

## Notes on behaviour patterns of Indian firefly

### *Luciola circumdata* (Coleoptera: Lampyridae)

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インド産ホタル *Luciola circumdata* の行動パターン

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インドの西ベンガル産ホタル *Luciola circumdata* MOTSCHULSKY は毎年6月上旬から7月中旬に出現し、雌雄ともに翅を有して飛翔できる。このホタルは薄暗くなってから竹林や植物が茂ったなかで緑黄色の光を放って飛翔した。ホタルが最初に飛翔する時刻は発光活動の解発と日没時刻に関係した。ホタルは日没後、25~31分後に発光し始めた。6月は19:05に暗くなり、ホタルは早く明滅して飛翔し始めた。6~8月に、雄は2回続いた明滅を1単位として1分間に60~65回発光しながら、植物が茂った地の約1m上をジグザグ状に飛翔した。雄の発光間隔は0.8~1秒であった。雄は比較的乾燥して植物が少ない場所を飛翔した時には、発光間隔がやや間延びし、1分間に40~50回であった。また飛翔高度は時には10mに達することがあり、その時には突然に大変長い発光間隔になった。しかし藪に戻ると通常の発光になった。3~5分間飛翔した雄は葉の上で休息し、この時には1分間に50~55回発光した。雌はやや直線的に飛翔し、雄より弱く発光した。短時間の飛翔後に、雌は葉にとまり、雄とは異なった単一の発光で、1分間に20~30回明滅した。このホタルの配偶行動の観察結果の概要は次の通りである。雌は少し飛翔した後に葉にとまり、1分間に25~30回発光し、この発光信号を発見した雄は、1分間に150~200回の割で単一発光し、発光明滅継続時間は5~7秒間であった。その時、雄は雌の後方から舞い降りてマウントし、脚で雌をしっかりと抱えた。雄は1分間に30~35回の割で単一発光したが、交尾した直後から交尾が終了するまで動かず、また発光しなかった。このホタルの雄は発光周期から雌を認知し、雌に乗ったときには性フェロモンが関与していると考えられる。一連の観察から日出時刻とホタルの最終発光時刻にも関係があることが判明した。

### Introduction

Significance of the light emitted by the fireflies led many workers to investigate the behaviour of these beetles, specially at night. Recently OHBA (1983) has dealt in detail the communication systems of Japanese fireflies. Synchronous rhythmic flashing of fireflies has been established as early as in 1938 by BUCK (1938a, b). Then various aspects of bioluminescence have been

reviewed and compiled (JOHNSON, 1955; JOHNSON and HANEDA, 1966).

Luminescent patterns and behaviour of fireflies have been given by OHBA (1979a, 1979b). Earlier OHBA (1978) had described the morphology and behaviour of the Lampyridae. Mating behaviour of a Japanese firefly *Hotaria* has been given in detail by OHBA (1980). However these are no report on the behaviour aspects, communication system, role of bioluminescence,

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of flashing pattern of the fireflies found in India., GANGULY (1980), in the notes on Indian firefly, has mentioned that the type of luminescence in the adult male and female forms of *Luciola praeusta* is a flash type. There is a sudden burst of bright yellow-green light for a function of second followed by few seconds of darkness and then another flash. The chief function of light emission in these adult fireflies is stated to assist in attracting the sexes together for mating. In case of larva, emission of light may be used to warn enemy as was mentioned by HESS (1920). Morphology, position of light organs and luminosity of male form of *Diaphanes marginella* has been described (GANGULY, 1973). Earlier GANGULY (1963) had described histology and cytology of luminescent organ of *Luciola gorhami*.

This paper accounts the behaviour patterns of *L. circumdata* from Kalimpong, West Bengal, India.

#### Material and method

Adult specimens of *L. circumdata*, both male and female forms were collected from bamboo plantations near Bombasti area at Kalimpong and were kept in wide-mouthed glass jars under proper condition for observation in the laboratory. Behaviour of these adult fireflies in the field at night hours from 18:00~22:00 was also recorded.

#### Observation

*L. circumdata* occurs at Kalimpong during the months of early June up to middle of August every year. Both the sexes are winged and can fly (Fig. 1).

In these months they are seen flying after dusk, in the midst of the bamboo plantations and in places of thick vegetations.

In the day time they are never seen to fly or glow in natural surroundings as well as in the laboratory under captivity. During the day these fireflies are found on the undersurface of leaves of dense shrubs and in dark crevices beneath the bushes. Through out the day, whether it is sunny, cloudy or rainy, they sit with collapsed legs and antennae drawn beneath the body and do not

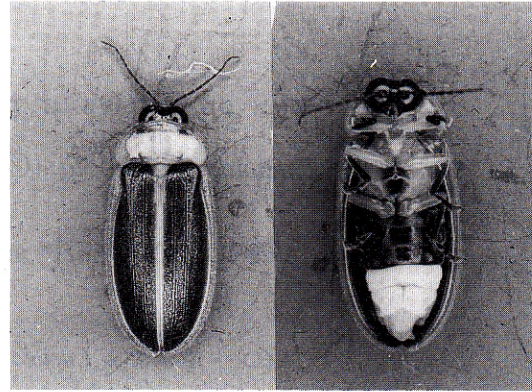


Fig. 1 Male of *Luciola circumdata*.

Left: dorsal view, Right: ventral view.

move or glow, even on stimulation like gentle shaking or pricking with needles.

The time of their first appearance in the open air, and the time of onset of their luminescent activity in relation to the time of sunset, were also recorded both from natural surroundings and from the captive specimens in the laboratory. In the laboratory, at different times of the day, the specimens were subjected to total darkness for half an hour each time, but none of them were observed to glow, even faintly. But towards dusk at 17:00, they were again treated like wise and, out of 43 specimens only four glowed and emitted little flashes without rhythm. They start glowing about 25 - 31 minutes after the sunset. In the field initially these fireflies give flashes of very low intensity and in lesser frequency, which is about 10-30/min. In this state they remain flightless till 18:50 in the month of June.

Table 1 Time of the sun set, first glowing and the time of the first appearance of *Luciola circumdata*.

Date	Sunset	First glow	First appearance
19800607	18:16	18:41	19:05
19800614	18:19	18:48	19:05
19800623	18:23	18:48	19:10
19810608	18:16	18:38	19:05
19810614	18:19	18:48	19:10
19810621	18:22	18:49	19:08



At about 19:05 they appear in the air flashing rapidly when the flare of the western sky fades out and it is dark enough. Table 1 shows the time of first glowing and the time of the first appearance of these beetles after sunset. From the table it might be concluded that there is a correlation between the time of sunset and the time of onset of luminescent activity in these beetles.

**Luminescent behaviour:** During June to August, the glowing males and females come out of the hidden corners and the males fly over thick, dense vegetations in a zigzag manner at the height of about one meter and give emissions (60–65 double flashes/min.), the interval between two consecutive double flashes being 0.8 - 1.0 sec. The male flashes are stronger than the female flashes. When the males fly over relatively dry and scanty area, they emit flashes after a bit long intervals. Consequently the number of flashes come to be 40–50 times/min. Again, during flight when one of them occasionally goes high up at about 10 meter, it suddenly dives down and giving flashes with very long intervals and comes to fly over the bushes in usual manner.

After flying for certain time, 3 - 5 minutes the fireflies come to rest on the upper surface of the leaves of small herbs, or on the tips of long grasses. During rest time male fireflies emit double flashes (50–55 flashes/min). It has been observed that the males are swift flies where as the females are not. The females fly in a somewhat straight way and not like the males. Sometimes they fly in a whorling manner and after a short flight they come to rest on the tips of grasses or on the upper surface of the leaves of small herbs and emit single flashes (25–30 flashes/min.). The intensity of the flashes are less than those of males but the duration of each flash is longer about 1.2 sec. The colour of the light is greenish yellow in both sexes.

Under captivity the time and manner of onset of glowing activity were observed to be the same as in free specimens. The males emitted double flashes (60–70 flashes/min.), while walking or sitting inside the rearing jars. They were never

seem to make a try for flight even. During the whole night, they continued emission of flashes without rest. Only towards dawn, they stopped glowing, however, they emitted about 30–35 minutes before sun rise, they decrease the frequency of flashes from normal 60–70 times down to 20–25 flashes/min. The intensity of the flashes was also reduced. Table 2 shows the time of last glow and sun rise. Onset of glowing there is also a correlation between the time of sun rise and last glow in these beetles.

**Mating behaviour:** Mating in *L. circumdata* is not a rare event. It does not take place in flying condition. It occurs when the female rests on a substratum like leaves of small herbs or apices of the twigs of small herbs. After having some flight the female rests on the apex of the leaf and emits slightly prolonged single flashes (25–30 flashes/min.). At this time one of the flying males detects her from a distance and approaches her emitting only single flashes at a very high rate which is 150–200 times/min. But the duration of this type of rapid single flash is only of 5–7 sec. Then the male lands in the vicinity of the female and mounts on her back, holding her with his legs firmly. During this act of physical association the male emits single flashes (30–35/min.). Till the starting of actual coition this continues. When the coition starts both the male and the female remain motionless and non luminous throughout the whole mating period which lasts for about two hours: under captivity mating takes place throughout the night, but the frequency is maximum at the early hours of night. Mild irritation

**Table 2** The time of last glow and sunrise of *Luciola circumdata*.

Date	Last glow	Sunrise
19810603	4:19	4:55
18910604	4:17	4:55
19810610	4:20	4:54
19810611	4:16	4:54
19810617	4:17	4:54
19810618	4:21	4:54

during mating does not separate the sexes apart, but the male emits flashes occasionally.

The position of the male and the female specimens has been observed to be two folds. In the beginning of mating the male is superimposed on the female but afterward the male turns opposite direction maintaining the genital interlock. It has been observed in case of *L. circumadata* the males detect the females by rhythm of their flashes and then land to the females. Sex pheromone may play a part than flashes.

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