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THE U.S. NATIONAL PARASITE COLLECTION— A CENTURY OF SERVICE

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ABSTRACT: The U.S. National Parasite Collection will complete its first century of service to the field of animal parasitology in 1992. A brief history of the collection and a description of current policies on deposit and loan of specimens are provided. The collection, started in 1892 by Charles Wardell Stiles and Albert Hassall, now includes several constituent collections: The USNM Helminthological Collection, The USDA Parasite Collection, The Hoffman-Bangham Collection of Parasites of Freshwater Fish, and The Southeastern Cooperative Wildlife Diseases Study Collection of Parasites of White-tailed Deer. Major personal collections have been donated by F. W. Douvres, J. H. Fischthal, A. O. Foster, A. Goldberg, E. P. Hoberg, R. Honess, R. A. Knight, D. C. Kritsky, R. E. Kuntz, G. L. LaRue, D. R. Lincicome, E. Linton, G. A. MacCallum, J. H. Sandground, L. Schultz, and H. J. Van Cleave. In addition to Stiles and Hassall, the collection has been curated by B. H. Ransom, M. C. Hall, A. McIntosh, W. W. Becklund, M. B. Chitwood, and the authors of this report. Other USDA researchers closely associated with the collection over the years include B. G. Chitwood, E. B. Cram, G. Dikmans, J. T. Lucker, E. W. Price, and E. E. Wehr. The collection includes about 90,000 lots of specimens, mostly helminths, but also significant numbers of ticks, mites, protozoans, and other miscellaneous parasites. Annually about 600–1,000 lots are accessioned and 300–400 lots are loaned to researchers around the world.

The U.S. National Parasite Collection maintained by the Biosystematic Parasitology Laboratory, Agricultural Research Service, Beltsville, Maryland, will complete its first century of service to parasitologists in 1992. It seems appropriate, therefore, to mark the occasion by reviewing the history of this national resource and describing its current status.

The collection contains animal parasites of humans and animals. It is one of the world's largest parasite collections and is the major repository for helminth type specimens for North American parasitologists as well as for others who lack adequate facilities.

HISTORY

The first 76 yr of the National Parasite Collection were described in detail by Becklund (1969a, 1969b). Descriptions of the collection were also provided by Lichtenfels (1977, 1982). For the convenience of the reader, the history of that period is summarized here, but the emphasis will be on the period 1969–1992 and current policies, procedures, and plans.

The collection was founded in 1892 by 2 U.S. Department of Agriculture (USDA) scientists, Charles Wardell Stiles and Albert Hassall, in the Bureau of Animal Industry (predecessor of the Agricultural Research Service) with their personal collections as a nucleus. Stiles was an

American who had studied in Europe and Hassall was born and trained in England. As a result, some of the oldest specimens in the U.S. National Parasite Collection are from Europe and date from the middle of the 19th century.

Over its 100-yr history, the collection has had various names and constituent collections have added additional names. Especially confusing to many is the relationship of the collection to the U.S. National Museum of the Smithsonian Institution. The collection was known initially as the Bureau of Animal Industry (BAI) Collection, and a catalogue of parasites was published (Stiles and Hassall, 1894) in which it was stated that "all types of the BAI Collection will be permanently deposited in the United States National Museum. . . ." To accomplish this, Stiles proposed, in 1894, that the Smithsonian establish a department of zoology or helminthology and volunteered to serve as honorary curator. In March 1894, Stiles was appointed Custodian of the USNM Helminthological Collection by the Secretary of the Smithsonian Institution. This began a tradition, still in effect, in which the Curator of the National Parasite Collection also serves as a Research Associate of the Smithsonian Institution. Whether specimens were ever physically transferred to the Smithsonian is unclear (Becklund, 1969a); however, types in the BAI Collection were given a separate block of catalogue numbers and designated as the USNM Helminthological Collection. This latter policy still is followed. It is clear also that the USNM

Helminthological Collection was founded and continuously curated for 100 yr by USDA scientists. If specimens ever were transferred physically to the Smithsonian, they were returned in 1936 (Becklund, 1969a), a time that appears to coincide with the movement of the BAI Collection from Washington, D.C., to new laboratory facilities in Beltsville, Maryland (Andrews, 1987). Over the years as bureau, agency, and division names changed, the BAI Collection became the Zoological Division Collection, the Animal Parasite Collection, the Beltsville Parasite Collection, and the USDA Parasite Collection. Thus, from 1894 there were 2 constituent collections, the BAI Parasite Collection and the USNM Helminthological Collection, each using blocks of catalogue numbers but all part of a single numerical series.

Constituent collections

In 1969, Becklund (1969a) proposed the overall name National Parasite Collection for these 2 constituent collections. This name was chosen by Becklund (1969a) because a broad range of organisms is included. Lichtenfels (1977, 1982) added U.S. to the name to distinguish it among international collections. Although helminths are the largest group in the collection, other groups include parasitic protozoans, pentastomes, lice, mites, ticks, and other miscellaneous parasites. Many of the parasites were collected during the course of survey and eradication programs of the USDA (Schwartz, 1952; Becklund, 1968, 1969a). About one-half of the specimens are stored in small bottles in a solution 92 parts of 70% ethanol, 3 parts formalin, and 5 parts glycerine. The others are mounted permanently on glass microscope slides.

Curators

In addition to Stiles and Hassall, the collection has been curated by B. H. Ransom, M. C. Hall, A. McIntosh, W. W. Becklund, M. B. Chitwood, and currently by J. R. Lichtenfels and P. A. Pilitt. Other USDA researchers closely associated with the collection over the years include B. G. Chitwood, E. B. Cram, G. Dikmans, J. T. Lucker, E. W. Price, and E. E. Wehr.

After the sudden death of Willard W. Becklund at age 47 in 1970, MayBelle Chitwood became curator of the National Parasite Collection until her retirement in 1973. Since 1973 the collection has been under the care of J. Ralph Lichtenfels, with the assistance of Patricia A. Pilitt since 1977.

Patricia Pilitt is the daughter of Allen McIntosh who curated the collection from 1930–1962. In 1990, Eric P. Hoberg joined the staff of the Biosystematic Parasitology Laboratory (BPL) and now shares curatorial duties with Lichtenfels and Pilitt. BPL was known previously as the Parasite Classification and Distribution Unit when the parasitology research at Beltsville was in a single laboratory.

COLLECTIONS AND FACILITIES

Collections and records

The collection includes about 90,000 lots of specimens. A lot consists of 1 to thousands of specimens. Additions to the collection receive the next available catalogue number. Specimens are not grouped taxonomically. A "Checklist of Types in the U.S. National Parasite Collection" was published in 1978 (Salley et al., 1978). The types are listed by species within large groups (phylum or class) and an index of genera is included. Copies of the checklist of types are available from the authors of the present report. The collection includes about 10,000 type lots including about 4,000 holotypes.

Constituent collections: In addition to the 90,000 catalogued lots, several large blocks of specimens have not been catalogued. These include: (1) The H. B. Ward Collection. After Ward's death, his collection was shipped to Beltsville along with its card file and logbook records. Allen McIntosh and Bill Becklund catalogued the types in the Ward Collection, but the bulk of it is uncatalogued except for Ward's records. (2) The Hoffman–Bangham Collection of Parasites of Freshwater Fishes. In 1986, this collection was moved to Beltsville from the Fish and Wildlife Service Fish Farming Experiment Station at Stuttgart, Arkansas, following the retirement of Glenn L. Hoffman. It includes the personal collections of G. L. Hoffman, R. V. Bangham, and a collection of Myxosporidia compiled by H. S. Davis. The Hoffman–Bangham Collection consists of more than 8,000 slides in boxes and numerous small vials in a steel chest of drawers. The specimens are indexed according to Hoffman's original records but have not been catalogued into the records of the U.S. National Parasite Collection. (3) The Southeastern Cooperative Wildlife Diseases Study Collection of Parasites of White-tailed Deer. This collection from 2,193 *Odocoileus virginianus* of 13 southeastern states was moved to Beltsville in 1988.

Each lot consists of a composite sample of all species collected from 1 deer in a single vial. Detailed records of host and parasites are available but there is no index of parasites, and this collection has not been catalogued into the records of the U.S. National Parasite Collection except for specimens used in recent studies.

Personal collections: In addition to the large constituent collections, significant personal collections of the following individuals are housed at Beltsville as part of the U.S. National Parasite Collection. Those followed by an (A) have been catalogued fully: F. W. Douvres, J. H. Fischthal (A), A. O. Foster (A), A. Goldberg, E. P. Hoberg, R. Honess, R. A. Knight, D. C. Kritsky (A), R. E. Kuntz, G. R. LaRue, D. R. Lincicome, E. Linton (A), G. A. MacCallum, J. H. Sandground (A), L. Schultz, and H. J. Van Cleave. The uncatalogued personal collections can be accessed only through original logbooks, host records, or, in some cases, by taxonomic grouping.

Computerized records: Catalogued specimens of the U.S. National Parasite Collection were indexed by host and parasite scientific names in a card file until 1990 when a computerized catalogue system was adopted. The host and parasite card indices prepared until 1990 are by genus and then species so users must know all possible genera in which a species may have been catalogued. The pre-1990 records currently are being entered into the computer data base by the curators, students, and volunteers.

The new computer system provides all necessary labels, logbooks and reports and permits logical searches for any string of characters in all fields. The system uses a software package developed by Roy F. Weston, Inc. called Hypercabinet. It includes a document image management system that is based on Database III Plus. Images of old specimen records are stored permanently on optical discs. Hardware includes an IBM-PC and WORM drives to handle the optical discs (WORM = Write Once Read Many) that are similar to compact discs except that WORM drives allow the recording of information. A laser printer can print any stored image along with its entered data or any labels, formatted reports, or results of searches or queries. New specimen records are entered directly into a formatted screen. Images are unnecessary for new records. Images of old specimen records can be called to the screen by catalogue number and data entered into a formatted split screen. Editing is handled the same way. Data entry priority will be given to the class

and to names of the parasite and host. These will be completed by the end of 1992. Formatted reports include a specimen label for bottled specimens, logbook report listing all data, host-parasite list, and parasite-host list. Other formatted reports can be designed. Searches can be performed on any entered data through a query panel that selects a subset of the records meeting specified criteria such as parasite or host name, geographic locality, body location, or any combination of these criteria. Selected records can be scanned, printed, saved, or transferred to a floppy disc. The data from the hard disc are backed-up daily on magnetic tape and periodically on an optical disc. Future plans include the preparation of compact discs, magnetic tapes, floppy discs, and printed lists of all or part of the specimen records for use by the scientific community.

Services associated with the collection include a liberal and efficient loan program for specimens and an open door policy for visiting scientists. Literature cannot be borrowed but is available to visitors. A microscope will be provided for visiting scientists, but visits must be prearranged.

Facilities

The collection has been located in Building 1180, Beltsville Agricultural Research Center-East, Beltsville, Maryland 20705-2350, since 1960. The facilities have been improved by the addition of movable steel shelving on rails (compactors) in 1984 and a fire suppression system and electronic intrusion and fire surveillance systems in 1988. Current storage space can accommodate 10–15 yr of normal accessions (about 1,000 lots per year). Additional storage will be constructed in 1996 that will provide space for anticipated donations of large collections.

SERVICES

A library associated with the U.S. National Parasite Collection includes literature indices, tools such as the *Index-Catalogue of Medical and Veterinary Zoology*, *Helminthological Abstracts*, and a computerized service to access any commercially available index of the literature. Primary literature, including more than 4,000 volumes and 52,000 reprints filed by author, is in-house. The National Agriculture Library is within a 10-min drive. Other resources available to scholars are the 25 professional parasitologists of the 4 parasitology research laboratories in

Beltsville and the state-of-the-art facilities of those laboratories.

Deposit of specimens

The following accounts of deposit and loan procedures and suggestions for packaging of specimens follow Becklund's (1969a) recommendations but are repeated here with necessary revisions as questions are received frequently regarding these subjects.

The collection provides permanent preservation for type and voucher specimens of helminths and other animal parasites of animals and related material worthy of such preservation for future reference. A large percentage of the specimens on deposit are mentioned by their catalogue numbers in scientific journals. Scientists are encouraged to add valuable material. All donors are notified of the catalogue numbers assigned to the specimens they contribute. The information required for specimen deposit is: name of the parasite, name of the host (genus and species preferred), anatomical location in or on the host, geographical locality in which the host was collected, including latitude and longitude coordinates, name of the collector and date, and name of the identifier of the parasite and date. The above are the minimum data that should be provided. Additional information on fixatives, stains, clearing or mounting media, identifier of the host, the location of the host specimen (museum collection), the location of additional museum specimens of the parasite, and the name of the journal where the specimens will be described should be provided also. All this information should be indicated clearly in a letter packaged with the specimens and a copy sent under separate cover to alert the staff of their coming. Labels on slides or in bottles are not adequate for providing specimen data because they do not give all the necessary information and are difficult to read.

Additional information is required for the deposit of specimens for taxonomic purposes. Parasitologists proposing new taxa should be familiar with the *International Code of Zoological Nomenclature* (Ride et al., 1985) and particularly with the section entitled "Types in the Species Group." Copies of the code are available from the American Association for Zoological Nomenclature, National Museum of Natural History, MRC 534, Smithsonian Institution, Washington, D.C. 20560. If an author proposes a new species, all the specimens on which it is based,

except for ones the author refers to as variants, etc., are regarded as the type series. The following names are used in designating specimens in the type series.

Holotype: The single specimen designated as the name-bearing type of a species or subspecies in the original publication, or the single specimen on which a taxon was based when no type was specified.

Paratype: Each specimen in a type series, other than the holotype.

Syntype: Each specimen in a type series from which neither a holotype nor a lectotype has been designated.

Lectotype: A syntype, designated as the single name-bearing type specimen after the original publication of a species or subspecies name.

Paralectotype: Each of the original syntypes remaining after the designation of a lectotype.

Neotype: A single specimen designated as the name-bearing type of a species or subspecies taxon for which no holotype (or lectotype), or syntypes, or prior neotype are believed to exist. A neotype should be chosen from any surviving paratypes or paralectotypes (Ride et al., 1985).

Hapantotype: One or more preparations of directly related individuals representing differing stages in the life cycle together forming a name-bearing type in an extant species of protozoa.

Although not regulated by the code, many workers, when dealing with a parasite in which the sexes are separate and identifiable, designate as the allotype 1 of the paratypes of the opposite sex from the holotype. Another name occasionally used is hypotype, a described or figured specimen used in a publication to extend or correct the knowledge of a previously defined species (Frizzell, 1933). A list of 168 kinds of types with definitions was provided by Frizzell (1933).

Authors sending specimens to the U.S. National Parasite Collection for deposit should send them early enough to receive the numbers assigned to them for inclusion in their manuscripts. It is mandatory that the specimens be received before numbers are assigned to them. All specimens in a type series must be labeled clearly. Designation of a specimen on a slide containing others may be accomplished by drawing a line around the specimen with a diamond pencil on the lower surface of the slide.

Scientists are also encouraged to designate and deposit paratypes. These are utilized for study whenever possible in place of a holotype to avoid unnecessary handling and possible damage to the

latter. Moreover, authors of a new species frequently use their paratypes to demonstrate various diagnostic morphologic characters through the use of different fixatives, stains, or serial sections.

Loan of specimens

The specimens in the collection were deposited for permanent preservation. Consequently, they are not available as gifts or on loan for teaching, contests, demonstrations, or student collections. Type specimens are available for study at the Biosystematic Parasitology Laboratory and on loan under certain conditions for 60 days, for essential comparisons when the original description of a species is thought to be inaccurate or inadequate. A strong justification is required for risking types, especially the name-bearing specimens, in the mail. Graduate students requiring specimens for comparative purposes may obtain them through their major professor who must request, receive, and be responsible for their safekeeping and return. Investigators requesting the loan of type material should indicate in their request the collection number (if known from published descriptions), original scientific name of the parasite, author's name, and date of description. No attempt is made to change the recorded names of the parasites in the collection to indicate synonymy or new name combinations. Therefore, requestors must provide all synonyms that a species might bear in the collection records if they wish to know the entire holdings of a species. In addition, requestors should remember that the specimen records are by class, genus, species, and subspecies only, so requests by other groupings such as families cannot be accommodated. Requests for the concurrent loan of both holotype and paratypes of 1 species are discouraged, as is the concurrent loan of numerous holotypes of a genus.

Packaging of specimens for mailing

Specimens must be packed in strong containers and surrounded by shock-proof absorbent material sufficient to withstand severe blows in transit and to absorb fluid in case specimen bottles are broken. Screw caps on glass vials should be taped in place to prevent loosening in transit and placed in separate small plastic bags. Slides must be dry and individually wrapped in paper (approximately 3" × 5") before being placed in a slide box with shock-absorbing material between them. This procedure prevents fragments

of 1 broken slide from hitting and breaking adjacent slides and greatly facilitates the recovery and reconstruction of damaged specimens and slide fragments. Wooden and flexible plastic slide boxes are preferred to inflexible hard plastic boxes. A letter describing the specimens should be sent under separate cover to alert us that they have been mailed and a copy of this same letter should be placed in each package. All slides and vials must be labeled clearly. To insure safe and prompt receipt of correspondence and parasite material, the following complete address should be used: National Parasite Collection, USDA: ARS:LPSI, Bldg. 1180, BARC-East, 10300 Baltimore Avenue, Beltsville, Maryland 20705-2350.

FUTURE DIRECTIONS

The use of the U.S. National Parasite Collection has changed somewhat in the past decade, and we foresee an accelerated period of change in the next decade. The overall effect of past and future changes broadens the areas of parasitology that the collection serves. In the last decade parasitologists became convinced that a wide variety of studies in which natural infections were sampled should be documented by voucher specimens. Journal editors have obligingly required that accession numbers of voucher specimens be included in manuscripts reporting such studies. Thus, a large number of such studies has been greatly increased in value to future generations of parasitologists by insuring the availability of the specimens from the study. The availability of such voucher specimens provides insurance of the continued value of the original work even though the taxonomic status of the parasite may change or the original identification might be questioned for other reasons. Experimental studies in any branch of parasitology can enjoy the same benefits by depositing voucher specimens of their experimental organisms and publishing the catalogue numbers. The U.S. National Parasite Collection welcomes specimens from all areas of parasitology. These arguments also support the deposition, into accredited museum collections, of host specimens from which parasite type specimens are described (Frey et al., 1992).

In the decade ahead the need for germplasm of parasites for research purposes will influence the U.S. National Parasite Collection in content, facilities, staffing, and the uses for preserved, fixed, and living specimens. Almost all research on controlling parasites has had and will contin-

ue to have a dependence on specimen collections or other genetic resources for its success. Increasingly there is a need for living genetic resources for research efforts. However, biotechnology has advanced to a point where the use of fixed genetic materials is possible, and museum collections may be the only available source of needed genetic information in many cases. This need for genetic information will add new value to fixed parasite collections. It will also require changes in policy regarding the use of specimens and an evaluation of fixation and preservation methods to maximize the retrieval of genetic information from fixed specimens. However, most museum specimens are intended for permanent reference and are not expendable. Moreover, the role of museum collections in the development and maintenance of collections of living specimens must be determined.

The U.S. National Parasite Collection constitutes a critical resource for exploring patterns of abundance, distribution, diversity, historical interactions, and biogeography of host and parasitic organisms. It provides a repository for specimens that may serve as the foundation for evaluations of biodiversity in North America and other regions of the world. Biodiversity programs are expected to increase sharply in the next decade. Such programs will be dependent upon basic descriptive research tied to accurate specimen records. Together this will make possible studies of a wide range of concepts, such as refugia, the significance of speciation and dispersal, and how they relate to the maintenance of a diverse biota. Thus we predict that in the coming years, the collection will be the focus of intensive research, coinciding with a revitalization of systematics and the recognition of parasitology as a broadly integrative interdisciplinary science.

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