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Flight Activity and Sex Ratios of a Damselfly, *Platycnemis echigoana* ASAHINA (Zygoptera, Platycnemididae)¹⁾

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Abstract Mark-and-recapture method was applied to a damselfly, *Platycnemis echigoana*, a rare species among the Platycnemididae in the cool temperate zone of Houshu, Japan. The peak activities of males were observed during 10 : 00-14 : 00, and those of females somewhat delayed. Tandems were also recognized during 11 : 00-14 : 00. Males defended a sunlit point, where the sunlight fell on the forest floor, by perching, and chasing conspecific males. Females encountered the male at the sunlit point, mated and then showed tandem behaviors. They oviposited into plant tissues on the water surface. The size of a mature egg was about 0.19 mm in diameter and 1.14 mm in length. A female seemed to have 250 mature eggs, and then laid about 170 eggs after a mating. A male showed strong residency perching at a sunlit point, while a female did not. Sexual differences in such behaviors were also reflected in the resident ratios.

Introduction

A damselfly, *Platycnemis echigoana*, has been considered to be a rare species among the Platycnemididae which is distributed at a few prefectures in the cool temperate zone of Honshu, Japan. Its habitat is restricted to ponds surrounded by forests of deciduous trees such as a beech. No more than twenty minor habitats of *P. echigoana* are counted in Japan. In spite of its narrow distribution, its local density at a habitat seems to be higher than the other common Coenagrionoidea species coexisting in the same habitat. However, little is known about this particular damselfly, *P. echigoana*, except a brief life history with occasional observations (e.g. EDA, 1965) and preliminary observations on diurnal behaviors (OHSAWA & WATANABE, 1984). This paper then describes the sex ratios with some population parameters, in relation to diurnal activities of males and females.

Study Area

The experimental area (4 km × 5 km) was located in Urabandai, Fukushima Prefecture, north-east Japan. The area is a highland with a lot of ponds surrounded by forests, where some Coenagrionoidea species (e.g. *Lestes sponsa* and *L. temporalis*) inhabit. A main study plot, Ningyo-no-ike (N), and six satellite study

1) Comparative ecological studies of Coenagrionoidea in woodlands II.

plots (S_1 - S_6) were chosen in consideration of topographic characteristics and abundance of *P. echigoana*.

The main study plot was a mixed forest of *Quercus crispula* and *Pinus densiflora* including a pond 200 m in circumference. *Rhus trichocarpa* and *Salix jessoensis* grew in shrub layer. Although the forest had closed crowns, a little penetrating sunlight fell here and there on the forest floor just like a spotlight. The water surface of the pond was covered by floating-leaf water plants up to its 80-90%.

The satellite study plots were arranged around the main study plot. The surrounding forest of each plot consisted of deciduous trees such as oaks, beeches and maples with some coniferous trees, though the size of each pond was variable (10 m-2.5 km around). The sunlight just like a spotlight also fell on the forest floor at every study plot.

Other detailed descriptions of the study plots in the experimental area are given in our earlier report (OHSAWA & WATANABE, 1984).

Methods

The number of adults was counted during the period from 28th July to 4th August, 1983. At each sampling, all the adults found during one hour in a day were captured by a net, anesthetized by carbon dioxide, and then, marked individually on their hind wing with a felt pen. The condition of the wings as well as the abdomen was recorded in order to know the age. It was considered that such procedures of marking gave little effects to their flight activities because most damselflies began to fly normally when they recovered from the anesthesia. The damselflies wounded by marking, if any, were treated as dead individuals in this study. In all, the total number of marked adults exceeded 450.

The change in number of adults seen during a day at the main study plot was intensively observed for five days, though all of the days were unfortunately cloudy.

All of the females found at the last sampling time were collected in all study plots, and some of them were dissected in order to assess her fecundity.

Results and Discussion

Diurnal activity

Most of *P. echigoana* found in the experimental area were in mature stages. They seldom flew away far from the forest, except for oviposition above the water surface. They made clear tandem behaviors for ovipositions, as reported by OHSAWA & WATANABE (1984).

The typical diurnal activities at the main study plot is shown in Fig. 1. From the mean quarter-hourly counts, males were the most active during 10:00-14:00, though females somewhat delayed. The tandems were observed from 11:00 to

14 : 00 in cloudy days and most females were in tandems during that time (Fig. 1). On a sunny day, similarly, the tandems were often found during 10 : 30–14 : 30 at satellite study plots.

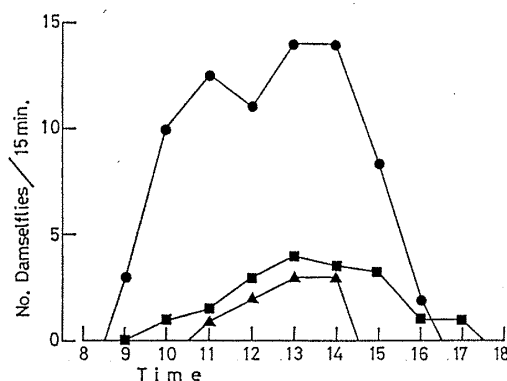


Fig. 1. Diurnal changes in the activities of the adult damselflies, *P. echigoana*, at the main study plot, N. The number of adults appearing at the plot per 15 minutes was averaged in 5 dull days. The circle and the square mean the number of males and that of females, respectively; the triangle means the number of tandems.

The daily arrival of males in the understory of forests began 9 : 00. They alighted from the forest crown down to the forest floor. He stayed at a particular sunlit point, the site of which is ranging from 30 cm × 30 cm to 1 m × 1 m, and spent much time perching at this point on an understory bush, a grass or a herb. If another male came into his point, however, the perching male dashed to the intruder and drove him away from the point. The sunlit point defended from other males may be called the territory, though we did not always observe the residential male making patrol. Mating behavior was found in the understories of the forest. Then, they made tandem, flew from the forest to the water surface and laid eggs into the plant tissues. Thus, copulation away from water occurs in *P. echigoana*, though territorial activities of many dragonfly species except *Nesciothemis nigeriensis* appear to be rare away from water (PARR, 1983). Detailed diurnal behaviors of both sexes were already reported (OHSAWA & WATANABE, 1984).

Estimated numbers by "MANLY and PARR method" (MANLY, 1971) at quarter-hourly samplings of *P. echigoana* on 3rd August, 1983 are shown in Fig. 2. The highest estimated number of males was observed in the morning but females in the afternoon. Each variance for estimated number of males in the morning was larger than that in the afternoon, while that of females in the morning was smaller than in the afternoon. Immigration and emigration of males occurred very often in the morning, but those of females in the afternoon. Such movements were in accordance with the results of observation on diurnal behaviors of this damselfly (OHSAWA & WATANABE, 1984).

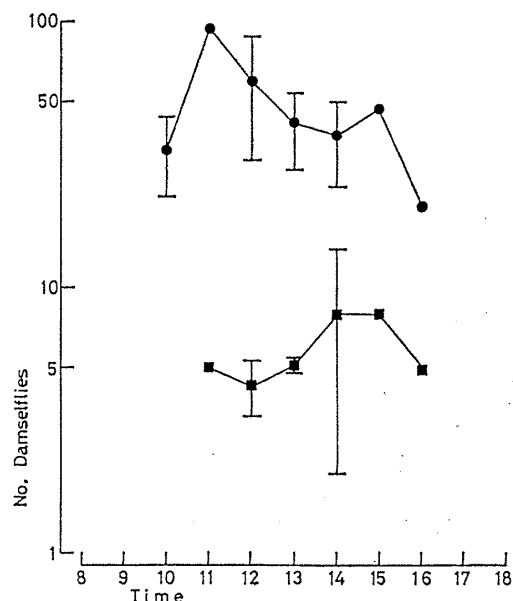


Fig. 2. Change in numbers estimated by MANLY and PARR method at the main study plot, N, 3rd August. The circle and the square mean the number of males and that of females, respectively (\pm s.d.).

Number of mature eggs

It is generally known that the condition of wings and abdomen is almost coincident with the age (e.g. WATANABE, 1979). Although we preliminarily classified the adults of *P. echigoana* into two grades (immature and mature), most of the individuals now studied were mature ones in the study period. Females examined were also mature, except two immature (=teneral) ones immediately after emergence.

The number of mature eggs and the condition of the sperm storage organ in adult females were investigated by dissections. No mature eggs were found in the immature females immediately after emergence (Table 1). The size of a mature egg was about 0.19 mm in diameter and 1.14 mm in length. Table 1 also shows that the mature females may be classified into two classes, whether there is full in sperm storage organ, though we do not know the function of the penis of *P. echigoana*, i.e. sperm removal and transfer as reported by WAAGE (1979). As it can be seen that a virgin female has an empty sperm storage organ, a female with full of sperm there is regarded as a mated individual. Thus, it seems that a virgin female had about 250 eggs and laid about 170 eggs after mating.

Table 1. The number of mature eggs in different classes of females (\pm s.e.).

	n	No. mature eggs
immediately after emergence	2	0
mature females with an empty sperm storage organ	6	247.7 \pm 19.5
mature females with a full sperm storage organ	14	75.5 \pm 20.5

n: number of females examined

Sex ratios and resident ratios

Table 2 shows the mean sex ratios of captured adults and those from estimated number at each sampling time. As expected from diurnal activities (Fig. 1), daily sex ratio was low among study plots (0.15–0.31). It was also low in estimated numbers calculated by two methods, CHAPMAN (1951) and "MANLY and PARR" (MANLY, 1971). There are many reports about an excess of male in samplings (and in estimated numbers) among many insect species, such as a swallowtail butterfly, *Papilio polytes*, in Nepal (WATANABE, 1979) and a satyrine butterfly, *Erebia epipsodea*, in Colorado (BRUSSARD & EHRLICH, 1970). Low sex ratio seems to be due to differences in the behaviors of both sexes.

A male stayed long at a sunlit point, while a female did only short near the point. Although no acute statistically significant difference between sexes in each study plot was observed, the daily resident ratio of males was higher than that of females at every study plot (Table 3). In addition, expected survival periods of both sexes were calculated by the resident ratios, assuming that they are constant

Table 2. Sex ratios ($\frac{\text{♀}}{\text{♂} + \text{♀}}$) calculated by the total number of captures and estimated numbers of *P. echigoana* in each study plot (\pm s.e.). C., estimated by CHAPMAN (1951) and MP., estimated by "MANLY and PARR" (MANLY, 1971)

Study plot	No. samplings	No. captured	No. estimated by C.	No. estimated by MP.
N	5	0.21 \pm 0.04	0.25 \pm 0.05	0.10 \pm 0.02
S ₁	5	0.24 \pm 0.07	—	—
S ₂	4	0.28 \pm 0.11	—	(0.26)
S ₃	4	0.15 \pm 0.09	—	—
S ₄	3	0.17 \pm 0.01	—	—
S ₅ *	3	0.31 \pm 0.07	0.24 \pm 0.01	(0.28)
S ₆ *	3	0.19 \pm 0.01	(0.11)	(0.14)

N: main study plot
S₁~S₆: satellite study plots
*: surveyed in 1982

Table 3. Mean resident ratio in a day and expected survival period of *P. echigoana* in each study plot (\pm s.e.).

Study plot	N	S ₁	S ₂	S ₃	S ₄
Male					
Resident ratio (\pm s.e.)	0.624 \pm 0.160	0.225 \pm 0.112	0.321 \pm 0.104	0.056 \pm 0.056	0.463 \pm 0.117
Survival period (day)	4.89	1.54	2.02	0.80	2.99
Female					
Resident ratio (\pm s.e.)	0.239 \pm 0.191	0.000 \pm 0.000	0.177 \pm 0.177	0.056 \pm 0.056	0.463 \pm 0.117
Survival period (day)	1.61	0.00	1.33	0.00	1.45

through their life span. Since disappeared individuals do not necessarily mean dead ones but include emigrated ones during the study period, the survival period means the length of stay. TAGUCHI & WATANABE (1984) studied the seasonal prevalence of the dragonflies, such as *Sympetrum eroticum* and *S. pedemontanum*, in a paddy field and classified them into two categories according to the difference of the number observed between sexes, i.e. the cases in which there was an excess of males, and those in which the numbers of both sexes were nearly equal. Males of the species classified in the former showed apparently territorial behaviors on the paddy field. The females, in contrast, moved about on the paddy fields, deciduous forests and meadows all the day. It thus follows that, in these species, only females move actively over wider ranges.

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