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Pollinator fauna associated with buckwheat, *Fagopyrum esculentum* Moench (Polygonales: Polygonaceae) in North Karnataka

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Abstract
An investigation was carried out at Main Agricultural Research Station (MARS), University of Agricultural Sciences, Dharwad to study the diversity of pollinators visiting buckwheat during *kharif* 2018. The pollinator fauna of buckwheat comprised of a total of twelve insect species belonging to four insect orders *viz*., Hymenoptera, Diptera, Lepidoptera and Hemiptera. Among these, Hymenoptera was the most dominant pollinator group with a maximum of 61.49 per cent proportion followed by Diptera (25.00%), Lepidoptera (12.16%) and Hemiptera (1.35%). The most abundant pollinator among the hymenopterans was the little bee, *Apis florea* Fabricius which recorded 28.38 per cent proportion followed by *Apis cerana* Fabricius and *Apis dorsata* Fabricius with 20.27 and 12.84 per cent proportion, respectively. Four species each of dipterans *viz.*, *Musca* sp., *Episyrphus* sp., *Lucilia* sp. and *Sarcophaga* sp. and lepidopterans *viz.*, *Hypolimnas bolina* Linnaeus, *Danaus chrysippus* Linnaeus and *Euchrysops cnejus* Fabricius and *Helicoverpa armigera* Hubner were also found visiting buckwheat flowers.

Keywords: Pollinators, buckwheat, Hymenoptera, *Apis florae* Fabricius

1. Introduction
Buckwheat (*Fagropyrum esculentum* Moench; Polygonales: Polygonaceae) is an Old World crop which is believed to have been originated in China [1] and was introduced into the New World by European settlers in 17th century [2]. Buckwheat is an economically important crop primarily due to its edible proteins and carbohydrate rich grains, hardiness of plants, short growth span and foliage that is used as a green vegetable. It is also used as livestock and poultry feed. In the present scenario of rapidly expanding population and their ever increasing demands, it can turn out as an important crop for feeding mankind and domestic animals and help in ensuring food safety.
The flowers of buckwheat are distylous and self-incompatible and can be pollinated by wind or insects [3]. There are 2 types of flower morphologies (pin or thrum), with pin flowers having long styles extending past their stamens and thrum flowers having long stamens that extend beyond the styles [4]. Flowering may start within three weeks of planting and continue for up to 10 week. The pollinators are important in buckwheat production since they increase its productivity [5]. The bees usually visit buckwheat crops from 8 a.m. to 1 p.m. A single visit of a blossom by a bee increases plant productivity by 25-30 per cent. Around 3-4 insect visits are enough to pollinate one blossom. The experimentation of Russian researchers showed that the bees-pollinators increase the buckwheat productivity and viability.
Buckwheat's shallow white blossoms attract beneficial insects *viz*. honeybees, hover flies (Syrphidae), predatory wasps, minute pirate bugs, insidious flower bugs, tachinid flies and lady beetles as evident from several reports. However, meagre studies have been carried out on pollination and related aspects of buckwheat in Karnataka and hence, the present investigations was undertaken targeting the same.

2. Materials and Methods
A systematic procedure was adopted for conducting the present investigation which was carried out at Main Agricultural Research Station (MARS), University of Agricultural Sciences (UAS), Dharwad, Karnataka during *kharif* 2018. Dharwad is a district head quarter in north Karnataka, situated at 15° 26′ North latitude, 75° 07′ East longitude and at an altitude of

731.80 m above mean sea level (MSL). The place lies in the North transitional zone (zone-8) with temperature and relative humidity ranging from 11 to 37°C and 40.00 to 85.00 per cent, respectively. An average annual rainfall of 860.00 mm is received here which is distributed all over the year.

Buckwheat was grown during *kharif* season of 2018 in order to study the pollinator fauna of the crop under Dharwad conditions. No plant protection measures were undertaken during the entire flowering period of the crop.

The observations on pollinator fauna was initiated during 10.00 per cent flowering of the crop and continued at regular intervals till its complete cessation. Observations were recorded at 1000 hr for different groups of pollinators visiting buckwheat flowers for 5 minutes in each square meter area from five such randomly selected spots. The representative samples of each of the pollinator observed during the course of the study was collected and was identified to the level of species, when possible; using published systematic keys.

3. Results and Discussions

The pollinator diversity of buckwheat in Dharwad constituted a total of 12 insect species which belonged to four insect orders *viz*., Hymenoptera, Diptera, Lepidoptera and Hemiptera. Among these, hymenopterans were the most abundant pollinators which constituted a maximum of 61.49 per cent proportion followed by Diptera (25.00%), Lepidoptera (12.16%) and Hemiptera (1.35%) (Fig 4). In Hymenoptera, the little bee, *A. florea* was the most prominent pollinator which recorded a highest per cent proportion of 28.38 followed by Indian bee, *A. cerana* and rock bee, *A. dorsata* with 20.27 and 12.84 per cent proportion, respectively (Fig. 1). Four species of dipterans *viz.*, *Episyrphus* sp., *Musca* sp., *Lucilia* sp. and *Sarcophaga* sp. were found to visit flowers of buckwheat with per cent proportion of 9.46, 8.11, 4.73 and 2.70, respectively (Table 1 and Fig. 2). As evident, syrphidae were found to dominate the dipteran pollinators. The pollinators belonging to Lepidoptera constituted three butterflies *viz., Euchrysops cnejus* Fabricius (4.73%), *Danaus chrysippus* Linnaeus (3.38%) and *Hypolimnas bolina* Linnaeus (2.70%) and a moth, *Helicoverpa armigera* Hubner (1.35%) which was comparatively less in number. Only one species of Hemiptera *viz*., *Lygaeus kalmii* Stal was observed to visit buckwheat flowers with a mere per cent proportion of 1.35 (Fig. 3).

The present findings are in line with the results of the experiment carried out at the Lithuanian Institute of Agriculture [6] wherein they recorded honey bees (84.40%) as the major pollinators of buckwheat followed by bumble bees (6.50%) and other pollinators (9.10%). This is in concurrence with the present findings that the family Apidae of Hymenoptera comprising of honey bees dominated the pollinator fauna of buckwheat. The abundance of little bees might be probably due to the small body size of these bees which enables to effectively pollinate the small sized flowers of buckwheat.

In another study carried out at north-central Florida, 5,300 visits of Italian bee, *Apis mellifera* was documented [7] on buckwheat flowers followed by 3,422 visits of non-*Apis* insects, the majority being wasps. The next dominant group was Diptera (12.50%) followed by non-*Apis* bees (5.80%). Similarly, in the present investigation, dipterans were the second most dominant pollinators of buckwheat. However, in contrast to this report, no Italian bees or other non-*Apis* bees were observed pollinating buckwheat under Dharwad conditions. Sixteen families of insects composed of at least 62 species of flower visitors were observed within the buckwheat fields in central Belgium. Among these, the activity of some syrphidae (*Eristalis* spp.) and other dipteran species were found during the entire flowering period and their frequency of occurrence was relatively high [8]. The higher activity of syrphidae and few dipteran species on buckwheat were also noted in the present findings.

4. Conclusion

The pollinator fauna of buckwheat in Dharwad, Karnataka comprised of four major insect orders *viz.*, Hymenoptera, Diptera, Lepidoptera and Hemiptera among which, the maximum occurrence of hymenopterans was noticed. In the order Hymenoptera, *A. florea* was the most active and abundant pollinator followed by *A. cerana* and *A. dorsata*. The next prominent floral visitors of buckwheat were of the order Diptera among which, syrphids were higher in abundance and the lycaenid butterflies were the major visitors among the lepidopterans.

5. Acknowledgement

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Table 1: Pollinator fauna recorded on buckwheat, *Fagopyrum esculentum* bloom during 2018-19

Order	Family	Scientific name/ Common name	No./m^2/5 min	Percentage proportion	Total
Hymenoptera	Apidae	*Apis florea* Fabricius	42	28.38	61.49
		Apis cerana Fabricius	30	20.27	
		Apis dorsata Fabricius	19	12.84	
Diptera	Syrphidae	*Episyrphus* sp.	14	9.46	25.00
	Muscidae	*Musca* spp.	12	8.11	
	Calliphoridae	*Lucilia* sp.	7	4.73	
	Sarcophagidae	*Sarcophaga* sp.	4	2.70	
Lepidoptera	Nymphalidae	*Danaus chrysippus* Linnaeus	5	3.38	12.16
		Hypolimnas bolina Linnaeus	4	2.70	
	Lycaenidae	*Euchrysops cnejus* Fabricius	7	4.73	
	Noctuidae	*Helicoverpa armigera* Hubner	2	1.35	
Hemiptera	Lygaeidae	*Lygaeus kalmii*	2	1.35	1.35

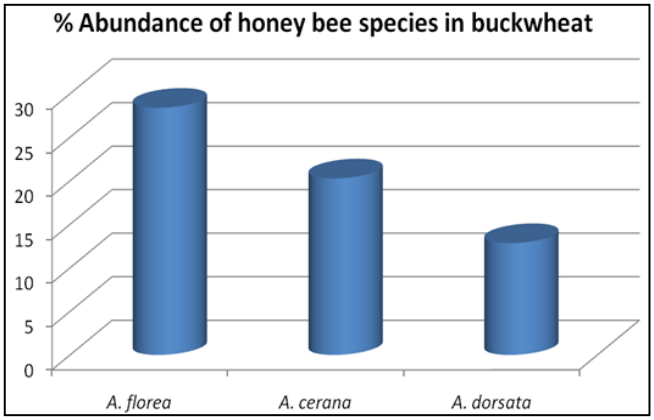


Fig 1: Abundance different honey bees species in the pollination of buckwheat

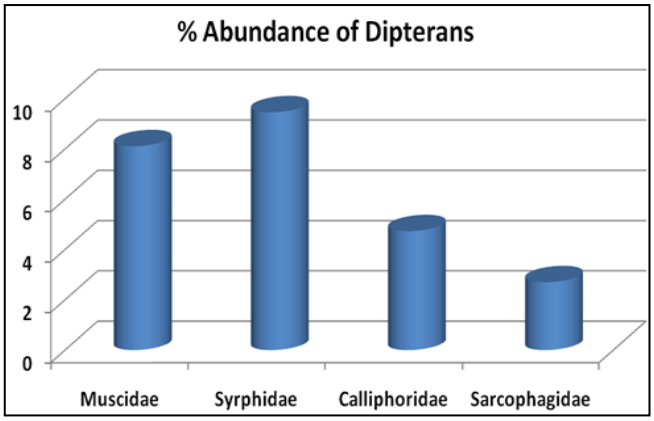


Fig 2: Abundance Dipteran families in the pollination of buckwheat

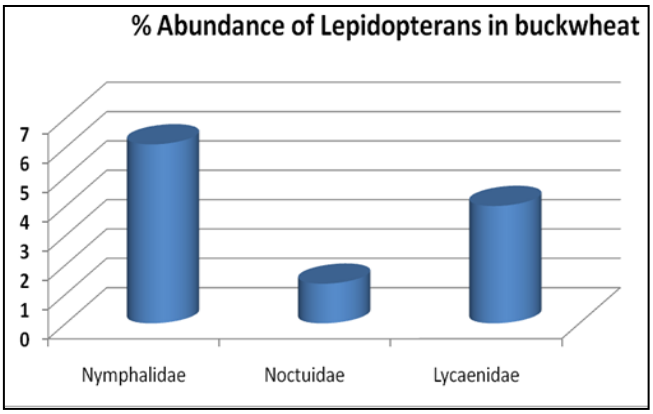


Fig 3: Abundance Lepidopteran families in the pollination of buckwheat

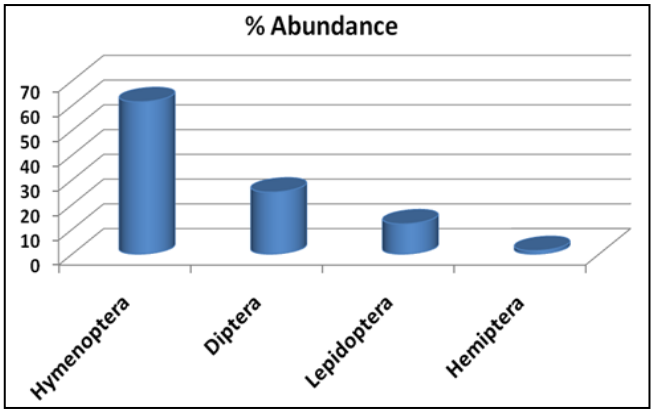


Fig 4: Abundance of insects of different orders in the pollination of buckwheat

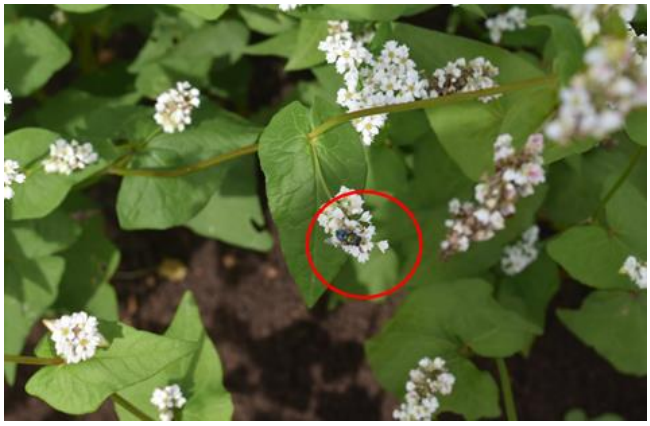
***Apis florea* Fabricius**

***Apis dorsata* Fabricius**

***Apis cerana* Fabricius**

Sarcophaga sp.

Danaus chrysippus Linnaeus



***Lucilia* sp.**

***Episyrphus* sp.**

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