

THE EXTERNAL MORPHOLOGY OF *ACRONEURIA* *EVOLUTA* KLAPALEK.

(PERLIDAE, PLECOPTERA.)

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Stone flies are very primitive insects. Due to their poorly developed breathing apparatus the immature forms live largely in well-aerated water. This study was made principally at Stone Laboratory, Gibraltar Island, Put-in-Bay, Ohio, and the specimens used were collected along the rocky shores of the Lake Erie Archipelago, where the waves dashing upon the rocks furnished sufficient oxygen for their development.

Acroneuria evoluta is one of the medium sized varieties of the stone flies, the females having a length to tip of wings of 35 to 37 mm. and an expanse of 60 to 64 mm.; males, length to tip of wings, 25 to 28 mm., expanse, 42 to 48 mm. This genus is distributed over a wide area, being found in all parts of the United States and Canada.

Realizing the importance of muscle attachments, the writer hoped to include such a discussion in this paper, but due to the season of the year in which this work was done and the correspondingly scarcity of material, it was impossible of accomplishment. That phase will be taken up in a later paper.

This study was suggested by and made under the direction of Professor C. H. Kennedy, of Ohio State University, to whom the writer owes sincere thanks for his many helpful criticisms and suggestions. Thanks are due, also, to Professor R. E. Snodgrass, who looked over the drawings and helped in the naming of some of the parts.

THE HEAD.

(Pl. I, Figs. A, B, C, D, E.)

The head of *Acroneuria evoluta*, family *Perlidae*, is wider than the prothorax, rather blunt in front at the labrum, and bears two long antennae. There is a dark area over the clypeus and also over the ocellar triangle. The frontal ridge is in the form of a broad letter "M." The head is capable of receding somewhat under the anterior edge of the pronotum. (Pl. I, Fig. A.)

The tentorium is braced in the back by two posterior tentorial arms, and extending forward from these are two arms which fit into the

lobes above the antennae and support the frontal region of the tentorium. (Pl. I, Fig. B.)

The head appendages.—The labrum is flatly rounded in front and is covered with short hairs. The mandibles in the adult are poorly developed. The maxillae consist of sharp distigalea, lacinia, five-jointed palpus, stipes and cardo. The labium bears two three-jointed palps, between which are the paraglossae and glossae. These proceed out from the mentum. The antennae consist each of approximately seventy segments, the basal joints being brown, followed by yellowish and darker segments toward the tips. The ocelli form an almost equilateral triangle, the hind ocelli quite larger than the fore, and closer to each other than to the eyes. (Pl. I, Fig. A.)

THE THORAX.

(Pl. I, Figs. 2, 3, and Pl. II.)

The prothorax is entirely covered dorsally by a plate-like pronotum. The pronotum is quadrangular, wider than long and narrows somewhat behind. The rugosities are rather strong and are yellow in a darker background. Attached ventrally to the side edge of the pronotum is the anopleura, to which articulates the trochantin. (Pl. I, Fig. 2.) The coxa lies directly below the trochantin. The prosternum is composed of the basi-sternum, furca-sternum and spini-sternum. These are fused together into more or less of a rigid plate. The furcal pits are inclined toward the center and are joined in front by a furcal suture. (Pl. II, Fig. 8.) The two furcal spines (sternal apophyses, Pl. II, Fig. 5) are so wide apart that they do not appear as a median organ as in higher insects.

The mesothorax extends forward dorsally to beneath the posterior edge of the pronotum by means of a prescutum which bears on the front a phragma. (Pl. I, Fig. 3.) The prealare (Figs. 2, 3, 4, 6, 7, "Pa") extends down the side of the prothorax, almost touching the anterior edge of the episternum. In the membrane of the pleurum, between the prothorax and the mesothorax, lies the mesothoracic spiracle. (Pl. I, Fig. 2, "Sp2.") The mesopleurum is crossed obliquely by a heavy pleural suture (Pl. I, Figs. 2, 4), the lower end of which articulates with the coxa. Anterior to and below the pleural suture lies the episternum, posterior and above lies the epimeron. By a finer suture, reaching the pleural suture at right angles the episternum is divided into an an-episternum and a kat-episternum. (Pl. I, Fig. 2.) The small anterior sclerite of the an-episternum, known as the pre-episternum (Pl. I, Fig. 2, "PEps.") adjoins the prealare. At the base of the wing are several small plates and fused with the episternum is a crescent-shaped sclerite or basalare. (Pl. I, Figs. 2, 3, 4.) Posterior to this in the membrane are two plates, known collectively as the subalare. (Pl. I, Figs. 3, 4.) The wing articulates with the thorax by the anterior and posterior notal wing processes. (Pl. I, Figs. 3, 4.) The shield-shaped mesosternum consists of precoxal pieces on the sides with a basi-sternum, furca-sternum and spini-sternum in the center. The furcal pits are inclined toward the center as in the other two thoracic segments and are connected by the furcal suture. The

trochantin extends down from the pleurum and articulates with the coxa. A presternum lies in the membrane anterior to the mesosternum. (Pl. II, Fig. 5.) Both the prosternum and mesosternum bear narrow processes which lie in the membrane posterior to each. (Pl. II, Fig. 5.) Lying posterior to the mesotergum is a postnotum which is fused with the tergum and extends laterally to the epimeron. (Pl. I, Fig. 2 and Pl. II, Fig. 6.) The postnotum bears a phragma posteriorly.

The metathorax bears a spiracle (Pl. I, Fig. 2, "Sp3") which lies in the membrane anterior to the metapleurum. The heavy pleural suture divides the pleurum into an episternum and epimeron. The sclerites at the base of the hind wing are the subalare, basalare and the anterior and posterior notal wing processes. The postnotum of the metatergum bears the posterior phragma. (Pl. II, Fig. 6.) The sternum of the metathorax is similar to that of the mesothorax except there is no sharp process in the membrane posterior to it.

The wings.—Among the species of the genus *Acroneuria* there is considerable variation in the number of crossveins in the outer submarginal fields of the wings, some having many and others none. In the forewing the cubito-anal crossvein is close to the apex of the anal cell. There are three anal veins unbranched, with two simple veins extending from the anal cell below. (Pl. III, Fig. 9.) As in all genera of the order the radial sector of the hind wing at its base is fused with the median vein instead of the radius. The second anal vein is four-branched. (Pl. III, Fig. 9.)

The legs of adult stone flies, being similar to those of the immature forms, extend laterally from the side of the body when the insect is at rest, and are adapted for clinging to the surface of stones. Each leg has three tarsal segments. The terminal one is longest and carries on the end an oval pad and two sharp claws.

THE ABDOMEN.

There are ten distinctly recognizable abdominal segments. All but the first are slightly hardened and are more or less cylindrical in shape. In each the tergite and sternite are closely fused at the sides, forming a narrow fold. Segment one is greatly reduced, appearing merely as a small rectangular dorsal sclerite. The pleural region of segment one is replaced by the attachment of the hind legs, and the ventral sclerite is lacking, being completely fused with the metasternum and the sternite of segment two. A surviving trace of an eleventh segment is found in the supra-anal plate of the female and the sub-anal lobes of the male. These will be discussed further as a part of the genital region."

THE GENITAL ORGANS.

(Pl. III, Figs. 10 to 17.)

There are ten abdominal segments, the ninth segment in the male bearing on its dorsal side an oval, transverse, polished hammer; and on the tenth segment, between the cerci, two subanal lobes modified into sharp, cylindrical, genital hooks. (Pl. III, Figs. 10, 11.) These extend forward ventrally to the middle of the tenth segment. The

abdomen is covered with short hairs and on the ventral surface of each of segments nine and ten are two patches of short spines. The penis extends from the end of the abdomen as in figure fourteen.

"The eighth ventral segment of the female is produced in the middle into a rather narrow subgenital plate which reaches half way across segment nine. The plate is slightly emarginate behind and having slight emarginations on the sides of the plate at the base."¹ At the end of the abdomen of the female, between the cerci, is a supra-anal plate which is a triangular protrusion of segment ten covering the anal cavity above. (Pl. III, Figs. 15, 16, "SAP.") Between the cerci are the subanal lobes or paraprocts. (Pl. III, Fig. 15, "Papt.") The cerci bear nineteen segments.

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¹"Plecoptera of North America," by Needham and Claassen.

EXPLANATION OF PLATES.

PLATE I.

- Fig. 1. A, Head, dorsal view. B, Same as above, posterior view. C, Maxillae, showing five-jointed palps. D, Mandible. E, Labium.
 Fig. 2. Lateral view of thorax region.
 Fig. 3. Ventral surface of mesotergum and upper pleural regions.

PLATE II.

- Fig. 5. Inner surface of mesotergum.
 Fig. 6. Inside view of metatergum showing anterior and posterior phragmas.
 Fig. 7. Dorsal view of thorax.
 Fig. 8. Ventral view of thorax.

PLATE III.

- Fig. 9. Wings of *Acroneuria evoluta*.
 Fig. 10. Ventral view of segments 8, 9 and 10 of the male, showing genital hooks.
 Fig. 11. Tenth segment, male, showing genital hooks, posterior view.
 Fig. 12. Lateral view of segment 9, male.
 Fig. 13. Same as above, posterior view, showing hammer.
 Fig. 14. End of abdomen, male with penis extended.
 Fig. 15. End of abdomen, female, ventral view, showing subanal lobes (paraprocts), and supra-anal plate.
 Fig. 16. Segment 10, female, ventral view, showing supra-anal plate as a part of the segment.
 Fig. 17. Sternum of segment 8, showing genital plate.

ABBREVIATIONS USED.

AEps.....	an-episternum	PIS.....	pleural suture
An.....	Anus	PN.....	postnotum
ANP.....	anterior notal wing process	PNP.....	posterior notal wing process
APL.....	anapleura	pmt.....	post mentum
Ba.....	basalare	prmt.....	prementum
Bs.....	basisternum	prs.....	presternum
Cer.....	cercus	Psc.....	prescutum
Cx.....	coxa	PTA.....	posterior tentorial arm
Dg.....	distigalea	s.....	stipes
Epm.....	epimeron	Sa.....	subalare
Eps.....	episternum	SAL.....	subanal lobe
Fs.....	furcal suture	SAP.....	supre-anal lobe
Gl.....	Glossa	Scl.....	scutellum
h.....	genital hook	Sct.....	scutum
ha.....	hammer	SGP.....	subgenital plate
KEps.....	kat-episternum	Sp.....	spiracle
Lc.....	lacinia	Ss.....	spini-sternum
Pa.....	prealare	Stn.....	sternum
Papt.....	paraproct	T.....	tergum
PEps.....	pre-episternum	Tg.....	tegula
Pgl.....	paraglossa	Tn.....	trochantin
Ph.....	phragma	Tr.....	trochanter

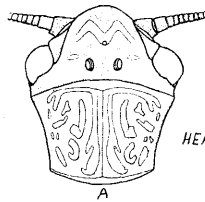
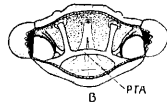
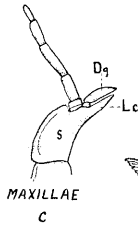


FIG. 1

HEAD - DORSAL VIEW



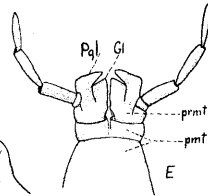
HEAD
 POSTERIOR VIEW



MAXILLAE
 C



MANDIBLE



LABIUM

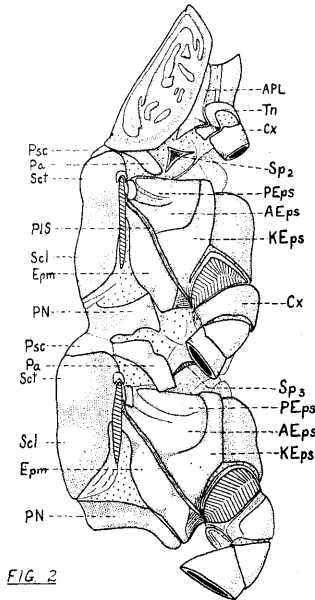


FIG. 2

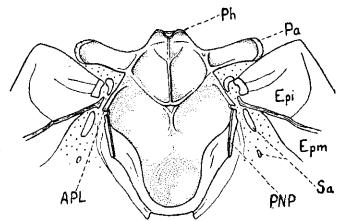


FIG. 3

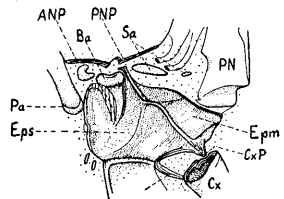
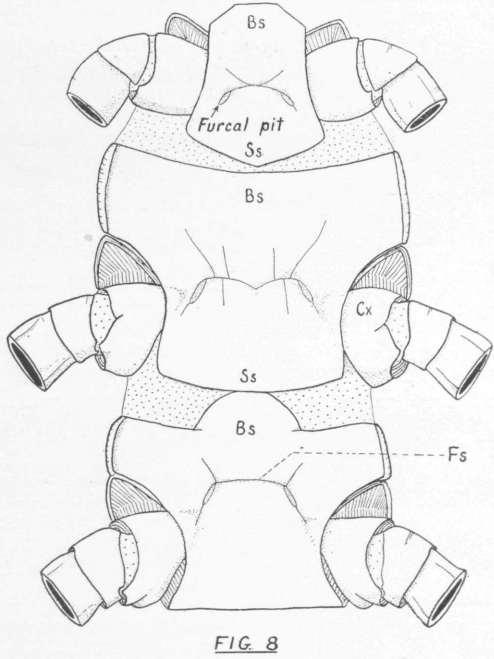
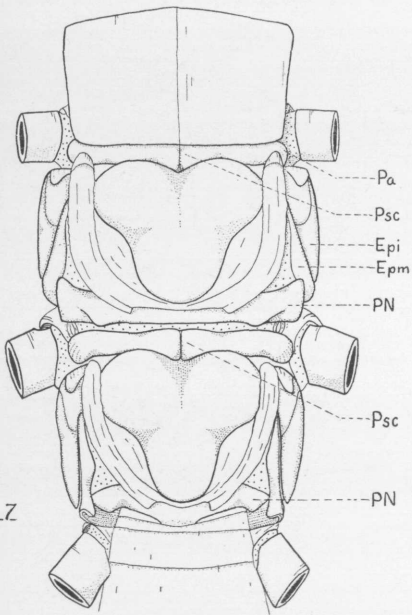
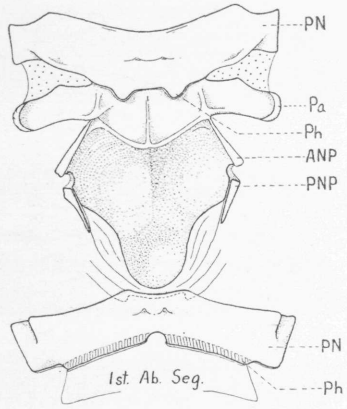
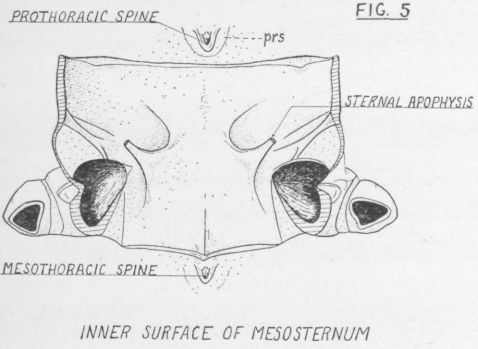


FIG. 4



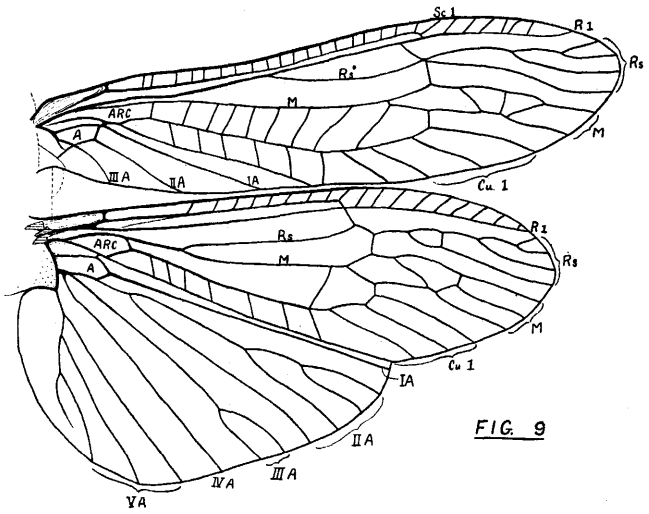


FIG. 9

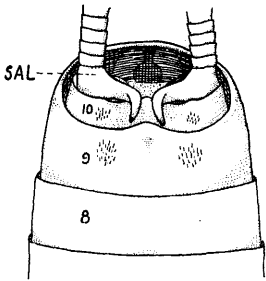


FIG. 10

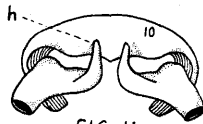


FIG. 11

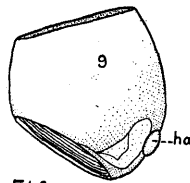


FIG. 12

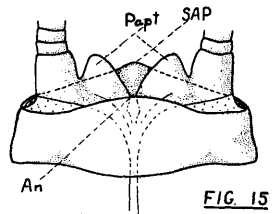


FIG. 15

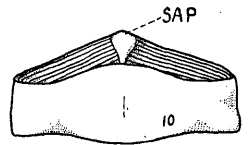


FIG. 16

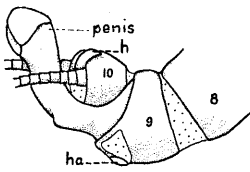


FIG. 14

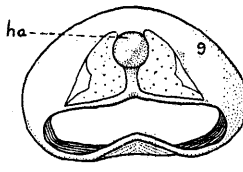


FIG. 13

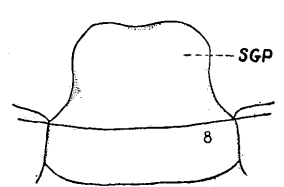


FIG. 17