Coccinellidae family is studied in the world: a review of papers from the Scopus database published in English for the period of 2007-2021

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Abstract. This article observes the problems in the study of perspective species of the family Coccinellidae worldwide: a review of papers from the Scopus database published in English for the period of 2007-2021. Trends of publications in the family of Coccinellidae, various journals on Coccinellidae family, authors and their affiliated country, top countries in the study of the Coccinellidae family were analyzed throughout the article. Relying on the results of this analysis, it was found out that paper publishing beat records from 2007 to 2021 with 120 and 62 respectively. Also, number of journals that are frequently used by scholars worldwide were studied. There, top 15 journals were chosen by scholars to publish 721 (44,23 %) of their papers. Countries that held the largest number of researches on the Coccinellidae family was also considered in our article. We identified funding institutions, among which National Natural Science Foundation of China has possessed the largest number with 40. Last but not least, the most influential and productive countries, including China, Brazil, and others, were recorded in our research.

1 Introduction

Coccinellidae family is included into the Coleoptera, and is considered the biggest group among insects. The tribe Coccinellini contains some of the more conspicuous and brightly colored members of the ladybird beetle family. While the group is well characterized in many regions, much of the diverse South American fauna has yet to be systematically collected and/or critically studied by specialists in the field (Vandenberg and González, 2008). Two species of ladybird beetles, one belonging to Phrynocaria Timberlake (Coccinellini) and the second to Chilocorus Leach (Chilocorini) collected by R.A. Wallace in the Maluku Islands (Indonesia) have identical body size and colour pattern with longitudinal stripes on elytra. Their external features were so similar that G.R. Crotch included both of them in the type series of Chilocorus wallacii (Crotch, 1874). The specimen designated as the lectotype of Chilocorus wallacii belongs to Phrynocaria. Coelophora wallacii (Crotch, 1874) is also transferred to Phrynocaria (new comb.) and becomes senior homonym and Phrynocaria crotchi new name is proposed for the secondary junior homonym. Chilocorus crotchi sp. nov. is described for the taxon

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misidentified according to *Chilocorus wallacii* Crotch (Li et al., 2014). Li et al. (2009), Australian genus *Australoneda* Lablokkoff-Khnzor, 1984 are revised. Seven species from New Guinea and single species from Australia are recognised, described and illustrated. Two new species: *A. bielawskii* sp. nov. (Irian Java), *A. ruitong* sp. nov. (Papua New Guinea) are described. A key to the species is also provided (Li et al., 2009). According to Piotr Łczyński (2012), Species of *Anisorcus* Crotch are revised, diagnosed and illustrated. Notes on the genus and nomenclatural history for each species are provided. Lectotypes are designated for *Anisorcus affinis* Crotch and *Anisorcus firyi* Crotch. *Anisorcus malayanus* Crotch is recorded from Solomon Islands and Vanuatu for the first time. Keys to Australasian genera of *Chilocorini* and to *Anisorcus* species are presented (Łczyński, 2012). Lectotypes and paralectotypes of *Hinda quindecimmaculata* Weise (1895) and of *H. modesta* Weise (1910) are designated. An error by Almeida and Milléo (2000) in designating a lectotype for *Hinda regularis* Ericson (1847) is corrected. Known geographical distributions of *H. modesta* and *H. humerata* are expanded (De Almeida et al., 2007).

Coccinellidae is studied as useful entomophagies, aphidophagies by several scientists. Along with this, the impact of some chemical drugs are also studied. In chemical plant protection against pests it is very important to know the indirect effects of insecticides on non-target organisms. This research shows the indirect effects of two insecticides (thiacloprid and lambda-cyhalotrin as active substances) on two different species of ladybirds, i.e., native in Europe *Coccinella septempunctata* and alien invasive species *Harmonia axyridis*, which were fed with aphids previously intoxicated by an insecticide. The products tested killed most instars of both ladybird species within 3 h of the start of the ingestion of the intoxicated prey. The action of thiacloprid, to which the predators are exposed by the same route, was more extended in time in both the coccinellids, and more variable between their developmental instars. The applications of thiacloprid caused different responses in the two predator species, which is nevertheless variable across instars (Twardowski et al., 2021). The aphid *Toxoptera aurantii* Boyer (Sternorrhyncha: Aphididae) is a major pest of the plant (*Camellia sinensis* (L.)). *Micraspis discolor* (F.) and *Menochilus sexmaculatus* (F.) (Coleoptera: Coccinellidae) are the most common predators of these pests in tea plantations of North East India. A laboratory study was conducted to evaluate the suitability of the tea aphid *Toxoptera aurantii*, as prey for these two ladybird beetles. The life cycle of *M. sexmaculatus* was found to be shorter than that of *M. discolor*. Aphid consumption by *M. sexmaculatus* was significantly higher than that by *M. discolor*. Aphid consumption by larvae of *M. discolor* and *M. sexmaculatus* was noticed to be higher in later instars. Females of both ladybird species consumed a significantly greater number of aphids per day than males. As for biological parameters and the predatory potential of the two ladybird species, the study results proved that *M. discolor* and *M. sexmaculatus* are effective biocontrol agents of the tea aphid and can be used in integrated pest management programs successfully (Roy and Rahman, 2014). Based on the importance of using low-risk compounds to protect beneficial agents, the present study evaluated the acute toxicity of lethal and sublethal concentrations of the insecticides thiacloprid, pyriproxyfen, and chlorantraniliprole on adults of *Aphelinus mali* (Haldeman), the main parasite of the woolly apple aphid, *Erioasca lanigerum* (Hausmann) (Radigrán-Navarro et al., 2021).

Population of aphids, and numbers of parasitoids and predators were recorded at weekly intervals. *Rhopalosiphum padi* Linnaeus, *Schizaphis graminum* Rondani, and *Sitobion avenae* Fabricius were the predominant aphid species (Homoptera: Aphididae). Two species of parasitoids *Aphidius ervi* L. and *Aphidius colemani* Viereck were recorded. *Coccinella septempunctata* L. (Coleoptera: Coccinellidae), *Chrysopeal carnea* Stephens (Neuroptera: Chrysomelidae), and several species of Hover flies (Diptera: Syrphidae) were the most common predators. In general, aphids were reported in all wheat cultivars (Zeb et
al., 2020). Two new species of *Epilachna* Dejean from Yunnan, China, are described: *Epilachna nodaodea* sp. nov and *E. lingulatus* sp. nov. (Yi and He, 2013). Two new species of the genus *Synonychimorpha* Miyatake, 1994 are described from Laos: *S. trimaculata* sp. nov. and *S. laosensis* sp. nov. A key to the known species of this genus is given (Wang et al., 2012). Our results showed that aphid colonies were not affected by any PSN or the black SN in the absence of predators. Aphid colony localization by adult coccinellids was delayed under black SN, and favored under pearl PSN, but overall aphid predation was unaffected by net type. There were no significant differences among treatments in interplant movement of L3, females, or males. We conclude that, under laboratory conditions, pearl PSN, red PSN, and black SN can affect aphid colony localization by *H. axyridis*, but do not affect predation efficiency. Subsequent trials in the field would be required to further clarify the effects of PSNs on *H. axyridis* foraging behavior (Yáñez Díaz et al., 2021). On the other hand, the predator *Cryptolaemus montrouzieri* Mulsant (Coleoptera: Coccinellidae) is native to Australia and has been used in augmentative releases against mealybugs in many crops and countries (Radrigán-Navarro et al., 2021). In the work contained in the above communication (Mishra & Omkar, 2006), we have assessed the role of physical and chemical interference by adults, if any, on reproduction in an aphidophagous ladybird beetle, *Propylea disseceta*. We found that both physical and chemical interference by adults had a negative influence on reproduction. There has been an error in citation of references on page 408 column 1 line 1, page 411 column 1 line 23, and the penultimate line of the discussion. Hemptinne et al. (1992, 1993) have worked on the role of physical presence of larvae and larval odour and not on the larval tracks as mentioned at these points (Mishra and Omkar, 2007).

Of the two tested insecticides, lambda-cyhalothrin kills most instars of *Coccinella septempunctata* and *Harmonia axyridis* within a 3 h period since the start of ingestion of intoxicated prey. The action of thiacloprid to which the predators are exposed by the same route is more extended in time in both the ladybirds, and more variable between their instars. It also allows for the survival of a considerable number of individuals beyond 48 h (Twardowski et al., 2021). Santos-Cividanes et al. (2015), *Cycloneda sanguinea* (L.) (Coleoptera: Coccinellidae) is a Host for *Homalotylus hemipterinus* (De Stefani) (Hymenoptera: Encyrtidae) in Brazil (Santos-Cividanes et al., 2015). Density dependent numerical response is considered advantageous for biocontrol agents. Although density dependent behaviors have been examined in aphidophagous ladybirds, they haven’t been studied for coccidophagous ladybirds. The relationship of prey density and prey oviposition stage on the aggregating behavior and oviposition of the coccidophagous predator *Nephus Includens* (Coleoptera: Coccinellidae) was empirically investigated (Milonas et al., 2015) [1-15].

### 2 Methods

In this article, we went to the selection publications on worldly knowledge from the research done. The search collects the English - language academic literature retrieved from the Scopus database for the period 2007-2021. The analysis was carried out in December 2022. A total of 1754 publications were downloaded with the keyword "Coccinellidae". In the next step, articles were categorized according to year of publication. A data base of all peer-reviewed papers was then created, including the year of publication, authors’ names, countries, publication type, journal name, number of citations per paper, the number of citations per journal, the percentage of publications by the topic cluster name and subject area. The analysis was performed using CSV file, Microsoft Excel 2021, RIS, VOS viewer and Map chart. Figure 1 shows the flow of the selected methodology for the research.
The reasons for our use of the methods mentioned above are related to Scopus, a well-known database that collects authoritative literature from around the world, especially on irrigation and drainage systems. English is a universal language, therefore, the literature in English is more standard and meaningful than literature in other languages.

3 Results and discussion

3.1 Trends of publications on Coccinellidae family

Overall, what stands out is that the number of published papers on a particular issue studied for the first time in the world. Total of 1754 papers published between 2007 and 2021 on Coccinellidae family issue. The number of records started to decrease between 2007 and 2021 from 120 to 62 publications. Figure 2 shows 120 (6.8%) number of papers at the beginning in year 2007. In 2008, the highest number of publications was reached during the period of analysis 176 (10%). From 2009 we can see the rapid increasing in the number of publications. There were 124 (7%) and 147 (8.4%) publications in 2009 and 2010. In 2011, 137 (7.8%), 2012, 158 (9%), 2013, 116 (6,6%), 2014, 117 (6,7%), 2015, 156 (8,9%), 2016 88 (5%), 2017 108 (6,2%), 2018 87 (5%), 2019 83 (4,7%), 2020 75 (4,3%). Almost 3,5% from the total number of publications were published in 2021 (Fig. 2).
Furthermore, our learning shows that the largest number 1630 (93%) of 1754 papers were research articles, followed by 30 (1.7%) articles in conference proceedings, 13 (5%) book chapters, 61 (3.5%) review papers whereas there were only 0.8% of other document types (e.g. Note 10, Short survey 4) (Fig. 3).

![Fig. 2. Number of papers on Coccinellidae family by the year of publication issues in the world.](image)

Fig. 3. Publication type on Coccinellidae family issues in the world.

### 3.2 Journals on Coccinellidae family

A wide variety of journals in different parts of the world are used by scholars to publish their research. The communication patterns of the scholars indicate that the total output was distributed across 158 journals published in 86 countries. 721 (44.23%) of these papers were published in top 15 journals and remaining 55.76% papers were published in other journals (Fig. 4). Table I lists the name of some of 13 journals which published 5 and higher number of papers during the abovementioned period.
Fig. 4. Top journals on Coccinellidae family by the year of publication issues in the world.

Table 1. List of the journals on Coccinellidae family by the year of publication issues in the world

<table>
<thead>
<tr>
<th>Scopus Source title</th>
<th>Number</th>
<th>Scopus Source title</th>
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<tbody>
<tr>
<td>Biocontrol</td>
<td>98</td>
<td>Plos One</td>
<td>23</td>
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<tr>
<td>European Journal of Entomology</td>
<td>95</td>
<td>Journal of Economic Entomology</td>
<td>21</td>
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<tr>
<td>Biological Control</td>
<td>81</td>
<td>Biological Invasions</td>
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<td>Environmental Entomology</td>
<td>76</td>
<td>Phytoparasitica</td>
<td>20</td>
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<td>Entomologia Experimentalis Et Applicata</td>
<td>67</td>
<td>Journal of Insect Science</td>
<td>18</td>
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<tr>
<td>Biocontrol Science and Technology</td>
<td>43</td>
<td>Applied Entomology and Zoology</td>
<td>17</td>
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<tr>
<td>Journal of Applied Entomology</td>
<td>41</td>
<td>Insect Science</td>
<td>17</td>
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<td>Pakistan Journal of Zoology</td>
<td>33</td>
<td>Journal of Asia Pacific Entomology</td>
<td>17</td>
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<tr>
<td>Coleopterists Bulletin</td>
<td>30</td>
<td>Egyptian Journal of Biological Pest Control</td>
<td>16</td>
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<td>Bulletin of Entomological Research</td>
<td>28</td>
<td>Entomological Science</td>
<td>16</td>
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<td>Ecological Entomology</td>
<td>27</td>
<td>Journal of Chemical Ecology</td>
<td>16</td>
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<tr>
<td>Annales Zoologici</td>
<td>26</td>
<td>Acta Horticulturae</td>
<td>15</td>
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<td>Florida Entomologist</td>
<td>26</td>
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<td>15</td>
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<td>Annals of The Entomological Society of America</td>
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<td>Pest Management Science</td>
<td>15</td>
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<tr>
<td>International Journal of Tropical Insect Science</td>
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<td>Journal of Insect Physiology</td>
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<td>13</td>
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<td>9</td>
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<td>Agriculture Ecosystems and Environment</td>
<td>11</td>
<td>Ecological Research</td>
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3.3 Authors and their affiliated country

Our research revealed that 160 authors from 86 countries conducted research on coccinellidae during 2007–2021. Figure 5 lists 15 authors who published 20 or more papers. Between them, Omkar with 45 publications, G. Mishra 36, H.E. Roy 34, M.E.N. Majerus 29, J.J. Obrycki 26, J.B. Torres 24, A.F.G. Dixon 23, A. Slipinski 21, E.W. Riddick 20 with research papers.

![Fig. 5. List of top authors published on Coccinellidae family issues in the world.](image)

The quality of papers published by researchers determines how institutions are ranked. One hundred sixty different institutions worked in cooperation to publish 1754 papers on Coccinellidae family the world the period of 2007-2021. Our analysis of the top 10 institutes' publications on Coccinellidae family allowed us to determine the influential and productive institutions in this field. As indicated in Fig. 6, of the 10 institutions, one of them were from China, three were from Brazil, two were from Japan and US, one each from India and Canada.
3.4 Top countries on Coccinellidae family

Research on Coccinellidae had been published in 87 countries around the world. Figure 7 lists 10 most prolific countries in the field of Coccinellidae research. Countries which published 1754 research papers in last 15 year (2007-2021) have been considered as prolific countries. These 10 countries published more than half (83.12%) of the total output. Among them, United States dominated with (452; 25.8%), India (171; 9.8%), China (167; 9.5%) publications, followed by the United Kingdom (152; 8.7%), Brazil (111; 6.03%), Japan (91; 5.2%), Iran (81;4.6%), Czech Republic (80; 4.6%), France (77; 4.4%), and Canada (76; 4.3%).

Fig. 6. List of top institutions on Coccinellidae family issues in the world.

Fig. 7. List of top countries on Coccinellidae family issues in the world.
3.5 Top funding sponsors on Coccinellidae family

There is a relationship between prevalence of affiliated countries and funding of large funding schemes and programs. One hundred fifty-nine different funding sponsors worked in cooperation to publish seven hundred thirty-three papers on Coccinellidae family over the world the period of 2007-2021. Based on our analysis of the top ten funding sponsors publications on Coccinellidae family, we were able to identify the most influential and productive institutions in the field. As indicated in Fig. 8, of the ten funding sponsors, seventy-four of them were from Brazil, sixty one from US, forty five from Japan, forty from China, the rest of the countries have one. Among these, National Natural Science Foundation of China occupies the 1st position in record rank (40 records), followed by the National Science Foundation (37) and Coordenacao de Aperfeicoamento de Pessoal de Nivel Superior (31 records).

![Fig. 8. List of top funding sponsors on Coccinellidae family issues in the world.](image)

4 Conclusion

While analyzing above mentioned problems in the study of perspective species of the family Coccinellidae worldwide: a review of papers from the Scopus database published in English for the period of 2007-2021, trend of publications in the family Coccinellidae, from 2007 to 2021, a total of 1754 articles were published on the family Coccinellidae, 120 (6.8%) articles were published in 2007, 176 (10%) in 2008, and 158 (9%) in 2012, while by 2015 156 (8.9%) and by 2021 the smallest number of articles (3.5%) indicates that interest in representatives of the Coccinellidae family is decreasing. Information about the Coccinellidae family is mainly reflected in articles, 1630 (93%) of 1754 papers were research articles, and 7% of information is presented in other sources.

During these years, information about the Coccinellidae family was covered in 158 journals published in 86 countries, including Biocontrol (98), European Journal of Entomology (95), Biological Control (81), Environmental Entomology (76), Entomologia
Experimentalis Et Applicata (67) magazines ranked in the top 5. When we analyzed the list of top institutions on Coccinellidae family issues in the world, it was found that the first place was occupied by China, while the United States was dominant in terms of Top countries on Coccinellidae family, and Brazil was dominant in terms of funding sponsors.

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