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Cover: Himalayan Gray Langur *Semnopithecus ajax* (adult female) © Rupali Thakur.



Firefly survey: adopting citizen science approach to record the status of flashing beetles

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Abstract: Fireflies are magnificent beetles, under the family Lampyridae (order Coleoptera). They form an exceptional part of a natural landscape. However, natural firefly populations are threatened by several stressors, predominantly driven by anthropogenic development. Evaluation of firefly abundance through counts of their flashes provides an insight into the good health of the ecosystem, which could be easily observed and recorded by citizen scientists. On the occasion of World Firefly Day (3–4 July 2021), a firefly counting survey was conducted to record their occurrence, by engaging people from all over India, using the online platform. A datasheet with appropriate questions was prepared; barcodes and links were generated for the people. Through the survey, we received suitable participation and fitting data from 14 states of India—Uttar Pradesh, Uttarakhand, Rajasthan, Gujarat, Maharashtra, Madhya Pradesh, Odisha, Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, West Bengal, Assam, and Ladakh. The total number of fireflies that were observed from all these states together was more than 26,000. Through the present study, significant data on fireflies occurrence have been recorded from various parts of the country. In addition to this, we get an understanding of using this citizen science approach on a bigger spectrum for varieties of projects and an effortless system of educating people.

Keywords: Anthropogenic development, beetles, bioindicators, bioluminescence, citizen scientists, ecosystem, Lampyridae, watch, World Firefly Day.

Citizen science is an approach of engaging non-technical people in gathering information, used by scientists to investigate research problems (Bonney et al. 2009). With this method of data collection, immense information could be gathered, and this could lead to a larger database (Trumbull et al. 2000).

Fireflies are known for showcasing the astonishing property of bioluminescence. The encounter with these charismatic beetles, left behind beautiful memories in people of all ages (Ho et al. 2009). Many people show interest and curiosity to know about their bioluminescent phenomena. There are several citizen science projects on fireflies in the USA, which worked successfully (Chow et al. 2014). Scientists have used this approach for the evaluation of many insects population around the world. But in India, we still lack these kinds of practices. There are more than 2,000 species of fireflies all over the world (Lewis 2016). They provide conspecific light signals for mating and predation (Lewis & Crastely 2008), and being holometabolous their life cycle completes in four different life stages namely- egg, larva, pupa, and

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adult. Unlike adults, the larva is a well-known predator of our garden pests like snails and slugs, and other small invertebrates, hence work as biocontrol agent and maintain the health of an ecosystem (Bogahawatta 2009). Other than this, fireflies are considered a flagship species, their conservation can also lead to the conservation of other flora and fauna sharing the same habitat (Fallon et al. 2019).

However, their population is declining (Lewis et al. 2020). Recently, 18 species of fireflies were characterized as threatened as per IUCN Red list (Fallon et al. 2021). Fireflies are not only important for our ecosystem but also play an appreciable role in boosting the economy (Lewis et al. 2021). As in countries like the USA, Malaysia, Thailand, and Mexico, they have set up firefly parks and sanctuaries for conservation purposes, which provides livelihood to the local people and helps in generating funds (Lewis et al. 2021). Not only in these countries but also in India we have places like Purushwadi, Bhandardara in Ahmednagar district of Maharashtra, where they have camping sites along with firefly trails. However, such practices make fireflies susceptible to numerous tourism-associated threats. But with proper training programs for guides, conserving the much needed habitats, and by local stakeholder involvement, these issues can be resolved (Lewis et al. 2021). Firefly populations are declining over the globe (Lewis et al. 2020; Chatragadda 2020), which attracted our attention and we came up with the citizen science approach as an appropriate tool for conducting the survey. We used the online platform to engage people in the survey. To address the importance of these magnificent beetles the whole world celebrates World Firefly Day on the 3–4 July every year. In 2021, the day was also celebrated in Dehradun (India) with an aim of generating information on fireflies occurrence from different areas of the country.

MATERIAL AND METHODS

The current study was a subset of a larger citizen science approach to assess occurrence reports of fireflies across various areas of the country. For this preliminary assessment an online survey on the occasion of World Firefly Day (3–4 July 2021) was conducted. For the event, a cover page was designed using MS PowerPoint with the theme of the event ‘firefly watch’ (Image 1). Datasheets (Image 2), two barcodes, and three links were generated using the software (ArcGIS Survey 123). One of the three links was for pinpointing the location in the dashboard so that exact coordinates of the fireflies sighting area could be extracted. Number of relevant questions were also

provided for the collection of the database (Image 2). All of these datasheets were circulated two days before the World Firefly Day, through personal contacts and also get uploaded on the website of the Wildlife Institute of India, Dehradun. In India, no study on fireflies has been done involving citizen scientists till date, there are no standardised protocol for doing such observations over the globe. However, a firefly watch project was organized in USA, which was solely based on the questionnaire and does not provide any standardised protocols useful for such citizen science programs. Thus, in this survey the participants were guided to observe the fireflies between 2000 h and 2200 h (peak time of sighting fireflies as per previous observation) around their nearby areas. The organizing team, covered the Kaduapani area of the Asharodi range in Dehradun district, Uttarakhand, India (30.288°N, 77.913°E) to observe the fireflies on the occasion, and in general in a 100-m walk they observed around 500 fireflies flying and flashing making it one of the potential areas to sight fireflies.

RESULTS

The data has been received from more than 71 individual sites from 14 different states of India. The total number of fireflies observed through the survey was more than 26,000 across the country. After analysing the numbers of fireflies from different regions of the country (Image 3), it was concluded that Makhala and Kolkas forest areas of Amravati district (Maharashtra), Kaduapani beat in Asharodi range (Uttarakhand), and Fulkamli village (West Bengal) were the most potential sites where fireflies were sighted in large numbers.

DISCUSSION

Over the world, there are several molecular and taxonomic studies on fireflies (Ballantyne & McLean 1970; Ballantyne et al. 2019). However, in India there is not much attention has been given to these beetles till date, which makes it data deficient, although, there are some studies related to the bioluminescence emission of fireflies from Guwahati (Barua et al. 2007). A study on the declining population of the genus *Abscondita* from Barrankula village of Andhra Pradesh (Chatragadda 2020), and a study discussing the records of two new species of subfamily Luciolinae has been found for the first time in India (Ghosh et al. 2020). But still, these studies are not enough and there is a lot more scope for evaluating firefly diversity and abundance throughout the country. Thus, this study aimed to generate preliminary information regarding their occurrence, across several observing areas from all over the country



Image 1. Cover page for World Firefly Day.

Image 2. Datasheets provided for the survey through online channels.

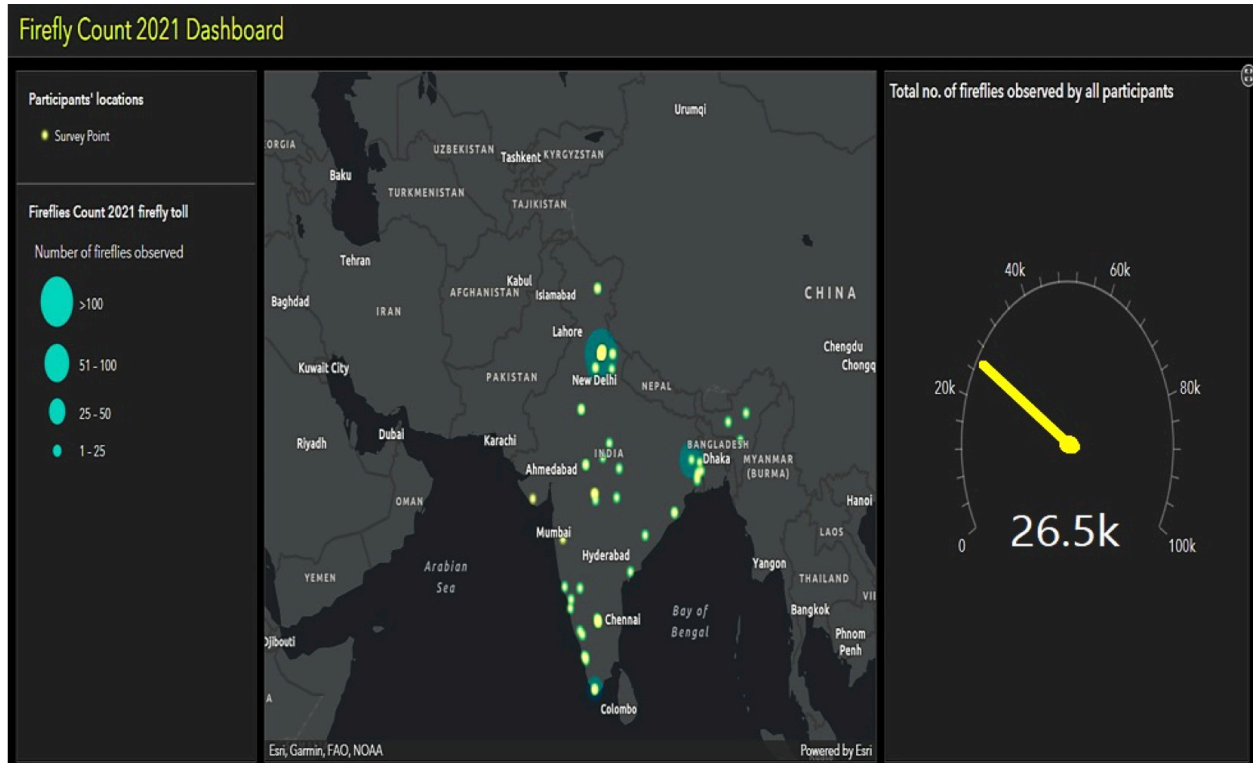


Image 3. Dashboard representing the abundance of fireflies from different surveyed areas.

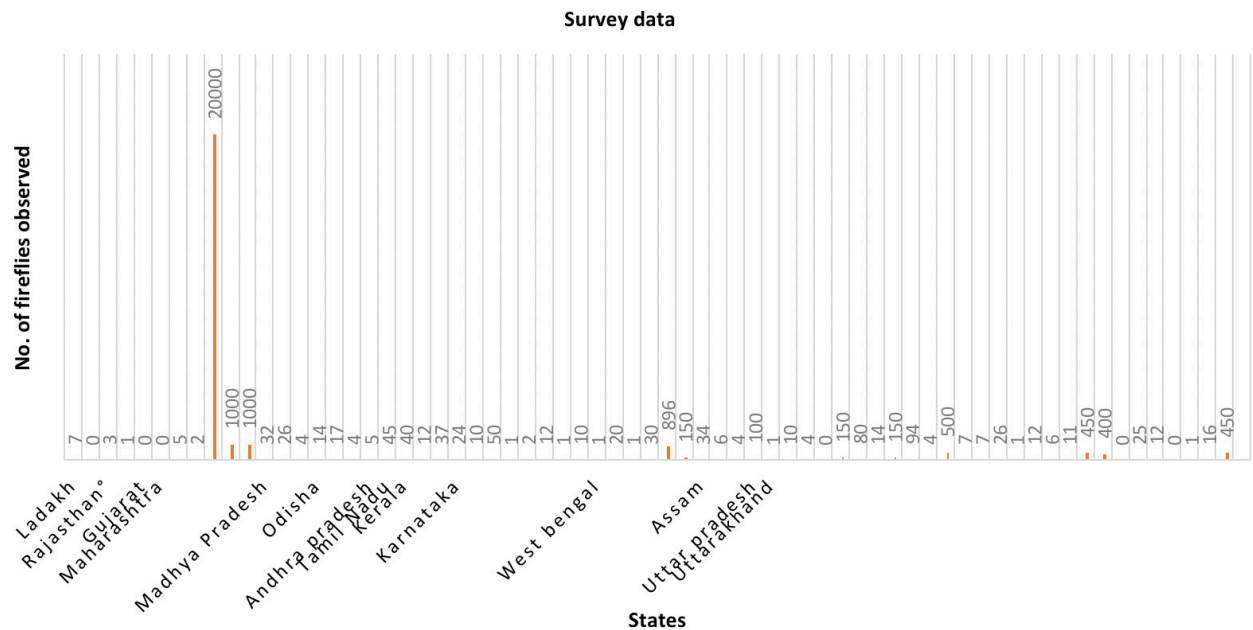


Figure 1. Bar graph representing the number of fireflies observed from different states.

through the citizen science program. But, as we did not receive data from half of the states, further projects and surveys by engaging people from all over the country

must be developed to have an estimate of the status of fireflies. The citizen science approach will also help in escalating awareness among people.

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