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Designing the invertebrates modules nocturnal inhabit and their adaptability toward different aqueous solutions

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Abstract
During present research from both aqueous solutions (10% formalin and sugar solution), from both solutions, total 2788 specimens were collected and maximum population was recorded from formalin solution 57.89% (N = 1614) and least population was recorded from sugar solution i.e. 42.11% (N=1174). As for as taxa composition was concerned, from formalin solution, total 89 species were recorded belonging to 9 orders, 43 families and 73 genera. Whereas, for sugar solution, total 74 species were counted pertaining to 08 orders, 33 families and 58 genera. In case of formalin solution, maximum population was recorded during 6th sampling (252±64.06), and least values were recorded during 5th and 1st sampling (69±53.32). Whereas, species abundance was recorded utmost in 3rd sampling (33 species) at temperature and humidity 38.9 °C and 28%, respectively. In case of sugar solution, maximum population was recorded during 6th sampling (195±54.87) and least values were recorded in 9th and 10th samples (71±32.81) and (62±39.17), respectively. Whereas, species abundance was recorded utmost in 4th sampling (29 species) at temperature and humidity 41.6 °C and 16.0%. For both solutions, maximum relative abundance was recorded for *Psammodes sulcicollis* (Tenebrionidae) 26.83% (N=433) "formalin solution" and 26.41% (N = 310) "sugar solution". Diversity (H') was recorded maximum among formalin solution (0.4035) and least was recorded among sugar solution (0.2935). Species richness was again recorded high among formalin (23.3968) and least among sugar solution (20.8780). Analysis of Variance (ANOVA) among both (formalin and sugar) showed non-significant results (F=0.22; P=0.6478).

Keywords: Urbanization, nocturnal invertebrates, formalin and sugar solution

Introduction
In spite of insects' importance in ecological pyramids, they are often overlooked in conservation projects owing to their small size or it is considered that they least valuable than vertebrates. Whereas, their abundance exceeds than vertebrates because 75% of total identified fauna consist of insects' population. They are fascinating and most beautiful creatures on earth biosphere, and being food for higher consumers, they are particularly important source of protein for survival of higher invertebrates [31]. Almost 1.5 million of species are identified as a vast group of arthropods with multi type habitats [5]; they show fluctuation in diversity and density with regard to abiotic factors e.g. temperature and humidity. Their physical characters e.g. size, life activities, habitat and trophic status also depend upon these factors [2], and such features make them eminent in ecosystem. While, their limited life span, extraordinary fertility and comfort of rising in test center promote their usage in biological exploration [33].
With extensive urbanization, there is huge invertebrate diversity within these areas, including unusual and important species [15]. Artificial lighting is being used to enlighten the dark environment for centuries and this trend is much high in urbanization for economic point of view. It influence ecosystem functioning and also impose negative impacts on invertebrate fauna [10]; because invertebrates are highly sensitive toward such lights, particularly photoreceptors. They experience vast range of complexity and potential of light-sensitive structures which range from simple nerve fibers of some sea urchins to the complex compound eyes of insects. Many of them depend upon the natural rhythms of day – night and on season that triggers vital stages in their lifecycles, while, some e.g. flying adult and mayflies are disorientated by artificial light [39].
Light traps were developed to collect the insects of medical importance like sand flies, black

flies, mosquitoes and midges, but its application for collecting nocturnal insects is also very old [6]. Different kinds of light traps are used to attract a wide variety of nocturnal insects nowadays. Some traps collect the live insects, while other draw them into killing chamber filled with formalin, cyanide crystals or a liquid preservative (80% ethanol) [13]. However, artificially enlightening in the nocturnal environment change the predictability of these regimes, as it potentially affects their communication, navigation, foraging and regulation of daily as well as seasonal cycles [27]. Impact of light is largely limited to its effects on organism physiology, behavior, reproduction and predator prey interactions [14]. Wherein nocturnal patterns of activity of invertebrates varied significantly in relation to temperature, season, duration of night and habitat. Overnight temperature is most important in the activity of nocturnal invertebrates [8].

There is vast diversity among insects with more than one million identified species [26] and order Lepidoptera, Coleoptera, Diptera, Dermptera and Hemiptera are major orders of interest, with their considerable diversity in all habitats. Order Lepidoptera is the 2nd largest order of insects and its eminent members like moths and butterflies having beautiful colored scales on the wings and other body parts as unique features [3].

Wherein order Diptera is a diverse group of two winged insects known as “true flies” [5, 24] e.g. black flies, mosquitoes, fruit flies, house flies and blow flies midges. They are “key stone” species in terrestrial ecosystem [28]. Mosquitoes are slender, long legged insects and are easily recognizable with distinct head bearing mouth brushes and antennae, a bulbous thorax that is wider than head and abdomen, posterior anal papillae [29].

Insects’ diversity varies in the seasons; generally less numbers of insects occur in winter season [40, 16]. Adults of beneficial insects and many pest species that are active at night show altered behaviour towards the artificial light sources necessary when man observes their behaviour. Therefore, the knowledge about nocturnal behavior of many species is largely limited. We believe that the basic understanding of nocturnal behavior is necessary for the development and designing of new efficient and effective technologies for population estimation. Consequently, the availability of the equipment which enable us to observe their behaviour at night without interfering their normal insect behavior is a matter of great importance. Now, such equipments are available in the form of low light level, NVG (night vision goggles) image intensifying devices and different light traps [20]. Nevertheless, the damage of natural habitats for financial and residents purposes can create greatest threat for insect diversity in dry and wetlands [7].

Hence, keeping in view the nocturnal invertebrate diversity and work done by various researchers in past, the present study was focused to collect, identify and compare the nocturnal invertebrates’ diversity in urban area of district Faisalabad for designing the modules with regard to attraction of nocturnal insects toward different solutions (10% formalin and sugar solution).

Materials and Methods

Study area

Present research was done to find the diversity of invertebrates nocturnal in habit under ecological conditions of Samundri (district Faisalabad), Punjab, Pakistan during the session 2015-2016. Samundri is located at 30°48'30N 71°52'15E, with an altitude of 130 meters (429 ft) above sea level, and is 45 km away from Faisalabad city.

Collection of data

To weigh up the objectives, light traps were used to collect the nocturnal invertebrates from dawn to dusk after one week interval. Two light traps tubs having different solutions e.g. 10% sugar solution and formalin solution were set at distance of 6 ft from each other and insects dropped in both tubs were collected separatly. Temperature and humidity of sampling night were noted. Collection was made by hand picking method and with the help of forcep.

Collected specimens were washed with fresh water, then stored in 70:30% alcohol and glycerin solution and shifted to Biodiversity Laboratory, Department of Zoology, Wildlife and Fisheries, University of Agriculture, Faisalabad for further systematic studies. Here, the specimens were preserved in separate glass vial containing 70:30% alcohol and glycerin solution for further identification.

Identification

The collected samples were sorted and identified with the aid of naked eye, magnifying glass and microscope. All the specimens were identified up to species level according to the taxonomic/ reference material [4] and on-line electronic keys.

Statistical analysis

Thereafter, all the observed specimens were arranged in table form according to their morphological and taxonomic characters e.g. order, family, genus and species. To determine the various aspects of diversity, Shannon Diversity Index was used [21].

Results & Discussion

Relative Abundance

Invertebrates are key motor of an ecosystem function and they can live in various ecological circumstances e.g. peak, plus or negative temperature, humidity, and desiccation; whereas, they have recreational and biological values to run our lives. They are key motor of an ecosystem function to sustain ecological pyramids [1, 25, 35]. Currently, their distribution over nocturnal habitat and adaptability toward aqeous solution of formalin and sugar solution were assessed for future concern. Among both solutions, total 2788 specimens were collected during entire sampling (10 sampling from each category) and maximum population was recorded from formalin solution 57.89% (N = 1614) and least population was recorded from sugar solution i.e. 42.11% (N = 1174). Taxa composition was recorded as follow: from formalin solution, total 89 species were recorded belonging to 9 orders, 43 families and 73 genera; whereas, from sugar solution, total 74 species were counted pertaining to 8 orders, 33 families and 58 genera. In case of formalin solution, maximum population was recorded during 6th sampling (252±64.06), followed by 245±59.11 (3rd sampling), 219±40.73 (9th sampling) and so on. While, least values were recorded during 5th and 1st sampling (69±53.32). Whereas, species abundance was recorded utmost in 3rd sampling (33 speciess) at temperature and humidity 38.9 °C and 28%, respectively. However least species abundance was recorded during 6th sampling i.e. 22 species at 40.6ºC (temperature) and 28% (humidity). In case of sugar solution, maximum population was recorded during 6th sampling (195±54.87), followed by 174±40.02 (8th sampling), 132±10.32 (5th sampling) and so on. While, least values were recorded in 9th and 10th samples (71±32.81) and (62±39.17), respectively. Whereas, species abundance was recorded utmost in 4th sampling (29 species) at temperature and humidity 41.6 °C and16.0% respectively. However, least species abundance was recorded during 7th sampling i.e. 19 species at 37.1 ºC (temperature) and 44% (humidity) (Table – 1; Fig. 1 & 2).

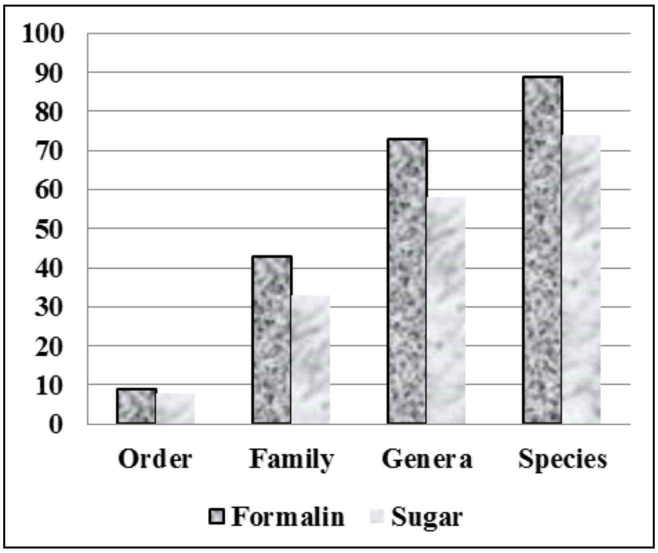

Fig 1: Taxa Composition

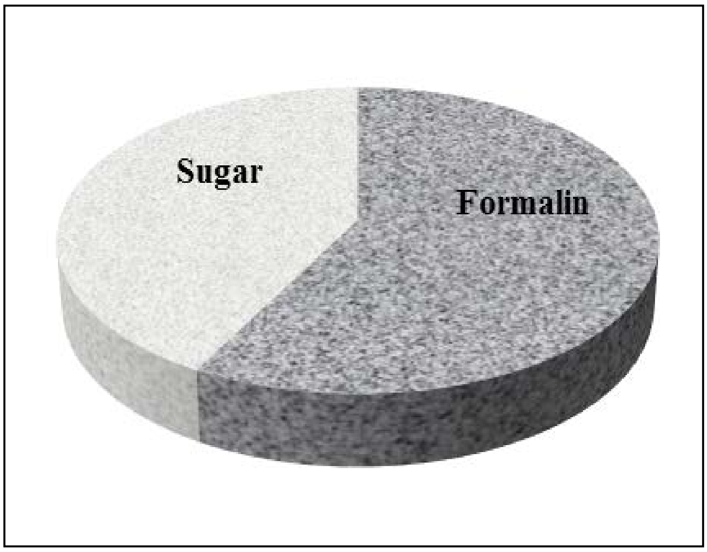

Fig 2: Population Dynamic

Table 1: Population Means±SD recorded for Formalin and Sugar solution

Sampling No.	Formalin		Sugar		Temperature (ºC)	Humidity (%)
	Mean±SD	Speciess	Mean±SD	Species		
1	90±50.49	23	62±39.17	25	26.5	56.0%
2	145±11.60	30	96±15.13	20	31.6	41.0%
3	245±59.11	33	114±2.40	23	38.9	28.0%
4	125±25.74	31	91±18.67	29	41.6	16.0%
5	109±37.05	29	132±10.32	22	39.4	26.0%
6	252±64.06	22	195±54.87	24	40.6	28.0%
7	118±30.69	25	131±9.62	19	37.1	44.0%
8	178±11.74	23	174±40.02	21	36.9	50.0%
9	219±40.73	32	108±6.65	26	39.5	37.0%
10	133±20.08	28	71±32.81	26	37.0	53%

From the overall findings, significant results were recorded in case of order Coleoptera from both solutions over the entire study period. The relative abundance was recorded maximum from formalin for order Coleoptera (45.72%) and least for order Araneae and Dermeptera (0.06%). Wherein Neuropteran population densities were recorded in conflicting contribution. However, impacts of climatic changes (temperature and humidity) were not significant over population dynamics for both solutions. Whereas, comparative relative abundance of each species from each solution was recorded heterogeneously (Table 2), because overall relative abundance of each species was vary from each other and between each solution; some species were recorded more abundantly in one solution while other fields were devoid off by them or exist with very lest abundance. Wherein a lot of speciess representing one solution instead of overall representation.

In case of formalin solution, *Psammodes sulcicollis* (Tenebrionidae) was recorded as an extraordinary contributing species with relative abundance of 26.83% (N=433). Thereafter, *Euceraphis betulae* (Aphididae) was recorded with utmost relative abundance 2.13% (N=166). After this relative abundance was recorded maximum for *Culex pipens* (Culicidae) 7.56% (N=122), followed by *Formicomus* spp. (Anthicidae) 6.20% (N=100), *Nysius cf ericae* (Lygaeidae) 5.70% (N=92), *Drosophila funebris* (Drosophilidae) 5.20% (N=84), *Atrecus macrocephalus* (Staphylinidae), *Anthicus cervinus* (Anthicidae) 3.59% (N=58), *Circulifer tenellus* (Cicadelidae) 2.42% (N=39), *Camponotus fragilis* (Formicidae) 2.35% (N=38), *Graminella nigrifrons* (Cicadelidae) 1.98% (N=32), *Chironomus* spp. (Culicidae) 1.92% (N=31), *Axarus festivus* (Culicidae) 1.55% (N=25), *Gonatocerus ashmeadi* (Mymaridae) 1.36% (N=22), *Herpetogramma licarsisalis* (Crambidae) 1.24% (N=20), *Cycloceohalus borealis* (Scarabaeidae) 1.12% (N=18), *Evergestis extemalis* (Crambidae), *Ceratagallia uhleri* (Cicadelidae) 1.05% (N=17), *Haploa reversa* (Arctiidae) 0.99% (N=16), *Culex eraticus* (Culicidae) 0.81% (N=13), *Macrosteles quadrilineatus* (Cicadelidae), *Ahaserus advena* (Silvanidae) 0.68% (N=11), *Scaphytopius californiensis* (Cicadelidae), *Bembidion semipunctatum* (Carabidae), *Myzius persicae* (Aphididae) 0.62% (N=10), *Typhaea stercorea* (Mycetophagidae), *Apis dorsata* (Apidae) 0.56% (N=09), *Amrasca biguttula* (Cicadelidae), *Amrasca terraereginae* (Cicadelidae) 0.50% (N=08), *Labarrus lividus* (Scarabaeidae), Amiota alboguttata (Drosophilidae), *Chironomus tuberculatus* (Culicidae) 0.43% (N=07) and Cacoxenus *Indagator* (Drosophilidae), *Chrysopa* spp. (Chrysopidae) 0.37% (N = 06). However, remaining all the taxa were recorded with least relative abundance (N≤05).

In case of sugar solution, again *Psammodes sulcicollis* (Tenebrionidae) was recorded as an extraordinary contributing species with relative abundance of 26.41% (N=310). Thereafter, *Culex pipens* (Culicidae) was recorded with utmost relative abundance 10.48% (N=123). After this relative abundance was recorded maximum for *Euceraphis* *betulae* (Aphididae) 7.84% (N=92), followed by *Nysius cf ericae* (Lygaeidae) 4.94% (N=58), *Anthicus cervinus* (Anthicidae) 3.92% (N=46), *Camponotus fragilis* (Formicidae), *Formicomus* spp. (Anthicidae), 3.83% (N=45), *Drosophila funebris* (Drosophilidae) 3.24% (N=38), *Culista annulata* (Culicidae) 2.30% (N=27), *Graminella nigrifrons* (Cicadelidae) 2.21% (N=26), *Amrasca biguttula* (Cicadelidae) 1.96% (N=23), *Ahaserus advena* (Silvanidae) 1.87% (N=22), *Bembidion semipunctatum* (Carabidae) 1.79% (N=21), *Nysius graminicola* (Lygaeidae) 1.70% (N=20), *Circulifer tenellus* (Cicadelidae) 1.62% (N=19), *Cycloceohalus borealis* (Scarabaeidae) 1.53% (N=18), *Herpetogramma licarsisalis* (Crambidae) 1.45% (N=17), *Haploa reversa* (Arctiidae) 1.28% (N=15), *Evergestis extemalis* (Crambidae) 1.11% (N = 13), *Axarus festivus* (Culicidae) 1.02% (N=12), *Macrosteles quadrilineatus* (Cicadelidae) 0.94% (N=11), *Scaphytopius californiensis* (Cicadelidae), *Anoplognathus chloropyrus* (Scarabaeidae) 0.60% (N=07) and *Anopheles atropervus* (Culicidae) 0.51% (N=06). However, remaining all the taxa were recorded with least relative abundance (N≤05). Previously, it was reported that various kind of fauna reside urban areas because it offers favorable conditions for their survival, while few species often not adaptive. Urbanization can even increase biodiversity by increasing habitat diversity [38] and can also influence the species richness [23]. On the other hand urbanization is a main cause of native species extinction [9]; however, complicated nature of urban land use can have a complex influence on invertebrate biodiversity. Whereas, some features of urbanization can support the increasing level of biodiversity [22] e.g. artificially enlightening in the nocturnal environment induce changes in the predictability of these regimes, potentially affecting communication, navigation, foraging and the regulation of daily and seasonal cycles of invertebrates [27]. Findings of present study are an acknowldgement with previous reports already documented over the world [12, 18, 37, 11, 41, 30] they reported similar findings in their results pertaining to studies conducted in various fields over the world.

Table 2: Relative abundance of nocturnal invertebrate fauna recorded for Formalin and Sugar solution

Order	Family	Species	Relative Abundance (%)	
			Formalin	Sugar
Hemiptera	Aphididae	*Euceraphis betulae*	8.98(145)	7.84(92)
		Myzus persicae	0.62(10)	0.34(4)
	Lygaeidae	*Nysius cf ericae*	5.70(92)	4.94(58)
		Nysius spp.	0.19(3)	0.43(5)
		Nysius graminicola	0.25(4)	1.70(20)
	Derbidae	*Apache* spp.	0.31(5)	0.17(2)
	Cicadelidae	*Amrasca biguttula biguttula*	0.50(8)	1.96(23)
		Amrasca terraereginae	0.50(8)	0.00(0)
		Scaphytopius californiensis	0.62(10)	0.60(7)
		Ceratagallia uhleri	1.05(17)	0.34(4)
		Graminella nigrifrons	1.98(32)	2.21(26)
		Circulifer tenellus	2.42(39)	1.62(19)
		Macrosteles quadrilineatus	0.68(11)	0.94(11)
Coleoptera	Silvanidae	*Ahasverus advena*	0.68(11)	1.87(22)
	Staphylinidae	*Atrecus macrocephalus*	1.96(23)	
	Tenebrionidae	*Psammodes sulcicollis*	26.83(433)	26.41 (310)
	Anthicidae	*Anthicus cervinus*	3.59(58)	3.92(46)
		Formicomus spp.	6.20(100)	3.83(45)
	Scarabaeidae	*Cyclocephalus borealis*	1.12(18)	1.53(18)
		Anoplognathus chloropyrus	0.19(3)	0.60(7)
		Labarrus lividus	0.43(7)	0.26(3)
	Aphodiidae	*Aphodius reyi reitter*	0.31(5)	0.26(3)
		Aphodius granaries	0.31(5)	0.26(3)
	Mycetophagidae	*Typhaea stercorea*	0.56(9)	0.00(0)
	Carabidae	*Bembidion semipunctatum*	0.62(10)	1.79(21)
Diptera	Culicidae	*Culex pipiens*	7.56(122)	10.48(123)
		Culex eraticus	0.81(13)	0.17(2)
		Chironomus spp.	1.92(31)	1.70(20)
		Chironomus tuberculatus	0.43(7)	0.00(0)
		Axarus festivus	1.55(25)	1.02(12)
		Anopheles gambiae	0.31(5)	0.26(3)
		Anopheles atropervus	0.00(0)	0.51(6)
		Culista annulata	0.00(0)	2.30(27)
	Drosophilidae	*Drosophila funebris*	5.20(84)	3.24(38)
		Amiota alboguttata	0.43(7)	0.09(1)
		Cacoxenus indagator	0.37(6)	0.43(5)
	Muscidae	*Musca domesticus*	0.31(5)	0.00(0)
Hymenoptera	Mymaridae	*Gonatocerus ashmeadi*	1.36(22)	0.51(6)
	Formicidae	*Lasius interjectus*	0.31(5)	0.34(4)
		Camponotus fragilis	2.35(38)	3.83(45)
	Apidae	*Apis dorsata*	0.56(9)	0.26(3)
Lepidoptera	Crambidae	*Herpetogramma licarsisalis*	1.24(20)	1.45(17)
		Evergestis extimalis	1.05(17)	1.11(13)
	Arctiidae	*Haploa reversa*	0.99(16)	1.28(15)
Neuroptera	Chrysopidae	*Chrysopa* spp.	0.37(6)	0.17(2)

To launch the IPM strategies in a best fitted manner, use of community representative for population suppression or to motivate the beneficial organisms is considered a cornerstone factor. For this purpose, highlighting a diversity and density of various existing families in under reference habitations can provide a realistic approach [36]. Hence, the fundamental issue (relative abundance) was again accessed at family level to overcome these aspects. In case of formalin solution, relative abundance was also recorded in the same context as it was observed in species case. From total of 46 recorded families, 43 were recorded from formalin solution and among them, higher relative abundance (26.83%; N = 433) was recorded for Tenebrionidae family, followed by Culicidae (12.76%; N=206), Anthicidae (9.91%; N=160), Aphididae (9.60%; N=155), Cicadelidae (8.05%; N=130), Drosophilidae (6.38%; N=103), Lygaeidae (6.32%; N=102), Staphylinidae (3.66%; N=59), Formicidae (3.10%; N=50), Crambidae (2.48%; N=40), Scarabaeidae (1.73%; N=28), Mymaridae (1.36%; N=22), Arctiidae (0.99%; N=16) and Silvanidae (0.68%; N=11). However, least relative abundance (N≤10) was recorded for Carabaeidae, Aphodiidae, Mycetophagidae, Muscidae, Apidae, Chrysopidae, Geocoridae, Derbidae, Cixinae, Lophopidae, Nabidae, Pentatomidae, Cerambycidae, Anobiidae, Scirtidae, Dermistidae, Chrysomelidae, Curculionidae, Hybosoridae, Cerylonidae, Syrphidae, Lauxaniidae, Braconidae, Taphiidae, Pergidae, Geometridae, Gryllidae, Theridiidae and Forficulidae; wherein from total of the 46 recorded families, 03 families were not recorded in formalin solution. From total of 46 recorded families, 32 were recorded from sugar solution and among them, higher relative abundance (26.41%; N=310) was recorded for Tenebrionidae family, followed by Culicidae (16.87%; N=198), Cicadelidae (8.35%; N=98), Aphididae (8.18%; N=96), Lygaeidae (7.75%; N=91), Formicidae (4.68%; N=55), Drosophilidae (4.43%; N=52), Crambidae (2.64%; N=31), Scarabaeidae (2.39%; N=28), Staphylinidae (2.04%; N=24), Silvanidae (1.87%; N=22), Carabaeidae (1.79%; N=21) and Arctiidae (1.28%; N=15). However, least relative abundance (N≤10) was recorded for family Geocoridae, Derbidae, Cixinae, Lophopidae, Aphodiidae, Anobiidae, Dermistidae, Chrysomelidae, Cerylonidae, Stratiomyidae, Mymaridae, Apidae, Geometridae, Tortricidae, Theridiidae, Lycosidae, Forficulidae, and Chrysopidae; wherein from total of the 46 recorded families, 14 families were not recorded in sugar solution.

While, in respect of order level presentation, total 9 orders were recorded in case of formalin solution and among them, higher relative abundance (45.72%; N=738) was recorded for order Coleoptera, followed by Himptera (24.85%; N=401), Diptera (19.83%; N=320), Hymenoptera (5.27%; N=85) and Lepidoptera (3.27%; N=60). However, least relative abundance (N≤10) was recorded for order Neuroptera, Orthoptera, Araneae and Dermiptera. From total of 9 of recorded orders, 8 orders were recorded from sugar solution and among them, higher relative abundance (43.44%; N=510) was recorded for order Coleoptera, followed by Hemiptera (24.79%; N=291), Diptera (21.64%; N=254) Hymenoptera (5.45%; N=64) and Lepidoptera (4.17%; N=49). However, least relative abundance (N≤10) was recorded for order Araneae, Neuroptera and Dermiptera; whereas, order Orthoptera was not recorded from sugar solution. Insects are dominant winged invertebrates with interesting ability to mimic their surroundings and order Lepidoptera, Coleoptera, Diptera, Dermoptera and Hemiptera are major orders of interest, with their considerable diversity in all habitats. Their diversity play key roles in environment for amenity values like recreation and aesthetic enjoyment [4]. With the large urbanization, there is huge invertebrate diversity within these areas, including unusual and important species [15]. Artificial lighting in urbanization disrupt them long which is great concern for conservationists owing to negative effects toward their lives [19, 10] and our findings supported their views.

Trophic Structure

Sustainablity of a particular habitat is always depending upon the energy flow in food chain and it can be possible only in the situation when habitual preference of all the insects fall as per natural lines. Because, these organisms play role for above mentioned functions and consist of; predator, prey, pest, parasite, deterivorus, scavenger and consumers etc. Enlisting of all these contributers is called trophic structure of the food chain in that particular ecosystem and their overall role and rate of energy transferring in that particular ecosystem is called “ecological efficiency” [32, 34, 35, 17]. Presently trophic structure of nocturnal invertebrate insects’ regarding the accessibility and adaptability formalin and sugar solution (Fig. 3) was accessed during their summer season because array of invading insects accelerate during this season with regard to many causes e.g. ideal temperature, less humidity, condence canopy, pest and prey densities etc. From the overall results, population densities pertaining to various represents were recorded non-significantly between each other:

From the total of recorded population, 0.92% (N=15) was recorded as pollinators from formalin solution pertaining to following taxa: *Apis dorsata, Calliphora vicina, Anthobosca insularis, Crambus perlella* – whereas, population density of pollinators among sugar solution were recorded very least 0.25% (N=03) and that population was consisting of *Apis dorsata, Calliphora vicina, Anthobosca insularis* and *Crambus perlella.*

In case of pest, from the total of recorded population, 64.26 % (N=928) was recorded as pest from formalin solution comprising of following taxa: *Herpetogramma licarsisalis, Herpetogramma phaeopteralis, Pyrilla perpusilla*, *Amrasca biguttula biguttula, Amrasca terraereginae, Cicadulina storeyi, Ceratgallia uhleri, Circulifera tenellus, Haplaxius xyron, Haplaxius ovatus, Nysius graminicola, Nysius cf ericae, Nysius* spp., *Nusius raphanus, Calliopum aeneum, Anthicus cervinus*, *Formicomus* spp., *Notonus desertus, Stricticollis tobias*, *Lasioderma serricorne, Chinavia hilaris, Palomena prasina, Cyclocephalus borealis, Anoplognathus chloropyrus, Typhaea stercorea, Ophimyia* spp., *Myzus persicae, Euceraphis betulae, Attagenus unicolor, Dermestes frischi, Evergestis extimalis, Haploa reversa, Operophtera bruceata, Xentoemna pallorana, Forficula auricularia, Myllocerus undatus, Apache* spp. and *Chilacis typhae* – whereas, population density of pest among sugar solution were recorded 35.34% (N=415) consisting of *Herpetogramma licarsisalis, Herpetogramma phaeopteralis, Pyrilla perpusilla, Amrasca biguttula biguttula, Amrasca terraereginae,Ceratgallia uhleri, Ceratagallia California, Circulifera tenellus, Haplaxius xyron, Nysius graminicola, Nysius cf ericae, Nysius* spp., *Nusius raphanus, Anthicus cervinus, Formicomus* spp., *Lasioderma serricorne, Arocatus chiasmus, Cyclocephalus borealis, Anoplognathus chloropyrus, Myzus persicae, Euceraphis betulae, Attagenus unicolor, Dermestes frischi, Evergestis extimalis, Haploa reversa, Operophtera bruceata, Xentoemna pallorana, Forficula auricularia, Thaia Subrufa* and *Apache* spp.

Predator population was recorded 8.36% (N=135) from formalin solution with regard to following species: *Musca domestica*, *Geocoris bullatus*, *Solenopsis invicta*, *Lasius interjects*, *Lasius alienus, Lasius niger, Crysopa* spp., *Theridion pierre, Nabis americoferus, Chironomus* spp., *Chironomus tuberculatus, Atrecus macrocephalus, Bembidion semipunctatum, Neivamyrmex nigrescens* and *Neivamyrmex opacithorax* – whereas, in sugar solution, it was recorded 7.32% (N=86) consisting of *Geocoris bullatus, Geocoris megacephalus, Solenopsis invicta, Lasius interjects, Crysopa* spp., *Theridion pierre, Hippasa holomerae, Chironomus* spp., *Atrecus macrocephalus, Atrecus americanus, Bembidion semipunctatum, Neivamyrmex harrisii, Neivamyrmex nigrescens.*

From the total of recorded population, 5.82% (N=94) was recorded as parasites/predators from formalin solution pertaining to following species*: Drosophila funebris, Drosophila hydei, Drosophila demipolita and Amiota alboguttata* – whereas, population density of parasites/ predators among sugar solution were recorded least 4.00% (N=47) and that population was consisting of: *Drosophila funebris, Drosophila transversa, Drosophila subobscura, Drosophila hydei*, *Amiota alboguttata*.

Parasite population was recorded upto 13.5% (N=218) from formalin solution pertaining to following taxa: *Culex pipiens, Cacoxenus indigator, Culex erraticus, Anopheles gambiae, Anopheles quadrimaculatus, Anopheles mansoniini, Anopheles mansoniini, Gonatocerus ashmeasdi, Eutettix variabilis, Scaphytopius californiensis, Scolopostethus tropicus, Graminella nigrifrons, Agalliota constricta and Coelidia olitoria* – from sugar solution, it was recorded as 18.14% (N=213) and that population was consisting of *Culex pipiens, Culiseta annulata, Cacoxenus indigator, Culex erraticus, Culex modesta, Anopheles gambiae, Anopheles quadrimaculatus, Anopheles mansoniini, Anopheles atropervus, Gonatocerus ashmeasdi, Eutettix variabilis, Scaphytopius californiensis, Scolopostethus tropicus* and *Graminella nigrifrons.*

From the total of recorded population, 0.43% (N=07) was recorded as herbivores from formalin solution pertaining to following taxa: *Plagiodera versicolora, Calliphora vicina* and *Calomela iopter* – whereas their population from sugar solution was recorded least 0.08% (N=01) pertaining to *Plagiodera versicolora.*

From the total of recorded population, only 01 specimen was recorded as parastioids from formalin pertaining to *Bracon* spp.and no representative was recorded from sugar solution; wherein 1.87% (N=22) specimens was recorded as fungivors from sugar solution pertaining to *Ahasverus advena* and from formalin, their population was recorded upto 0.74% (N=12) pertaining to *Ahasverus advena* and *Pinophilus gracilis*.

However, from the total of recorded population, 4.08% (N=66) was recorded as scavengers formalin solution pertaining to following taxa: *Labarrus lividus***,** *Aphodius reyi reitter***,** *Aphodius granaries***,** *Crossidius suturalis***,** *Elodes minuta***,** *Germarostes aphodiodies***,** *Philothermus glabriculus***,** *Camponotus fallax***,** *Camponotus fragilis***,** *Acrodulecera* spp.**,** *Anxipha exiqua***,** *Ahasverus adven* and *Pinophilus gracilis* – whereas, their population from sugar solution was recorded upto 4.68% (N=55) and that population was consisting of *Labarrus lividus***,** *Aphodius reyi reitter***,** *Aphodius granaries***,** *Philothermus glabriculus***,** *Camponotus fragilis* and *Acrodulecera* spp.

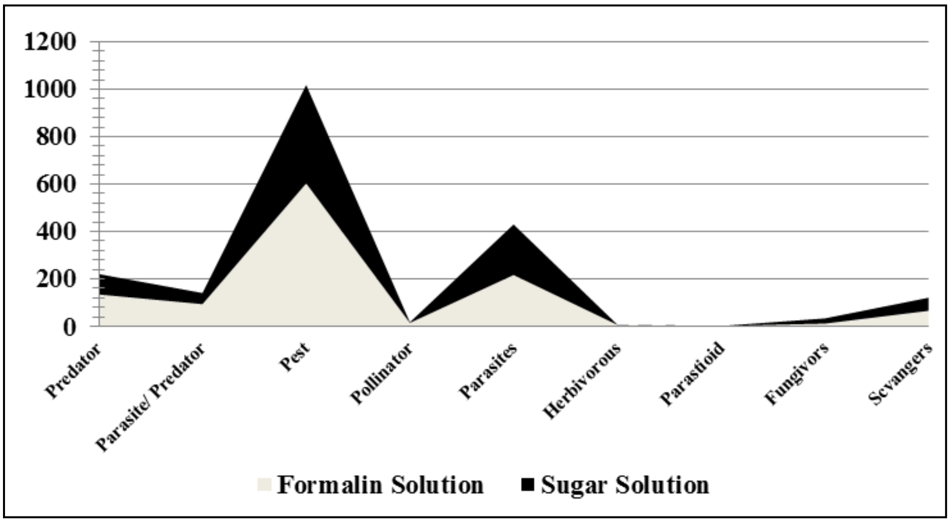

Fig 3: Trophic Structure

Hence, from the overall results and discussion, it is quite obvious that our findings are an acknowledgement with the previous researchers but urbanization territory induced depart situation for various insects' that vary case to case [32, 25, 1, 34, 35, 36, 17].

Conclusions

It is concluded from the present study that invertebrates inhabit urbanization variably than other areas of this biosphere and community should be aware about their ecological role on earth planet, so that they try to conserve them in residential areas. Fear and hunches about various species should also be share with them to decrease their obstacles regarding their conservation and to safeguard their life stages in in-situ conditions.

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