

THE PHENOLOGY OF DRAGONFLIES IN THE DEHRA DUN VALLEY, INDIA

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Seasonal distribution of some Indian species, which centers largely around different types of larval habitats, is discussed. Two main types of larval habitats are present in the valley, viz. the perennial streams, and seasonal monsoon ponds. The observations seem to indicate that in the species developing in perennial streams, the larval period is prolonged for some 5-8 months, while the adults are on wings for not less than 3-4 months. On the other hand, the larval period of species breeding in seasonal monsoon ponds is shortened to about 2-4 months, while their adult life span is prolonged to 8-9 months.

INTRODUCTION

Though GAMBLES (1960) and CORBET (1962) have discussed the environmental factors and their effects on seasonal distribution of some dragonfly species of the tropical region, similar observations on Indian species are scarce. The present work was thus undertaken to fill in this gap.

The Dehra Dun Valley was selected for these investigations because its topography and climate provide ideal breeding habitats and because no thorough survey of its odonate fauna has been undertaken so far.

The Valley, enclosed by the Siwalik Hills and the outer scarps of the Himalaya, covers an area of about 1200 km² between 77°35' and 78°20'E and 29°57' and 31°2' N. The climate is of the tropical monsoon type; the annual precipitation amounts to about 2500 mm, 75% of which falls in the months of

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June, July, August and September. The mean annual temperatures vary between 3°C and 40°C.

TECHNIQUES OF OBSERVATION AND TYPES OF LARVAL HABITATS

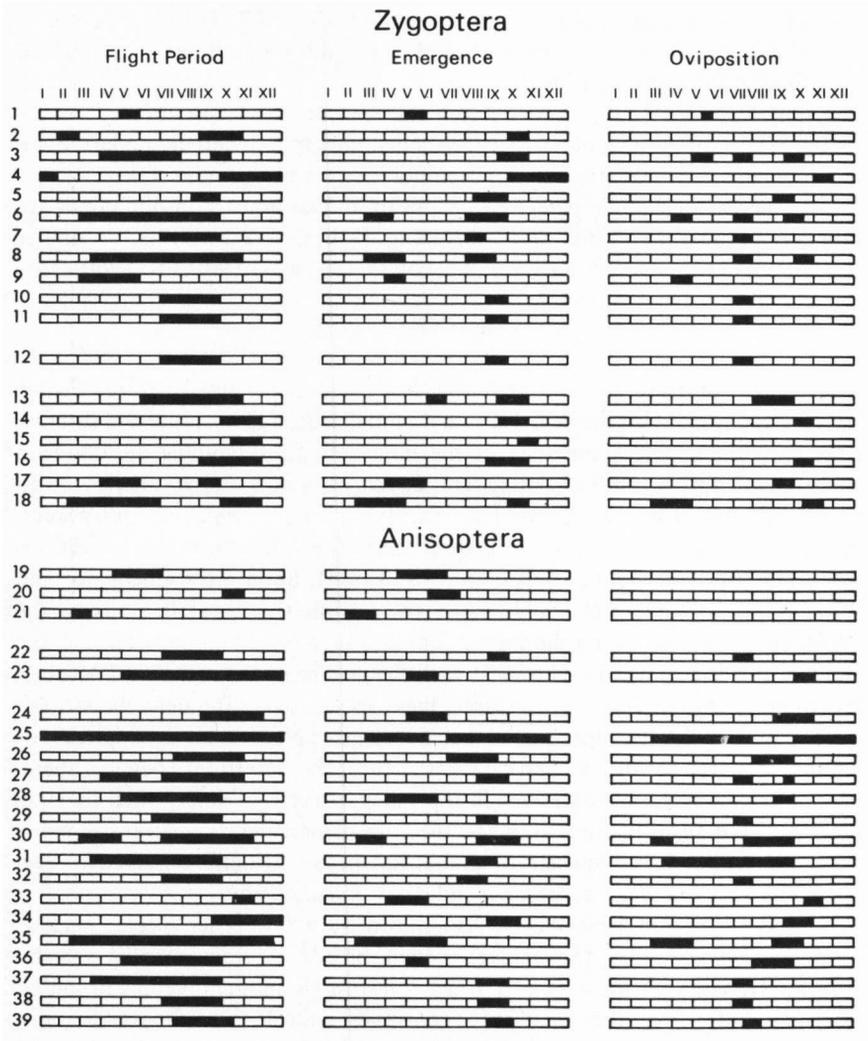
Oviposition and emergence were regularly recorded in the field for a number of species during the years 1967-70. Duration of egg and larval stages was studied in the laboratory also (KUMAR, 1971b, 1972a, 1972b, 1972c, 1972d). Larvae were extensively collected in the field throughout the year and were reared to adults in the laboratory (cf. SANGAL & KUMAR, 1970a, 1970b; KUMAR, 1971a). Nevertheless, our observations are still fragmentary, therefore the present review on the life history pattern and seasonal behaviour should be regarded as provisional only.

Aquatic habitats in the valley are mainly of two types, viz. permanent and temporary (seasonal).

Permanent habitats are mainly rivers, hill streams, slow running marshy streams and cemented garden tanks. The velocity of hill streams is usually high, while their beds are generally stony and sandy. The seasonal habitats of the valley are formed as a result of South-West monsoons, and contain water during about 3 months only (July to September), thus for an interval not exceeding one larval generation (GAMBLES, 1960; KUMAR, 1972a). They are spatially very restricted. The water is warm and stagnant. The substratum is muddy and consists of rotting vegetation.

The suitability of both types of habitats for larvae is chiefly dependent on the rainfall.

Fig. 1. Phenology of some Dehra Dun dragonflies. (Roman numerals indicate months). (1-11): Coenagrionidea: 1. *Desparoneura campioni* Fraser, 2. *Copera marginipes* (Rambur), 3. *Pseudagrion rubriceps* Selys, 4. *P. laidlawi* Fraser, 5. *P. decorum* (Rambur), 6. *Ceriagrion coromandelianum* (Fabricius), 7. *Coenagrion dyeri* Fraser, 8. *Ischnura delicata* (Hagen), 9. *I. senegalensis* (Rambur), 10. *Rhodischnura nursei* (Morton), 11. *Agriocnemis pygmaea* (Rambur); - (12): Lestoidea: *Lestes praemrosa praemrosa* Selys; - (13-18): Calopterygoidea: 13. *Rhinocypha unimaculata* Selys, 14. *R. trifasciata* Selys, 15. *R. quadrimaculata* Selys, 16. *Anisopleura comes* Selys, 17. *Bayedra indica* (Selys), 18. *Neurobasis chinensis chinensis* (Linnaeus); - (19-21): Gomphidae: 19. *Mesogomphus lineatus* (Selys), 20. *Burmagomphus sivalikensis* Laidlaw, 21. *Anisogomphus occipitalis* Selys; - (22-23): Aeshnidae: 22. *Anax guttatus* (Burmeister), 23. *A. immaculifrons* Rambur; - (24-39): Libelluloidea: 24. *Macromia moorei* Selys, 25. *Orthetrum pruinum neglectum* (Rambur), 26. *O. brunneum brunneum* (Fonscolombe), 27. *O. sabina* (Drury), 28. *O. taeniolatum* (Schneider), 29. *Potamarcha obscura* (Rambur), 30. *Crocothemis servilia servilia* (Drury), 31. *Bradinopyga geminata* (Rambur), 32. *Tholymis tillarga* Fabricius, 33. *Sympetrum commixtum* (Selys), 34. *Trithemis aurora* (Burmeister), 35. *T. festiva* (Rambur), 36. *Zyxomma petiolatum* Rambur, 37. *Brachythemis contaminata* (Fabricius), 38. *Pantala flavescens* (Fabricius), 39. *Tramea basilaris burmeisteri* Kirby.



PHENOLOGY

GAMBLES (1960), CORBET (1962, 1964) and KUMAR (1972a) pointed out that, unlike in the temperate regions where the temperature is the chief factor controlling the dragonfly life history pattern (cf. CORBET, 1954, 1962, 1964), in the tropics seasonal monsoon rainfall is the most important factor which modifies the life history pattern.

In the Dun Valley, the majority of the species emerge either before the start of the monsoon or towards its decline, depending upon whether the larvae are developing in perennial streams, or in temporary monsoon ponds (cf. Fig. 1).

The species breeding in perennial streams or in temporary monsoon ponds are generally uni-voltine, while those breeding in both are bivoltine. A similar pattern has been recorded, for some Nigerian species, by GAMBLES (1960).

UNIVOLTINE SPECIES

The first group of species, viz. those that breed in perennial streams (which become torrential with the heavy seasonal rainfall), emerge in spring and summer (April to June), before the start of the monsoon, thus avoiding the floods in their larval forms. Among these are *Bayedera indica* Selys, *Desparoneura campioni* Fraser, *Libellago lineata lineata* (Burmeister), *Anisoptera comes* Selys, *Rhinocypha* spp., *Sympetrum commixtum* (Selys), *Anax immaculifrons* Rambur, *Macromia moorei* Selys, etc. (cf. Tab. I). Soon after emergence and during the monsoon, the adults move away from the larval habitats to the comparative shelter of neighbouring forests and are seldom seen around the streams during this period. However, with the decline of the monsoon (October-November), when the water decreases, these species again frequent the stream. During this period the reproductive behaviour takes place. With the approach of winter, the adults again gradually disappear from the waterside. They are, therefore, common around the streams in the valley in early summer, when they are emerging, and again in autumn, when they are ovipositing, thereafter becoming scant gradually. This sequence of events has been distinctly observed in two species at least, viz., *Bayedera indica* and *Anax immaculifrons*.

The same type of behaviour is also shown by a few other species, such as *Orthetrum taeniolatum* (Schneider), which breeds in slow running marshy streams. However, in the case of *Trithemis festiva* (Rambur) breeding in similar biotopes and rivers, the emergence continues almost throughout the year, (though it is more abundant during spring) and its reproductive period is also prolonged almost throughout the year. Similar is the case of *Orthetrum pruinosum neglectum* (Rambur), which oviposits in almost every type of aquatic habitat, save the hill streams; it is a most common and conspicuous dragonfly in the valley throughout the year. The larval period of the foregoing group of

Table I
Some Dehra Dun dragonflies according to their breeding habitats

Stream breeding species	Pond breeding species	Species breeding in streams and in ponds
<i>Desparoneura campioni</i> Fraser	<i>Coenagrion dyeri</i> Fraser	<i>Pseudagrion rubriceps</i> Selys
<i>Pseudagrion laidlawi</i> Fraser	<i>Rhodischnura nursei</i> (Morton)	<i>Ischnura delicata</i> (Hagen)
<i>Pseudagrion decorum</i> (Rambur)	<i>Agriocnemis pygmaea</i> (Rambur)	<i>Ceriagrion coromandelianum</i> (Fabricius)
<i>Ischnura senegalensis</i> (Rambur)	<i>Lestes praemrosa praemrosa</i> Selys	<i>Orthetrum sabina</i> (Drury)
<i>Rhinocypha unimaculata</i> Selys	<i>Anax guttatus</i> (Burmeister)	<i>Crocothemis servilia servilia</i> (Drury)
<i>Rhinocypha trifasciata</i> Selys	<i>Potamarcha obscura</i> Rambur	
<i>Rhinocypha quadrimaculata</i> Selys	<i>Brachythemis contaminata</i> (Fabricius)	
<i>Anisopleura comes</i> Selys	<i>Bradinyopyga geminata</i> (Rambur) (Cement Tanks)	
<i>Bayedra indica</i> Selys	<i>Zyxomma petiolatum</i> (Rambur) (Cement Tanks)	
<i>Anax immaculifrons</i> Rambur	<i>Tholymis tillarga</i> (Fabricius)	
<i>Anisogomphus occipitalis</i> Selys	<i>Pantala flavescens</i> (Fabricius)	
<i>Burmogomphus sivalikensis</i> Laidlaw	<i>Tramea basilaris burmeisteri</i> Kirby	
<i>Mesogomphus lineatus</i> (Selys)		
<i>Macromia moorei</i> Selys		
<i>Orthetrum brunneum brunneum</i> (Fonscolombe)		
<i>Orthetrum taeniolatum</i> (Schneider)		
<i>Orthetrum pruinosum neglectum</i> (Rambur)		
<i>Trithemis festiva</i> (Rambur)		
<i>Trithemis aurora</i> (Burmeister)		
<i>Neurobasis chinensis chinensis</i> (Linnaeus)		

species may last 4-8 months (Tab. II). The second group of dragonflies are those which breed in temporary monsoon ponds. These are: *Lestes praemrosa praemrosa* Selys, *Agriocnemis pygmaea* (Rambur), *Coenagrion dyeri* Fraser, *Rhodischnura nursei* (Morton), *Anax guttatus* (Burmeister), *Crocothemis servilia servilia* (Drury), *Pantala flavescens* (Fabricius), *Tramea basilaris burmeisteri* Kirby, *Tholymis tillarga* (Fabricius), etc. (Tab. I). These ponds contain water from July to October only. The species which inhabit such ephemeral habitats are bound to complete their larval development very rapidly; the adults emerge towards the decline of the monsoon in September and early October (cf. BICK, 1951; GAMBLES, 1960; KUMAR, 1972a). During this period the teneral adults

Table II
Data on larval growth of some Dehra Dun dragonflies

Species	Larval habitat	Oviposition (months)	Emergence (months)	Duration of egg and larval stages (in days)	References
<i>Orthetrum brunneum</i> <i>brunneum</i> (Fonsc.)	tributaries of hill streams	IX - X	V - VI	250 (approx.)	KUMAR, 1971b
<i>O. pruinosum neglectum</i> (Rambur)	slow running streams, rivers, etc.	continuous	continuous	155	KUMAR, 1972c
<i>Trithemis festiva</i> (Rambur)	slow running streams etc.	X - XI	III - IV	110	KUMAR, 1972b
<i>Bradynopyga geminata</i> (Rambur)	perennial cemented garden tanks	III - IV	VII - IX	160	KUMAR, 1972d
<i>Lestes praemrosa</i> <i>praemrosa</i> Sel.	temporary monsoon ponds	VI - VII	IX - X	90	KUMAR, 1972a

are found in large numbers around the temporary ponds, and in the rice vegetation of neighbouring fields. Shortly afterwards they disappear from these sites suddenly. The most conspicuous and first to disappear are *Pantala flavescens* and *Tramea basilaris burmeisteri*. The adults of this group of species are not found around the larval habitats during the later part of the year, and not until the following monsoon. Adults of some of the smaller species, i.e., *Lestes praemrosa praemrosa* were found to be present in the neighbouring forests (KUMAR, 1972a), a phenomenon which has been observed in other tropical species of this genus as well (FRASER, 1955; GAMBLES, 1960). The adults of larger species, e.g., *Pantala flavescens* and *Tramea basilaris burmeisteri* are believed to migrate from the valley, as they do in other tropical countries (GAMBLES, 1960; CORBET, 1962). The process of emigration and immigration and the adaptations in connection with this phenomenon have been discussed by various authors (cf. CORBET, 1962). The insects again frequent the newly forming ponds as soon as the next monsoon rainfall starts in June-July, and show reproductive behaviour. The precise cause of the stimuli to come back to the breeding grounds are not known, though rise in humidity is believed to be one of the reasons (GAMBLES, 1960).

The oviposition at this time is vigorous, and any patch of water, whether suitable or not, is tried to be made use of. The small Zygopterous species are commonly observed *in tandem* around these ponds, ovipositing endophytically in those plants which are soon to be submerged in water. In the early part of the monsoon, after rainy nights, the adults of *Pantala flavescens* in tandem were observed during the early morning on wet cemented roads trying to oviposit in

large numbers on water patches which had formed on the roads and which were not more than 2-3 mm deep. These patches eventually dried up as soon as the sun came out in a few hours time.

After oviposition, the adults gradually disappear. Thus, the species which breed in temporary ponds are common in the valley during September and October when they are emerging in large numbers, and are in teneral condition during this period. They are observed next during July and August of the following year, when they oviposit in newly formed ponds. The period in between is spent away from larval habitats.

BIVOLTINE SPECIES

There is a third group of species in the valley which makes use of both temporary and permanent larval habitats; examples are: *Pseudagrion rubriceps* Selys, *Ischnura delicata* (Hagen), *Ceriagrion coromandelianum* (Fabricius), *Orthetrum sabina* (Drury) and *Crocothemis servilia servilia* (Drury). The adults of these species emerge from temporary ponds when the monsoon is on the decline. They soon attain sexual maturity and begin to frequent the slow running streams and rivers, when they oviposit frequently in these habitats. With the approach of winter they disappear gradually. From this larval generation the adults emerge in the following spring and summer. They again frequent and oviposit in temporary ponds in July and August. Thus, because of their bivoltine life history, the adults of these species are common in the valley almost continuously from spring to early winter. GAMBLES (1960) has also discussed briefly the possibility of many-brooded species in Nigerian dragonflies, while SANGAL (1961), when studying the biology of *Crocothemis servilia* in Dehra Dun, found as many as three larval generations in a year.

Two species in the valley, viz., *Zyxomma petiolatum* and *Bradinopyga geminata*, are peculiar in that they breed specifically in cemented garden tanks, and thus can almost be called suburban or garden species. At the same time, however, they differ from each other considerably in their seasonal distribution and habits.

Bradinopyga geminata emerges in considerable numbers from the tanks during the monsoon (July to September). With the coming of autumn, the insects move away to sheltered sites where they can be observed, on bright sunny days, throughout the winter. Once during a winter, the author came across a deserted building in a forest in the valley of the Rispana River at Rajpur. The building harboured a colony of this species, but strangely enough, the six specimens collected were all females.

As the winter declines, by the middle of February, the old adults again frequent their original larval habitat; the males appear first followed soon by the females. Now oviposition starts, and is most vigorous during March and April. It

continues scantily throughout the summer and monsoon almost up to the end of August. Larval development is completed in a short period of about five months, and emergence takes place again in the coming July and August. This has been confirmed also by the study of the life history of the species in the laboratory (cf. Tab. II). The fate of the eggs which were laid as late as August in one particular tank, is not known, because the tank in which the oviposition was observed also held a large population of fish, which would track the ovipositing females, as they flew from one side of the tank to the other, and eventually ate up almost all the eggs. The same type of behaviour among fishes was also observed in this tank when the females of *Zyxomma petiolatum* would oviposit. The newly emerged adults immediately move away from their larval habitats and appear only in March. Thus, these adults oviposit about seven months after their emergence.

The adults of *Bradinopyga geminata* are common around their breeding grounds from spring to autumn, and after that they move away to sheltered sites.

However, *Zyxomma petiolatum* is considerably different in its behaviour. It is a crepuscular species, and in normal routine frequents the tanks from afternoon to late evening, until it gets completely dark. It emerges during a short period and occurs in May. The adults are common on the wing from May till the end of September. Oviposition takes place from June to September. No adults are found around larval habitats during winter.

B. geminata was found breeding in static tanks in which the water was relatively fresh and had not been disturbed; at this time *Z. petiolatum* was not found in this habitat. Subsequently, as the water stagnated in these tanks the former species was no longer found, but had been replaced by the latter.

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