Taxonomy at Face Value: An assessment of entomological postage stamps as effective teaching aids for science educators

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Abstract

Entomological postage stamps are unique means of communication of science with the public and have been suggested as effective teaching tools in primary and secondary education. A survey of the taxonomic and other information contained on insect- and arachnid-themed stamps issued globally from 1891 to 2020 reveals that 30% of these stamps contain various errors and are scientifically unreliable. In addition, representations of insects are highly biased towards only two orders (Lepidoptera and Odonata), while other mega-diverse orders (e.g. Coleoptera, Diptera, Hymenoptera) are poorly represented or not represented at all. This phenomenon can negatively affect public perception of priorities in biodiversity and conservation. Standardization of taxonomic information on entomological stamps and implementation of rigorous quality control measures are encouraged to assure dissemination of accurate scientific information.

Keywords

Philately, insects, entomophilately, taxonomic bias, science education

Introduction

Postage stamps are unique outlets for countries to showcase important issues, raise public awareness, and commemorate persons or events of national significance. Stamps are windows into the art and culture of nations, and they document the spirit of time when they were designed and published. Thus, subjects represented on stamps are by nature wide and varied. With millions of hobbyists worldwide, stamp collecting is among the top past-times and its contribution to global economy is non-trivial.

Most philatelists are thematic stamp collectors specializing only on particular topics. Thematic catalogues exist for many subjects in biology, including for fungi (Greenewich

1997), birds (Eriksen et al. 2002), mammals (Eriksen and Eriksen 1986), horses (Wetmore 1966), flowers (Tucker and Weber 1960), fish, amphibians and reptiles (Bearse et al. 1977), marine life (Balazs and Linsley 1995; Zhao Bin 2000), prehistoric animals, and even cryptozoology (Shuker 2008). Entomology is among the most popular themes on stamps and subject of numerous books, catalogues and checklists (Smit 1978; Stanley 1979; Hamel 1990; Hamel 1991; Coles and Phipps 1991; Domingo-i-Gimeno 1992; Wright 1993; Bonafonte 2000; Costa Neto 2002; Covell Jr 2009; Congrove 2016). Several general online catalogues (e.g. Colnect, Stampworld, Stampdata, Lastdodo etc.) also aid collectors, while websites such as *Malaria Stamps* focus more narrowly on particular entomological topics.

It should not be surprising that the animal diversity represented on stamps does not accurately reflect the real world: While charismatic fauna appear frequently on stamps, obscure taxa are regularly neglected (Nemesio et al. 2013). In addition, scientific errors introduced through stamps, which are rarely corrected in philatelic publications, can spread misinformation at a global scale (Kozlev 2019; Sikes 2020). No reviews of the accuracy of scientific identifications on stamps exist so far. Here I present a first and comprehensive review of the reliability of taxonomic information contained on globally issued insect- and arachnid-themed stamps.

Material and methods

A list of unique depictions of insects and arachnids on postage stamps issued until 31 December 2020 was compiled using various published and online catalogues (Suppl. material 1). Marginal representations of insects (images on the mini- or souvenir sheets outside of the enclosing perforation of the stamps) were also included. All personalized, local, cinderella and illegal issues were excluded. Entomology-related entries with no insects shown (e.g. stamps depicting insect products, spider webs, beehive patterns, insect-borne diseases, insect-themed fishing lures, etc.) were also excluded.

Each stamp was individually databased and studied for accuracy of the scientific names and depictions of insects. Each unique insect depiction was given a separate entry; e.g. five species on a single stamp received five separate entries, while multiple specimens of the same species on a stamp were counted as one. Where life history was depicted, early life stages (caterpillars or chrysalis) were noted but not included in the count. Overprints and surcharges were not counted separately. The final list contained 20341 entries, 551 of which were Arachnids.

Verbatim IDs on stamp were recorded and separately adjusted according to the most current taxonomy. Unidentified species and higher classifications were all determined by the author. Errors and other discrepancies were noted and classified under six general categories:

a) *Insufficient taxonomy*: no taxonomic information, common names only, ID to some level above species, abbreviated family or genus names; b) *Incorrect taxonomy*: Misidentifications, mix-up of names in mini-sheets, incorrect spelling of scientific, common

or author's names, association errors (subspecies assigned to incorrect species, species assigned to incorrect genus), misallocations (genus and species epithet transposed), missing genus names, incorrect author or year; c) Incorrect information: Incorrect common name, count, geography, gender, cast, life stage etc., other spurious information; d) *Typographical errors*: Incorrect spacing, unnecessary or missing characters, problems with selected fonts resulting in loss of information; e) *Presentation errors*: Poor drawings, incorrect colors, inaccurate wing shapes or sizes, mix-up of upper- and underside of the wings; f) *Other*: Unusual combinations, common names used as scientific names or vice versa, 'Frenchified' scientific name used as common name (e.g. *Centrote Cornu*).

Errors resulting from production (perforation, offset, overprints etc.) were excluded. Certain inaccuracies, such as out-of-date taxonomies, incorrect capitalization or italization of scientific names, or impossible juxtapositions of species belonging to separate biogeographical realms were ignored primarily due to their overwhelming prevalence.

Depictions of each insect or arachnid order were counted separately for every issuing authority. Diversity was estimated using Shannon's and Simpson's indices for each country: Simpson's diversity index is a measure of dominance within a community and is weighted towards common species, while Shannon's index is a measure of evenness that combines species composition and abundance (Shannon and Weaver 1949; Magurran 1988; Veech et al. 2002). Taxonomic bias was examined by performing a chi-square test on the overall number of observed insect species depicted on postage stamps versus numbers expected if stamps were to reflect the actual species diversity among insect orders; Current species numbers in each order was adopted from Stork (Stork 2018).

Results

Number of representation of insects varied greatly by country and overtime, but the overall trend showed a steady increase since the 1950s (Fig. 1). Of the 866 issuing entities (Colnect 2021), 332 (38%) have issued stamps depicting insects. Among currently recognized countries listed by the UN (The National Accounts Section of the United Nations Statistics Division 2021), with the exception of Myanmar (Burma), South Sudan and Timor-Lesthe, all others have issued at least one insect-themed stamp. Exponential increases in overall number of issues was observed in the case of countries who have relegated their stamp production rights to the Lithuanian company *Stamperija*.

The first insect depicted on a stamp is a butterfly ornament in the hair of Queen Liliuokalani (1838-1917), on a Hawaii stamp issued in 1890 (Scott's stamp number: US-HA52). In 1902, four stylized *Hippotion celerio* (Lepidoptera: Sphingidae) decorated the corners of Queen Wilhelmina's portrait on a series of monochrome stamps issued by Netherland's East Indies (NL-IN48-58), and the first insect stamps in full color are a series published by Switzerland in 1950 (CH B197-200). None of those, however, had any scientific identifications. The First insect stamp with a scientific ID was issued also in 1950 by Sarawak, depicting a Rajah Brooks birdwing, "*Troides brookiana*" (Lepidoptera: Papilionidae) alongside King George VI's portrait (MY-SR180).

Themes. Beside simple individual portrayals where an insect is the main theme of the stamp, insects also appear in various scientific contexts, including biodiversity, conservation, biological control, diseases and their vectors, entomophagy, extinction and fossils, beneficial and harmful insects, mimicry, natural enemies of insects, parasitism, insect migration, insect products, pest control, and pollination. Scenes of collecting or studying insects are not uncommon on stamps. Insects sometimes accompany portraits of famous entomologists, politicians, Nobel laureates, athletes, and scouts. Biological curiosities, such as aberrations and gynandromorphs, have been depicted a few times on stamps, as well as yet unnamed new insects (e.g. “Discovered 2001: Working name - gladiator, order: Mantophasmatodea”; Namibia 2003, NA1010). One species inaugurated on a stamp is “*Othreis toddi, Zayas (In Litt.)*” (Lepidoptera: Noctuidae) (Cuba 1961, CU696); this name appeared on the stamp four years prior to its official description in a scientific paper (Hessel 1968).

Other popular themes in which insects have been incorporated include art, archaeology, astronomy, children’s animations, books and toys, ceramics, coins, costumes, dance, drama, ex-libris, fairy tales, flags, graphic arts, handicrafts, heraldry, jewelry, literature, medieval manuscripts, music, pop culture, petroglyphs, recycling, sculpting, space, and sports. Honeybees appear in beekeeping scenes, spiders on Halloween-themed stamps, and dung beetles and wasps on stamps about ancient Egypt. Fruit flies appear on stamps about genetics, while stamps with themes on economy and saving often depict ants. Some of the political topics in which insects have appeared include women’s liberation, nuclear proliferation, justice and freedom, enhancement of quality of life, gender equality, environmental protection, Individuality, integration of disabled people, and racism.

Uneven taxonomy. Overall, depictions of three arachnid and twenty-five insect orders were found on stamps. Unidentifiable insects and arachnids were counted under two general order-level categories “Insecta” and “Arachnida”, resulting in a total of 30 orders. Schematic insects appeared frequently on stamps as decorative elements or as part of organizational or event logos; since a scientific ID is not expected in those cases, all stylized depictions (1271 of 20341) were excluded from analyses. Among the remaining depictions, 3440 (18%) had no ID and 1006 (5.2%) were presented only with their common names. Among those with a scientific ID, 18 were identified only to order, 4 to superfamily, 136 to family, 15 to subfamily, 2 to tribe, 1 to subtribe, 315 to genus, 14095 to species (64 without generic assignment, 12 with sub-generic assignments), 918 to subspecies, and 14 to infra-subspecific names (forms and varieties). Overall, only 1078 scientific names included author’s name or abbreviation, and only 53 of those also included the year of description. Scientific names were presented in various levels and combinations (Suppl. material 2), and proper IDs, such as “*Psallus pseudoplatani* Reichl, 1984 (Heteroptera)” (Luxembourg 1990, LU837), were very rare. A total of 414 stamps also included one or more types of additional information (e.g. gender, life stage, cast, indication of specimen size, geography etc.), and in a few cases this information was also found to be erroneous.

Taxonomic bias. Lepidoptera unequivocally dominated entomological stamps (69%), followed distantly by Coleoptera (9%) and Hymenoptera (9%)(Fig. 1inset). A Chi-square test on the overall number of depicted insect species versus numbers expected if stamps

were to reflect actual diversity revealed significant over-representations of Lepidoptera (136.82) and Odonata (18.21), and to lesser extent Mantodea (1.31) and Scorpiones (1.67), while Coleoptera (-9.57), Diptera (-9.85), Acari (-3.84), Hemiptera (-3.02), and Hymenoptera (-1.26) were underrepresented (Fig. 2). Other orders did not deviate significantly from the expected values. Six insect orders (Archaeognatha, Embioptera, Grylloblattodea, Zoraptera, Thysanoptera and Strepsiptera) and many arachnid orders have so far never been represented on legally issued stamps, and several orders are depicted only once: Collembola (Falkland Island dependencies 1982, FK-GE68), Megaloptera (Belize 1995, BZ1044), Phthiraptera (Czechoslovakia 1968, CS1597), Psocoptera (Madagascar 1991, MG1013), Raphidioptera (Bulgaria 1993, BG3711) and Zygentoma (Kenya 2011, KE855k).

Within some orders, skewed representation towards charismatic or important species was observed. *Anopheles* mosquitoes dominated depictions in Diptera (56%) mainly due to the series of stamps issued globally for the campaign against Malaria in 1962, while honeybees (31.2%) were the prevalent depiction in Hymenoptera. With 289 depictions, the Monarch (*Danaus plexippus*) was the most common Lepidopteran species on stamps. Despite their dominance, so far only 34% of families, 7% of genera and 2% of species of Lepidoptera have been represented on stamps. Among butterflies, all six families (except Hedylidae), 36% of genera and 13.1% of species have been depicted, with the highest number of species in Papilionidae (53.5%), and much smaller proportions for Hesperiidae (2.88%), Riodinidae (6.23%) and Lycaenidae (7.41%).

Diversity Index. Most countries depicted insects in 1–7 orders, and with 15 insect orders depicted, Mozambique had the highest richness. In assessing the diversity and abundance of insect orders, Shannon's diversity index (H) was found to be more informative in defining diversity. Among countries issuing insect stamps, Qatar (number of stamps n=37) had the highest H diversity (H=2.07), followed by Canada (n=43, H=2.02) and Upper Volta (n=22, H=1.94). Many of the countries with greater numbers of entomological stamps showed much lower diversity, for example São Tomé and Príncipe (n=611, H= 0.67), Guinea-Bissau (n=651, H=0.82) and Guinea (n=799, H=1.11) (Fig. 3).

Errors. Observed errors were classified under six general categories: Insufficient taxonomy, incorrect taxonomy, incorrect information, typographical errors, presentation errors, and other (see Fig. 4 for some examples). On average, 30% of insect-themed stamps issued by all countries contained one or more errors. Stamps with more than one type of error were not uncommon, and even with stylized depictions excluded from the analyses, the most common type of error was lack of taxonomy where the depicted insect was the primary subject of the stamp. Top issuers with perfect accuracy (no errors) included Cocos Islands (n=31), St. Eustatius (n=25) and Saint Helena (n=17), while worst issuers (100% erroneous stamps) were Ajman (n=94), Manama (n=48) and Bermuda (n=7). While the overall proportion of errors was relatively consistent until 2010, it showed a decrease since then (Fig. 1). With a genus and species always given with very few errors, the massive number of repetitive stamps produced by the for-profit company *Stamperija* has unintentionally contributed to the overall decrease in proportion of errors on entomological stamps.

Discussion

Entomological postage stamps have been suggested as effective teaching aids in primary and secondary education (Palmer 1991; Matthews et al. 1997; Calver et al. 2011; Nawlakhe 2013; Turienzo 2018), even though it has been shown that stamp issues do not reflect species diversity in animals, including insects (Nemesio et al. 2013). The uneven distribution of insect orders issued on stamps by various countries, and the highly biased overall representations towards only two insect orders (Lepidoptera and Odonata), can have a negative effect on how students and the public perceives biodiversity and priorities in conservation.

Accurate and replicable taxonomic identification is the cornerstone of biology, without which entomological research risks becoming irreproducible and thus unscientific. Insects identified by unqualified persons often introduce errors in literature that take decades to rectify (Kozlev 2019). Publication of incorrect identifications or data about insects distorts public understanding of their distribution and biology, and misidentification of pest species can easily result in incorrect pest management and incur unnecessary costs. This study reveals that approximately 30% of depictions of insect on legally issued postage stamps worldwide are scientifically inaccurate and unreliable (see also Kabourek 2017; Raupach 2018). The most common type of error is lack of any identifying information when an insect or arachnid is the primary subject of the stamp. A universal standard needs to be implemented, perhaps through an international body such as the Universal Postal Union (UPU), to mandate issuing authorities to include a minimum of scientific identification on such stamps. Beside a common name, issuers should be required to provide a minimally acceptable scientific ID. However, since a species- or even genus-level identification may not be possible for certain groups of insects, it should not be mandatory. For example, many of the spider-themed stamps include an identification only at genus or family level mainly because the accurate identification of the depicted individuals to species require dissections.

Among the 20341 depictions examined, the source of identifications for depicted specimens was not provided even once. Considering their wide-ranging effects, these identifications should always be performed by professionals and peer-reviewed for accuracy by qualified entomologists. Packer and colleagues (Packer et al. 2018) suggest that science journals should require authors of entomological papers to provide, among other things, information about the individual who did their identifications, their contact information and/or institutional affiliation. I propose that such a standard should also be applied to entomological stamps, and major stamp cataloguers should require issuing authorities to make this information available to be included in their catalogues.

It is important to note that even though 30% of entomological stamps are not scientifically reliable, the remaining 70% are so to various extents, and as such they do indeed provide a unique and valuable resource for educators. Science communicators should remain cautious and skeptical when teaching taxonomy using stamps, however, the remarkable

diversity of other themes represented and the various contexts in which insects appear on entomological stamps provide an excellent avenue to familiarize students with aspects of entomology in art, culture, science and everyday life around the world.

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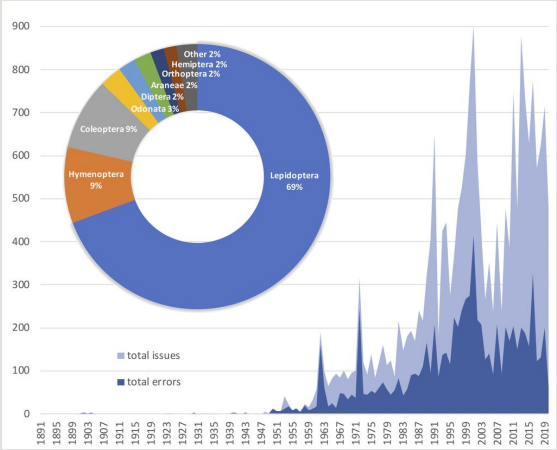

Figure 1.

Annual number of entomological stamps issued globally (light blue) vs. number of errors (dark blue). Inset: Proportional representation of insect and arachnid orders on entomological stamps, 1891-2020.

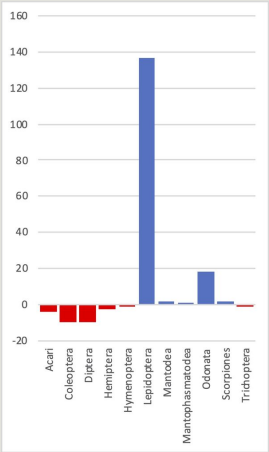

Figure 2.

Entomological stamps issued relative to the number expected to be issued assuming that stamp issuing should reflect the actual species diversity in each insect order. Blue bars show taxa for which stamp issuing was greater than expected, and red bars show taxa for which stamp issuing was lower than expected (x −1). Differences between observed and expected values were not significant in orders that are not shown (Chi-square test, P > 0.001).

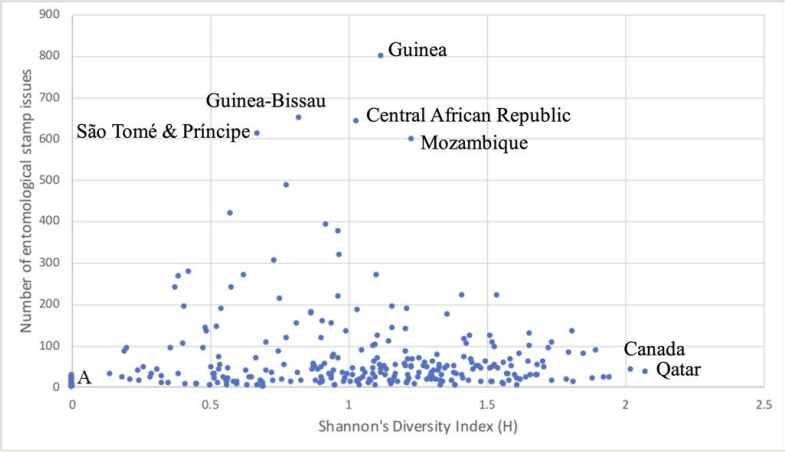

Figure 3.

Shannon's Diversity Index (H) vs. number of entomological stamp issues. Only issuers with highest H and highest number of issued stamps are labeled. Fifty-three countries with an H=0 (A, bottom left) have issued stamps belonging to a single order.

Figure 4.

Examples of errors on stamps. Numbers shown are Scott's stamp numbers (Sn). No scientific or common names: **A)** (*Phaeostigma notata*, Raphidioptera); Misidentifications: **B)** "Monarch" (*Euphaedra coprates*, Nymphalidae); **C)** "African Violets *Saintpaulia ionanthe*" (*Alcides metaurus*, Uraniidae); **D)** "Cymbospondylus" [Ichthyosaur!] (*Utetheisa ornathrix*, Erebidae); **E)** "*Ephemera Denica*" (*Rhyssa* sp., Ichneumonidae); **F)** "Bhutanitis lidderdalii" (*Attacus atlas*, Saturniidae); **G)** "Unidentified taxco" (*Melanis cephise*, Riodinidae); Misspelling of scientific and common names: **H)** "Checked White *Pontina protodice*" (Checkered White *Pontia protodice*); Incorrect information: **I)** "*Kallima inachus (Eastern Europe)*" (Oriental species); **J)** " *Lomagostus jeanneli* n. sp." (species described by Villiers in 1958); Poor depictions: **K)** "Citrus Swallowtail – *Papilio demodocus*" (stylized butterfly); **L)** "Cymothoe sangaris" (this is a red species); **M)** "Diaethria neglecta" (uppersides of wings shown as undersides and vice versa).

Supplementary materials

Suppl. material 1: Entomological stamps issued globally 1891–2020

Authors: Vazrick Nazari
Data type: Dataset
Download file (3.92 MB)

Suppl. material 2: Summary of taxonomic information presented on entomological stamps

Authors: Vazrick Nazari
Data type: Table
Brief description: First row shows number of stamps with no taxonomic information where the depicted insect was the primary subject of the stamp.
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