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THE MESOSTIGMAL COMPLEX OF SIX *ARGIA* SPECIES USING SCANNING ELECTRON MICROSCOPY (ZYGOPTERA: COENAGRIONIDAE)

B.G. JUSTUS[1], S.E. TRAUTH[2] & G.L. HARP[2]

[1]1910 Deborah, Pearl, Mississippi 39208, United States

[2]Department of Biological Sciences, Arkansas State University, State University, Arkansas 72467, United States

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The mesostigmal complexes of adult female *A. fumipennis violacea*, *A. sedula*, *A. moesta*, *A. immunda*, *A. plana* and *A. bipunctulata* were examined using scanning electron microscopy (SEM). Significant differences were noted among all 6 spp. as well as spp. previously reported in the literature, particularly with regard to the mesostigmal lobes and median carina arms.

INTRODUCTION

Argia is thought to be a phylogenetically young genus which originated in the Neotropic region (PRITCHARD, 1982). This is one of the largest odonate genera, with 136 species reported (DAVIES & TOBIN, 1984).

In most instances, zygopteran copulation occurs after the male caudal appendages grasp the posterior lobe of the female pronotum and press the cerci onto a pair of structures, the mesostigmal plates, located on the anterior end of the mesothorax. This position, known as tandem, may or may not be maintained through the process of oviposition (WAAGE, 1984). The purpose of this study is to describe the mesostigmal plates and associated structures from six species of *Argia* using scanning electron microscopy (SEM). This study, with that of MOULTON et al. (1987), completes an examination of the eastern North America species of this genus.

MATERIAL AND METHODS

Collections of female *Argia fumipennis violacea* (Hagen) and *A. sedula* (Hagen) were made along

streams in northeastern Arkansas between 29 July and 15 October 1988. Four specimens of *A. moesta* (Hagen), two of *A. plana* Calvert and one of *A. bipunctulata* (Hagen) were taken from the macroinvertebrate collection of the Arkansas State University Museum of Zoology. Dr Sidney Dunkle kindly provided a second specimen of *A. bipunctulata* and two of *A. immunda* (Hagen) for this study. The specimens, which represent at least two populations for each species, were dried in 100% acetone for at least 24 hours, placed in small paper envelopes, labeled and stored. Subsequent preparation and scanning of the mesostigmal plates followed the procedures of MOULTON et al. (1987), except that specimens were viewed at an accelerating voltage of 40 kV.

RESULTS

A dorsal view of *A. f. violacea* illustrating the mesostigmal complex and associated structures is shown in Figure 1; morphometric determinations for each species are shown in Table I.

Table I

Mean linear dimensions (mm) of the mesostigmal plates for *Argia fumipennis violacea, A. sedula, A. moesta, A. immunda, A. plana* and *A. bipunctulata* (see also Fig. 1).

Linear dimension	*f. violacea*	*sedula*	*moesta*	*immunda*	*plana*	*bipunctulata*
A	0.355	0.515	0.490	0.460	0.265	0.230
B	0.272	0.317	0.310	0.400	0.375	0.240
C	0.511	0.538	0.700	0.560	0.800	0.430
D	0.190	0.248	0.227	0.255	0.305	0.210
E	0.421	0.304	1.037	0.660	0.520	0.315
(N)	5	3	4	2	2	2

A: Length of posterior edge; — B: Length of anterior edge; — C: Anterior distance between plates; — D: Width of plate at widest point; — E: Posterior distance between plates; — (N): No. of specimens.

ARGIA FUMIPENNIS VIOLACEA (HAGEN)

Figures 1, 2A, 3A

The anterior carina of the mesostigmal complex is straight but curves slightly posteriorly as it approaches the lateral carinae. Two projections anterior to the anterior carina (Fig. 2A) appear to be extensions of the lateral carinae. Each lateral carina is noticeably concave and projects posteriorly, joining the postero-mesal corner of the mesostigmal plate. The mesal margin of this lobe is curved ventrally, then laterally (Fig. 3A). Each carina is continuous with the apex of the lobe and forms a ridge which divides the curvature. A small tubercle exists at the base of each lobe and is best observed in dorso-posterior view. The middorsal thoracic carina is bifurcated with each arm terminating between the mesal borders of the mesostigmal plates as flattened pads whose common anterior border is sinuate. This bifurcation occurs just caudal to the posterior lobe of the

complex (Fig. 2A). The plates are long triangles. They, the lobes and the median carina arms are uniformly covered with pad-like tuberosities.

ARGIA SEDULA (HAGEN)
Figures 2B, 3B

The anterior portion of the complex is similar to that of *A. f. violacea* (Fig. 2B). The anterior carina is relatively straight except at the distal margins; also, two projections anterior to this carina appear to be extensions of the lateral carinae. The lateral carinae are again noticeably concave posteriorly but do not form wide lobes. Instead, they fuse with the median carina arms just mesal to the long

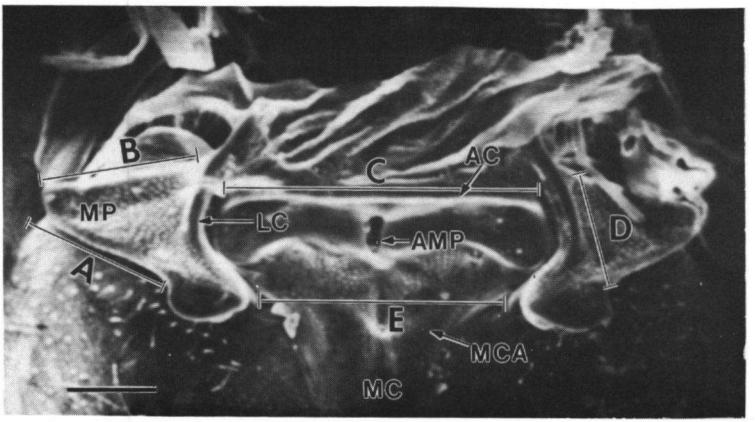

Fig. 1. Enlarged mesostigmal complex of *Argia fumipennis violacea*. LC: lateral carina; — AC: anterior carina; — MC: middorsal carina; — MCA: median carina arm; — AMP: anterior median pit; — MP: mesostigmal plate. — [Line = 143 μm].

finger-like lobes of the mesostigmal plates (Fig. 3B). The length of each lobe is greater than the width of the lobe's base. Each lobe is directed mesally, its edge is tilted dorsally and undulations present give each a wavy appearance. The bifurcation of the middorsal thoracic carina occurs posteriorly to the mesostigmal lobes, and the arms extend for some distance to the inner margins of the lateral carinae. They terminate as rather flattened pads. Their common anterior border is sinuate, as seen in *A. f. violacea*. The mesostigmal plates are short concave triangles with wide, concave bases. They are uniformly covered by tuberosities, but the lobes are not.

ARGIA MOESTA (HAGEN)
Figures 2C, 3C

The anterior portion of the mesostigmal complex is similar to those of the two previously described species (Fig. 2C). The lateral carinae are markedly concave and extend posteriorly to the bases of the lobes of the mesostigmal plates. From the base of each lobe the lateral carinae curve mesally and attach to the median carina arms. These in turn arise from the middorsal carina, which bifurcates some distance posterior to the mesostigmal plates. The median carina arms flare anteriorly, forming broad plates. Their common anterior border is sinuate, as seen in the previous two species. The mesostigmal plates are elongate, concave triangles with distinct thumb-like posterior lobes. The length of each lobe is equal to or greater than the width of its base (JOHNSON, 1972). The lobes diverge, rather than converge, as do those of the previously described species (Fig. 3C). Beneath each lobe is a distinct depression in the mesothoracic surface. Pad-like tuberosities cover the median carina arms and the mesostigmal plates proper, but are absent from the lobes.

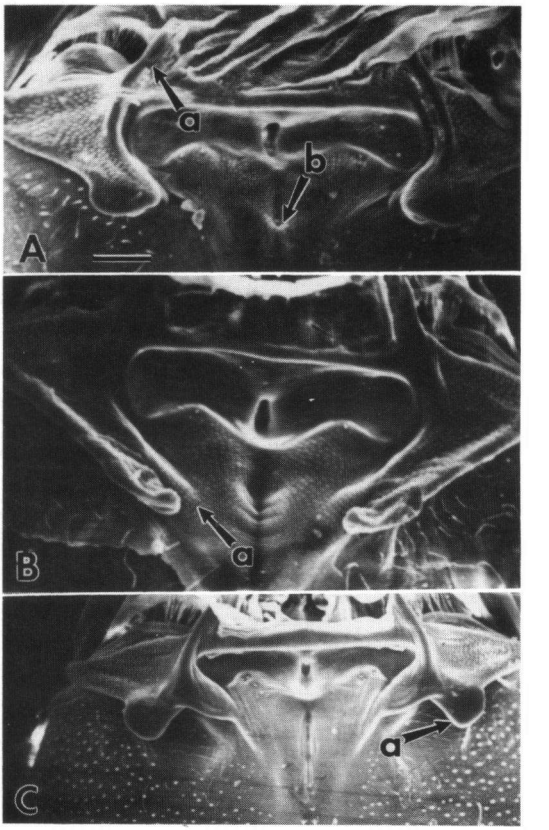

Fig. 2. (A) *Argia fumipennis violacea*, (a) arrow denotes projection anterior to the anterior carina, — (b) arrow points to bifurcation of middorsal carina; — (B) *A. sedula*, 100x: (a) arrow denotes termination of lateral carina; — (C) *A. moesta*, (a) arrow points to divergent lobe. — [Line in A = 85 μm for A and B but 170 μm for C].

ARGIA IMMUNDA (HAGEN)
Figures 4A, 5A

The anterior carina is straight, and the lateral carinae are concave (Fig. 4A).

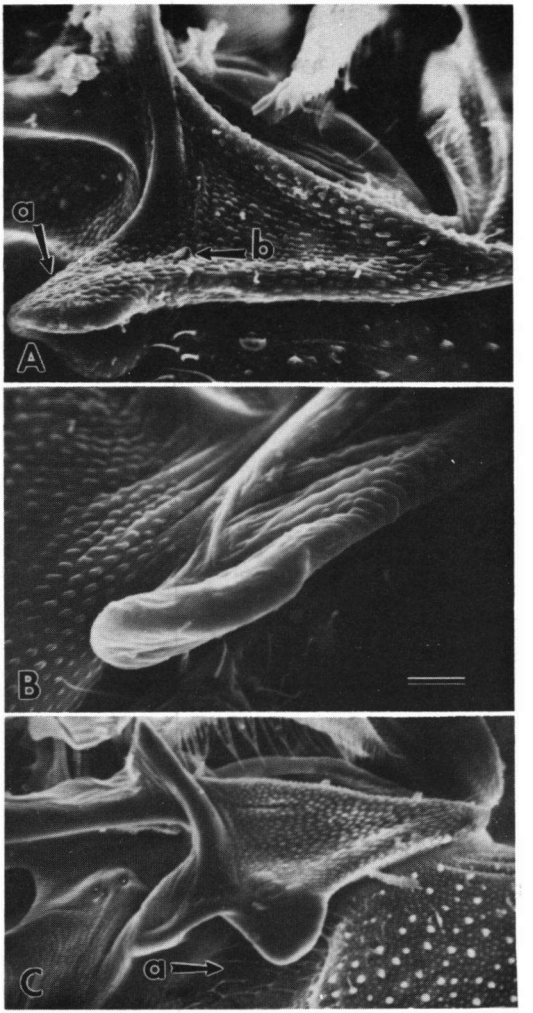

Fig. 3. (A) *Argia fumipennis violacea*, 200x: (a) arrow denotes curved lobe, — (b) arrow points to small tubercle; — (B) *A. sedula* 300x, depicting undulated lobe; — (C) *A moesta* 100x: (a) arrow points to cone-shaped depression. — [Line in B = 43 μm for A, 21 μm for B and 85 μm for C].

The middorsal thoracic carina bifurcates posterior to the mesostigmal plates, and the median carina arms curve laterally as ridges, which fuse with the posterior ends of the lateral carinae. The mesostigmal plate is a long concave triangle, covered with pad--like tuberosities. The posterior edge of the mesostigmal plates is smoothly rounded (Fig. 5A).

ARGIA PLANA CALVERT
Figures 4B, 5B

The anterior carina is straight, and the lateral carinae are concave (Fig. 4B). The middorsal thoracic carina bifurcates posterior to the mesostigmal plates, and the median carina arms extend anteriorly to form more-or-less fused flattened pads. The anterior edge of the plates is rather deeply concave medially. Each mesostigmal plate is an abbreviated concave triangle whose posterior edge is the shortest. The postero--mesal corner of each mesostigmal plate is developed as a distinct lobe (Fig. 5B). It is divergent and has a shallow central depression. The median carina arms and mesostigmal plates, including lobes, are uniformly covered with tuberosities, although these are somewhat more sparse in the distal half of the plate concavity.

ARGIA BIPUNCTULATA
(HAGEN)
Figures 4C, 5C

In this species the anterior carina is broadly convex. The concave lateral carinae fuse posteriorly with the postero-mesal corner of the mesostigmal plates to form a broad-based, rounded lobe which points to the rear (Fig. 4C). The middorsal thoracic carina bifurcates posterior to the mesostigmal plates, and the median carina arms extend anteriorly as partially fused, flattened pads. The common anterior border of these pads is shallowly concave mesially. The median carina arms and mesostigmal plates, including lobes, are uniformly covered with tuberosities (Fig. 5C).

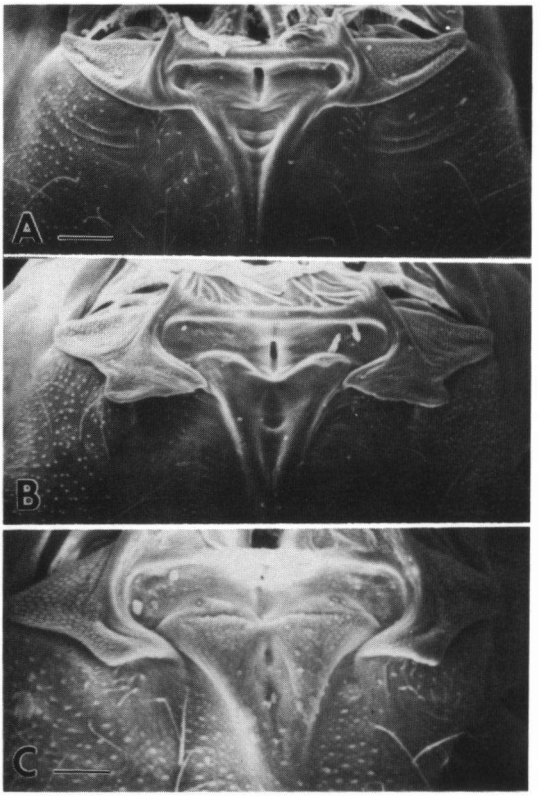

Fig. 4. (A) *Argia immunda*, 50x; — (B) *A. plana*, 50x; — (C) *A. bipunctulata*, 100x. — [Line in A = 200 μm for A and B, line in C = 100 μm for C].

DISCUSSION

In describing the mesostigmal plates of 34 North American species of *Enallagma*, DeGREVE (1989) found a major structural difference to be whether plates were rectangular/squarish or triangular, while secondary differences included presence or absence of ridges or grooves on those plates. These criteria do not apply to the *Argia* species examined to date. The mesostigmal plates of all nine *Argia* species are triangular, concave centrally and uniformly covered by pad-like tuberosities, as described by MOULTON et al. (1987). The one minor exception to this general description is a paucity of tubercles centrally on the plates of *A. plana*. Furthermore, the *Argia* species examined to date typically have straight anterior carinae (that of *A. bipunctulata* is broadly convex),

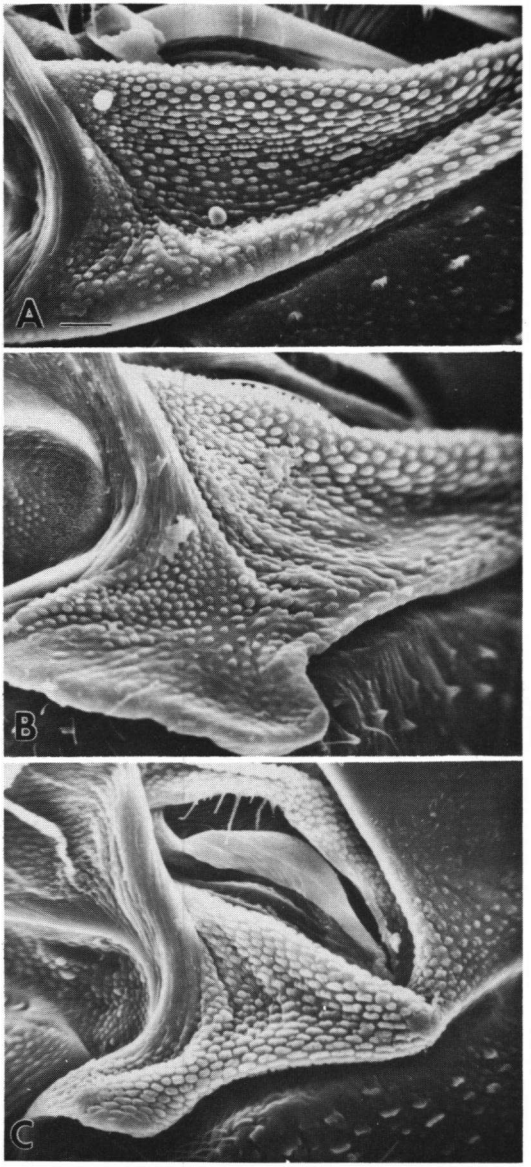

Fig. 5. (A) *Argia immunda*, 200x; — (B) *A. plana*, 200x; — (C) *A. bipunctulata*, 200x. — [Line in A = 50 μm for A-C].

concave lateral carinae (that of *A. tibialis* is linear) and tuberosities which rather uniformly cover the median carina arms, whether they be ridges or pads.

The major morphological differences noted among the nine *Argia* species pertain to the mesostigmal lobes and median carina arms. Using these criteria, there are two basic groups, one of six species and the other of three species. In one group, *A. f. violacea* and *A. sedula* are most similar, having mesostigmal lobes that converge and median carina arms as pads whose anterior borders are sinuate. Four other species loosely associated with this group are as follows. *A. moesta* has median carina arms in the form of pads, and their anterior border is sinuate, but the mesostigmal lobes are divergent. In *A. translata* the mesostigmal lobes are convergent and the anterior edge of the median carina arms is sinuate, but the arms themselves are of an intermediate ridge/pad form. Still less similar are *A. bipunctulata* and *A. plana*, which have median carina arms as pads, but the anterior edge is concave (form of sinuate?), and the mesostigmal lobes of *A. bipunctulata* point rearward, while those of *A. plana* are divergent (shared with *A. moesta*).

The second group includes *A. apicalis, A. immunda* and *A. tibialis.* The first two species lack lobes on the mesostigmal plates, and the median carina arms are in the form of ridges. *A. tibialis* also lacks mesostigmal lobes, but the median carina arms are of the intermediate ridge/pad configuration (as in *A. translata*), and their common anterior edge is sinuate.

It is premature to ascribe phylogenetic significance to the morphological differences noted herein. Nevertheless, such data exemplify the initial steps required for eventual clarification of phylogeny.

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