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ABNORMAL TARSI IN ADULT ZYGOPTERA: GENETIC ABNORMALITIES OR INCOMPLETE REGENERATION?

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Amputated legs of larval Coenagrionidae regenerate to the same size, but not to the same form, as normal legs. Thus the abnormal tarsi described by D.J.F. HILTON (1985, *Odonatologica* 14: 247-250) may be the result of incomplete regeneration of lost legs rather than genetically transmitted deformities.

INTRODUCTION

HILTON (1985) reported that 34% of 107 adult *Amphiagrion saucium* collected near Sand Hill, Quebec, Canada had "abnormal" tarsi and suggested that tarsal abnormalities could be used as genetic markers in mating studies of adult Zygoptera. While Hilton admitted that he was uncertain as to whether the abnormalities were genetically transmitted, he suggested that such was the case because 87% of the abnormal tarsi (n=40) were identical in form. We use evidence from experimental studies on limb regeneration to argue that the abnormal tarsi of adult Zygoptera may be explained more simply by incomplete regeneration after leg loss or injury.

MATERIAL AND METHODS

A total of 63 larval *Ischnura verticalis* and *Enallagma ebrium* in instars F-6 through F-1 were collected from the Erindale pond (BAKER, 1986). We amputated one leg from each larva by holding it with forceps and waiting for the larva to autotomize the leg at the "breaking joint" (CHILD & YOUNG, 1903). After wounding, larvae were maintained individually in vials filled with water and supplied with a dowel for a perch. Water temperature was 21° C, photoperiod was 16 h light: 8 h dark, and larvae were fed ad libitum with *Daphnia* and enchytraeid worms.

After each molt we measured the relative size of the wounded limb by comparing it to the

unwounded limb on the other side of the body. We also made notes on the size and shape of the tarsal claws. Larvae were preserved when they reached the final instar. We did not rear larvae to adults since the experiment was originally designed to interpret the rate of regeneration in larvae and not to test the effects of larval limb loss on morphology of adult limbs.

RESULTS

Many of the autotomized legs had regenerated to 75% of their full size following one molt after being autotomized (see Fig. 1 in BAKER & DIXON, 1986); almost all of the legs had regenerated to approximately 100% of their full size after two molts. However, although the size of the wounded legs was restored soon after molting, the form of the tarsal claws was never restored for any larva. Normal legs of both adults and larvae terminate in two equal size claws that articulate with the last tarsal segment (Fig. 1a), but regenerated legs of larvae terminated in a single, non-articulated claw with a tooth-like projection approximately midway between the base and the mid-point of the ventral surface. This stage of regeneration was usually achieved within two instars after the leg was wounded. Subsequent molts did not increase the degree of regeneration so that, regardless of what instar the larvae was wounded in, the regenerated legs of larvae wounded in F-6 to F-3 all looked the same by the time they reached the final instar. Legs of larvae wounded in instar F-2 showed varying degrees of regeneration by the time the larvae molted to the final instar, some reached the one claw stage while others had legs much shorter than normal. Larvae wounded in F-1 usually showed little regeneration when they molted into the final instar.

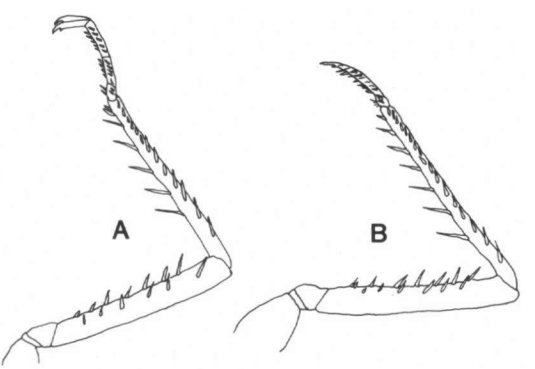

Fig. 1. Legs of a coenagrionid adult, redrawn from CHILD & YOUNG (1903): (A) Normal leg; — (B) Regenerated leg (opposite leg to A) showing the abnormal tarsus and claw; the leg was autotomized in instar F-6.

The regenerated legs in our study appeared very similar to some of the regenerated legs drawn by CHILD & YOUNG (1903) (Fig. 1b). In addition, the regenerated legs in our study, and the regenerated legs described by CHILD & YOUNG (1903) appear very similar to the "typical abnormalities" described by HILTON (1985).

DISCUSSION

The fact that the "typical abnormality" described by HILTON (1985) is so similar to the regenerated legs described by ourselves and CHILD & YOUNG (1903) suggests that the "abnormalities" are not genetic defects as suggested by Hilton but merely the incomplete regeneration of wounded legs. HILTON (1985) suggested that the abnormalities may be genetically based since most of them were very similar. However, this can be explained by the fact that regenerated legs quickly reach the single claw phase and then do not regenerate any further, this results in wounded legs converging on a single pattern. The "atypical abnormalities" described by Hilton can be interpreted as the incomplete regeneration of legs wounded in instars F-2 or F-1. Larvae wounded in these instars do not have enough time to reach the single claw phase by the time they emerge and thus show a more pronounced, but less frequent, type of abnormality. Thus, in conclusion, abnormal legs of adult odonates are most likely the result of leg loss and incomplete regeneration and should not be used as "genetic markers".

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