

New Feature: ID Corner

We've all been there: You saw a detailed Facebook thread regarding the finer points of S2 markings on *Aeshna* darners, but you didn't write it into your field guide and now you can't find the post again. Or maybe you're kicking yourself for not having saved the close-up wing photo that somebody posted (but who?!?) showing exactly where the radial planate is. Facebook is ephemeral; new posts quickly bury old ones, and it's easy to lose a thread or spend a lot of time hunting for something you could swear you read about a year ago but you're not quite sure which group it was in or who posted it. ARGIA, however, is forever (we hope!). With that in mind, welcome to the ID Corner, the brain child of Robert DuBois, who leads our first foray into this new realm. It is our hope that additional DSA members with expertise will contribute notes in the future.

The idea behind ID Corner is that the development of odonate identification is blossoming as more newcomers come into the dragonflying fold. The ranks of DSA members range from those who are happiest looking at detailed characteristics of adult male hamules or palpal lobes of nymphs under a microscope to avid photographers who want to know the best field marks to identify an individual to species. Old hands as well as newcomers can have questions about the best morphological "tells" for challenging species and how they vary. For these reasons, an ID-themed section would provide more structure and accountability than those myriad Facebook threads (even though not peer-reviewed), and could even be interactive, with specific topics raised in one issue and responded to in the next. Topics and questions can address aspects of identification of adults, nymphs, or exuviae. This would not only benefit all users, but could help field guide authors and key builders to improve the next generation of odonate identification tools.

We are still working out the details, but as with all new features in ARGIA, we want to know what you think. If you have comments or a burning ID question that you would like to either see addressed or address yourself in future issues, please contact me at <editor@dragonflysocietyamericas.org>. And now, on to our inaugural ID Corner article...

Reliability of field marks for distinguishing females of *Aeshna canadensis* (Canada Darner) and *Aeshna verticalis* (Green-striped Darner), by Robert DuBois, Department of Natural Resources, Superior, Wisconsin <robert.dubois@wisconsin.gov>

Distinguishing the females of *Aeshna canadensis* (Canada Darner) and *A. verticalis* (Green-striped Darner) has long

been difficult because of the great overall similarity of the two species (Walker, 1912, 1958; Paulson, 2011), and both species can have green-form females. A variety of marks on the thorax and abdomen have been proposed as useful characters in keys, field guides, and some online venues, but they have not been rigorously tested for reliability, and some appear to be variable enough to compromise their use in identification. For this note I tested the reliability of eight character states on four thoracic and abdominal marks for determining females of both species.

Methods

Eleven females of each species were selected for testing from the Odonata Collection of the Wisconsin Department of Natural Resources in Superior, Wisconsin. These included all of the females of *A. verticalis* in the collection, and a like number of females of *A. canadensis* that were selected in chronological order of their collection date. I had previously determined them using a suite of characters in keys by Needham et al. (2014) and Walker (1958). All specimens were from the Upper Midwestern United States (10 specimens of each species from Wisconsin, one *A. verticalis* from Michigan and one *A. canadensis* from Minnesota). Five of the *A. canadensis* and one of the *A. verticalis* had been reared in captivity, so structural aspects of the labia of the exuviae were also considered when determining them.

I used these 22 firmly determined specimens to evaluate the reliability of eight character states on four marks on the thorax and abdomen that have been used for distinguishing the females of these species in keys (e. g. Walker, 1958; Needham et al., 2014), field guides (e. g. Dunkle, 2000; Nikula et al., 2003; Mead, 2009; Paulson, 2011), and have been discussed in at least one blog (Craves and O'Brien, 2011) and at least one Facebook page <<https://www.facebook.com/groups/wisconsindragonflysociety/>>. All estimates and measurements (mm) were made on the left side of the specimens in lateral view. I used t-tests for independent means with alpha set at 0.05 to test for significant differences between measurement and ratio means, but statistically significant differences do not necessarily equal usefulness for identification purposes if the ranges of the measurements and ratios overlap. The value of characters for use in identification was considered to be greater for those that lacked overlap between the species, were unambiguous, and were at least potentially observable in the field through binoculars, in close-up (macro) photographs, or in the hand using a hand lens.

Several attributes of both the anterior lateral thoracic

stripe (ALTS; also known as the mesepimeral pale stripe) and the posterior lateral thoracic stripe (PLTS; also known as the metepimeral pale stripe) were included in this analysis. I assessed two character states regarding the angle of the “indent” or “notch” on the anterior margin of the ALTS and the constriction of the stripe at that point. The angle of the indent was estimated to the nearest 5° with a small protractor held next to the specimen. The width of the ALTS was measured at its narrowest point at the indent and at its widest point below the indent to provide a ratio. Another character of the ALTS, the rearward trailing “flag” at the upper end of the stripe, was measured at its widest point in its vertical dimension. I also measured the vertical dimension of a pale mesepimeral spot that is often visible mid-laterally between the ALTS and PLTS of both species.

Several characteristics on the PLTS were given by Walker (1958) and Needham et al. (2014) to distinguish these species. I therefore noted the shape of the anterior and posterior margins of the PLTS, whether the stripe widened gradually or abruptly at the upper end, and tallied the presence or absence of a posteriorly (ventrally, strictly speaking) directed curve at the upper end.

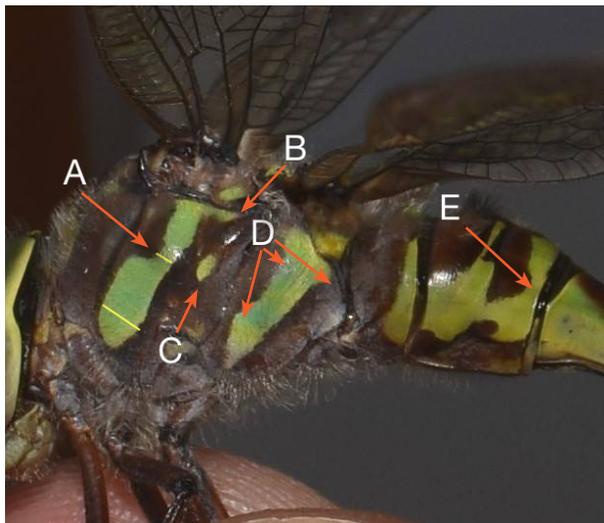


Figure 1. Side view of the thorax and basal abdominal segments of a female Canada Darner (*Aeshna canadensis*) showing the angle of the indent (about 90°) on the front margin of the ALTS (A), and constriction of the stripe at the indent (upper yellow line) relative to the wide part of the stripe below (lower yellow line); the thin, rearward trailing flag at upper end of the ALTS (B); the relatively large mesepimeral pale spot between the ALTS and the PLTS (C), that is longer than the width of the narrow flag above it (B); various attributes of the PLTS showing a slight bulge on the lower front edge (D, left arrow), and an abrupt widening at the upper end (D, center arrow) that includes a rearward-directed curve (D, right arrow); and a shallowly cleft pale mark on S2 that is not completely split (E). Photo by J. Sommerfeld.

A complexly-shaped pale mark is located near the posterior-lateral margin of abdominal segment 2 (S2) on both species. This mark includes the postero-dorsal spot above and the postero-lateral spot below, which may be fused together into what appears to be one mark, or they may be separated. Nikula et al. (2003) noted that the mark is “shallowly cleft” mid-laterally on *A. canadensis*, but “deeply cleft or split” there on *A. verticalis*. I retained their terminology to avoid confusion and tallied whether or not the mark was completely split.

Several structural characters have been used to distinguish females of these species including the lengths of the cerci and two attributes of the genital valves. I did not examine these characters in this analysis for the following reasons. The lengths of the cerci were given by Walker (1958) as a means for distinguishing females of these species, but the ranges given had some overlap and these structures are often partly broken off during oviposition. Except for the specimens I had reared, most of the specimens available to me did not have complete cerci. A small sample of specimens with unbroken cerci would have shed little light on the topic, and the diagnostic value of the cercus is severely limited by its frequently incomplete condition. Regarding the genital valve of the ovipositor, the ventral groove mentioned by Paulson (2011) was difficult for me to see without using a microscope, as was the extent of the lateral ridge along each side of the genital valve of the ovipositor as described by Walker (1958) and Needham et al. (2014). In the absence of illustrations of exceptional clarity and detail, these characters have been challenging to interpret.

Results and Discussion

Despite its frequent use, the angle of the indent on the front margin of the ALTS was variable and did not consistently distinguish the species. The means (in degrees) of this angle differed significantly between the species, but there was considerable range overlap (Table 1). This character was mentioned in all of the resources cited in this report, usually in the context of the angle being about 90° (right-angled) for *A. canadensis* (Figure 1) and somewhat greater than 90° (obtusely-angled) for *A. verticalis* (Figure 2). Although this angle was close to 90° on all *A. canadensis*, about a third of the specimens of *A. verticalis* had angles that were also close to that value. Therefore, the character is only useful if the angle of indent exceeds about 110°, in which case it suggests *A. verticalis*, but an angle of <110° does not necessarily indicate *A. canadensis*.

The ratio of the width of the ALTS at the indent to the width of the ALTS at its widest point below the indent (shown with yellow lines in Figure 1) was also variable for

both species, with significantly different means, but with overlap (Table 1). This ratio was given by Needham et al. (2014) as being about $\frac{1}{3}$ on *A. canadensis* and about $\frac{1}{2}$ on *A. verticalis*, but because the ratio always exceeded $\frac{1}{3}$ for *A. canadensis*, the couplet is problematic as stated. Further, because of intraspecific variation and overlap between the species, use of this character in any form is not recommended. However, the maximum width of the flag at the upper end of the ALTS had mean differences that were highly significant between species and ranges that only barely overlapped (Table 1). This width was consistently close to 1.0 mm for *A. verticalis* and averaged slightly more than 0.5 mm for *A. canadensis*. The flag was described by Walker (1958), Dunkle (2000), Mead (2009), and Paulson (2011) as wider on *A. verticalis* than on *A. canadensis*, and the statement appears to be generally valid.

The size of the mesepimeral pale spot between the ALTS and the PLTS was also significantly different between the species with non-overlapping ranges (Table 1). On *A. canadensis* this spot is relatively large, averaging slightly more than 1.0 mm in vertical height, and was clearly defined in all cases. On *A. verticalis* this spot averaged less than 0.5 mm, did not exceed 0.7 mm, and was faint on three specimens and absent on two others. This spot has not been used as a character in field guides or keys to my knowledge. Nikula et al. (2003) mentioned its placement when discussing *A. canadensis* and it was present in their illustration of that species, but no mention of it was made regarding *A. verticalis* and it was not present in their illustration of that species. However, I have seen Facebook and blog discussions that have speculated that the spot might be larger on *A. canadensis* than on *A. verticalis*.

All three of the shape characters of the PLTS that I examined were consistently different between the species; these were presence or absence choices rather than measurements or comparisons and are therefore particularly well suited for use as field characters. Consistent with statements by Walker (1958) and Needham et al. (2014), the upper end of the PLTS curved posteriorly on all *A.*

Table 1. Comparison of means, ranges, and P values for four characters used to distinguish females of *Aeshna canadensis* and *A. verticalis*.

	Mean (range)		p value
	<i>A. canadensis</i>	<i>A. verticalis</i>	
ALTS angle of indent (°)	92 (85 - 110)	107 (90 - 130)	0.004
ALTS width at indent / maximum width (ratio)	0.45 (0.38 - 0.53)	0.55 (0.47 - 0.69)	0.0003
maximum width of ALTS flag (mm)	0.58 (0.4 - 0.8)	0.85 (0.8 - 1.0)	<0.00001
vertical length of mesepimeral spot (mm)	1.07 (0.95 - 1.30)	0.41 (0 - 0.7)	<0.00001

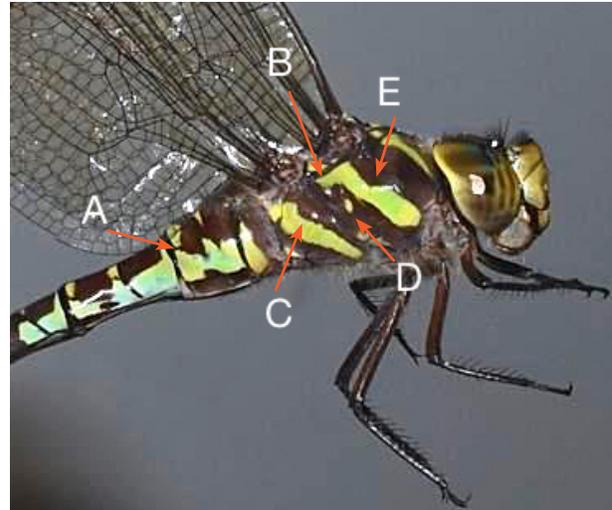


Figure 2. Side view of the thorax and basal abdominal segments of a female Green-striped Darner (*Aeshna verticalis*) showing pale mark on S2 completely split (A); rearward trailing flag at the upper end of the ALTS is relatively wide, as wide as or wider than the length of the spot below it (B); PLTS has front edge straight with notch at upper end, stripe widens gradually and rear edge is straight, lacking a rearward curving extension at upper end (C); mesepimeral spot between the ALTS and PLTS smaller than on Canada Darner (D); and indent angle on ALTS is sometimes $>90^\circ$ (E); if the angle is $>110^\circ$ as here, it is likely a Green-striped Darner, but this angle varies on both species. Photo by J. Sommerfeld.

canadensis, but did not do so on any *A. verticalis*. Thus, the PLTS curves anteriorly (dorsally) and posteriorly (ventrally) at the upper end on *A. canadensis* giving the mark the appearance of widening abruptly there, whereas the PLTS curves only dorsally at the upper end on *A. verticalis* giving the appearance of widening more gradually (Needham et al., 2014). Further, the anterior margin of the PLTS was always straight on *A. verticalis* except at the upper end where a knob was directed dorsally, but on *A. canadensis* the margin consistently had a convex, anteriorly-directed curve or bulge at about the lower third.

The pale mark located mid-laterally on S2 was completely split on all specimens of *A. verticalis*, whereas none of the *A. canadensis* were so marked, having instead the mark shallowly cleft. This character, mentioned by Nikula et al. (2003) and by Craves and O'Brien (2011), appears deserving of wider use.

Conclusions and Recommendations

Based on this analysis there are attributes of four marks that differed consistently and noticeably between females of *A. canadensis* and *A. verticalis*: the vertical width of the ALTS flag, the size of the mesepimeral spot, the overall shape of the PLTS, and the presence or absence of a com-

plete mid-lateral split on the S2 pale mark. All of these could easily be seen in side view with a hand lens and are often visible in close-up photographs of perched or hand-held specimens (based on the author's history of vetting photographs submitted to two Odonata databases).

The often-used angle of indent on the front margin of the ALTS, and the relative width of the stripe at that point, are both too variable to be reliable characters for distinguishing females of these species and their use should be reduced. Because the width of the ALTS flag and size of the mesepimeral spot both lacked significant overlap in their measured ranges and both are easily seen in close proximity in a side view close-up look or photograph of the thorax, they each have potential as diagnostic characters. But because both characters would require measurements if taken individually, their usefulness as field marks could be enhanced by comparing their relative dimensions in combination. Therefore, the following decision rule is recommended:

flag width < spot length = *A. canadensis*;
flag width > spot length = *A. verticalis*

This rule would have correctly determined all of the specimens in this study. The shape of the PLTS was noticeably different between all specimens of both species and several attributes of this stripe could also be worked into a useful decision rule as follows:

PLTS with front and rear margins straight and having no posteriorly curving extension at upper end = *A. verticalis*;
PLTS with front margin curving slightly anteriorly at or below mid-mark and with a posteriorly curving extension at the upper end = *A. canadensis*

The presence or absence of a complete split of the pale mark on S2 would also have correctly determined all specimens in this study and therefore can also be formed into a useful decision rule:

S2 mark shallowly cleft mid-laterally = *A. canadensis*;
S2 completely split mid-laterally = *A. verticalis*

Cultural Odonatology

DSA members are as diverse as the insect order we all love; we approach Odonata as scientists, educators, naturalists, artists, poets, photographers, essayists, bloggers, and more, with many wearing several of these hats. Cultural Odonatology focuses on different aspects of the human relationship with odonates, showcasing dragonflies in art, architecture, literature, and legend, and may contain original works or discussions of odonates in existing works. If

It seems reasonable to postulate the existence of some amount of variation in all of these marks, and I have observed during my vetting experience that the S2 pale mark does not always appear to be completely split on all photographs of females of *A. verticalis*. I therefore recommend a "weight-of-evidence" approach when determining females of these species. When any two of the three decision rules given above point to one of these species, I suggest that the species so indicated is likely to be the correct determination. These recommendations are offered tentatively pending more data and should be applied cautiously outside Wisconsin.

References

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you would like to contribute to this feature, contact me at <editor@dragonflysocietymamericas.org>.

In this instalment, Jacki Morrison shares her views of the importance of Cultural Odonatology and its intersection with science; and Kitty Leaken provides some fascinating insights on the role of odonates in Navajo culture.