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Plant-Firefly Interactions in Kanger Valley National Park, Chhattisgarh, India

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***Abstract*:** Fireflies are renowned for their bioluminescent capabilities and are often considered the jewels of nature. These tiny luminescent creatures play significant ecological, economic, cultural, and medical roles. This study explores the floral associations of fireflies, emphasizing their importance for conservation efforts. The research specifically examines firefly preferences between trees and smaller vegetation, as well as potential role as pollinators. Observations focused on two categories of plants: associate plants and display plants. The *Abscondita perplexa* firefly species was associated with 15 different floral families and showed preference for trees over smaller vegetation. Among the trees, the preference for Combretaceae and Dipterocarpaceae families was the highest. The fireflies exhibit a greater preference for non-flowering plants compared to flowering ones.

***Keywords*:** *Abscondita perplexa*, Plant-firefly, Kanger Valley National Park, Combretaceae, Dipterocarpaceae

Fireflies are nocturnal insects that belong to the family Lampyridae. These fascinating insects can be bioluminescent, a phenomenon resulting from a chemical reaction in the abdominal region. In this process, luciferin, in the presence of luciferase, reacts with oxygen to create light. Approximately 2,000 species of fireflies are found globally and inhabit diverse regions across the globe, including Asia, Europe, Africa, Australia, and the Pacific islands (Lewis et al., 2020). The primary function of the light produced by fireflies is communication and plays a crucial role in deterring potential predators (Zhu et al., 2024, Novák and Jakubec 2024). Fireflies gather around certain vegetation types, such as mangroves and display trees (Jusoh et al., 2010). Male fireflies use these trees for courtship, where they come together to form a synchronized display. The diversity and structure of plant life can significantly influence the behaviour of fireflies, the arrangement and size of leaves may impact the population levels of fireflies, and the density of leaves also influences courtship behaviour (Seri et al., 2022). Additionally, chemicals released by plants can affect firefly behaviour, underscoring vegetation's crucial role in shaping firefly populations (Seri and Rahman 2024). Vegetation influences mating behaviour, as males use light signals from prominent spots on plants to attract females. Healthy, diverse vegetation supports larger firefly populations, ensuring their persistence in various ecosystems. Approximately 530 plant species are Kanger Valley National Park were reported by Kotia et al. (2013). This study focuses on firefly species *Abscondita perplexa* (Walker 1858), interactions with its floral associates in the mixed deciduous forest of Kanger Valley National Park (KVNP), Bastar, Chhattisgarh. This research will possibly aid in uncovering species of fireflies, identifying hotspot areas and understanding the plant firefly interactions within Kanger Valley National Park.

MATERIAL AND METHODS

Study area: Kanger Valley National Park (18° 51' 57.60" N, 82° 09' 53.64" E), located in the Bastar district of Chhattisgarh, covering an area of 200 square kilometres. Approximately 50 villages border Kanger Valley National Park. The targeted study sites within the study area were selected randomly based on two habitat characteristics: woodland area and wetland area. A total of 11 sites (6 wetland and 5 woodland) were selected from 5 different ranges of KVNP (Fig. 1).

Data collection: The study commenced in December 2024, and the field survey was conducted until March 30, 2025. A sweeping net was employed to collect firefly specimens, while a Naivete LED headlamp and a rechargeable LED mini torch were used for nocturnal surveys. Field observations were documented using a Nikon Coolpix DSLR camera P950, and detailed images of the firefly specimens were captured with an Adcom 12X/24X macro lens.

Collection vials were utilized to store the specimens. The fireflies were preserved in 70% ethanol. GPS waypoint app was used to track locations and save the line transect data.

Digital microscope was used to visualize the dissected genitalia of fireflies for identification purposes.

Methodology: Stratified random line transect sampling was employed to evaluate the diversity and distribution of fireflies in KVNP (Fewster et al., 2005). This method ensures that various habitat types are included, and randomization eliminates bias in the selection of sampling sites.

The study area was initially divided into distinct strata based on habitat characteristics: woodland and wetland. Three line transects were randomly placed within each stratum, each measuring 250 meters long. To ensure independent sampling units, there was a gap of 300 meters between each line transect, allowing for a practical study of the site. During the observation of each line transect survey, the species of fireflies were recorded, their floral associations, and other parameters, including latitude, longitude, altitude, temperature, humidity, soil type, and moon phase for each transect was also recorded. During the observation of floral associates of fireflies, the vegetation was categorized into two groups: associate plants (AP) and display plants (DP). For the identification of the plant species the botanical literature and guide were used (Nanda and Shaw 2008, Khanna et al., 2024).

Associate plants include plants that adult fireflies and larvae prefer for perching, resting, and laying eggs. In contrast, display Plants are the plants that male fireflies typically use for courtship to attract female fireflies. Net Sampling was conducted in two portions: the lower vegetation, which includes grass, shrubs, and the lower branches of trees, and the mid-canopy, which refers to the middle portions of the trees. The sample size for each sampling unit was 10, with 5 samples collected from the lower vegetation and 5 samples from the mid-canopy. The net sweeping method (Jaikla et al., 2020) was employed in both habitats to capture fireflies for study effectively. As a result, a diverse collection of fireflies was obtained, facilitating further analysis of their distribution and behaviour. The visual count was used to count the number of fireflies in the field based on the flashes that can be observed easily (Yiu et al., 2024, Evans et al., 2019). The time for observing, counting, and collecting fireflies was from 6 PM to 9 PM, coinciding with the emergence of fireflies between 6:20 PM and 6:40 PM, while their disappearance occurred from 7:30 PM to 9 PM.

Data analysis: R programming was used for the analysis. A Chi-square test will investigate the preferences of fireflies between different tree species and plants, contributing to a deeper understanding of their habitat selection and ecological interactions. In addition, calculating the median firefly counts will provide insights into their preferences for flowering versus non-flowering plants. Another chi-square test analysis, focusing on comparing fireflies' preferences for distinct plant categories, such as Display plants (DP) and Associated plants (AP), was performed.

RESULTS AND DISCUSSION

Fifteen plant families have been recorded in association with fireflies. The top four families include Combretaceae, Dipterocarpaceae, Asteraceae and Sapindaceae being 41.15, 14.90, 10.26, and 10.62%, respectively (Fig. 2).

The fireflies prefer trees over smaller plants, such as herbs and shrubs (Fig. 3). This can be due to wide shelter, broader leaves to hide, and tall enough so that male fireflies can perform courtship display. The mean and median values for the occurrence of fireflies in flowering and non-flowering plants indicated significant disparity between the mean and median values for both types of plants, with the median being

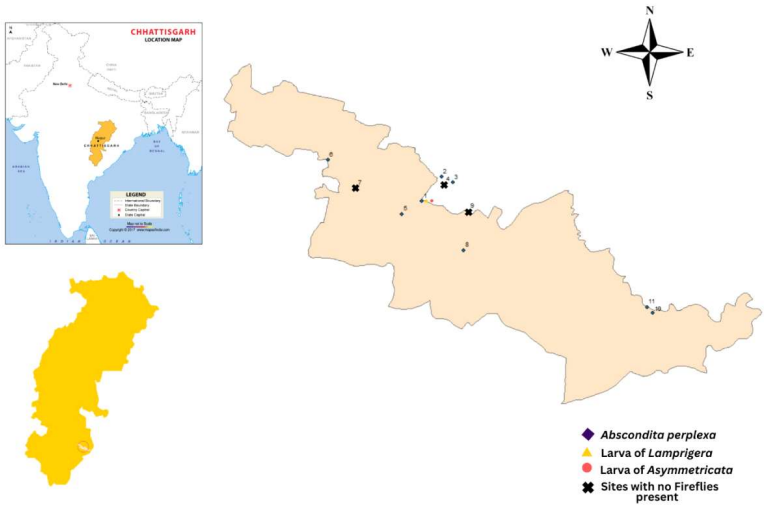

Fig. 1. Kanger Valley National Park with the study sites

lower than the mean (Fig. 4). This suggests that the data is not normally distributed and is right-skewed. Consequently, the median is a more appropriate measure for understanding firefly preferences. The median indicates that fireflies show a greater preference for non-flowering plants compared to flowering plants. To investigate whether fireflies have a preference for non-flowering plants over flowering ones, a Mann-Whitney U test was conducted. The calculated U minimum was 6, which is smaller than the critical value of 7 which indicates a significant difference in the preferences of fireflies for flowering versus non-flowering plants, leading us to reject the null hypothesis. Thus, based on the median values, can be concluded that fireflies prefer non-flowering plants over flowering ones. Chi-square test was conducted to assess the fireflies' preference for display plants (DP) versus associated plants (AP). The fireflies exhibit a stronger association with display plants compared to associated Plants. The higher number of males than females using a display plant for courtship likely stems from competition among males for the limited female population. Males often

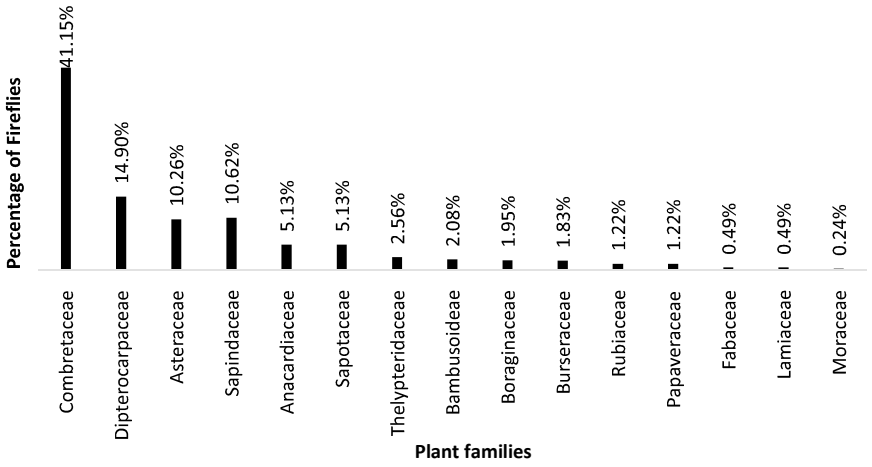

Fig. 2. Occurrence of fireflies in different floras

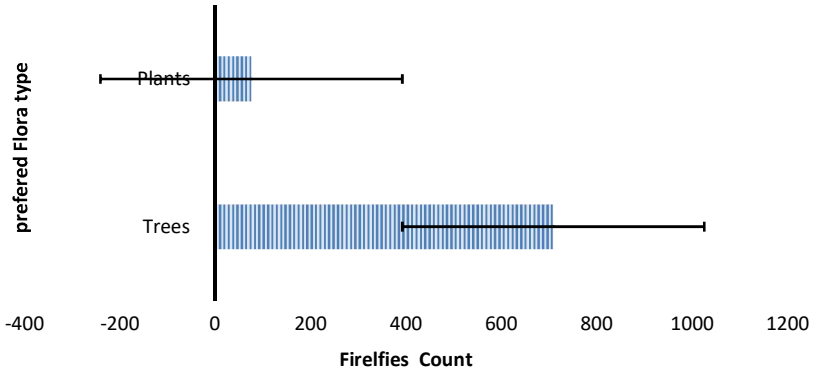

Fig. 3. Fireflies preference for trees and smaller vegetation's

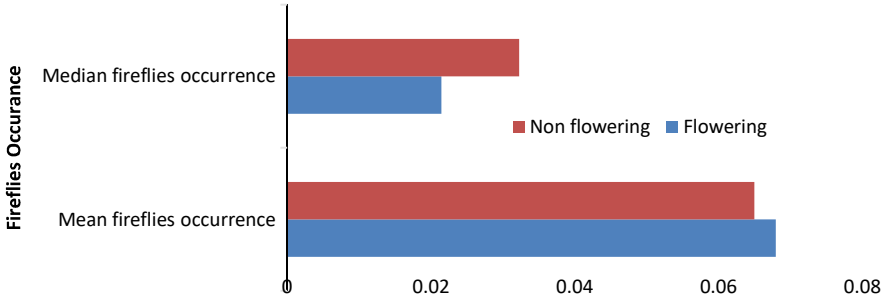

Fig. 4. Comparison of firefly preferences for flowering vs non-flowering plants

utilise these plants to showcase their traits and attract mates. This behaviour is influenced by evolutionary strategies that favour males displaying their fitness.

Additionally, environmental factors may contribute to a skewed gender ratio, further emphasizing the role of these display plants in mating dynamics. Fireflies are associated with a wide range of plants, mainly belonging to the families Combretaceae, Asteraceae, Dipterocarpaceae, and Sapindaceae, where their occurrence was highest.

When comparing flowering and non-flowering plants, fireflies favour non-flowering plants, suggesting that they are not significant pollinators. However, among flowering plants, the highest occurrence of fireflies has been observed in the Asteraceae family, which consists mainly of weeds. This indicates that fireflies may act as pollinators for these weeds. A higher number of fireflies occurs as display plants which signifies a greater number of active males. To comprehensively understand the bioecology of the fireflies in central India, future studies must incorporate a detailed analysis of abiotic environmental factors.

Table 1. GPS Location of study sites

Site ID	Range name	Latitude	Longitude
1	Nagalsar	18.864038°	81.971140°
2	Nagalsar	18.877927°	81.982376°
3	Nagalsar	18.874743°	81.988784°
4	Nagalsar	18.873435°	81.983960°
5	Darbha	18.856633°	81.959676°
6	Kotumsar	18.887568°	81.917359°
7	Kotumsar	18.871281°	81.933650°
8	Netanar	18.835859°	81.994980°
9	Netanar	18.858132°	81.997939°
10	Kolenge	18.800152°	82.103108°
11	Kolenge	18.803544°	82.099938°

Table 2. Plant families preferred as AP or DP

Plant family	AP	DP
Combretaceae	-	+
Asteraceae	+	-
Dipterocarpaceae	-	+
Sapindaceae	-	+
Anacardiaceae	-	+
Sapotaceae	-	+
Boraginaceae	-	+
Thelypteridaceae	-	+
Lamiaceae	+	-
Rubiaceae	-	+
papaveraceae	+	-
Bambusoideae	-	+
Burseraceae	-	+
Moraceae	-	+
Fabaceae	-	+

CONCLUSION

This study examines the interaction between plants and fireflies within Kanger Valley National Park. It reveals a clear preference among fireflies (*Abscondita perplexa*) for trees over smaller vegetation and for non-flowering plants over flowering ones. Among the diverse flora preferred by fireflies, the families Combretaceae and Dipterocarpaceae stand out with the highest preference. The findings also indicate that while fireflies are not significant pollinators, they do assist in the pollination of certain weed species, notably within the Asteraceae family. These insights strongly emphasize the importance of conserving habitats rich in flora for the protection of firefly populations.

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