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INITIAL STAGE OF TANDEM CONTACT IN *PLATYCNEMIS PENNIPES* (PALLAS) (ZYGOPTERA: PLATYCNEMIDIDAE)

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The behaviour of the ♂ during the initial stage of tandem contact was photo- and videorecorded in the experiments with ♀ models in their natural habitats. The ♂ holds the ♀ at the dorso-posterior edge of her head with its mouthparts, and at the lateral walls of the pronotum with the fore legs. The geometrical centre of the triangle of the ♂ points of support is situated along the ♀ longitudinal body axis in the region of the ♀ mesostigmal plate. It is suggested that the initial stage of tandem contact provides the tactile orientation for the subsequent tandem formation.

INTRODUCTION

It is known that damselfly males recognize their females distantly, using visual cues (BUCHHOLTZ, 1956; CORDERO, 1989; FORBES, 1991; CORDOBA-AGUILAR, 1992; GORB, 1992; FORBES & TEATHER, 1994). After catching the female by the male both sexes can examine conspecificity of the partner using the lock-key system, which is represented in Zygoptera by the male anal appendages (key) and female mesostigmal plate, situated dorsally in the mesothoracal region (lock) (BATTIN, 1993a; 1993b).

The seizure of the female by the male is usually so quick that the observer can notice only the rapid rush of the male to the female (whereafter the pair often falls into the vegetation) and then the individuals form a tandem. Thus, males can quickly and at a distance recognize the potential sexual partner and then very quickly orientate on the female body to fix its anal appendages at the corresponding female mesostigmal plate. In the present paper, based on field photographs and videofilms, the sequence of the male behavioural pattern in *Platycnemis pennipes* was examined.

METHODS

Field observations and experiments were carried out in July-August, 1993 at moist meadows near the Supoy Lake (Kiev province, central Ukraine) and in July, 1994 near Alteberg (Lower Austria). For this experiment a photo-unit, which included a mirror-photocamera (Zenit TTL) with a macro-objective (Volna-35MC) and a flash unit were arranged. To keep the female model in focus of the camera, the metal holder serving for keeping the female models in front of the objective was fixed by the camera. The system was movable, and models (freshly-killed females) were presented to the perching males in different positions to the objective (lateral, dorsal, and frontal aspects).

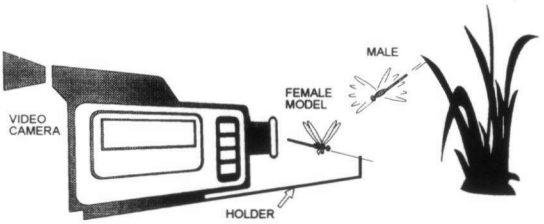


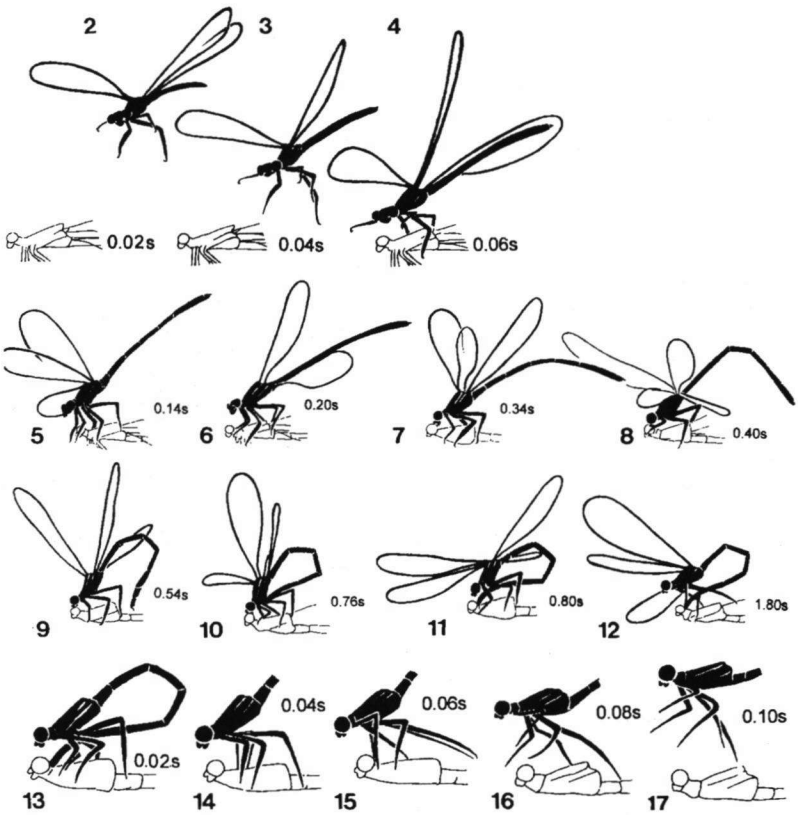
Fig. 1. Arrangement of the field experiment.

Males, which were in contact with the female models, were photographed or videofilmed (camcorder Canon EX1hi with "High-Speed-Shutter" positions at 1/500s and 1/1000s) from above or from the side (Fig. 1). With a video-timer the reaction times could be determined with a resolution of 0.02 s. Sequences of movements were reconstructed and drawn on the basis of single frame analysis (videorecorder: Panasonic NV-FS 100 HQ, 50 pictures/s). Experiments were carried out from 10.00 to 17.00. In all, 20 male responses were videorecorded and 72 responses were photographed.

RESULTS

After recognizing the model as a female, the male immediately rushes to it. This is the substage of the approach, during which the male usually keeps its legs widely spread (Figs 2-4). After the seizure of the female by its legs, the male starts to preorientate on the female body and deposite its legs laterally of the female thorax. If the male catches the female from the side or from the front, he usually displaces himself to occupy position faced anteriorly and parallel to the female body direction. The fore legs were usually situated ventrally on the prothorax, the second pair ventrally on the pterothorax, the hind legs on the posterior edge of the pterothorax of the female (Fig. 6). Then the male, with its mouthparts, tries to take the female's head at the dorso-posterior part (Fig. 7). Subsequently it begins to bend his abdomen and orientates to deposit his abdominal appendages at the corresponding structures of the female mesothorax (Figs 7-10). Whenever the female model was seized at the mesostigmal plate, the male released the female's head and took off with a jump (Figs 12, 13-17). To produce the jump, the male retracted its legs simultaneously. The bended abdomen serves probably as a string to give an additional force during its stretching.

I have analyzed few videosequences of this behaviour and found that the duration of different substages differs from each other (Fig. 18). The substage of the orientation, when the male deposits his anal appendages, is much longer. The approach and jump substages are rapid (less than 0.5 s each). The position of the



Figs 2-17. *Platycnemis pennipes*, stages of tandem contact (drawings from the video recording, time scale calculated from the beginning of the rushing to the model, as shown in Fig. 2): (2-4) the APPROACH stage, male rushing to the female model and displaces himself in the air to size from behind and approaches with the legs spread; – (5-12) initial stage of tandem contact: (5-6) PREORIENTATION substage, positioning of the legs, – (7) seizure of the female by her head, – (8-10) ORIENTATION substage, positioning of the anal appendages by the male on the corresponding structures of the female mesothorax, – (11-12) JUMP of the male to start the flight; – (13-17) details of the jump of the male to start the flight.

mouthparts and fore legs were practically identic in all photographs showing the early stage of the male abdomen bending before deposition of the anal appendages on the mesostigmal plate.

DISCUSSION

Tandem linkage is an important mating stage, which shifts the communication channel from visual to tactile modalities (UTZERI, 1989; BATTIN, 1993a; 1993b),

and it is essential for the understanding of courtship behaviour, recognition of conspecifics and for partner choice. I have described only the initial stage of tandem formation, in which the male has the leading role.

The majority of Zygoptera males, such as *Ischnura elegans*, can approach the female from different directions, but most often from behind. Such a position is probably more convenient for the subsequent manipulations. Females *Platycnemis pennipes*, which usually demonstrate refusal display with raised abdomen (GORB, 1992), can prevent in this way the possibility to be caught from behind.

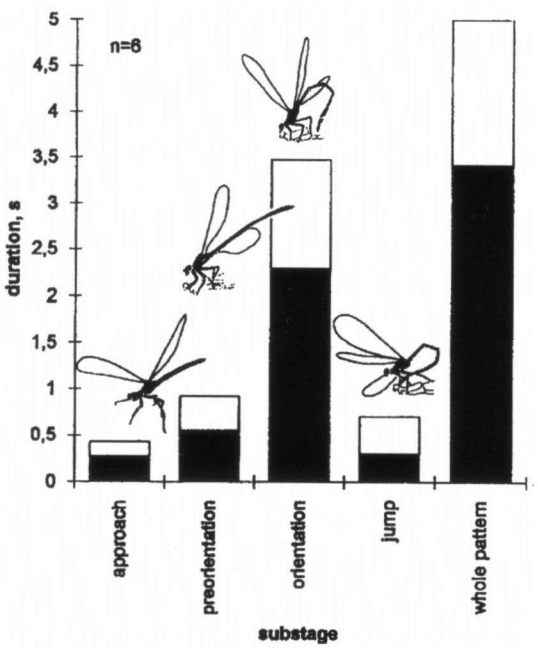


Fig. 18. Duration of different substages during the initial stage of tandem contact. – [Black: the means, white: standard deviation]

As far as the observed behavioural pattern was stable, it can be concluded that each substage [(1) approach, (2) preorientation, leg positioning and seizure of the female by its head, (3) holding the female's head and orientation on the female body with its anal appendages, (4) jump to the tandem flight] is released by the corresponding tactile stimuli as received by the male.

For release of the first and the second substage, the information received from the legs about the size and curvature of the female prothorax might be used. The third stage starts only, when the male seized the female by its head. During this stage the male has three points of support on the female body (Fig. 19). Such construction is stable, especially so with the support of two postcervical sclerites of the arrester system, which can fix the head to the prothorax (GORB, 1989; 1990a; 1990b; 1990c; 1991; 1993). The geometrical centre of the triangle of the male points of support [(1) male left leg 1 + the left side of female prothorax, (2) male mouthparts + the dorso-posterior edge of the female head, (3) male right leg 1 + the right side of female prothorax] is placed along the female longitudinal body axis in the region of the female mesostigmal plate. This central point may, probably, serve as an indicator of the place of the mesostigmal plate to help the male in orientation on the female body. After having found these three points, the male deposits its appendages very quickly and exactly at the mesostigmal plate. It seems that the last

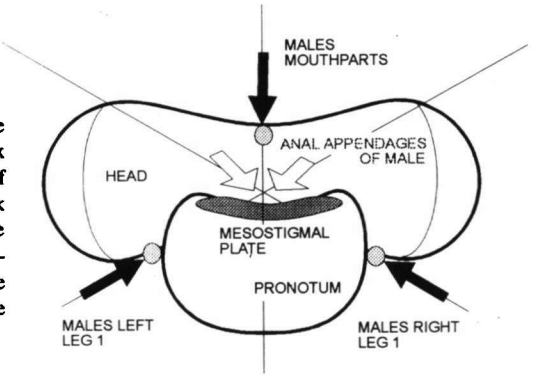


Fig. 19. Schematic silhouette of the zygopteran female head and mesothorax (view from behind), with the points of support of the hypothetical triangle (black arrows), when the male holds the female during the initial stage of tandem contact. – [White arrows indicate how the male finds the female mesostigmal plate as a centre of the triange of support].

stage is released by information from mechano-receptors of the male anal appendages. It can be hypothesized that males of Zygoptera can also recognize the conspecificity of the females by the shape of the described triangle, which is probably different in different species.

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REFERENCES

BATTIN, T.J., 1993a. The odonate mating system, communication, and sexual selection: a review. *Boll. Zool.* 60: 353-360.

BATTIN, T.J., 1993b. Revision of the puella group of the genus Coenagrion, with emphasis on morphologies contributing to reproductive isolation (Odonata, Coenagrionidae). *Hydrobiologia* 262: 13-29.

BUCHHOLTZ, C., 1956. Eine Analyse des Paarungsverhaltens und der dabei wirkenden Auslöser bei den Libellen Platycnemis pennipes Pall. und Platycnemis dealbata Klug. *Z. Tierpsychol.* 13: 13-25.

CORDERO, A., 1989. Reproductive behaviour of Ischnura graellsii (Rambur) (Zygoptera: Coenagrionidae). *Odonatologica* 18(3): 237-244.

CORDOBA-AGUILAR, A., 1992. Comportamiento reproductivo y polycromatismo en Ischnura denticollis Burmeister (Zygoptera: Coenagrionidae). *Bull. Am. Odonatol.* 1(3): 57-64.

FINCKE, O., 1987. Female monogamy in the damselfly Ischnura verticalis Say (Zygoptera: Coenagrionidae). *Odonatologica* 16(2): 129-143.

FORBES, M.R.L., 1991. Female morphs of the damselfly Enallagma boreale Selys (Odonata: Coenagrionidae): a benefit for androchromatypes. *Can. J. Zool.* 69: 1969-1970.

GORB, S.N., 1989. Functional morphology of the arrester system in dragonflies. *Vest. Zool.* 1989(3): 62-67. – [Russ.].

GORB, S.N., 1990a. Microsculpture of the head fixing system in dragonflies as seen by a scanning electron microscope. *Zool. Zh.* 69(2): 147-154. – [Russ.].

GORB, S.N., 1990b. Internal morphology of the arrester system in a dragonfly Erythromma najas

(Zygoptera, Coenagrionidae). *Vest. Zool.* 1990(6): 59-62 + 1. – [Russ.].

GORB, S.N., 1990c. The external morphology of the head fixation system in Calopterygoidea (Odonata, Zygoptera). *Zool. Zh.* 69(11): 37-45. – [Russ.].

GORB., S.N., 1991. Fixation reflexes of the head in the flight of the dragonflies (Odonata). *Z. evol. Biohim. Fiziol.* 27(4): 472-478. – [Russ.].

GORB, S.N., 1992. An experimental study of refusal display in the damselfly Platycnemis pennipes Pall. (Zygoptera: Platycnemididae). *Odonatologica* 21(3): 299-307.

GORB, S.N., 1993. Skeleton-muscle organization of the head fixation system in dragonflies (Odonata) and its evolutionary implicatons: a comparative study. *Petalura* 1: 3-17.

UTZERI, C., 1989. Tactile communication through the tandem link in the Odonata and the problem of tandem oviposition in Sympetrum (Libellulidae). *Opusc. zool. flumin.* 35: 1-6.