Floral and Faunal Diversity in Sri Lankan Mangrove Forests: A Systematic Review

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Abstract: The paper gives a historical overview, and a summary of key findings from 70 previously published research papers giving scientific data over the years from 1980 to 2019. They concern the flora and/or fauna in the mangrove forests along the Sri Lankan coast, addressing diversity, taxonomy, distribution, and ecological interactions. A total of 28 mangrove floral species from 13 plant families have been reported so far. Similarly, faunal diversity studies have reported 99 invertebrates, dominated by Arthropoda (n = 55) and Mollusca (n = 26), and 214 vertebrates comprising Pisces (n = 112), Aves (n = 72), Reptilia (n = 13) and Amphibia (n = 2). Most studies have been concentrated on the Southwestern coast (n_flora = 20, n_fauna = 6). Negombo has been a hotspot for mangrove research, with a higher number of studies (n_flora = 11, n_fauna = 5). The majority of the mangrove studies were focused on mangrove floral diversity and taxonomy and were conducted over recent years (2010–2019). Scientific data on mangrove fauna is restricted to a certain geographical extent. This paper intends to identify the research gaps in the field of Sri Lankan mangroves regarding various aspects and suggests advancement in future studies. Overall, outputs from the present study would be helpful for upcoming researchers to focus more on filling the gaps in knowledge.

Keywords: Sri Lanka; mangroves; research gap; conservation; mangrove flora; mangrove fauna

1. Introduction

Mangroves are unique ecological assemblages of woody halophytes, circumscribed to the intertidal zone generally found in the tropical and subtropical zones. Mangroves comprise angiosperms that are uniquely adapted to extreme saline environments by means of salt-secreting leaves, low water potentials, and high intercellular salt concentrations, making them able to maintain favorable water relations in saline environments, as well as viviparous water-dispersed propagules [1]. Mangroves have been widely acknowledged for their immense coastal significance, like coastal productivity [2], powerful carbon sequestration [3], and providing nesting, breeding, and feeding grounds to a variety of marine and brackish species [4], as well as climate change mitigation and coastal protection [5]. Mangroves are globally distributed across 112 countries, covering an extent of 18 million hectares [6], of which nearly 42% are confined to Asia [7].

Sri Lanka is a tropical island located in the Indian Ocean toward the southeast of India, between latitudes 5°55′–9°51′ North and longitudes 79°41′–81°54′ East. It spans about 65,610 km², with a coastline of nearly 1705 km [8] and a continental shelf of 30,000 km² that is 120 m in depth [9]. Sri Lanka enjoys a wide array of coastal ecosystems, such as mangroves, coral reefs, salt marshes, and seagrasses since it covers a total brackish water area of about 158,016 ha [5]. Sri Lankan mangroves are unique, yet they are not distributed evenly throughout the island. As the tidal amplitude can be as low as 75 cm [4,8],...
mangrove distribution tends to exhibit a narrow spread and seldom displays an isolated forest patch [10].

Sri Lankan mangroves are often under-studied and underrepresented in the conservation agenda [11]. The wider scope of knowledge on Sri Lankan mangrove flora and fauna species composition and distribution has not been documented cohesively, despite the great progress that has been achieved during the past few decades. This review intends to achieve an exhaustive checklist of the species distribution of Sri Lankan mangrove ecosystems available, to be published for a global platform. In this present study, we aimed to provide a list of mangrove flora in the Sri Lankan mangrove ecosystems, supported by taxonomic re-identification of the previously reported taxa. Secondly, mangrove fauna previously reported in the research were gathered and organized accordingly, so that they reflected the taxonomic groupings. Accordingly, the spatiotemporal distribution of mangrove flora and fauna was overviewed in terms of biogeography, highlighting faunal and floral assemblages that, in particular, reflect habitat classification. Finally, an opportunity for imminent research studies assisting the sound science behind ecosystem-based management of the Sri Lankan mangrove ecosystems was suggested, by highlighting the potential biodiversity of mangrove flora and fauna and creating a way forward for effective conservation.

2. Materials and Methods

The existing peer-reviewed articles, based on the faunal and floral studies in the highest cohort concerning research quality, were collected through certain science-based search engines. We sourced peer-reviewed articles from the 1980s to the present (2019) to analyze the trends of scientific research related to Sri Lankan mangrove biodiversity. The analysis was conducted in two stages. First, a review of existing literature on mangrove floral and faunal distribution was conducted to identify the range of research materials, academic papers, and other documents available on the topic. This systematic, quantitative literature review identified 70 documents, including articles and research papers, via a preliminary screening process of 134 articles. We excluded those articles that did not address the purpose of our present review. English-language scientific studies (including original research papers and conference proceedings), and technical reports relevant to the research objective, were identified from the online scientific databases, including Web of Science (WoS), Science Direct and Google Scholar. Local research papers and proceedings were collected from the locally available databases. The search was conducted over an extended period and finalized in May 2020. The principal keywords used were “mangroves”, “Sri Lanka”, and “distribution”. Spare terms like “mangrove flora” and “mangrove fauna” were also used. Additionally, we examined the References sections of each preliminary article for pertinent documents that might have been missed in the initial research.

As soon as a group of papers defining the research the purpose related to the keywords had been identified, the selection was refined with respect to whether the paper addressed the specific purpose of this review. The final collection of 70 documents were reviewed to ensure each of them addressed mangrove flora and fauna in Sri Lanka. Each of the 70 documents in the final selection was coded according to a variety of variables: author nomenclature, publication year, journal type, source journal (if available), study location, climatic zone, tidal range, and whether the article discussed fauna or flora or both (Supplementary Data: Table S1). Once we compiled the data, all the taxa of mangrove flora were cross-checked with the mangrove reference database and herbarium. Available online https://www.marinespecies.org/mangroves/ (accessed on 1 April 2020), and specific literature sources. For the mangrove fauna, the taxonomical data were verified and presented with the accepted name, as defined by the World Register of Marine Species (WoRMS) database (available online: https://www.marinespecies.org/ (accessed on 15 April 2020)), the UniProt database (available online: https://www.uniprot.org/ (accessed on 10 February 2020)), the Reptilian database (https://reptile-database.reptarium.cz/ (accessed on 15
The second component was the complementary data collection of mangrove conservancy actions and regulations in Sri Lanka, with a focus on the future of mangrove ecosystems. The inspection of significant activities and updated laws and legislations is extended in this paper and appraised, so that theoretical perspectives and critical analysis are informed by reference to practice. This could also serve as an aid to increase the efficacy of research and conservatory actions undertaken in the future.

3. Results and Discussion

The review intends to focus on synchronizing the available published scientific data into one meta-dataset. The summary of the collected data is given in Table 1.

| Study Location          | Type of Study (Flora/Fauna) | Reference |
|-------------------------|----------------------------|-----------|
| All islands             | Flora                      | [3,9,12–24] |
|                         | Fauna                      | [25,26]   |
|                         | Fauna and flora            | [4,27,28] |
| Ampara                  | Flora                      | [5,10]    |
| Batticaloa              | Flora                      | [29–32]   |
| Chilaw                  | Flora                      | [33,34]   |
|                         | Fauna                      | [35]      |
| Galle—Unawatuna         | Flora                      | [36,37]   |
| Kalametiya              | Flora                      | [38]      |
| Kilinochchi             | Flora                      | [39]      |
| Maduganga               | Flora                      | [40]      |
| Mannar                  | Flora                      | [41]      |
| Matara                  | Flora                      | [42–47]   |
| Negombo                 | Flora                      | [48]      |
|                         | Fauna                      | [49–52]   |
|                         | Fauna and flora            | [53–63]   |
| Puttalam                | Flora                      | [64]      |
|                         | Fauna and flora            | [65–68]   |
| Rekawa                  | Flora                      | [69]      |
| Trincomalee             | Flora                      | [70,71]   |

3.1. Trend of Mangrove Research in Sri Lanka

Of the 70 documents examined in this study, 66 were peer-reviewed articles, three were “gray literature” (annual reports from the IUCN (International Union for the Conservation of Nature (Sri Lanka)), FAO (Food and Agriculture Organization (Sri Lanka)) and NARA (National Aquatic Resources Research and Development Agency (Sri Lanka)) and one Ph.D. thesis. All the articles reviewed were focused on the topic of either mangrove flora or fauna, or both. The documents were published between 1980 and 2020. The facts show that only a few articles [11] had been published before the year 2000, and more than half of the studies [45] have been carried out long after 2010. This indicates that a promising scientific effort has been made on mangrove ecology during recent years, and the numbers are expected to increase with time (Figure 1A). The majority of the data have been published in local journals; hence, the global onlookers were not aware of the potential of Sri Lankan mangrove ecosystems. It is believed that this compendious review will provide the international assembly with a prospective understanding of the biodiversity and distribution of mangrove ecosystem diversity in Sri Lanka, in a chronological manner. The degree of studies was mostly (44%) based on discussing the diversity, taxonomy and distribution of the mangrove flora and fauna (Figure 1B). Corresponding to that,
research efforts have been made involving the ecosystem services that would relate most significantly to fisheries and tourism.

Of the chosen studies, 15% have focused on economical assessment, landscape decline (with aerial photography), and modeling ecosystem functions, while 13% were focused on ecosystem dynamics, mostly on salinity gradient influence and carbon sequestration. Very few studies were made on chlorophyll assessment and productivity measurement, which is a drawback in mangrove research since net primary productivity assessments are means of determining forest productivity. On the other hand, it is understandable that, for a nation developing its research efforts toward mangrove ecosystems, taking a big step forward is not possible. This could also be explained by the fact that there is no research study based on DNA metabarcoding and ecological assessment with eDNA analyses. This analysis of research studies will provide a concise view of the state research efforts at the moment in the country, as well as encouraging the upcoming scientists to work more on the areas where data are lacking.

It should be noted that, even though there are research studies based on diversity, dynamics, and services, we do not have a comprehensive study including all the sections in one, or of the entire mangrove forests reported so far. It is recommended that such a collective effort should be taken, involving experts in the fields of ecology, taxonomy, and molecular biology.

Taking a closer look at the degree of studies across the locality throughout the years, mangrove research has been concentrated more on the western and southern parts of the country, especially on Negombo [11], since the 1980s (Figure 2). The primary reason for this could be the location of Negombo in a wet zone; the area is expected to exhibit higher mangrove density and diversity, since mangrove diversity is believed to be influenced by climatic factors [6]. Otherwise, Puttalam, Batticaloa, and Rekawa have mostly been targeted. Puttalam and Batticaloa are in the dry zone, and Rekawa is in the intermediate zone. Few or no studies have been conducted in the northern and eastern parts of the country since the sites were not accessible for longer periods. Currently, attempts are being
made to study the ecology of wetlands in those areas, and future papers are expected to demonstrate a promising research output in the coming years. Figure 3 explains the spatial and temporal distribution of mangrove-based scientific research efforts that have been reported to date from the 1980s. It is clear and accurate that lesser or no research efforts are taken in the northern, eastern and southern coastal line, while studies have been more concentrated toward the western coast. In addition, analysis shows that research efforts have focused more on estuarine mangrove diversity than on fringe areas. It should be noted that fringe mangroves are not taken into exclusive consideration, and we think that this might be because the Sri Lankan coastline exhibits a widespread extent of estuarine mangroves [27].

Figure 2. Overview of the representation of the status of mangrove research in Sri Lanka (both flora and fauna) at a glance, gathered from the review of 70 chosen articles.
There are ambiguities in the exact extent of island-wide mangrove distribution since the Northern and Eastern areas were not accessible, due to the civil war. From time to time, the data on the mangrove extent varies with the updates. Past studies reported an estimated total of 12,189 hectares of mangroves, whereas NARA (1997) indicated that 18,489 hectares were covered with mangroves [4]. However, estimates represent the total extent of mangroves of Sri Lanka to be about 15,670 ha [18], of which 5,009 ha are in the dry and intermediate zones, 644 ha in the intermediate zone, and 430 ha in the wet zone [3]. At present, mangrove forests subsist in patches, in association with the estuaries and lagoons [27]. The present study intended to provide an updated extent of mangrove distribution, according to the latest records, and it shows the current spatial distribution of mangrove flora to be a total of 15,981 hectares (Table 1). According to existing and collected data, the largest mangrove patch is reported in Puttalam, in the Kalpitiya lagoon, and the second and third are in the Jaffna peninsula and the Trincomalee–Batticaloa coastal belt, respectively [8]. Since mangrove distribution is affected by climate and soil texture [57],...
and Sri Lanka exhibits a widespread distribution of climatic regimes, ranging from dry to wet zones [72], mangrove distribution shows a high discrepancy.

Mangroves are broadly categorized into true mangrove, species restricted to mangrove habitats and mangrove associates, and species not confined to the intertidal areas but that occur in the vicinity of terrestrial vegetation [22]. In general, most of the true mangroves are visible all around the country. However, the floristic composition of the dry zone varies more than that of the wet zone [27]. Fluctuations in the freshwater influx differ widely from the wet zone to the dry zone, which influences the salinity gradient and the cohesive ecosystems [73] of mangroves. Salinity fluctuates from 0–35 ppt and can be affected by freshwater discharge, tidal amplitude, topography, and the extent of the lagoon or estuary [8]. Studies have reported “low saline” and “high saline” mangrove forest types in Sri Lanka, addressing the floristic characteristics [26]. According to their perspective, the “low saline” environment is present in the river estuaries, while “high saline” environments would be on the shores of lagoons and adjacent islands. Depending on the intensity of flooding and the topographical characteristics, mangrove forests are further categorized as scrub, overwash, and basin [27].

3.2. Analysis of the Mangrove Flora in Sri Lanka and an Updated Checklist

Considering the floral species, uncertainties prevail in the number of mangrove species available in Sri Lanka. While previous studies [26] have reported twenty-three true mangrove species, while a recent has recorded twenty-one, which is widely accepted at the present time [13]. This paper has collected a significant range of studies conducted throughout the past decades and provides a list of the true mangrove species recorded in each study. Table 2 demonstrates that the cumulative number fluctuates between 20 and 29. Figure 2 elucidates that there is a gap prevailing in assessing the species richness and abundance of mangrove flora in Sri Lanka with respect to the region, and with developing research methodologies; this should be acknowledged as far as possible. The west coast of the country is mainly targeted for mangrove-based research since it falls under the wet zone and is the easiest to access. Furthermore, the literature shows that there is a potential need for a critical review on the species richness of mangrove flora in Sri Lanka, and to address the possible scientific implications when preparing a nationwide comprehensive checklist for mangrove flora in Sri Lanka.

The total number of species recorded ranges from 17 to 25. A notable number of mangrove species have been recorded by [13] that includes 20 species, whereas [32] has recorded 17 species from the Chilaw lagoon alone. The number of species listed by de [26] and [37] is identical, yet the latter included two more species. The list gives a concise view of the mangroves growing in Sri Lanka, of which almost all the researchers have recorded Avicennia marina, Aegiceras corniculatum, Bruguiera gymnorrhiza, Exoecaria agallocha, Lumnitzera racemosa, Rhizophora apiculata, and R. mucronata (Figure 3A). To date, the final list provided by a recent study has been used as a standard key to the mangrove floral regime [17], which includes a total of 22 species of true mangrove, from 12 families. The majority of the species come from the Rhizophoraceae (32%) and Sonneratiaceae (14%). A total of 15 families have been reported so far, while others are less frequently studied and are more or less equally distributed (Figure 4A). The fact that other species are less studied is probably because they are either absent or are fewer in number.

A comprehensive list has been created, including the entire mangrove flora recorded over the past 40 years. All the scientific meta-data were validated with the mangrove reference database and herbarium, and also specific literature sources. In addition, details such as habitat type, and information regarding some minor environmental parameters, if available, were also included in the list. Such an analysis shows that Sri Lankan mangroves represent 13 families, which brings the net total to 28 (Table 2). For a country whose mangrove extent is restricted, this kind of numerical representation is useful and indeed valuable, such that conservation becomes an essential tool. Still, this number could have been an underestimation, given the fact that most of the country’s mangrove forests were
not extensively studied. As we believe, the actual number is still undefined since some parts of the country are not included in the survey prospectus.

![Figure 4](image_url) **Figure 4.** Summary of the key findings of the most-reported taxa: (A) flora, and (B) fauna, in the Sri Lankan mangrove forests, gathered from the 70 articles reviewed.

| District       | Mangrove Areas                                                                 | Area (ha) | Remarks |
|----------------|-------------------------------------------------------------------------------|-----------|---------|
| Mullaitivu     | Nathikadal estuary, Nayaru estuary, Kokkilai estuary                         | 1040      | *       |
| Kilinochchi    | Punareen, Mandakal aru, Pallakuda, Nachchikuda, Ratchamunai                   | 1855      | *       |
| Mannar         | Vidanthal tivu, Vanakali, Aruvi aru                                          | 1351      | *       |
| Jaffna         | Thondamanr, Chundikkulam, Jaffna estuary                                     | 2505      | *       |
| Galle          | Bentota, Kosgoda, Madu ganaga, Madampe oya, Hikkaduwa                         | 406       | *       |
| Matara         | Thodanduwa, Gin ganga, Unawatuna, Koggala                                    | 39        | *       |
| Hambantota     | Polattu modara, Kirala kele, Nilwala estuary, Devundara estuary,              | 692       | *       |
|                | Tangalle, Rekawa, Kahanda modara, Ambalanthottai, Walawa ganga estuary,       |           |         |
|                | Kalametiya, Bundala                                                           |           |         |
| Puttalam       | Puttalam lagoon                                                               | 2300      | [23]    |
| Gampaha        |                                                                                | 634       |         |
| Ampara         | Pottuvil                                                                      | 618       | **      |
| Batticaloa     | Batticaloa lagoon, Dutch bar, Mattikali, Kokkadicholai, Saththurukondan       | 2071      | **      |
| Trincomalee    | Uppar lagoon, Yan Oya                                                         | 2395      | [74]    |
| Kalutara       | Kalutara                                                                      | 75        | [4]     |
|                | Total                                                                         | 15981     |         |

* Forest Department of Sri Lanka; ** Coast Conservation Department, Sri Lanka.
On a separate note, some mangrove species have been recorded by only one author, such as Dolichandrone spathacea, Exoecaria indica [57], and Xylocarpus moluccensis [18]. This might be due to their being either exclusive to a specific area or not very abundant throughout the island, or they could have been removed from their native area. It should also be understood that since only one study has reported them for the past few decades, the reliability of the data remains insignificant. It is clear that the southwest coastline, specifically Chilaw and Negombo, represents almost the entire floral regime that has been reported throughout the island, according to the studies [19]. This might be a prospective reason for further mangrove research studies to be concentrated more on these areas.

3.3. Analysis of Mangrove Fauna in Sri Lanka with Taxonomic Remarks

To provide a list of the mangrove faunal species reported in Sri Lanka, their occurrence and distribution were analyzed based on the metadata collected from previous articles. Unlike the extensive studies conducted on mangrove flora, faunal studies are comparatively fewer. Of the 70 articles screened, only 14 reported data regarding the faunal assemblage. This has restricted the scope of the paper in the field of regional comparison. Further research has targeted only the southwest coast and is especially concentrated on Negombo (n = 7) (Figures 2 and 3B). Most of them are more recent, after the year 2000. This paper intends to propose that there is a research gap prevailing in the field of mangrove fauna distribution throughout the island, and that this might be due to several reasons, such as a lack of access to mangrove sites, lack of expertise, or poor research facilities in which to conduct extensive faunal assemblage and community studies. One study in the 1980s and two studies in the 1990s shows that there was no or very little effort taken by the scientific community in reporting the faunal diversity in the Sri Lankan mangrove ecosystems (Figure 3). It is obvious that floral studies have been proliferating steadily with time, but faunal reporting has not. Many more attempts should be made to address such a research gap in the field of mangrove ecology in Sri Lanka.

Of the reported species, vertebrates and invertebrates have prominently occupied their niches in the mangrove ecosystem. Invertebrate fauna include a wide range of species from nematodes to arthropods, while chordate diversity includes species ranging from fish to mammals. Arthropods seem to have a potential role to play in the mangrove ecology, whereas the majority of the Pisces family is of vertebrates (Figure 4). Other than that, mollusks, annelids, and very few nematodes are reported in Sri Lanka, whilst birds were prominently observed in mangrove ecosystems. It could be understood that amphibians and reptiles would be “migrating” from place to place, due to which factor a proper survey would not have been possible. One likely technique for reporting them could be a long-term monitoring survey. Taking a glance at the trend in mangrove faunal research, it can be stated that scientific studies have focused more on macrofauna rather than microfauna distribution. The literature has not recorded a promising amount of either macrofauna or micro. Even though Sri Lankan mangrove ecosystems are prominent, and the country’s economy is widely dependent on fisheries and aquaculture, it is disappointing to see the scientific implication of reporting such a flourishing richness of species. The outcomes of this review suggest that scientists should concentrate more on the species richness and assemblage of mangrove fauna, and report them to the global arena, which would collateral promote their conservation.

As a part of this review, we attempted to provide a critical re-identification of the previously reported species, via comparisons with the database of the world register of marine species (WoRMS) and appropriate literature sources. The list of recent, valid (or appropriate) taxonomic names from the previously identified species was specifically suggested for 99 species: 1 Nematoda, 17 Annelids, 26 Mollusca, and 55 Arthropoda (Table 4). The species were identified to genus or species level, and are listed alphabetically under each phylum, which finally yields an updated list of invertebrates in the Sri Lankan mangrove ecosystem. See Table 3 below. Correspondingly, 214 vertebrates, including 112 Pisces, 2 Amphibians, 13 Reptilia, 72 Aves, and 15 Mammalia species, were crosschecked and an updated check-
list was prepared (Table 5). Their taxonomical nomenclature was checked with WoRMS, UniProt, the reptilian database, Avibase, and the Indian biodiversity portal, respectively. Tables 4 and 5 show the structured comprehensive list, as aforementioned.

Table 3. Collective list of mangrove flora reported to date in Sri Lankan mangrove forests, gathered from the scientific research articles reviewed in the present study.

| Family          | Species with Revised Scientific Nomenclature | Remarks |
|-----------------|----------------------------------------------|---------|
| Acanthaceae     | Acanthus ilicifolius L.                      | 1       |
| Pteridaceae     | Acrostichum aureum L.                       | 1       |
| Primulaceae     | Aegiceras corniculatum (L.) Blanco           | 1       |
| Acanthaceae     | Avicennia marina (Forssk.) Vierh.           | 1       |
| Acanthaceae     | Avicennia officinalis L.                     | 1       |
| Rhizophoraceae  | Bruguiera cylindrica (Linnaeus) Blume        | 1       |
| Rhizophoraceae  | Bruguiera gymnorrhiza (L.) Lamk.             | 1       |
| Rhizophoraceae  | Bruguiera sexangula (Lour.) Poir.           | 1       |
| Rhizophoraceae  | Ceriops decandra (Griff.) Ding Hou          | 1       |
| Rhizophoraceae  | Ceriops tagal (Perr.) C.B. Robinson         | 1       |
| Fabaceae        | Cynometra iripa Kostel                      | 2       |
| Bignoniaceae    | Dolichandrone spathacea (L. fil.) K. Schum. | 2       |
| Euphorbiaceae   | Excoecaria agallocha L.                     | 1       |
| Euphorbiaceae   | Excoecaria indica (Willd.) Muell.-Arg.      | 1       |
| Malvaceae       | Hirtiera littonilis Dryand.                 | 1       |
| Combretaceae    | Lumnitzera litora (Jack) Voigt              | 1       |
| Combretaceae    | Lumnitzera racemosa Willd.                  | 1       |
| Arecaaceae      | Nypa fruticans (Thurb.) Wurmb.              | 1       |
| Lythraceae      | Pemphis acidula Forst.                      | 1       |
| Rhizophoraceae  | Rhizophora apiculata Bl.                    | 1       |
| Rhizophoraceae  | Rhizophora mucronata Lamk.                  | 1       |
| Rubiaceae       | Scyphiphora hydrophyllacea Gaertn. f.       | 1       |
| Lythraceae      | *Sonneratia alba J. Smith                   | 1       |
| Lythraceae      | Sonneratia apetala Buch.-Ham.               | 1       |
| Lythraceae      | Sonneratia casicolaris (L.) Engler          | 1       |
| Meliaceae       | *Xylocarpus granatum König                   | 1       |
| Meliaceae       | Xylocarpus moluccensis (Lamk.) Roem.        | 1       |
| Meliaceae       | Xylocarpus rumphii (Kostel.) Mabb.          | 3       |

* Reported as Endangered Species in Sri Lanka; 1—Mangrove Reference Database and Herbarium, 2—India Biodiversity Portal, 3—the Plant List.

Table 4. Comprehensive checklist of invertebrates observed in mangrove ecosystems previously reported in Sri Lanka, assembled from the scientific research articles studied in the current review.

| Phylum        | Taxa (Notation)                  | Habitat       | Remarks |
|---------------|----------------------------------|---------------|---------|
| Nematoda      | Dorylaimus stagnalis (Dujardin, 1845) | Brackish, Fresh | WoRMS   |
| Annelida      | *Eunice* (Cuvier, 1817)          | Marine        | WoRMS   |
| Gonioda       | *Audouin and H Milne Edwards, 1833 | Marine        | WoRMS   |
| Heterospionidae | *Hartman, 1965*                        | Marine        | WoRMS   |
| Limnodrilus   | *Claparede, 1862*                       | Brackish, Fresh | WoRMS   |
| Lumborineridae | *Schmarda, 1861*                          | Marine        | WoRMS   |
| Neanthes      | *negomboensis* (De Silva, 1965)           | Marine        | WoRMS   |
| *Nephys*      | (Cuvier, 1817)                       | Marine        | WoRMS   |
| Nereididae    | *Blainville, 1818*                    | Marine        | WoRMS   |
| Pilargidae    | *Saint-Joseph, 1899*                 | Marine        | WoRMS   |
| Sabella       | *Linnaeus, 1767*                     | Marine        | WoRMS   |
| Sabellariidae | *Johnston, 1865*                     | Marine        | WoRMS   |
| Sphaeridoridae | *Malmgren, 1867*                        | Marine        | WoRMS   |
| Spionidae     | *Grube, 1850*                        | Marine        | WoRMS   |
| Syllidae      | *Grube, 1850*                        | Marine        | WoRMS   |
| Neanthes      | *manatensis* (Pillai, 1965)            | Marine        | WoRMS   |
| Phylum   | Taxa (Notation)                                           | Habitat       | Remarks       |
|----------|----------------------------------------------------------|---------------|---------------|
| Mollusca |                                                          |               |               |
|          | Trypanosyllis zebra (Grube, 1860)                        | Marine        | WoRMS         |
|          | Neopomatus uschakovi (Pillai, 1960)                      | Brackish      | WoRMS         |
|          | Anadara (Gray, 1847)                                     |               | WoRMS         |
|          | Cassidula multiplicata (Martens, 1865)                   | Marine        | WoRMS         |
|          | Cassidula nucleus (Gmelin, 1791)                         | Brackish, Terrestrial | WoRMS |
|          | Cassidula quadrasi (Hidalgo, 1888)                       | Marine        | WoRMS         |
|          | Cerithidea cingulata (Gmelin, 1791)                      | Brackish      | WoRMS         |
|          | Crassostrea (Sacco, 1897)                                |               | WoRMS         |
|          | Dentalium (Linnaeus, 1758)                               | Marine        | WoRMS         |
|          | Faunus ater (Linnaeus, 1758)                             | Brackish      | WoRMS         |
|          | Cafarinium tumidum (Röding, 1798)                        |               | WoRMS         |
|          | Geloina bengalensis (Lamarck, 1818)                      | Brackish      | WoRMS         |
|          | Geloina coaxans (Gmelin, 1791)                           |               | WoRMS         |
|          | Littorina scabra (Linnaeus, 1758)                        | Marine        | WoRMS         |
|          | Marcia (H. Adams and A. Adams, 1857)                     |               | WoRMS         |
|          | Melampus (Melampus) fasciatus (Deshayes, 1830)           | Brackish, Terrestrial | WoRMS |
|          | Meretrix casta (Gmelin, 1791)                            | Marine        | WoRMS         |
|          | Nerita polita (Linnaeus, 1758)                           | Marine        | WoRMS         |
|          | Perna (Bruguière, 1789)                                  | Marine        | WoRMS         |
|          | Pinna bicolor (Gmelin, 1791)                             |               | WoRMS         |
|          | Pleuroloca trapezium (Linnaeus, 1758)                    | Marine        | WoRMS         |
|          | Saccostrea cucculata (Born, 1778)                        | Marine        | WoRMS         |
|          | Telescopium telecopium (Linnaeus, 1758)                  | Marine, Brackish | WoRMS |
|          | Terebralia palustris (Linnaeus, 1767)                    | Marine, Brackish | WoRMS |
|          | Squamopleura imitator (Nierstrasz, 1905)                 | Marine        | WoRMS         |
|          | Euchelus asper (Gmelin, 1791)                            | Marine        | WoRMS         |
|          | Cellana radiata (Born, 1778)                             | Marine        | WoRMS         |
| Arthropoda|                                                          |               |               |
|          | Alpheus edwardsii (Audouin, 1826)                        | Marine        | WoRMS         |
|          | Atyopsis spinipes (Newport, 1847)                        | Fresh         | WoRMS         |
|          | Balanus amphitrite (Darwin, 1854)                        | Marine, Brackish | WoRMS |
|          | Balanus (Costa, 1778)                                    | Marine        | WoRMS         |
|          | Baruna socialis (Stebbing, 1904)                         | Marine        | WoRMS         |
|          | Caridina gracilrostris (de Man, 1892)                    | Fresh         | WoRMS         |
|          | Caridina propinqu (de Man, 1908)                         | Fresh         | WoRMS         |
|          | Carinilae zeylanica (Arudrangasam and Costa, 1962)       | Fresh         | WoRMS         |
|          | Ceridocus (Costa, 1853)                                  | Marine        | WoRMS         |
|          | Chironantes darinensis (Campbell, 1967)                  | Marine, Fresh | WoRMS         |
|          | Chiromantes (Gistel, 1848)                               | Marine, Fresh | WoRMS         |
|          | Cirolana villegi (Stebbing, 1904)                        | Marine        | WoRMS         |
|          | Cribanarius longifars (de Haan, 1849)                    | Marine        | WoRMS         |
|          | Entomobrya (Rondani, 1861)                               | Marine        | WoRMS         |
|          | Episesarma versicolor (Tweedie, 1940)                    | Marine, Brackish | WoRMS |
|          | Eupagurus (Brandt, 1851)                                 |               | WoRMS         |
|          | Holotrichia (F.Schmitz, 1897)                            | Marine        | WoRMS         |
|          | Lembos (Spence Bate, 1857)                               | Marine        | WoRMS         |
|          | Lembos (Spence Bate, 1857)                               | Marine        | WoRMS         |
|          | Ligia exotica (Roux, 1828)                               | Terrestrial   | WoRMS         |
|          | Macrobrachium elegantum (Pan, Hou and S. Li, 2010)       | Fresh         | WoRMS         |
|          | Macrobrachium rosenbergii (de Man, 1879)                 | Marine        | WoRMS         |
|          | Macrobrachium scabrum (Heller, 1862)                     | Fresh         | WoRMS         |
|          | Macrophthalmus depressus (Rüppell, 1830)                | Marine        | WoRMS         |
|          | Macrophthalmus sulcatus (H. Milne Edwards, 1852)        | Marine        | WoRMS         |
|          | Messor bidens                                           | Terrestrial   | [75]           |
|          | Messor darwinensis                                      | Terrestrial   | [75]           |
|          | Messor spp.                                             | Terrestrial   | [75]           |
Faunal diversity varied widely from meiofauna to macrofauna, comprising members from nematodes to mammals. The invertebrate diversity seemed to be dominated by arthropods (56%) whilst the vertebrate peak in number was Pisces (52%) (Table 5). As the literature suggests [76], mangroves serve as a habitat for most marine, brackish and freshwater invertebrates, and for fish during the spawning, reproductive and juvenile phases of their lifecycle. The present review supports the fact that arthropods, mollusks, and fishes are recurrently reported in mangrove environments. Yet, it is unclear whether the researchers have reported juveniles or adults in their publications. This poses uncertainty in validating the aforesaid point. Meanwhile, it should be appreciated that mangrove ecosystems have the capability to harbor a massive number of species, and undoubtedly can be marked as a biodiversity hotspot. Mangroves represent a unique ecological niche for many species of fauna.

Prominent invertebrates, seen in all mangroves regardless of the climatic zone, include grapsid crabs, portunid crabs, hermit crabs, and fiddler crabs. Penaeid prawns are abundantly seen in all the estuaries and lagoons. Studies have reported that the mangrove environment is dominated by gastropods and grapsid crabs, but the present review presents the dominance of arthropods over the mollusks [26]. This could mean that either the study has underreported some species, or there has been a promising increase in the scientific reporting of invertebrate fauna. Mud lobsters (Thalassina anomala) are unique to the mangrove ecosystems [28].
Table 5. Comprehensive checklist of vertebrates observed in the mangrove ecosystems of Sri Lanka, as reported in previous literature, collected from the scientific research articles reviewed in the existing study.

| Class       | Species                                      | Habitat                              | Remarks |
|-------------|----------------------------------------------|--------------------------------------|---------|
| Pisces      | Acanthopagrus latus (Houttuyn, 1782)         | Marine, Brackish, Fresh              | WoRMS   |
|             | Acanthurus weberi (Ahl, 1923)                | Marine                               | WoRMS   |
|             | Acanthurus (Forsskål, 1775)                  | Marine                               | WoRMS   |
|             | Ambassis commersoni (Cuvier, 1828)           | Marine, Brackish, Fresh              | WoRMS   |
|             | Ambassis dayi (Bleeker, 1874)                | Brackish, Fresh                      | WoRMS   |
|             | Ambassis urontina (Bleeker, 1852)            | Marine, Brackish, Fresh              | WoRMS   |
|             | Anchovella indica (van Hasselt, 1823)        | Marine                               | WoRMS   |
|             | Anguilla bicolor (McClelland, 1844)          | Marine                               | WoRMS   |
|             | Apaprius (Jordan and Richardson, 1908)       | Marine                               | WoRMS   |
|             | Aplocheilus melastigma (McClelland, 1839)    | -                                    | WoRMS   |
|             | Apogon thermalis (Cuvier, 1829)              | Marine                               | WoRMS   |
|             | Arios cælatus (Valenciennes, 1840)          | Marine, Brackish                     | WoRMS   |
|             | Arios dissimulieri (Valenciennes, 1840)      | Marine, Brackish, Fresh              | WoRMS   |
|             | Arios jella (Day, 1877)                     | Marine                               | WoRMS   |
|             | Arios platystomus (Day, 1877)                | Marine                               | WoRMS   |
|             | Arios subrostreus (Valenciennes, 1840)       | Marine                               | WoRMS   |
|             | Arios venosus (Valenciennes, 1840)          | Marine                               | WoRMS   |
|             | Arothron hispidus (Linnaeus, 1758)           | Marine                               | WoRMS   |
|             | Arothron immaculatus (Bloch and Schneider, 1801) | Marine                              | WoRMS   |
|             | Arothron reticulatis (Bloch and Schneider, 1801) | Marine                              | WoRMS   |
|             | Arothron stellatus (Anonymous, 1798)         | Marine                               | WoRMS   |
|             | Autistes puta (Cuvier, 1829)                 | Marine                               | WoRMS   |
|             | Bagrus thalassinus (Rüppell, 1837)           | Marine, Brackish, Fresh              | WoRMS   |
|             | Bathygobius fuscus (Rüppell, 1830)           | Marine, Brackish, Fresh              | WoRMS   |
|             | Brachirus orientalis (Bloch and Schneider, 1801) | Marine                              | WoRMS   |
|             | Butis butis (Hamilton, 1822)                 | Marine                               | WoRMS   |
|             | Calligonon fasciatus (Valenciennes, 1840)    | Marine                               | WoRMS   |
|             | Carangoides (Bleeker, 1851)                  | Marine                               | WoRMS   |
|             | Caranx ignobilis (Forsskål, 1775)            | Marine                               | WoRMS   |
|             | Caranx sexfasciatus (Quoy and Gaimard, 1825) | Marine, Brackish, Fresh              | WoRMS   |
|             | Caranx (Lacepède, 1801)                      | Marine                               | WoRMS   |
|             | Centropomus (Lacepède, 1802)                 | Marine                               | WoRMS   |
|             | Chaetodon suratensis (Bloch, 1790)           | Brackish                             | WoRMS   |
|             | Chanos canos (Forsskål, 1775)                | Marine, Brackish, Fresh              | WoRMS   |
|             | Cheilodipterus butis (Hamilton, 1822)        | Marine, Brackish, Fresh              | WoRMS   |
|             | Chelonodon patoca (Hamilton, 1822)           | Marine                               | WoRMS   |
|             | Cichlops (Müller and Troschel, 1849)         | Marine                               | WoRMS   |
|             | Claris braehii (Günther, 1864)               | Fresh                                | WoRMS   |
|             | Cottus chatareus (Hamilton, 1822)            | Brackish, Fresh                      | WoRMS   |
|             | Cygnoglossus bilineatus (Lacepède, 1802)     | Marine, Brackish                     | WoRMS   |
|             | Decuria malabaricus (Jerdon, 1849)           | Fresh                                | WoRMS   |
|             | Electris fusca (Forster, 1801)               | Marine, Brackish, Fresh              | WoRMS   |
|             | Epinephelus tawina (Forsskål, 1775)          | Marine                               | WoRMS   |
|             | Eulophus melanurus (Bleeker, 1851)           | Brackish, Fresh                      | WoRMS   |
|             | Eucromis cyanus (Bleeker, 1850)              | Brackish, Fresh                      | WoRMS   |
|             | Gerres argyreus (Forster, 1801)              | Marine                               | WoRMS   |
|             | Gerres ogena (Forsskål, 1775)                | Marine                               | WoRMS   |
|             | Gerres (Quoy and Gaimard, 1824)              | Marine, Brackish, Fresh              | WoRMS   |
|             | Glossogobius bicellatus (Valenciennes, 1837) | Marine, Brackish, Fresh              | WoRMS   |
|             | Glossogobius celebrius (Valenciennes, 1837)  | Marine, Brackish, Fresh              | WoRMS   |
|             | Gobius koeleri (Pallas, 1770)                | Marine                               | WoRMS   |
|             | Gobius sadananus (Hamilton, 1822)            | Marine                               | WoRMS   |
|             | Hemirhamphus margaritus (Forsskål, 1775)     | Machine                              | WoRMS   |
|             | Heniochus ammicatus (Linnaeus, 1758)         | Marine                               | WoRMS   |
|             | Holocentrus surinamensis (Bloch, 1790)       | Marine                               | WoRMS   |
|             | Hyporhamphus xanthopterus (Valenciennes, 1847)| Marine                              | WoRMS   |
|             | Icthyocampus carce (Hamilton, 1822)          | Marine, Brackish, Fresh              | WoRMS   |
| Class | Species | Habitat | Remarks |
|-------|---------|---------|---------|
| Lates calcarifer (Bloch, 1790) | Marine, Brackish, Fresh | WoRMS |
| Leiognathus brevirostris (Valenciennes, 1835) | Marine, Brackish | WoRMS |
| Leiognathus (Lacepède, 1802) | Marine, Brackish, Fresh | WoRMS |
| Liza ceramensis (Bleeker, 1853) | Marine, Brackish, Fresh | WoRMS |
| Liza macrolepis (Smith, 1846) | Marine, Brackish, Fresh | WoRMS |
| Liza oligolepis (Bleeker, 1859) | Marine, Brackish, Fresh | WoRMS |
| Lutjanus argentimaculatus (Forsskål, 1775) | Marine, Brackish, Fresh | WoRMS |
| Lutjanus diascanthus (Lacepède, 1802) | Marine, Brackish | WoRMS |
| Lutjanus fulviflamma (Forsskål, 1775) | Marine, Brackish | WoRMS |
| Lutjanus gymnocaephalus (Lacepède, 1802) | Marine, Brackish, Fresh | WoRMS |
| Macrones guilo (Hamilton, 1822) | - | WoRMS |
| Monodactylus argenteus (Linnaeus, 1758) | Marine, Brackish, Fresh | WoRMS |
| Monodactylus argenteus (Linnaeus, 1758) | Marine, Brackish, Fresh | WoRMS |
| Monodactylus argenteus (Linnaeus, 1758) | Marine, Brackish, Fresh | WoRMS |
| Monotretus cutcutia (Hamilton, 1822) | - | WoRMS |
| Mugil macrolepis (Smith, 1846) | Marine, Brackish, Fresh | WoRMS |
| Mugil parsia (Hamilton, 1822) | Marine, Brackish, Fresh | WoRMS |
| Mugil strongylcephalus (Richardson, 1846) | Marine, Brackish, Fresh | WoRMS |
| Mugil tade (Forsskål, 1775) | Marine, Brackish, Fresh | WoRMS |
| Mugil waigensia (Quoy and Gaimard, 1825) | Marine, Brackish, Fresh | WoRMS |
| Muraena brummeri (Bleeker, 1858) | Marine | WoRMS |
| Ophichthus rutidodermatoides (Bleeker, 1852) | - | WoRMS |
| Ophiturus cancrivorus (Richardson, 1848) | Marine, Brackish, Fresh | WoRMS |
| Ophiurocus rutidodermatoides (Bleeker, 1852) | Marine, Brackish | WoRMS |
| Osteogeneiosus sphenochephalus (Day, 1877) | Marine, Brackish, Fresh | WoRMS |
| Pelates quadrilineatus (Bloch, 1790) | Marine, Brackish | WoRMS |
| Periophthalmus koelreuteri (Pallas, 1770) | Marine, Brackish, Fresh | WoRMS |
| Pimelodites sona Hamilton, 1822 | Marine, Brackish | WoRMS |
| Platax orbicularia (Forsskål, 1775) | Marine, Brackish | WoRMS |
| Plotosus canius (Hamilton, 1822) | Marine, Brackish, Fresh | WoRMS |
| Prancesus duodecimalis (Valenciennes, 1835) | Marine, Brackish | WoRMS |
| Promicrops lanceolatus (Bloch, 1790) | Marine, Brackish | WoRMS |
| Puntius vittatus (Day, 1865) | Brackish, Fresh | WoRMS |
| Puntius (Hamilton, 1822) | Brackish, Fresh | WoRMS |
| Rasbora daniconius (Hamilton, 1822) | Brackish, Fresh | WoRMS |
| Siganus concatenatus (Valenciennes, 1835) | Marine, Brackish | WoRMS |
| Siganus fasciatus (Houttuyn, 1782) | Marine, Brackish | WoRMS |
| Siganus javus (Linnaeus, 1766) | Marine, Brackish | WoRMS |
| Siganus ocellatus (Bloch & Schneider, 1801) | Marine, Brackish | WoRMS |
| Siganus vermiculatus (Valenciennes, 1835) | Marine, Brackish | WoRMS |
| Siganus (Forsskål, 1775) | Marine, Brackish | WoRMS |
| Silius maculatus (Thunberg, 1792) | Marine, Brackish, Fresh | WoRMS |
| Silius militaris (Linnaeus, 1758) | Marine, Brackish, Fresh | WoRMS |
| Sphagebranchus longipinnis (Kner and Steindachner, 1867) | Marine, Brackish | WoRMS |
| Sphyraena (Artedi, 1793) | Marine, Brackish | WoRMS |
| Syngnathus spicifer djarong (Bleeker, 1853) | - | WoRMS |
| Tachysurus caelatus (Valenciennes, 1840) | Marine, Brackish | WoRMS |
| Terapon jarbua (Forsskål, 1775) | Marine, Brackish, Fresh | WoRMS |
| Tetrodon fluviatilis (Hamilton, 1822) | - | WoRMS |
| Therapon theraps (Cuvier, 1829) | Marine, Brackish, Fresh | WoRMS |
| Thyrsites macrura (Bleeker, 1854) | Marine, Brackish, Fresh | WoRMS |
| Toxotes chatareus (Hamilton, 1822) | - | WoRMS |
| Triacanthus brevirostris (Temminck & Schlegel, 1850) | Marine, Brackish | WoRMS |
| Tylosurus strongylurus (van Hasselt, 1823) | Marine, Brackish | WoRMS |
| Zenarchopterus dispar (Valenciennes, 1847) | Marine, Brackish, Fresh | WoRMS |
| Class        | Species                           | Habitat          | Remarks                  |
|-------------|-----------------------------------|------------------|--------------------------|
| Amphibia    | *Bufo melanostictus* (Schneider, 1799) | Terrestrial      | UniProt                  |
|             | *Limnonectes limnocharis* (Gravenhorst, 1829) | Terrestrial      | UniProt                  |
|             | *Ahaetulla nasuta* (Bonnaterre, 1790) | Terrestrial      | The Reptile Database     |
|             | *Calotes calotes* (Linnaeus, 1758)  | Terrestrial      | The Reptile Database     |
|             | *Cerberus rynchops* (Schneider, 1799) | Terrestrial      | The Reptile Database     |
|             | *Crocodilus palustris* (Lesson, 1831) | Terrestrial      | The Reptile Database     |
|             | *Crocodilus porosus* (Schneider, 1801) | Terrestrial      | The Reptile Database     |
|             | *Daboia russelli* (Shaw and Nodder, 1797) | Terrestrial      | The Reptile Database     |
|             | *Dendrelaphis tristis* (Daudin, 1803) | Terrestrial      | The Reptile Database     |
|             | *Fowlea piscator* (Schneider, 1799)  | Terrestrial      | The Reptile Database     |
| Reptilia    | *Gerarda prevostiana* (Eydoux and Gervais, 1837) | Terrestrial, open marshes | Avibase                  |
|             | *Ahaetulla nasuta* (Bonnaterre, 1790) | Terrestrial      | The Reptile Database     |
|             | *Calotes calotes* (Linnaeus, 1758)  | Terrestrial      | The Reptile Database     |
|             | *Cerberus rynchops* (Schneider, 1799) | Terrestrial      | The Reptile Database     |
|             | *Crocodilus palustris* (Lesson, 1831) | Terrestrial      | The Reptile Database     |
|             | *Crocodilus porosus* (Schneider, 1801) | Terrestrial      | The Reptile Database     |
|             | *Daboia russelli* (Shaw and Nodder, 1797) | Terrestrial      | The Reptile Database     |
|             | *Dendrelaphis tristis* (Daudin, 1803) | Terrestrial      | The Reptile Database     |
|             | *Fowlea piscator* (Schneider, 1799)  | Terrestrial      | The Reptile Database     |
|             | *Gerarda prevostiana* (Eydoux and Gervais, 1837) | Terrestrial, open marshes | Avibase                  |
|             | *Naja naja* (Linnaeus, 1758)        | Terrestrial      | The Reptile Database     |
|             | *Ptyas mucosa* (Linnaeus, 1758)     | Terrestrial      | The Reptile Database     |
|             | *Python molurus* (Linnaeus, 1758)   | Terrestrial      | The Reptile Database     |
|             | *Varanus salvator* (Laurenti, 1768) | Terrestrial      | The Reptile Database     |
|             | *Acridotheres tristis* (Linnaeus, 1766) | Terrestrial      | Avibase                  |
| Aves        | *Anas acuta* (Linnaeus, 1758)       | Terrestrial, Aquatic | Avibase                  |
|             | *Anas crecca* (Linnaeus, 1758)      | Aquatic, Wetlands | Avibase                  |
|             | *Anas penelope* (Linnaeus, 1758)   | Terrestrial, Aquatic, Wetlands | Avibase |
|             | *Anas querquedula* (Linnaeus, 1758) | Terrestrial      | Avibase                  |
|             | *Ardea alba* (Linnaeus, 1758)       | Marine, Freshwater, Terrestrial | Avibase |
|             | *Ardea cinerea* (Linnaeus, 1758)    | Terrestrial      | Avibase                  |
|             | *Ardea modesta* (Gray, J.E., 1831)  | Shallow water    | Avibase                  |
|             | *Ardea purpurea mantensis* (Meyen, 1834) | Terrestrial, Fresh water | Avibase |
|             | *Ardea grisea* (Sykes, 1832)        | Terrestrial      | Avibase                  |
|             | *Arenaria interpres* (Linnaeus, 1758) | Terrestrial, Estuarine | Avibase |
|             | *Bubulcus ibis* (Linnaeus, 1758)    | Terrestrial      | Avibase                  |
|             | *Calidris ferruginea* (Pontoppidan, 1763) | Terrestrial, Fresh water | Avibase |
|             | *Calidris minuta* (Leisler, 1812)   | Marine           | Avibase                  |
|             | *Caprimulgus asiaticus* (Latham, 1790) | Terrestrial      | Avibase                  |
|             | *Ceruleus leucomelas* (Reichenbach, 1851) | Terrestrial, Aquatic, Wetlands | Avibase |
|             | *Ceryle rudis* (Linnaeus, 1758)     | Terrestrial      | Avibase                  |
|             | *Charadrius alexandrinus* (Linnaeus, 1758) | Terrestrial      | Avibase                  |
|             | *Charadrius dubius* (Scopoli, 1786)  | Terrestrial      | Avibase                  |
|             | *Charadrius leucophaeus* (Lesson, 1826) | Terrestrial      | Avibase                  |
|             | *Charadrius mongolus* (Pallas, 1776) | Terrestrial      | Avibase                  |
|             | *Chlidonias hybrida* (Pallas, 1811)  | Terrestrial      | Avibase                  |
|             | *Chlidonias leucopterus* (Temminck, 1815) | Terrestrial      | Avibase                  |
|             | *Chroicocephalus brunnicephalus* (Jerdon, 1840) | Terrestrial      | Avibase                  |
|             | *Crypsilus saularis* (Linnaeus, 1758) | Terrestrial      | Avibase                  |
|             | *Corvus macrorhynchos* Wagler, 1827  | Terrestrial      | Avibase                  |
|             | *Dendrocopos major* (Horsfield, 1821) | Terrestrial      | Avibase                  |
|             | *Egretta garzetta* (Linnaeus, 1766)  | Terrestrial      | Avibase                  |
|             | *Egretta garzetta* (Linnaeus, 1766)  | Terrestrial      | Avibase                  |
|             | *Egretta gularis asha* (Sykes, 1832)  | Terrestrial      | Avibase                  |
|             | *Egretta intermedia* (Wagler, 1829)  | Terrestrial      | Avibase                  |
|             | *Eudynamys scolopaceus* (Linnaeus, 1766) | Terrestrial      | Avibase                  |
|             | *Fulica atra* (Linnaeus, 1758)      | Terrestrial, Marine, Fresh water | Avibase |
|             | *Gelochelidon nilotica* (Gmelin, 1789) | Terrestrial      | Avibase                  |
|             | *Haliaeetus leucogaster* (Gmelin, 1789) | Terrestrial, Wetlands | Avibase |

Table 5. Cont.
Table 5. Cont.

| Class                      | Species                                                  | Habitat                      | Remarks   |
|----------------------------|----------------------------------------------------------|------------------------------|-----------|
| Himantopus himantopus      | (Linnaeus, 1758)                                         | Terrestrial, Shallow water   | Avibase   |
| Hydropogne caspia          | (Pallas, 1770)                                           | Terrestrial, Marine, Estuarine | Avibase   |
| Larus brunnicephalus       | (Jerdon, 1840)                                           | Terrestrial                  | Avibase   |
| Larus fuscus               | (Linnaeus, 1758)                                         | Terrestrial                  | Avibase   |
| Limosa lapponica           | (Linnaeus, 1758)                                         | Terrestrial                  | Avibase   |
| Limosa limosa              | (Linnaeus, 1758)                                         | Terrestrial                  | Avibase   |
| Microcarbo niger           | (Vieillot, 1817)                                         | Terrestrial                  | Avibase   |
| Mycereria leucocephala     | (Pennant, 1769)                                          | Terrestrial                  | Avibase   |
| Numenius arquaia           | (Linnaeus, 1758)                                         | Terrestrial                  | Avibase   |
| Nycticorax nycticorax      | falklandicus (Hartert, 1914)                             | Terrestrial                  | Avibase   |
| Nycticorax nycticorax      | (Linnaeus, 1758)                                         | Terrestrial                  | Avibase   |
| Oriolus xanthornus          | (Linnaeus, 1758)                                         | Terrestrial                  | Avibase   |
| Pelargopsis capensis       | gural (Pearson, 1841)                                    | Terrestrial                  | Avibase   |
| Phalacrocorax fuscicollis  | (Stephens, 1826)                                         | Terrestrial                  | Avibase   |
| Phalacrocorax nigro        | (Vieillot, 1817)                                         | Terrestrial                  | Avibase   |
| Phoenicopterus ruber       | (Linnaeus, 1758)                                         | Terrestrial                  | Avibase   |
| Platalea leucorodia        | (Linnaeus, 1758)                                         | Terrestrial                  | Avibase   |
| Pluvialis dominica         | (Müller, 1776)                                           | Terrestrial                  | Avibase   |
| Pluvialis squatarola       | (Linnaeus, 1758)                                         | Terrestrial                  | Avibase   |
| Psittacula eupatria        | eupatria (Linnaeus, 1766)                                | Terrestrial                  | Avibase   |
| Serra albitrons            | (Pallas, 1764)                                           | Terrestrial                  | Avibase   |
| Serra hirundo              | (Linnaeus, 1758)                                         | Terrestrial                  | Avibase   |
| Serra albitrons sinensis   | (Gmelin, JF, 1789)                                       | Terrestrial                  | Avibase   |
| Thalaseus bergii           | (Lichtenstein, MHC, 1823)                               | Terrestrial                  | Avibase   |
| Threskiornis melanocephalus| (Latham, 1790)                                           | Terrestrial                  | Avibase   |
| Tringa glareola            | (Linnaeus, 1758)                                         | Terrestrial                  | Avibase   |
| Tringa nebularia           | (Gunnerus, 1767)                                         | Terrestrial                  | Avibase   |
| Tringa stagnatilis         | (Bechstein, 1803)                                        | Terrestrial                  | Avibase   |
| Tringa totanus             | (Linnaeus, 1758)                                         | Terrestrial                  | Avibase   |
| Tringa totanus             | (Linnaeus, 1758)                                         | Terrestrial                  | Avibase   |
| Vanelus indicus            | (Boddart, 1783)                                         | Terrestrial                  | Avibase   |
| Zarpinia fusca zeuglatica  | (Baker, ECS, 1927)                                       | Terrestrial                  | Avibase   |
| Zapernia pusilla           | (Pallas, 1776)                                           | Terrestrial                  | Avibase   |
| Mammalia                   |                                                          |                              |           |
| Axis axis                  | (Erxleben, 1777)                                         | Terrestrial                  | India Biodiversity Portal   |
| Babalus bubalis            | (Linnaeus, 1758)                                         | Terrestrial                  | India Biodiversity Portal   |
| Canis aureus               | (Linnaeus, 1758)                                         | Terrestrial                  | India Biodiversity Portal   |
| Elephas maximus            | maximus (Linnaeus, 1758)                                 | Terrestrial                  | BioLib    |
| Loris tardigradus          | (Linnaeus, 1758)                                         | Terrestrial                  | India Biodiversity Portal   |
| Latra lutra                | (Linnaeus, 1758)                                         | Terrestrial                  | India Biodiversity Portal   |
| Melursus ursinus           | (Shaw, 1791)                                             | Terrestrial                  | India Biodiversity Portal   |
| Moschiola meminna          | (Erxleben 1777)                                          | Terrestrial                  | BioLib    |
| Panthera pardus kotiya     | (Deraniyagala, 1956)                                     | Terrestrial                  | Veron et al., 2015 1        |
| Paradoxurus zeyloneensis   | (Schreber, 1776)                                         | Terrestrial                  | India Biodiversity Portal   |
| Preshysis entellus         | (Dufresne, 1797)                                         | Terrestrial                  | India Biodiversity Portal   |
| Priomylurus virocurrentius | (Bennett, 1833)                                          | Terrestrial                  | India Biodiversity Portal   |
| Rusa unicolor              | (Kerr, 1792)                                             | Terrestrial                  | India Biodiversity Portal   |
| Sus scrofa                 | (Linnaeus, 1758)                                         | Terrestrial                  | India Biodiversity Portal   |
| Trachypithecus vetulus     | (Erxleben, 1777)                                         | Terrestrial                  | Rudran, 2007 2              |

Disappointingly, only one article has reported about microfauna, and it includes only Carpella spp., Noctiluca spp., and Ceratium spp. [27], of which the former two were reported in Kalpitiya and Batticaloa, and the latter in the Negombo lagoon. This implies a huge limitation in assessing microfaunal diversity in the mangrove ecosystem, and the reason for such a drop is still unknown. The paper has also identified the Cladocerans and rotifers
that are found in the wet zone, but still, it lacks a specific scientific notation and proper ecological survey. This limits the faunal studies to the basics, and data analysis resting on such a basis makes it impossible to predict any fact regarding this data.

Vertebrates, especially birds (72 species), have been thoroughly recorded in the mangrove ecosystems, yet scientific data fails to report whether they are endemic or migratory. Despite this missing fact, it should be appreciated that most of the Sri Lankan mangrove wetlands and swamps could house immense numbers of bird species. Avifaunal diversity includes a wide range of cormorants, ducks, egrets, gulls, herons, and so on. Mangrove wetlands play an important role in attracting migratory birds at any phase of their life cycle, seeking their food in the creeks and channels, and nesting in the trees [77]. Among the fish, *Periophtalmus koelreuteri*, commonly called the mudskipper, is prominently found in almost all the mangrove forests. Research [4] suggests that there are more than 150 species of fish, yet we have managed to record only 112 of them. Many of the tetrapods tend to be migrants in a mangrove forest, and we think that this could mainly be because of the salinity of the environment. This could be also a reason why they are not significantly considered for ecological surveys.

3.4. Limitations in the Literature Review

Although the systematic literature review was conducted by searching the research topic using the combined keywords “mangrove flora” and “mangrove fauna”, and “Sri Lanka” through the scientific databases, there were still some relevant studies that could not be included. In addition, native-language publications were not considered in this study. This might lead to a slight prejudice in the metadata that is generated. In addition, the limitations of this search strategy could not only lead to some uncertainty regarding the integrity and representativeness of the analytical literature but could also result in a biased distribution of the publications. Since mangroves belong to estuarine, fringe, and/or marine habitats, not including such terminologies on the search engine could shrink the number of studies to be considered. Thus, the search stratagem of considering mangrove habitats should be further extended in future studies.

Since there is a lesser number of publications on mangrove faunal diversity, and most of them focus on Negombo while the other coastal districts are left behind, we cannot look at the regional occurrence of fauna and their distribution pattern. In addition, some mangrove faunal studies have ambiguities from the taxonomical perspective [48]. Certain studies have sought to identify and analyze the macrobenthic community in the Negombo estuary, although they could have reported the taxonomical nomenclature up to class and/or order level. Only a few species have been identified to the lower taxonomy, while the majority remain at the highest possible level. This might create a bias in the data analysis, as mentioned above.

3.5. Deforestation and Anthropocene Decline of Mangrove Ecosystems

Mangroves have an adaptive capability, as demonstrated by the fact that they have survived harsh environmental conditions, and climate and sea-level changes, for millennia [78,79]. However, due to the unprecedented increase in such factors over the past few years, mangroves tend to suffer extensive degradation. Major factors responsible for the decline of mangroves in Sri Lanka are aquaculture and urban development (Forest Department, 2015, NAQDA (National Aquaculture Development Authority of Sri Lanka), 2018). Studies have reported the decline of mangroves in Sri Lanka due to illegal felling, encroachment, and intensive clearing for infrastructure development, landfilling for housing schemes, and firewood. Dayalatha and Ali (2018) reported that nearly 34 percent of the mangrove in the Puttalam-Kalpitiya area has been converted for industrial shrimp farming. Researchers suggest that the intact mangroves support much of the local community via fisheries and sources of food, timber, medicine, and fuelwood. However, the overexploitation of resources over the past few decades has resulted in an enormous decline in mangrove forests [80]. Apart from these problems, tourism-aided mangrove
disturbance has also been studied recently. The fact that they house plenty of animals and birds and carry a scenic beauty makes mangroves one of the potential sites for sustainable tourism development. However, mangrove-based tourism activities and related forest decline are discussed and explored from the point of view of tourism development, rather than mangrove forest disturbance. In other words, monetary profits overtake mangrove sustainability on the country’s development agenda.

As an important point, Sri Lanka harbors three mangrove species declared to be “Endangered” by IUCN. This category includes *Brugueira cylindrica*, *Sonneratia alba*, and *Xylocarpus granatum* [22]. This calls for an immediate and intensified conservation plan, coupled with government policy to ensure sustainable mangrove productivity. Moreover, the loss of mangroves is the initial stage for biodiversity decline, both in quality and quantity [81], that would significantly affect the health and livelihoods of the coastal community. The shrinking of mangroves means a loss of a wide ecological niche for the feeding, breeding and, hatching of many marine creatures, as well as migratory species. This would have a profoundly negative impact on the coastal communities and coastal health of Sri Lanka.

3.6. Conservation Actions and Legal Protection of Mangroves in Sri Lanka

Problems arising from uncertainties are the fundamental reason why some attacks on the scientific consensus are unavoidable. Despite their unique ecological contributions, mangroves are being destroyed and degraded due to haphazard activities, mainly by humankind. The reasons include urbanization, coastal development, and/or reclamation projects [8]. Even though there is a lack of a solitary organization committed to the protection and conservation of mangroves, they are being protected by parts of several jurisdictions, statutory bodies, and a national policy. However, applying partial knowledge to extant problems (as may be proposed) may invite other, much-feared types of unforeseen consequences.

Primary conservancy action is provided by the Forest Department under the Forest Ordinance of 1907. Secondary protection is provided by the Wildlife Conservation Department, under the Fauna and Flora Protection Ordinance and by the Coast Conservation Department [24]. Apart from these laws and legislations, certain sections of the following acts contribute toward the protection and conservation of mangroves in Sri Lanka:

I. The National Resources Energy & Science Authority (NARESA);
II. The National Aquatic Resources Agency (NARA);
III. The Soil Conservation Act, 1951;
IV. The Crown Lands Ordinance of 1947;
V. The Tourist Development Act, 1968;
VI. The Urban Development Authority Law of 1978;
VII. The National Environment Act of 1980;
VIII. The Coast Conservation Act of 1981.

In addition, a non-governmental organization named “Sudeesa”, set up in 1992, is exclusively committed to mangrove replanting and conservation activities on the Sri Lankan coast.

A generalized list of potential problems is devastating and extremely difficult to work with, for both political and scientific reasons. A science-based focus on the obvious and ubiquitous types of damage might help in that situation, emphasizing an item of great interest, and would hence be useful in education. Educating the public about the possible problems ahead is a necessary and most welcomed activity. A national mangrove conservation policy or an act endorsing participants from government, private and public sectors is needed to conduct and harmonize the future of mangrove conservation, management, restoration/rehabilitation, and the sustainability of Sri Lankan mangroves.
4. Conclusions

In the present review, a total of 70 scientific papers noting mangrove floral and faunal studies in the Sri Lankan coast over the past 40 years was analyzed, to create intensive metadata representing Sri Lanka’s mangrove biodiversity in a single source. A comprehensive checklist has been created with the metadata collected. We have listed a total of 99 invertebrate species and 214 vertebrate species, with updated and revised taxonomy and nomenclature. Among the invertebrates, Arthropoda was the most prominent class, with 55 species, while Pisces was recorded with the richest species diversity of 112, followed by the Aves class with 72 species. Expedited mangrove studies have been concentrated on the southwestern coast, most significantly in Negombo, resulting in a legitimate bias in the distribution of scientific efforts.

We recommend the following suggestions for further studies on Sri Lankan mangrove ecological and taxonomical study: (1) efforts should be taken to study the mangrove fauna extensively; (2) efforts should be harmonized to investigate for a more even distribution of species and localities along the coast; (3) the efforts of conservation and public awareness on mangrove protection should be rationalized, both legally and institutionally.

Supplementary Materials: The following are available online at https://www.mdpi.com/article/10.3390/su13179487/s1, Table S1: Results of the systematic literature review (with detailed data coding).

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