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A review on pollinator's diversity on chili & capsicum

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Abstract
A review has been made on the entitled study "A review on pollinator's diversity on chili & capsicum" to understand the pollinators diversity associated with chilli and capsicum. The present review observed that the chilli and capsicum flower attract a wide range of insect visitors during their flowering period. Order Hymenoptera and Lepidoptera were found to be the predominant orders of pollinators whereas family Apidae from Hymenoptera and Nymphalidae from Lepidoptera were the dominant one for Chilli. But for capsicum, Order Hymenoptera and Diptera were the major orders. Among the pollinators *Apis cerana indica, Apis melifera, Apis dorsata* were the major pollinators from order Hymenoptera whereas Nymphalids were major lepidopteran pollinators. Apart from this stray population of Halictids, Vespids, Dipterans and Coleopteran beetles were also found to be associated with these crops.

Keywords: pollinators diversity, insects, chilli and capsicum

Introduction
The contribution of insect pollinators to the ecology and production of food crops is threatened by excessive use of pesticides, urbanization, deforestation & mono-cropping etc. The diversity of pollinators depends on food availability and habitat quality. This review emphasizes the diversity of insect pollinators. In case of chilli pant blossoms resemble solanaceae flowers which have a white corolla containing 1-1.5 mg of pollen. Anthesis and dehiscence in chilli flowers occur in the morning between 7 and 9 am. Pentameric, bisexual, hypogynous flower of capsicum are 10 - 15 mm in diameter. The flowers remain open for less than 24 hours and usually close at different times of the day to prevent drying of the stigma which remains receptive for 2 days after anthesis. Pollen grains become fertile a day before anthesis and are released 1 - 4 hours after flower opening depending on the cultivar. Although the flowers of capsicum are capable of self-pollination, the introduction of insect pollinators has a positive effect on fruit quantity and quality. There is an increasing demand globally to increase pollination of green pepper most especially in green houses and this can be achieved through insect pollination. Therefore, with the above need of studies this review has been collected for diversity study of pollinators.

Review and Discussion
Putra *et al.* in 2021 has conducted their experiment on "Indirect effect of pesticides utilization towards diversity of pollinator insects in chilli plantation" at Jambi, Indonesia. They have recorded 9 different species from 2 orders (Lepidoptera and Hymenoptera which were contributing 57% and 43% respectively). (Table No.1). *Apis cerana indica* and *Apis melifera* were the two pollinators belonging to same family Apidae of Order Hymenoptera. A single species of *Eurema hecabe* belonging to family Pieridae of Lepidopteran Order. Family Nymphalidae constituted the maximum number of species of Order Lepidoptera *i.e. Neptis leucporus, Acrae violae, Cupha erymanthis, Junonia orithya, Hypolimnas bolina* and *Mycalesis perseus.* Order Lepidoptera was the dominant as compared to order Hymenoptera. Family Nymphalidae was the most abundant family followed by Apidae and Pieridae. *Apis mellifera* was found to be the most abundant pollinator (Hymenoptera) (27%) followed by *Apis cerana indica* (Hymenoptera) (16%), *Eurema hecabe* (Lepidoptera) (14%).

Table 1: Number of species and individual insect pollinators in chilli plantations, 2021

Species	Family	Order
Apis cerana indica	Apidae	Hymenoptera
Apis melifera	Apidae	Hymenoptera
Eurema hecabe	Pieridae	Lepidoptera
Neptis leucporus	Nymphalidae	Lepidoptera
Acrae violae	Nymphalidae	Lepidoptera
Cupha erymanthis	Nymphalidae	Lepidoptera
Junonia orithya	Nymphalidae	Lepidoptera
Hypolimnas bolina	Nymphalidae	Lepidoptera
Mycalesis perseus	Nymphalidae	Lepidoptera

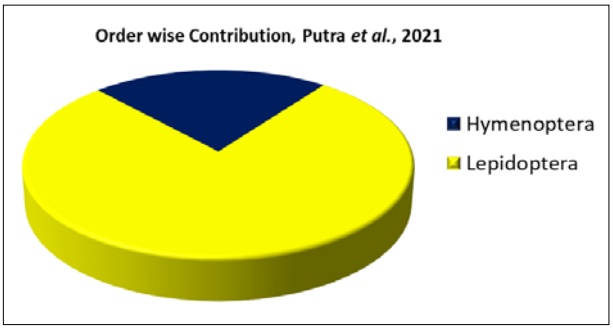

Fig 1: Order wise diversity of pollinators, Putra *et al.*, 2021

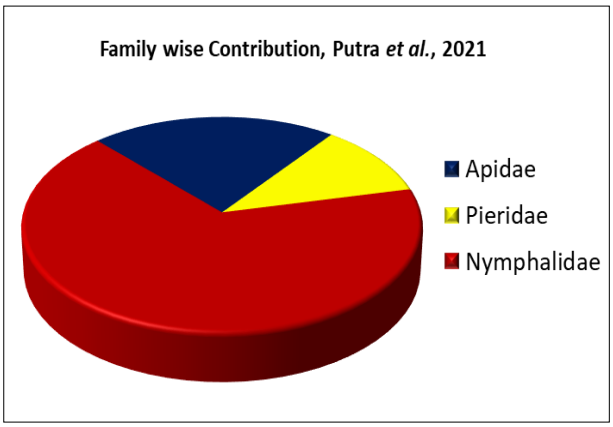

Fig 2: Family wise diversity of pollinators, Putra *et al.*, 2021

Soli *et al.*, in 2020 [2] in their research "Insect Pollinator Diversity and Their Influence on Yield and Quality of *Capsicum annuum* Linné (Solanaceae)" conducted at Machakos, Kenya. In their investigation they have recoded 13 different insect pollinators of 7 families of 3 orders visiting the flowers of chilli. (Table No. 2). Among the three orders Order Hymenoptera (82.9%) was the most dominant one consisting 11 species belonging to 5 different families followed by Order Diptera and Coleoptera each consisted of single species.

Table 2: Number of species and individual insect pollinators in chilli plantations, 2020

Species	Order	Family
Apis mellifera	Hymenoptera	Apidae
Macrogalea candida	Hymenoptera	Apidae
Xylocopa calens	Hymenoptera	Apidae
Amegilla cymatilis	Hymenoptera	Apidae
Amegilla sp.	Hymenoptera	Apidae
Lipotriches sp.	Hymenoptera	Halictidae
Lasioglossum sp.	Hymenoptera	Halictidae
Nomia sp.	Hymenoptera	Halictidae
Megachile sp.	Hymenoptera	Megachilidae
Cathimeris sp.	Hymenoptera	Scoliidae
Camponotus maculutus	Hymenoptera	Formicidae
Phytomia incisa	Diptera	Syrphidae
Coccinella sp.	Coleoptera	Coccinellidae

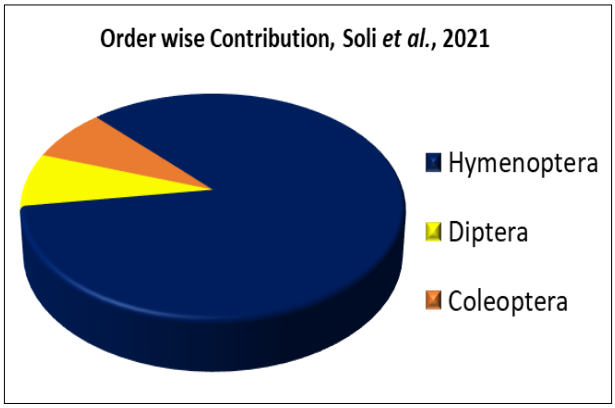

Fig 3: Order wise diversity of pollinators, Soli *et al.*, 2020 [2]

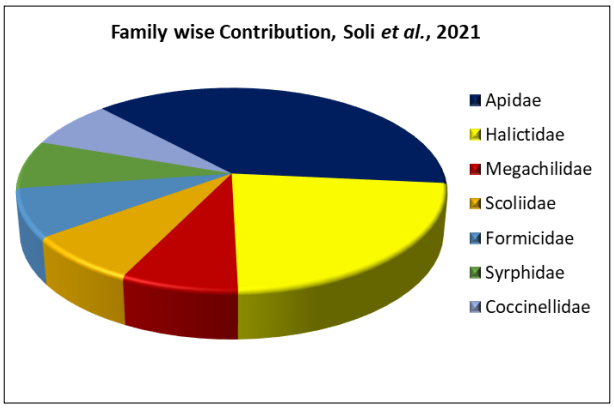

Fig 4: Family wise diversity of pollinators, Soli *et al.*, 2020 [2]

Chaita T in 2019 in her MSc Ag research "Pollinator fauna, diversity and their role in enhancing yield in chilli, *Capsicum annuum* L." conducted at University of Agricultural Sciences, GKVK, Bengaluru observed 12 different numbers of pollinators visiting flowers of capsicum belonging to 6 different families of 4 different orders. (Table No. 3). Order Hymenoptera (9) was found to be the most dominant one followed by Diptera (2) and Lepidoptera (1). Family Apidae from order Hymenoptera consisted of 7 different species and 4 different genus those are *Apis dorsata*, *Apis florae*, *Apis cerana indica*, *Apis mellifera*, *Tetragonula iridipennis*, *Ceratina binghami* and *Amegilla zonata*. 5 other families were also observed those are Halictidae (*Halictus ligatus*), Vespidae (*Vespula vulgaris*), Pieridae (*Belenois aurota*), Syrphidae (*Syrphus* sp.) and Sarcophagidae (*Sarcophaga* sp.).

Table 3: Number of species and individual insect pollinators in chilli plantations, 2019

Species	Order	Family
Apis dorsata	Hymenoptera	Apidae
Apis florae	Hymenoptera	Apidae
Apis cerana indica	Hymenoptera	Apidae
Apis mellifera	Hymenoptera	Apidae
Tetragonula iridipennis	Hymenoptera	Apidae
Ceratina binghami	Hymenoptera	Apidae
Amegilla zonata	Hymenoptera	Apidae
Halictus ligatus	Hymenoptera	Halictidae
Vespula vulgaris	Hymenoptera	Vespidae
Belenois aurota	Lepidoptera	Pieridae
Syrphus sp.	Diptera	Syrphidae
Sarcophaga sp.	Diptera	Sarcophagidae

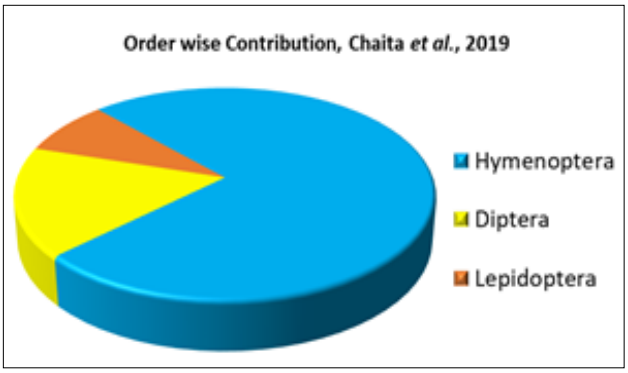

Fig 5: Order wise diversity of pollinators, Chaita *et al.*, 2019

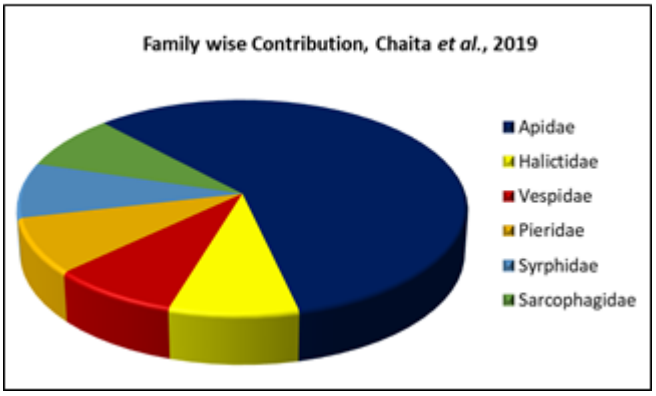

Fig 6: Family wise diversity of pollinators, Chaita *et al.*, 2019

Lucia *et al.* in 2015 in their research "The management of bee communities by intercropping with flowering basil (*Ocimum basilicum*) enhances pollination and yield of bell pepper (*Capsicum annuum*)" conducted at Sa˜o Joa˜o del Rei, Brazil has recorded *Apis mellifera*, *Paratrigona lineata*, *Trigona spinipes* and *Tetragonisca angustula* as the major pollinators.

Justino *et al.* in 2012 [5] in their research "Estimate of natural cross-pollination rate of Capsicum annuum using a codominant molecular marker associated with fruit pungency" conducted at Brasília-DF, Brazil has revealed that Capsicum flowers were predominantly visited by the Orders Hymenoptera, Coleoptera, Lepidoptera, and Diptera.

Kasina *et al.*, in 2009 [6] has reported wild bees, ants and other biotic organism as major pollinators of capsicum. He had also depicted that these pollinators have positive contribution towards productivity of capsicum.

Cruz *et al.*, in 2005 [7] has revealed that the stingless bee *Melipona subnitida* which led to the production of heavier fruits *C. annuum* (sweet pepper) in Brazil.

Kwon *et al.*, in 2003 [8] has revealed Bumble bees such as Bombus terrestris as the major pollinators which improve the pollination of greenhouse hot pepper (*C. annuum*)

Conclusion

The present review concludes that the chilli and capsicum flower attract a wide range of insect visitors during their flowering period. Order Hymenoptera and Lepidoptera were found to be the predominant orders of pollinators whereas family Apidae from Hymenoptera and Nymphalidae from Lepidoptera were the dominant one. Among the pollinators *Apis cerana indica*, *Apis melifera*, *Apis dorsata* were the major pollinators from order Hymenoptera whereas Nymphalids were major lepidopteran pollinators. Apart from this stray population of Halictids, Vespids, Dipterans and Coleopteran beetle were also found to be associated with these crops.

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