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Seasonal Dynamics in Arthropod Assemblages on *Ricinus communis* (Family: Euphorbiaceae) and *Calotropis procera* (Family: Apocynaceae): Diversity, Richness, and Evenness

Verma Rakhi[1], Samuel Raina Nivedita[1] and Samuel Joy Nivedita[2]*

[1]Department of Zoology, St. Andrew`s College, Gorakhpur 273001, Uttar Pradesh, India
[2]Department of Zoology, Sunbeam Women's College, Varuna, Varanasi 221005, Uttar Pradesh, India

**Corresponding Author*

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Abstract: This study examines seasonal variations in arthropod assemblages associated with *Ricinus communis* and *Calotropis procera*, focusing on floral and extrafloral visitors. We analyzed diversity, richness, and evenness using the Simpson Index of Diversity (1-D), Shannon-Wiener Index (H), Margalef's Index, and Pielou's Evenness Index across spring, rainy, and winter seasons.

For *R. communis*, floral visitor diversity exhibited significant seasonal fluctuations. The Simpson Index for floral visitors was highest in winter (0.7295) and lowest in the rainy season, where indices dropped to zero due to minimal visitation. Conversely, extrafloral visitors showed highest diversity in winter (0.8324) and lowest in the rainy season (0.6282). Seasonal variation in species richness was observed, with winter supporting higher richness for both floral (4.3692) and extrafloral visitors (5.6377) compared to spring and rainy seasons. The species evenness for floral visitors remained relatively high across seasons, whereas extrafloral evenness decreased in the rainy season. In *C. procera*, the floral visitors' Simpson Index peaked in spring (0.7841) and declined in the rainy season (0.5436), reflecting the highest diversity in spring. The Shannon Index mirrored this trend, with spring showing the greatest diversity (1.9674). Species richness was also highest in spring (5.8211), with a notable decrease during the rainy season. For extrafloral visitors, the Simpson Index of Diversity was highest in winter (0.8786) and lowest in the rainy season (0.6911), with the Shannon Index showing a similar pattern. Our findings highlight that both *R. communis* and *C. procera* attract diverse arthropod assemblages, with significant seasonal variations. *C. procera* supports a higher arthropod diversity, particularly in spring, compared to *R. communis*. Both plants demonstrate a marked seasonal shift in arthropod composition, emphasizing the dynamic role of plant-pollinator interactions and the importance of seasonal ecological patterns in maintaining herbivore-predator balances.

Keywords: Diversity indices, Arthropod assemblage, Seasonal variations, Floral and extrafloral visitors

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Introduction

Arthropods are the most abundant group of invertebrates on the earth and have co-existed with plant since time immemorial and are involved in a wide variety of interactions (Whitney and Glover, 2013). Pollination, dispersal and protection are some of the insect-mediated services derived by plants, while many species of insects use various plant-parts for food, shelter and/or for oviposition. Many plant-visiting insects inflict damage through herbivory which adversely affects the overall growth and productivity of plants (Lucas-Barbosa, 2016). Therefore, plants have evolved a diverse range of direct and indirect defensive mechanisms by interacting with insects (such as the predators), occupying the third trophic level in order to cope with the herbivores, occupying the second trophic level (Waterman *et al*., 2019).

Calatropis procera (Aitom) WT Aiton (Family: Apocynaceae) commonly known as 'sodom's apple' or 'giant milkweed' and *Ricinus communis* L. (Family: Euphorbiaceae) commonly known as 'castor bean' are naturally growing, flowering plants mostly native to tropics and inhabit a wide range of habitats. They are of great medicinal value and are widely used in traditional system of medicine. *C. procera* is a multipurpose plant, which provides a wide range of ecosystem services. It has been widely used in traditional medicinal system in North Africa, Middle –East Asia, South Asia and South –East Asia (Al Sulaibi *et al*., 2020). *R. communis* L. (Family: Euphorbiaceae) is a naturally growing as well as cultivated plant mostly grown for its oil seeds. It grows wild in varied climatic conditions and is used in traditional medicine such as, abdominal disorder, arthritis, backache and sciatica, chronic headache etc. (Chouhan *et al*., 2021).

C. procera has great potential to endure stress caused by roadside pollutants and contaminated soil (Khalid *et al*., 2018). The flowers of C*. procera* are produced throughout the year and are pollinated by bees and butterflies (Al Sulaibi *et al*., 2020). It also attracts a wide variety of arthropods and its faunal diversity has been reported to include insects belonging to Orders Hemiptera, Coleoptera, Hymenoptera and Orthoptera (Kaur *et al*., 2021). It is a major host plants of many species of *Danaus* butterflies including monarch butterfly *Danaus plexippus* which bypass all host defences to feed up on this plant (Fernandes *et al*., 2020).

R. communis is a myrmecophylic plant species which has specialized extrafloral nectaries producing extrafloral nectar that serves to attract predatory insects, which in return protect plant tissues against herbivores. Nectar is an energy rich substance secreted by glands situated at the base of flowers (floral nectar, FN) or in other parts such as leaves, stems, rachis, etc. (Extrafloral Nectar, EFN) (Shah *et al*., 2016); while FN attracts pollinating insects EFN attracts aggressive ants and other mutualists, which in turn provide antiherbivore protection to plants (Marazzi *et al*., 2013).

The present study aims at exploring the seasonal variations in arthropod assemblage by determining species richness, abundance and diversity of arthropod visitors on the plants *C. procera* and *R. communis,* as these plants thrive throughout the year and a great variety of visiting arthropods can be observed all the year round. We also intend to identify their ecological contributions with respect to insect –plant interactions. This study provides some preliminary observations regarding changes in arthropod assemblage patterns in different seasons on these two plants, which would obviously affect the biotic interactions among different tropic levels and have a marked effect on plant fitness.

Materials and Methods

The study pertaining to seasonal dynamics of arthropod assemblages on *C. procera* and *R. communis* was carried out at St. Andrew`s College Campus, Gorakhpur, Uttar Pradesh, India for three consecutive years from 2021 to 2023. Both plants grow wild in the area and flourish round the year in good number, attract a great variety of arthropod visitors and therefore, furnish suitable material to study plant specific seasonal variations in arthropod abundance and diversity. The range of day temperature in spring, winter and rainy season lies between 15^{0}C to 35 ^{0}C, 12^{0}C to 22^{0}C, and 32^{0}C to 35^{0}C, respectively. Our study area receives good amount of rain fall between July to September thus rainy season is extremely humid, while relative humidity ranges between 45%to 60% in springs and 60% to 70% in winters.

In order to study the variations in arthropod assemblage in different seasons twenty plants of *R. communis* and *C. procera* were randomly selected and tagged to record the presence of different species of arthropods visiting the plants. The composition of arthropod assemblage was determined at two levels i.e. at floral and extra floral levels and visual scan method was adopted to determine the visitors for both the levels. Any arthropod which approached the flower and remained there for a few seconds was regarded as floral visitor while the arthropods which were found resting or moving or foraging on plant parts other than flowers were regarded as extrafloral visitors. Observations and collection were made in spring (February to April), rainy (July to September) and winter (October - December) seasons to find out the diversity of arthropod species on tagged plants thrice a week, three times a day i.e. in the morning, afternoon and evening from February 2021 to December 2023. Each plant was inspected thoroughly and the presence of arthropods was carefully recorded, the flying insects were collected using sweep nets while others by hand picking method. Collected samples were transferred to the killing bottles with chloroform and brought into the laboratory for preservation and identification at the Department of Zoology, St. Andrew`s College, Gorakhpur. Based on their functional role arthropods were assigned to one of four guilds: herbivores, floral visitors/potential pollinators, predators and parasitoids.

In the present program of investigation seasonal variations in arthropod assemblage in terms of diversity, abundance, richness and evenness of arthropod species (floral and extrafloral visitors) on *R. communis* and *C. procera* in spring, winter and rainy seasons in the study area has been estimated by calculating Simpson index, Simpson index of diversity, Shannon index, Margalef’s index and Evennes index(e)/Pielou’s Index using MS Excel.

Shannon-Weiner entropy (H)=-Σ_i^s =1Pi’In Pi

Simpson Index (D)=$\sum_{i=1}^{s} P\ i2$

Simpson Index of Diversity= (1-D)

Richness Index of species by Margalef = S-1/In N

Evenness(e)- H/Hmax,

Where, n=Number of insects species, N= Total no of insects in sample, Pi’= (n/N), In= natural log, S=Total number of species, e=evenness index, H= Shannon-Weiner Index, Hmax is the maximum possible value of H, equal to Hmax = In(S),

Results and Discussion

The results regarding seasonal variations in arthropod assemblage on *R. communis* during the study period is shown in Table 1 and that of *C. procera* is shown in Table 2. The overall arthropod assemblage in case of *R. communis* consists of 28 species, belonging to 20 families of 7 Orders of Class Insecta (Hymenoptera: Formicidae, Vespidae, Ichneumonidae; Lepidoptera: Nymphalidae, Papilionidae; Hemiptera: Aphididae, Cicadellidae, Aleyrodidae, Scutelleridae; Coleoptera: Chrysomelidae, Curculionidae, Coccinellidae; Orthoptera: Tettigoniidae; Diptera: Sepsidae, Calliphoridae, Rhiniidae, Tipulidae, Dolichopodidae, and Mantodea: Mantidae, Hymenopodidae) and one Arachnid family i.e. Salticidae while the overall arthropod assemblage on *C. procera* recorded during the period of study consisted of 50 species belonging to 31 families of 7 Orders of Class Insecta (Hymenoptera: Formicidae, Scoliidae, Apidae, Halticidae, Chrysididae, Sphecidae, Vespidae; Lepidoptera: Nymphalidae, Papillionidae, Lycaenidae,

Table 1: Floral and extra floral visitor species recorded on *Ricinus communis* in spring, winter and rainy season (Mean±SE)

S. No.	Class	Order	Family	Species	Foraging on	Summer (Mean±SE)	Winter (Mean±SE)	Rainy season (Mean±SE)
1	Insecta	Hymenoptera	Formicidae	*Tapinoma melanocephalum*	EFN	6.17±0.84	0	6.17±0.71
2				*Componotus compressus*	EFN	1.49±0.18	0.99±0.15	1.43±0.18
3				*Componotus refugluacus*	EFN	1.33±0.18	0.30±0.09	0
4				*Lasius niger*	EFN	0	0.42±0.12	0
5			Vespidae	*Polistinae*	Predator	0.25±0.07	0	0.57±0.08
6			Ichneumonidae	*Xanthopimpla punctata*	Parasitoid	0.21±0.06	0	0
7		Lepidoptera	Nymphalidae	*Ariadne merion*	Floral visitor	0.50±0.08	0.67±0.11	0.37±0.07
8			Papilionidae	*Graphium doson*	Floral visitor	0.19±0.05	0	0
9			Nymphalidae	*Junonia almana*	Floral visitor	0.20±0.05	0	0
10		Diptera	Sepsidae	*Sepsis fulgens*	Floral visitor	0	0.72±0.20	0
11			Calliphoridae	*Chrysomya megacephala*	Floral visitor	0	0.24±0.07	0
12			Rhiniidae	*Stomorhina obsoleta*	Floral visitor	0	0.80±0.12	0
13			Tipulidae	*Tipuloidea*	Floral visitor	0	0.05±0.02	0
14			Dolichopodidae	*Dolichopus*	Predator	0.34±0.09	0	0.43±0.09
15		Hemiptera	Cicadellidae	*Empoasca flavescens*	Herbivore	1.18±0.17	0.75±0.18	0.73±0.13
16			Aleyrodidae	*Trialeurodes vaporariorum*	Herbivore	1.10±0.20	0	0
17			Aphididae	*Cannabis aphid*	Herbivore	0	1.84±0.54	0
18			Scutelleridae	*Solenosthedium liligerum*	Herbivore	0.18±0.05	0	0.69±0.11
19		Orthoptera	Tettigoniidae	*Tettigonia viridissima*	Herbivore	0	0.15±0.05	0
20		Coleoptera	Coccinellidae	*Cheilomenes sexmaulata*	Predator	0.96±0.11	0	0
21				*Coccinella setempunctata*	Predator	0.24±0.07	0	0
22			Curculionidae	*Naupactus cervinus*	Herbivore	0.26±0.07	0	0.56±0.10
23				Altica spp.	Herbivore	0	0.14±0.04	0
24			Chrysomelidae	*Cassida viridis*	Herbivore	0	0.30±0.07	0
25		Mantodea	Mantidae	*Stagmomantis carolina*	Predator	0.19±0.05	0	0
26			Hymenopodidae	*Odontomantis planiceps*	Predator	0	0.17±0.05	0.02±0.05
27	Arachnida	Araneae	Salticidae	*Telamonia dimidiata*	Predator	0.18±0.05	0.16±0.04	0
28				*Phintella vittata*	Predator	0	0.62±0.09	0

Scythridae; Hemiptera: Aphididae, Berytidae, Lygaeidae, Pentatomidae, Pseudococcidae, Reduviidae, Coreidae, Derbidae, Scutelleridae, Aphrophoridae; Coleoptera: Chrysomelidae, Coccinellidae; Diptera: Calliphoridae, Sarcophagidae, Syrphidae, Dolichopodidae, Bibionidae; Neuroptera: Hemerobiidae and Mantodea: Mantidae, Hymenopodidae) and three Arachnid families - Oxyopidae, Salticidae and Thomisidae.

The plants *R. communis* and *C. procera* show a great deal of seasonal variations in arthropod assemblage in terms of diversity and abundance - during spring, rainy and winter seasons which has been estimated by calculating Simpson index of diversity (1 - D) and Shannon index (H) while species richness is estimated by determining Margalef's index and species evenness by Evenness index(e)/Pielou's Index at both floral and extrafloral levels separately and are shown in Tables 3 and 4.

In case of *R. communis* the flower visitors exhibit a marked seasonal variation in all the four indices computed as shown in Table 3. In the spring season for floral visitors, the value of Simpson index of Diversity (1-D) has been calculated as 0.5888 whereas in winter season it is 0.7295.The value of the Shannon- Weiner index H for floral visitors is in spring season 0.9898, in winter the value of H is 1.3851 showing significant diversity of arthropods in both the seasons. Species richness was estimated by calculating Margalef's index that was found in case of floral visitors as 0.2944 in the spring and 4.3692 in the winter seasons, respectively. Species evenness was estimated by calculating Evenness index(e)/Pielou's Index which is in case of floral visitor in spring is 0.9009 and in winter is 0.8605. There is striking decline in floral visitors during rainy season as only a sole species was observed dropping the calculated indices to zero.

The various indices of species diversity, abundance, richness and evenness for the extrafloral visitors on *R. communis* also exhibit seasonal variations as shown in Table 3. The value of Simpson index of Diversity (1-D) has been calculated as 0.7607 in spring season, 0.8324 in winter season, and 0.6282 in the rainy season. The value of the Shannon index H in spring is 1.8981, in winter it is 2.0511 and value of H in rainy season is 1.4058. Species richness was estimated by calculating Margalef's index that was found to be 4.9411 in the spring, 5.6377 in the winter and 2.9617 in the rainy seasons. Species evenness was estimated by calculating Evenness index(e)/ Pielou's Index which is in case of extrafloral visitor in spring is 0.7192, winter 0.8553 and in rainy season it is 0.6761.

For *C. procera* Simpson index of Diversity (1-D) for floral visitors is 0.784058 in the spring season while in winter and rainy season it is 0.709424 and 0.543603, respectively. This shows highest diversity of arthropod floral visitors in spring followed by that in winter and lowest floral visitor diversity in rainy season. The Shannon index H for floral visitors in spring is 1.96738 which is highest, in winter it is 1.5019 and in rainy season 1.12108 also showing significant diversity of insect in all the three seasons. Species richness was estimated by calculating Margalef's index that was found to be 5.82106 in the spring, 4.757402 in the winter and 2.83984 in rainy season which is highest in spring followed by winter season and lowest in rainy season. Species evenness for floral visitors on *Calotropis procera* was estimated by calculating Evenness index(e)/Pielou's Index which is in spring 0.709, winter 0. 683 and in rainy season it is 0.696.

Arthropod assemblage of extrafloral visitors on *C. procera* comprises of herbivores and predators and the value of Simpson index of Diversity (1-D) has been calculated to be 0.857882 in spring and in the winter season it is 0.8786 and in rainy season it is 0.691095 (Table 4). The value of Shannon index in spring is 2.47688, while in winter and rainy season it is 0.1019 and 1.56569, respectively showing highest diversity in spring followed by that of rainy and winter season. Species richness for extra floral visitors was estimated by calculating Margalef's index that was found to be 8.009875 in spring, 1.358266 in

Table 2: Floral and extra floral visitor species recorded on *Calotropis procera* in summer, winter and rainy season (mean±SE)

S.No.	Class	Order	Family	Species	Foraging on	Spring	Winter	Rainy season
						Mean±SE	Mean±SE	Mean±SE
1	Insecta	Hymenoptera	Formicidae	*Tapinoma melanocephalum*	Floral visitor	5.01±0.34	2.66±0.18	2.66±0.18
2				*Componotus parius*	Floral visitor	2.91±0.03	0.71±0.01	0.39±0.01
3				*Campsomeriella collaris*	Floral visitor	0.23±0.01	0	0
4			Apidae	*Apis florea*	Floral visitor	1.11±0.01	0	0
5				*Xylocopa fenestrate*	Floral visitor	0.16±0.01	0	0
6				*Xylocopa sulcatipes*	Floral visitor	0.19±0.01	0	0
7				*Xylocopa pubscens*	Floral visitor	0.18±0.01	0	0
8			Halticidae	*Nomia melanderi*	Floral visitor	0.11±0.01	0.11±0.01	0
9			Chrysididae	*Emerald wasp*	Floral visitor	0.17±0.01	0	0
10			Sphecidae	*Podalonia tydei*	Floral visitor	0.33±0.01	0	0
11			Vespidae	*Polistinae*	Predator	0.49±0.01	0.26±0.01	0
12		Lepidoptera	Nymphalidae	*Danaus chrysippus*	Floral visitor	0.96±0.01	0.76±0.02	0.23±0.01
13				*Ariadne merione*	Floral visitor	0	0.21±0.01	0
14			Papilionidae	*Graphium doson*	Floral visitor	0.38±0.01	0	0
15			Lycaenidae	*Chilades lajus*	Floral visitor	0.11±0.01	0	0
16			Scythridae	*Erectmocera impactelia*	Floral visitor	1.01±0.03	0.20±0.01	0.39±0.01
17		Diptera	Calliphoridae	*Stomorhina lunata*	Floral visitor	0.10±0.01	0	0
18				*Chrysomya megacephala*	Floral visitor	0	0.21±0.01	0
19			Sarcophagidae	*Sarcophaga carneria*	Floral visitor	0.15±0.01	0.28±0.01	0.40±0.01
20			Syrphidae	*Episyrphus balteatus*	Floral visitor	0	0.20±0.01	0
21			Dolichopodidae	*Dolichopus*	Predator	0.29±0.01	0	0
22			Bibionidae	*Plecia nearctica*	Predator	0.12±0.01	0	0
23		Hemiptera	Aphididae	*Aphis nerii*	Herbivore	3.89±0.03	170.50±0.69	0
24			Berytidae	*Berytidae*	Herbivore	0.20±0.01	0	0
25			Lygaeidae	*Spilostethus pandurus*	Herbivore	1.54±0.02	0	0
26				*S. hospes*	Herbivore	0.91±0.01	0	0.23±0.01
27			Pentatomidae	*Palamena prasina*	Herbivore	0	0	0.11±0.01
28				*Eysarcoris guttiger*	Herbivore	0.18±0.01	0	0
29			Pseudococcidae	*Planococcus citri*	Herbivore	0.26±0.01	0	0
30			Reduviidae	*Zelus renardii*	Herbivore	0	0.17±0.01	0
31			Coreidae	*Leptoglossus chilensis*	Herbivore	0	0.17±0.01	0
32			Derbidae	*Proutista moesta*	Herbivore	0	0.12±0.01	0
33			Scutelleridae	*Solenosthedium liligerum*	Herbivore	0	0	0.23±0.01
34			Aphrophoridae	*Abidma refula*	Herbivore	0.22±0.01	0	0
35		Coleoptera	Chrysomelidae	*Chrsochus cobaltinus*	Herbivore	0	0	2.16±0.07
36				*Epilachna indica*	Herbivore	0.17±0.01	0	0
37			Coccinellidae	*Coccinella magnifica*	Predator	0.57±0.01	0	0
38				*C. setempunctata*	Predator	0.20±0.01	0	0
39				*C.undecipunctata*	Predator	0.57±0.01	0	0
40				*Cheilomenes sexmaculata*	Predator	0.92±0.01	0	0
41				*Harmonia axyridis*	Predator	0.11±0.01	0	0
42		Neuroptera	Hemerobiidae	*Hemerobius*	Predator	0.29±0.01	0	0
43		Mantodea	Mantidae	*Stagmomantis californica*	Predator	0.29±0.01	0.26±0.01	0
44			Hymenopodidae	*Euantissa pulchara*	Predator	0	0	0.22±0.01
45	Arachnida	Araneae	Thomisidae	*Thomisus*	Predator	0.28±0.01	0	0
46			Oxyopidae	*Oxyopus salticus*	Predator	0.35±0.01	0	0
47			Salticidae	*Trite planicepes*	Predator	0	0	0.30±0.01
48				*Phintella vittata*	Predator	0	0	0.20±0.01
49				*Telamonia dimidiata*	Predator	0	0	0.73±0.01
50				*Telamonia festiva*	Predator	0	0	0.23±0.01

winter and 4.849741 in the rainy seasons. Species evenness was estimated by calculating Evenness index(e)/Pielou's Index which is in case of extrafloral visitor in spring 0.813, winter 0. 049 and in rainy season it is 0.7529.

Our study related to seasonal variations in arthropod assemblages clearly demonstrated that both plants *C.procera* and *R. communis* attract a wide spectrum of arthropod visitors throughout the year but there exists a marked difference in the composition of assemblage with the change in season. In *C. procera* highest arthropod assemblage is found in springs at both floral and extra floral levels as compared to winter and rainy seasons. In spring season species richness is highest as 16 species of floral visitors were recorded while 7 species in winter and 4 species in rainy season were registered, these include ants, bees, wasps, butterflies, and true flies which feed up on the nectar of flower and may accomplish the pollination services. Of these, bees are regarded as pollinators while other species may be regarded as opportunists that merely exhaust the floral reward without providing pollination (Ali and Ali, 1989). In the same manner the extrafloral visitors also show high species richness in spring as 21 species of herbivores and predators do visit *C. procera* plant of which *Aphis nerii, Spilostethus pandurus, S. hospes* and *Cheilomenes sexmaculata* show highest representation among herbivores and predators, respectively. In winter season low species richness is recorded as only 4 herbivores and only one predator show their presence owing to this the number of aphid *Aphis nerii* is high during this period, which also greatly influences the species evenness during winter season. In rainy months 4 species of herbivores and 5 species of predators (one praying mantis and 4 spiders) were registered marking low species richness and diversity. Our study is akin to previous studies which reported *Aphis nerii*, *S. hospes* as chief herbivores of *C. procera* besides caterpillars of butterflies *Danus chrysippus, D. plexippus* (Chandra *et al*., 2011) (the larval stages of insects are not considered in this study). In our study the floral visitors which were consistently present in all the three seasons were ant species *Camponotus parious, Tapinoma melanocephalum* and butterfly *Danus chrysippus.*

Floral and extrafloral arthropod assemblage on *R. communis* comprised of ants, wasps, butterflies, flies, bugs, beetles, katydid, praying mantis and spiders out of which only butterflies and dipteran flies visit flowers while all others were confound to extrafloral parts. Bees which were previously reported as major pollinator of *R. communis* (Navatha and Sreedevi, 2012) could not register their presence in our study. Spring season and winter season recorded almost equal abundance as 3 floral visitors and 14 species of extrafloral visitors of which 4 herbivore, 6 predators, one parasitoid and 3 ant species were present in spring while winter season records 4 floral visitors including one butterfly and 3 flies and 13 extrafloral visitors including 3 arboreal ant species, 6 herbivores, and 4 predators. In rainy season the floral visitors are at their lowest as only one butterfly *Ariadne merion* is recorded to visit flowers, 8 extrafloral species of which 2 ants, 3 predators and 3 herbivores were present. Floral visitor *Ariadne merion* and Extrafloral visitor *Componotus compressus* and herbivore *Empoasca flavescens* are the most consistent visitors of *R. communis* which have registered their presence in all the three seasons during the study period. During flowering stage, the blooming flowers of plant *Ricinus communis* attracted flies and butterflies of which *Ariadne merione, Junonia almanac* (Nymphalidae), *Graphium doson* (Papilionidae) were found to be actively engaged in foraging activity on flowers. All the floral visitors foraged on nectar and pollen and exploited the floral food resources can be considered as potential pollinators.

In our study four ant species viz. *Tapinoma melanocephalum*, *Componotus compressus,* Lasiusniger and *Componotus rufoglaucus* were found to visit *Ricinus communis* and all of them were observed foraging on extrafloral plant parts which possess extrafloral nectarines but not on

Table 3: Diversity indices of arthropod assemblage of floral and extra floral visitors on *Ricinus communis* in spring, winter and rainy seasons

	Spring		Winter		Rainy season	
	Floral	**Extrafloral**	**Floral**	**Extrafloral**	**Floral**	**Extrafloral**
Margalef's index of species richness (SR)	0.2944	4.9411	4.3692	5.6377	0	2.9617
Simpson's index of diversity (1-D)	0.5888	0.7607	0.7295	0.8324	0	0.6282
Shannon-Wienner index(H)	0.9898	1.8981	1.3851	2.0511	0	1.4058
Evenness index(e)/Pielou's Index	0.9009	0.7192	0.8605	0.8553	0	0.6761

Table 4: Diversity indices of arthropod assemblage of floral and extra floral visitors on *Calotropis procera* in spring, winter and rainy seasons

	Spring		Winter		Rainy season	
	Floral	**Extrafloral**	**Floral**	**Extrafloral**	**Floral**	**Extrafloral**
Margalef index of species richness (SR)	5.8211	8.0098	4.7574	1.3582	2.8398	4.8497
Simpson's index of diversity (1-D)	0.7841	0.8578	0.7094	0.8786	0.5436	0.6910
Shannon-Wienner index(H)	1.9674	2.4768	1.5019	0.1019	1.1210	1.5656
Evennes index(e)/Pielou's Index	0.7195	0.8135	0.6835	0.0490	0.6965	0.7593

flowers. Extrafloral nectar is produced by many plants as a critical food source and protects the plants from herbivores (Trager *et al*., 2010). EFN glands are visited by a large variety of predatory insects such as – ants, wasps and parasitoids (Del-Claro *et al*., 2013) which often serves to increase both the predation and parasitism rates of herbivorous insects feeding on plants bearing EFN glands (Gentry, 2002). Thus, extrafloral nectaries attract ants and other carnivorous species and play an important role in plant defense against herbivores by providing nectar rewards.

One thing which very clearly stands out from our study that there exists a well-marked seasonal variation in composition of arthropod assemblages on both plant species under consideration. In different seasons both plant species invite different arthropods to accomplish their pollination services and maintain the herbivore-predator equilibrium.

Conclusion

The seasonal variations in arthropod assemblage on *C. procera* and *R. communis* reveal significant patterns in diversity and abundance. For *C. procera*, the highest diversity and richness of both floral and extrafloral visitors occur in the spring, with a notable decline in the rainy season. This pattern highlights the plant's role as a crucial resource for various arthropods, particularly in spring when the plant attracts a wide range of species including bees and butterflies that contribute to pollination. Conversely, *R. communis* demonstrates a more varied seasonal pattern, with spring hosting the highest number of extrafloral visitors and winter showing increased diversity among extrafloral species. The low diversity and richness during the rainy season for both plants indicate reduced arthropod activity and potential changes in plant-arthropod interactions in the season.

The findings underscore the ecological significance of seasonal changes in arthropod assemblages and their impact on plant-pollinator dynamics as well as inter-guild and intra-guild resource exploitation ability. The presence of specific species and their seasonal variations suggest adaptive responses to environmental conditions, affecting pollination efficiency and plant defense mechanisms. The study also highlights the role of extrafloral nectaries in attracting predatory insects that may help in controlling herbivore populations, thus enhancing the overall fitness of the plants. Understanding these dynamics is crucial for conserving plant-arthropod interactions and managing agricultural and natural ecosystems effectively.

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