fish Commission, both of which were outgrowths of activities fostered by the Smithsonian. His interest in the economic aspects of ichthyology led to the publication of the natural and economic history of the American menhaden (1879).

Another able investigator, Tarleton Hoffman Bean, came to the National Museum from Pennsylvania as Goode's colleague and held the position of curator of Fishes from 1880 to 1895. He became a leading authority on American fresh-water fishes and with G. Brown Goode published "Oceanic ichthyology" in 1895. In addition to his noteworthy taxonomic studies, Bean also became the most distinguished fish culturist in America. His brother, Barton A. Bean, was in charge of the fish collection from 1895 to 1932 and published a number of articles on deep-sea and fresh-water fishes. B. A. Bean's successor, George S. Myers, remained with the National Museum from 1933 to 1936 and in that interval described some remarkable deep-sea fishes, oviparous cyprinodonts, and Asiatic and South American fishes. The present curator of Fishes, Leonard P. Schultz, took charge of the Division in 1936, and since then his main contributions have been studies on the fishes of Phoenix and Samoan Islands and the fresh-water fishes of Venezuela.

The fish collection of the National Museum has constituted the basis for a large number of technical revisions and monographs by David Starr Jordan and his associates, including Alembert W. Brayton, John O. Snyder, Edwin C. Starks, Henry W. Fowler, Barton W. Evermann, Charles H. Gilbert, Joseph Swain, Seth E. Meek, and Carl H. Eigenmann, as well as by S. F. Hildebrand and other members of the Fish and Wildlife Service.

Hugh M. Smith, formerly U. S. Commissioner of Fisheries (1913–22), adviser in fisheries to the Siamese Gov-

ernment (1923–35), and after 1922 associate in zoology in the National Museum, prepared before his death in 1941 "The fresh-water fishes of Siam, or Thailand" (1945).

Insects

From most of the government expeditions the Smithsonian received large quantities of zoological specimens, sometimes more than could be handled readily by the staff, and consequently some provision had to be made for the storage and preservation of such materials. Thus, in accordance with the original plan adopted for fostering scientific research both at home and abroad, most of the insects were forwarded to prominent entomologists, the orders being distributed as follows: Coleoptera to John Lawrence LeConte, George Henry Horn, and Henry Ulke; Hemiptera to Philip Reese Uhler; Orthoptera to Samuel H. Scudder and Cyrus Thomas; Lepidoptera to William Henry Edwards, John Goodlove Morris, James Brackenridge Clemens, and Richard Harper Stretch; Hymenoptera to Henri de Saussure, of Geneva, Switzerland, Edward Norton, and Ezra Townsend Cresson, Sr.; Diptera to Hermann Loew, of Vienna, and Baron Carl Robert Osten Sacken, a Russian diplomat; and Neuroptera to Hermann August Hagen. The records also show that among other arthropods the myriapods were distributed to Horatio Charles Wood and the spiders to James Henry Emerton. According to the Annual Report of the Smithsonian for 1868, "all of the specimens of insects which have been collected by the institution have been divided among collaborators for study and arrangement, to be reclaimed at any time when required by the institution."

In the interval between its founding and 1868, the Institution thus materially aided the study of entomology, not only by making collections in that branch of zoology available to qualified investigators but also by arranging for the preparation and subsequent publication of a series of memoirs in which would be recorded the state of knowledge at that time. In 1865, however, it was announced that the insects received had been placed as usual in charge of the Entomological Society of Philadelphia, and this policy seems to have been continued until about 1874, when it was decided to make the Department of Agriculture the repository. Nevertheless, at least one collection of insects in 1868 was turned over to Townend Glover, who had received in the winter of 1853–54 an appointment in the Bureau of Agriculture of the Patent Office to collect "statistics and other information on seeds, fruits and insects."

Following the retirement of Glover in 1878, Charles Valentine Riley was appointed entomologist to the U. S. Department of Agriculture. The present entomological collection does not date from much earlier than 1881, when Riley deposited his collection in the National Museum and was designated honorary curator of Insects. When, in 1886, the Museum appointed John D. Smith as assistant curator of Insects, Riley formally transferred the entire insect collection, then numbering 115,000 specimens. Riley retired in 1894 with the intention of devoting the rest of his life to research, but was killed in September 1895.

With the appointment of L. O. Howard in 1895 as successor to Riley in the Department of Agriculture, and as honorary curator of Insects in the National Museum, several of his economic staff were designated as custodians. Among them were D. W. Coquillett for Diptera, William H. Ashmead for Hymenoptera, E. A. Schwarz for Coleoptera, Harrison G. Dyar for Lepidoptera, and Nathan Banks for Arachnida. These men and their successors were recognized as authorities for the groups under their charge, and while they were expected to perform their official duties of identifying insects for the Department they were also charged with the responsibility of classifying, improving, and increasing the reference collections.

John B. Smith held the position of assistant curator of Insects for approximately three years and subsequently, following his acceptance of the office of state entomologist of New Jersey, attained considerable prominence as an economic entomologist. Although no assistant curator was appointed for eight or nine years after Smith's departure, Martin L. Linell, an aid, took care of the collection until his death in 1896. Linell's reputation as an entomologist rests chiefly on his report on the beetles of the Galápagos Islands.

As stated previously, William H. Ashmead was detailed by Howard in 1895 with the concurrence of the administrative officials of the National Museum to be custodian of the Hymenoptera. On 1 July 1897, however, he was transferred to the position of assistant curator, Division of Insects, and continued in the employ of the Museum until April 1908. Especially noteworthy as regards originality and general usefulness were his memoirs, "Classification of the ichneumon flies" (1900) and "Classification of the chalcid flies" (1904). Ashmead's studies on the parasitic Hymenoptera constitute the basis for all similar work of recent years.

James C. Crawford succeeded Ashmead as assistant curator of Insects in May 1908 and was promoted to associate curator in 1911. Until March 1919, when he transferred to the U. S. Department of Agriculture, Crawford was chiefly occupied with the reorganization of the insect collection and was responsible for the installment of a unit system for the storage of specimens, the greatest single contribution to the preservation of the collection.

John M. Aldrich, honorary custodian of Diptera since December 1918, was appointed associate curator, Division of Insects, on 4 April 1919 and advanced to curator on 1 July 1928. Two publications, "Catalogue of North American Diptera or two-winged flies" (1904) and "Sarcophaga and its allies in North America" (1916), on which Aldrich's reputation as an entomologist mainly rest, were printed before he came into association with the Museum. Subsequently, after visiting European museums, Aldrich became interested in determining the true identity of early described species of muscoid flies.

Following the death of Aldrich on 27 May 1934, the vacancy in the Division of Insects was filled on 1 July

1934 by transfer of Edward A. Chapin from the Bureau of Animal Industry. Chapin has written generic revisions of the clerids, scarabaeids, and coccinellids. Richard E. Blackwelder, the present associate curator, came to the Division as assistant curator during July 1940. Previously, as the recipient of the Walter Rathbone Bacon Traveling Scholarship, Blackwelder was enabled to visit certain Caribbean Islands and to collect the necessary materials for his "Monograph of the West Indian beetles of the family Staphylinidae" (1943).

Marine Invertebrates

William Stimpson, a student of Louis Agassiz and naturalist for the North Pacific Exploring Expedition commanded by Commodore Ringgold and Captain Rodgers, on his return in 1856 began the preparation of his report at the Smithsonian Institution. Stimpson seems to have been, nominally at least, in charge of the collection of invertebrates in the Institution until 1865, when he was appointed curator and secretary of the Chicago Academy of Sciences. When Stimpson died in 1872, he left an enviable reputation for his work on the invertebrates. The collections made by him while he was attached to the North Pacific Exploring Expedition, as well as more than 10,000 jars of the Smithsonian collection of Crustacea, then the largest of its kind in the world and including many of James D. Dana's types from the U. S. Exploring Expedition (Wilkes, 1838–42), were totally destroyed in the Chicago Academy of Sciences by the disastrous fire of 8–11 October 1871.

In addition to the invertebrates received from these earlier expeditions, numerous investigations of the seas and fresh waters conducted from vessels belonging to the U. S. Fish Commission as well as from others under private auspices brought together a large amount of material for the study of the lower forms of aquatic life. Prior to 1880 funds at the disposal of the Institution were not adequate for the employment of someone to assume direct care of the invertebrate collections. It is therefore fortunate that these collections were examined from time to time by competent naturalists searching for materials to further their own studies, and in this manner their safety was assured. W. H. Dall, who had a special interest in mollusks, had paid attention to the care and preservation of other groups of marine invertebrates and in recognition of these voluntary services had been designated curator of Marine and Aquatic Invertebrates in 1879.

Richard Rathbun was appointed in 1878 scientific assistant to the U. S. Fish Commission, whose collections were then in New Haven, Connecticut. In 1880 Rathbun was transferred from New Haven to Washington, where he subsequently became curator of Marine Invertebrates in the National Museum, a position he held until 1914, although he was made assistant secretary in charge of the National Museum in July 1898. Rathbun specialized on the economic aspects of marine biology, and his report on the natural history of the crustaceans, worms, radiates, and sponges is recognized as a work of highest value. One of the most important contributions to marine economic zoology is his survey of ocean temperatures. The copepods collected and identified by Rathbun formed the basis for the report on the Woods Hole region by Charles B. Wilson in 1932. Rathbun's contributions to our knowledge of the echinoids and parasitic copepods are equally well known.

Prior to his appointment on 13 January 1890 as assistant curator in the Division of Marine Invertebrates, James E. Benedict had been naturalist on the U. S. Fisheries steamer *Albatross*. The most noteworthy publications of Benedict until 1909, when he was placed in charge of the Museum exhibits, were those relating to the hermit crabs, king and rock crabs, and the small lobsterlike crustaceans of the family Galatheidae.

Mary Jane Rathbun, a sister of Richard Rathbun, received world-wide recognition for her research on recent and fossil decapod crustaceans. Her monographs on the grapsoid, spider, cancroid, oxystomatous, and allied crabs of America and the fresh-water crabs of the world in particular are recognized as outstanding contributions. She came to the National Museum in 1886 and resigned in 1914 but continued her association with the Institution as honorary associate in zoology until her death in 1943.

Her successor, Waldo La Salle Schmitt, became curator of the Division of Marine Invertebrates in 1920 and a specialist in carcinological research, publishing accounts of the decapod crustaceans of California, nonbrachyuran decapods of the American Museum Congo Expedition, the penaeid shrimps collected by the F.I.S. *Endeavour* in Australian seas, the mantis shrimps (stomatopods) of the West Coast, and the fresh-water *Aegla* of South America.

From 1900 until his retirement as associate curator in March 1944, Clarence R. Shoemaker was engaged in revisionary studies on the amphipods, the results of which were published in various publications. Special mention is made of his reports on the amphipods of the Canadian Arctic, Hudson and James Bay, and Bermuda.

With the limited funds at its disposal, the Institution has never been in a position to employ enough specialists for the furtherance of research on all the phyla in the animal kingdom, but has had to rely on the interested cooperation of specialists in other institutions for the preparation of reports as well as for the identification of such materials. Some of the most distinguished zoologists in North America between 1870 and the present time have based memoirs largely on invertebrate materials in the National Museum.

Over the years, first James M. Flint and later Joseph A. Cushman have materially benefited the collection by the identification of the Foraminifera. The Institution has published a number of Cushman's comprehensive memoirs, notably "A monograph of the Foraminifera of the North Pacific Ocean" (1910–17) and "The Foraminifera of the Atlantic Ocean" (1918–31). The opalinid protozoans, salps, and pyrosomas were described by Maynard M. Metcalf.

The sponges have been studied by Alpheus Hyatt, Edward Potts, H. V. Wilson, and M. W. De Laubenfels.

For many years Charles Cleveland Nutting was the chief cooperating specialist on the hydroids, and afterward assistance was given by C. McLean Fraser. Many of the jellyfish were included in the publisned works of Alfred G. Mayer. The siphonophores obtained on the cruises of the *Albatross* were reported on by Henry B. Bigelow. Studies by Addison Emory Verrill on the coelenterates while employed by the U. S. Fish Commission constitute one of his chief contributions to invertebrate zoology. Oscar Carlgren was the author of several papers on the anemones, and Walter K. Fisher revised the hydrocorals. The nemerteans have been the subject of special studies by Wesley R. Coe. From 1914 to 1929, Harry K. Harring, custodian of the Trochelminthes, in collaboration with Frank J. Meyers, advanced our knowledge of this phylum.

Since 1912, Raymond C. Osburn has assisted with the identification of the bryozoans (Molluscoidea). Frank Smith and Gordon E. Gates devoted most of their lives to studying earthworms. Among the authorities who have contributed to our knowledge of the marine annelid worms (polychaets) are James E. Benedict, A. L. Treadwell, and Olga Hartman. The gephyreans were at one time identified by Henry B. Ward and R. V. Chamberlin; the most detailed report, however, was published by John Hiram Gerould. A comprehensive study of the echiuroid worms was recently completed and published by Walter K. Fisher. Many of the leeches were submitted to J. Percy Moore for identification. Several specialists, including Edmund B. Wilson, Leon J. Cole, Wm. Allen Hilton, and Joel Hedgpeth, have studied the sea spiders (Pycnogonida). Another recognized authority, Henry A. Pilsbry, has identified the barnacles (Cirripedia), although H. Boschma did some work on the rhizocephalans.

Reference should also be made to the work of Chancey Juday with the Cladocera. Of special interest and importance is the work of Charles Dwight Marsh with the fresh-water copepods. Reports on the collections of mysid shrimps have been prepared by Wm. M. Tattersall. Harriet Richardson, later Mrs. Searle, a voluntary collaborator since September 1896, is best known for her studies on the isopods and especially for her "Monograph of the isopods of North America" (1905). Indispensable contributions to the classification of the euphausid shrimps were made by H. J. Hansen. As regards the crayfish, Walter Faxon and W. P. Hay were the chief collaborators, and Robert Payne Bigelow was the author of fundamental studies on the stomatopods.

The ascidians or sea squirts (Urochorda) were reported on in part by William E. Ritter and by A. G. Huntsman and more fully by Willard G. Van Name. These specialists and many others not mentioned by name have assisted the Institution in carrying out its original plan for the preparation and publication of manuals of natural history.

Mollusks

The early history of the Division of Mollusks was much the same as some of the others, with quantities of shells pouring into the Smithsonian from the exploring expeditions and apparently with no one evincing a special interest in such specimens. It was not until 10 years after the founding of the Institution that any mention was made of efforts being made to further research on mollusks.

Augustus Addison Gould, of whom it has been stated that no one with the possible exception of Thomas Say had exercised a greater influence in developing the study of mollusks in this country, after the publication in 1852 of his report on the Mollusca brought back by the U. S. Exploring Expedition (Wilkes, 1838–42), gave his services to the Smithsonian Institution during the years 1858–60 and at intervals thereafter until his death in 1864.

During the winter of 1859–60, Philip Pearsall Carpenter, a British clergyman residing at Warrington, England, having been requested by the British Association for the Advancement of Science to prepare a report on the Mollusca of the Northwest Coast of America, visited Washington. At that time he volunteered to identify the collection of the Smithsonian. Since the task proved to be too extensive to be completed during the year, Secretary Henry made arrangements to ship the entire collection to England, where Carpenter devoted four years to the comparison of these mollusks with named forms in Hugh Cuming's collection, which in 1866 was purchased by the British Museum (Natural History). Carpenter contributed these services gratuitously in order that American students might have the benefit of such named specimens. Some of these old printed labels, which bear the inscription, "Named by Hugh Cuming, Esq., for the Smithsonian Institution, Washington, D. C.," are still associated with shells in the National Museum collection.

Voluntary assistance in the identification of mollusks was given also by Isaac Lea and Edward Foreman on the fresh-water clams, by Lea and George W. Tryon on fresh-water snails, by William Greene Binney on land shells, by Temple Prime on Sphaeriidae and Corbiculidae, by William Stimpson on Atlantic Coast mollusks, and by Thomas Bland on South American mollusks.

William Healey Dall, one of America's foremost malacologists, came under the influence of S. F. Baird when he arrived in Washington in 1865 to secure special training for his duties as a member of the scientific staff of the Russian-American Telegraph Company's North Pacific Exploring Expedition. Returning to Washington in 1868, Dall was assigned a room in a tower of the Smithsonian Building, where he worked on his collections and on the preparation of "Alaska and its resources," which was published in 1870. From 1871 to 1874, Dall was in charge of reconnaissance surveys of Alaskan coastal waters for the Coast Survey but found time to continue his malacological studies. He returned to Washington in 1875 and prepared the invertebrate catalogue for the International Exhibition of 1876. Dall was transferred in 1884 from the Coast and Geodetic Survey to the Geological Survey and as paleontologist was detailed to the National Museum, where he continued his research as honorary curator of the Division of Mol-

lusks and Tertiary Fossils until his death in 1927. Dall was the author of more than 1,600 papers, among which were many outstanding contributions to malacology, including his studies on Pacific Coast marine shells, Florida Tertiary mollusks, the brachiopods, and his general classification of the pelecypods.

Paul Bartsch, who had been appointed aid in the Division of Mollusks in 1896, became curator of Marine Invertebrates on the death of Rathbun in 1914, and at the time of his retirement in 1946 was curator of the Division of Mollusks. During his association with the National Museum, Bartsch was the author of a large number of technical reports of which those dealing with the Philippine land shells, the teredos (shipworms), the pyramidellid mollusks, and the West Indian land shells deserve special mention.

Papers on almost every group of mollusks were published by Robert E. C. Stearns, associate in zoology, between 1866 and 1908. Besides the well-prepared synopsis of the pearly fresh-water mussels (1900), Charles T. Simpson, a divisional aid from 14 December 1889 to 31 December 1902, attracted well-deserved notice for his popular accounts of the natural history of lower Florida. The pearly fresh-water mollusks were also the chief interest of William B. Marshall, first employed as aid on 1 April 1895 and subsequently as assistant curator from 1914 to 1934. Other fresh-water mollusks as well as land shells were reported on by Marshall.

Harald Alfred Rehder has been a member of the staff since 1932 and succeeded Bartsch as acting curator on 1 May 1946. The major research of Rehder during this period appears in "New marine mollusks from the Antillean region" (1943) and, in joint authorship with Dall and Bartsch, in "A manual of the Recent and fossil marine pelecypod mollusks of the Hawaiian Islands" (1938).

The care and preservation of the coral collection form also one of the responsibilities of the Division of Mollusks. When Rathbun took charge of the invertebrates in 1880, the stony corals (Actinozoa) were said to comprise not only a collection of great value and beauty, but also the largest then existing in the number of kinds represented. Important additions to our knowledge of the corals were made by Addison Emory Verrill in the interval between 1871 and 1887, when he was in charge of scientific work in southern New England for the U. S. Fish Commission and prior to the physical transfer of those collections to the National Museum. These corals have also been reported on by others, including J. Playfair McMurrich and Alfred Goldsborough Mayer. Nearly 50 years have elapsed since T. Wayland Vaughan, the dean of coral specialists and custodian of Madreporaria, commenced his studies.

Partly for administrative purposes and partly because of the personal interest of the former curator, Paul Bartsch, the parasitic helminth worms were allocated to the Division of Mollusks. Charles Wardell Stiles served as custodian of the helminths from 1894 until 1931, and more recently the parasitic forms have been referred to Benjamin Schwartz and Emmett W. Price, of the Bureau of Animal Industry.

Echinoderms

Although the Division of Echinoderms is a comparatively recent offshoot of the Division of Marine Invertebrates, a limited amount of research work on this phylum had been sponsored much earlier by the Institution. The starfishes, sea urchins, crinoids, and other echinoderms received from the North Pacific Exploring Expedition were placed in the hands of J. M. Barnard in 1858 for study and description, but unforeseen circumstances prevented the publication of the reports of this expedition. Subsequently, in 1861, both William Stimpson and Louis Agassiz examined all the echinoderms stored in the Smithsonian.

Theodore Lyman, another student of Louis Agassiz, began publication of papers on the brittlestars belonging to the Smithsonian collection in 1858, and during the ensuing years additional material was transmitted to him for study. In the period between 1882 and 1891, Lyman was studying the Astrophytons. Addison E. Verrill reported on the echinoderms secured by the U. S. Fish Commission on the northeast coast of North America and on a collection received from Kerguelen Island. His assistant, Katharine J. Bush, prepared the catalogue for the echinoderms dredged along the coast of Labrador. The sea cucumbers (Holothuroidea) were studied by Hubert Ludwig, Hubert L. Clark, and Charles L. Edwards. Arrangements were made in the interval between 1882 and 1891 with Alexander Agassiz for studies on the sea urchins (Echinoidea).

Austin Hobart Clark, who had been acting chief of the scientific staff of the steamer *Albatross* during 1906–07, became associated with the National Museum in 1908 as collaborator in marine invertebrates. When the Division of Echinoderms was established in 1920, Clark was appointed curator. Since then he has specialized on crinoids and has also given some consideration to problems related to oceanography and marine biology. The results of Clark's investigation on the echinoderms are recorded in numerous shorter articles as well as in "A monograph of the existing crinoids" (1915–41).

Special mention should be made of the many monographs and shorter articles on the starfishes and their kin by Walter K. Fisher and, in particular, "Asteroidea of the North Pacific and adjacent waters" (1911–30) and the "Starfishes of the Philippine seas and adjacent waters" (1919).

Comparative Anatomy

Frederick A. Lucas had charge of the Division of Comparative Anatomy from 1881 until 1904, first as assistant curator and subsequently in 1898 as curator. During these years all the vertebrate skeletal materials now in the care of the respective divisions were under his supervision. Lucas was chiefly responsible for the large and well-organized comparative anatomy exhibit in the National Museum. His investigations dealt mainly

with the osteology of the vertebrates and among his publications of this period mention should be made of "The expedition to the Funk Island with observations upon the history and anatomy of the great auk" (1890) and "On the structure of the tongue in hummingbirds" (1891).

Plants

For the first decade at least in the existence of the Smithsonian Institution, some of the officers in charge of various government expeditions apparently received no definite instructions regarding the disposition of plant materials. Consequently, a considerable portion of the botanical collections made by the United States and Mexican Boundary Survey, the military reconnaissance expeditions, and the Pacific Railway Surveys were shipped directly to John Torrey, who held the post of professor of chemistry at Princeton University from 1830 to 1854 and after 1856 became professor of botany and chemistry at Columbia University. In the identification of these materials, Torrey obtained the cooperation of such specialists as Asa Gray, William S. Sullivant for the mosses and liverworts, Edward Tuckerman and M. A. Curtis for the lichens, George Engelmann for the Cactaceae, and George Thurber for the grasses.

Other plant collections brought back by government scientific or exploring expeditions, travelers, and collectors or received from other sources accumulated in the Smithsonian Institution. About 1860, Prof. Torrey wrote Secretary Henry that he was willing to supervise the selection and preparation, without compensation for his personal services, of a single series of specimens from all the botanical collections made by the various government exploring expeditions as well as from the plant materials then stored in the Institution. This disinterested offer of collaboration by Torrey resulted in the arrangement of a fairly complete set of some 15,000 to 20,000 specimens for the National Herbarium, as well as several duplicate sets for presentation to the principal American and European museums, and the remainder for distribution to colleges and private herbaria. When he reached the age of 70 years, Torrey found it necessary in 1868 to make arrangements for the return of this collection of plants to the Smithsonian, and because of the inadequate appropriations for the maintenance of the museum the National Herbarium was transferred the same year to the Department of Agriculture.

Charles Christopher Parry, who had spent the winter of 1852–53 in Washington preparing his report as botanist to the United States and Mexican Boundary Survey, in 1869 was appointed botanist to the Department of Agriculture, a position he held for three years. This appointment was terminated in 1871 because the then U. S. Commissioner of Agriculture held the opinion that "the routine operations of a mere herbarium botanist are practically unimportant." It is generally conceded that the identification and care of the plant collections which were being received by the national repository required considerable technical ability.

On 1 April 1872, George Vasey was appointed botanist of the Department of Agriculture and placed in charge of the National Herbarium. The task of organizing the collection of plants that had accumulated from exploring voyages and transcontinental railroad surveys under government auspices was a difficult undertaking but one that Vasey carried through with unusual success. Vasey became a distinguished specialist on grasses and was honorary curator of the Department of Botany in the National Museum until his death in 1893.

Frederick Vernon Coville in 1893 succeeded Vasey as botanist and curator of the National Herbarium, which remained in the custody of the Department of Agriculture until 1896, and at the same time became honorary curator of the Division of Plants in the National Museum, a post he held until his death in 1937. Coville was best known for his observations on ecological plant geography in "Botany of the Death Valley Expedition," for his taxonomic studies on the rushes (Juncaceae) and on our native currants and gooseberries (Grossulariaceae), and for his experimental studies relating to the improvement of strains of blueberries, particularly the effect of soil acidity and the stimulating role of cold.

When the National Herbarium was returned to the National Museum in 1896, Joseph Nelson Rose was transferred from the Department of Agriculture. He is best known for his studies on cacti and Crassulariaceae, which from 1912 to 1923 were carried on while on furlough from the National Museum under the auspices of the Carnegie Institution of Washington.

William R. Maxon entered the employ of the National Museum on 10 July 1899 as aid and was promoted through the grades, becoming curator of Plants on 1 February 1937 and retiring on 31 May 1946. Many articles by Maxon on tropical American ferns in *Contributions from the United States National Herbarium* stand as an enduring monument to his industry.

The contributions to botany by Paul Carpenter Standley, formerly associate curator and a member of the staff from 1909 to 1928, are centered around systematic works dealing with Mexican and Central American plants. Especially noteworthy as regards general usefulness are his "Trees and shrubs of Mexico" (1920–26) and the "Flora of the Panama Canal Zone" (1927).

Ellsworth P. Killip, who has been with the National Museum since 7 July 1919, succeeded Maxon as curator on 1 June 1946. Aside from the recording of field observations and the collecting of plant materials in Colombia, Venezuela, Peru, and Brazil, Killip has published the "American species of Passifloraceae" (1938).

The general growth of the plant collection necessitated the employment of additional staff members. Emery C. Leonard joined the staff as aid on 2 January 1918 and was reallocated to assistant curator on 1 June 1928. He has specialized on the West Indian Acanthaceae and has begun an elaborate work on the flora of Hispaniola. Conrad V. Morton was appointed aid on 20 August 1928 and was promoted to assistant curator on 16 March 1939. He is a specialist on the Gesneriaceae of Mexico and Central America and also has made important con-

tributions to our knowledge of the potato family. Asiatic botany, particularly that of China, has been the special interest of Egbert H. Walker, who accepted an appointment as aid on 2 July 1928 and was advanced to assistant curator on 1 February 1942.

In conclusion, it should be emphasized that this article directs attention to only the most outstanding pieces of research that the Smithsonian has sponsored. It should be borne in mind also that the staff has always given a considerable portion of its time to helping others less advantageously situated by identifying materials, collating data, and furnishing literature. Such has always been the pervasive and far-reaching influence of Smithsonian activities. Its great collections representing the natural history of the earth belong to the American people, and it is right that they should use them to the utmost.

A Century of Smithsonian Publications

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From the very beginning, publications have constituted a major item in the Smithsonian Institution's program dedicated to the increase and diffusion of knowledge among men. It has used, and still uses, other methods of diffusing knowledge—among them, museum and art gallery exhibits, a world-wide correspondence on scientific matters, the International Exchange Service which it was instrumental in initiating, lectures, radio programs, and science news releases—but the foremost method has always been the printed word. Joseph Henry, first secretary of the Institution, saw clearly the great need at that time of more media for publication of scientific discoveries, and among his first acts as secretary was the establishment of a series of Smithsonian publications, *Contributions to Knowledge.* From this single initial series, the publications of the Institution have expanded with the growth of its research work until today 14 distinct series appear under the Smithsonian imprint, each series serving a particular function.

Prof. Henry felt so strongly the importance of diffusing knowledge more widely in the early days of the Institution that he wrote in 1852:

> The worth and importance of the Institution are not to be estimated by what it accumulates within the walls of its building, but by what it sends forth to the world. Its great mission is to facilitate the use of all the implements of research, and to diffuse the knowledge which this use may develop.

Probably the best-known publications of the Institution proper are its *Annual Reports.* Each year the General Appendix contains a carefully selected group of 20–25 articles presenting as far as possible in nontechnical language the progress and important developments in nearly all branches of science. The Smithsonian Reports find a wide field of usefulness among teachers, students, and the general public, and they have doubtless had a not inconsiderable part in building up the present widespread appreciation of the value of science. All members of the Institution's scientific staff aid in selecting articles for the Annual Report, and a large number of journals dealing with scientific subjects are examined each year in order that no major development may be overlooked. A complete set of Smithsonian Reports constitutes in effect a history of 100 years of progress in science.

The other two series published by the Institution proper—*Smithsonian Contributions to Knowledge* and *Smithsonian Miscellaneous Collections*—are technical in character and contain the results of research in many fields of science by members of the Institution's staff and by collaborators and outside scientists. The Contributions series was established soon after the founding of the Institution, the first monograph to appear being Squier and Davis' "Ancient monuments of the Mississippi Valley," published in 1848. The Contributions soon became widely known among scholars, and numerous important monographs appeared in the series in ensuing years. The only requirement was that each paper should constitute a positive addition to knowledge based on original research. A few of the well-known papers in this series are: "Memoir on mechanical flight," by Langley and Manly; Coffin's "The winds of the globe"; Shaler's "Comparison of earth and moon"; and Morely's "On the densities of oxygen and hydrogen, and the ratio of their atomic weights." The Contributions appeared in quarto form, and because of the greater cost of printing in that form, the series was discontinued in 1916.

The Miscellaneous Collections, started a few years after the Contributions, contained, as long as the latter series existed, shorter papers in all branches of science, although mainly anthropology, biology, geology, and astrophysics. Since 1916, however, the Miscellaneous Collections has included practically all the scientific material published by the Institution, except the semipopular papers appearing in the Annual Report. Some of the better-known works in this series are the Smithsonian Physical Tables and the Smithsonian Meteorological Tables, the World Weather Records, Secretary Wetmore's "A systematic classification for the birds of the world," Hrdlička's "The skeletal remains of early man," Walcott's several volumes on Cambrian Geology and Paleontology, and Abbot's papers on solar radiation studies. The Miscellaneous Collections is now in its 106th volume.

Out of the early activities of the Institution there developed a number of bureaus which were later recognized as public necessities and received governmental support. To provide outlets for the work of these bureaus other series of publications were established, the earliest