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THE DIEL PATTERNS OF COMMUNAL ROOSTING BEHAVIOUR IN *POTAMARCHA CONGENER* (RAMBUR) (ANISOPTERA : LIBELLULIDAE) *

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The diel patterns of the communal roosting behaviour of the dragonfly *Potamarcha congener* in the Calicut University Campus are described. The average sex-ratio observed in the dormitories, some remarks on the factors such as the nature of the roosting site, light and group effect which influence communal roosting and on the benefits that may be derived from such roosting, are given. The probable role of some of the special attributes of these dragonfly aggregations in orientation to the fixed roosting site day after day possibly by visual or pheromonal cues, or both of these, are discussed.

INTRODUCTION

Among the heterometabolous insects, diel patterns of roosting behaviour and associated phenomena have been reported only in the adults of Odonata (CHOPARD, 1949 ; CORBET, 1960) which are adapted for an entirely predatory mode of life. Odonate roosting behaviour has been studied by RAU & RAU (1916) and PENN (1950) in the U.S.A., by O'FARRELL (1971) in Australia, by GAMBLES (1971), PARR & PARR (1974) and HASSAN (1976) in Africa. The first note on the communal roosting behaviour of Indian dragonflies was that of FRASER (1944). O'FARRELL (1971) referred to roosting as a normal and routine behaviour of adult odonates

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associated with rest and sleep for the night. It was GAMBLES (1971) who introduced the term "odonate dormitories" to refer to the roosting sites. Here we use the term "dormitories" to refer to the communal nature of the roosting behaviour as well as to the roosting site.

This paper deals with important features of the diel patterns in the communal roosting behaviour of *Potamarcha congener*. The sex-ratio observed in the dormitories, certain remarks on the factors (such as the nature of the roosting site, light and group effect) which influence communal roosting and on the benefits that may be derived from such roosting, are given. The possible role of visual or pheromonal mechanisms which enable dragonfly aggregations to be formed on the same sites day after day, are discussed.

LOCALITY AND MATERIAL

Our studies on the communal roosting behaviour of the dragonflies were made in the Calicut University Campus (located 24 km to the South of Calicut City; latitude 11° 35'-45' N and longitude 75° 45'-50' E; altitude: 40-60 m above sea level), Kerala, from 1983 to 1988 during the drier part of the year from January to April. The observations were made with the help of field binoculars (8 × 30) from as close as possible to the dragonfly dormitory located on a particular tree in a group of some 25 casuarina trees forming an avenue about 30 m long. In a given dormitory the females could be distinguished, based on their prominent latero-ventral foliations on the eighth abdominal segment. Other individuals without this conspicuous structure were recorded to be males. The taxonomic determination of the dragonflies involved in this study was made by one of us (A.R.L.).

OBSERVATIONS

NUMBERS AND SEX-RATIO IN THE DORMITORY

Many *P. congener* are commonly seen in flight during the daytime in several areas of the Calicut University Campus throughout most of the year. An aggregation of this dragonfly was first observed to roost night after night on a particular casuarina tree at a height of approximately 3 m from the ground level, from the first week of March to the middle of April, 1983, on the "leafless" terminal twig of a lateral branch. From then on, each year till 1988 roosting by the same species of dragonflies was observed during the drier part of the year from January to April. Over this period of 6 years, the maximum number of individuals counted in a dormitory was 125 in February 1988, and the minimum number in another dormitory, during the middle of April 1987, was 18. Data collected during this study period revealed an approximate average of 70% females and 30% males in a dormitory.

DIEL PATTERNS OF THE ROOSTING BEHAVIOUR

The following are our observations on the diel paterns of roosting behaviour in *P. congener* for a typical evening of 7th April 1983 and the following morning. The

Fig. 1. A roosting aggregation (dormitory) of *Potamarcha congener* on the terminal portions of two nearby twigs of a casuarina tree, photographed soon after sunset. Many of the individuals are in the perching position ; others have changed over to the roosting posture.

first arrivals of about 6 individuals at the roosting site were noticed around 15.45 hours. These perched close together towards the tip of the twig. More individuals kept arriving at the site and these hovered about before finding suitable perches in the communal roost. Whenever new arrivals tried to perch in locations occupied by earlier arrivals, the latter actively whirred their wings as if "in protest". The new arrivals thereupon perched in nearby unoccupied locations either on the same twig or on a nearby twig. The arrival of small batches of individuals continued intermittently for about one hour till the sun set at 18.47 hours. By 19.00 hours, with further decrease in light intensity and temperature, many of the individuals which were perching on the twig with their wings spread out horizontally, changed over to the roosting posture of hanging down from the twigs with the head uppermost (Figs 1 & 2) and the long axis of their bodies making an angle of 90° or less (angle between the twig and the long axis of the insect's body is considered) with their twigs, depending on the location of their perch in the dormitory. This roosting posture remained unchanged in the majority of the individuals of the dormitory throughout the night. No particular preferred direction (West, East, North or South) in the orientation of individuals in the dormitory was observed in our study.

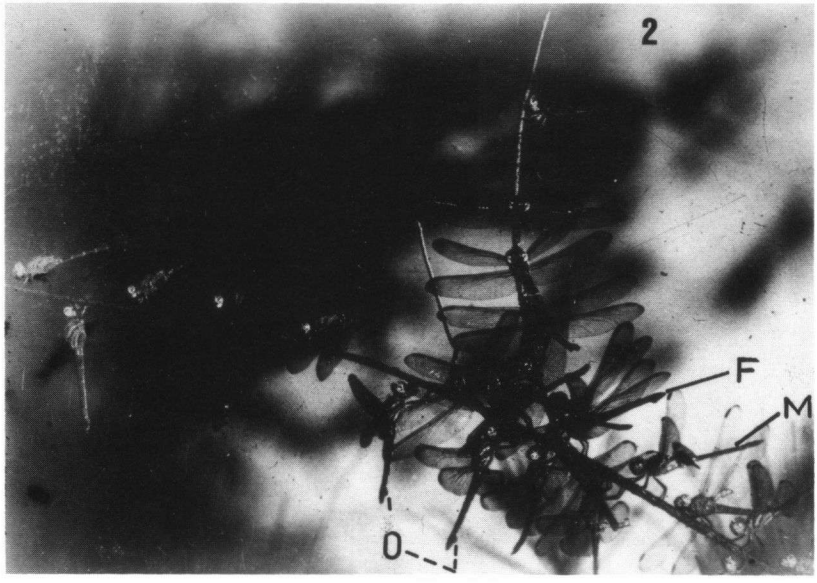

Fig. 2. Close up of a portion of the same roosting aggregation showing the distinguishing features (in field) of females and males. F : females ; M : males ; O : prominent latero-ventral foliations of 8th abdominal segment in female.

Sunrise between 6.15 and 6.20 hours (average for the period) on clear days induced many individuals to change over to a perching posture (early morning activity) on the twigs. On cloudy days with lower temperature, most of the individuals in the dormitory continued to maintain their roosting posture for a longer period. On cloudy days with moderate rain during the same period of the early morning, the majority of individuals in the dormitory could be seen to maintain their roosting posture. They were occasionally seen wiping their heads and eyes by means of their fore legs. Drops of rainwater were observed trickling down the tips of their suspended abdomens. In fair weather, between 6.45 and 7.35 hours, one by one and in small batches the insects left the roost.

The duration of roosting in *P. congener* (varying from 12 hours 30 minutes to 12 hours 45 minutes), was always slightly longer than the average monthly night hours in the Calicut University Campus. It was found that the intensely bright but momentary flash of an electronic light (used for photography) did not at all disturb these dragonflies roosting in aggregation.

DISCUSSION

The study of the diel patterns of the roosting behaviour of our abundant odonate fauna has received little attention in India. FRASER (1944) published a brief note on the diurnal and nocturnal resting habits of the libellulid *Bradynopyga geminata* (Rambur), of which a small swarm of about 16 individuals roosted in aggregation for a period of about 20 days on the guy-ropes of chicks (bamboo sun-screens) in the shelter of the varandah of a bungalow in Madras in 1918. The various postures assumed by zygopteran odonates during perching, roosting and early morning activity as well as during the switch over from one to the other, have been described by O'FARRELL (1971) for *Austrolestes annulosus* and *Austrolestes leda* inhabiting a cold region in Australia. HASSAN (1976) gave an account of the roosting postures assumed by the anisopteran libellulids *Palpopleura lucia lucia* and *Acisoma panorpoides inflatum* under humid tropical conditions in Nigeria and compared them with their normal daytime postures near water. The head wiping behaviour of roosting odonates during the course of the day in the rain in the case of the zygopteran *Calopteryx* sp. of Europe was reported by HEYMER (1973) and in *Bayadera hyalina* at Shillong, India, by LAHIRI (1975).

PREFERENCE FOR CASUARINA TREES FOR ROOSTING

The aggregation of *P. congener* seemed to prefer the same group of casuarina trees year after year for roosting perhaps on account of their small, needle-shaped "leaves" permitting fairly unhindered vision all around and allowing for escape from possible predators. The following incident very well illustrates this point. A roosting aggregation of *P. congener* on a casuarina tree at a height of 11 m from the ground in the same locality, kept under observation from the first week of January 1986, was

attacked by a female of a pair of the paradise flycatchers (*Terpsiphone paradisi* L., winter migrants) on the early morning of 20th and 21st January, each day predating on one of the dragonflies of the roost. On both days all the remaining individuals of the roost escaped predation by flying away producing a synchronous and very clearly audible whirring wing sound, perhaps serving as an anti-predator warning signal.

Factors determining duration of roosting

The duration of roosting for the libellulid studied by Hassan (1976) at Ibadan, Nigeria was, as in *P. congener*, always slightly longer than the average monthly night hours. Corbet (1960) considered that among the ecological factors, light intensity and temperature influence the diel patterns of roosting behaviour in dragonflies. Cloudsley-Thompson (1960) is of the opinion that light acts as a "master factor" in arthropods and that only when it rises above or falls below certain threshold values do other factors such as temperature and humidity exert an effect. According to Hassan (1976) if no other factor intervenes, light intensity is the overriding factor determining the time roosting is initiated and also perhaps the time at which daily initial (morning) flight occurs. Our observations on the duration of roosting and on factors determining the initiation and termination of roosting behaviour in *P. congener* are consistent with the views of the above mentioned authors.

Advantages of communal roosting

In different species of roosting odonates, the reaction to strong lights varies, depending on the duration of the light period. Hassan (1976) found that *Palpopleura lucia lucia* kept in a glass cage at 25-30°C and roosting singly, began to fly about as soon as the laboratory lights were switched on. In the dragonflies *Libellula needhami* and *Pachydiplax longipennis*, Penn (1950) found that artificial light does disturb the roosting posture of those individuals not roosting in aggregation. The observation of the present authors that the bright but momentary flash of an electronic light did not at all disturb the posture of communally roosting *P. congener* further strengthens the view that species given to communal roosting have a definite advantage based on what Grassé (1946) called "effet de groupe", over species roosting singly. The group effect may be the outcome of mutual stimulation and interaction of individuals forming the aggregation.

Roosting in aggregation, as is well known in the case of various other animals living in aggregations and societies, also affords protection from predatory animals by minimising the danger from the predator. Grouped prey often detect an approaching predator sooner than do solitary individuals (Pulliam, 1973 ; Powell, 1974 ; Siegfried & Underhill, 1975 ; Lazarus, 1979). Earlier detection increases the likelihood of escape ; this advantage may be particularly large if group members give an alarm when a predator is sighted (Charnov & Krebs, 1975 ; Seifarth *et*

al., 1980). The advantages derived by communally roosting *P. congener* are thus evident.

ORIENTATION TO ROOST BY VISUAL OR PHEROMONAL CUES OR BY BOTH

Our observations on the communal roosting behaviour of *P. congener* raise the question whether the orientation to the fixed roosting site or dormitory is effected through visual cues, pheromonal cues or both of these. Dragonflies have very large eyes and extremely good vision. The daily evening flight of *P. congener* in small batches to the communal roost on the selected tree, located fairly far from the diurnal haunts of these insects, indicates a well developed capacity for learning the route to the roosting site by remembering the important landmarks along the route (a capacity which is highly developed in many aculeate Hymenoptera). Alternatively, or in addition, there may be the intervention of an aggregation pheromone (somewhat of the nature of "locustol" of NOLTE *et al.*, 1973 and NOLTE, 1976) produced and detected by individuals of the species aggregation. Such an aggregation pheromone may serve to direct the conspecifics to the temporarily fixed roost which itself may be "scent-marked" as has been found in the communal roosting behaviour of the solitary sphecid wasp *Chalybion californicum*, SCHOENLY & CALABRESE, 1983.

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REFERENCES

CHARNOV, E. L. & J. R. KREBS, 1975. The evolution of alarm calls : altruism or manipulation ? *Am. Nat.* 109 : 107-112.

CHOPARD, L., 1960. Ordre des odonates. *In* : P.-P. Grassé, *Traité de zoologie*, tome 9, pp. 312-354. Masson, Paris.

CLOUSDSLEY-THOMPSON, J. L., 1960. Adaptative functions of circadian rhythm. *Cold Spring Harbor Symp. quant. Biol.* 25 : 343-355.

CORBET, P. S., 1960. Patterns of circadian rhythms in insects. *Cold Spring Harbor Symp. quant. Biol.* 25 : 357-360.

FRASER, F. C., 1944. Diurnal and nocturnal resting habits of Bradinopyga geminata (Rambur) (Odonata : Libellulidae). *Ent. mon. Mag.* 80 : 76-77.

GAMBLES, R. M., 1971. Dragonfly dormitories. *Niger. Fld* 36 (4) : 166-170.

GRASSÉ, P. P., 1946. Sociétés animales et effet de groupe. *Experientia* 2 (3) : 77-82.

HASSAN, A. T., 1976. Studies on the roosting behaviour of Palpopleura lucia lucia (Drury) and Acisoma panorpoides inflatum Sélys (Anisoptera : Libellulidae). *Odonatologica* 5 (4) : 323-329.

HEYMER, A., 1973. Verhaltensstudien an Prachtlibellen. Beiträge zur Ethologie und Evolution der Calopterygidae Sélys, 1950 (Odonata : Zygoptera). *Fortschr. Verhaltensf.* 11 : 1-100.

LAHIRI, A. R., 1975. A note on the behaviour of Bayadera hyalina Sélys in the rain (Zygoptera : Euphaeidae). *Odonatologica* 4 (4) : 255-257.

LAZARUS, J., 1979. The early warning function of flocking in birds : an experimental study with captive quelea. *Anim. Behav.* 27 : 855-865.

NOLTE, D. J., 1976. Locustol and its analogues. *J. Insect. Physiol.* 22 (6) : 833-838.

NOLTE, D. J., S. H. EGGERS & I. R. MAY, 1973. A Locust Pheromone : Locustol. *Jl Insect. Physiol.* 18 (8) : 1547-1554.

O'FARRELL, A. F., 1971. Roosting and related activities in Australian Zygoptera. *Jl R. ent. Soc. Lond.* (A) 46 (1) : 79-87.

PARR, M. J. & M. PARR, 1974. Studies on the behaviour and ecology of Nesciothemis nigeriensis Gambles (Anisoptera : Libellulidae). *Odonatologica* 3 (1) : 21-47.

PENN, G. H., 1950. Observations on the nocturnal habits of adult dragonflies. *Proc. ent. Soc. Wash.* 52 : 88-90.

POWELL, G. V. N., 1974. Experimental analysis to the social value of flocking by starlings (Sturnus vulgaris) in relation to predation and foraging. *Anim. Behav.* 22 : 501-505.

PULLIAM, H. R., 1973. On the advantages of flocking. *J. theor. Biol.* 38 : 411-422.

RAU, P. & N. RAU, 1916. The sleep of insects. An ecological study. *Ann. ent. Soc. Am.* 9 : 227-274.

SCHOENLY, K. & D. M. CALABRESE, 1983. An aggregation of Chalybion californicum (Hymenoptera : Sphecidae) in a bell. *Ent. News* 94 : 145-146.

SEYFARTH, R. M., D. L. CHENEY & P. MARLER, 1980. Velvet monkey alarm calls : semantic communication in a free-ranging primate. *Anim. Behav.* 28 : 1070-1094.

SIEGFRIED, W. R. & L. G. UNDERHILL, 1975. Flocking as an anti-predator strategy in doves. *Anim. Behav.* 23 : 504-508.