

WING SPINE DISTRIBUTION: A NEW CHARACTER FOR SEXUAL DIFFERENTIATION IN LESTIDAE (ZYGOPTERA)*

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The ratio between the number of spines in the cubito-anal fields of the fore and hind wings of *Lestes barbarus*, *L. dryas*, *Chalcolestes viridis*, and *Sympecma fusca* is significantly higher in the females and constitutes a sexual distinction analogous to what is found in Calopterygoidea. This ratio is much less pronounced in *L. virens vestalis*.

INTRODUCTION

Odonata wing nerve spines have been the subject of two studies aimed at clarifying their general traits and relationship to other wing parameters and group systematics (D'ANDREA & CARFÌ (1988, 1989). One of these traits, the presence of a sexual dimorphism in their distribution, was first noted in the superfamily Calopterygoidea. The present paper shows that this trait is not exclusive to this superfamily.

MATERIAL AND METHODS

The specimens examined come from private collections (C. Utzeri, F. Terzani, A. Mascagni, L. Fiorini and M. D'Andrea) and the "La Specola" Zoological Museum (Florence University). The following species were examined:

- *Lestes barbarus* (Fabr.): 76 ♂, 55 ♀ (Abruzzi, Basilicata, Corsica, Latium, Apulia, Sardinia, Sicily, Tuscany).
- *L. dryas* Kirby: 58 ♂, 33 ♀ (Abruzzi, Basilicata, Campania, Emilia-Romagna, Liguria, Sicily, Tuscany, Trentino).
- *L. virens vestalis* Ramb.: 91 ♂, 41 ♀ (Emilia-Romagna, Latium, Apulia, Sardinia, Tuscany).

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- *Chalcolestes viridis* (Vander L.): 202 ♂, 128 ♀ (Abruzzi, Basilicata, Campania, Corsica, Emilia-Romagna, Friuli-Venezia Giulia, Latium, Liguria, Apulia, Sardinia, Sicily, Tuscany, Umbria).
- *Sympecma fusca* (Vander L.): 44 ♂, 49 ♀ (Corsica, Emilia-Romagna, Liguria, Lombardy, Sardinia, Tuscany, Umbria).

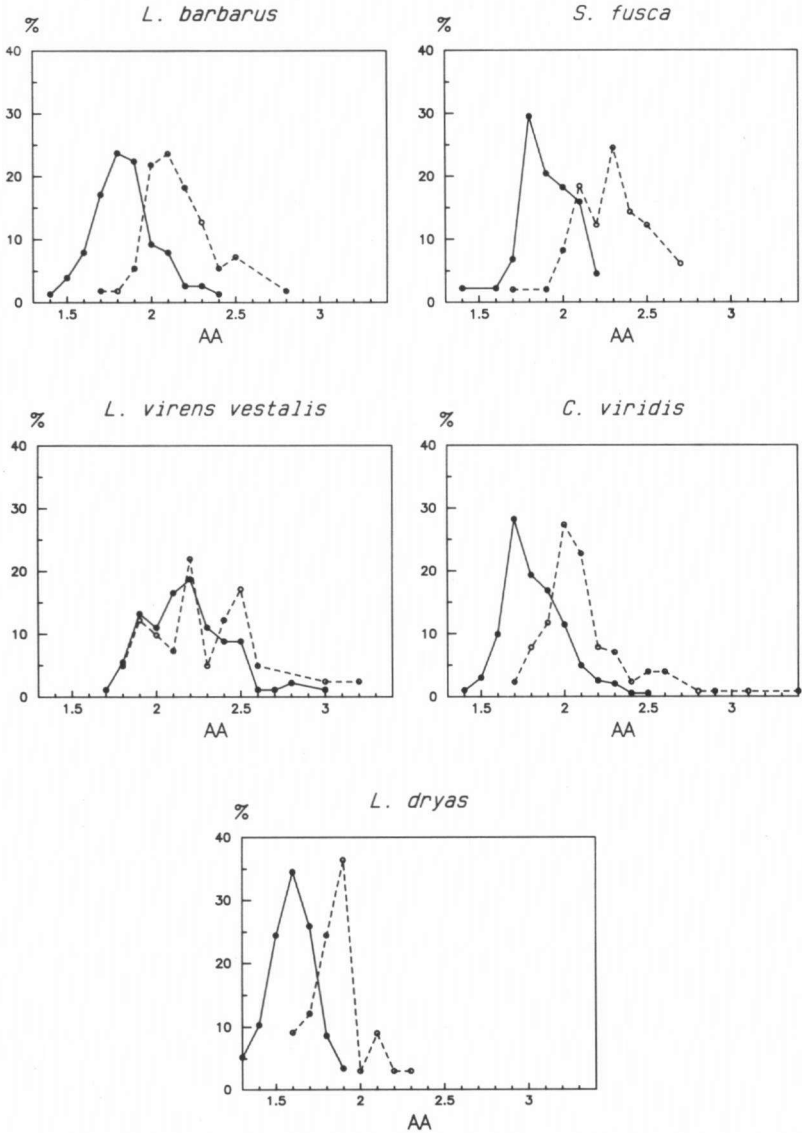


Fig. 1. Relative frequencies of the ratio classes (AA): solid line, males; — dashed line, females.

Counts were made of the spines between the CuP nervure and trailing edge of the left wing and, in about 20% of the specimens chosen at random, of the right wing. Following the terminology used in D'ANDREA & CARFÍ (1988, 1989), this field is called A and the ratio between the cubito-anal fields of the fore and hind wings AA. The AA ratio and the number of spines on the fore and hind wings were compared in conspecific males and females using the two-tailed Student's t-test. Table I and Figure 1 were compiled after lumping the ratios in classes approximating the values to the first decimal.

RESULTS OF THE STATISTICAL ANALYSIS

AA RATIOS

The absolute and relative frequencies of each ratio class are shown in Table I. The former values are highly variable, running from a minimum of 1.3 (*L. dryas*, ♂) to a maximum of 3.4 (*C. viridis*, ♀), but the majority range between 1.7 and 2.5. The relative frequency values, illustrated in Figure 1, clearly suggest a form of sexual differentiation in four species (*L. barbarus*, *L. dryas*, *C. viridis*, *S. fusca*). While the male and female curves are superimposed in the midranges, only male values occur in the lower extremes and only female values in the upper ones. Instead, no such differentiation appears in *L. virens vestalis* where not only are both values almost completely superimposed but also the curve peaks of classes 1.9 and 2.2 are notably concordant. A slight plateau appears in the males between 2.4-2.5 in correspondence to a peak in the females.

Table I
Number of specimens for each ratio class (AA) and, in parentheses, their relative frequency (%)

Species	Sex	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1	3.2	3.3	3.4 (AA)	
<i>L. barbarus</i>	♂	1 (1.3)	3 (3.9)	6 (7.9)	13 (17.1)	18 (23.7)	17 (22.4)	7 (9.2)	6 (7.9)	2 (2.6)	2 (2.6)	1 (1.3)												
	♀					1 (1.8)	1 (1.8)	3 (5.4)	12 (21.8)	13 (23.6)	10 (18.2)	7 (12.7)	3 (5.4)	4 (7.2)				1 (1.8)						
<i>L. dryas</i>	♂	3 (5.2)	6 (10.3)	13 (22.4)	20 (34.5)	9 (15.9)	5 (8.6)	2 (3.4)																
	♀				3 (9.1)	4 (12.1)	8 (24.4)	12 (36.4)	1 (3.0)	3 (9.1)	1 (3.0)	1 (3.0)												
<i>L. virens vestalis</i>	♂					1 (1.1)	5 (5.5)	12 (13.2)	10 (11.0)	15 (16.5)	17 (18.7)	10 (11.0)	8 (8.8)	8 (8.8)	1 (1.1)	1 (1.1)	2 (2.2)					1 (1.1)		
	♀							2 (4.9)	5 (12.2)	4 (9.8)	3 (7.3)	9 (21.9)	2 (4.9)	5 (12.2)	7 (17.1)	2 (4.9)					1 (2.4)		1 (2.4)	
<i>C. viridis</i>	♂	2 (1.0)	6 (3.0)	20 (9.9)	57 (28.2)	39 (19.3)	34 (16.8)	23 (11.4)	10 (4.9)	5 (2.5)	4 (2.0)	1 (0.5)	1 (0.5)											
	♀					3 (2.3)	10 (7.8)	15 (11.7)	35 (27.3)	29 (22.7)	10 (7.8)	9 (7.0)	3 (2.3)	5 (3.9)	5 (3.9)			1 (0.8)	1 (0.8)			1 (0.8)		1 (0.8)
<i>S. fusca</i>	♂	1 (2.2)			1 (2.2)	3 (6.8)	13 (29.5)	9 (20.4)	8 (18.2)	7 (15.9)	2 (4.5)													
	♀					1 (2.0)		1 (2.0)	4 (8.2)	9 (18.4)	6 (12.2)	12 (24.5)	7 (14.3)	6 (12.2)				3 (6.1)						

Table II

Comparison of the AA ratios in conspecific males and females. — [\bar{x} : mean ratios; — σ_n : standard deviation; d.f. = degrees of freedom. — the number of specimens examined is indicated in "Material and methods"]

Species	Sex	\bar{x} (range)	σ_n	t	d.f.	P
<i>L. barbarus</i>	♂	1.85416 (1.42149-2.4)	0.19017	-8.873599	129	< 0.001
	♀	2.15965 (1.70968-2.84932)	0.20029			
<i>L. dryas</i>	♂	1.59185 (1.32780-1.90345)	0.13457	-8.535724	89	< 0.001
	♀	1.86825 (1.58763-2.29221)	0.17054			
<i>L. virens vestalis</i>	♂	2.18147 (1.74038-2.78571)	0.24770	-1.641291	130	0.1035
	♀	2.26265 (1.81250-3.13235)	0.29442			
<i>C. viridis</i>	♂	1.82401 (1.49580-2.50000)	0.18089	-11.813580	328	< 0.001
	♀	2.11597 (1.73148-3.40476)	0.26798			
<i>S. fusca</i>	♂	1.90305 (1.42466-2.16667)	0.16235	-9.488739	91	< 0.001
	♀	2.27229 (1.75155-2.74138)	0.20722			

The statistical analysis of these data is reported in Table II. The difference between males and females is highly significant in four species, but not so in *L. virens vestalis*, despite the presence of slightly higher ratios in the females.

NUMBER OF SPINES ON THE FORE AND HIND WINGS

The difference in ratio values was analyzed with the t-test, comparing the absolute quantity of spines in field A on the fore wings of conspecific males and females. The same test was then applied to the hind wings. The results, reported in Table III, clearly indicate a significant difference in the number of spines on the fore wings in three of the five species examined (*L. barbarus*, *L. dryas*, *S. fusca*), while the same difference appeared in the hind wings of *C. viridis*. Only a very faint tendency appears in the fore wing of *L. virens vestalis*.

Table III

Comparison of the number of spines on the fore wings (fw) and hind wings (hw) in conspecific males and females. — [\bar{x} : mean number of spines; — σn : standard deviation; — the number of specimens examined is indicated in "Materials and methods"]

Species	Sex	\bar{x} (range)	σn	t	d.f.	P	Wing
<i>L. barbarus</i>	♂	215.8816 (149-322)	35.42390	-4.410039	129	< 0.001	fw
	♀	244.0727 (186-337)	37.04095				
	♂	117.5263 (75-172)	22.16873	0.778682	129	0.4379	hw
	♀	114.4182 (73-186)	23.06247				
<i>L. dryas</i>	♂	294.8448 (185-418)	45.39140	-3.896862	89	< 0.001	fw
	♀	338.4546 (239-434)	60.46595				
	♂	186.1552 (128-259)	31.24931	0.635243	89	0.5272	hw
	♀	181.8182 (117-234)	31.42099				
<i>L. virens vestalis</i>	♂	173.9780 (130-233)	27.95313	-1.149384	130	0.2532	fw
	♀	180.3171 (121-254)	32.18807				
	♂	80.5165 (49-116)	14.32353	0.092043	130	0.9269	hw
	♀	80.2683 (59-115)	14.36319				
<i>C. viridis</i>	♂	203.2030 (114-349)	33.54886	-1.684730	328	0.0932	fw
	♀	209.5234 (135-287)	32.66122				
	♂	112.9109 (56-168)	23.21867	4.745916	328	< 0.001	hw
	♀	100.9219 (42-156)	20.93131				
<i>S. fusca</i>	♂	245.8182 (196-314)	34.99453	-3.912602	91	< 0.001	fw
	♀	275.1429 (196-344)	37.03827				
	♂	131.5000 (107-156)	18.43215	2.504300	91	0.0141	hw
	♀	121.8776 (78-164)	18.56142				

DISCUSSION

L. barbarus, *L. dryas*, *C. viridis* and *S. fusca* are seen to differ sexually in having significantly different numbers of spines in the cubito-anal field of their wings, similar to what has been found in some Calopterygoidea (cf. D'ANDREA & CARFÍ, 1988, tab. XIII), *Hetaerina rosea*, *H. macropus*, *Vestalis melania*, *Phaon iridipennis*, *Mnesarete pudica* (Calopterygidae); *Euphaea amphicyana*, *Epallage fatime* (Euphaeidae); and *Rhinocypha colorata* (Chlorocyphidae). In Calopterygoidea the dimorphism is peculiar to the fore wing where, in comparison to the males, the females have both tinier and fewer spines to the extent that some nervures are smooth. Further research is underway on some genera which should reveal whether or not such a dimorphism is present in the Coenagriodea. Also under investigation are some Anisoptera, where nothing of the kind has been noted during a preliminary study. However, the latter aimed at understanding other characteristics of the wings in this suborder (D'ANDREA & CARFÍ, 1989).

It is noteworthy that the differences present in such marked degree in the cubito-anal field of the males and females do not occur in any of the other wing fields. Furthermore, the ratio between the quantities of spines on the fore and hind wings is higher, in regard to the rest of the wing, in Lestoidea as it is in the Coenagriodea. In these two superfamilies the postnodal field shows even more marked similarities. But, while the spines of the postnodal nervure of Coenagriodea are fairly easy to count, those in the Lestoidea are often toothed or wrinkled which does not facilitate counting and has made it impossible to verify whether there is any sexual dimorphism in this field as well. The postnodal (leading edge) and cubito-anal (trailing edge) fields are aerodynamically important and the presence of higher ratios may be related to this fact. The existence of a sexual dimorphism in the cubito-anal field is surprising for its (eventual) aerodynamic consequences. In the Lestidae studied, the sexual dimorphism revealed it could have a faint influence on their flight behavior. But what about Calopterygoidea? The marked differences, evident in at least certain species, seem to be in contrast to the aerodynamic function of the spines. Perhaps this question can be answered by carefully comparing the flight of conspecific males and females filmed at high speed.

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