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Loss of Specimens in Heritage Collections: The Case of the Vespidae Wasps of the National Museum of Costa Rica

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Case Report

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Abstract

Scientific collections are vitally important for scientific research; however, the larger the collection, the more difficult it is to keep an accurate record of the specimens. This is especially true for the National Museum, which received a very large collection from the National Biodiversity Institute (INBio). It was necessary to initiate an inventory of specimens to corroborate the database. A review of the Vespidae (Hymenoptera) family revealed that 12% of the specimens were missing, as well as more than a thousand specimens that were not registered in the database. Considering these results, it is vital to consider inventories and systematic collection management as a priority technical task in the management of Natural History Museums.

Keywords: Collections; Loans; Vouchers; Wasps

Introduction

Scientific entomological collections play a fundamental role in advancing taxonomy, providing essential voucher specimens for species verification, description, and re-evaluation [1-3]. In particular, national museums act as irreplaceable repositories of biodiversity, preserving materials that document the temporal and geographic distribution of insects [2,4]. These collections allow for the validation of previous research and the promotion of new approaches, including the use of advanced molecular tools that revitalize modern taxonomy [5].

The National Museum of Costa Rica houses a historic collection of Vespidae, a family that includes social wasps such as Polistinae, Epiponini, and Vespinae. In Costa Rica, more than 100 species of Polistinae have been reported, encompassing 18 genera of paper wasps, with recent taxonomic keys developed specifically for the local fauna [6]. Natural history data, such as the fact that *Agelaia pallipes* is an aggressive species distributed from Costa Rica to South America and represents a prominent example of a Neotropical Epiponini [7], is available through collection records. Another example is the wasp *Leipomeles dorsata*, also recorded in Costa Rican collections, notable for its "cyclic oligogyny" phenology within its colonies [8]. Other common species in Costa Rica include *Polistes instabilis*, widely distributed in tropical lowlands and with colonial structures typical of polistines [9], and *Polybia occidentalis*, a eusocial wasp that builds stacked nests and is abundant in Costa Rican Neotropical forests [10], are just a few examples of the invaluable natural history data that scientific collections can house.

The Museum's collection not only contributes to regional taxonomic knowledge but also supports ecological, historical, and phylogenetic research on Vespidae in Costa Rica and Central America. The presence of types, historical lots, and reference material allows for the study of changes in distribution, taxonomy, and biodiversity, as well as the integration of morphological and genomic data into systematic reviews. This paper presents a detailed analysis

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of the vespidae collection at the National Museum of Costa Rica, highlighting its relevance to contemporary taxonomy and the documentation of Costa Rican vespidae fauna.

In this work, an inventory was made of the National Museum's collection of wasps from the Vespidae family, in order to verify the actual volume of specimens present in the collection.

Methodology

As part of the National Museum's daily activities, a new line of work was incorporated to clarify the actual size of the physical insect collection. In 2015, the collection was received from the National Biodiversity Institute (INBio), which recorded a volume of nearly three million specimens in its database. However, curators and visitors repeatedly failed to find the material that was supposed to be available. In response, an inventory process was initiated. Given the size of the collection, it was carried out by family as follows:

- The family Vespidae was selected to begin work on the order Hymenoptera.
- Using a code scanner, all the specimens physically located in the warehouses were inventoried, including those in the section of the shelves assigned to the family, as well as materials scattered in other sections, materials in transit, samples from other projects, and specimens in the process of being identified at the genus and species levels, which are usually separated into service boxes.
- Once the list of specimens was compiled, the code was compared code by code with the information in the database to determine the exact number of missing specimens.

Results

A total of 26,628 specimens belonging to the Vespidae collection were found in the Museum's database, of which 12% were found to be absent (Table 1).

Condition	Samples quantity
Total Specimens	26628
In Collection and Database	22354
Present in the Collection	23397
Present in the Collection but not recorded in the Database	1042
Recorded in the Database, but physically absent	3231

Table 1: Quantification of specimens of the Vespidae family.

It is important to highlight that among the lost specimens are listed 670 of *Agelaia myrmecophila* and 145 of *Agelaia pallipes*, both new reports for Costa Rica based on the review by Valverde, et al. [6] and that not a single one of these species remains in the collection.

Finally, another important piece of information is the verification of how the species appears written in the database, since when extracting it, it was found that some inconsistencies affected the accounting due to this problem, for example: the species Polistes dorsalis appeared written as "Polistes dorsalis", "Polistes dorsalis neotropicus" and "Polistes dorsalis?" with respectively 1, 96 and 1 specimens, which when reviewed corresponded to the same species for a real total of 98 specimens, this affected the metric by appearing as three different species, since the systems are not capable of detecting that they are the same, so it was necessary to manually clean the final inventory of taxa to achieve clear accounting.

Discussion

The loss of specimens in entomological collections is a recurring problem worldwide and has critical consequences for taxonomic research. In the case of Vespidae deposited at the National Museum of Costa Rica, the disappearance of material due to unreturned loans compromises the integrity of the historical collection and the ability of researchers to review species, especially when it comes to reference types or series [11,12]. This situation is not unique to Costa Rica: similar reports have been documented in Hymenoptera collections in museums in North America and Europe, where the lack of loan controls caused irreparable gaps in the biological record [13,14].

The loss of specimens has direct implications for taxonomy. Systematic reviews rely on historical material to establish synonyms, redescriptions, or the delimitation of new species [15,16]. The lack of vouchers hampers the application of molecular tools such as museomics, which allows DNA extraction even from ancient specimens, a technique increasingly relevant for Vespidae and other Hymenoptera [17,18]. Furthermore, the lack of specimens in the collection affects the verification of distribution records, which generates biases in biodiversity and conservation studies [19,20].

The problem of unreturned loans can be replicated in other sections of the insect collection, given that orders such as Lepidoptera and Coleoptera are also of high scientific interest and receive frequent requests for material [21,22]. Vulnerability increases when there are no clear digital tracking protocols or formal agreements with the responsible researchers [23]. This implies a heritage risk that goes

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beyond the scientific level, given that collections represent part of a country's cultural and biological legacy [24].

In economic terms, the repatriation of missing specimens poses a significant challenge. The recovery of material dispersed in foreign collections requires budgets for travel, digitization, and legal processes, which compete with funds allocated to routine collection maintenance [25,26]. Countries with high biodiversity but limited resources, such as Costa Rica, face a tension between safeguarding their heritage and supporting contemporary research programs [27]. A priority strategy is to strengthen international collaboration networks with museums and establish bilateral agreements to ensure the return of heritage material or, at least, access to digitized duplicates of the specimens [28,29].

Conclusions

- It is essential to maintain up-to-date inventories of natural history collections to record how many specimens are available for work and how many have been removed, whether due to loss, loan, or damage.
- Loan systems should be implemented in an orderly manner, marking each specimen as "on loan" in the database, if permitted.
- It is necessary to prioritize the cataloging of unregistered specimens within collection management efforts, as this better reflects the reality in the database, so that consultants can clearly understand the volume of material actually available for work.
- It is recommended to conduct an in-depth study of the entire insect collection at the National Museum, in order to identify the total missing specimens, as well as an approximate calculation of the monetary value of the collection, because unlike scientific collections in the rest of the world, this is part of Costa Rica's national treasure, so it is vital to clearly know this information.

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