



Loss of Specimens in Heritage Collections II: Economic Valuation of the Hymenoptera Collection of the National Museum of Costa Rica

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Abstract

One aspect that international policy has overlooked is the importance of scientific collections to the economy. Far from being a simple repository of specimens, each one provides the basis for decision-making regarding food security, health, conservation, and management of the natural resources on which the industry depends. This study reviewed and calculated the economic value of the Hymenoptera collection at the National Museum of Costa Rica, establishing standard values at the family level, considering a minimum value for regular specimens and a maximum value for type specimens. Thus, based on data from the National Museum, the collection is valued at approximately \$24,563,285.

Keywords: Ants; Bees; Wasp; Bioeconomy; Price

Introduction

Scientific collections constitute critical infrastructures for biological research, biodiversity conservation, and bioeconomic innovation. However, despite their importance, the maintenance costs and the true economic value of specimens have rarely been accurately quantified [1,2]. In the case of Costa Rica, the Hymenoptera heritage collection at the National Museum represents a unique resource that is part of the national treasure, but it faces significant challenges in terms of unreturned loans and specimen losses, which compromise its scientific and heritage integrity [3,4].

Entomological collections, and particularly those of Hymenoptera, provide essential information for evaluating ecosystem services such as pollination, natural pest control,

and nutrient recycling [5-7]. These services have a global economic value estimated in the billions of dollars, and their loss would have direct consequences for agriculture, food security, and the global economy [8-10]. Likewise, many Hymenoptera families include species of interest in biotechnology, commercial pollinator production, and biological control, justifying the need to establish an economic valuation framework applicable to collection specimens [11-13].

The recognition of scientific collections as national heritage implies that they must be governed by legal and administrative frameworks similar to those for cultural assets, with effective systems for loaning, safekeeping, and repatriation of specimens [14,15]. The lack of a measurable economic value makes the implementation of these mechanisms difficult, as

losses cannot be translated into verifiable heritage figures. This study proposes a methodology for assigning economic values to Hymenoptera specimens in the collection of the National Museum of Costa Rica, considering their scientific, heritage, and bioeconomic importance.

Metodology

Information Sources

To estimate the economic values of the Hymenoptera families present in the heritage collection of the National Museum of Costa Rica, data were collected from three main sources:

- Data were compiled from the scientific literature on pollinator ecosystem services [5,8,9] and biological control [11,12].
- Entomological market studies reporting insect prices in private collections and the sale of preserved or live specimens for pets and collectors [13,16].
- Indirect estimates derived from the heritage, historical, and scientific importance of the collections, including costs of repatriation of specimens and maintenance in museum institutions [2-4,14-29].
- Finally, the values found in these studies were considered to determine minimum and maximum average values for specimens at the family level, and minimum average values for unidentified specimens.

Valuation Criteria

- The assignment of economic values was based on five main criteria:
- Direct ecosystem value: associated with the contribution of groups to pollination, natural pest control, or soil formation.
- Commercial use value: determined by the existence of species used in biocontrol programs or traded in targeted pollination markets.
- Collector value: based on the demand for certain groups in private markets (e.g., families such as Chrysididae and Mutillidae due to their rarity and coloration).
- Heritage and scientific value: reflected in the uniqueness of specimens, especially when they are nomenclatural types.
- Relative availability: Families widely represented in international collections received intermediate values, while those that were rare or in low abundance were adjusted toward higher values.

Assignment Categories

Three reference categories were established for assigning values per specimen based on the information found:

- High economic importance: 70–200 USD/specimen (e.g., Apidae, Formicidae, Vespidae, Chrysididae).
- Intermediate importance: 40–120 USD/specimen (e.g., Braconidae, Ichneumonidae, Pompilidae, Halictidae).
- Low importance or primarily scientific/heritage importance: 20–60 USD/specimen (e.g., Evaniidae, Cynipidae, Tenthredinidae).

Calculation Procedure

Each family was classified within the previous categories based on its contribution to the criteria described. A range of economic value in US dollars per specimen was assigned, based on the median prices reported in the literature and specialized markets. The values were adjusted considering the representativeness of the family in the National Museum's collection and its potential use in applied scientific research.

Finally, total heritage value ranges were calculated by multiplying the average number of specimens per family by the estimated value, with an additional correction in the case of type specimens, for which a multiplying factor between 10 and 50% of the base value was established to determine the maximum value per specimen.

Finally, based on information from the National Museum of Costa Rica database (<https://biodiversidad.museocostarica.go.cr/>), a range of average values per specimen at the family level was calculated for specimens in the general collection, in order to define an approximate value for the Hymenoptera collection.

Results

Specimens from the families Apidae, Formicidae, and Vespidae were the families with the highest economic value (USD 100–200/specimen) due to their importance in pollination, pest control, and cultural value. Braconidae, Ichneumonidae, Halictidae, and Pompilidae had intermediate values (USD 60–120/specimen) associated with biocontrol services. Families such as Evaniidae, Cynipidae, and Tenthredinidae were placed in the low range (USD 20–60/specimen) due to their limited use in direct commercial applications, although they have high heritage significance.

The total heritage estimate for the collection suggests a value of several million dollars (Table 1), depending on the actual number of specimens per family and the percentage of nomenclatural types present, which were not considered as such in this calculation for reasons of simplicity, but rather as ordinary specimens. However, even with this detail in mind, the collection is valued at a minimum of \$24,563,285 based on the specimens registered in the MNCR database.

If we consider the results obtained in the previous article regarding the lost specimens of the Vespidae family [30], this collection would have an exact value of \$1,597,680, considering that there are no type specimens and all have

an average value of \$60, which in turn means that the lost specimens represent an economic loss of \$193,860 for the country.

Family	Value/specimen	Collection specimens
Agaonidae	70 – 100	833
Ampulicidae	40 – 80	257
Andrenidae	60 – 120	53
Aphelinidae	30 – 60	3
Apidae	80 – 150	36 102
Argidae	20 – 40	540
Astatidae	40 – 80	1
Aulacidae	20 – 35	12
Bethylidae	25 – 50	10 666
Braconidae	40 – 80	38 034
Bradynobaenidae	20 – 35	3
Ceraphronidae	20 – 35	1 979
Chalcididae	25 – 50	6 087
Chrysididae	100 – 200	2 455
Colletidae	60 – 120	1 645
Crabronidae	40 – 80	3 073
Cynipidae	20 – 35	136
Diapriidae	20 – 35	31 368
Diprionidae	20 – 40	1
Dryinidae	20 – 35	2 214
Elasmidae	20 – 35	93
Embolemidae	20 – 35	39
Encyrtidae	30 – 60	2 066
Eucharitidae	20 – 35	1 916
Eulophidae	30 – 60	8 833
Eupelmidae	25 – 50	781
Eurytomidae	25 – 50	2 352
Evaniidae	20 – 35	4 701
Figitidae	25 – 50	8 116
Formicidae	50 – 100	74 386
Gasteruptiidae	70 – 120	71
Halictidae	60 – 120	7 705
Heloridae	20 – 35	1
Ibaliidae	20 – 35	2
Ichneumonidae	40 – 80	116 910
Leucospidae	70 – 120	148
Liopteridae	20 – 35	12
Megachilidae	60 – 120	1 558
Megaspilidae	20 – 35	91

Monomachidae	20 – 35	247
Mutillidae	80 – 150	4 707
Mymaridae	40 – 60	1 416
Ormyridae	20 – 35	1
Pelecniidae	70 – 120	1 182
Pergidae	20 – 40	305
Perilampidae	20 – 35	454
Platygastridae	25 – 50	2 591
Pompilidae	40 – 80	16 683
Proctotrupidae	20 – 35	2 070
Pteromalidae	30 – 60	11 314
Rhopalosomatidae	20 – 35	548
Scelionidae	30 – 60	21 710
Sclerogibbidae	20 – 35	26
Scolecbythidae	20 – 35	21
Scoliidae	40 – 70	3 830
Sphecidae	40 – 80	8 292
Stephanidae	70 – 120	97
Tanaostigmatidae	20 – 35	6
Tenthredinidae	20 – 40	378
Tiphiidae	40 – 70	4 048
Torymidae	20 – 35	1 135
Trichogrammatidae	30 – 60	16
Trigonalyidae	40 – 70	53
Vespidae	60 – 120	25 589
Xiphydriidae	70 – 120	51
No Ident.	10 – 20	5 990

Table 1: Values in US dollars of the specimens by family.

Discussion

The analysis shows that the Hymenoptera collection at the National Museum of Costa Rica cannot be valued solely in scientific terms, but also as a bioeconomic heritage. Its status as a national treasure differentiates it from international collections, as it implies that the specimens are under the protection of the State, and their loan or loss represents not only academic damage but also national economic detriment [3,14].

The problem of unreturned loans highlights the need for a robust custody and traceability system, with clear legal responsibilities for each user [4,15]. Furthermore, a repatriation system for specimens, supported by international agreements, is required to recover material loaned or held in foreign institutions. This would not only preserve the integrity of the collection but also consolidate the country's scientific sovereignty.

The economic valuation presented constitutes a starting point for public policies that ensure the protection of scientific collections through insurance, loan contracts, and conservation budgets, integrating these holdings into a national bioeconomy strategy [8,10,11].

Conclusions

- The Hymenoptera collection at the National Museum of Costa Rica represents a biological and cultural heritage of high economic and scientific value.
- It is urgent to establish official economic values per specimen, which allow for calculating losses and supporting decisions regarding insurance, loans, and public policies.
- It is recommended to implement an effective repatriation system for specimens, accompanied by legal mechanisms and open digital databases.
- It is necessary to strengthen loan protocols with clear

legal responsibilities for researchers and receiving entities.

- The collection should be explicitly incorporated into the national bioeconomy strategy as essential infrastructure for research and sustainable development.

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