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Review

The Potential Impacts by the Invasion of Insects Reared to Feed Livestock and Pet Animals in Europe and Other Regions: A Critical Review

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Abstract: While the use of alien insect species for food and feed can help to alleviate protein shortage and provide for a more sustainable feed production, their invasive potential should be considered since invasive alien species represent one of the five main global threats to biodiversity. In the European Union (EU), eight insect species have already been authorized to be used as feed ingredients for aquaculture organisms, pets, poultry, and pigs. These species were selected based on available national risk assessments, as most of them are non-native to Europe. However, it is not clear how these risk assessments truly consider all EU bioregions, given that the information used was mostly biased towards northern European regions. As a large proportion of invasive alien species already present in the EU were introduced unintentionally, it is therefore crucial to understand and manage the potential pathways of such introductions in a more effective way. Here, we provide a critical overview of the potential risks of rearing alien insect species as feed or as pet food (for both livestock and exotic pets) in the EU. The results showed that some of these insect species have an invasive potential, either due to their reproductive capacity in different climates or due to the fact that they have already established populations in areas where they were introduced, with negative effects on local ecosystems or causing economical losses. For this reason, it is recommended that risk assessments should be performed in other EU bioregions as well as monitoring programs to control the spread of insect species with invasive potential. In addition, other available native insect species with potential to be used as feed ingredients should be considered.

Keywords: invasive alien species; ecological impacts; biological invasion; insect pests; insect farming

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1. Introduction

The current prediction of human population increase (estimated in more than 9 billion by 2050) urges the need to provide sufficient nutritious food for all. However, the need to increase food production does not come cheap, as the availability of natural resources, arable land, and natural stocks are decreasing [1]. More recent estimates suggest that food production will have to increase by 60% to feed everyone [2].

Most of the arable land worldwide is used to grow grains, including soybean, rice, and wheat. These crops require large areas of arable land often in regions of ecological and economic global importance, contributing directly for the deforestation in several developing countries [3,4]. In addition, grain crops such as soybean have a high energy, water, chemicals, and soil footprint [5]. A huge proportion of these grains is produced for animal feed. Some animals (e.g., carnivorous fish) require a high protein diet for optimal growth [6]. Fish meal and soy meal both have high quality protein and are the most used protein sources for animal feeding [1].

Fishmeal and fish oil are obtained from natural stocks, representing an important percentage of the total world fisheries. The total world fish production has increased from 167 million tonnes in 2014 to 179 million tonnes in 2018, and the share of world fish production used for direct human consumption has increased from 146 in 2014 to more than 156 million tonnes in 2018. Almost all of the remaining 22 million tonnes (21 million in 2014) were destined to non-food products, of which 82 percent (18 million tonnes) (15.8 million in 2014) were processed to produce fishmeal and fish oil in 2018 [1,7].

Global feed production is the main cause of the environmental impacts of livestock production, representing up to 71% for eutrophication and 85% for climate change induced by pig production, 78.8% of environmental impact for poultry production, and up to 99% of marine eutrophication for farmed fish [8–11].

Therefore, due to a growing population and the environmental impacts currently caused by feed production and use, there is a clear need for alternative sources of protein for animal feeds and human food. However, these need to be obtained through sustainable methods. In this context, insects show great potential, as their production requires using warehouses rather than large field areas. They are good food converters, use much less water than livestock or agricultural crops, and have high protein values depending on species and life stage (larval, pupal, adult) [12].

When compared to other animal sources of protein, insects have higher edible portions, since they can be eaten whole (with only a few parts at times not being used) [12]. In addition, some insect species can be used for the conversion of organic wastes, which reduces the rearing costs [13,14].

Hence, insects are good alternatives for animal protein production and over the last years several companies have started to produce insects at a commercial scale for use as animal feed or even human consumption as snacks or cereal bars. In the EU, there are several features regarding the species of insects used for this end, namely not being pathogenic or not having adverse effects on plant, animal, or human health (e.g., diseases vectors). Additionally, these insects should not be listed either as protected or invasive alien species. These features were introduced in the EU by the commission, through the Regulation No 2001/999 (Annex IV), amended by the Regulation 2017/893 (Annex X), which authorizes the use of insect protein as an ingredient for aquaculture feed. The insect species currently reared in the EU are considered to fulfil all safety conditions legally determined for insect production for feed. To date insect species whose production has been authorized in the EU for this purpose are: Black Soldier Fly (*Hermetia illucens* Linnaeus, 1758) (Diptera: Stratiomyidae), Common Housefly (*Musca domestica* Linnaeus, 1758) (Diptera: Muscidae), Yellow Mealworm (*Tenebrio molitor* (Linnaeus, 1758)) (Coleoptera: Tenebrionidae), Lesser Mealworm (*Alphitobius diaperinus* (Panzer, 1797)) (Coleoptera: Tenebrionidae), House cricket (*Acheta domesticus* Linnaeus, 1758) (Orthoptera: Gryllidae), Banded cricket (*Gryllodes sigillatus* (Walker, 1869)) (Orthoptera: Gryllidae) and Field Cricket (*Gryllus assimilis* (Fabricius, 1775)) (Orthoptera: Gryllidae) [15].

In November 2021, another insect species was added to the list of currently authorized insect species for production of animal protein for feed-use in the EU, which was considered to have the safety requirements for feeding non-ruminants farmed animals, the domestic silkworm (*Bombyx mori* Linnaeus, 1758) (Lepidoptera: Bombycidae), a species already farmed for the silk market, and implement through the Regulation (EU) 2021/1925.

Moreover, also in 2021 with the Regulation (EU) 2021/1372 of 17 August 2021, the EU Commission Regulation lifted the "feed ban" rules for non-ruminants farmed animals, which now has authorized the production and use of insect proteins as an ingredient in formulated feeds for poultry, swine, pets (e.g., dogs, cats, birds or reptiles), and fur animals (e.g., Mink (*Mustela lutreola* (Linnaeus, 1761)) (Carnivora: Mustelidae)).

Some of these EU authorized species are exotic in the European territory (e.g., *A. diaperinus*, *G. sigillatus*, *G. assimilis*, and *B. mori*), and it is not clear how risk assessments related to insects being used as animal feed conducted in northern European countries, such as Belgium, the Netherlands, or France, can be representative of all EU bioregions, namely those in southern countries. Moreover, most insect species that are considered invasive in Europe were introduced unintentionally (e.g., Asian tiger mosquito *Aedes albopictus* (Skuse, 1894) (Diptera, Culicidae), Asian long-horned beetle *Anoplophora chinensis* (Forster, 1771) (Coleoptera, Cerambycidae)), by means of transportation of agriculture products, ornamental plants, or shipment transport, with just a small portion being deliberately introduced for biological control (e.g., the multi-coloured ladybeetle, *Harmonia axyridis* (Pallas, 1773) (Coleoptera, Coccinellidae), the whitefly parasitoid *Encarsia formosa* Gahan 1924 (Hymenoptera, Aphelinidae), and the ailanthus silkmoth *Samia cynthia* (Drury, 1773) (Lepidoptera, Saturniidae)) [16,17].

Exotic species can become stablished in new environments through a diverse evolutionary adaptability [18], and those with a favourable genetic variability if introduced in habitats with particular conditions and biotic pressures may often experience rapid evolutionary adjustments [19]. Moreover, species currently considered to have low potential as invasive species might increase this potential, as climate change pushes mean global temperature up, which may prompt the spread of insect species to higher latitude and altitudes (increasing the threat of pests in crops and forests) [20,21].

Increasing temperatures have enabled the spread of insect species to more northern parts of Europe with the additional aid of accidental transport by humans, or indirectly benefited by human infrastructure [22]. This northward movement of insect species is expected to cause more impacts to the environment, where insect pests may present both increase in population growth and metabolic rate in temperate regions [23]. Additionally, with a 2 °C higher mean global temperature, the crop losses for insect pests are estimated to escalate by 46, 19 and 31% for wheat, rice, and maize, respectively [23]. Furthermore, there is no likely saturation for the current invasion of species in a global scale with new pathways for introduction appearing constantly [24].

The present work aims to provide a critical review of potential underling risks of rearing non-native insect species for both livestock feed and as pet food with an emphasis in the EU, but also addressing other regions around the world and discussing the possibility of rearing native species.

2. Materials and Methods

For this critical review, a systematic search was performed using the search databases of Web of Science™ (WoS™), Scopus, Google Scholar, Science Direct, CABI Data Repository, and the Global Biodiversity Information Facility (GBIF). We searched for peer-reviewed journal articles that provided an evaluation on the nutritional composition of commercially available insects currently used as feed for livestock and pets.

The keywords and search syntaxes used were: "insect meal", insect nutritional composition", "insect rearing", "insect as feed", "live food", and "insects for animal food". We also used several combinations of these keywords in various languages (for example, traditional Chinese, Japanese, English, French, Spanish, and Portuguese).

Due to the lack of scientific information on the name of insect species commonly used as pet food, we complemented our search by surveying online fora of exotic pets' care, and exotic pet shops websites to find this information. The species found to be produced as exotic pet's food were only included if found on two or more websites and those no longer available in the market were excluded.

Insect species used both for livestock and exotic pets were then selected and a systematic search was performed in the search databases previously mentioned to investigate their invasive potential by adding the species name to keywords: "first record", "invasive potential", "temperature limit", "rearing conditions", "pest control", and "thermal performance". This search was carried out mostly targeting the EU, but also addressed other regions around the world (hence the use of search engines in different languages).

Species found to have potential nutritional profile to be used as animal feed or with desirable rearing conditions for this end were included as potential opportunities to the current insect markets.

The present study specifically targets insects reared as feed for livestock and pets, considering the positive and negative impacts they have, both for native fauna and flora and the environment. Therefore, insect species used exclusively for human food, alternative medicines, or snacks were excluded since they are not used for animal feed, as well as species harvested in the wild.

To avoid confusion onwards, the terms used are exotic pet's food (for insects that are sold whole dried), live feed (for when they are sold alive to feed exotic pet's), pet's feed (for when insects are used as ingredients for pet feed), and livestock feed (for when the insects are used as ingredients for livestock feed).

3. Results

3.1. Potential Risks of Introduction of Exotic Insect Species Being Used for Livestock Feed and Exotic Pets' Food in Europe

The introduction of exotic species is an important cause of many agricultural crop losses, with high impacts in food production [25]. The impact suffered from the introduction of insects pest is especially harmful in developing countries with less diverse Gross Domestic Product (GDP) income such as Sub-Saharan Africa countries, that are more dependent on agriculture [25]. Despite increasing awareness, invasions by alien species are still occurring at an accelerated pace due to human transportation and activities worldwide [26], with the introduction of alien species being one of most rapidly growing causes of native species extinction worldwide [18]. Insects' invasions have high economical costs, with estimates of a minimum of US$ 70 billion (€63 billion) per year globally in goods and services and US$ 3.6 billion (€3.25 billion) in Europe alone [27]. The total health costs caused by invasive insects can exceed US$ 6.9 billion (€6.23 billion) per year globally [27].

Nonetheless, risk assessment studies in more southern European countries addressing insect species currently produced for exotic pet's food and livestock feed in Europe, namely on their invasive potential, or impacts to native species, are still largely missing. This scenario is even more pronounced for insect species being produced to feed exotic pets, a practice that more often than desired is unregulated. We provide here a compilation on the most common insect species reared as exotic pet's food and as livestock feed and address if the species is native to the territory where it is being produced and discuss its potential for invasion.

3.1.1. *Hermetia illucens* Linnaeus, 1758 (Diptera, Stratiomyidae)

Commonly known as the Black Soldier Fly (BSF), *H. illucens* (Figure A1a) currently has a cosmopolitan distribution, being native from the Neotropical region [28]. It is a species largely produced in the EU, for both pet food and aquaculture feeds. One of its key features is its remarkable waste processing ability that is already being explored by some companies [14]. BSF is also the target of many studies on its use as an ingredient for aquafeeds formulations [29,30], as well as feed for livestock, such as pigs [31]. Although rare, there are records of BSF causing myasis in humans. A report from Cuba specifically refers a case of intestinal myasis caused by the larvae of BSF [32]. There are other records of enteric myasis in humans caused by this species in Malaysia and Costa Rica [33,34]. Additionally, a rare case of animal myasis caused by BSF was reported from a domestic dog in Argentina [35]. Due to its industrial use, BSF has settled across Europe, now being considered a cosmopolitan species found in the wild in multiple countries, that continues to spread its presence and having been recently recorded from Slovenia in 2011, Greece in 2015, the Czech Republic in 2017, and Russia in 2019 [36–39].

3.1.2. *Musca domestica* Linnaeus, 1758 (Diptera, Muscidae)

The common housefly, *M. domestica* (Figure A1b) is a cosmopolitan species, that it is known to carry diseases and to be highly associated to humans' activities. It is often found close to kitchens in residences and restaurants, where there is food available which attracts them to breed, becoming a nuisance for people and possibly spreading pathogens [40]. The house fly also has usages for animal feeding or food waste management, being studied for use in aquaculture or poultry feeding [41]. They can be used successfully for swine manure biodegradation, reducing its ecological impact [42]. They can also be successfully used as poultry feed, increasing the live weight of chickens [43]. This species is known to carry pathogens for both humans and farm or pet animals such as *Salmonella enteritidis* [44], *Escherichia coli* O157:H7, and *Campylobacter* spp. [45]. The house fly displays a long fly range, being able to reach up to 7 km and, as such, colonize distant places from its breeding sites [46].

3.1.3. *Drosophila melanogaster* Meigen, 1830 (Diptera, Drosophilidae)

This fruit fly species, *D. melanogaster* (Figure A1c), is originated from sub-Saharan Africa, but now has a cosmopolitan distribution, including islands [47]. This species is widely used for research in genetics, microbial pathogenesis, physiology and life history, since the early 1900′s, making it one of the most studied insect species [48]. In the exotic pet market, they are found to be sold as flightless flies, that are suitable as live feed for small species of lizards and anurans [49]. Although they are distributed around the world, there is no record of impacts caused by this species, mostly due to the fact that they feed on decaying matter, not fresh fruits, and they are not known to carry any human pathogens [48].

3.1.4. *Drosophila hydei* Stutervant, 1921 (Diptera, Drosophilidae)

This species is known as fruit fly, or vinegar fly, *D. hydei* (Figure A1d). Despite the name, it is not a pest for fruit crops, as some other flies within the genus, but rather feed on decaying and decomposing fruit on the ground [50]. It is a cosmopolitan species and popular live feed for pets such as reptiles, amphibians, or beta fish [51]. This species is sold at online pet shops as flightless flies, which makes them popular for feeding exotic pets, also this flightless feature lowers its ability for escaping and invade new ecosystems [51].

3.1.5. *Gryllus bimaculatus* De Geer, 1773 (Orthoptera, Gryllidae)

The Mediterranean field cricket, or two-spotted cricket, *G. bimaculatus* (Figure A1e), is distributed along south Europe, Africa and Asia [52]. In the wild they have very small effective populations sizes, and need warm and moist oviposition sites [53,54]. They are popularly used to feed pet tarantulas and other animals [55]. Although this species needs warm climate for its development, they have been recorded in colder places in Europe, namely Belgium, Germany, and Poland, according to the Global Biodiversity Information Facility [56].

3.1.6. *Gryllodes sigillatus* (Walker, 1869) (Orthoptera, Gryllidae)

The tropical house cricket, *G. sigillatus* (Figure A1f), native to Southeast Asia, is common on urban areas and sometimes occurs indoors, feeding on litter and vegetables, causing losses and a nuisance for households [57]. This cricket is used in Europe as pet food and can be sold live or canned [58]. This species was recently recorded as an invasive insect in Costa Rica, meaning it is spreading across the globe [59]. Moreover, the species was also found in the wild in the EU, specifically in Belgium, Germany and Austria [60]. The microbial content of this species was recently analysed, but more studies are needed for the identification of potential pathogens [61,62].

3.1.7. *Gryllus assimilis* (Fabricius, 1775) (Orthoptera, Gryllidae)

Gryllus assimilis (Figure A1g), is a species of common brown cricket native to Jamaica and distributed in the Caribbean islands, south of Texas and Mexico [63]. It is commonly found in pet-shops being used as pet food in both the USA and Europe. Although in Europe many sellers claim to sell *G. assimilis*, they are actually selling *Gryllus locorojo* Weissman and Gray, 2012 (Orthoptera, Gryllidae) [64]. They have spread through Eastern United States, currently being found close to fish markets in Florida, and may have been introduced by human activities and has a large population, in comparison to native crickets [65]. Although not settled in the wild in Europe, it has the potential for colonizing the Mediterranean area due to the absence of diapause [66].

3.1.8. *Acheta domesticus* Linnaeus, 1758 (Orthoptera, Gryllidae)

Acheta domesticus (Figure A1h), commonly known as the house cricket, is likely native to southwestern Asia, but is now a cosmopolitan species due to its production and use to feed pets. Moreover, it is being tested for mass production for use as a feed ingredient replacement for fish meal for feeding livestock [67,68]. Wild populations have been found in California and Mexico, probably resulting from individuals that escaped from pet shops and bait shops [69].

3.1.9. *Tenebrio molitor* Linnaeus, 1758 (Coleoptera, Tenebrionidae)

Commonly known as mealworm beetle, *T. molitor* (Figure A1i) is native to the Mediterranean region, and has been introduced to most temperate territories [70] and is now nearly cosmopolitan, found in all its life stages mostly in stored goods (e.g., wheat flour, maze flour) [71]. It is produced at an industrial scale, being used whole or dried for pets and, feed ingredient for livestock [12]. Although this species shows a great potential as livestock feed, it is considered a pest for stored goods (e.g., wheat flour), aiding the dispersal of the plant pathogen fungus *Fusarium* sp., and it is often used to study chemical pest control, as it can be easily cultured [72–74]. Despite being consider native to Mediterranean region, according to CABI it was introduced in Germany. It is also considered invasive in the Moldova Republic [75].

3.1.10. *Zophobas morio* (Fabricius, 1776) (Coleoptera, Tenebrionidae)

Zophobas morio (Figure A2a), is commonly known in its larval state as superworm, and is easily found on online exotic pet shop for use as pet food for reptile pets [76,77]. Moreover, it presents high potential to be used as ingredient to feed livestock and for biodiesel production, making this species a strong candidate for mass production [78,79]. However, the superworm is also a pest of stored goods such as wheat flour, and is commonly used in studies addressing its control (e.g., the use of entomopathogenic fungus to control its larvae) [80].

3.1.11. *Callosobruchus maculatus* (Fabricius, 1775) (Coleoptera, Chrysomelidae)

The cowpea weevil or cowpea seed beetle, *C. maculatus* (Figure A2b), is a cosmopolitan species, that originated from western Africa and invaded other parts of the globe probably by transportation along with vegetables and other crops [81]. Their larvae feed on legume seeds from the inside out, hence the name cowpea seed beetle. Adults do not need water or food, and spend their lifetime (two to three weeks) mating and laying eggs [82]. Due to its small size, this beetle is used to feed exotic pets that prefer small preys, such as pet geckos, small amphibians and invertebrates such as tarantulas, and it is mostly sold through British websites [83]. They are considered major pests of stored beans in countries of different continents that mass produce these legumes, including Brazil, China, India, and Nigeria [84]. Although they are not considered major pests in Europe, their pupae are relatively resistant to both cold (0 °C) and warm (42 °C) temperatures, which may represent a potential for invasion in some parts of Europe [85]. Moreover, increasing temperatures may cause pests such as the cowpea weevil to cross more zoogeographical boundaries, especially when considering the ability of this species to adapt to new hosts [84,86]. In Europe they are registered as an invasive species in France, Turkey, Greece, Italy, Spain, and South European Russia [87,88].

3.1.12. *Pachnoda marginata* (Drury, 1773) (Coleoptera, Scarabaeidae)

The sun beetle, *P. marginata* (Figure A2c), is a species of Cetoniidae widely distributed in equatorial Africa, with several subspecies [89]. In captivity, their larvae can develop very well when fed on beech litter and dry leaves [90]. The larvae are popular as live feeds for exotic pets in the United Kingdom, but also the adult beetles are kept as pets themselves [91,92]. There are no records of infestation or invasion caused by this species, however, *P. interrupta* a species of the same genera, is known for causing infestations on sunflower and sorghum crops in Sudan and more studies are necessary to address its invasive potential in the EU [93,94].

3.1.13. *Alphitobius diaperinus* (Panzer, 1797) (Coleoptera, Tenebrionidae)

The larvae of this cosmopolitan species, *A. diaperinus* (Figure A2d), known as the lesser mealworm is native from sub-Saharan Africa [95]. It is produced in Europe as live or canned food for small reptiles, amphibians or birds [96]. This species is a common pest in poultry farms, feeding on manure [95]. When the larvae matures, they start to migrate and find pupation sites, in which they begin tunnelling their way to thermal isolation, through polystyrene, polyurethane and fiberglass pupating successfully on the first two, but causing damage nonetheless to these three materials, impacting the thermal isolation of poultry farms and causing economical losses for farmers [95,97,98]. Additionally, this species acts as a reservoir of avian pathogens such as infectious bursal disease virus (IBDV), Turkey enterovirus and rotavirus, *Salmonella* sp., the protozoan Eimeria, the Turkey coronavirus and *Escherichia coli* [99–104].

3.1.14. *Locusta migratoria* (Linnaeus, 1758) (Orthoptera, Acrididae)

This grasshopper known as the migratory locust, *L. migratoria* (Figure A2e) is a major pest for crops, widely distributed in Southern Europe, Asia and Africa, and have spread through the northern hemisphere for more than 1 million years [105,106]. It forms dense adults swarms that can quickly infest crops [105]. It can be produced as live or canned food for larger pet lizards [107]. This species has developed a highly efficient energy supply to fly long-distances, which makes them more likely to invade new areas [108].

3.1.15. *Schistocerca gregaria* (Forskal, 1775) (Orthoptera, Acrididae)

The desert locust, *S. gregaria* (Figure A2f) is common in Northeast Africa, but it may have originated from the Americas and have crossed the Atlantic by flight [109]. This species is produced in Europe and used as pet feed, it has a high protein percentage, up to 76%, but it is low on fat, 13% [110]. Although it is used as live feed, this species has great potential as a pest, being the biblical locust popularized for forming massive swarms [109]. They can fly up to 150 km a day and can increase their number by 400 times in just six months and up to 8000 times after nine months. Furthermore, a single square kilometre of the desert locust swarm can contain up to 80 million adults and can consume the same amount of food in a day as 35,000 people [111]. In 2020, a swarm of *S. gregaria* hit several East Africa and Middle East countries [112,113], and is estimated to have affected 25 million people and costed US$1.3 billion (€1.16 billion) in damages inflicted over 23 countries [114].

3.1.16. *Galleria mellonella* (Linnaeus, 1758) (Lepidoptera, Pyralidae)

The greater wax moth, as it is commonly-known or honeycomb moth, *G. mellonella* (Figure A2g), was first recorded as a pest in Greece by B.C. 384–322, as described in the writings by Aristotle [115]. It is now a cosmopolitan species found in all continents [116]. This species is used as model for understanding the virulence of bacterial pathogens in humans, for its ability to survive in temperatures up to 37 °C [117]. It is also used as live feed for pet invertebrates, amphibians and reptiles [118]. Moreover, it has the capacity to bio-degrade plastic (Polyethylene), although not necessarily to digest it [119]. Although the current wax moth pest status is under control, it can still rise its capacity to pest honeybees in some countries due to climate change (in areas that are considered unsuitable for them now) [117].

3.1.17. *Shelfordella lateralis* (Walker, 1868) (Blattodea, Blattidae)

The cockroach known as red runner or rusty red cockroach, *S. lateralis* (Figure A2h), is a species used mostly as live feeds for pet reptiles, as it is considered easier to rear than mealworms by users of online forums of insect breeders [120,121]. It is native to a wide area of the Middle East, including Libya, Afghanistan, Pakistan, Uzbekistan, and southern Russia [122]. They are considered indoor pests, more commonly found in houses and offices with basements and gardens [123]. It was recently recorded for the first time in Cyprus and Turkey [124].

3.1.18. *Blaptica dubia* (Serville, 1839) (Blattodea, Blaberidae)

The Dubia roach, also known as Argentinian wood roach, *B. dubia* (Figure A2i), is a tropical cockroach, found in Central and South America [125]. They are popular among exotic pet keepers, as it is a slow-moving insect that cannot climb smooth surfaces and is quieter than crickets. Despite their popularity for being easy to rear, Dubia roaches require high temperature and high humidity for a quicker and more effective development. Nevertheless, adults have been reported to survive in temperatures ranging from 8 to 31 °C, which can make possible for them to survive in southern regions of Europe [126].

3.1.19. *Blaberus craniifer* Burmeister, 1838 (Blattodea, Blaberidae)

The death's head cockroach, *B. craniifer* (Figure A3a), is native to North America (Florida and Mexico) and Central America [127]. They are a terrestrial species with omnivorous feeding on decaying organic matter [128]. They are a popular live feed for pet lizards and tarantulas, being commercially available online in the United Kingdom and United States [129,130]. Online forums and exotic pet shop websites recommend feeding them with fruits, vegetables, and dog's wet food. Adults have a crude protein value of 66.6%, which makes them very nutritious for animals [131]. The recommended temperature for rearing ranges between 25 and 30 °C, with lower temperatures keeping production low, thus making this species less likely to invade new areas.

3.2. Potential Risks of Non-Native Species Introduction for Livestock Feed and Exotic Pets' Food in Other Regions

In this section, we provide brief commentaries on the production of insects reared for animal feed in other regions of the world. The large-scale production landscape of insects remains consistent over different continents, commonly targeting the same species (e.g, *H. illucens*, *T. molitor*, *A. domesticus*, *G. sigillatus*), but for smaller scale production some differences do occur, namely the commercialization of some native species for exotic pet's food. Therefore, we discuss which insect species are produced on specific regions and whether they have the potential to become invasive when they are not native for that region. If the insect species is native for that region, we discuss its potential to be invasive elsewhere.

3.2.1. Africa and Middle East

In the sub-Saharan Africa region (SSA), there is no report on constant and large-scale farming of insects for animal feeds [132]. Insects are indeed used as an ingredient for formulated feeds for both fish and poultry but are known to be harvested from the wild or, in the case of poultry, cultured specimens are raised outdoors and access wild insects [132]. In South Africa the company Agri-Protein has successfully upscaled the production of both BSF and House fly, and the company Sanergy is able to mass-culture BSF [133]. The other insect species reared in SSA are used in lab research or for households' production for the exotic pet food market, not representing a large market share of insect use for feeding animals. While in some Muslim countries of North Africa and the Middle East the consumption of insects is forbidden to humans, its production for export to countries where they can be consumed as livestock feed has been promoted [134]. Although there is no available online information on the production of insects for other countries in the region, Israel is mass-producing BSF and grasshoppers. The species produced as feed for animals were mostly BSF and mealworm. The other species not found in other world regions are listed below.

Gromphadorhina portentosa (Schaum, 1853) (Blattodea, Blaberidae)

The Madagascar hissing cockroach, also simply known as hissing cockroach, *G. portentosa* (Figure A3b), is endemic to the island of Madagascar [135]. Its name is derived by the hissing sound it makes by expelling air from a pair of specialized abdominal spiracles [136]. They usually feed on decaying organic matter, and in terrariums they can be fed with fresh fruit and vegetables. They are used mostly as live feed for pet lizards, but this species is at times raised as pets themselves. The average temperature suggested for its rearing is around 26 °C, with higher or lower values keeping production low, as already known for other species of Blattaria [137].

3.2.2. North America

In North America alone the total yearly cost of invasive insects is around US$27.3 billion (€24.66 billion) for goods and services and around US$2.06 billion (€1.86 billion) for human health diseases [27]. Common pathways are maritime cargo carrying, wood, tiles, machinery, marble steel and ironware [138,139].

Insect species currently produced for animal feed in North America are similar to the ones produced in Europe. These include *B. dubia*, *S. lateralis*, *H. illucens*, *M. domestica*, *D. hydei*, *D. melanogaster*, *T. molitor*, *Z. morio*, *G. melonella*, and the crickets, *A. domesticus*, *G. bimaculatus*, *G. sigillatus*, and *G. assimilis*. Some of these species have invaded and spread through the United States due to escapes from pet shops and bait shops [65,69]. It is also listed below some other species found to be produced exclusively in North America. Description of previously mentioned species is not given, with only comments concerning their spread throughout North America being provided.

Considering insects used as feed ingredient for livestock or live feed for exotic pets, the cricket *G. assimilis* has spread through the Eastern United States, being often found close to fish markets in Florida. This cricket may have been introduced by human activities, and has large populations in the wild, in comparison to native crickets [65].

Acheta domesticus populations were found in California and México, and are probably individuals that escaped from pet and bait shops [69]. *Alphitobius diaperinus* can be found in the United States of America infesting poultry farms [140].

Shelfordella lateralis has spread to the United States, being found in Arizona, and are considered house pests, found under matted ground and under debris in lawns [141].

Manduca sexta (Linnaeus, 1763) (Lepidoptera, Sphingidae)

Manduca sexta (Figure A3c) is commonly known as the tobacco hornworm, or tomato hornworm, due to its characteristic head shape and feeding habits, which include solanaceous plant leaves, for example, tobacco, tomato or potato [142]. They are native to North America and tend to predominate in southern areas [143]. They are sold in pet shops websites in the USA as live prey for small reptiles and pet tarantulas [144]. They represent an important pest for solanaceous crops as described before, with their larvae in the wild not surviving temperatures below 15 °C and survival also declining at temperatures above 35 °C. Consequently, this species is more likely to survive and spread over in warmer regions [145].

Blaberus discoidalis Serville, 1838 (Blattodea, Blaberidae)

Commonly known as the discoid cockroach, B. discoidalis (Figure A3d), is distributed through Central America up to the State of Florida in the USA [146]. They are often found in websites from the State of Florida as a replacement for *B. dubia*, whose trade is not allowed in this state [147]. It is sold as a cockroach easy to raise in captivity, since they cannot climb smooth surfaces such as plastic or glass, preventing escapes. This species was also used as a model for building a power plant for an insect-based robot [148]. This species, such as the other Blattodea mentioned before, are limited in their upper thermal tolerance when exposed to different temperatures, as it cannot survive temperatures below 10 °C or above 37 °C, posing little threat for invasion in colder environments [149].

3.2.3. Asia and Oceania

In many Asian countries, insects are consumed as food for centuries as part of natural diets. In these countries it is relatively easy to introduce insects in the market both for livestock feeding ingredients and for exotic pets food [15]. In Thailand and some parts of China, the demand for insects has grown over the years and has been accompanied by more effective collecting techniques and the industrialization of insect rearing [150]. In Asia the total cost of the impact of alien insect species for goods and services is close to US$1 billion (€0.9 billion), as for Oceania the cost is about US$0.19 billion (€0.18 billion) [27]. However, these values are roughly estimated, due to a lack of comprehensive studies on biological invasions in countries such as China [151]. Due to the increase of having exotic pets (e.g., lizards) and the demand for insect meals as an ingredient for livestock formulated feeds, the production of insects in Asia has also grown. The species produced for livestock feeds are mostly BSF and *T. molitor*, but also the cricket *A. domesticus* [152]. The other species produced in the region for animal feed and pet food are listed below.

Rhynchophorus ferrugineus (Olivier, 1790) (Coleoptera, Curculionidae)

The palm weevil, *R. ferrugineus* (Figure A3e), is a snout beetle, native from South and Southeast Asia [153]. Adult beetles lay their eggs in frond bases (petioles), cracks, crevices and wounds in palm trees made by the females [154]. This species is produced as live or canned feed for pet, especially for pet geckos [152]. They are considered nutritive due to its high protein and fat content, 27.97% and 59.71%, respectively [155]. The grubs that hatch in the palm tree feed on it, which leads to the formation of tunnels inside the palm that often causes tissue decay. Overlapping generations of grubs can be found in the same palm, causing serious damage, leading to topping of the palm [154]. This species has expanded its geographical range since the 1980s, invading countries in Europe, Near East, Northern Africa, and the Caribbean. They are considered a palm plant pest and have caused economic impacts around the world. They can be easily distributed due to the import and movement of infested plant material [153].

Bombyx mori (Linnaeus, 1958) (Lepidoptera, Bombycidae)

Bombyx mori (Figure A3f), is a moth species commonly known as silkworm and is native to China. They feed on mulberry leaves and are used for sericulture, the production of silk, long before the Bronze Age [156]. They were introduced throughout the world for sericulture, and more recently for human consumption and as pet food. The production of dry silkworm pupae reaches up to 440,000 tons per year in China alone, although most pupae are treated as waste from sericulture or used as fertilizer, some of them being used as ingredients for chicken or fish feed formulation [157,158]. Still a large number of desilked silkworm pupae is disposed, which can cause serious environmental problems due to putrilage of the waste [159]. China is the greatest producer of silkworm cocoons, followed by India, Uzbekistan, and Brazil. The silkworm was also introduced in other countries in Europe, Asia, and Africa [160]. This species is no longer able to fly, which makes them less prone to invade new ecosystems.

Teleogryllus emma (Ohmachi & Matsuura 1951) (Orthoptera, Gryllidae)

The Japanese field cricket, *T. emma* (Figure A4a), as the name implies, is native to the islands of Japan [161]. They occur all over Japan, with mean annual temperatures ranging from 7 °C in the north to 18 °C in the south [162]. They are popular as live feed for pets, and are massively produced in Japan and Korea for animal feed [163]. Albeit in the wild they survive in a wide temperature range, under laboratory conditions, the nymphs do not survive temperatures lower than 18 °C; optimal egg laying temperature is 25 °C [164]. This species is dominated by the above-mentioned insect species *G. bimaculatus* for its diapause in the egg phase, making it less capable to establish itself in other regions [165].

3.2.4. South and Central America

Agriculture is a primary sector that generates a massive income in developing countries such as Brazil, where in 2020 the crop production reached US$91.15 billion (€79.79 billion) [166]. Insect pests of crops in Brazil generate an annual loss of approximately US$14.69 (€13.28 billion) to the Brazilian economy [167]. There is currently no information on the possible impacts on the farming of insects for animal feed in South America, such as *T. molitor* or *H. illucens*, which originates from the Neotropics. However, some insects produced for pet food, are considered pests, or have the potential to become invasive species [168], with species commonly found for sale being *H. illucens* and *T. molitor*, followed by *Z. morio* and *G. assimilis*. Other insect species found only in this region are mentioned below.

Nauphoeta cinerea (Olivier, 1789) (Blattodea, Blaberidae)

The Cinerous Cockroach, *N. cinerea* (Figure A4b), is native from north-eastern Africa, and has invaded Circumtropical regions, probably due to their associations with human ships [169]. It is an ovoviviparous species, popularly used as pet lizard live feed, since they are considered easy to keep due to its fast reproduction and little care required to maintain culture [170]. Although they reproduce fast, they do not grow significantly under lower temperatures, since their optimal growth occurs at 32.3 °C and they display a 32% reduction of their growth rate when temperature drops to 28.3 °C [171]. For temperate regions, it shows a lower potential to become an invasive species, but further studies are required to evaluate its invasive potential in tropical regions.

Oxyhaloa deusta (Thunberg, 1784) (Blattodea, Blaberidae)

The red head cockroach, *O. deusta* (Figure A4c), has its name due to the unusual red colour of its head, which distinguishes it from other species. This ovoviviparous cockroach is native from Africa [128]. This species is typically reared to feed small pet reptiles due to its small size and soft cuticle [172]. This species seems to not reproduce in temperatures below 15 °C, which means they cannot populate temperate regions. It should be noted, however, that further studies are still needed to confirm this information [173–175].

Ulomoides dermestoides (Chevrolat, 1878) (Coleoptera, Tenebrionidae)

Known as the peanut-beetle, *U. dermestoides* (Figure A4d) this species is native from Asia and was introduced in South America probably by Japanese's colonies that used it for human consumption [176]. They are found as pests in stored products (e.g., corn and wheat) [168]. This species is popular both as live feed for lizards, birds and fishes, but also as human snack, or eaten as a popular medicine for asthma, leukaemia or sexual impotence [176]. This species represents a potential public health hazard since these beetles are capable of serving as a host for *Macracanthorhynchus hirudinaceus* (Pallas, 1781) (*Oligacanthorhynchida*, *Oligacanthorhynchidae*), a species of *Acanthocephala*, which can infect human beings [177].

In Table 1 is summarized the already known impacts on the environment or on the economy of the previous listed species, with information regarding the current distribution and the species native range, as well as their main uses (i.e., exotic pet's food and animal feed).

Table 1. Insect species produced for animal feed or pet food with information regarding their known impacts and distributional range.

Species	Native Range	Current World Distribution in the Wild	Known or Potential Impacts	Main Uses	Invasive Potential /Impacts	Invasive Potential (References to Studies)
Diptera						
Drosophila hydei	Cosmopolitan	Worldwide except Antarctica		Exotic pet's food	NO	
Drosophila melanogaster	Sub-Saharan Africa	Worldwide except Antarctica		Exotic pet's food	NO	
Hermetia illucens	Neotropical	Worldwide except Antarctica	Enteric myasis	Livestock Feed, Pets feed	YES	[32–37,39,178–180]
Musca domestica	Central Asia	Worldwide except Antarctica	Carries human/livestock pathogens	Livestock Feed, Pets feed	YES	[46]
Orthoptera						
Acheta Domesticus	Southwestern Asia	Worldwide except Antarctica		Livestock Feed, Pets feed	NO	
Gryllodes sigillatus	Southeast Asia	Worldwide except Antarctica		Livestock Feed, Pets feed	NO	[59]
Gryllus assimilis	Carribean islands and South Texas	North America, South America and Europe		Livestock Feed, Pets feed	YES	[65,66]
Gryllus bimaculatus	Mediterranean	Europe, Asia and Africa		Exotic pet's food	NO	
Locusta migratoria	Africa	Africa, Asia, Europe and Oceania	Crop pest	Exotic pet's food	YES	[108]
Schistocerca gregaria	American continent	Europe, Africa, Southeast Asia, Central America	Crop pest	Exotic pet's food	YES	[109]
Teleogryllus emma	Japan	Korea and Japan		Exotic pet's food	NO	
Coleoptera						
Alphitobius diaperinus	Sub-Saharan Africa	Worldwide except Antartica	Poultry litter pest	Livestock Feed, Pets feed	YES	[140]
Callosobruchus maculatus	West Africa	Worldwide except Antartica	Stored legumes pest	Exotic pet's food	YES	[85]
Pachnoda marginata	Equatorial Africa	Equatorial Africa		Exotic pet's food	NO	
Rhynchophorus ferrugineus	South and Southeast Asia	Europe, Asia and Oceania	Palm tree pest	Exotic pet's food	YES	[153]
Tenebrio molitor	Europe	Worldwide except Antarctica and South America	Stored good's pest	Livestock Feed, Pets feed	NO	[181]
Ulomoides dermestoides	Asia	Asia	Stored cereals pest	Exotic pet's food	YES	[177]
Zophobas morio	Central America	Central America	Stored good's pest	Livestock Feed, Pets feed	YES	[79]
Lepidoptera						
Bombyx mori	China	Worldwide except Antartica		Livestock Feed, Pets feed	NO	
Galleria mellonella	Asia	Worldwide except Antarctica	Honey-bee nest pest	Exotic pet's food	YES	[117]
Manduca sexta	North America	American continent	Solanaceous pest	Exotic pet's food	YES	[145]

Table 1. *Cont.*

Species	Native Range	Current World Distribution in the Wild	Known or Potential Impacts	Main Uses	Invasive Potential /Impacts	Invasive Potential (References to Studies)
Blattodea						
Blaberus craniifer	North and Central America	North and Central America		Exotic pet's food	NO	
Blaberus discoidales	Central America and Florida (USA)	Central America and Florida (USA)		Exotic pet's food	NO	
Blaptica dubia	Neotropical	American Continent, Europe		Exotic pet's food	YES	[126]
Gromphadorhina Portentosa	Madagascar	North America, Madagascar		Exotic pet's food	NO	
Nauphoeta cinerea	Northeastern Africa	North America, Africa and Australia		Exotic pet's food	NO	[169]
Oxyhaloa deusta	Africa	Africa		Exotic pet's food	NO	
Shelfordella lateralis	Middle East	North America, Europe and Middle East	Indoor pest	Exotic pet's food	YES	[124,141]

3.3. The Potential of Native Species

Despite the fact that current production of insect meals and products for human and animal feed mostly use Asian and neotropical species, it is already acknowledged that native species display good nutritional-values and conditions for mass production. The requirements for its mass production include a short life cycle, a high fecundity, and the ability to breed continuously in an artificial environment [182].

Recent studies showed that some Diptera, Coleoptera, and Orthoptera species present a high protein-value, comparable to soymeal, but lower than fishmeal. Nonetheless, the potential of order Diptera is still high as an alternative to fish meal by displaying a similar amino acid profile [183].

In fact, several insect species belonging to the orders Coleoptera and Diptera, which are part of the natural diets of Atlantic salmon (*Salmo salar* Linnaeus, 1758 (Salmoniformes, Salmonidae)), show adequate composition in polyunsaturated fatty acids (PUFA), nutrients necessary for fish growth. Therefore, they present significant potential to be used as a supplementation of the diets commonly employed to farm this fish [184].

Additionally, *Apis mellifera ligustica* Spinola, 1806 (Hymenoptera, Apidae) (Figure A4e), a subspecies of the European honeybee, showed great potential to be used as animal feed, due to its high protein content in the adult stage (51%). This species is also promising as a larva, presenting 30% of fat composition, which decreases over larval development, as well as it carbohydrates content [185].

Several blowflies show potential to be used as feed ingredients [186]. For instance, the blowfly (*Chrysomya megacephala* (Fabricius, 1794) (Diptera, Calliphoridae)) (Figure A4f) was evaluated as substitute of fishmeal in red Tilapia (*Oreochromis* sp.) production, with an average crude protein level of 54.4%. They contain all necessary amino acids to promote a suitable growth for this fish species. Feeds with 100% replacement of fish meal by maggot meals were successfully validated with no significant differences being recorded from a control commercial diet [187].

The Egyptian locust, *Anacridium aegyptium* (Linnaeus, 1764) (Orthoptera, Acrididae) (Figure A4g), occurring throughout most European territory, presents favourable PUFA percentages, although they have a low oil content, which can be used as co-product derived from the insect processing industry [188]. *Pseudochorthippus parallelus* (Zetterstedt, 1821)

(Orthoptera, Acrididae) (Figure A4h) is another Orthopteran native to Europe with a suitable nutritional profile to be used as exotic pet food or livestock feed [189].

The common green bottle fly, *Lucilia sericata* (Meigen, 1826) (Diptera, Calliphoridae) (Figure A4i), is a blowfly found in most regions of the world [190]. Although they are known for causing myasis, with economic impacts for sheep producers [191], they present a high content in monounsaturated fatty acids and may be viable ingredient for animal feed [186].

In India, two preferred edible insect species have great potential to be used as animal feed: the ant *Oecophylla smaragdina* (Fabricius, 1775) (Hymenoptera, Formicidae) (Figure A4j) and the termite *Odontotermes* sp. (Figure A5a). Their protein content is 55.28% and 33.67%, their fat content is 14.99% and 50.93%, and their fibre is 19.84% and 6.30%, respectively. Their PUFA content is also important, with 8.19% for the first species and 2.59% for the second one [192].

The Owl butterfly, *Caligo memnon* Felder, 1866 (Lepidoptera, Nymphalidae) (Figure A5b), native to South America also has a good potential to be used as animal feed, since it has a concentration of 62.5 mole % of α-linolenic acid (ALA) in total Fatty Acids, which is an essential omega-3 PUFA [193].

The dung beetle, *Acrossus rufipes* (Linnaeus, 1758) (Coleoptera, Scarabaeidae) (Figure A5c), is found in most of Europe and East Coast of the United States [194]. This species has great potential as animal feed, especially for fish, when considering their amino acid content. They exhibit essential amino acids, namely histidine and threonine, in higher concentrations than some cultivated fish species, such as catfish (*Clarias gariepinus* (Burchell, 1822) (Siluriformes, Clariidae)) or crayfish (*Procambarus clarkii* (Girard, 1852) (Decapoda, Cambaridae)) [195].

The stick insect *Cladomorphus phyllinum* Gray, 1835 (Phasmida, Phasmatidae) (Figure A5d), native to the Brazilian forests [196], showed potential as an alternative insect-based protein source. The dried samples showed a protein content of 64.6%, with the presence of essential amino acids, and a lipid content containing 57.03% of oleic acid, 15.94% of palmitic acid, 13.76% of linoleic acid and 10.76% of stearic acid [197].

The Chinese grasshopper *Acrida cinerea* (Thunberg, 1815) (Orthoptera, Acrididae) (Figure A5e), native to East Asia [198], was successfully used to replace the protein content of broilers feed, an addition of up to 150 g Kg^{-1}, and also showed potential to be mass reared [199].

The Mormon cricket, *Anabrus simplex*, Haldeman, 1852 (Orthoptera, Tettigoniidae) (Figure A5f), is native to North America, recorded for the USA and Canada [200]. This species has the potential to be used as broiler feed. No significant difference has been found between chicks fed with corn-soybean meal diet and the ones fed with corn-ground cricket when comparing weight gain and feed/grain ratio. Additionally, there was no adverse effect on the taste of the meat from the specimens fed the corn-cricket diet, as determined by a taste panel [201].

The field cricket native to China, *Teleogryllus (Macroteleogryllus) mitratus* (Burmeister, 1838) (Orthoptera, Gryllidae) (Figure A5g), synonym of *Gryllus testaceus* [200], has a crude protein of 58.3%, crude fat of 10.3%, chitin 8.7% and ash 2.96% (on dry matter basis), respectively. When fed as a replacement of 15% of soybean meal, it showed no significant differences with the control group (poultry feedstuff) in weight gain, feed intake, or gain/feed ratio [202].

The variegated grasshopper, *Zonocerus variegatus* (Linnaeus, 1758) (Orthoptera, Acrididae) (Figure A5h), is a common pest in Africa, and was recently reported in the United Kingdom [203]. However, its insect meal showed potential to be used as a fishmeal replacement for the African catfish, *Clarias gariepinus*, in which a replacement of 25% had no adverse effects on both the growth rate and nutrient utilization when compared to the control group [204].

The Chilean moth, *Chilecomadia moorei* Silva Figuero, 1915 (Lepidoptera, Cosiidae) (Figure A5i), whose larvae are known as butterworm, is native to Chile. They are used to feed insectivore exotic pets such as geckos. They are considered to be a good source of fat, due to its high fat content [205]. This species is popular among reptile owners since they have a distinct scent which attracts the lizards [206,207]. They are exported out from Chile to many countries and are not able to reproduce elsewhere, since they are dependent of the host tree *Retanilla trinervia* (Gillies and Hook.) Hook. and Arn. (Rosales, Rhamnaceae), endemic to Chile, and are considered a pest to this tree species [208,209].

Recently, the long-legged fly *Machaerium maritimae* Haliday, 1832 (Diptera, Dolichopodidae) (Figure A5j), a fly species native to western Europe, adapted to thrive in brackish waters, was reported as a potential feed ingredient for aquaculture due to its content in important omega 3 PUFA, including eicosapentaenoic acid (EPA), an essential nutrient for the healthy growth of marine organisms [210].

4. Native vs. Non-Native Species

Most of the insect species produced for both livestock feed and exotic pets' food are known to be exotic in regions such as Europe. They have some advantages when compared to native insect species, such as well-established rearing protocols for mass production and extensive studies to improve their productivity and potential to replace mainstream ingredients in formulated animal feeds (e.g., fish meal in aquafeeds). Nonetheless, native insect species are still interesting alternatives that are worth exploring, considering both the possible impacts caused by the escapes of exotic insects from pet shops and rearing facilities and the levels of some key nutrients on their biochemical profiles (e.g., PUFA). Both strengths and weaknesses, as well as opportunities and threats of using exotic or native species of insects as livestock feed are discussed below using a SWOT analysis (Figure 1).

Exotic species demand a higher energy supply for climatic control due to their need for higher temperature, namely when species originate from tropical regions (e.g., BSF). The use of native species can help to overcome challenges that the industry of formulated feeds currently faces associated with the diversification of omega-3 sources to manufacture aquafeeds for marine organisms.

The production of native species still lacks several studies, for instance regarding their microbiological content (particularly on *Salmonella* sp. or *Escherichia coli*, as their presence would make these species unsuitable for use as livestock feed ingredients). However, it is important to highlight that bacterial hazard for humans and animals related to insects originate from its rearing conditions, substrate, feed, handling, and processing, which needs to be carefully monitored to reduce the potential of these insects' species to act as vehicles of known zoonotic pathogens. Despite this, the presence of bacterial pathogens for animals found in substrates do not seem to replicate actively in insects, emphasizing the importance of substrate selection [211].

In Europe, one of the conditions to produce an insect meal for animal feed is that the target species cannot be listed as invasive according to the Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014. This constraint is also an advantage to those advocating the use of native insect fauna to produce insect meals. However, the establishment of rearing protocols can be time consuming and financiallydemanding, considering that it can take hundreds or even thousands of generations to attain a desirable lineage, optimal for mass production, with individuals resistant to high density production and disease [182]. These features are already displayed by the insect species currently approved by the EU, due to decades of rearing, namely BSF which has been used for long in forensic entomology. Some of the species that hold potential to be used as feed already have well-established protocols for laboratory-scale culture that can be upgraded for industrial uses.

Regarding the legal framework in the EU on the production of insects for livestock feed, is currently limited to eight species (*H. illucens*, *M. domestica*, *T. molitor*, *A. diaperinus*, *A. domesticus*, *G. sigillatus*, *G. assimilis*, *B. mori*) considering that the origin of the substrate used for feeding the insects is not agricultural waste, or insects from the same species. The permission to use these insects as ingredients for formulated feeds employed in poultry and swine production was recently approved by the Commission Regulation (EU) 2021/1372, following the authorization of insects in aquaculture animals (EU reg.2017.893) and pet which was already permitted. Other countries outside the EU (e.g., the USA and Brazil), current regulatory guidelines for the production of insects for livestock feed do not have a specific legislation. These fall under the novel foods category, meaning that rules that apply are those for any other food operator, considering that its production, packaging, transportation, and storage fall under the good hygiene conditions and that products are properly labelled [212].

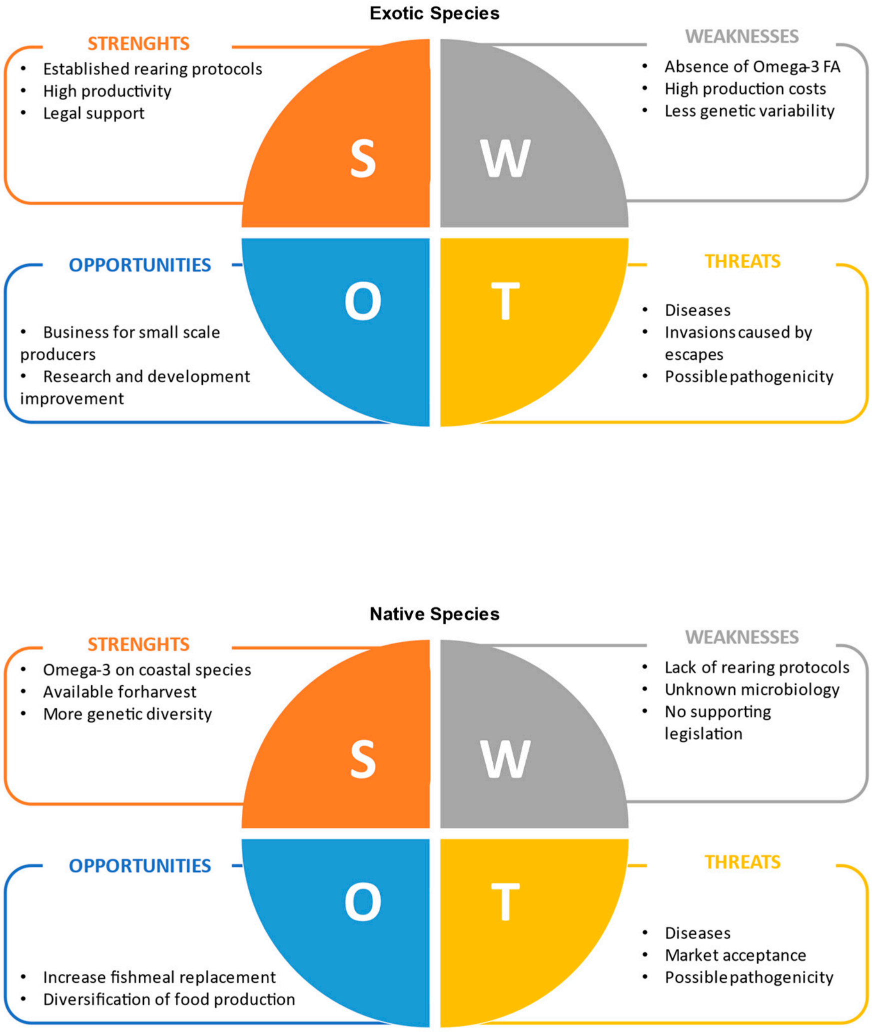

Figure 1. SWOT analysis (strengths, weaknesses, opportunities, and threats) associated with the use of exotic and native insect species for livestock feed and exotic pets' food.

The production of native insect species can increase the biodiversity of food production, which today is considerably low, if one considers that only a dozen of species of animals provide up to 90% of all of the animal protein consumed globally and just four crop species provide half of all plant based calories for human diets [213]. Moreover, the production of native insect species can help to overcome the challenges of inbreeding, which reduces the intraspecific genetic variability, possibly making farmed populations more susceptible to disease that can cause significant economic losses [64].

Moreover, the insect production for livestock feed and pet's food, faces the challenge of the possible allergenicity carried by the presence of IgE Immunoglobulin or tropomyosin, which is known for causing allergic reactions for human consumers, but also for pets such as dogs [214,215]. In addition, insects can accumulate heavy metals in their tissues if these are present in their feeding substrates (e.g., cadmium from wheat, rice, mussels and corns), as well as pathogens from the rearing environment, which must be carefully considered when rearing insects for feed [216].

5. Final Remarks

This review documents the most common species used for animal feed worldwide, both for livestock, and exotic pets, and briefly discussed their invasive potential when introduced in regions where they are exotic. Several insect species were highlighted with potential to be mass-produced as feed ingredients for animals, mostly due to their nutritional value. The review also highlights the potential of native insect species to be reared for feed, however, further research is necessary to establish adequate rearing protocols for their mass-production, or for their inclusion in formulated diets for livestock. Moreover, the use of these native insect species is important, considering that in the past the introduction of exotic species as biocontrol agents for pests resulted in the establishment of some of these species in regions where previously they were unable to settle [20]. Introduced species for biological control, not only were able to spread to areas that previously were considered unsuitable for them, but also were recorded having impacts on non-target species, impacting local biodiversity. As such, biological control introduced species, such as the coccinellid *H. axyridis*, seems to be able to adapt and cope with climatic conditions different from its native range [217]. Further, the tachinid fly, *Compsilura concinnata* (Meigen, 1824) (Diptera, Tachinidae), which was introduced to control the spongy moth, *Lymantria dispar* (Linnaeus, 1758) (Lepidoptera, Erebidae), in North America, was found to parasitise several non-target species [218].

Rearing insects as livestock feed or as exotic pet's food should be carried in indoor environments, not only for optimal productivity but also to prevent escapes of the animals being produced and avoid exposure of the local environment to pests and diseases. Although rare, escapes can still occur, particularly when considering small-scale farms producing insects as live feeds for exotic pets. Consequently, risk assessment studies on the invasive potential of exotic insect species must be updated and revised for different regions, namely for southern EU countries (with milder winters which can facilitate the establishment of some species) that need to replicate risk assessment procedures already performed by other EU countries, namely France, Belgium, and the Netherlands. In addition, the use of native insect species should therefore be given a renewed attention.

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Appendix A

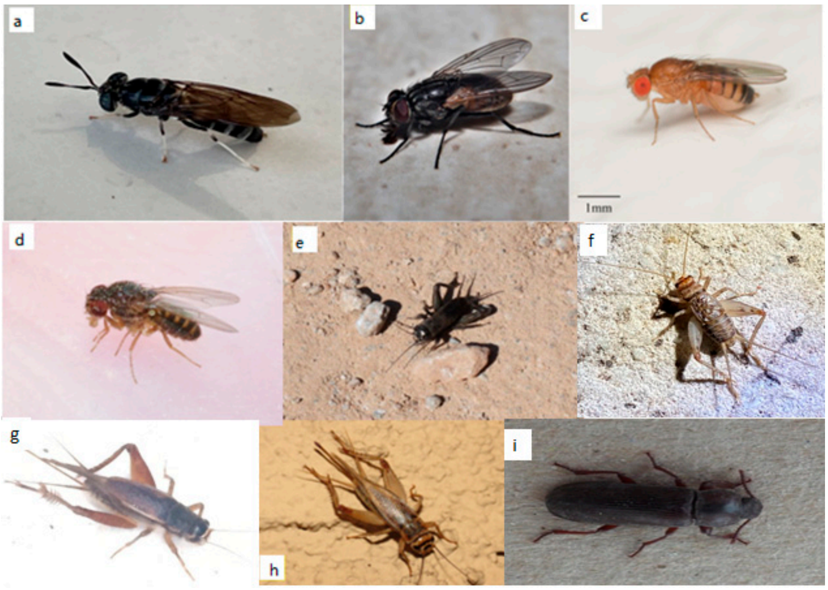

Figure A1. (**a**) *Hermetia illucens* [219]. Public Domain 2022 David Peden; (**b**) *Musca domestica*. Reprinted with permission from ref. [220]. Copyright 2013 Bill Lucas; (**c**) *Drosophila melanogaster* [221]. Public Domain 2018 Jesse Rorabaugh; (**d**) *Drosophila hydei.* Reprinted with permission from ref. [222]. Copyright 2017 James Bailey; (**e**) *Gryllus bimaculatus*. Reprinted with permission from ref. [223]. Copyright 2022 Valia Pavlou; (**f**) *Gryllodes sigillatus* [224]. Public Domain 2022 Jade Fortnash; (**g**) *Gryllus assimilis*. Reprinted with permission from ref. [225]. Copyright 2017 Andre Hospers; (**h**) *Acheta domesticus*. Reprinted with permission from ref. [226]. Copyright 2014 Chris Mallory; (**i**) *Tenebrio molitor* [227]. Public Domain 2021 Vesa Oikonen.

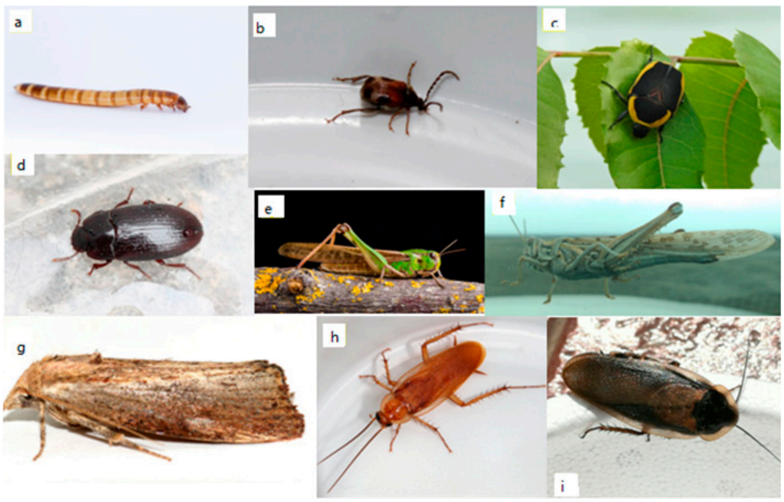

Figure A2. (**a**) *Zophobas morio*. Reprinted with permission from ref. [228]. Copyright 2011 Brian Gratwicke; (**b**) *Callosobruchus maculatus*. Reprinted with permission from ref. [229]. Copyright 2021 Savvas Zafeiriou; (**c**) *Pachnoda marginata*. Reprinted with permission from ref. [230]. Copyright 2019 Steven Schulting; (**d**) *Alphitobius diaperinus*. Reprinted with permission from ref. [231]. Copyright 2014 Marie Lou Legrand; (**e**) *Locusta migratoria*. Reprinted with permission from ref. [232]. Copyright 2016 Enrique Baquero; (**f**) *Schistocerca gregaria*. Reprinted with permission from ref. [233]. Copyright 2019 Altaf Habib; (**g**) *Galleria mellonella*. Reprinted with permission from ref. [234]. Copyright 2018 Ellura Sanctuary; (**h**) *Shelfordella lateralis*. Reprinted with permission from ref. [235] Copyright 2020 Dennis White; (**i**) *Blaptica dubia*. Reprinted with permission from ref. [236]. Copyright 2020 María Carolina Lago.

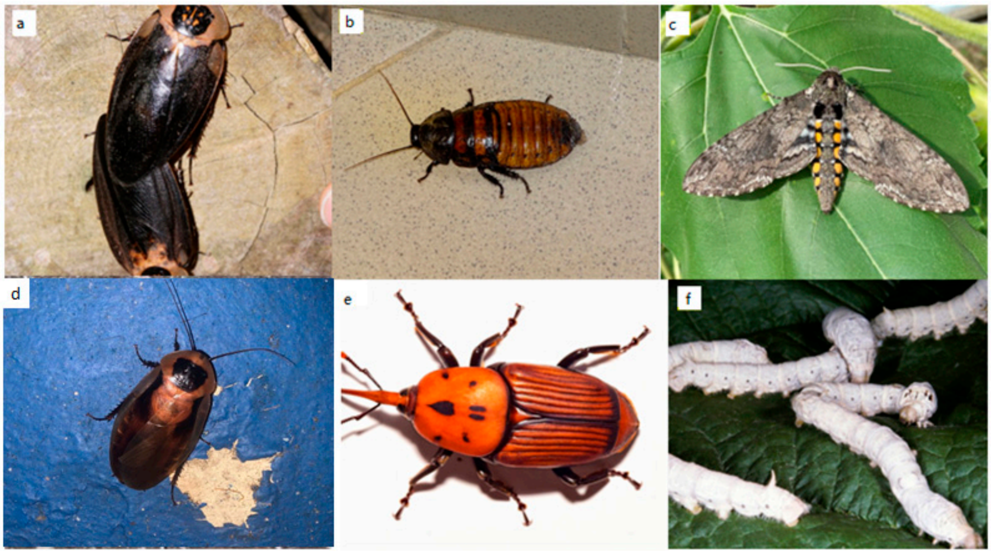

Figure A3. (**a**) *Blaberus craniifer*. Reprinted with permission from ref. [237]. Copyright 2016 Benjamin Schwartz; (**b**) *Gromphadorhina portentosa*. Reprinted with permission from ref. [238]. Copyright 2018 Mica Fraire; (**c**) *Manduca sexta*. Reprinted with permission from ref. [239]. Copyright 2021 Jeff Skrentny; (**d**) *Blaberus discoidalis*. Reprinted with permission from ref. [240]. Copyright 2021 Luis Méndez; (**e**) *Rhynchophorus ferrugineus*. Reprinted with permission from ref. [241]. Copyright 2017 Marcel Nadal; (**f**) *Bombyx mori*. Reprinted with permission from ref. [242] Copyright 1986 Lupoli Roland.

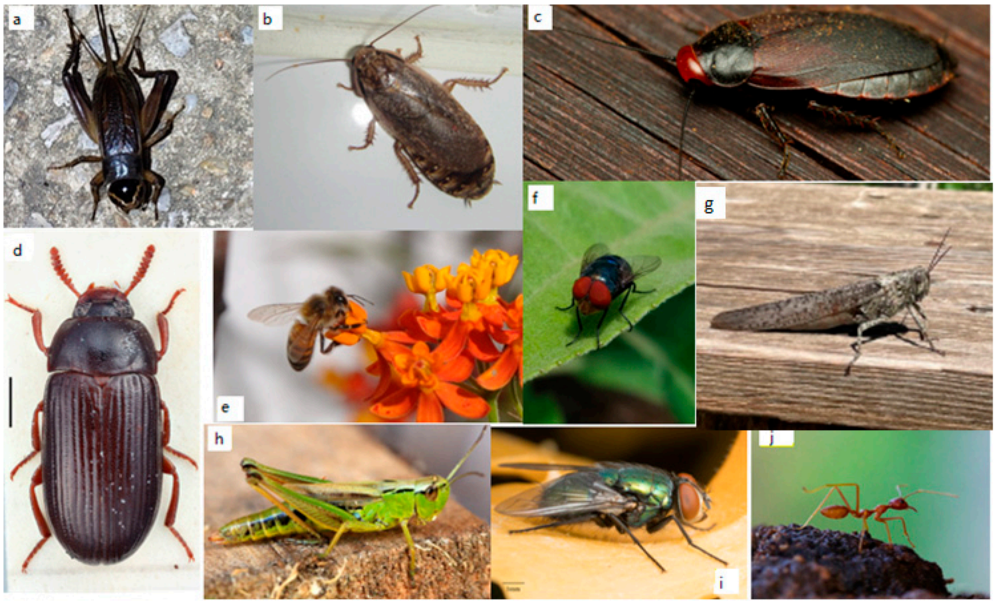

Figure A4. (**a**) *Teleogryllus emma*. Reprinted with permission from ref. [243]. Copyright 2021 Amaël Borzée; (**b**) *Nauphoeta cinerea*. Reprinted with permission from ref. [244]. Copyright 2019 Robert Taylor; (**c**) *Oxyhaloa deusta*. Reprinted with permission from ref. [245]. Copyright 2021 Ruan Booysen; (**d**) *Ulomoides dermestoides*. Reprinted with permission from ref. [246]. Copyright 2018 Biological Museum, Lund University (MZLU); (**e**) *Apis mellifera*. Reprinted with permission from ref. [247]. Copyright 2018 Coronado Govaerts; (**f**) *Chrysomya megacephala*. Reprinted with permission from ref. [248]. Copyright 2021 Lucy Cash; (**g**) *Anacridium aegyptium* [249]. Public Domain 2022 Niklas Wahlberg; (**h**) *Pseudochorthippus parallelus*. Reprinted with permission from ref. [250]. Copyright 2021 Ramunė Vakarė; (**i**) *Lucilia Sericata* [251]. Public Domain 2018 Jesse Rorabaugh; (**j**) *Oechophylla smaragdina*. Reprinted with permission from ref. [252]. Copyright 2021 Rosawanis Rosli.

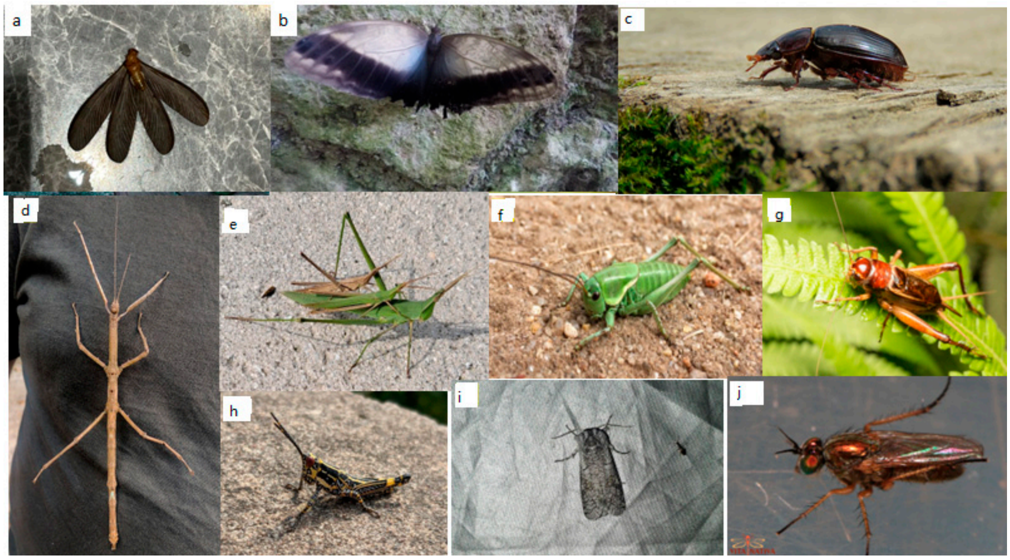

Figure A5. (**a**) *Odontotermes formosanus*. Reprinted with permission from ref. [253]. Copyright 2022 Xiaoling Fang; (**b**) *Caligo memnon*. Reprinted with permission from ref. [254]. Copyright 2017 Laura Méndez; (**c**) *Acrossus rufipes*. Reprinted with permission from ref. [255]. Copyright 2021 Lola Smirnova; (**d**) *Cladomorphus phyllinum*. Reprinted with permission from ref. [256] Copyright 2021 Luciano Bernardes; (**e**) *Acrida cinerea*. Reprinted with permission from ref. [257]. Copyright 2021 Rob Macfie; (**f**) *Anabrus Simplex*. Reprinted with permission from ref. [258]. Copyright 2017 Micah Lauer; (**g**) *Teleogryllus mitratus*. Reprinted with permission from ref. [259]. Copyright 2021 Colin Chiu; (**h**) *Zonocerus variegatus* [260]. Public Domain 2020 Isaac Caswell; (**i**) *Chilecomadia moorei*. Reprinted with permission from ref. [261]. Copyright 2020 Rigoberto Yáñez; (**j**) *Machaerium maritimae*. Reprinted with permission from ref. [262]. Copyright 2021 Associação Vida Nativa.

References

1. Food and Agriculture Organization of the United Nations. The State of World Fisheries and Aquaculture 2020. In *Sustainability in Action*; FAO: Rome, Italy, 2020. [CrossRef]
2. Alexandratos, N.; Bruinsma, J. *World Agriculture towards 2030/2050 the 2012 Revision*; ESA Working Paper No. 12-03; FAO: Rome, Italy, 2012. Available online: https://ageconsearch.umn.edu/record/288998 (accessed on 9 May 2022).
3. Food and Agriculture Organization of the United Nations. *The State of the World's Land and Water Resources for Food and Agriculture: Managing Systems at Risk*; FAO: Rome, Italy; London, UK, 2011. Available online: https://www.fao.org/land-water/solaw2021/en/ (accessed on 9 May 2022).
4. Lehuger, S.; Gabrielle, B.; Gagnaire, N. Environmental impact of the substitution of imported soybean meal with locally-produced rapeseed meal in dairy cow feed. *J. Clean. Prod.* **2009**, *17*, 616–624. [CrossRef]
5. Prudêncio da Silva, V.; van der Werf, H.M.G.; Spies, A.; Soares, S.R. Variability in environmental impacts of Brazilian soybean according to crop production and transport scenarios. *J. Environ. Manag.* **2010**, *91*, 1831–1839. [CrossRef] [PubMed]
6. Naylor, R.L.; Goldburg, R.J.; Primavera, J.H.; Kautsky, N.; Beveridge, M.C.M.; Clay, J.; Folke, C.; Lubchenco, J.; Mooney, H.; Troell, M. Effect of aquaculture on world fish supplies. *Nature* **2000**, *405*, 1017–1024. [CrossRef] [PubMed]
7. Food and Agriculture Organization of the United Nations. *The State of World Fisheries and Aquaculture 2016*; FAO: Rome, Italy, 2016. Available online: http://www.fao.org/3/a-i5555e.pdf (accessed on 9 May 2022).
8. Basset-Mens, C.; Van Der Werf, H.M.G. Scenario-based environmental assessment of farming systems: The case of pig production in France. *Agric. Ecosyst. Environ.* **2005**, *105*, 127–144. [CrossRef]
9. Boggia, A.; Paolotti, L.; Castellini, C. Environmental impact evaluation of conventional, organic and organic-plus poultry production systems using life cycle assessment. *World's Poult. Sci. J.* **2010**, *66*, 95–114. [CrossRef]
10. Dourmad, J.Y.; Ryschawy, J.; Trousson, T.; Bonneau, M.; Gonzàlez, J.; Houwers, H.W.J.; Hviid, M.; Zimmer, C.; Nguyen, T.L.T.; Morgensen, L. Evaluating environmental impacts of contrasting pig farming systems with life cycle assessment. *Animal* **2014**, *8*, 2027–2037. [CrossRef] [PubMed]
11. Biermann, G.; Geist, J. Life cycle assessment of common carp (*Cyprinus carpio* L.)—A comparison of the environmental impacts of conventional and organic carp aquaculture in Germany. *Aquaculture* **2019**, *501*, 404–415. [CrossRef]
12. Van Huis, A. Potential of Insects as Food and Feed in Assuring Food Security. *Annu. Rev. Entomol.* **2013**, *58*, 563–583. [CrossRef]
13. Diener, S.; Zurbrügg, C.; Tockner, K. Conversion of organic material by black soldier fly larvae: Establishing optimal feeding rates. *Waste Manag. Res.* **2009**, *27*, 603–610. [CrossRef]

14. Čičková, H.; Newton, G.L.; Lacy, R.C.; Kozánek, M. The use of fly larvae for organic waste treatment. *Waste Manag.* **2015**, *35*, 68–80. [CrossRef]
15. Van Huis, A.; Van Itterbeeck, J.; Klunder, H.; Mertens, E.; Halloran, A.; Muir, G.; Vantomme, P. *Edible Insects Future Prospects for Food and Feed Security*; Food and Agriculture Organization of the United Nations: Rome, Italy, 2013; ISBN 9789251075951.
16. Roques, A.; Rabitsch, W.; Rasplus, J.-Y.; Lopez-Vaamonde, C.; Nentwig, W.; Kenis, M. Alien Terrestrial Invertebrates of Europe. In *Handbook of Alien Species in Europe*; Springer: Dordrecht, The Netherlands, 2009; Volume 569, pp. 63–79, ISBN 978-1-4020-8279-5.
17. Kenis, M. Insects-Insecta. In *An Inventory of Alien Species and their Threat to Biodiversity and Economy in Switzerland*; Wittenberg, R., Ed.; Report to the Swiss Agency for Environment, Forests and Landscape; CABI Bioscience Switzerland Centre: Delémont, Switzerland, 2005; Volume 29, pp. 131–212.
18. Cox, G.W. *Alien Species and Evolution: The Evolutionary Ecology of Exotic Plants, Animals, Microbes, and Interacting Native Species*; Island Press: Washington, DC, USA, 2004; ISBN 1-55963-008-6.
19. Thompson, J.N. Rapid evolution as an ecological process. *Trends Ecol. Evol.* **1998**, *13*, 329–332. [CrossRef]
20. Nayak, S.B.; Rao, K.S.; Ramalakshmi, V. Impact of Climate Change on Insect Pests and their Natural Enemies. *Int. J. Ecol. Environ. Sci.* **2020**, *2*, 579–584.
21. Skendžić, S.; Zovko, M.; Živković, I.P.; Lešić, V.; Lemić, D. The impact of climate change on agricultural insect pests. *Insects* **2021**, *12*, 440. [CrossRef] [PubMed]
22. Walther, G.R.; Roques, A.; Hulme, P.E.; Sykes, M.T.; Pyšek, P.; Kühn, I.; Zobel, M.; Bacher, S.; Botta-Dukát, Z.; Bugmann, H.; et al. Alien species in a warmer world: Risks and opportunities. *Trends Ecol. Evol.* **2009**, *24*, 686–693. [CrossRef]
23. Deutsch, C.A.; Tewksbury, J.J.; Tigchelaar, M.; Battisti, D.S.; Merrill, S.C.; Huey, R.B.; Naylor, R.L. Increase in crop losses to insect pests in a warming climate. *Science* **2018**, *361*, 916–919. [CrossRef]
24. Seebens, H.; Blackburn, T.M.; Dyer, E.E.; Genovesi, P.; Hulme, P.E.; Jeschke, J.M.; Pagad, S.; Pyšek, P.; Winter, M.; Arianoutsou, M.; et al. No saturation in the accumulation of alien species worldwide. *Nat. Commun.* **2017**, *8*, 1–9. [CrossRef]
25. Paini, D.R.; Sheppard, A.W.; Cook, D.C.; De Barro, P.J.; Worner, S.P.; Thomas, M.B. Global threat to agriculture from invasive species. *Proc. Natl. Acad. Sci. USA* **2016**, *113*, 7575–7579. [CrossRef]
26. Ewel, J.J.; O'Dowd, D.J.; Bergelson, J.; Daehler, C.C.; D'Antonio, C.M.; Gómez, L.D.; Gordon, D.R.; Hobbs, R.J.; Holt, A.; Hopper, K.R.; et al. Deliberate Introductions of Species: Research Needs. *Bioscience* **1999**, *49*, 619–630. [CrossRef]
27. Bradshaw, C.J.A.; Leroy, B.; Bellard, C.; Roiz, D.; Albert, C.; Fournier, A.; Barbet-Massin, M.; Salles, J.M.; Simard, F.; Courchamp, F. Massive yet grossly underestimated global costs of invasive insects. *Nat. Commun.* **2016**, *7*, 1–8. [CrossRef]
28. Hauser, M. The historical spread of the Black Soldier Fly, *Hermetia illucens* (L.) (Diptera, Stratiomyidae, Hermetiinae), and its establishment in Canada. *J. Entomol. Soc. Ontario* **2015**, *146*, 51–54.
29. Kroeckel, S.; Harjes, A.G.E.; Roth, I.; Katz, H.; Wuertz, S.; Susenbeth, A.; Schulz, C. When a turbot catches a fly: Evaluation of a pre-pupae meal of the Black Soldier Fly (*Hermetia illucens*) as fish meal substitute—Growth performance and chitin degradation in juvenile turbot (*Psetta maxima*). *Aquaculture* **2012**, *364*, 345–352. [CrossRef]
30. Sealey, W.M.; Gaylord, T.G.; Barrows, F.T.; Tomberlin, J.K.; McGuire, M.A.; Ross, C.; St-Hilaire, S. Sensory analysis of rainbow trout, *Oncorhynchus mykiss*, fed enriched black soldier fly prepupae, *Hermetia illucens*. *J. World Aquac. Soc.* **2011**, *42*, 34–45. [CrossRef]
31. Newton, G.L.; Booram, C.V.; Barker, R.W.; Hale, O.M. Dried *Hermetia illucens* Larvae Meal as a Supplement for Swine. *J. Anim. Sci.* **1977**, *44*, 395–400. [CrossRef]
32. González, O.F.; Oliva, G.R. First report of intestinal myiasis caused by por *Hermetia illucens* (Diptera: Stratiomyidae) | Primer reporte en Cuba de miasis intestinal por *Hermetia illucens* (Diptera: Stratiomyidae). *Rev. Cubana Med. Trop.* **2009**, *61*, 97–99.
33. Calderón-Arguedas, O.; Murillo Barrantes, J.; Solano, M.E. Miasis entérica por *Hermetia illucens* (Diptera: Stratiomyidae) en una paciente geriátrica de Costa Rica. *Parasitol. Latinoam.* **2005**, *60*, 162–164. [CrossRef]
34. Lee, H.L.; Chandrawathani, P.; Wong, W.Y.; Tharam, S.; Lim, W.Y. A case of human enteric myiasis due to larvae of *Hermetia illucens* (Family: Stratiomyiadae): First report in Malaysia. *Malays. J. Pathol.* **1995**, *17*, 109–111.
35. Mulieri, P.R.; Patitucci, L.D.; Scolaro, A. A Rare Case of Pseudomyiasis in a Dog by *Hermetia illucens* (Diptera: Stratiomyidae). *J. Med. Entomol.* **2019**, *56*, 1726–1728. [CrossRef]
36. Hora, M. A northernmost European record of the alien black soldier fly *Hermetia illucens* (Linnaeus, 1758) (Diptera: Stratiomyidae)/Nejsevernější evropský výskyt nepůvodní bráněnky *Hermetia illucens* (Linnaeus, 1758) (Diptera: Stratiomyidae). *Acta Musei Sil. Sci. Nat.* **2013**, *62*, 101–106. [CrossRef]
37. De Groot, M.; Veenvliet, P. *Hermetia illucens* L. (Diptera, Stratiomyidae), a new alien invasive species in Slovenia. *Acta Entomol. Slov.* **2011**, *19*, 195–198.
38. Tsagkarakis, A.E.; Arapostathi, E.I.; Strouvalis, G.I. First record of the black soldier fly, *Hermetia illucens*, in Greece. *Entomol. Hell.* **2015**, *24*, 27–30. [CrossRef]
39. Gladun, V.V. The First Record of *Hermetia illucens* (DIPTERA, STRATIOMYIDAE) from Russia. *Nat. Conserv. Res.* **2019**, *4*, 111–113. [CrossRef]
40. Hewitt, C.G. *The House-Fly, Musca domestica Linn: Its Structure, Habits, Development, Relation to Disease and Control*; Cambridge University Press: Cambridge, MA, USA, 2011.
41. Sánchez-Muros, M.J.; Barroso, F.G.; Manzano-Agugliaro, F. Insect meal as renewable source of food for animal feeding: A review. *J. Clean. Prod.* **2014**, *65*, 16–27. [CrossRef]

42. Čičková, H.; Pastor, B.; Kozánek, M.; Martínez-Sánchez, A.; Rojo, S.; Takáč, P. Biodegradation of pig manure by the housefly, musca domestica: A viable ecological strategy for pig manure management. *PLoS ONE* **2012**, *7*, e32798. [CrossRef] [PubMed]
43. Hwangbo, J.; Hong, E.C.; Jang, A.; Kang, H.K.; Oh, J.S.; Kim, B.W.; Park, B.S. Utilization of house fly-maggots, a feed supplement in the production of broiler chickens. *J. Environ. Biol.* **2009**, *30*, 609–614. Available online: http://www.jeb.co.in/index.php?page=issue_toc&issue=200907_jul09 (accessed on 6 May 2022). [PubMed]
44. Ostrolenk, M.; Welch, H. The House Fly as a Vector of Food Poisoning Organisms in Food Producing Establishments. *Am. J. Public Health Nations Health* **1942**, *32*, 487–494. [CrossRef] [PubMed]
45. Szalanski, A.L.; Owens, C.B.; McKay, T.; Steelman, C.D. Detection of Campylobacter and Escherichia coli O157:H7 from filth flies by polymerase chain reaction. *Med. Vet. Entomol.* **2004**, *18*, 241–246. [CrossRef]
46. Nazni, W.A.; Luke, H.; Rozita, W.M.W.; Abdullah, A.G.; Sa'Diyah, I.; Azahari, A.H.; Zamree, I.; Tan, S.B.; Lee, H.L.; Sofian-Azirun, M. Determination of the flight range and dispersal of the house fly, *Musca domestica* (L.) using mark release. *Trop. Biomed.* **2005**, *22*, 53–61. Available online: https://eprints.um.edu.my/5793/ (accessed on 6 May 2022).
47. Baudry, E.; Viginier, B.; Veuille, M. Non-African populations of *Drosophila melanogaster* have a unique origin. *Mol. Biol. Evol.* **2004**, *21*, 1482–1491. [CrossRef]
48. Markow, T.A. The Natural History of Model Organisms: The secret lives of Drosophila flies. *eLife Sci* **2015**, *4*, e06793. [CrossRef]
49. Fruit Flies Wingless Small. Available online: https://www.livefoodsdirect.co.uk/products/FFS1TUB/fruit-flies-wingless-small (accessed on 24 March 2022).
50. Atkinson, W.; Shorrocks, B. Breeding site specificity in domestic species of Drosophila. *Oecologia* **1979**, *29*, 223–232. [CrossRef]
51. Large Fruit Fly (D. hydei) Go-Large. Available online: https://www.advancedhusbandry.co.uk/drop-shipping/7-fruit-fly-drosophila-hydei-flightless.html (accessed on 24 March 2022).
52. Harrison, R.G.; Bogdanowicz, S.M. Mitochondrial DNA phylogeny of North American field crickets: Perspectives on the evolution of life cycles, songs, and habitat associations. *J. Evol. Biol.* **1995**, *8*, 209–232. [CrossRef]
53. Ferreira, M.; Ferguson, J.W.H. Do Mediterranean crickets *Gryllus bimaculatus* de Geer (Orthoptera: Gryllidae) come from the Mediterranean? Largescale phylogeography and regional gene flow. *Bull. Entomol. Res.* **2010**, *100*, 49–58. [CrossRef] [PubMed]
54. Ferreira, M. Evolutionary Implications of Variation in the Calling Song of the Cricket *Gryllus bimaculatus* De Geer (Orthoptera: Gryllidae). Ph.D. Thesis, University of Pretoria, Hatfield, South Africa, 2006.
55. Exotic-pets.co.uk. Black Crickets. Available online: https://www.exotic-pets.co.uk/black-crickets.html (accessed on 24 March 2022).
56. Taxonomy, G.B. *Gryllus bimaculatus* De Geer, 1773 in GBIF Secretariat. 2021. Available online: GBIF.org (accessed on 9 September 2021).
57. Ahmad, D. Bionomics and Control of *Gryllodes sigillatus* Walker. Ph.D. Thesis, Aligarh Muslim University, Aligarh, India, 1965.
58. Banded Brown Crickets. Available online: https://www.thepetexpress.co.uk/live-reptile-food/banded-brown-crickets-gryllodes-sigillatus-live-food/ (accessed on 24 March 2022).
59. Hanson, P. Los insectos invasores de Costa Rica. *Rev. Biocenosis* **2009**, *22*, 1–2. Available online: https://revistas.uned.ac.cr/index.php/biocenosis/article/view/1255 (accessed on 8 May 2022).
60. Taxonomy, G.B. *Gryllodes sigillatus* (Walker, 1869) in GBIF Secretariat. 2021. Available online: https://www.gbif.org/species/1722299 (accessed on 4 May 2022).
61. Vandeweyer, D.; Wynants, E.; Crauwels, S.; Verreth, C.; Viaene, N.; Claes, J.; Lievens, B.; Van Campenhout, L. Microbial dynamics during industrial rearing, processing, and storage of tropical house crickets (*Gryllodes sigillatus*) for human consumption. *Appl. Environ. Microbiol.* **2018**, *84*, e00255-18. [CrossRef] [PubMed]
62. Vandeweyer, D.; Crauwels, S.; Lievens, B.; Van Campenhout, L. Microbial counts of mealworm larvae (Tenebrio molitor) and crickets (*Acheta domesticus* and *Gryllodes sigillatus*) from different rearing companies and different production batches. *Int. J. Food Microbiol.* **2017**, *242*, 13–18. [CrossRef]
63. Weissman, D.B.; Walker, T.J.; Gray, D.A. The Field Cricket Gryllus assimilis and Two New Sister Species (Orthoptera: Gryllidae). *Ann. Entomol. Soc. Am.* **2009**, *102*, 367–380. [CrossRef]
64. Weissman, D.B.; Gray, D.A.; Thi Pham, H.; Tijssen, P. Billions and billions sold: Pet-feeder crickets (Orthoptera: Gryllidae), commercial cricket farms, an epizootic densovirus, and government regulations make for a potential disaster. *Zootaxa* **2012**, *3504*, 67–88. [CrossRef]
65. Alexander, R.D.; Walker, T.J. Two Introduced Field Crickets New to Eastern United States (Orthoptera: Gryllidae). *Ann. Entomol. Soc. Am.* **1962**, *55*, 90–94. [CrossRef]
66. Barranco, P. El grillo de campo jamaicano, Gryllus assimilis (Fabricius, 1775), posible especie invasora para España (Orthoptera, Gryllidae). *Boletín La SEA* **2012**, *55*, 537–538.
67. Tilami, S.K.; Turek, J.; Červený, D.; Lepič, P.; Kozák, P.; Burkina, V.; Sakalli, S.; Tomčala, A.; Sampels, S.; Mráz, J. Insect meal as a partial replacement for fish meal in a formulated diet for perch perca fluviatilis. *Turkish J. Fish. Aquat. Sci.* **2020**, *20*, 867–878. [CrossRef]
68. Labbouz, Y. Use of House Cricket (*Acheta domesticus*) Meal as a New Source of Protein for Ruminants. Effects on Ruminal Fermentation, Degradation and Biohydrogenation. Master's Thesis, Universidad de Zaragoza, Zaragoza, Spain, 2021.
69. Weissman, D.B.; Rentz, D.C.F.; Alexander, R.D.; Loher, W. Field crickets (Gryllus and Acheta) of California and Baja California, Mexico (Orthoptera: Gryllidae: Gryllinae). *Trans. Am. Entomol. Soc.* **1980**, *106*, 327–356. Available online: https://www.jstor.org/stable/25078267 (accessed on 8 May 2022).

70. Bousquet, Y. *Beetles Associated with Stored Products in Canada: An Identification Guide*; Publication-Agriculture Canada: Ottawa, ON, Canada, 1990; ISBN 0660132664. Available online: http://esc-sec.ca/wp/wp-content/uploads/2017/03/AAFC_bousquet1990.pdf (accessed on 8 May 2022).
71. Richards, O.W.; Davies, R.G. *Imms' General Textbook of Entomology: Volume 2: Classification and Biology*; Springer Science & Business Media: Berlin/Heidelberg, Germany, 2013; ISBN 978-94-017-0472-4.
72. Mewis, I.; Ulrichs, C. Action of amorphous diatomaceous earth against different stages of the stored product pests Tribolium confusum, Tenebrio molitor, Sitophilus granarius and Plodia interpunctella. *J. Stored Prod. Res.* **2001**, *37*, 153–164. [CrossRef]
73. Goptar, I.A.; Semashko, T.A.; Danilenko, S.A.; Lysogorskaya, E.N.; Oksenoit, E.S.; Zhuzhikov, D.P.; Belozersky, M.A.; Dunaevsky, Y.E.; Oppert, B.; Filippova, I.Y.; et al. Cysteine digestive peptidases function as post-glutamine cleaving enzymes in tenebrionid stored-product pests. *Comp. Biochem. Physiol. Part B Biochem. Mol. Biol.* **2012**, *161*, 148–154. [CrossRef]
74. Guo, Z.; Pfohl, K.; Karlovsky, P.; Dehne, H.W.; Altincicek, B. Dissemination of Fusarium proliferatum by mealworm beetle Tenebrio molitor. *PLoS ONE* **2018**, *13*, e0204602. [CrossRef] [PubMed]
75. Timuș, A. The invasive coleopterofauna for Republic of Moldova. *Curr. Trends Nat. Sci.* **2015**, *4*, 41–49.
76. Tortuga-Petshop. Zophoba. Available online: https://tortuga-petshop.com/index.php?id_product=42&id_product_attribute=0&rewrite=zophoba&controller=product (accessed on 4 May 2022).
77. WaxwormsUK. Morio Worms. Available online: https://www.waxwormsuk.com/morio-worms (accessed on 4 May 2022).
78. Leung, D.; Yang, D.; Li, Z.; Zhao, Z.; Chen, J.; Zhu, L. Biodiesel from *Zophobas morio* larva oil: Process optimization and FAME characterization. *Ind. Eng. Chem. Res.* **2012**, *51*, 1036–1040. [CrossRef]
79. Rumbos, C.I.; Athanassiou, C.G. The superworm, *Zophobas morio* (Coleoptera:Tenebrionidae): A 'sleeping giant' in nutrient sources. *J. Insect Sci.* **2021**, *21*, 1–11. [CrossRef]
80. Gołębiowski, M.; Urbanek, A.; Pietrzak, A.; Naczk, A.M.; Bojke, A.; Tkaczuk, C.; Stepnowski, P. Effects of the entomopathogenic fungus Metarhizium flavoviride on the fat body lipid composition of *Zophobas morio* larvae (Coleoptera: Tenebrionidae). *Sci. Nat.* **2020**, *107*, 1–11. [CrossRef]
81. Tran, B.M.D.; Credland, P.F. Consequences of inbreeding for the cowpea seed beetle, Callosobruchus maculatus (F.) (Coleoptera: Bruchidae). *Biol. J. Linn. Soc.* **1995**, *56*, 483–503. [CrossRef]
82. Beck, C.W.; Blumer, L.S. *A Handbook on Bean Beetles, Callosobruchus Maculatus*; National Science Foundation: Virginia, VA, USA, 2011. Available online: https://www.beanbeetle.org/handbook/ (accessed on 6 May 2022).
83. Bean Weevil Cultures. Available online: https://www.exotic-pets.co.uk/bean-weevil.html (accessed on 24 March 2022).
84. Kalpna; Hajam, Y.A.; Kumar, R. Management of stored grain pest with special reference to Callosobruchus maculatus, a major pest of cowpea: A review. *Heliyon* **2022**, *8*, e08703. [CrossRef]
85. Loganathan, M.; Jayas, D.S.; Fields, P.G.; White, N.D.G. Low and high temperatures for the control of cowpea beetle, callosobruchus maculatus (F.) (coleoptera: Bruchidae) in chickpeas. *J. Stored Prod. Res.* **2011**, *47*, 244–248. [CrossRef]
86. Desroches, P.; Mandon, N.; Baehr, J.C.; Huignard, J. Mediation of host-plant use by a glucoside in Callosobruchus maculatus F. (Coleoptera: Bruchidae). *J. Insect Physiol.* **1997**, *43*, 439–446. [CrossRef]
87. Taxonomy, G.B. *Callosobruchus maculatus* (Fabricius, 1775) in GBIF Secretariat (2021). Available online: https://www.gbif.org/species/1047343 (accessed on 9 September 2021).
88. Zampetti, M.F. Fauna Europaea: Chrysomelidae. In *Fauna Europaea: Coleoptera, Bettles*; Audisio, O., Ed.; Fauna Europaea version 2017.06; Museum für Naturkunde: Berlin, Germany, 2013. Available online: https://fauna-eu.org (accessed on 4 May 2022).
89. Rigout, J. *The Beetles of the World. Volume 9: The Cetoniini*; Science Nat: Venette, France, 1989.
90. Cazemier, A.E.; Den Camp, H.J.M.O.; Hackstein, J.H.P.; Vogels, G.D. Fibre digestion in arthropods. *Comp. Biochem. Physiol. Part A Physiol.* **1997**, *118*, 101–109. [CrossRef]
91. *Pachnoda marginata* Marginata (RCA). Available online: https://www.bughouse.be/Pachnoda-marginata-marginata-(RCA)-# (accessed on 24 March 2022).
92. EvolutionReptiles. Sun Bettle. Available online: https://www.evolutionreptiles.co.uk/animals/invertebrates/beetles/sun-beetle/ (accessed on 3 May 2022).
93. Mohemed Osman, S.E.; Hamid, H.A.; Ahmed Ishag, A.E.S.; Salim Eisa, M.A. Survey and level of infestation of Pachnoda interrupta (Oliver) (Coleoptera: Scarabaeidae) in Gedarif State. *Int. J. Eng. Appl. Sci. Technol.* **2020**, *4*, 73–77. [CrossRef]
94. Wolde-Hawariat, Y.; Seyoum, E.; Jembere, B.; Negash, M.; Hansson, B.S.; Hillbur, Y. Behavioural and electrophysiological response of sorghum chafer Pachnoda interrupta (Coleoptera: Scarabaeidae) to plant compounds. *Int. J. Trop. Insect Sci.* **2007**, *27*, 53–61. [CrossRef]
95. Geden, C.J.; Hogsette, J. Research and Extension Needs for Integrated Pest Management for Arthropods of Veterinary Importance. In Proceedings of the Workshop in Lincoln, Lincoln, NE, USA, 12–14 April 1994. Available online: https://digitalcommons.unl.edu/usdaarsfacpub/1039/ (accessed on 6 May 2022).
96. Buffalo Worms. Available online: https://www.exotic-pets.co.uk/buffalo-worms.html (accessed on 24 March 2022).
97. Vaughan, J.A.; Turner, E.C.; Ruszler, P.L. Infestation and Damage of Poultry House Insulation by the Lesser Mealworm, *Alphitobius diaperinus* (Panzer). *Poult. Sci.* **1984**, *63*, 1094–1100. [CrossRef]
98. Geden, C.J.; Axtell, R.C. Factors affecting climbing and tunneling behavior of the lesser mealworm (Coleoptera: Tenebrionidae). *J. Econ. Entomol.* **1987**, *80*, 1197–1204. [CrossRef]

99. McAllister, J.C.; Steelman, C.D.; Newberry, L.A.; Skeeles, J.K. Isolation of infectious bursal disease virus from the lesser mealworm, *Alphitobius diaperinus* (Panzer). *Poult. Sci.* **1995**, *74*, 45–49. [CrossRef]
100. Despins, J.L.; Axtell, R.C.; Rives, D.V.; Guy, J.S.; Ficken, M.D. Transmission of Enteric Pathogens of Turkeys by Darkling Beetle Larva (*Alphitobius diaperinus*). *J. Appl. Poult. Res.* **1994**, *3*, 61–65. [CrossRef]
101. Goodwin, M.A.; Waltman, W.D. Transmission of Eimeria, viruses, and bacteria to chicks: Darkling beetles (*Alphitobius diaperinus*) as vectors of pathogens. *J. Appl. Poult. Res.* **1996**, *5*, 51–55. [CrossRef]
102. Watson, D.W.; Guy, J.S.; Stringham, S.M. Limited transmission of turkey coronavirus in young turkeys by adult *Alphitobius diaperinus* (Coleoptera: Tenebrionidae). *J. Med. Entomol.* **2000**, *37*, 480–483. [CrossRef] [PubMed]
103. McAllister, J.C.; Steelman, C.D.; Skeeles, J.K. Reservoir competence of the lesser mealworm (Coleoptera: Tenebrionidae) for Salmonella typhimurium (Eubacteriales: Enterobacteriaceae). *J. Med. Entomol.* **1994**, *31*, 369–372. [CrossRef] [PubMed]
104. McAllister, J.C.; Steelman, C.D.; Skeeles, J.K.; Newberry, L.A.; Gbur, E.E. Reservoir Competence of *Alphitobius diaperinus* (Coleoptera: Tenebrionidae) for Escherichia coli (Eubacteriales: Enterobacteriaceae). *J. Med. Entomol.* **1996**, *33*, 983–987. [CrossRef] [PubMed]
105. Scanlan, J.C.; Grant, W.E.; Hunter, D.M.; Milner, R.J. Habitat and environmental factors influencing the control of migratory locusts (*Locusta migratoria*) with an entomopathogenic fungus (Metarhizium anisopliae). *Ecol. Modell.* **2001**, *136*, 223–236. [CrossRef]
106. Tokuda, M.; Tanaka, S.; Zhu, D.H. Multiple origins of *Locusta migratoria* (Orthoptera: Acrididae) in the Japanese Archipelago and the presence of two major clades in the world: Evidence from a molecular approach. *Biol. J. Linn. Soc.* **2010**, *99*, 570–581. [CrossRef]
107. Werning, H. Egyptian Walking Grasshoppers (Locusta migratoria). Available online: https://www.bugs-international.com/en-insekten-wanderheuschrecken.html (accessed on 24 March 2022).
108. Wang, X.; Fang, X.; Yang, P.; Jiang, X.; Jiang, F.; Zhao, D.; Li, B.; Cui, F.; Wei, J.; Ma, C.; et al. The locust genome provides insight into swarm formation and long-distance flight. *Nat. Commun.* **2014**, *5*, 1–9. [CrossRef]
109. Song, H. On the origin of the desert locust *Schistocerca gregaria* (Forskål) (Orthoptera: Acrididae: Cyrtacanthacridinae). *Proc. R. Soc. B Biol. Sci.* **2004**, *271*, 1641–1648. [CrossRef]
110. Zielińska, E.; Baraniak, B.; Karaś, M.; Rybczyńska, K.; Jakubczyk, A. Selected species of edible insects as a source of nutrient composition. *Food Res. Int.* **2015**, *77*, 460–466. [CrossRef]
111. FAO. Desert Locust. Available online: www.fao.org/locusts/en (accessed on 20 January 2022).
112. Editorial. A lack of locust preparedness will cost lives. *Nature* **2020**, *579*, 174. [CrossRef]
113. Roussi, A. The battle to contain gigantic locust swarms. *Nature* **2020**, *579*, 330. [CrossRef]
114. Green, J. The Unique Challenges of Responding to Desert Locust Outbreaks. Available online: https://entomologytoday.org/2022/01/11/unique-challenges-integrated-pest-management-desert-locust-outbreaks/ (accessed on 20 January 2022).
115. Paddock, F.B. The Chronological Distribution of the Beemoth. *J. Econ. Entomol.* **1926**, *19*, 136–141. [CrossRef]
116. Kwadha, C.A.; Ong'Amo, G.O.; Ndegwa, P.N.; Raina, S.K.; Fombong, A.T. The biology and control of the greater wax moth, *Galleria mellonella*. *Insects* **2017**, *8*, 61. [CrossRef] [PubMed]
117. Kay, S.; Edwards, J.; Brown, J.; Dixon, R. *Galleria mellonella* infection model identifies both high and low lethality of clostridium perfringens toxigenic strains and their response to antimicrobials. *Front. Microbiol.* **2019**, *10*, 1281. [CrossRef] [PubMed]
118. Live Wax Moth Larvae WaxWorms. Available online: https://www.livefoods.co.uk/live-wax-moth-larvae-waxworms-15g-galleria-mellonella-p-50.html (accessed on 24 March 2022).
119. Réjasse, A.; Waeytens, J.; Deniset-Besseau, A.; Nielsen-Leroux, C.; Crappart, N.; Sandt, C. Plastic biodegradation: Do *Galleria mellonella* larvae—Bio-assimilate polyethylene? A spectral histology approach using isotopic labelling and infrared microspectroscopy. *Environ. Sci. Technol.* **2021**, *56*, 525–534. [CrossRef] [PubMed]
120. *Shelfordella lateralis* "Turkestan Cockroach". Available online: https://insektenliebe.com/en/shop/shelfordella-lateralis-turkestan-cockroach/ (accessed on 24 March 2022).
121. Red Runner Roaches. Available online: https://www.tcinsects.com/product/1-4-live-red-runner-roaches-for-sale/ (accessed on 24 March 2022).
122. Alesho, N.A. Synathropic cockroaches of Russia. In *International Colloquia on Social Insects: Volume 3–4.*; Socium, St.: Petersburg, Russia, 1997; pp. 45–50.
123. Memona, H.; Manzoor, F.; Riaz, S. Species diversity and distributional pattern of cockroaches in Lahore, Pakistan. *J. Arthropod. Borne. Dis.* **2017**, *11*, 249–259. Available online: https://pubmed.ncbi.nlm.nih.gov/29062850/ (accessed on 8 May 2022).
124. Davranoglou, L.; Hadjiconstantis, M. First record of the Turkestan cockroach (*Shelfordella lateralis*) from Cyprus and Turkey (Dictyoptera: Blattidae) First record of the Turkestan cockroach (*Shelfordella lateralis*) from Cyprus and Turkey (Dictyoptera: Blattidae). *Isr. J. Entomol.* **2020**, *50*, 1–8. [CrossRef]
125. Alamer, A.H. Endocrine Control of Fat Body Composition and Effects of the Insect Growth Regulators Methoprene and Pyriproxyfen on the Development and Reproduction of the Argentinian Cockroach, *Blaptica dubia* Serville (Blattaria: Blaberidae). Ph.D. Thesis, Universität Bayreuth, Bayreuth, Germany, 2013.
126. Wu, H.; Hu, X.P.; Appel, A.G. Temperature-Dependent Development and Thermal Sensitivity of *Blaptica dubia* (Blattodea: Blaberidae). *J. Econ. Entomol.* **2017**, *110*, 546–551. [CrossRef]
127. Taxonomy, G.B. *Blaberus Craniifer* Burmeister, 1838 in GBIF Secretariat. 2021. Available online: https://www.gbif.org/species/5150233 (accessed on 9 September 2021).

128. Beccaloni, G.W. Cockroach Species File Online. Version 5.0/5.0. Available online: http://blattodea.speciesfile.org (accessed on 9 September 2021).
129. "Death's Head" Roaches: 50 Mixed Nymphs (No Adults). Available online: https://royalroaches.com/shop-1/ols/products/deaths-head-roaches-10-mixed-nymphs-no-adults (accessed on 24 March 2022).
130. Deaths Head Cockroach. Available online: https://www.exotic-pets.co.uk/deaths-head-cockroach.html (accessed on 24 March 2022).
131. Kulma, M.; Kouřimská, L.; Homolková, D.; Božik, M.; Plachý, V.; Vrabec, V. Effect of developmental stage on the nutritional value of edible insects. A case study with Blaberus craniifer and *Zophobas morio*. *J. Food Compos. Anal.* **2020**, *92*, 103570. [CrossRef]
132. Babarinde, S.A.; Mvumi, B.M.; Babarinde, G.O.; Manditsera, F.A.; Akande, T.O.; Adepoju, A.A. Insects in food and feed systems in sub-Saharan Africa: The untapped potentials. *Int. J. Trop. Insect Sci.* **2021**, *41*, 1923–1951. [CrossRef]
133. Ssepuuya, G.; Namulawa, V.; Mbabazi, D.; Mugerwa, S.; Fuuna, P.; Nampijja, Z.; Ekesi, S.; Fiaboe, K.K.M.; Nakimbugwe, D. Use of insects for fish and poultry compound feed in sub-Saharan Africa—A systematic review. *J. Insects Food Feed* **2017**, *3*, 289–302. [CrossRef]
134. Ostadi, Y.; Yavari, G.; Fadaei, M.S.; Ahmadian, M.; Imani, S. Challenges in breeding and consumption of insects as feed and food in Iran. *J. Human Health Halal Metrics* **2020**, *1*, 37–46. [CrossRef]
135. Taxonomy, G.B. *Gromphadorhina portentosa* (Schaum, 1853) in GBIF Secretariat. 2021. Available online: https://www.gbif.org/species/1994576 (accessed on 9 September 2021).
136. Nelson, M.C. Sound production in the cockroach, *Gromphadorhina portentosa*: The sound-producing apparatus. *J. Comp. Physiol.* **1979**, *132*, 27–38. [CrossRef]
137. Mulder, P.; Shufran, A. Madagascar Hissing Cockroaches: Information and Care. Available online: https://extension.okstate.edu/fact-sheets/madagascar-hissing-cockroaches-information-and-care.html (accessed on 24 March 2022).
138. Work, T.T.; McCullough, D.G.; Cavey, J.F.; Komsa, R. Arrival rate of nonindigenous insect species into the United States through foreign trade. *Biol. Invasions* **2005**, *7*, 323–332. [CrossRef]
139. Haack, R.A. Exotic bark- and wood-boring Coleoptera in the United States: Recent establishments and interceptions. *Can. J. For. Res.* **2006**, *36*, 269–288. [CrossRef]
140. Dunford, J.C.; Young, D.K. An Annotated Checklist of Wisconsin Darkling Beetles (Coleoptera: Tenebrionidae) with Comparisons to the Western Great Lakes Fauna. *Trans. Am. Entomol. Soc.* **2004**, *130*, 57–76. Available online: https://www.jstor.org/stable/25078836 (accessed on 6 May 2022).
141. Olson, C.A. Blatta (Shelfordella) lateralis, the Turkestan Cockroach (Blattoidea: Blattidae) Recorded from Arizona. *Bull. Entomol. Soc. Am.* **1985**, *31*, 30. [CrossRef]
142. Del Campo, C.M.L.; Renwick, J.A.A. Dependence on host constituents controlling food acceptance by *Manduca sexta* larvae. *Entomol. Exp. Appl.* **1999**, *93*, 209–215. [CrossRef]
143. Whitney Cranshaw Hornworms and Sphinx Moths. In *Garden Insects of North America: The Ultimate Guide to Backyard Bugs*; Princeton University Press: Princeton, NJ, USA, 2004; pp. 146–149.
144. Hornworms for Sale. Available online: https://reptilesupply.com/collections/hornworms-for-sale (accessed on 24 March 2022).
145. Kingsolver, J.G.; Nagle, A. Evolutionary divergence in thermal sensitivity and diapause of field and laboratory populations of *Manduca sexta*. *Physiol. Biochem. Zool.* **2007**, *80*, 473–479. [CrossRef]
146. Beccaloni, G.W. Species *Blaberus discoidalis* Serville. 1838. Available online: http://cockroach.speciesfile.org/Common/basic/Taxa.aspx?TaxonNameID=1174169 (accessed on 2 February 2022).
147. Florida State. Introduction, Possession or Movement of Arthropods, Biological Control Agents, Plant Pests, Noxious Weeds, and Invasive Plants, Regulated by the Department, United States. 2020. Available online: https://www.flrules.org/gateway/ChapterHome.asp?Chapter=5b-57 (accessed on 6 May 2022).
148. Steltz, E.E. Redesign of the Micromechanical Flying Insect in a Power Density Context. Ph.D. Thesis, Univeristy of California, Berkeley, CA, USA, 2008.
149. Goode, M.L. Effects of Thermal Acclimation on the Critical Thermal Maxima of the Tropical Cockroaches: *Blaptica dubia*, Eublaberus Posticus and *Blaberus discoidalis* (Blaberidae). Master's Thesis, Eastern Kentucky University, Richmond, KY, USA, 2013. Available online: https://encompass.eku.edu/etd/171/ (accessed on 6 May 2022).
150. Yen, A.L. Insects as food and feed in the Asia Pacific region: Current perspectives and future directions. *J. Insects Food Feed* **2015**, *1*, 33–55. [CrossRef]
151. Xu, H.; Ding, H.; Li, M.; Qiang, S.; Guo, J.; Han, Z.; Huang, Z.; Sun, H.; He, S.; Wu, H.; et al. The distribution and economic losses of alien species invasion to China. *Biol. Invasions* **2006**, *8*, 1495–1500. [CrossRef]
152. Hanboonsong, Y.; Jamjanya, T.; Durst, P.B. *Six-Legged Livestock: Edible Insect Farming, Collecting and Marketing in Thailand*; RAP Publication 3: Bangkok, Thailand, 2013. Available online: https://www.fao.org/publications/card/en/c/76e0a383-3ca0-5a7c-8d5a-b3a4262b857f/ (accessed on 6 May 2022).
153. EPPO *Rhynchophorus ferrugineus*. EPPO Datasheets on Pests Recommended for Regulation. Available online: https://gd.eppo.int (accessed on 22 February 2021).
154. Abraham, V.A.; Shuaibi, M.A.A.; Faleiro, J.R.; Abozuhairah, R.A.; Vidyasagar, P.S.P.V. An Integrated Management Approach for Red Palm Weevil *Rhynchophorus ferrugineus* Oliv. a Key Pest of Date Palm in the Middle East. *J. Agric. Mar. Sci. JAMS* **1998**, *3*, 77–83. Available online: https://journals.squ.edu.om/index.php/jams/article/view/522/525 (accessed on 6 May 2022). [CrossRef]

155. Leatemia, J.A.; Patty, J.A.; Masauna, E.D.; Noya, S.H.; Hasinu, J.V. Utilization of sago grub (*Rhynchophorus ferrugineus* Olivier) (Coleoptera: Curculionidae) as an alternative source of protein. *IOP Conf. Ser. Earth Environ. Sci.* **2021**, *800*, 012028. [CrossRef]
156. Barber, E.J.W. *Prehistoric Textiles: The Development of Cloth in the Neolithic and Bronze Ages with Special Reference to the Aegean*; Princeton University Press: Princeton, NJ, USA, 1992; ISBN 9780691002248.
157. Wei, Z.J.; Liao, A.M.; Zhang, H.X.; Liu, J.; Jiang, S.T. Optimization of supercritical carbon dioxide extraction of silkworm pupal oil applying the response surface methodology. *Bioresour. Technol.* **2009**, *100*, 4214–4219. [CrossRef] [PubMed]
158. Rao, P.U. Chemical Composition and Nutritional Evaluation of Spent Silk Worm Pupae. *J. Agric. Food Chem.* **1994**, *42*, 2201–2203. [CrossRef]
159. Wang, J.; Wu, F.A.; Liang, Y.; Wang, M. Process optimization for the enrichment of α-linolenic acid from silkworm pupal oil using response surface methodology. *Afr. J. Biotechnol.* **2010**, *9*, 2956–2964. [CrossRef]
160. Popescu, A. Trends in world silk cocoons and silk production and trade, 2007–2010. *Anim. Sci. Biotechnol.* **2013**, *46*, 418–423.
161. File, O.S. *Teleogryllus emma* (Ohmachi & Matsuura, 1951) in Cigliano M M (2019). Available online: https://www.gbif.org/species/100538918 (accessed on 11 September 2021).
162. Mazaki, S. Adaptation to local climatic conditions in the Emma field cricket (Orthoptera: Gryllidae). *Entomol. Soc. Jpn.* **1963**, *31*, 249–260.
163. Ghosh, S.; Lee, S.M.; Jung, C.; Meyer-Rochow, V.B. Nutritional composition of five commercial edible insects in South Korea. *J. Asia. Pac. Entomol.* **2017**, *20*, 686–694. [CrossRef]
164. Kim, N.-J.; Hong, S.-J.; Seol, K.-Y.; Kim, S.-H.; Ahn, N.-H.; Kim, M.-A. Effect of Temperature on Development and Reproduction of the Emma Field Cricket, *Teleogryllus emma* (Orthoptera: Gryllidae). *Int. J. Ind. Entomol.* **2007**, *15*, 69–73. Available online: https://www.koreascience.or.kr/article/JAKO200735822452285.page (accessed on 6 May 2022).
165. Lee, E.; Ohseok, K. The Effect of Invasive Cricket Species, *Gryllus bimaculatus* on the Survival of Korean Cricket Species, *Teleogryllus emma*. *Korean J. Ecol. Environ.* **2013**, *46*, 67–74. [CrossRef]
166. IBGE PAM 2020: Valor da Produção Agrícola Nacional Cresce 30,4% e Chega a R$ 470,5 Bilhões, Recorde da Série. Available online: https://agenciadenoticias.ibge.gov.br/agencia-sala-de-imprensa/2013-agencia-de-noticias/releases/31672-pam-2020-valor-da-producao-agricola-nacional-cresce-30-4-e-chega-a-r-470-5-bilhoes-recorde-da-serie (accessed on 23 March 2022).
167. Oliveira, C.M.; Auad, A.M.; Mendes, S.M.; Frizzas, M.R. Crop losses and the economic impact of insect pests on Brazilian agriculture. *Crop Prot.* **2014**, *56*, 50–54. [CrossRef]
168. Chua, T.H.; Chandrapal, R. The influence of restricted food supplies on the development of larvae and on the fecundity of *Palembus dermestoides* fairn. (Tenebrionidae). *J. Stored Prod. Res.* **1978**, *14*, 81–86. [CrossRef]
169. Rehn, J.A.G. Man's Uninvited Fellow Traveler-The Cockroach. *Sci. Mon.* **1945**, *61*, 265–276. Available online: https://www.jstor.org/stable/18346 (accessed on 6 May 2022).
170. Schimpf, N.G.; Matthews, P.G.D.; White, C.R. Discontinuous gas exchange exhibition is a heritable trait in speckled cockroaches Nauphoeta cinerea. *J. Evol. Biol.* **2013**, *26*, 1588–1597. [CrossRef] [PubMed]
171. Lombardi, E.J.; Bywater, C.L.; White, C.R. The effect of ambient oxygen on the thermal performance of a cockroach, Nauphoeta cinerea. *J. Exp. Biol.* **2020**, *223*, jeb208306. [CrossRef] [PubMed]
172. Greven, H.; Herrmann, J.; Kiwitt, G. Supplementary Observations on the Reproduction of the Viviparous Cockroach Oxyhaloa deusta (Thunberg, 1784) with Some Notes on its Locomotory Activity (Blaberidae: Oxyhaloinae). *Entomol. Heute* **2019**, *31*, 1–24.
173. Wormblog. Red Head Roach Care Sheet. Available online: https://wormman.blog/red-head-roach-care-sheet/ (accessed on 24 March 2022).
174. Ozymandias Feeder Roaches: Care and Breeding. Available online: https://www.roachforum.com/topic/3029-feeder-roaches-care-and-breeding/ (accessed on 3 May 2022).
175. Blattodea313. Oxyhaloa Deusta Housing. Available online: https://www.roachforum.com/topic/4632-oxyhaloa-deusta-housing/ (accessed on 3 May 2022).
176. Fenilli, R. Life Cycle, Morphology and Effects of Gamma Radiation (60 Co) on Adults of *Palembus dermestoides* (Fairmaire, 1893) (Coleoptera, Tenebrionidae). Ph.D. Thesis, USP, São Paulo, Brazil, 1982.
177. Stumpf, I.V.K.; Luz, E.; Tonin, V.R. Infecção experimental de *Palembus dermestoides* por larvas de Macracanthorhynchus hirudinaceus. *Acta Biológica Parana.* **1990**, *19*, 45–49. [CrossRef]
178. Adler, A.I.; Brancato, F.P. Human furuncular myiasis caused by *Hermetia illucens* (Diptera: Stratiomyidae). *J. Med. Entomol.* **1995**, *32*, 745–746. [CrossRef]
179. Harwood, P.D.; Meleney, H.E. Human Intestinal Myiasis Due to the Larvae of the Soldier Fly, *Hermetia illucens* Linné (Diptera, Stratiomyidae). *Am. J. Trop. Med. Hyg.* **1935**, *1*, 45–49. [CrossRef]
180. Martínez-Sánchez, A.; Magaña, C.; Saloña, M.; Rojo, S. First record of *Hermetia illucens* (Diptera: Stratiomyidae) on human corpses in Iberian Peninsula. *Forensic Sci. Int.* **2011**, *206*, 2010–2012. [CrossRef]
181. Banga, K.S.; Kumar, S.; Kotwaliwale, N.; Mohapatra, D. Major insects of stored food grains. *Int. J. Chem. Stud.* **2020**, *8*, 2380–2384. [CrossRef]
182. Mackauer, M. Genetic aspects of insect production. *Entomophaga* **1972**, *17*, 27–48. [CrossRef]
183. Barroso, F.G.; de Haro, C.; Sánchez-Muros, M.J.; Venegas, E.; Martínez-Sánchez, A.; Pérez-Bañón, C. The potential of various insect species for use as food for fish. *Aquaculture* **2014**, *422*, 193–201. [CrossRef]

184. Bell, J.G.; Ghioni, C.; Sargen, J.R. Fatty acid composition of 10 freshwater invertebrates which are natural food organisms of Atlantic salmon parr (*Salmo salar*): A comparison with commercial diets. *Aquaculture* **1994**, *128*, 301–313. [CrossRef]
185. Ghosh, S.; Jung, C.; Meyer-Rochow, V.B. Nutritional value and chemical composition of larvae, pupae, and adults of worker honey bee, Apis mellifera ligustica as a sustainable food source. *J. Asia. Pac. Entomol.* **2016**, *19*, 487–495. [CrossRef]
186. Prado e Castro, C.; Ameixa, O.M.C.C. Blow flies (Diptera: Calliphoridae) promising candidates as animal feed ingredients. *J. Insects Food Feed* **2021**, *7*, 1065–1076. [CrossRef]
187. Sing, K.W.; Kamarudin, M.S.; Wilson, J.J.; Sofian-Azirun, M. Evaluation of blowfly (*Chrysomya megacephala*) maggot meal as an effective, sustainable replacement for fishmeal in the diet of farmed juvenile red tilapia (*Oreochromis* sp.). *Pak. Vet. J.* **2014**, *34*, 288–292.
188. Ramos-Bueno, R.P.; González-Fernández, M.J.; Sánchez-Muros-Lozano, M.J.; García-Barroso, F.; Guil-Guerrero, J.L. Fatty acid profiles and cholesterol content of seven insect species assessed by several extraction systems. *Eur. Food Res. Technol.* **2016**, *242*, 1471–1477. [CrossRef]
189. Paul, A.; Frederich, M.; Uyttenbroeck, R.; Malik, P.; Filocco, S.; Richel, A.; Heuskin, S.; Alabi, T.; Megido, R.C.; Franck, T.; et al. Nutritional composition and rearing potential of the meadow grasshopper (*Chorthippus parallelus* Zetterstedt). *J. Asia. Pac. Entomol.* **2016**, *19*, 1111–1116. [CrossRef]
190. Taxonomy, G.B. *Lucilia Sericata* (Meigen, 1826) in GBIF Secretariat. 2021. Available online: https://www.gbif.org/species/5063973 (accessed on 13 September 2021).
191. Hall, M.; Wall, R. Myiasis of Humans and Domestic Animals. *Adv. Parasitol.* **1995**, *35*, 257–334. [CrossRef]
192. Chakravorty, J.; Ghosh, S.; Megu, K.; Jung, C.; Meyer-Rochow, V.B. Nutritional and anti-nutritional composition of *Oecophylla smaragdina* (Hymenoptera: Formicidae) and *Odontotermes* sp. (Isoptera: Termitidae): Two preferred edible insects of Arunachal Pradesh, India. *J. Asia. Pac. Entomol.* **2016**, *19*, 711–720. [CrossRef]
193. Guil-Guerrero, J.L.; Ramos-Bueno, R.P.; González-Fernandez, M.J.; Fabrikov, D.; Sánchez-Muros, M.J.; Barroso, F.G. Insects as Food: Fatty Acid Profiles, Lipid Classes, and sn-2 Fatty Acid Distribution of Lepidoptera Larvae. *Eur. J. Lipid Sci. Technol.* **2018**, *120*, 1700391. [CrossRef]
194. Taxonomy, G.B. *Aphodius Rufipes* (Linnaeus, 1758) in GBIF Secretariat. 2021. Available online: https://www.gbif.org/species/8321792 (accessed on 13 September 2021).
195. Oriolowo, O.B.; John, O.J.; Mohammed, U.B.; Joshua, D. Amino acids profile of catfish, crayfish and larva of edible dung beetle. *Ife J. Sci.* **2020**, *22*, 9–16. [CrossRef]
196. Taxonomy, G.B. *Cladomorphus phyllinus* G.R.Gray, 1835 in GBIF Secretariat. 2021. Available online: https://www.gbif.org/species/1413211 (accessed on 13 September 2021).
197. Botton, V.; Chiarello, L.M.; Klunk, G.A.; Marin, D.; Curbani, L.; Gonçalves, M.J.; Vitorino, M.D. Evaluation of nutritional composition and ecotoxicity of the stick insect *Cladomorphus phyllinum*. *Eur. Food Res. Technol.* **2020**, *247*, 605–611. [CrossRef]
198. File, O.S. *Acrida cinerea* (Thunberg, 1815) in Cigliano M M (2019). Available online: https://www.gbif.org/species/5099473 (accessed on 13 September 2021).
199. Wang, D.; Zhai, S.W.; Zhang, C.X.; Zhang, Q.; Chen, H. Nutrition value of the Chinese grasshopper *Acrida cinerea* (Thunberg) for broilers. *Anim. Feed Sci. Technol.* **2007**, *135*, 66–74. [CrossRef]
200. Cigliano, M.M.; Braun, H.; Eades, D.C.; Otte, D. Orthoptera Species File Version 5.0/5.0. Available online: http://orthoptera.speciesfile.org/HomePage/Orthoptera/HomePage.aspx (accessed on 6 May 2022).
201. Finke, M.D.; Sunde, M.L.; DeFoliart, G.R. An Evaluation of the Protein Quality of Mormon Crickets (*Anabrus Simplex* Haldeman) When Used as a High Protein Feedstuff for Poultry. *Poult. Sci.* **1985**, *64*, 708–712. [CrossRef]
202. Wang, D.; Shao, W.Z.; Chuan, X.Z.; Yao, Y.B.; Shi, H.A.; Ying, N.X. Evaluation on nutritional value of field crickets as a poultry feedstuff. *Asian-Australas. J. Anim. Sci.* **2005**, *18*, 667–670. [CrossRef]
203. Taxonomy, G.B. *Zonocerus variegatus* (Linnaeus, 1758) in GBIF Secretariat (2021). Available online: https://www.gbif.org/species/1727818 (accessed on 13 September 2021).
204. Alegbeleye, W.O.; Obasa, S.O.; Olude, O.O.; Otubu, K.; Jimoh, W. Preliminary evaluation of the nutritive value of the variegated grasshopper (*Zonocerus variegatus* L.) for African catfish Clarias gariepinus (Burchell. 1822) fingerlings. *Aquac. Res.* **2012**, *43*, 412–420. [CrossRef]
205. Finke, M.D. Complete Nutrient Content of Four Species of Feeder Insects. *Zoo Biol.* **2013**, *32*, 27–36. [CrossRef]
206. Recorpinc Butterworms. Available online: http://www.recorpinc.com/butterworms.php (accessed on 7 May 2022).
207. Topflightdubia Butterworms. Available online: https://www.topflightdubia.com/butterworms (accessed on 7 May 2022).
208. Iriarte, J.A.; Feinsinger, P.; Jaksic, F.M. Trends in wildilife use and trade in Chile. *Biol. Conserv.* **1997**, *81*, 9–20. [CrossRef]
209. Ureta, E. Revisión de la familia Cossidae en Chile. *Bol. Mus. Nac. Hist. Nat.* **1957**, *27*, 129–153. Available online: https://bibliotecadigital.infor.cl/handle/20.500.12220/7999 (accessed on 6 May 2022).
210. Duarte, P.M.; Maciel, E.; Pinho, M.; Domingues, M.R.; Calado, R.; Lillebø, A.I.; Ameixa, O.M.C.C. Omega-3 on the fly: Long-legged fly *Machaerium maritimae* as a potential source of eicosapentaenoic acid for aquafeeds. *J. Insects Food Feed* **2021**, *7*, 1089–1100. [CrossRef]
211. Committee, E.S. Risk profile related to production and consumption of insects as food and feed. *EFSA J.* **2015**, *13*, 60. [CrossRef]
212. Montanari, F.; Pinto de Moura, A.; Cunha, L.M. *Production and Commercialization of Insects as Food and Feed*; Springer International Publishing: Cham, Switzerland, 2021; pp. 29–39.

213. Food and Agriculture Organization of the United Nations. *FAO Commission on Genetic Resources for Food and Agriculture Assessments*; Scherf, B.D., Pilling, D., Eds.; FAO: Rome, Italy, 2015.
214. Premrov Bajuk, B.; Zrimšek, P.; Kotnik, T.; Leonardi, A.; Križaj, I.; Jakovac Strajn, B. Insect protein-based diet as potential risk of allergy in dogs. *Animals* **2021**, *11*, 1942. [CrossRef]
215. Ribeiro, J.C.; Cunha, L.M.; Sousa-Pinto, B.; Fonseca, J. Allergic risks of consuming edible insects: A systematic review. *Mol. Nutr. Food Res.* **2018**, *62*, 1–12. [CrossRef]
216. Hong, J.; Han, T.; Kim, Y.Y. Mealworm (Tenebrio molitor larvae) as an alternative protein source for monogastric animal: A review. *Animals* **2020**, *10*, 2068. [CrossRef]
217. Ameixa, O.M.C.C.; Šipoš, J.; Burda, M.; Soares, A.M.V.M.; Soares, A.O. Factors influencing the introduction and spread of Harmonia axyridis in the Iberian Peninsula. *Biol. Invasions* **2019**, *21*, 323–331. [CrossRef]
218. Hill, M.P.; Clusella-Trullas, S.; Terblanche, J.S.; Richardson, D.M. Drivers, impacts, mechanisms and adaptation in insect invasions. *Biol. Invasions* **2016**, *18*, 883–891. [CrossRef]
219. Peden, D. *Hermetia illucens*. Public Domain. Available online: https://www.inaturalist.org/photos/194457135 (accessed on 5 May 2022).
220. Lucas, B. *Musca domestica*. CC-BY-NC. Available online: https://www.inaturalist.org/observations/27665746 (accessed on 24 March 2022).
221. Rorabaugh, J. *Drosophila melanogaster*. CC-BY-NC. Available online: https://inaturalist.ca/photos/14360123 (accessed on 24 March 2022).
222. Bailey, J. *Drosophila hydei*. CC-BY-NC. Available online: https://www.inaturalist.org/observations/8441616 (accessed on 24 March 2022).
223. Pavlou, V. *Gryllus bimaculatus*. CC-BY-NC. Available online: https://www.inaturalist.org/observations/109283434 (accessed on 24 March 2022).
224. Fortnash, J. *Gryllodes sigillatus*. Public Domain. Available online: https://www.inaturalist.org/photos/186351772 (accessed on 24 March 2022).
225. Hospers, A. *Gryllus assimilis*. CC-BY. Available online: https://www.inaturalist.org/photos/23333074 (accessed on 24 March 2022).
226. Mallory, C. *Acheta domesticus*. CC-BY-NC. Available online: https://www.inaturalist.org/observations/5277240 (accessed on 24 March 2022).
227. Oikonen, V. *Tenebrio molitor*. Public Domain. Available online: https://www.inaturalist.org/observations/84739305 (accessed on 24 March 2022).
228. Gratwicke, B. *Zophobas morio*. CC-BY-2.0. Available online: https://www.flickr.com/photos/briangratwicke/5414327015/in/photolist-9frQMM-9frR5e (accessed on 25 March 2022).
229. Zafeiriou, S. *Callosobruchus maculatus*. CC-BY-NC. Available online: https://www.inaturalist.org/observations/68570028 (accessed on 25 March 2022).
230. Schulting, S. *Pachnoda marginata*. CC-BY-NC. Available online: https://inaturalist.ca/photos/54808258 (accessed on 25 March 2022).
231. Legrand, M. Lou *Alphitobius diaperinus*. CC-BY-NC. Available online: https://inaturalist.ca/observations/49949068 (accessed on 25 March 2022).
232. Baquero, E. *Locusta migratoria*. CC-BY-NC. Available online: https://www.inaturalist.org/observations/4314983 (accessed on 25 March 2022).
233. Habib, A. *Schistocerca gregaria*. CC-BY-NC. Available online: https://www.inaturalist.org/observations/20990673 (accessed on 25 March 2022).
234. Sanctuary, E. *Galleria mellonella*. CC-BY-NC-ND. Available online: https://www.inaturalist.org/observations/46916897 (accessed on 25 March 2022).
235. White, D. *Shelfordella lateralis*. CC-BY-NC. Available online: https://www.inaturalist.org/observations/51307601 (accessed on 25 March 2022).
236. Lago, M.C. *Blaptica dubia*. CC-BY-NC. Available online: https://inaturalist.ca/observations/62266049 (accessed on 25 March 2022).
237. Schwartz, B. Blaberus craniifer. CC-BY-NC. Available online: https://www.inaturalist.org/observations/2584268 (accessed on 25 March 2022).
238. Fraire, M. *Gromphadorhina portentosa*. CC-BY-NC. Available online: https://www.inaturalist.org/observations/36924580 (accessed on 25 March 2022).
239. Skrentny, J. *Manduca sexta*. CC-BY-NC. Available online: https://www.inaturalist.org/observations/93210706 (accessed on 25 March 2022).
240. Méndez, L. *Blaberus discoidalis*. CC-BY-NC. Available online: https://www.inaturalist.org/photos/127331827 (accessed on 25 March 2022).
241. Nadal, M. *Rhynchophorus ferrugineus*. CC-BY-NC. Available online: https://www.inaturalist.org/observations/102432275 (accessed on 25 March 2022).
242. Roland, L. *Bombyx mori*. CC-BY-NC. Available online: https://www.inaturalist.org/observations/69171140 (accessed on 25 March 2022).
243. Borzée, A. *Teleogryllus emma*. CC-BY-NC. Available online: https://www.inaturalist.org/observations/94811230 (accessed on 25 March 2022).

244. Taylor, R. *Nauphoeta cinerea*. CC-BY. Available online: https://uk.inaturalist.org/observations/21385592 (accessed on 25 March 2022).
245. Booysen, R. *Oxyhaloa deusta*. CC-BY-NC. Available online: https://www.inaturalist.org/observations/79272523 (accessed on 25 March 2022).
246. Biological Museum, L.U. *Ulomoides dermestoides*. CC-BY-NC. Available online: https://www.flickr.com/photos/127240649@N08/45560037744/in/photolist-ACJiHE-AoqqLw-zHZT4U-AF2yvP-2cpZ6W9-2c8gdZ8/ (accessed on 25 March 2022).
247. Govaerts, C. *Apis mellifera*. CC-BY-NC. Available online: https://www.inaturalist.org/observations/19301657 (accessed on 25 March 2022).
248. Cash, L. *Chrysomya megacephala*. CC-BY-NC. Available online: https://inaturalist.ca/observations/85549044 (accessed on 25 March 2022).
249. Wahlberg, N. *Anacridium aegyptium*. Public Domain. Available online: https://www.inaturalist.org/photos/188061647 (accessed on 25 March 2022).
250. Vakarė, R. *Pseudochorthippus parallelus*. CC-BY-NC. Available online: https://inaturalist.ca/observations/102162754 (accessed on 25 March 2022).
251. Rorabaugh, J. *Lucilia Sericata*. Public Domain. Available online: https://inaturalist.ca/observations/12062145 (accessed on 25 March 2022).
252. Rosli, R. *Oechophylla smaragdina*. CC-BY-NC. Available online: https://www.inaturalist.org/observations/76430415 (accessed on 25 March 2022).
253. Fang, X. *Odontotermes formosanus*. CC-BY-NC. Available online: https://www.inaturalist.org/photos/196990438 (accessed on 25 March 2022).
254. Méndez, L. *Caligo memnon*. CC-BY-NC. Available online: https://www.inaturalist.org/photos/197834596 (accessed on 25 March 2022).
255. Smirnova, L. *Acrossus rufipes*. CC-BY-NC. Available online: https://www.inaturalist.org/observations/100110967 (accessed on 25 March 2022).
256. Bernardes, L. *Cladomorphus Phyllinum*. CC-BY-NC. Available online: https://www.inaturalist.org/observations/90645896 (accessed on 25 March 2022).
257. Macfie, R. *Acrida cinerea*. CC-BY-NC. Available online: https://www.inaturalist.org/observations/93819021 (accessed on 25 March 2022).
258. Lauer, M. *Anabrus Simplex*. CC-BY-NC. Available online: https://inaturalist.nz/observations/6684282 (accessed on 25 March 2022).
259. Chiu, C. *Teleogryllus mitratus*. CC-BY-NC. Available online: https://www.inaturalist.org/observations/104687913 (accessed on 25 March 2022).
260. Caswell, I. *Zonocerus variegatus*. Public Domain. Available online: https://www.inaturalist.org/observations/37759544 (accessed on 25 March 2022).
261. Yáñez, R. *Chilecomadia moorei*. CC-BY-NC. Available online: https://www.inaturalist.org/observations/37670097 (accessed on 25 March 2022).
262. Associação Vita Nativa *Machaerium maritimae*. CC-BY-NC. Available online: https://inaturalist.ca/observations/92608804 (accessed on 25 March 2022).