

Fireflies May Transform Damodar Based Banka-Siphon As Eco-Tourism Spot: Focused Ecological Foot Print Biodiversity Conservation Natural Resources Socio-Economic Management Ecosystems Improving Environmental Policy!

Subhas Chandra Datta

Headmaster, Secretary, and Coordinator, Kanchannagar D.N.Das High School (HS), India

Corresponding author

Subhas Chandra Datta, Headmaster, Secretary, and Coordinator, Kanchannagar D.N.Das High School (HS), India.

Received: October 04, 2023; **Accepted:** October 12, 2023; **Published:** October 19, 2023

ABSTRACT

The Damodar River (DR) based in Kanchannagar, Burdwan Town, West Bengal, India attached to Eden Canal (EC) and Banka-Siphon-Dam (BSD) of Banka River (BR) covering we surveyed first time covering 10-12 km sq km area, is the oldest enriched habitat of different flora- and faunal- diversity with large population densities of biological light producing insect, fireflies that attract nature lovers and tourists for their ability to make rhythmic synchronous flashing light in 45 years ago. But fireflies were decreasing gradually due to the oldest diurnal tourist spots and modern artificial lighting; coming massive tourists, picnic parties with large sound systems, killing of wild animals, cutting the trees, disturbing, catching, unethical human behaviours, and urbanization nearby badly affected 'Nocturnal Biodiversity specially Fireflies', and it adversely affects the environment (Water, Sanitation and Ecology) and societal problems. On the other hand, it is well known that fireflies are the most charismatic beetles with attractive bioluminescent courtship displays that have recently been swept onto the global stage of nature tourism, especially the 'Nocturnal Natural Fireflies Eco-Tourism'. To overcome it, the main aims and objectives are to survey the densest firefly population zone with nocturnal biodiversity for the focus and establishment of the 'Nocturnal Firefly Eco-Tourism Spot', and provide suggestions for future tourist behaviour to minimize the impact on firefly populations with nocturnal biodiversity. All the child scientists of Kanchannagar D. N. Das High School will engage and get scope to identify the prospects and study of management of land, water and living resources promoting wildlife conservation and sustainable use in an equitable way, and can also study the ecosystem management. They observed that the highest firefly populations with nocturnal biodiversity in the 'Banka Siphon Dam'. The main animals in the night were the foxes, grey-coloured water monitor lizards, turtles, fishing cats, civet cats, barn owls, and even migratory birds. One white-coloured fox was seen in the BS. It may be enriched by planting plans and management of water bodies and land that focus recommendations of firefly tourist sites that can enhance the visitor experience, protect natural resources, and socio-economic benefit of local communities, and help promote the conservation of wildlife biodiversity and research also improving 'World Policy'. The perfect ecological balance of fireflies with water, land and vegetation may develop any 'Future-Socio-Economic-Nocturnal Eco-Tourist-Spot'. So, it may tell, "Fireflies May Transform Damodar-Based Banka-Siphon As Eco-Tourism Spot Focusing Ecological Foot Print Biodiversity Conservation Natural Resources Socio-Economic Management Ecosystems Improving World Environmental Policy! And Emerging Fireflies Eco-Tourism Economies Need Much More Private Financing for Climate Transition.

Keywords: Fireflies, Tourist-Spot, Banka-Siphon, Management, World Policy

Introduction

According to Peterson JCK in the Bengal District Gazetteers, Burdwan [1]. Bengal Secretariat Book Depot. Calcutta, 1910; the Damodar River (DR) based in Kanchannagar, Burdwan Town, West Bengal, India (Figure 1), covering a 10-12 sq km area, attached to Eden Canal (EC) and Banka-Siphon-Dam (BSD) of Banka River (BR) (covering a 3-5 sq km area), is the oldest enriched habitat of different flora- and faunal- diversity (Figure 2) with large population densities of biological light producing insect, fireflies that attract nature lovers and tourists for their ability to make rhythmic synchronous flashing light in 45 years

ago [2,3]. It is a Coleopteran (order) Lampyridae (family) beetle, 'Fireflies', also known as lightning bugs, with four stages in their lifecycle: egg, larva, pupa, and adult, and firefly fauna is very much understudied and has not received much attention for the last 100 years or so in India [4]. In the mega-diverse biodiversity of India, the fireflies were decreasing gradually due to the oldest diurnal tourist spots and modern artificial lighting [5]; coming massive tourists, picnic parties with large sound systems, killing of wild animals, cutting the trees, disturbing, catching, unethical human behaviours and urbanization (Figure 3) nearby badly affected 'Nocturnal Biodiversity specially Fireflies', and it adversely affects the environment (Water, Sanitation and Ecology) and societal problems [2-5]. On the other hand, it is well known that fireflies are the most charismatic beetles with

Citation: Subhas Chandra Datta. Fireflies May Transform Damodar Based Banka-Siphon as Eco-Tourism Spot: Focused Ecological Foot Print Biodiversity Conservation Natural Resources Socio-Economic Management Ecosystems Improving Environmental Policy! *J Envi Sci Agri Res.* 2023. 1(1): 1-6.

DOI: doi.org/10.61440/JESAR.2023.v1.05

attractive bioluminescent courtship displays that have recently been swept onto the global stage of nature tourism, especially the ‘Nocturnal Natural Fireflies Eco-Tourism’ [5,6]. Recently it is emphasized that a broad mix of policies is needed to unlock the necessary private capital in emerging markets and developing economies and ensure a positive climate impact. Policies need to refocus on creating climate impact rather than supporting activities that are already “green” and should consider the specific needs of emerging markets and developing economies.

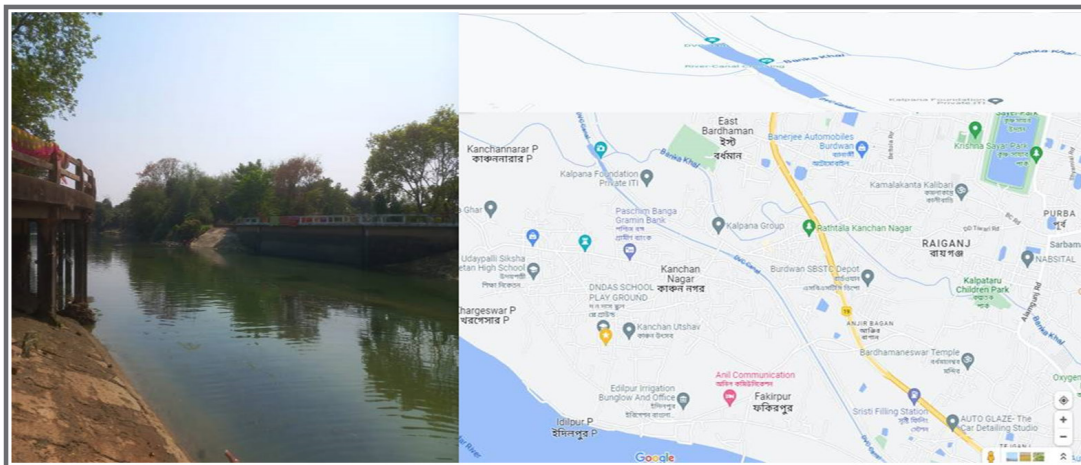


Figure 1: Study Area of Kanchannagar; Damodar-Based, Banka-River, Banka-Siphon, Eden-Canal, Pond and Land (Source: Mobile Photography by Arnab Das and Google map; Ref. 2 &3).

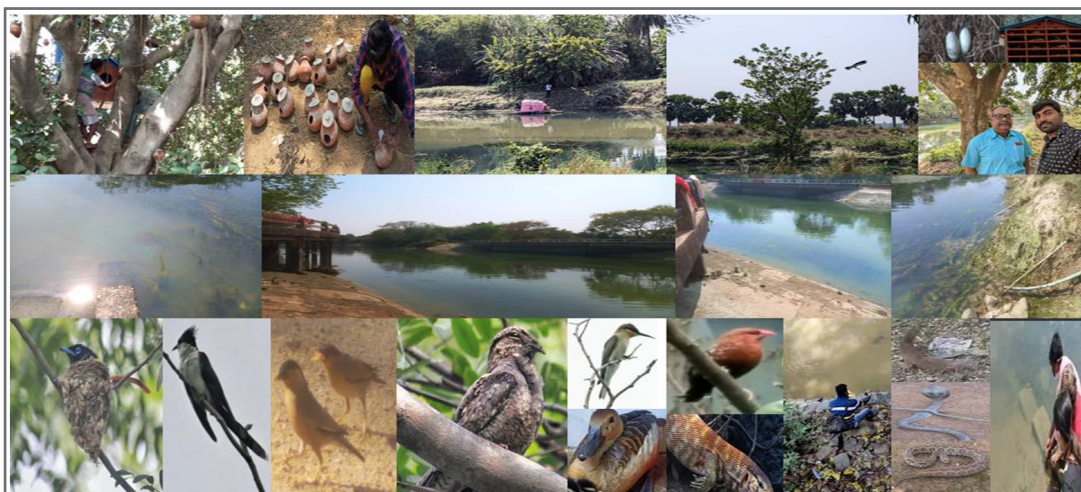


Figure 2: Flora- and Faunal- Diversity in Kanchannagar; Damodar-Based, Banka-River, Banka-Siphon, Eden-Canal, Pond and Land (Source: Mobile Photography by Arnab Das and Google map; Ref. 2 &3).



Figure 3: Rescue of Different Animals in Kanchannagar; Damodar-Based, Banka-River, Banka-Siphon, Eden-Canal, Pond and Land (Source: Mobile Photography and Google map; Ref. 2 &3).

Aims and Objectives

- The main aims and objectives are to survey the density of firefly population in nocturnal biodiversity ecology.
- To establish or focus the 'Nocturnal Natural Fireflies Eco-Tourism Spot'.
- All student scientists will get the scope to identify the prospects and study / explore how integrated management of land, water and living resources promotes 'Fireflies' with other animals' conservation and sustainable use in an equitable way.
- Children can also study the wide range of ecosystem management activities that increase resilience and reduce the vulnerability of people and the environment to climate change.
- To encourage children to find local-level problems and take initiatives for developing local technological solutions from green technology, appropriate technology, information and communication technology, or improvising traditional technology based on the principles of frugal innovation.
- So, in the Azadi Ka Amrit Mahotsav (77th-Anniversary of Indian Independence), primarily the general aims and objective is to survey the densest firefly population zone with nocturnal biodiversity for establishing or focusing the 'Nocturnal Natural Fireflies Eco-Tourism Spot', OR ultimately it is tried to focus the "Emerging Fireflies Eco-Tourism Economies Need Much More Private Financing for Climate Transition".

Work Plan

Here, the students of Kanchannagar D. N. Das High School (HS), from Class-V to Class-X student of as 'Child/Students Scientists' properly discuss among themselves, undertake, identifying patterns, trends and local problem, and interaction-survey and mentions some of the solutions deployed to overcome the problem by innovative ideas regarding Kanchannagar establish or focus the 'Nocturnal Natural Fireflies Eco-Tourism Spot' focusing the Focal Theme: "Understanding Eco-System for Health and well-being", and Sub-theme: "Ecosystem-based approach (EBA) for self-reliance".

Materials and Methods

- **Study Area with Weather-** Kanchannagar, Burdwan Municipality, Purba Bardhaman District, West Bengal, India (Figure 1) covering 10-12 km, where the temperature was $22\pm 5^{\circ}\text{C}$, relative humidity was $75\pm 5\%$, is situated beside the Damodar, and it is surrounded by rivers, siphon, ponds, forest, different trees, park, garden, playground, different storehouse, rice mill, markets, agriculture-horticulture-land, brave-yard, temples, etc. forming the 'Location-Wise an Ideal Place' for keeping-and-caring of the nocturnal 'Fireflies', with the average rainfall was 150 millimetres, and it was the locality as 'Sample Area' for "Sustainable Future 'Nocturnal Natural Fireflies Eco-Tourism Spot Ecology'" [2-6].
- **Group Formation-** The 12 groups were formed from 611 'Child/student scientists residing in different localities of Kanchannagar; standard-5 to standard-10' with one team leader, one team member, 2 captains per 10 core students/group, and some senior ex-students-NGOs from the local communities. According to the age of class- V to X students were divided into 6 average groups from 10 yrs to 16yrs [2-6].
- **Sampling of Survey-** The observation-based- survey (three times in the evening:6:30 pm to 9:30 onwards), and an

interaction-based survey/design study on questions were developed on the contents, randomly asked, and interacted to collect answers with qualitative and quantitative data on fireflies with nocturnal biodiversity issues focusing mainly on personal views, opinions, and perceptions of the various respondents impacts, and collecting data from nature-lover, tourists, photographers, visitors, guardian, teachers, ex-students, local communities, experience old worker/labour, fisherman, and farmer, etc., also [2-6].

- **Study Samples-** The 'Study Samples' were the density of fireflies with nocturnal biodiversity in different localities of the 4 major zones [2-6].
 - **Duration of Study-** The duration of study for the 4 major zones was May 2023 to September 2023, and up-to-date [2-6].
 - **Counting-** Different teams of students helped with the proper count of fireflies in the various kinds of trees as well as in the land and water. The direct counting technique is used at random [2-6].
 - **Collection and Recording of Data-** The data were collected by Child/student scientists and were recorded in the 'Logbook' and were authenticated by the guiding teacher Dr. S. C. Datta [2-6].
 - **Analysis of Data-** The data were analyzed by comparison and referring to well-reputed published papers [2-6].
 - **Science Technology Communication Applications Ecology-** The students, NGOs, scholars, researchers, artists, teachers, staff, community, photographers, different scientists, academicians, clinicians, administrators, institutions, farmers, media personnel, and visitors make the news of "Sustainable Future 'Nocturnal Natural Fireflies Eco-Tourism Spot Ecology'", and published it in different prestigious journals [2-6].
- ## Observations
- In Table 1 and Table 2, the following observations of the fireflies with nocturnal animals depend on the survey in the Damodar River based Kanchannagar for the "Sustainable Future 'Nocturnal Natural Fireflies Eco-Tourism Spot Ecology'" were recorded as mentioned.
- **Observed in the 4 Significant Zones;** I-Damodor Base, II-Banka River, Banka Siphon, and IV-Pond & Land.
 - **Average Visibility Thrice in the Evening Time Period;** 6:30 pm to 7:30 pm, 7:30 pm to 8:30 pm and 8:30 pm to 9:30 pm onwards.
 - **Average Visibility Thrice in the Different Plants;** Herb, Serbs and Trees.
 - **Average Visibility Thrice in Different Colors;** Yellow, Orange/Red/Chocolate, and Green or Blue.
 - **Average Visibility Thrice in Different Temperature;** Low (20°C), Medium (30°C) and High (40°C).
 - **Average Visibility Thrice in Different Humidity;** Low (60%RH), Medium (70%RH) and High (80%RH).
 - **Average Visibility Thrice in Land, Water and Others;** Different localities of 4 Zones.
 - **Average Visibility of Other Nocturnal Animals;** Fox,

Mongoose, Turtles, Porcupine, Fishing Cat/Civet Cat, Snake, Owls, and Water Monitor.

- Average Visibility of Other Nocturnal Animals; Land, Water, and Others.

Table 1: Fireflies Survey in the Damodar River Based Kanchannagar Burdwan

Average Visibility during May to September 2023																
Survey Zones	Distribution of Fireflies										Average Visibility in Different					
	Average Visibility in Evening Time Period			Average Visibility in Different Plants			Average Visibility in Different Colors				Average Temperature			Average Humidity/Rainy Day		
	6.30pm to 7.30pm	7.30pm to 8.30pm	8.30pm to 9.30pm	Different Plants	Serb	Trees	Yellow	Orange/Chocolate	Red	Green/Blue	Low 20°C	Medium 30°C	High 40°C	Low 60% RH	Medium 70% RH	High 80% RH
I- Damodor Base	09.21 cx ±0.01	19.51 cy ±0.03	29.26 cz ±0.17	20.57cx ±0.03	29.23 cy ±0.17	08.98 cz ±0.02	27.26 cx ±0.13	20.58cy ±0.02	17.47 cy ±0.03	07.11 cz ±0.03	32.26 cx ±0.17	32.44 cy ±0.12	06.21 cz ±0.01	34.67 cx ±0.12	28.13 cy ±0.14	07.23 cz ±0.01
II- Banka River	14.83 bx ±0.08	24.72 by ±0.16	54.13 bz ±0.14	25.44bx ±0.13	53.10 by ±0.13	13.13 bz ±0.08	52.15 bx ±0.12	25.78by ±0.12	21.65 by ±0.13	17.61 bz ±0.02	56.13 bx ±0.12	56.22 by ±0.12	10.31 bz ±0.02	58.96 bx ±0.14	52.86 by ±0.12	15.88 bz ±0.02
III-Banka Siphon	19.87 ax ±0.05	36.56 ay ±0.08	69.79 az ±0.18	38.51ax ±0.08	67.31 ay ±0.13	17.89 az ±0.03	65.79 ax ±0.11	37.59ay ±0.03	35.43 ay ±0.03	23.53 az ±0.03	72.24 ax ±0.14	69.38 ay ±0.11	12.87 az ±0.02	78.82 ax ±0.12	77.38 ax ±0.11	80.55 ax ±0.12
IV- Pond & Land	05.11 dx ±0.03	11.82 dy ±0.07	23.69 dz ±0.11	11.03dx ±0.03	16.83 dy ±0.07	04.14 dz ±0.02	21.67 dx ±0.13	05.19dy ±0.01	04.29 dy ±0.02	03.17 dy ±0.01	25.72 dx ±0.11	18.86 dy ±0.04	03.42 dx ±0.01	28.92 dx ±0.12	15.83 dy ±0.03	04.42 dz ±0.01

‘a,b,c..’- Different small letters in a column, and ‘x,y,z’ different small letters in a row show significant difference by the analysis of variance ‘ANOVA’ (P<0.01).

Table 2: Survey of Other Animals in Night at the Damodar River based Kanchannagar

Survey Zones	Average Number of Other Main Visible Animals in Night during May to September 2023									
	Fox	Mongoose	Porcupine	Turtles	Fishing/ Jungle Cat	Snakes	Water Monitor	Owls	Migratory Birds	Indian Hare/ Black Neck Hare
I-Damodor Base	32b±0.2	48b±1.14	24b±1.12	48b±1.22	35a±1.03	13a±0.07	49b±0.13	16d±1.20	68a±1.04	3b±0.01
II-Banka River	23c±0.1	33c±0.13	13c±0.09	38c±1.16	11c±0.07	9b±1.01	26c±1.12	23c±1.11	13c±0.07	1c±0.01
III-Banka Siphon	44a±0.2	67a±1.11	35a±1.03	56a±1.14	25b±1.03	7b±0.01	59a±1.01	44a±1.06	56b±1.04	11a±0.01
IV-Pond & Land	3d±0.1	25d±1.05	3d±0.01	12d±1.02	7d±0,01	6c±1.03	18d±0.04	32b±0.42	6d±0.02	00

‘a,b,c..’- Different small letters in a column shows significant difference by the analysis of variance ‘ANOVA’ (P<0.01).

Results and Discussion

Table 1 and Table 2, show mainly the ‘Fireflies’ survey in the Damodar river-based Kanchannagar as follows;

- It is observed that all 4 Survey Zones; I-Damodar Base, II-Banka River, Banka Siphon, and IV-Pond & Land, were enriched with fireflies.
- The number of fireflies is increasing from early evening 6:30 pm to night 9:30 pm onwards.
- The number of fireflies is larger (10-20 numbers/group) in the Banka Siphon and Banka River than in Damodar Base, Land and Pond.
- The Banka Siphon represents the largest group of fireflies (50-60 numbers/group), medium Banka River (40-50 numbers/group), lower Damodar Base (9-10 numbers/group), and lowest in land & ponds (2-4 numbers/group).
- Large number of fireflies is seen in Serb plants and lowest in trees.
- Yellow-lighting fireflies are maximum, and movement is restricted to 10-12 seconds (attractive bioluminescent courtship behaviour).

- The fireflies are seen most in the low temperature (20°C).
- The fireflies are also seen most in the low humidity (60%RH).
- The fireflies disappear in all 3 zones except Banka Siphon after raining.
- The visibility of fireflies is maximum beside the water bodies (adjutant to land and water).
- The common visible other nocturnal animals are foxes, Mongoose, Turtles, Porcupine, Fishing Cat/Civet Cat, Snake and Water Monitor, Owls, Migratory Birds, Black Neck Hare, etc.
- The largest group of visible nocturnal animals present in the Banka Siphon.
- Average visibility of nocturnal animals on land.

Note: Blue-lighting fireflies are seen in some land and ponds in the residential area of Kanchannagar, and a white-coloured fox is seen in the Banka Siphon.



Figure 4: Fireflies and Larva in Kanchannagar; Damodar-Based, Banka-River, Banka-Siphon, Eden-Canal, Pond and Land (Source: Mobile Photography by Pomy Ghosh and Arnab Das).

Discussion (Solution to the Problem)

The firefly survey will encourage children to find local-level problems and take initiatives for developing local eco-technological solutions from green technology, appropriate technology, information and communication technology, or improvising traditional technology based on the principles of frugal innovation. All student scientists have got the scope to identify the prospects and study / explore how integrated management of land, water and living resources promotes 'Fireflies' with other animals' conservation and sustainable use in an equitable way. Children can also study the wide range of nocturnal ecosystem management activities that increase resilience and reduce the vulnerability of people and the environment to climate change. The 'Eco-Technologies' are not only environment-friendly, cost-effective, and local local-indigenous technology but also easily applicable and available technology that prevents any toxic effects improving natural immunities highlighting the main research question, "Use Eco-Technologies Save World" [2-6].

Future Plan

The 'Banka-Siphon attached Eden-Canal of Damodar' may not only be transformed as 'Nocturnal Firefly Eco-Truism and Research Institution' but also focuses the 'Different Nocturnal Biodiversity Research Hub' depend on 'Eco-technology' Improving World Policy. And the perfect ecological balance of water, land and vegetation may develop any 'Future-Nocturnal-Natural Socioeconomically-Ecological-Tourist-Hub' with advances in 'Eco-Technology Hub' for "Understanding Eco-System for Health and well-being with Ecosystem-based approach (EBA) for self-reliance advancing a global phenomenon toward a brighter future" [2-6].

Conclusions

The whole of Kanchannagar is enriched with charismatic beetle fireflies with attractive bioluminescent courtship behaviour that may transform into nocturnal nature tourism with the brightest future ecology. Here, the Banka Siphon with Eden Canal itself covering a 3-5 sq km area is an attribute of the major firefly nocturnal tourism sites with enriched nocturnal biodiversity. It is estimated (May to September 2023) through student scientists for firefly-watching that impacts local firefly populations, and

to highlight the biological factors that make certain species especially vulnerable to tourism-associated threats. It also offers science-based best practices of ecosystem for firefly ecotourism and suggests to: conserve the biodiversity/habitat, involving local communities as key stakeholders, and providing training programs for guides and interpretive materials for all. It is also suggested to transform tourist behaviour to minimize the impact on firefly populations and develop management plans, and recommendations, firefly tourist sites can enhance the visitor experience, protect natural resources, benefit local communities, and help promote the conservation of nocturnal natural biodiversity.

It may be enriched by planting plans and management of water bodies and land that focus recommendations of firefly tourist sites that can enhance the visitor experience, protect natural resources, and socio-economic benefit of local communities, and help promote the conservation of wildlife biodiversity and research also improving 'World Policy'. The perfect ecological balance of fireflies with water, land and vegetation may develop any 'Future-Socio-Economic-Nocturnal Eco-Tourist-Spot'. So, it may conclude, "Fireflies May Transform Damodar-Based Banka-Siphon As Eco-Tourism Spot Focusing Ecological Foot Print Biodiversity Conservation Natural Resources Socio-Economic Management Ecosystems Improving World Environmental Policy! And Emerging Fireflies Eco-Tourism Economies Need Much More Private Financing for Climate Transition.

Acknowledgement

The two students of Class VIII carry out the research work as 'Junior Scientists'; Team Leader- POMY GHOSH, and Team Member- MEGHAADHIKARI for the "31st- National Children's Science Congress (NCSC) 2023" with the help of all students, teaching staff, and communities. I thank the eminent scientist, educationist, and guide teacher, Dr. Subhas Chandra Datta, for his inspiration and guidance. I am thankful to Mr Arnab Das, Animal Lover, Social Worker, Researcher, and Member of the Burdwan Society for Animal Welfare, Burdwan for his intensive research help. I am also thankful to all students' scientists, ex-students, visitors, tourists, photographers, teachers, communities, eminent

scientists, educationists, and guide teachers for inspiration and guidance. I express my deep gratitude to all the students, teachers, staff, communities, and senior ex-students-NGOs for the help and arrangement of awareness for the “Understanding Eco-System for Health and well-being with Ecosystem-based approach (EBA) for self-reliance”.

Reference

1. Peterson JCK. Bengal District Gazetteers, Burdwan. Bengal Secretariat Book Depot. Calcutta, 1910.
2. Datta SC, Das A. Banka-Siphon Attached Eden-Canal of Damodar May be Develop as ‘Biodiversity-Biomedicines-Hub’ Improving World Policy. *Journal of World Policy and Development Studies (JWPDS)*. 2023. 9: 62-68.
3. Datta SC. Advances in Clinical Toxicology Depend on Eco-Technology. *Advances in Clinical Toxicology (ACT)*. 2023. 8: 000271.
4. Ghosh S, Sarkar SK, Chakraborty S. New distributional records of fireflies (Coleoptera, Lampyridae, Luciolinae) from two Eastern States of India with notes on their biology and an updated Indian checklist. *Biodiversity Data Journal*. 2023. 11: e98948.
5. Owens AC, De Cock R, Lewis SM. Behavioral responses of bioluminescent fireflies to artificial light at night. *Frontiers in Ecology and Evolution*. 2022. 10: 946640.
6. Datta SC. Ecology of biomedicine physiology in agriculture horticulture enhances food-security wildlife-biodiversity-conservation science-technology-communication issues. Proceeding in 3rd Edition of Global Conference on Agriculture and Horticulture (AGRI-2023). Joint Event on Plant science and agriculture, Hybrid Event, 8th-Edition. 188-191, Sep 11-13, 2023, Valencia, Spain.
7. Datta SC, Ghosh P, Adhikari M. Fireflies May Transform Damodar Based Banka-Siphon As Eco-Tourism Spot! 31st-District Level National Children’s Science Congress 2023. 25thSeptember 2023, DDE Auditorium, The University of Burdwan, Golapbag, Purba Bardhaman.