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How Many Edible Insect Species Are There? A Not So Simple Question

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Abstract: Insects used as food and medicine are receiving increased attention. There is a need to scrutinise recent estimates of which and how many insect species are used as we have noticed inappropriate assessments and overestimations. We review the contemporary list of edible insects of the world published online by Wageningen University and compiled by Ijde Jongema since it is widely used in the literature. Each of the 2403 entries were scrutinised, including checking name validity, verifying insect usage in cited references, and categorising each entry. Our revision indicates inappropriate assessments and inclusions such as spiders (not insects) and insect products (e.g., honeydew) when the insect itself is not used. With relevant and accepted definitions, we provide a critical assessment and estimate of the number of food insects (1611) and medicinal insects (81), which is lower than Wageningen University and Jongema's estimate of 2111 "edible insects". We acknowledge that our critical assessment may also be an overestimate or an underestimate and deserves further scrutiny, and we encourage a more practical use of a database of food and medicinal insects with our suggestion for a querying online curated database. We conclude that making accurate estimates is a difficult feat but that inappropriate assessments can and need to be avoided.

Keywords: food insect; medicinal insect; insect resource; inventory; biodiversity; entomophagy

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1. Introduction

After the antiphon "How many insect species are there on earth?" [1,2], a new question emerges: "How many edible insect species are there on earth?". Indeed, in recent years, the interest in human entomophagy, the practice of eating insects by humans (see [3] for an analysis of this terminology), has increased in western societies, offering a resurrection to the seminal work of Holt [4], Bequaert [5], Bergier [6], Bodenheimer [7] and DeFoliart [8], leading to renewed attention paid to former and contemporary entomophagous practices [9]. This resulted in attempts to inventory the insect species consumed by humans through the production and then update of a "List of edible insects of the world" made available online by Wageningen University [10,11]. This pioneering work is a considerable compilation of the literature dedicated to entomophagy. It is based upon 167 publications dated from 1919 to 2016, plus 12 referenced webpages and concludes there are 2111 edible insect species. This figure is close to the 2086 species given by Ramos-Elorduy [12] (but without giving its source), and close to the 2141 species listed in a similar approach by Mistuhashi [13]. Generally, a figure above 2000 is often echoed in publications related to entomophagy [14–17]. However, although we acknowledge Jongema [11] for accompanying his list with precautionary comments (e.g., "The names of species marked with check are mostly not valid, but this needs to be checked further"; "M is an insect eaten for medical purposes"; "Groups as termites and stingless bees are the most problematic in getting the right species names", "Hepialidae from China should be treated with care", ...), there still are issues with the way the list assesses "edible insects" and, consequently, with the estimated number of "edible insects" of the world.

Earlier comments were made on the 2015 [10] version (e.g., [18]) but were not or insufficiently dealt with in the latest 2017 [11] version. We therefore made a critical assessment of the publicly available "List of edible insects of the world (1 April 2017)" compiled by Jongema [11]. Our critical assessment should be likened to a detailed peer-review report of a widely cited and previously not peer-reviewed work. First, we suggest that a clear definition of what an "edible insect species" is should be added, to avoid the inappropriate listing and counting of, e.g., insect products or toxic species. Then, we suggest adoption of clear rules to face the taxonomic difficulties of such inventory. As Insecta is a hyper-diverse taxon with an ever-evolving taxonomy and frequent changes in species nomenclature, accurately identifying the specimen eaten is challenging as it requires the initial identification to be correct and changes in the nomenclature to be tracked. Finally, we advocate for a transformation of this list into a dynamic searchable online database, providing additional information about the traditional uses of each species, the process each species may require before it is to be eaten and biological traits that may be taken into consideration to promote the species' consumption or rearing.

2. Materials and Methods

The Jongema [11] database is organised in nine columns that are titled as follows: (i) genus, (ii) species, (iii) family, (iv) order, (v) common names, (vi) fauna, (vii) distribution and references, (viii) remarks, and (ix) life stages. Every entry is a scientific name found in the literature that deals with insects used as food and medicine. The "fauna" column indicates the biogeographical zones. The "life stages" column indicates which life stage is eaten (e.g., larvae) but may also clarify that an insect product (e.g., honey) or not actually an insect (e.g., gall) is consumed, although this is not specified for every entry. The "remarks" column may contain the notation 'M' to indicate medicinal use.

The "remarks" column may also contain a scientific name that may be accompanied by the notation syn. This appears to be a junior synonym of the entry, i.e., a name which describes the same taxon as a previously published name (a junior synonym is the latest accepted name of an organism; scroll down to 'synonym' at [19]). When the "genus" or "species" columns contain the notation syn, Jongema appears to indicate that the entry is a senior synonym, i.e., the earliest name given to a taxon (a senior synonym is an older name of a taxon; scroll down to 'synonym' at [19]). Hence, a senior synonym and a junior synonym are both names of a single species or genus. Jongema [11] is however not consistently clear about which entries are junior synonyms and which entries are senior synonyms. An arguably weak analogy, but one that may help to convey the gist of the relation between a senior and a junior synonym, is the boxer Cassius Clay, also known as Muhammad Ali. Cassius Clay, his birthname in short, can be regarded as the senior synonym (i.e., the first and thus older name he was given) while Muhammad Ali, the name he took when he was 22, is the equivalent of the junior synonym (i.e., his latest name). Both Cassius Clay and Muhammad Ali refer to the same person.

To provide more clarity about the entries and to improve the assessment of the entries, we scrutinized each of the 2403 entries in the publicly and online available list of Jongema [11]. After converting the pdf file to an excel file, we applied the following categorization (see Supplementary Materials for the Jongema list with our column Category added):

- **Food insect** is an entry that was identified to the species level of which at least one of its developmental stages is used as food, and with little to no ambiguity as to its reported identification in the cited literature. The entry is appropriately appointed under the latest accepted name of the taxon (junior synonym).
- **Food insect and medicinal insect** is an entry that is a food insect and that is also used for medicinal purposes. The entry is appropriately appointed under the latest accepted name of the taxon (junior synonym).
- **Medicinal insect** is an entry for which it is clarified in the remark column by "M" that the insect is used for medicinal purposes and hence not as food. Medicinal insect

entries include specimens not identified to the species level. We might be generous about medicinal insects that are not identified to the species level since some medicinal genera are food insect entries (a medicinal insect identified to, e.g., the genus level only, while that genus has already been listed as a food insect, might still, upon reinvestigation of the actual specimen, be the same species as the food insect and thus be both a food and a medicinal insect). It is the latest accepted name of a taxon (junior synonym).

- **Senior synonym** is an entry that is an older name of a taxon of a food and/or medicinal insect. We verified that for a senior synonym entry the food insect name and the medicinal insect name (junior synonym) was also an entry.
- **Unidentified, potential food insect** is an entry that is not identified to the species level but to the genus, family, suborder, or order level, and the genus, family, suborder, or order does not occur among food insect entries in the reported biogeographical zone and/or nearby zones. Nearby zones are considered because biogeographical zones do not actually follow political borders and an edible insect from, e.g., the north of Thailand (Oriental zone in the list) might very well also occur in the south of China (Palaearctic zone in the list). Additionally, if a particular consulted reference/author already identified an adult specimen to the species level in a certain genus and identified other adult specimens to the same genus but not the species level, we categorized the unidentified entry as a potential food insect, unless original references were not clear as is the case with citing DeFoliart [20] and this thus needs further scrutiny.
- **Unidentified, not potential food insect** is an entry that is not identified to the species level but to the genus, family, suborder, or order level, and the genus, family, suborder, or order does not occur among food insect entries in the reported biogeographical zone and/or nearby zones, and this could not be resolved.
- **Double entry** is a multiple-occurring name.
- **Not an insect** is an entry that does not belong to the class Insecta.
- **Insect product only** is an entry for which it is clarified in the remark or usage columns that not the insect itself but only an insect product is eaten (e.g., honey). In some entries, the life stages column indicates that the insect is consumed as well as its product (e.g., bee larvae as well as honey), and we then categorized the entries as food insects. In some other cases that involve insect products, species were given two separate entries: one for their consumed insect stages (e.g., larvae) and we categorized them as food insects, and another for their products (e.g., honey) and we categorized them as insect product only. Hence, our count of insect product only is an underestimate of the number of insects used for their products.
- **Subspecies** is a subspecies of an entry that is a food insect and/or a medicinal insect.
- **Unclear** is an entry with a name that is not valid or a probable misidentification that could not be resolved (e.g., a food insect that does not occur in the biogeographical zone for which it has been reported), and/or contains "check" in the genus or species column, and that could not be resolved neither by Jongema [11] nor by this study.

The name validity of junior and senior synonyms was mostly verified with [21]. We ignored new junior synonyms when they were validated after 1 April 2017 since Jongema [11] (2017) is updated to this exact date. Some cited references were checked for insect uses when we deemed it necessary (e.g., if the use was not clarified for a bee, we checked whether the bee developmental stages were used as food/medicine or if only honey was used).

Many entries qualify for multiple categories. For example, the entry *Araneus edulis* is both a spider (not an insect) and a senior synonym (its junior synonym *Nephila edulis* is also an entry). For this example, we found it more relevant to categorize the entry as "not an insect" than as a "senior synonym". We refrained from providing all possible categories that apply to each entry and we prioritised categorization in the following order: not an insect > insect product only > junior synonym + senior synonym (i.e., checked simultaneously) > subspecies > unidentified, potential food insect + unidentified, not potential food insect

(i.e., checked simultaneously) > double > medicinal insect + food insect and medicinal insect (i.e., checked simultaneously) > probable misidentification > unclear.

3. Results

What is an edible insect species? According to the Merriam-Webster online dictionary, "edible" means "something that is suitable or safe to eat" and "a food item" [22]. Such a definition is in accordance with Gahukar [23] who defined entomophagy as "the process of eating insects as food". Basically, edible thus refers to an act of alimentary consumption, to gain energy and nutrients, since alimentary means "of or relating to nourishment or nutrition" and "furnishing sustenance or maintenance" [24]. Consequently, an edible insect, as an edible fruit, should be a food that can be eaten either routinely or occasionally, with no deleterious effect on the consumer's health as far as the "edible insect" is included in a balanced diet. Here, we therefore prefer the term food insect, as once used by Gene DeFoliart for The Food Insect Newsletter [25], for entries that are insects specifically used as food (Table 1).

Table 1. Categorization of Jongema's [11] list entries and a comparison of edible insect species estimates between Jongema [11] and this study. N.A. = not applicable.

Categories	Jongema [11]	This Study	
		Number	Percentage (%) of Jongema [11]
Edible insects	**2111**	**N.A.**	**80 *****
Food insect		**1611**	**76**
Food insect species		1383	66
Food insect and medicinal insect species *		4	0.2
Unidentified, potential food insect species		224	11
Medicinal insect		**81**	**4**
Medicinal insect species		77	4
Food insect and medicinal insect species *		4	0.2
Double species entries	**292 ****	**291**	**N.A.**
Senior synonyms		186	N.A.
Double entry		105	N.A.
Not acceptable		**424**	**20**
Not an insect		19	1
Insect product		82	4
Subspecies		32	2
Unidentified, not potential food insect species		249	12
Unclear		42	2
Total (entries)	**2403**	**2403**	**1.00**

* For clarity and ease, the category "Food insect and medicinal insect" is mentioned twice. The calculation of the category "Edible insects" for "This study", however, only counts "Food insect and medicinal insect" once. ** We presume that Jongema [11] subtracted the number of "Senior synonym" and "Double entry" from his total number of entries to estimate the number of "Edible insects" since in our counts the difference between Jongema's [11] "Edible insects" estimate and total number of entries equals the sum of the number of "Senior synonym" and "Double entry". We, however, categorised one of the senior synonyms as an insect product since it appears only lac is consumed according to the cited reference. *** This value is included in the table to put into perspective the amount of error in percentage of Jongema [11]. Edible insects are food insects by definition; see text.

Insects that are used only for medicinal reasons and not for alimentary purposes should hence not be classified as edible insects. Medicinal means "tending or used to cure disease or relieve pain" [26]. It is therefore necessary to distinguish between medicinal insects and food insects. However, some entries are insect species used both for medicinal reasons and

for human food (Table 1). Even if disentangling what is a strict alimentary use of an insect from a medical use may be challenging, there are clear situations that are not appropriately treated in Jongema [11]. One of the most prominent is the case of thirty-six *Hepialus* and *Thitarodes* species cited as insects consumed in China based on Chen et al. [27]. All but three are potential hosts of the entomopathogenic fungus *Ophiocordyceps sinensis* [28] and their consumption is commonly related to entomotherapy rather than to entomophagy [29]. Table 1 summarises our assessment of 1611 food insects (including unidentified, potential food insects) and 81 medicinal insects, which includes four insects that are used both as human food and medicinally. All other categories are not acceptable for estimating the number of food and medicinal insect species of the world.

A subspecies is "a category in biological classification that ranks immediately below a species and designates a population of a particular geographic region genetically distinguishable from other such populations of the same species and capable of interbreeding successfully with them where its range overlaps theirs" [30], and "a particular type within a species, the members of which are different in some clear ways from those of other types of the species" [31]. Hence, a subspecies may not be treated as a separate species when the parent species or another subspecies of the parent species is already listed. This appears to occur 32 times, e.g., for the parent species *Locusta migratoria* and its three listed subspecies *L. m. capito*, *L. m. manilensis*, and *L. m. migratorioides*.

Arachnids are unfortunately entered as "edible insects". We found 19 arachnid entries ("Not an insect", 18 spiders and one tick entry; we did not further critically review how many species this could involve and leave this correction up to the host of the list). An insect is "Any member of Class Insecta (Hexapoda)" and Insecta have been described as follows: " . . . Anatomical features include: mandibulate tracheates with 3 body tagma (head, thorax, abdomen), multisegmented antenna, thorax composed of 3 segments, wings usually present or secondarily lost and associated with middle and posterior segments; each pair of legs articulated with and consecutively arranged on each of thoracic segments. Characterized by a complex life-cycle involving metamorphosis. . . . " [32]. In contrast, for example, Arachnids (including spiders and ticks) have been described as " . . . Body of 2 tagma (prosoma = head + thorax; opisthosoma = abdomen), lacking antenna; possessing several simple eyes, chelicerae, 8 legs, pedicel, unsegmented abdomen, book lungs and spinnerets at apex of abdomen; male palpus modified into a sperm-containing device for insemination . . . " [32].

Jongema [11] also inappropriately lists a large variety of insect-related products rather than strictly "edible insects": pollen and larval food harvested by wild bees, (*Xylocopa* sp.), honey produced by managed (*Apis mellifera*, *Trigona* sp., *Melipona* sp., etc.) and wild bees (*Bombus* sp., *Anthophora* sp., etc.), sweet exudates (manna, lerp sugar) produced by sap-sucking insects, vegetal galls induced by insects, wax, and lac. Some of those insect-related products are listed under the unclear mention of "excreta", while they are clearly identified as "frass" or "faeces" in the referenced publications [19,20]. This is the case for both the stick insect *Eurycnema versirubra*, the moths *Hydrillodes morosa* and *Aglossa dimidiatus*, whose faecal pellets are steeped to produce a special tea, in the same way as a slimming "bagworm tea" used to be obtained from *Psychid* larval cases in Mexico [19,20]. Put together, those insect-originating products represent about 82 entries, which is about 4% of the 2111 "edible insect species" listed by Jongema [11]. Some of these insect species that are not consumed per se, cannot, however, be completely separated from their product. This is true for the honey ants, *Camponotus inflatus* in Australia. Repletes, i.e., individuals full of sweet liquid, are dug up, but not the other individuals in the colony, and according to Bourne [33] "When the ant is eaten it is gripped by the head, the abdomen is placed between the lips and the honey is squeezed out into the mouth". There are online videos depicting that the ants themselves are not consumed (e.g., [34], or search for online videos with keywords such as "honeypot ants eating"). This also stands for the Mexican honeypot ants, different *Myrmecocystus* species as "They are held by the front end and the abdomen

is bitten off" [19,20], and for some Bumble-bees and *Zygaena* and *Syntomis* moths that are dissected to take off and eat the nectar-filled crop [35].

Precaution should be taken about reported species that are or could be toxic. Since this may have consequences on the insect consumer health, we must alert readers to the presence of the Colorado potato beetle, *Leptinotarsa decemlineata*, on the list. This species, like several other leaf beetle, bear aposematic colours which suggest it is distasteful and/or toxic. Indeed, Hough-Goldstein et al. [36] demonstrated it is distasteful and has no acute toxicity but "subtle" toxic effects over chicks. When not starved, *L. decemlineata* gut contains glycoalkaloids originating from its Solaneous host plants [37], and a toxic dipeptide is present in larval defensive secretion [38] so that *L. decemlineata* may be edible but probably requires a certain preparation. This may also apply to other leaf beetles such as *Aplosonyx chalibaeus* (Hope). *Aplosonyx chalibaeus* is a shiny-coloured beetle which feeds on taro, a plant known to be toxic when eaten raw [39]. A similar concern exists with the blister beetles *Meloe* sp. and *Mylabris* sp., which usually produce cantharidin that can cause poisoning [40] and the burnet moth *Zygaena* sp., which sequesters toxic cyanogenic glucosides as a chemical anti-predator defence [41]. Some other listed species were previously clearly identified as toxic in their raw state, thus requiring specific preparation prior to be eaten: *Zonocerus variegatus, Encosternum [Natalicola] delagorguei* [42], and the stinging caterpillar *Hadraphe ethiopica* [43], but are listed without any warning in Jongema [11].

The inclusion of 105 double entries is unfortunate. They seem to mostly be caused by organizing species by biogeographical zone in Jongema [11] when some species occur in multiple biogeographical zones. For example, the parent species *Locusta migratoria* is reported as an insect used as human food in the Australian, Oriental, and Palaearctic regions. Senior synonyms of food insects and medicinal insects that are entries are a form of double entries since the senior synonym(s) and the junior synonym refer to the same species. For each senior synonym entry, the accepted junior synonym in 2017 was also an entry. Fortunately, Jongema [11] seemingly realised this issue and we assume that he excluded 187 senior synonyms and 105 doubles, totalling 292 entries (Table 1), to estimate the number of "edible insect species" to 2111 out of 2403 entries. We, however, categorised one of the senior synonyms as an insect product since it appears only lac is consumed according to the cited reference.

Unidentified species entries include entries that are identified to the genus level only, and even the family, suborder, and order level. Admittedly, this is a difficult category to assess for many entries, and we assume Jongema [11] gave the benefit of the doubt to all the unidentified entries and included a single count for each in the estimate of "edible insect species" of the world. We recognized two categories of unidentified species entries (see Section 2). An unidentified but potential food insect is, e.g., a *Acathoplus* sp. cricket [44] since there are no other entries for this genus. Assuming that the genus has been correctly identified by the author, this entry probably involves at least one species. A clear unidentified but not potential food insect is the *Oecophylla* sp. weaver ant entry, reported from Cameroon and Congo. The *Oecophylla* genus has only two extant species, i.e., the African *O. longinoda* and the Asian *O. smaragdina* [45], both of which are entries themselves, and we classified these as food insects. Specimens of the *Oecophylla* genus collected in Cameroun and Congo can only be the African *O. longinoda*. It is hence incorrect to treat the entry *Oecophylla* sp. as a separate species from the only two extant species.

Unclear entries (see Section 2) remain unsolvable and should therefore probably not be treated as valid entries and should not be included in the estimate of the number of "edible insect species" of the world.

4. Discussion

We argued through accepted and relevant definitions against several substantial errors in Jongema [11] that have led to an inappropriate assessment of food and medicinal insects and an inappropriate estimation of the number of food and medicinal insects in the world. Rather than a list of edible insects of the world, Jongema [11] is a list of all names reported

in the literature of edible and medicinal insects and arachnids (with the lowest level of identification reported for an entry being the subspecies, species, genera, family, suborder, or order level) as well as edible products of insects, edible organs of insects, and edible galls in the world. Jongema [11] seemingly correctly removed 187 senior synonyms and 105 double entries, by our calculations (Table 1), to estimate the number of "edible insect species" to 2111, although we categorised one of the senior synonyms as an insect product since it appears only lac is consumed according to the cited reference. However, based on the list itself, this number is still a severe overestimate. By removing errors and applying a higher degree of critique on the entries, we estimate a smaller number of food and medicinal insect species than Jongema [11]. Our critical assessment estimates 1611 food insect species and 81 medicinal insect species known in the world in 2017, which includes four species that are both used as food and medicine. Making a reliable estimate is a difficult feat and we should therefore be aided by reducing the size of error. We find the difference between our critical assessment and Jongema [11] to be sizeable. Mitsuhashi [13] has made similar inappropriate assessments to Jongema [11], and his list should also be scrutinized.

If edible arachnids deserve attention [46], then why not include edible scorpions, or even shrimps (Crustacea), earthworms (Annelida), and snails (Mollusca) [47] in a list of "edible insects"? Where should one draw the line? This is where definitions show their value (see Results), but it is also where misconceptions arise. Some people may think that spiders are insects [48]. Moreover, the Merriam-Webster online dictionary also defines an insect as "any of numerous small invertebrate animals (such as spiders or centipedes) that are more or less obviously segmented—not used technically". The dictionary seemingly acknowledges the misconception of the public by adding that it is a non-technical definition. In science, accurate and technical definitions matter very much. Entomologists have hence expressed dissatisfaction that the public holds this misconception about spiders and insects [49]. The topic of insects used as human food and medicine attracts a vast array of professionals including anthropologists, archaeologists, economists, engineers, environmental scientists, human geographers, microbiologists, nutritionists, psychologists, sociologists, and others. They may include highly educated individuals who yet do not know that spiders are not insects. Entomologists should not call something an insect when they know it is not. It may very well feed the public misconception that spiders are insects.

Cochineal insects, *Dactylopius* spp., are not "clearly" insects used for food as they are only used as a dye and will provide energy or nutrients only in a limited capacity [50]. Nevertheless, at this stage, we categorize cochineal insects as food insects. Food is more than energy and nutrients for humans and colour plays a major role in food perception [51].

Insect taxonomy is a highly specialised field. The referenced literature in Jongema [11] and used for this study may include misidentifications unbeknownst to us, e.g., due to lack of access to taxonomic expertise and lack of access to the best taxonomic literature and technologies available such as molecular analyses. Our adjusted estimate for 2017 might be an underestimate or an overestimate.

It would be an underestimate if specimens were accidentally misidentified as already reported food and medicinal species, but maybe molecular analysis would have shown that the investigated specimens were actually not previously reported food and medicinal species. It would be an overestimate if specimens were accidentally misidentified as not previously reported food and medicinal species, but maybe molecular analysis would have shown that the investigated specimens were actually already reported food and medicinal species. For most publications it is unclear whether taxonomic expertise was available and used, and many publications do not clearly report who identified the specimens and if, how, and where specimens are stored.

Unidentified entries in our study were either discarded ("unidentified, not potential food insect species") or they were counted as single entries. This too can lead to both an underestimate as well as an overestimate, even for our category of "unidentified, potential food insect species". These entries were not identified to the species level but to the

genus, or even family, suborder, or order level. It is most apparent when these entries constitute batches of immature stages which are often notoriously difficult to identify through morphological assessments (e.g., [52]), and these are often eaten [11]. This is likely the case with, e.g., the entry Zygoptera (Damselflies), a suborder. Since only larvae were investigated, this entry might very well be a collection of multiple species. However, collected juveniles might also be of the same species as the adult specimens investigated in the same referenced literature. Arguably, some of our categorisations of unidentified entries deserve further scrutiny and we invite insect taxonomists to do so.

We recommend reorganizing the list of Jongema [11] into separate lists for edible (i.e., food) insects and medicinal insects, and, if desired, also for the other categories of edible arachnids, edible organs and products of insects, and edible galls. Further, an online curated and searchable database would increase the practical use of the information. Searchable online databases are recent tools already used in various fields of life sciences, including entomology (for species pheromone composition see Pherobase, [53]; for species occurrence, see GBIF [21]). One dedicated to edible insects would be useful as edible insects are a proposed means to improve livelihoods worldwide [9] and should be built with the following complementary objectives (1) facilitating research in the field of ethnoentomology, (2) promoting a sustainable entomophagy with both the consumer's health and insects' conservation as major concerns, (3) informing the lawmakers involved in the regulation of entomophagy practices, and (4) encourage the diversification of additional crop species.

Such a list should thus accurately name the insect species according to an internationally recognised taxonomic repository and allow the easy (automatised?) tracking of nomenclature changes. An update of Jongema [11] is already necessary as papers have since been published that contribute previously unreported species (e.g., [52,54]). Additionally, the use or uses of each species should be stated as clearly as possible regarding its type (alimentary, medicinal, or other) and frequency, and detailing the preparation preceding consumption. This should be performed referring to some pre-defined nested categories such as first "alimentary" and then "routine year-round food" or "routine seasonal food" or "occasional consumption (for peculiar social events?)". Pharmaceutical uses should be clearly indicated and toxicity should be documented, when possible, as "No known toxicity", "Probably toxic if eaten with no previous preparation" or simply "Not evaluated". This could also aid our conversation about what we think we know, what we do not know, and what we might know about food and medicinal insect diversity of the world.

5. Conclusions

We acknowledge that it is difficult to accurately assess food and medicinal insect species and estimate their number in the world based on existing literature. Further, we clearly compliment Jongema for his huge work of compilation. However, we show that the final estimates are inappropriate and therefore misleading. We argued that most of the identified errors should be easy to fix in the future by critically assessing each new entry. Our focus on Jongema [11] was entirely due to its wide acceptance as a benchmark among edible insect publications. We have argued that clear and technical definitions as well as critical scientific argumentation are most helpful in the process of assessing food and medicinal insect species and subsequently estimating the number of food and medicinal insect species. We are confident that the mark of 2000 food insect species will soon be surpassed, even with assessments as critical as ours, when edible insect studies maintain taxonomic standards, further increase their attention to biodiversity and inventory work (such as in the limitedly explored regions of South America and the Pacific), and the use of molecular analyses is increased.

Supplementary Materials: The following supporting information can be available at: https://www.mdpi.com/article/10.3390/d14020143/s1: Table S1: Database. A publicly available dataset was analysed in this study. These data can be found here: [11] and ref citation [55–75].

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