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CRITICAL COMMENT . . .

Designation and Curatorial Management of Type Host Specimens (Symbiotypes) for New Parasite Species

ABSTRACT: The accurate identification of a host organism is an important component in the taxonomic recognition of a new species of parasite. Correct identification, curatorial management, and safekeeping of the host specimen from which a parasite type specimen is collected is also desirable. We recommend that the host from which the type of a new parasite species is described should be designated as a symbiotype.

It has become increasingly clear that the current global rate of biological extinction far exceeds what would be expected by chance alone (Anonymous, 1989). This realization has triggered an international effort to measure more accurately the actual rate of extinction and to determine whether anything can be done to counter the trend. One of the startling discoveries of this effort is that our knowledge of one of the most basic variables needed to solve the equation, i.e., how many kinds of extant organisms exist and where they occur, either is understood poorly or is totally lacking, even for relatively well known regions such as North America. As a result, there is an urgent call for a substantial increase in survey and inventory research (Yates and Estes, 1992).

Usually, during field collections of plants or animals, standard voucher specimens are prepared and sent to appropriate museums and, in the past, these have been used primarily for morphological studies. However, in recent years, a wide array of collateral material such as karyotypes, frozen tissues for genetic analyses, and detailed ecological data, now commonly are preserved for each organism that is collected. One of the goals of diversity studies is to document the occurrence of symbiotic associates; therefore, parasites also are collected routinely from voucher organisms. A result of our increased awareness and interest in diversity is that the collection of specimens, and their collateral material, has preceded the development of standardized procedures and policies designed to facilitate management of this "data trail" between the final repositories of both hosts and their parasites. In certain cases, increased activity in field collections and studies of biological diversity have fostered corresponding increases in the descriptions of new taxa of parasites (Schmidt, 1974; Levine, 1988). Museums that house voucher specimens of hosts have had to compensate for this increased activity.

A particularly difficult problem involves specimens used in the formal designation of species. The "type" provides a standard reference for determining the application of a scientific name (Articles 61a and 72g of the *International Code of Zoological Nomenclature* [ICZN] [Ride et al., 1985]). Usually, the nominal taxon is based on a holotype, an original single specimen, or 1 specimen that has been singled out of a type series (remaining individuals of the series are called paratypes). In type series where no holotype has been designated (syntypes), a lectotype (the remaining being called paralectotypes) may be designated, or, in exceptional circumstances where no holotype, lectotype, or syntype exists due to loss or destruction, a new specimen may be designated the neotype. The importance of these specimens cannot be overstated. The type is objective and unchanging, whereas the taxon limits are subjective and subject to change (Ride et al., 1985). The type, therefore, is a taxonomic tool and provides a reference point for changes in taxonomy (Wiley, 1981). Only by reference to the type can doubt as to the identity of a nominal species be resolved (Mayr, 1969).

The designation of types in taxa of parasites follows the standard conventions used for other taxa in zoology. This is true even for taxa such as the coccidia, which have historically suffered problems because of poor preservation and hence the designation of a type (Bandoni and Duszynski, 1988). However, parasites present an additional component, namely, the parasite is associated intimately with its host taxon. Therefore, data on the type (of the parasite) should include the collection locality (recommendation 72h of the ICZN [Ride et al., 1985]), which is the collection locality of the individual host from which the type specimen was obtained. Mayr and Ashlock (1991) pointed out that the range of the host often takes the place of the geographic range of the parasite. The type locality of a parasite is, therefore, essentially the host and the collection locality of the host from which the parasite was collected. Thus, when new parasite species are described, not only is a type for the parasite designated, but information on the host specimen from which the parasite was taken also is recorded (e.g., Duszynski et al., 1982, 1988). The host species is generally referred to as the "type host" in parasitological literature (e.g., Ride et al., 1985; Gardner and Schmidt, 1986).

Patterns of host–parasite relationships revealed by studies of phyletic coevolution may indicate strict cospeciation between the 2 symbionts, colonization of the host by the parasite (host switching or phénomène de capture, see Chabaud [1957]), or both colonization and cospeciation (Brooks, 1985; Gardner, 1991). In the case of strict coevolution between the host and parasite taxa, the evolution of the parasite is linked to the evolution and, hence, taxonomy of the host. Thus, studies of host–parasite coevolution absolutely require that the host be identified accurately as conclusions relative to processes of coevolution are meaningless if the hosts are incorrectly identified. Additionally, Lynch (1989) suggested that sympatric speciation may be more common than previously thought. Host switching has been postulated to be an important prerequisite to sympatric speciation in parasites (Bush, 1975). Patterns of host-switching would remain undetected if hosts were incorrectly identified and described in the beginning.

Many parasites (e.g., coccidia) are thought to exhibit a relatively high degree of host specificity. Taxonomic changes in the host group would require that the host specimen from which the parasite taxon was described

be examined to refer the parasite accurately to the correct host taxon. In addition, different species of parasites may parasitize sibling species of hosts (Mayr, 1963). For example, 2 sibling species of *Octopus* were distinguished when it was discovered that individuals of the 2 species were parasitized by different species of mesozoan parasites (Pickford and McConnaughey, 1949). Detection of these morphologically cryptic host species is increasing rapidly as modern molecular methods are applied to systematic problems, and even in relatively well studied areas new taxa are being discovered at a high rate (e.g., Modi and Lee, 1984; Sullivan et al., 1986). Subspecies is likely the taxonomic category most susceptible to changes in such instances. Because many parasites form host races (Bush, 1969), it is essential to retain the host from which a parasite was described to assure that it will be assigned accurately to the correct host taxon.

Bacterial, viral, protozoan, insect, and helminth parasites are of major economic importance in issues of human health, veterinary medicine, and wildlife conservation. Wild animal reservoirs of zoonotic diseases are important not only in developing regions of the world (e.g., Chagas disease and leishmaniasis in South America) but in industrialized countries as well (e.g., alveolar hydatid disease in Switzerland and Australia and Lyme disease and babesiosis in the U.S.A.). Only through accurate documentation of the species of host from which a parasite is obtained can an understanding of its evolution, natural history, and zoonotic potential be gained.

Correct identification and safekeeping of the individual host from which a new species of parasite is described are extremely important. Scott and Hillis (1989: 569) noted the "importance of depositing voucher specimens of parasitological hosts and subjects of physiological studies in institutional museum collections" when they corrected the identification of a host from which a new trematode taxon had been described previously. Article 72g of the ICZN (Ride et al., 1985: 147) states that types "are held in trust for science by all zoologists and by persons responsible for their safe keeping" and provides several recommendations for their preservation. In accordance, the Museum of Southwestern Biology, The University of New Mexico, has developed a method for curating zoological type host specimens. We make the following recommendations for designating and curating zoological host specimens, which largely follow Mayr and Ashlock's (1991) suggestions for curating type specimens as well as recommendations of the ICZN (Ride et al., 1985).

1) A single host specimen from which the type of a new parasite species (or subspecies) is described should be referred to as a symbiotype from the Greek "symbio-" meaning to live together.

2) A symbiotype should be designated and preserved for every new parasite species (or subspecies) described. In some circumstances it is not possible to preserve the symbiotype as a standard museum voucher specimen (e.g., host is not killed, host is too large). In these cases, the host could be documented and archived through photographs and/or tissue samples that can be utilized in genetic analyses (see specific recommendations regarding tissue samples and photographs [Dessauer et al., 1990]).

3) Symbiotypes should be deposited in lending collections of public or private institutions where they will receive perpetual care (Yates et al., 1987). Because museum personnel may not be exposed to parasitological literature on a regular basis, parasitologists should alert museum personnel as to any symbiotype held in the collection.

4) Ideally, symbiotypes might be removed from the general collection and housed in a separate location (type case), though this may not always be possible. If space for a type case is limited, symbiotypes might be housed in the main collection. A distinctive colored tag should he selected to label symbiotypes clearly. Every effort should be made to ensure the safety of these specimens along with collateral material such as frozen tissues and karyotypes. The latter should be labeled in a distinctive fashion to alert users of the unique status of these samples.

5) A copy of the original publication from which 1 or several symbiotypes was designated should be made available.

6) The institution that houses the material should make every effort to make these specimens available for study by qualified researchers.

7) A list of symbiotypes in the collection should be published.

8) When first describing a new parasite species (or subspecies), every effort should be made to designate a symbiotype. The collection and/or institution in which the symbiotype is stored should be reported and the genus, species, identifying numbers (i.e., catalogue, collector, and collateral material), date of collection, and collection locality of the symbiotype should be reported accurately as appears on the specimen tag.

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