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Taxonomic analysis of phototactic beneficial insects as biocontrol agents (Predators and parasites) collected in light trap in rice ecosystem at Jabalpur

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Abstract
The field experiment was conducted at Jabalpur (M.P) during *kharif* season 2016, using light trap tool in rice ecosystem for integrated pest management. Phototactic beneficial insects as biocontrol agents (predators and parasites) collected in rice ecosystem from June to October 2016. Taxonomic analysis revealed that these 30 beneficial insects belonging to total 8 orders and 18 families, (7 order, 26 species and 15 family predators and single order Hymenoptera, 3 families & 4 species are parasites) were recorded throughout the *kharif* season. Based on number of species collected, largest collection was represented by order Coleoptera 12 species (40%) followed by order Hemiptera 7 species (23%), Hymenoptera 4 species (13%), Odonata 2 species (7%), Neroptera 2 species (7%) Dictyoptera 1 species (3%), Orthoptera 1 species (3%), Dermaptera 1 species (3%).

Keywords: Taxonomic analysis, beneficial insects, rice, phototactic, predators, parasites

1. Introduction
Light traps are mainly used at night in the field to collect a various phototactic diversity of insects like moths, Coleopteran predadors, Hemipteran bugs and other crop insects species etc. Taxonomic analysis revealed that these 30 beneficial insects belonging to total 8 orders and 18 families, (7 order, 26 species and 15 family predators and single order Hymenoptera, 3 families & 4 species are parasites) were recorded throughout the *kharif* season in rice ecosystem, Jabalpur (2016). Many of the biocontrol agents are nocturnal and some diurnal insects are positively phototropic in nature. Record of those bio-control species which were collected in trap consistently throughout the cropping season of paddy, in Madhya Pradesh, rice is cultivated on 1.76 million hectares with annual production of 3.00 million tonnes and productivity of 1807 kg ha-1 [1]. In India average losses in paddy production due to insect pests are 25-30% [2] and in Madhya Pradesh about 40-100% losses were observed [3]. Phototropic behavior and phototactic response of insects are being largely used to monitor pest activity for their effective suppression [4]. Nocturnal insects are often attracted to light sources that emit a large amount of UV radiation, and devices that exploit this behavior, such as light traps for forecasting pest outbreaks, and electric insect killers, have been developed [9], Upadhyay *et al.* [11] reported that a total of 17 predatory species belongs to 9 families and 4 parasitic species belongs to 2 families collected through light trap. Use of light trap is one of the oldest, a conventional and effective method for collecting phototactic fauna and used in sustainable agriculture. The objective of this study was to identify phototactic beneficial insects as biocontrol agents (predators and parasites) using light trap tool in rice ecosystem and describe them on the basis of taxonomic and economic aspects.

2. Materials and methods
The experiment was conducted at the Krishi Nager experimental farm, JNKVV, Jabalpur (MP) during the period between the Junes to October, 2016, with Jawahar light trap model (SM- 96) with mercury vapor lamp (80 Watt) was used. Incidence of phototactic beneficial insects as biocontrol agents (predators and parasites) were recorded on daily basis by operating the light trap.

2.1 Geographical location and Climate
The experiment was conducted at the Krishi Nager experimental farm, Adhartal, Jabalpur (MP) during the period between June to October, 2016. The climatic conditions prevalent in Jabalpur are essentially semi-arid and sub-tropical. It is situated at 23.9°N latitude, 79.58° E longitude and at an altitude of 411.78 m above the mean sea level.

2.2 Light trap design
Jawahar light trap model (SM- 96) developed at JNKVV, Jabalpur with mercury vapor lamp (80 W) as a light source was used for the study. The light trap units comprised of two parts are as follows.

2.2.1 Trapping device
It is made up of 24 gauges GI sheet consisting of a funnel (40 cm top diameter) baffle plates each 30 x 12 cm in size. In this design long funnel stem (pipe) is provided in place of collection chamber which is directly attached to collection trey.

2.2.2 Insect collection device
It is made up of 24 gauge GI sheet 40 cm x 40 cm x 15 cm in size with cupboard and built-in locking system. The insects collected in the chamber of light trap were killed by the exposure of Dichlorvos 76 EC vapors (as fumigating agent) which is directly placed in collection tray for instant killing of trapped insects

2.3 Identification of insects
For the taxonomic documentation, the light trap was operated every night and collection was observed on the next day morning. Observations will be recorded every day throughout the *kharif* season. Total insects was observed and sorted out on the basis of their order and family. Identification of insects was done on the basis of specimens available in insect museum of the Department of Entomology, JNKVV, Jabalpur, Department of Entomology, UAS, Bangalore and Zoological Survey of India, Jabalpur. Dried specimens was prepared by keeping the pinned insects in oven for 24 hours at 30 °C and thereafter well labeled specimens was stored in insect boxes.

3. Results and discussion
3.1 Taxonomic analysis of composition of phototactic beneficial insects as biocontrol agents (predators and parasites) in rice ecosystem
Taxonomic analysis revealed that these 30 beneficial insects belonging to total 8 orders and 18 families, (7 order, 26 species and 15 family predators and single order Hymenoptera, 3 families & 4 species are parasites) were recorded throughout the *kharif* season in rice ecosystem (2016). Based on number of species collected, largest collection was represented by order Coleoptera 4 families including 12 species (40%) followed by order Hemiptera 4 families and 7 species (23%), Hymenoptera 3 families and 4 species (13%), Odonata 2 families and 2 species (7%), Neroptera 2 families and 2 species (7%) Dictyoptera 1 family and 1 species (3%) Orthoptera 1 family and 1 species (3%), Dermaptera 1 family 1 species (3%) (Figure 1). Record of these 30 insect species based on of their economic importance as beneficial insects as biocontrol agents (predators and parasites) which were collected in trap throughout the cropping season of paddy (Table 1).

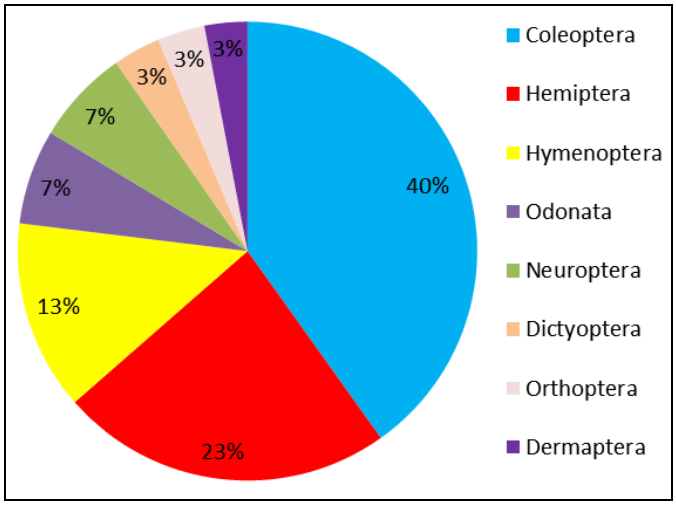

Fig 1: Percent distribution of number of Beneficial insects- as bio-control agents (Predators and Parasites) of different order trapped in light trap installed in paddy *Kharif* 2016 (June to October).

Table 1: Taxonomic distribution of biocontrol agents collected in light trap during *kharif* season -2016. Beneficial insects: as bio-control agents (Predators and Parasites)

S. No.	Insect species collected	Total of seasons collection (June to Oct.) 2016	Economic status Beneficial- Predatory / Parasitic as bio control agents
	ORDER- COLEOPTERA		
	A) Family- Carabidae		
1)	*Prothyma* sp. Tiger beetle	388	Predator of Colorado potato beetle and small insects
2)	*Cicindela flexuosa* (Distant)	14	General predator of small insects
3)	*Chlaenius pictus* (Choudoir)	66	General predator of Lepidopterous larvae
4)	*Chlaenius nigricans*(Wiedemann)	43	Predaceous upon *Laphgma pyrausta nubilalis* and *Pinusinsiguos* sp.
5)	*Diplocheila polita* Fab.	62	General predator
6)	*Brachinus sexmaculeatus* (Dejean)	32	General predator
7)	*Brachinus longipalpis* (Wiedemann)	54	General predator
8)	*Crosopedophorus elegans* (Dejean)	38	Predator of Lepidoptera larvae and soft body insects
	B) Family- Hydrophilidae		
9)	*Hydrochara caraboides* (Latreille) Water scavenger	613	General predator of aquatic insects
10)	*Tropisternus latelalis*	7638	Genral aquatic predator
	C) Family- Scarabaeidae		
11)	*Onitis falcutus* (Wulfen) Dung beetle	147	General predator of aphid, coccids, white fly and bugs
	D) Family- Scirtidae		
12)	*Cyphon padi* (Fleming) Lady bird beetle	415	General predator of small insects
	ORDER- HEMIPTERA		
	A) Family- Reduviidae		

13)	*Sirthenea carinata* (Fabricius)	115	Predator of mole cricket and G*ryllus* sp.
14)	*Sirthenea* sp.	38	Generaly feed upon *Orycetes* sp.,*Scapterisus* sp. and small insects
15)	*Ectomocoris ululans* (Rossi)	53	Predator of caterpillars and small insects
	B) Family- Pentatomidae		
16)	*Eocanthecona furcellata* Wolff	31	Predator of caterpillars and small insects
	C)Family- Belostomatidae		
17)	*Diplonychus rusticus* Fabricius Water bug	1725	Feed on aquatic insects
18)	*Lethocerus americanus* Leach	28	Feed on aquatic insects
	D) Family- Pyrrhocoridae		
19)	*Antilochus conqueberti* (Fab.)	48	Predator of nymph of red cotton bug
	ORDER- HYMENOPTERA		
	A) Family- Vespidae		
20)	*Vespa orientalis* (Linnaeus)	74	General parasite of Lepidopterous, Coleopterous and Dipterous insects
	B) Family- Formicidae		
21)	*Myrmicaria brunnea* Saunders	388	Egg parasite of Lepidopteran insects
22)	*Dorylus* sp.	27	General parasite of Lepidopterous and Dipterous insects
	C) Family- Ichneumonidae		
23)	*Enicospilus purgatus* (Say)	157	Larval parasite of stem borer, leaf folder and Lepidopterous insects
	ORDER- ODONATA		
	A) Family- Coenagrionidae		
24)	*Coenagrion* sp. Damsel fly	174	Predator of monarch butterfly, stem borer, gall midge and leaf eating caterpillar
	B) Family- Libellulidae		
25)	*Pantala flavescens* (Fabricius)	346	General predator on Lepidopterous, Dipterous and Hymenopterous insects
	ORDER- NEUROPTERA		
	A) Family- Chrysopidae		
26)	*Chrysoperla sillemi* (Esben-petersen) Green lace wing	161	General predator on leaf hoppers and aphids
	B) Family- Ascalaphidae		
27)	*Ascalaphus* sp. Owl fly	186	Adult feed on caterpillars and grubs
	ORDER- DICTYOPTERA		
	A) Family- Mantidae		
28)	*Archimantis latistyla* (Serville) Mantis	51	Nymph feed on leaf hopper and aphids while adult feed on caterpillars
	ORDER- ORTHOPTERA		
	Family- Tettigoniidae		
29)	*Conocephalus* sp. Long horn grass hopper	48	Predator of Lepidopteran eggs
	ORDER- DERMAPTERA		
	A) Family- Forficulidae		
30)	*Elaunon bipartitus* (Kirby) Earwigs	232	General predator on Lepidopteran larvae

Beneficial insects as natural biocontrol agents was represented by 30 beneficial insects belonging to total 8 orders and 18 families, (7 order, 26 species and 15 family predators and single Order Hymenoptera, 3 families & 4 species are parasites). Among the predatory species order Coleoptera was represented by the highest number of 4 families including 12 species (40%) in which family Carabidae has the highest 8 predatory species namely Prothyma sp. (388 beetles), *Chlaenius pictus* Choudoir (66 beetles), *Brachinus longipalpis* Wiedemann (54 beetles) *Diplocheila polita* Fab. (62 beetles), *Brachinus sexmaculeatus* Dejean (32 beetles), *Chlaenius nigricans* Wiedemann (43 beetles), *Crosopedophorus elegans* Dejean (38 beetles) and *Cicindela flexuosa* (Distant) (14 beetles) while, family Scarabaeidae was reported by one species Dung beetle, *Onitis falcutus* (Wulfen) (147 beetles). The highest catch was observed of *Tropisternus latelalis* fabricius (7638 beetles), *Hydrochara caraboides* Latreille (613 beetles), Lady bird beetle, *Cyphon padi* Fleming (415 beetles). Khan (1983) [6] also reported 21 predaceous and 8 parasitic species of insect collected in light trap at Jabalpur and observed that the species of Carabidae and Cicindelidae among the predaceous Coleoptera and Reduviids in order Hemiptera were most responsive while Coccinellids were the least responsive to light.

Order Hemiptera was represented by 4 families and 7 species. Major predatory species were *Diplonychus rusticus* Fabricius (1725 bugs), *Sirthenea carinata* (Fabricius) (115 bugs), *Ectomocoris ululans* (Rossi) (53 bugs), *Antilochus conqueberti* (Fabricius) (48 bugs), *Lethocerus americanus* (Leach) (28 bugs) *and Eocanthecona furcellata* (Wolff) (31 bugs), *Sirthenea* sp. (38). Similarly Sharma *et al.* (2013) [8] also reported that order Hemiptera was represented by 4 families and 6 species in trap catches including major predatory species viz. *Canthacona furcellata* (176), *Antilochus* sp. (126). *Geocories bullatus* Sp. (105) and *Sirthenea* sp. (96) Comparing the relative size of trap catches the highest catch was observed of *Diplonychus rusticus* Fabricius (1725 bugs) among all the species of order Hemiptera. Muchhala (2014) [7] also reported that the highest trap catch was observed of *Diplonychus rusticus* Fabricius (2655 bugs) among all the species of order Hemiptera.

Order Hymenoptera was represented by 3 families and 4 species as parasites. In terms of relative size of trap catch *Myrmicaria brunnea* Saunders (388 wasps) has the highest trap catch followed by *Enicospilus purgatus* (Say) (157 wasps) and *Vespa orientalis* Linnaeus (74 wasps), while *Dorylus* sp. (27 wasps) was represented by the lowest size of trap catch. Corresponding Upadhyay (1996) [10] also reported that parasitic group was represented by 2 families viz. ichneumonidae and Braconidae of the order Hymenoptera through trap collection at Jabalpur.

Order Odonata contained two species namely Pantala *flavescens* (Fabricius) (346 flies) and *Coenagrion* sp.(174 flies) which belongs to family Libellulidae and Coenagrionidae respectively. Similarly Sharma *et al.* (2013)

[8] also reported that predatory orders Odonata was represented by *Libellula* sp. (213) & *Coenagrion* sp. (48) belonging to family Libellulidae and Conenagriidae, respectively. Order Neuroptera was represented by two species namely *Ascalaphus* sp. (186 flies) and *Chrysoperla sillemi* (Esben-petersen) (161 green lace wings) which belongs to family Ascalaphidae and Chrysopidae respective. Honek and Kraus (1981) [5] also reported Chrysoperla *sillemi* (Esben-petersen) (Neuroptera: Chrysopidae) though light trap catches.

Order Dermaptera, Dictyoptera and SOrthoptera were represented by only one species each i.e. Earwigs, *Elaunon bipartitus* (Kirby) (232 earwigs) family Forficulidae, Mantis, *Archimantis latistyla* (Serville) (51 mantis) family Mentidae and Long horn predatory grass hopper, *Conocephalus* sp. (48 hoppers) family Tettigoniidae respectively. In conformity with the present findings Muchhala (2014) [7] also repoted that order Dermaptera, Dictyoptera and Orthoptera were represented by only one species each i.e. Earwigs, *Elaunon bipartitus* (Kirby) (240 earwigs) family Forficulidae; Mantis, *Archimantis latistyla* (Serville) (8 mantis) family Mentidae and Long horn predatory grass hopper, *Conocephalus* sp. (238 hoppers) family Tettigoniidae respectively.

4. Conclusions

The experiment has provided consequential knowledge on 30 beneficial insects belonging to total 8 orders and 18 families (7 order, 26 species and 15 family predators and single order Hymenoptera, 3 families & 4 species are parasites) were recorded throughout the *kharif* season in rice ecosystem. This information will be very useful for surveillance and monitoring of insects for forecasting and light trap is effective in insects catches in integrated pest management.

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