

## FORE LEGS OF DRAGONFLIES USED TO REPEL MALES

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A defensive behaviour performed by males and females of *Leucorrhinia rubicunda* is described. When attacked by a male a dragonfly will stretch its fore legs above the thorax and head to prevent the aggressive male from coupling his appendages to that region. This behaviour was observed also in other species, and it may be common throughout the order.

### INTRODUCTION

Dragonflies use their legs for walking, perching, grooming, catching prey or a female, and also as a weapon in aggressive encounters. The particular features of the fore legs as means for cleaning have been described by ST. QUENTIN (1936). BUCHHOLZ (1957) remarked that in *Orthetrum* only the middle and hind legs are used during perching, while in the Lestidae, Calopterygidae and Coenagrionidae the fore legs are put up behind the head against the prothorax, the "knees" pointing upwards. HEYMER (1969) described this as a general behaviour in the Libellulidae.

The position of the fore legs during flight is hardly recognizable with the naked eye. The photographs by DALTON (1982) and NAGEL & NACHTIGALL (1988) exclusively show the take-off and landing manoeuvres with all legs stretched out. Only slow motion films of freely flying *Leucorrhinia rubicunda* (RÜPPELL 1989) allowed a description of the hitherto unknown defense behaviour as reported here.

### MATERIAL AND METHODS

Dragonflies, flying freely in nature, *Orthetrum cancellatum* (RÜPPELL, 1984), *Lestes viridis*

(RÜPPELL, 1987) and *Leucorrhinia rubicunda* (RÜPPELL, 1989), have been filmed using a slow motion camera (Locam, Mod. -51; lenses: Kern Switar 16-100 mm, Canon 200 mm; Fujicolor Negative film 500 ASA). Time markings (1/100) s on the film allow a detailed analysis, using a single-frame projector (NAC, Mod. DF 168).

The reproductive behaviour of the species, especially the intention of the males to catch females, was filmed as completely as possible. The films were made in resp. 1984, 1987, and 1988 in northern Germany, all at temperatures above 20° C.

## RESULTS

### POSITION OF THE LEGS DURING FLIGHT

Dragonflies differ remarkably from other insects in the manner in which they hold their legs during flight. While the middle and hind legs are held in a parallel position tightly along the thorax with the femora pointing backwards and the tibiae and tarsi pointing forwards, nearly perpendicular to them the folded fore legs are carried, parallel to each other behind the head. The femur-tibia hinges point upwards, projecting above the prothorax. The tibiae point downwards, extending partly below the prothorax (Fig. 1). From their resting position the middle and hind legs can immediately be extended forwards and downwards to grasp a female or when attacking another male.

In *Orthetrum cancellatum* and *Leucorrhinia rubicunda* sometimes only the hind legs may be opened in such manoeuvres, but most often the middle legs are extended as well.

All three pairs of legs are used during landing, beginning with the opening of the hind legs, and the fore legs extending last.

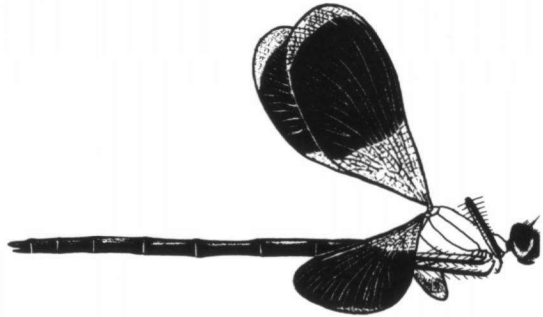


Fig. 1. During flight most Odonata keep their fore legs in a vertical position alongside the prothorax, as shown in this male *Calopteryx splendens*, drawn after a photograph by E. Bartels and H. Schulz.

### DEFENSIVE BEHAVIOUR USING THE FORE LEGS

In early summer, in species like *L. rubicunda* the number of males present at a water body is usually extremely high. During the early summer of 1988 an especially high population density was met at a pond of about 25 m diameter in a bog near Hannover, northern Germany. Here females of *L. rubicunda* often were

chased by up to 20 males simultaneously, the attacks resulting in chains of up to 4 coupled males with a trailing female.

Pairs in wheel or tandem position arriving for egg laying were also regularly attacked by males trying to get into tandem linkage.

Having been released from the normal wheel position for oviposition, females would immediately sit down motionless on the water surface or on drifting *Sphagnum* mats where they pressed out clumps of eggs directly into the water. Even in this camouflaged position they were spotted and attacked by males.

Under such circumstances the females would try to repel an approaching male with their fore legs stretched up above their head, and pushing them repeatedly against the male. The slow motion films revealed identical defensive behaviour in coupled tandem males when attacked by another male (Fig. 2), as well as in females being attacked while still in the wheel position (Fig. 3).

When stretched, the fore legs rise above the thorax for a distance approxi-

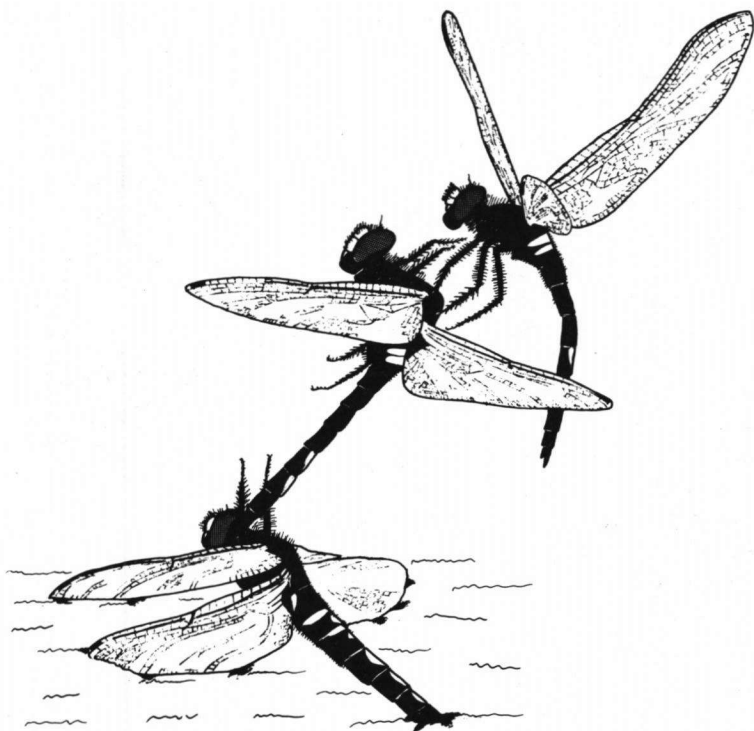


Fig. 2. Defensive behaviour using the fore legs in *Leucorrhinia rubicunda*. — A female laying eggs while drifting on the water surface had tried in vain to push off with her fore legs a male who at last could establish tandem linkage. In the same moment another male tries to fasten his appendages to the tandem male who kicks him with his fore legs.

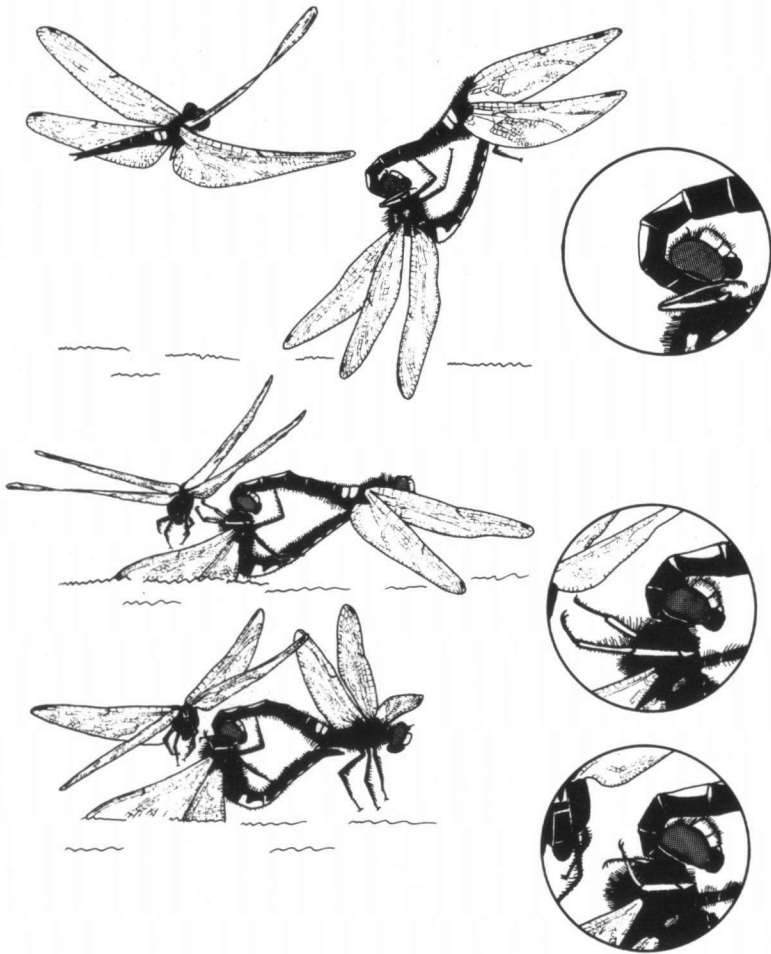


Fig. 3. Defensive behaviour using the fore legs in *L. rubicunda* during wheel position. From bottom to top: A sudden upward extending of the female's fore legs wards off a second male. Then the pair takes off in wheel position (bottom and middle), and the female folds her fore legs to normal flight posture (top).

mately equalling its vertical diameter. Flinging the tibiae upwards to the position parallel to the femora takes only about 0.01 s. Flapping the wings against the aggressive male adds to the efficacy of pushing with the fore legs. The fore legs may be stretched from their folded position alongside the prothorax (the position usually adopted in Libellulidae during flight or on the perch) or from clinging to the perch. This repelling leg posture is assumed only when an aggressive male is trying to get into direct contact with the head of a female or male.

Once a male *L. dubia* attacked a female *L. rubicunda* who pushed her fore legs upwards against him at the beginning of the attack; then during a looping which both individuals performed the fore legs were withdrawn, and at the end of the attack the legs were projected up again. The folding of the legs takes considerably more time (0.08 s) than the extending.

The same defensive behaviour, involving the fore legs, could be identified on photographs of tandems of *Enallagma civile* and of *Lestes viridis*. In the case of *E. civile* a male had grasped with his appendages a resting female from the water surface; in *Lestes viridis* the egg deposition female was warding off an interfering male in this way.

## DISCUSSION

Between dragonfly males there is a strong competition for females (WAAGE, 1984). Especially under conditions of high male density, single females, males leading a tandem, and single males are frequently attacked by other males. Attacks against males as well as attempts to grasp a mate are usually performed from above, because higher velocities can be achieved in diving flight, and in doing so an opponent's ventral region, which is protected by mouthparts and legs, is avoided. The target of all attacks against females — and often also males — is the vertex region of the head where the male appendages hook in. This region is protected by the fore legs extending upwards. This behaviour of pushing the fore legs upwards protects females from harassment by males and allows uninterrupted oviposition.

Males who successfully grasped a female employ this behaviour to guard themselves from being caught by competitors, thus increasing their own reproductive success.

Probably the defense behaviour described here is common in many, if not all Odonata, an assumption which is supported by the facts that this behaviour has been observed in unrelated species, that strong competition among males is present in all Odonata species and that during flight in most species the fore legs are kept folded alongside the prothorax.

A mechanism like a key and lock is effective in coupling the male appendages to the counterparts on the female head or prothorax. Warding off the coupling attempts by extending and pushing the fore legs upwards behind the head may be compared to the effect of a dog's spike-armed collar which keeps its bearer safe from being bitten.

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