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Hymenoptera Family Diversity and Abundance in Kumhari Village's Leafy Vegetable Crop, Drug

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ABSTRACT:
Put Your Order in The Hymenoptera class of insects is important because it contains species that are good for the environment, economy, and agriculture. They also act as indicators of the environment. Hymenopteran parasitoids have the potential to act as bio-control agents in farming environments. Bumblebees, honey bees, and ants are among the efficient pollinators. Studying the diversity and distribution of organisms is necessary for biodiversity conservation. In Kumhari village, Durg District, Chhattisgarh, the biological diversity of hymenopteran families in green cultivars was examined in the current study. The study was conducted between January 2022 to December 2022. The study discovered that the area was home to fifteen species and four groups of Hymenoptera. A total of 303 insects were sampled throughout the inquiry. The Formicidae family was the most common in the study area. It was also found that Vespidae, Apidae, and Tenthredinidae were dominant in the green vegetable fields. The ideal light intensity, humidity, and temperature were present during the hymenopteran insect's life cycle from September to march, as indicated by the results, which also showed that evenness and the Shannon index were much elevated. Summer, the first half of the year, was characterized by comparatively low population and variety.

Keywords:
Parasitoids, Ants, Shannon-Wiener Index, Species Richness, Simpson's Index of Diversity, Kumhari Village

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INTRODUCTION

As a source of nutrients for humans, vegetables are valuable commodities. Foliated numerous vegetables, such as palak, lal bhaji, and cholai bhaji, have been grown. Vegetables are becoming more and more popular. The analysis of biological markers, which aid in our understanding of biodiversity, sheds light on the significance of vegetable biotas and their regulation. (Pearce and Venier, 2006; Maleque et al., 2009).

The ecology of leafy vegetable fields is the main focus of research on the biodiversity of insects. ((Kwon *et al*., 2013; Lee and Kwon, 2014; Lee *et al*., 2014). As key markers of semi-urbanization's impact on biodiversity, insects may sense changes in the number and quality of their habitats, as well as changes in management strategies associated with semi-urbanization. (Clarke *et al*. 2008; Jaganmohan *et al*. 2012). In semi urban ecosystems, insects perform critical roles in pollination, soil aeration, organic matter decomposition, and nutrient cycling (Thompson, and McLachlan, 2007). Although arthropod species such as ant and aesthetic are prevalent in semi-urban habitats, little is known about their distribution (Yamaguchi 2005, Waite *et al* 2012). Major Green areas of urban vegetable fields or residual woods have often been the subject of most studies on urban biodiversity (Oleyar *et al*. (2008); Khera *et al*. (2009). Nonetheless, a growing body of studies indicates that even in places with a moderate population density, modest, dispersed habitats—like leafy vegetable fields, community gardens, green roofs, and backyard gardens—can sustain abundant biodiversity (Jaganmohan *et al*. (2012), Matteson *et al*. (2010), and McIvor and Lundholm (2011).

Nearly every environment contains some kind of insect life, and the distribution of each type of bug is governed by factors such as habitat, population density, and insect biology. Every organism's population in an ecosystem varies from time to time, and the ecosystem that is made up of that population and its physical surroundings also changes and expands throughout time (Rizali *et al*.2002). Agro ecosystems are less diverse in terms of biotic and genetic elements than natural ecosystems. Because of human activity, especially those of ecosystem managers, agro ecosystems are inherently unstable and constantly undergo change. A number of interconnected variables influence variations in the variety of ecosystem types, including: i) a long-lasting ecosystem contains a greater variety of species than one that was recently formed because communities diversify throughout time. ii) The variety of space; the plant and fauna communities is more complex in physically diverse environments. iii) Competition, which arises when many species utilize an identical source. iv) Predation is the mechanism that keeps populations of rival species stable. Reduced species variety might result from predator intensity that is either too high or too low. v) Climate stability: An environment's diversity increases with the degree of stability in its salinity, pH, humidity, and temperature. vi) For a high degree of diversity, productivity may also be a prerequisite.

The interaction between these variables determines the species diversity among various communities (Firmansyah 2008). In agriculture, naturally, there will always be pests and their natural enemies. The latter play important roles as beneficial elements of the ecosystem (Power 2010). Environmental management is critical to preserving the variety and productivity of insect communities in a crop and preventing insect pests while maintaining beneficial insects in an agro-ecosystem (Lohaus *et al*., 2013). Additionally, the physical and nonphysical environmental conditions of vegetable fields change, which has an impact on the variety of insects that live there. Research on the variety of insects in vegetable producing regions is thus required.It is common to find Hymenoptera in a variety of agricultural areas, woodlands, and other locations where these insects may find food, such vegetable gardens and floral plants. Apocrita and Symphyta are the two sub-orders that make up the Hymenoptera order. (Pedigo & Rice, 2006.Nurhikmah, 2020). Plant pests are not as frequently categorized as leaf insects belonging to the Suborder Symphyta. Parasites make up the majority of the suborder Apocrita (Kalshoven, 1981). There are 8423 living genera in the order Hymenoptera, along with 685 extinct genera, 2 suborders, 27 superfamilies, and 132 families. . Among the insect orders with the highest species richness, there are 153088 extant species that have been described, and 2429 extinct species. (Aguiar *et al.* (2013)). Compared to the aculeate group, the Hymenoptera parasitika group was found to be more diversified (84%) and numerous (96%) than the latter. Ikhsan *et al*. (2020) found that the structure of the agricultural landscape and the diversity of habitats may have an impact on the distribution, richness, and diversity of parasitic Hymenoptera taxa in the Cianjur watershed. Hymenoptera parasitika is impacted by the age of the vegetable plants and the habitat conditions around agricultural fields (blocks) (Herlina *et al*, 2011).

There were fourteen families of parasitoids: Platygastroidea, Pipunculidae, Eulopideae, Vespidae, Diapriidae, Chalcidoidea, Bethylidae, Braconidae, Ichneumonidae, and Lygaeidae.(Rosa and Mariana 2012). One of the primary pollinators of agricultural plants is the hymenoptera, which includes bees and wasps (Widhiono, 2015). The family of insects that includes honeybees and wasps helps produce syrup and wax, blooming plants, and keeping pests away that damage plants (Pedigo & Rice, 2006). Due to their vast population, quick generation time, excellent mobility, and exceptional ability to adapt to changes in their environment, hymenopteran fauna provides the most accurate indication of insect activity. (Kwon *et al*. (2014); Lee and Kwon (2012); Kwon *et al.* (2014).

MATERIAL AND METHOD

Experiment location

The study was conducted between January 2022 to December 2022 in leafy vegetable farms in Kumhari Village, Durg District, Chhattisgarh.

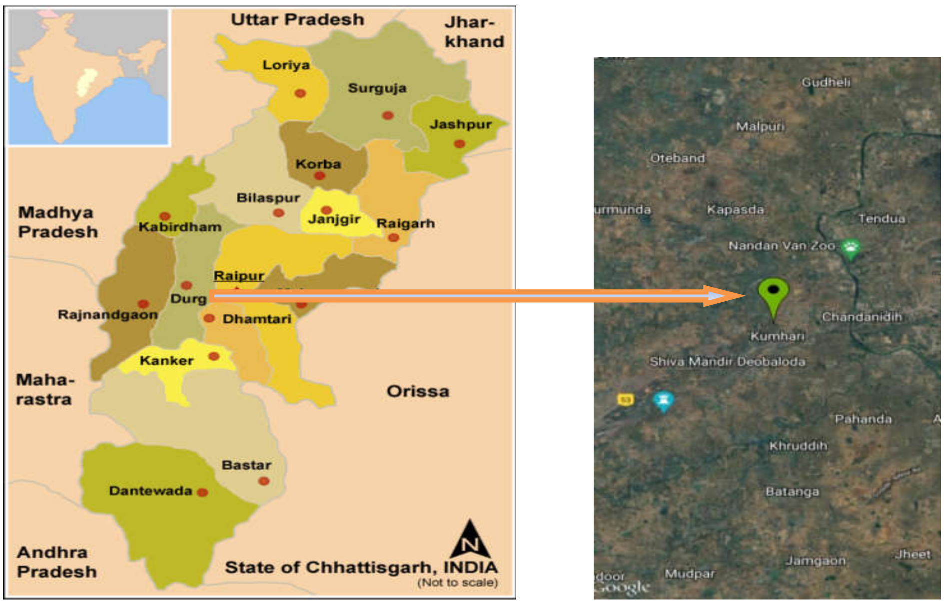

Figure 1: The picture of data collection area of kumhari leafy vegetable fields in Drug, District of Chhattisgarh.

Data for the current study are gathered using a quantitative descriptive technique. In particular, green vegetable monoculture fields like those growing palk, lal, and cholai are the sites of field studies. We used an altered procedure from to collect insect samples. (Masfiyah *et al.*, 2014).

Data collection methods

Approximately 284 meters above sea level are the locations of these vegetable crops. A diagonal line was used to methodically define five sample plots, each measuring 10 by 10 m2, and five rows of plants were examined in each vegetable field with green foliage. Using a pitfall trap and an insect swing net, manually selected insects were sampled. To gather every bug on the sample plot, hand picking was done (Zahoor *et al.,* 2003). In the meantime, insects present in the plant area were gathered using an insect swing net (a sweep sample technique) (Gadakar *et al.*, 1990). The net, which resembles a cone, is constructed from gauze, and its mouth is structured like a quadrangular frame with a circumference of thirty centimetres. The randomly selected plots were walked upon, and the net was swept twenty times in each direction, in order to get samples from each unique plot. (Hendrival & Ali, 2011). An earth-immersed container with a surface parallel to the ground and contents of water and detergent was used to create a pitfall trap. An interval of one week was observed between each of the eight sample occasions. We looked at crop age, farmer-applied pesticides, and environmental factors surrounding the spot. After collection, the creatures were placed in jars containing seventy percent alcohol to aid in documenting.With photographs, the Insect Identifier app (version 1.0.12) identified the insects. Following the orderly separation of the acquired insects, species-level identification was conducted using the identification keys of (Triplehorn & Jhonson, 2005, Kalshoven, 1981).

Data analysis

Place in order as a collection of species with economic, ecological, and agricultural value, the Hymenoptera is a significant member of the class Insecta. Additionally, they serve as ecological indicators. Agents of bio control in agriculture might be hymenopteran parasitoids. Bees: Bumblebees, honey bees, and ants are excellent pollinators. Prerequisite research for the protection of biodiversity is the diversity and distribution of animals. In this study, green vegetable crops in Kumhari village, Durg District, Chhattisgarh, were used to examine the biological variety of hymenopteran families.

i) The following algorithm was utilized to determine the percentage abundance of each taxon in the survey region :

Percent abundance =No. of species ÷ total no of species×100

ii) To find the diversity index, the Shannon-Wiener (H') formula was applied. (Brower *et al.*1990):

$H' = -\Sigma\, pi \ln pi$

Whereas

The Shannon-Weiner index is H',

pi is ni/N,

The total population of a species is represented by ni.

N is the total number of members in every species.

The diversity index is composed on these criteria:

Low diversity is indicated by $H' \leq 1$.

A diversity of $1 < H' \leq 3$ is considered moderate.

High variety is indicated by $H' \geq 3$.

iii) An insect community's evenness index (E) indicates how many individuals of different sizes are present; The ecological system is predicted to be healthier the more evenly distributed individuals there are among the species.

Index of Shannon-Evenness (E) = H'/ln S

Details:

E: Shannon-Evenness index

H': The Shannon-Wiener Diversity Measure

S: The whole species

The homogeneity index ranges in value from zero to one. Furthermore, the evenness index based on Kreb (1989) falls into the following categories:

A depressed community is indicated by $0 < E \leq 0.5$.

A community is unstable if 0.5

A stable community is indicated by 0.75

The population homogeneity is also less the lower the evenness index is. It demonstrates that there is a propensity for one species to dominate since the distribution of individual numbers within each species is not identical. The more similar or hardly different the biota numbers are within each species, the higher the uniformity score.

iv) Applying the Simpson formula to the Dominance Index (D) (Brower *et al*., 1990):

(D) = Σ (pi) 2 pi = ni.ni/N is Simpson's Dominance Index.

Details:

D: The Index of Dominance
pi: Each species' share of the total samples
ni: The quantity of individuals in every species
N: The overall count of people apprehended

In the following categories, index values vary from 0 to 1:

If $0 < D < 0.5$, then the dominance value is low.
If D is less than 0.75, then there is moderate dominance
If $0.75 < D \leq 1, 0$, then dominance is high.

RESULTS AND DISCUSSION

Distribution of taxa and population size

Four families and fourteen species of hymenopteran orders make up the 303 total insect individuals found in the research region for agricultural ecosystems, which are ecological green vegetables with varying fields. The sources of the insects were verdant agricultural environments. (Table 1.)

Table 1: Diversity and Abundance of hymenopteran in leafy vegetable Field, kumhari, Drug

S. No.	Family	Name	Common Name	occurrence	% abundance of family	collection
	Vespidae	*Vespa cincta sp.* *Vespidae velutina sp.* *Monobia quadridens sp.*	greater banded hornet Asian hornet four-toothed mason wasp	27 24 28	26.07	NT
	Apidae	*Lepidotrigona arcifera sp.* *Trigona fuliviventris sp.*	Cockerell culo-de-vaca	24 18	13.83	NT
	Tenthredinidae	*Athalia rosae sp.* *Eutomostethus ephippium sp.* *Rhogogaster sp*	Turnip Sawfly Sattelblattwespe Comman wasfly	26 21 28	24.75	NT,PT

	Formicidae	*Oecophylla smargdina sp.*	Weaver ant	14	35.31	NT,PT
		Tapinomini sp.	Dolichoderinae ants	17		
		Tapinoma sessile sp.	odorous house ant	19		
		Lasius niger sp.	Black garden ant	18		
		Monomorium minimum (Buckley) sp.	Little black ant	19		
		Camponotus compressus sp.	Common black ant	20		
Total species: 14						
Total Individual: 303						

Percentage of Abundance of Hymenopteran insects

Fig. 1 displays the % abundance of hymenopterans in green vegetable crops. The Foemicidae family's observed hymenopteran order percent abundance was 35.31, which was considerably greater than the percentage abundances of the Vespidae (26.07) and Tenthredinidae (24.75) families. On the other hand, the Apidae family had the lowest percent abundance (13.83).

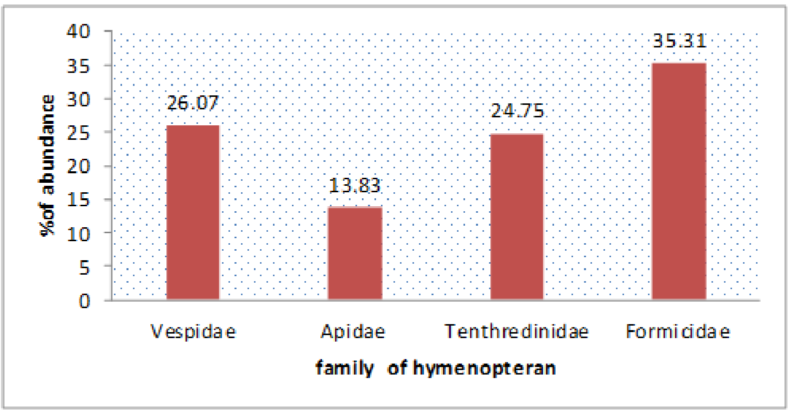

Figure 1: % of Abundance of Hymenopteran family in leafy vegetable field, Kumhari

Occurrence of hymenteran family's in leafy vegetable field of kumhari during year (month wise).

Table 1 lists the 14 species and 4 groups of hymenopteran insects that were studied in this study. The observations and specimens gathered indicate that from January to December, insects were prevalent in various mounts. All sessions included individuals of the Formicidae family, however, these indivisuals viability peaked in January, February, and December and decreased in May, June, and July due to unfavorable abiotic factors like humidity, temperature, and food sustainability. The individual was highly active in the first half year (March) and the second half year (December), and it was not seen in the months of May, June, and July, along with the tenthredinidae family. Because of the right combination of temperature, humidity, and light intensity, Apidae family insects demonstrated foraging from December to February, whereas Vespidae family insects had their highest activity from February to March.shown the (fig. 2).

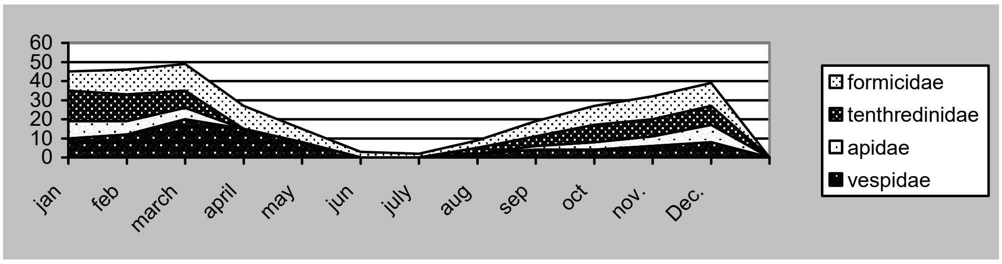

Figure 2: Month wise occurrence pattern of hymenopteran family in leafy vegetable Field of Kumhari, Durg.

(a.) Diversity index of Shannon-wiener (H')

The diversity index (H') characterizes the species richness of a location. The diversity of a system will be lower the fewer species there are and the fewer individuals there are in each species as the variance in the quantity of individuals per variety determines the value of the diversity index. The diversity index study's findings included a range of variety index values in (Table 2, Figure 3), with a total diversity index of 2.61 for hymenopteran insects in green vegetable fields. An agricultural community's evenness in a vegetable field is influenced by its variety value. In the leafy vegetable field of Kumhari, gathered insects from the hymenopteran diversity index value show that the biota community of these insects is diversified, with no dominant biota species. This is represented by the diversity index (H') of hymenopterans. The distribution of hymenopterans in the Kumhari vegetable field ranges from 0.68 (Apidae) to 1.78 (Formicidae), indicating a considerable variety (one < H'≤ 3). Vegetable fields' high and low diversity values (H') are determined by the ecosystem's production. The value of diversity is determined by variations in the extent of hymenopteran species found in vegetable fields. (Ulfah *et al.*, 2018, Setiawan *et al.,* 2017).

(b.) Shannon-Evenness's Index (E)

The evenness index, or evenness (E), indicates how many individuals of different sizes are found in an insect community. An ecosystem is better balanced when its members are dispersed more equally among species. The overall evenness index for insects in Kumhari's green vegetable fields is 0.992. This displayed the evenness index's third category. Because a stable society is indicated by an evenness index of 0.75<0.992<1. The values of the Shannon-Evenness's Index (E) vary from 0.985 (apidae) to 0.998 (vespidae) in Table 2. The each species evenness value showed the 0.75 <E ≤ 1 category its means the more similar or hardly different the biota numbers are within each species, the higher the uniformity score.

(c.) Simpson's Index of Dominance (D)

The overall number of members and the distribution of those members among themselves both affect the outcome of the Simpson dominance index, which has a range of 0 to 1. The Simpson dominance index value decreases as the community's membership grows and as its population becomes more evenly distributed. There is no discernible dominance of one or more community members, as shown by the dominance index's lower value. (Magurran (1991)). In leafy vegetable fields, the values of the dominance index (D) varied from 0.338 (Tenthredinidae) to 0.033 (vaspidae), with a total dominance index of 0.074 (Table 2, Figure 3).

Table 2: For hymenopteran insects gathered from the leafy vegetable field of Kumhari, Drug, there are three different markers of diversity: Shannon-Wiener (H'), Shannon-Evenness's (E), and Simpson's Dominance (D)

S. No.	Family	Shannon-wiener diversity index (H′)	Shannon-Evenness's Index (E)	Simpson's Dominance Index (D)
1.	Vespidae	1.097	0.998	0.0335
2.	Apidae	0.683	0.985	0.51
3.	Tenthredinidae	1.092	0.994	0.338
4.	Formicidae	1.786	0.997	0.169

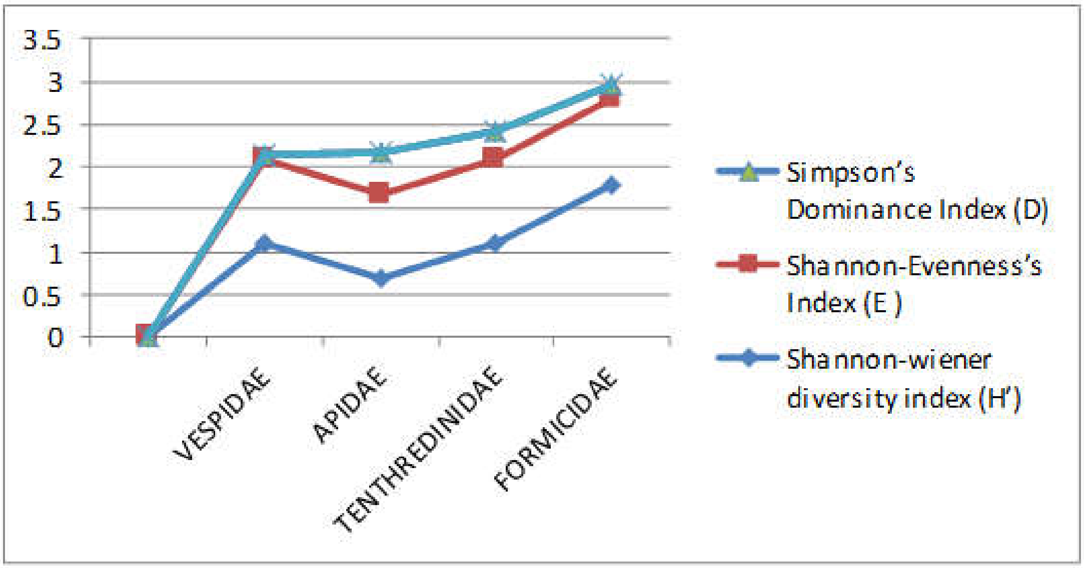

Figure 3: This graph connected to the Shannon-wiener diversity index (H'), Shannon-Evenness's index (E), and Simpson's dominance index (D) for hymenopteran insects was collected from a leafy vegetable field in Kumhari,

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