Butterfly Identification App (BIA): A mobile application for identification and monitoring of butterflies in the state of Karnataka

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Abstract

Butterflies attract the attention of everyone, but it is difficult to identify and know their names instantly. Even for the students and researchers, identifying them in the field itself necessitates capturing and referring field guides. A novel mobile application known as Butterfly Identification App (BIA) has been developed by Environmental Management and Policy Research Institute EMPRI, Bengaluru, India to identify butterflies in the field. It is a colour-based identification application, which can be used by anyone having an android mobile phone. It is not necessary to capture the butterflies but photos taken can be compared with the photos in the colour based groups in the BIA database. The identification of all butterflies reported from Karnataka is possible through the BIA. The usage of this by proficient taxonomists, students and environmentalists can contribute to the monitoring and conservation of butterfly species in their localities. Pilot studies conducted in six green spaces in Bengaluru (12.9716° N, 77.5946° E) with GPS locations (Lalbhag: 12.9487,77.5887; Cubbon Park: 12.9798,77.5968; Doresanipalya: 12.8971,77.5905; IISc: 13.0173,77.5712; GKVK: 13.0808,77.5677; Bannerghatta: 12.785,77.5745) using the BIA is presented in the paper.

Keywords: Android mobile, Butterfly Identification App, EMPRI.

Introduction

According to Ghazoul (2002), about 19,238 species of butterflies have been documented from all over the world, which includes 1501 species from India (Kunte *et al.*, 1999). Ashish *et al.,* (2007) have reported 332 species from the Western Ghats. In Karnataka, about 323 species of butterflies have been recorded (Remadevi *et al.,* 2020) and around 140 species are found in Bengaluru alone

(Yates, 1933; Remadevi et al., 2018). Climate change and environmental degradation are indicated by butterflies. Butterflies react faster to ecological changes than birds and vascular plants (Thomas *et al*. 2004). They are important components in the food chain of birds, reptiles, spiders and predatory insects. They help in pollinating many economically important crops. The crucial information on the ecology of a particular region is provided by a faunistic survey of butterflies based on

their occurrence and characteristics (Ghazoul, 2002). In general, monitoring butterfly populations are considered an essential means of evaluating change in the ecosystem and also the state of habitation for biodiversity (Paul and Sultana, 2020). Van Swaay *et al*., (2012) stated that these trends contribute as an indicator of biodiversity status and to interpret the environmental change. Butterflies act as best bio-indicators for effect on climate change (Ghazanfar, et al., 2016). Since butterflies are one of the most eye-catching insects with various colour patterns, the identity of a butterfly could be mistaken.

Utilizing Information and Communication Technologies (ICT) in agriculture and economy can boost production in the shortest and fastest way (Nitin *et al.,* 2020). Smart phone technology helps in field for delivery of information. In contrast to printed publications, the information conveyed through the mobile application can be augmented, restructured, updated, and corrected repeatedly. For extension professionals in turf grass management, the development of application and the delivery of information through this technology present an invaluable, fast, accurate, new resource and delivery of information (McCullough *et al*., 2011).

Identification of butterflies using mobile applications is being practiced in many countries. Fox *et al*., (2015) through the scheme "Butterflies for the New Millennium (BNM)" which runs in partnership with the Biological Records Centre (part of the UK Centre for Ecology & Hydrology) surveys butterfly distributions across the UK. The BNM scheme uses smart mobile technology to aid and strengthen the recording of butterfly distribution. A free mobile app named "iRecord Butterflies" was developed and more than 10,000 users have started using this app since the launch of the app in 2014. Using the app, a butterfly surveyor/recorder can log and submit sightings as a single process and also make use of the built-in GPS facility in their mobile phone to automatically generate high-resolution grid references for their records. The app also acts as a simple identification guide to help new surveyors/recorders and guides them through the process of submitting butterfly records.

Andre Poremski (2019) developed a mobile app named "Leps" which is funded privately by Public Good Projects, United States. Leps was developed using image recognition technology to identify butterflies and moths (Lepidoptera) which is achievable with a photo, date and location of the species observed. The app uses a machine learning framework named "Fieldguide" to help identify the butterflies and moth. The "Butterfly Id" is a paid mobile app developed by Sunbird Images, Germany. This app is used to identify butterfly species very easily with available butterfly records created by professional ecologists. This app also provides information about the anatomy, ecology and

taxonomy of the butterflies. To aid in fast identification of the species, this app provides information about every butterfly's hind and forewings.

Shubhalaxmi *et al.* (2016) have developed a butterfly mobile app under the U.S. State Department's International Exchange Alumni programme. The mobile app characterizes 50 common Indian butterfly species with their images, common and scientific name, host plants and other related facts. Theivaprakasham Hari (2019) has developed an app called "Butterfly Vision" which helps in the identification of nearly 300 butterflies from the Western Ghats region. This app uses a machine learning technique to help identify butterflies in the field. This app was developed to exclusively engage school kids to identify butterflies and thus helps in the documentation of butterfly fauna with the adoption of technology. This app is linked with the website https://butterflyvision.in/ which also provides facility to upload the captured butterfly images and in return helps to identify the butterfly with similarity index using percentage.

The Nature Web's "Indian Butterflies" app is an offline mobile app which provides butterfly information along with the butterfly's regional names viz., Assamese, Bengali, Marathi, Malayalam and Tamil. "Indian Butterflies" app is easy to use as a field guide by providing information such as habitat, host plant, wingspan, sexual differences, etc. This

app is linked with http://www.indiabutterflies. com which acts as the butterfly repository. It also allows creating checklists of the on-field observations and can be further exported into CSV file.

1. Materials and Methods

Thus, BIA has been developed to identify the butterflies based on their major colour in the wings. This mobile app can be used for the continuous monitoring of butterflies in specific areas with the involvement of naturalists, officials from the forest department, eco clubs, school children etc.

1.1 Butterfly Identification Mobile Application (BIA)

For monitoring the diversity and the impact of climate change on butterflies in Karnataka, an android mobile app (BIA - butterfly identification app) was developed. BIA is extremely simple to use and. it can be downloaded into any android mobile and the information such as GPS of the location, name of the area, date and time along with the identified butterfly information reaches the BIA dashboard through the internet transfer protocols. The minimum requirement for the operating system to download the BIA is Android 5 Lollipop. BIA allows taking pictures of butterfly resting with open or closed wings in field conditions. BIA app would help in identifying nearly 300 butterfly species of Karnataka. In BIA, the butterflies of Karnataka, a state in south India are classified

based on their major colours like white, blue, yellow, orange, brown and black. Photo taken can be zoomed in and out and matched with details and image of the butterflies that are available in the BIA database, for identification. If the identification is confirmed, by pressing the SUBMIT button the information collected will be submitted to the database. In case the captured butterfly is not present in any of the colour code available, then the identification can be submitted as UNIDENTIFIED. Later this category will be checked and processed by the resource persons available at EMPRI to identify or add the new species into the BIA database.

1.1.1   Steps involved in using BIA app

1) Open the app and press the "Start" button

2) Notice the butterfly in the field and take photos of open / closed wings of a butterfly. Press the "Skip" button if the second photo cannot be taken

3) To acquire only the image of butterfly, crop the background

4) Notice the major colour in butterfly wings and press a similar colour button

5) Butterflies photos with chosen colour will be displayed below

6) Scroll, compare and match with the butterfly photo taken and the butterfly photo available from the database

7) Tap and zoom the photos to notice the wing patterns and read about wings description

8) After verifying the identification, press the SELECT button

9) Identified butterfly details will be displayed for further verification

10) Finally, press the SUBMIT button to send the identified butterfly data

1.2 BIA Dashboard

The identified/unidentified information about the butterflies sent from BIA such as the butterfly name and photos along with the geographical information fetched using the mobile phone's GPS system are transferred to the dashboard available at Karnataka State Climate Change Strategic Knowledge Portal (KSCCSKP) Link - http://skcccempri. karnataka.gov.in. The portal was developed under the Department of Science and Technology, DST-SPLICE funded project. The main objective of KSCCSKP is to disseminate information on climate change and related activities in the state of Karnataka. The dashboard is developed on the basis of 2-tier architecture using Laravel PHP and MYSQL software application. The dashboard displays various reports on identified butterflies based on the family, region and year-wise using pie charts and displays the butterfly name (scientific and common name) and geographical information. Fig.-2 represents the flow diagram of the complete butterfly identification process.

2. Results and discussion

The BIA app is intended for documenting the diversity in different seasons and has particularly been developed to be simple to use. A training workshop was conducted on how to use BIA android application to eco-club school teachers as a part of NGC activity at EMPRI on 2nd Feb 2019 and a pilot testing using BIA for the identification of butterflies at EMPRI campus was organized. As an outcome, 55 records were received until June 2019. Further, a presentation was provided to Karnataka districts teachers from eco-club schools through SATCOM (Satellite communication) and after that 42 records were received until October 2019. A pilot test study using BIA was made during winter seasons in 2019 and 2020 (October, November, December and January) in the 6 green spaces of Bangalore and a total of 69 species were recorded in different regions.

Fig. 1 depicts the total butterfly species found in different survey areas Doresanipalya has the highest number of species found with 22 per cent (69 species) followed by Bannerghatta with 21 per cent (68 species). IISc has 19 per cent (59 species) and GKVK has 18 per cent (58 species) of butterfly species. Lalbagh has the second least butterfly species with 12 per cent (39 species) and least is Cubbon Park with 8 per cent (26 species) of butterfly species.

Fig. 2 depicts butterfly families found in different survey regions. Nymphalidae is found to be dominant in all the study areas with 25 species in Doresanipalya and Bannerghatta and 9 species in Cubbon Park which is least among other areas. Lycaenidae is found to be second most dominant with 18 species in Doresanipalya and 17 species in Bannerghatta and least in Cubbon Park with 6 species. Pieridae and Papilionidae are moderate with 15 species in Bannerghatta and 8 species in Doresanipalya, GKVK and IISc respectively. Riodinidae is the least in Doresanipalya and Bannerghatta with one species whereas it is not found in the other four study areas. Hesperiidae is second least with 7 species in Doresanipalya and 4 species in Lalbagh and GKVK.

Conclusions

Over the past centuries, many researchers have significantly contributed to the field of butterfly diversity and ecology within the various ecosystems in India. Monitoring diversity in different geographical locations, integrating more than the conventional hotspots, makes it quite feasible to identify changes over an extensive range of habitations. This might provide an enhanced knowledge of the species associations in various vegetation categories. The phenological changes in plants due to climatic variability and changes in different areas is reflected in the diversity of butterflies in the area. A mobile application "Butterfly Identification Application (BIA)" is developed by EMPRI to achieve the dual purpose of helping butterfly field identification

effortlessly and receiving the butterfly diversity information for further studies of butterfly ecology in Karnataka in relation to climatic and environmental changes. BIA helps in easy identification of butterflies by anyone from anywhere in Karnataka. Currently, the app helps in the identification of 323 butterfly species reported from Karnataka. BIA can be downloaded in any Android mobile and the information such as GPS of the location, name of the area, date and time along with the identified butterfly information reaches the BIA dashboard through the internet transfer protocols. The BIA dashboard is developed using Laravel PHP and MYSQL for database and has linked to both EMPRI website and the Karnataka State Climate Change Strategic Knowledge Portal (KSCCSKP). This BIA dashboard developed for processing the butterfly data is hosted in Karnataka State Data centre (KSDC) and shall be accessible to everyone interested to know the butterfly information of the state. The link to the BIA dashboard is https://bmpempri.karnataka.gov.in/.
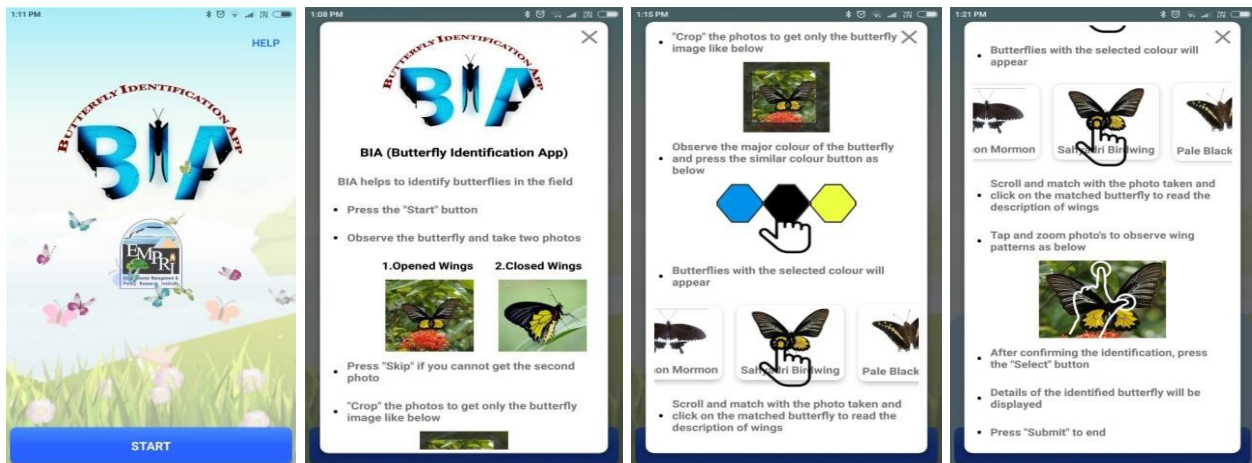

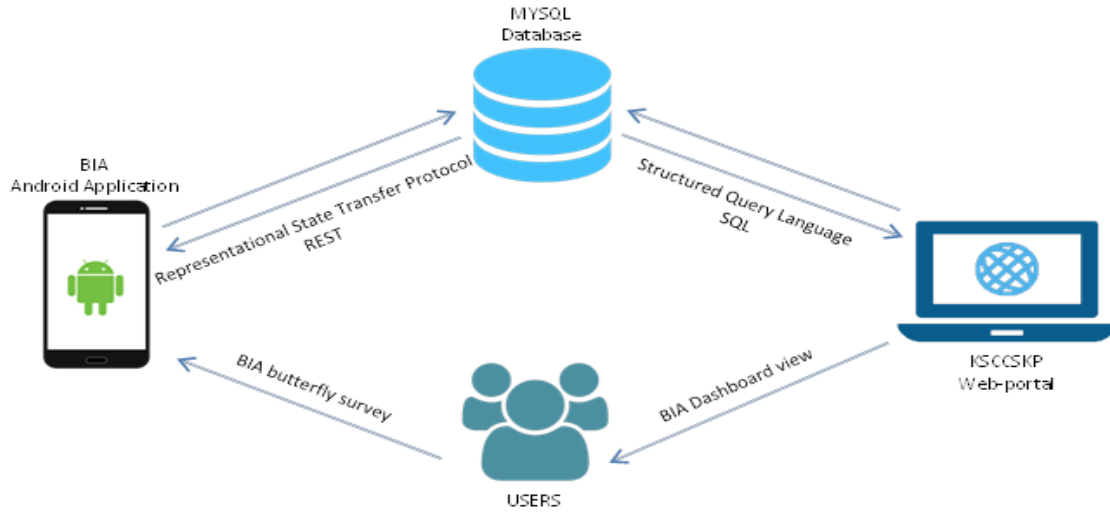**Fig. 1: Butterfly Identification Application screenshots**

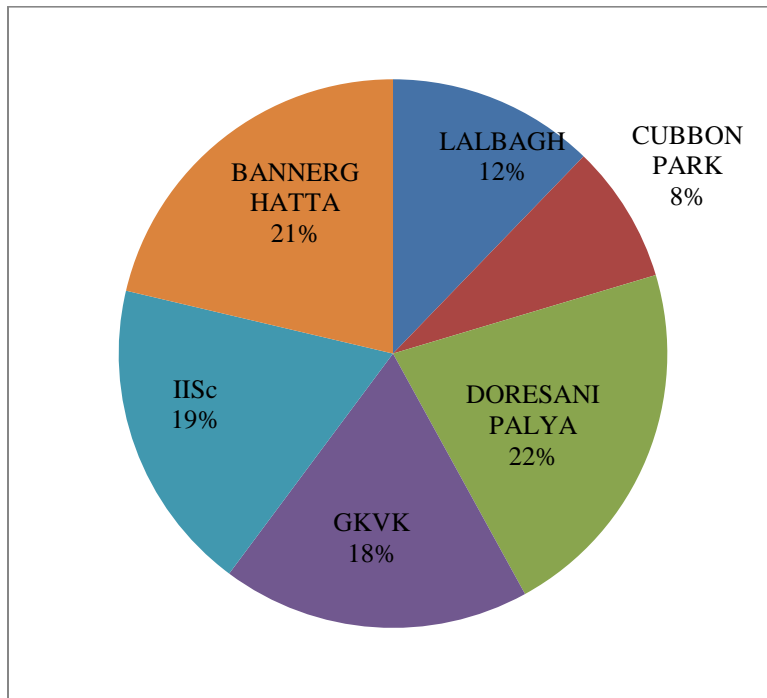**Fig. 2: Flow diagram of Butterfly Identification Application**

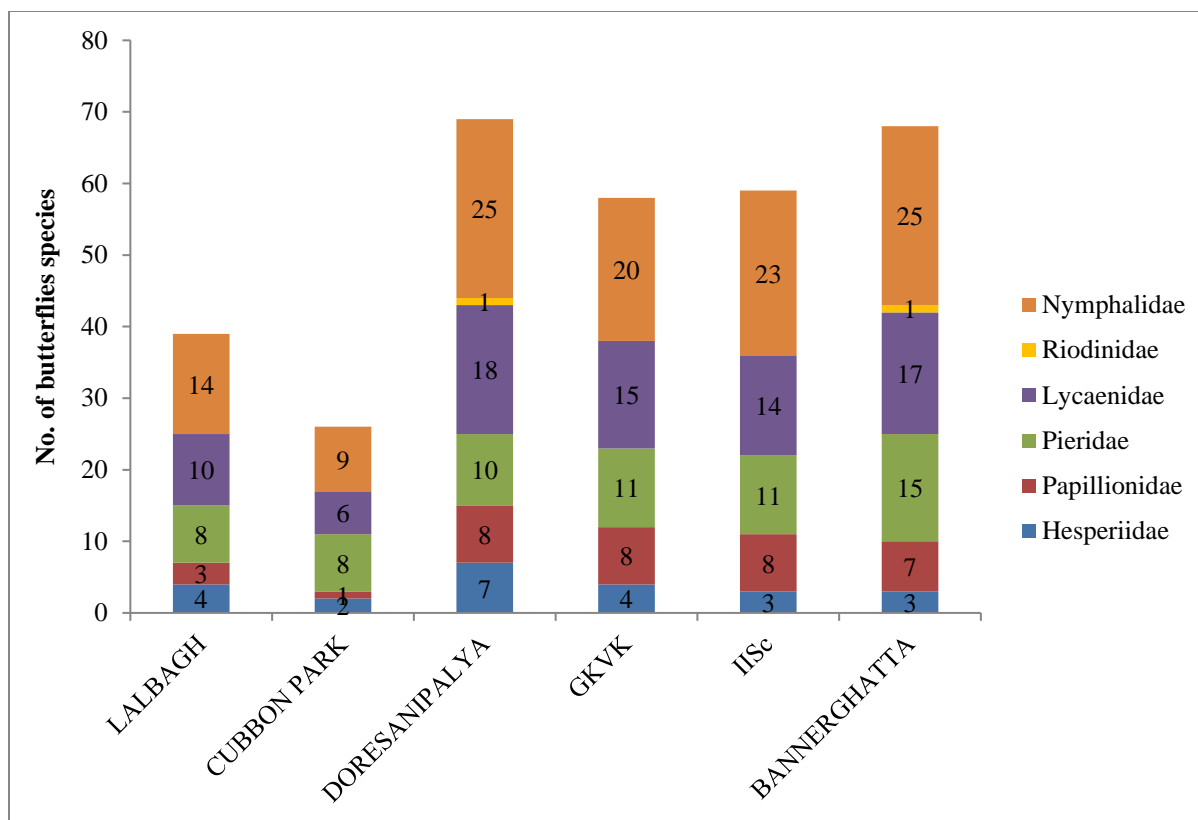**Fig. 3: Butterfly species recorded by BIA in survey areas**

Fig. 4 Butterfly family-wise distribution in different areas

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