

## OCULAR MATING MARKS IN FEMALE NEARCTIC AESHNIDAE (ANISOPTERA)

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The occurrence and location of marks impressed into the compound eyes of female North American aeshnids by the male epiproct during tandem or copulation is given. Females judged to be in a physiologically immature sexual state had mating marks in *Coryphaeschna*, *Epiaeschna*, and *Triacanthagyna*. Female cerci do not appear to be broken during copulation except possibly in species of *Coryphaeschna*, *Oplonaeschna*, and *Triacanthagyna*.

### INTRODUCTION

The dorsally projecting points of the male epiproct in certain Anisoptera press into the compound eyes of the female during copulation or tandem flight, leaving impressions here termed mating marks. CALVERT (1920) points them out as "ocular cicatrices" in the aeshnids *Anax junius* (Drury), *A. imperator* Leach, and *A. parthenope* (Selys), and the gomphids *Epigomphus verticornis* Calvert, *E. armatus* Ris, *E. quadracies* Calvert, and possibly *E. tumefactus* Calvert. CORBET (1957) also describes "copulation marks" in *Anax imperator*. The anisopteran male's cerci and epiproct often scar the female's head at several points during mating, but the extensive smooth surface of aeshnid compound eyes shows such marks especially well.

### METHODS

I examined the compound eyes of female North American aeshnids at 40-60x. The dried specimens I looked at are in my collection or the Florida State Collection of Arthropods. All nearctic species occurring north of Mexico are represented, and 10 females of each were inspected. Fewer than 10 females of

some species were available and more than 10 were examined where I thought useful information might be gained.

## RESULTS

Results are presented in Table I and in a paragraph on each genus below. Age changes are described for those genera in which young females had mating marks.

In *Gomphaeschna* the mating marks are faint and variable. When present, they are on the anterior eye margin behind the lateral ocelli. In *G. furcillata* (Say), marks were found on only one side in 2 of 4 marked females, and one of the females marked on just one side was collected in tandem. Thus ocular mating marks in this genus probably result from an insecure grip by the male at the start of tandem.

Mated females of *Basiaeschna* and *Boyeria* had intact cerci. One *Boyeria grafiana* Williamson had mating marks at the rear of the eye seam, the other at half the length of the eye seam, the latter probably the normal position.

*Anax* shows conspicuous mating marks due to the short and wide male epiproct. *A. walsinghami* McLachlan has 4 marks created by the 4 dorsal points of the male epiproct, instead of the pair of marks found in other nearctic aeshnids. One female *A. walsinghami* had apparently been taken in tandem by a male *A. junius*. All mated *Anax* females had one or both cerci unbroken.

Mating marks in *Oplonaeschna* were inconspicuous, adjacent to the eye seam. All females examined had the cerci missing.

*Coryphaeschna* is the most interesting genus with respect to age changes. In female *C. ingens* (Rambur) the wings are at first brown-orange to the arculus and clear beyond. With age, this wing coloration reverses and becomes transparent basal to the triangle and brown-orange beyond it. The eyes change from green to blue above and the long streaming cerci break off. Some females develop a thin whitish-blue pruinosity. Males show none of these age changes. Unfortunately, no definite mating marks could be found in this species. But they were present in *C. luteipennis* Burmeister which has essentially the same wing color changes. Two of the 3 mated female *C. luteipennis* had the "immature" wing coloration. The 3 *C. viriditas* Calvert females I saw had the wings amber to the arculus and clear beyond, and had no definite mating marks. PAULSON (1966) also describes these color changes with age in *Coryphaeschna* and those in *Triacanthagyna* mentioned below.

*Nasiaeschna* and *Cynacantha* had no definite mating marks.

Young female *Epiaeschna* have the wings flavescent from triangle to stigma. The wings become tinted brown with age beginning at the tip and progressing toward the base, and the eyes change from mostly blue to mostly

Table I

Ocular mating marks in female Nearctic Aeshnidae: location of male epiproct marks on the compound eyes between the anterior point of the occiput and the anterior end of the eye seam is given as a fraction of that distance, measured from the anterior point of the occiput.

Species	No. examined	No. with mating marks	Location mating marks
<i>Gomphaeschna antilope</i> (Hag.)	10	2 (?)	Anterior eye margin
<i>G. furcillata</i> (Say)	10	4	Anterior eye margin
<i>Basiaeschna janata</i> (Say)	10	5	2/3
<i>Boyeria grafiana</i> Wlmsn	2	2	Occiput point, and 1/2
<i>B. vinosa</i> (Say)	13	2	1/4-1/3
<i>Anax amazili</i> (Burm.)	10	4	Occiput point
<i>A. junius</i> (Dru.)	21	12	Lateral to occiput
<i>A. longipes</i> Hag.	7	6	Occiput point
<i>A. walsinghami</i> McLachl.	2	2	1/3
<i>Oplonaeschna armata</i> (Hag.)	7	6	7/8-8/9
<i>Coryphaeschna ingens</i> (Ramb.)	17	0	
<i>C. luteipennis</i> (Burm.)	7	3	Anterior, on eye seam
<i>C. viriditas</i> Calv.	3	0	
<i>Nasiaeschna pentacantha</i> (Ramb.)	10	0	
<i>Epiaeschna heros</i> (Fab.)	17	12	2/5
<i>Aeshna californica</i> Calv.	8	3	1/2
<i>A. canadensis</i> Walk.	5	4	5/6
<i>A. clepsydra</i> Say	4	3	5/6
<i>A. constricta</i> Say	12	8	Anterior, on eye seam
<i>A. dugesi</i> Calv.	5	5	Anterior, on eye seam
<i>A. eremita</i> Scudd.	9	4	Anterior, on eye seam
<i>A. interrupta</i> Walk.	14	7	Anterior end
<i>A. juncea</i> (L.)	4	2	Anterior, on eye seam
<i>A. multicolor</i> Hag.	8	3	Anterior, on eye seam
<i>A. mutata</i> Hag.	1	1	Anterior, on eye seam
<i>A. palmata</i> Hag.	10	7	Anterior end
<i>A. persephone</i> Donnelly	1	1	Anterior end
<i>A. septentrionalis</i> Burm.	3	2	Anterior, on eye seam
<i>A. sitchensis</i> Hag.	6	2	Anterior end
<i>A. subarctica</i> Walk.	1	1	Anterior end
<i>A. tuberculifera</i> Walk.	10	10	5/6
<i>A. umbrosa</i> Walk.	10	7	Anterior end
<i>A. verticalis</i> Hag.	6	2	1/11
<i>A. walkeri</i> Kenn.	1	0	
<i>Gynacantha nervosa</i> Ramb.	10	0	
<i>Triacanthagyna trifida</i> (Ramb.)	25	7	2/7

brown. Males show the same wing color change but at a slower rate, and the eyes remain blue. Amber-winged females, even soft ones, had mating marks. Cerci are rarely broken in female *Epiaeschna*.

Young female *Triacanthagyna trifida* (Rambur) have the forewing flavescent between nodus and stigma, and long streaming cerci. Old females develop dark brown wings and the cerci break off. The eyes are dark brown in teneral becoming rapidly green with age. The oldest females develop the metallic blue anterior transverse eye line of the mature male. Males show parallel but different changes. In young males the basal half of the hindwing is flavescent, and the wings become only pale brown through aging. Eyes of males change from dark brown to green as in the female, but then become blue above. Finally, the lateral spots of segments 2 and 3 of the abdomen and the dorsal area between the hindwing bases change from green to sky blue in mature males. Both brown-winged and amber-winged females had mating marks. All mated females had lost their cerci except for one which had 1 cracked cercus remaining.

Mating marks in *Aeshna*, where present in my sample, were usually located at the anterior end of the eye seam. However, some species had mating marks positioned more posteriorly, and some had marks on the eye seam rather than on the eye facets. The majority of mated females in all species except *A. clepsydra* had one or both cerci unbroken.

## DISCUSSION AND CONCLUSIONS

Mating marks showed that females in some genera, at least, mated in what I judge to be a physiologically immature sexual state. These genera were *Coryphaeschna*, *Epiaeschna*, and *Triacanthagyna*, which also show some of the most conspicuous age changes. My original hypothesis was that features of the "mature" coloration would serve as releasers for the male sexual responses, preventing mating with unhardened teneral females. But it seems the reverse could be true, that the "mature" coloration inhibits males from mating so that females can spend more time ovipositing. My subjective impression is that the older a female appeared to be, the deeper and more conspicuous were the mating marks, indicating that females continue to mate throughout their lifetime beginning at a young age. The purpose of the age color changes in aeshnid females remains obscure to me. Further examination of freshly caught females and mated pairs, especially in the 3 genera listed above, would be interesting.

Next, we may wonder about the purpose of cerci in female aeshnids, since these are often broken off in many species. Some aeshnid genera have short cerci in the female which do not normally break, as in *Gomphaeschna*, *Boyeria*, and *Nasiaeschna*. The leaflike cerci of some other genera are apparently not broken off during copulation, because most of the females

with mating marks have intact cerci, as in *Basiaeschna*, *Anax*, *Epiaeschna*, and *Aeshna*. The cerci are easily broken off and are missing in nearly all mated females of *Oplonaeschna* and *Triacanthagyna*. Quite probably the cerci are broken off during mating in these genera and in *Coryphaeschna ingens* and *C. viriditas* (the cerci are genetically short in *C. luteipennis*), and are certainly broken during oviposition if not before. Especially in *Coryphaeschna* and *Triacanthagyna* with their long ribbonlike cerci, these appendages could serve as part of the "immature" female facies.

Finally, it seems maladaptive for the act of copulation to damage the eyes of the female, who after mating carries the genes of the next generation. Yet the most abundant North American aeshnid, *Anax junius*, has the most eye damage because pairs very often oviposit in tandem. *Aeshna constricta* Say also had noticeable eye damage. WALKER (1958) reports that this species has a wild, erratic mating flight. *A. constricta* is also a common species, and so we may conclude that any eye damage caused by the male epiproct has an insignificant effect on survival.

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