

379
N81
No. 5008

THE STONEFLIES (PLECOPTERA) OF TEXAS

THESIS

Presented to the Graduate Council of the
North Texas State University in Partial
Fulfillment of the Requirements

For the Degree of

MASTER OF SCIENCE

By

Stanley W. Szczytko, B. S.

Denton, Texas

May, 1975

Szczytko, Stanley W., The Stoneflies (Plecoptera) of Texas. Master of Science (Biology), May, 1975, 133 pp., 65 illustrations, literature cited, 98 titles.

An illustrated key to the adults and known nymphs of Texas Plecoptera is provided. Species accounts, including geographic distribution within Texas, and biological notes are given.

Of the twenty-seven species of Plecoptera known from Texas, six are new state records. Two species new to science, Isoperla jewetti and Isoperla coushatta are described.

Taeniopteryx starki Stewart and Szczytko, Zealeuctra arnoldi Ricker and Ross, and Zealeuctra hitei Ricker and Ross are endemic to the Edwards Plateau area of Texas. Two species, Mesocapnia frisoni (Baumam and Gaufin) and Isoperla jewetti New Species are western in origin. The remaining nineteen species (excluding Anacroneuria) are typically eastern species.

ACKNOWLEDGMENTS

Several individuals and museums have cooperated in lending specimens for comparison and examination.

Among these are Dr. Glenn Longley (Southwest Texas State University), Dr. William W. Gibson (Stephen F. Austin State University), Bill P. Stark (University of Utah), Dr. Richard W. Baumann (Smithsonian Institution), Dr. Donald Webb (Illinois Natural History Museum), and Mr. Stanley G. Jewett.

TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTS	iii
LIST OF ILLUSTRATIONS	v
Chapter	
I. INTRODUCTION	2
II. MATERIALS AND METHODS	7
III. RESULTS AND DISCUSSION	10
List of Texas Stoneflies	10
Key to the Families, Subfamilies and genera	13
Genus <u>Taeniopteryx</u>	25
Genus <u>Zealeuctra</u>	40
Genus <u>Allocapnia</u>	48
Genus <u>Mesocapnia</u>	57
Genus <u>Amphinemura</u>	59
Genus <u>Hydroperla</u>	62
Genus <u>Isoperla</u>	67
Genus <u>Acroneuria</u>	93
Genus <u>Perlesta</u>	98
Genus <u>Perlinella</u>	103
Genus <u>Neoperla</u>	106
Genus <u>Paragnetina</u>	109
Questionable Records	117
Seasonal Emergence	118
IV. SUMMARY	123
LITERATURE CITED	125

LIST OF ILLUSTRATIONS

Figure	Page
1. Nymph of <u>Isoperla couthatta</u>	1
2. Left forewing of <u>Isoperla mohri</u> male	18
3. Left hindwing of <u>Isoperla mohri</u> male	18
4. Left forewing of <u>Amphinemura nigritta</u> male.	18
5. Left forewing of <u>Neoperla clymene</u> male . . .	20
6. Left forewing of <u>Isoperla jewetti</u> male . . .	20
7. Left forewing of <u>Isoperla couthatta</u> male	20
8. Left forewing of <u>Hydroperla crosbyi</u> male	20
9. Left forewing of <u>Perlesta placida</u> male	22
10. Left forewing of <u>Perlinella drymo</u> male	22
11. Left forewing of <u>Acroneuria arenosa</u> male	22
12. Left forewing of <u>Paragnetina fumosa</u> male	22
13. Left forewing of <u>Zealeuctra hitei</u> male	24
14. Left forewing of <u>Taeniopteryx starki</u> male	24
15. Left forewing of <u>Allocapnia malverna</u> male	24

LIST OF ILLUSTRATIONS--Continued

Figure	Page
16. Left forewing of <u>Mesocapnia frisoni</u> male	24
17. Hind femur of <u>Taeniopteryx maura</u> male.	29
18. Hind femur of <u>Taeniopteryx burksi</u> male	29
19. Hind leg of <u>Taeniopteryx burksi nymph.</u>	29
20. Hind leg of <u>Zealeuctra hitei nymph</u>	29
21. Labium of <u>Taeniopteryx burksi nymph.</u>	29
22. <u>Taeniopteryx lita</u> male.	31
23. <u>Taeniopteryx lonicera</u> male	31
24. <u>Taeniopteryx starki</u> male	31
25. Left paraproct of <u>Taeniopteryx lita</u> male	31
26. Left paraproct of <u>Taeniopteryx starki</u> male	31
27. Left paraproct of <u>Taeniopteryx lonicera</u> male	31
28. Female subgenital plate of <u>Taeniopteryx</u> <u>lonicera</u>	31
29. Female subgenital plate of <u>Taeniopteryx</u> <u>lita</u>	31
30. Female subgenital plate of <u>Taeniopteryx</u> <u>starki</u>	31
31. Variation of female subgenital plate of <u>Taeniopteryx starki.</u>	31

LIST OF ILLUSTRATIONS--Continued

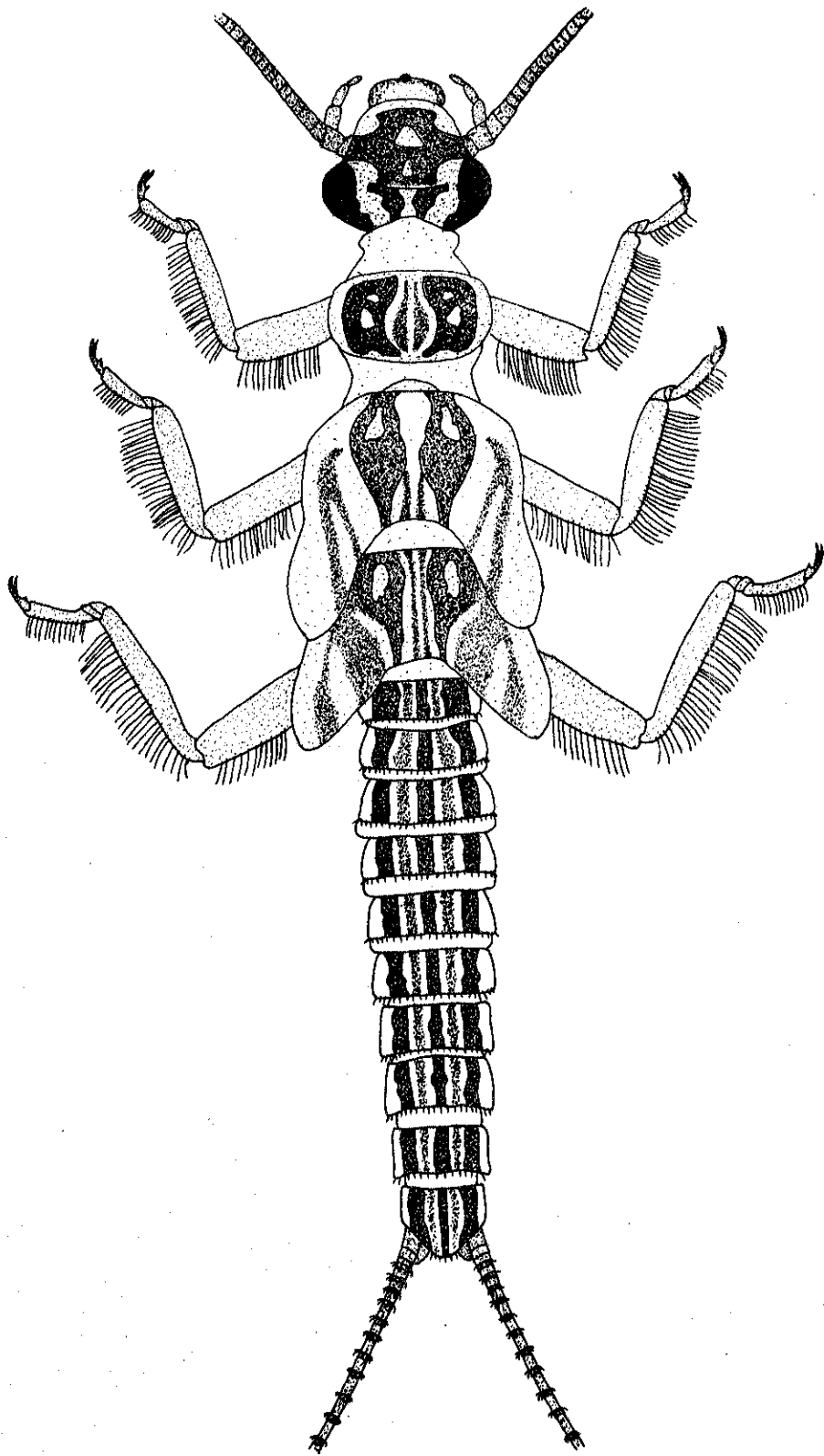
Figure	Page
32. Terminal dorsal segments of <u>Zealeuctra</u> <u>claasseni</u> male	44
33. Terminal dorsal segments of <u>Zealeuctra</u> <u>hitei</u> male	44
34. Terminal dorsal segments of <u>Zealeuctra</u> <u>arnoldi</u> male	44
35. Terminal ventral abdominal view of <u>Zealeuctra claasseni</u> female	44
36. Terminal ventral abdominal view of <u>Zealeuctra hitei</u> female.	44
37. Terminal ventral abdominal view of <u>Zealeuctra arnoldi</u> female.	44
38. Epiproct of <u>Zealeuctra hitei</u>	44
39. Epiproct of <u>Zealeuctra arnoldi</u>	44
40. Epiproct of <u>Zealeuctra claasseni</u>	44
41. Terminal ventral abdominal view of <u>Allocapnia granulata</u> female.	53
42. Terminal ventral abdominal view of <u>Allocapnia malverna</u> female	53
43. Terminal lateral view of <u>Allocapnia</u> <u>granulata</u> male	53
44. Dorsal process of <u>Allocapnia granulata</u> male	53
45. Dorsal process of <u>Allocapnia malverna</u> male	53
46. Terminal lateral view of <u>Allocapnia mal-</u> <u>verna</u> male	53

LIST OF ILLUSTRATION--Continued

Figures	Page
47. Labrum of <u>Isoperla</u> <u>Sp.</u> A nymph	73
48. Labrum of <u>Isoperla</u> <u>coushatta</u> nymph	73
49. Labrum of <u>Isoperla</u> <u>mohri</u> nymph	73
50. Lacinia of <u>Isoperla</u> <u>Sp.</u> A nymph.	73
51. Lacinia of <u>Isoperla</u> <u>coushatta</u> nymph.	73
52. Lacinia of <u>Isoperla</u> <u>jewetti</u> nymph	73
53. Lacinia of <u>Isoperla</u> <u>mohri</u> nymph.	73
54. Labrum of <u>Isoperla</u> <u>mohri</u> nymph	75
55. Labrum of <u>Isoperla</u> <u>coushatta</u> nymph	75
56. Right mandible of <u>Isoperla</u> <u>Sp.</u> A.	75
57. Right mandible of <u>Isoperla</u> <u>jewetti</u> nymph	75
58. Labium of <u>Isoperla</u> <u>jewetti</u> nymph.	75
59. Labium of <u>Isoperla</u> <u>Sp.</u> A Nymph	75
60. Right mandible of <u>Isoperla</u> <u>mohri</u> nymph	75
61. Right mandible of <u>Isoperla</u> <u>coushatta</u> nymph	75
62. Lateral view of <u>Isoperla</u> <u>jewetti</u> aedeagus.	80
63. Terminal ventral view of <u>Isoperla</u> <u>jewetti</u> male	80
64. Terminal dorsal view of <u>Isoperla</u> <u>jewetti</u> male	80
65. Terminal ventral view of <u>Isoperla</u> <u>mohri</u> male	84

LIST OF ILLUSTRATIONS--Continued

Figure	Page
66. Terminal lateral abdominal view of <u>Isoperla mohri</u> with aedeagus extruded.	84
66A. Posterior view of <u>Isoperla mohri</u> aedeagus.	84
67. Head of <u>Perlinella drymo</u> nymph	84
68. Female subgenital plate of <u>Isoperla jewetti</u>	86
69. Female subgenital plate of <u>Isoperla coushatta</u>	86
70. Female subgenital plate of <u>Isoperla mohri</u>	86
71. Terminal dorsal abdominal view of <u>Isoperla coushatta</u> with aedeagus extruded.	88
72. Terminal lateral abdominal view of <u>Isoperla coushatta</u> with aedeagus extruded	88
73. Terminal ventral abdominal view of <u>Isoperla coushatta</u> with aedeagus extruded	88
74. Distribution of fall-winter stoneflies	112
75. Distribution of spring-summer stoneflies	114
76. Distribution of spring-summer stoneflies	116
77. Seasonal emergence of Texas Plecoptera	121



CHAPTER I
INTRODUCTION

Until the work of Stewart, et al. (1974), only nine species of stoneflies were reported from Texas and most of those were known from single localities. Six species had been attributed to Texas by Illies (1966) in his catalog, two new endemic Zealeuctra, arnoldi and hitei, were reported by Ricker and Ross (1969) in their revision of that genus, and the Claassen (1925) report of Acroneuria pumila (now Hesperoperla pacifica) was placed in great doubt.

Stewart et al. (1974) reported 23 species of stoneflies representing 116 county, and numerous locality records. In that paper, they stated that Texas specimens of Isoperla appeared closest to namata, except that many nymphal populations fit the description of Isoperla mohri Frison (1935) almost perfectly, and that additional study and comparisons with the types of mohri and namata would be necessary for exact determination. They also suggested that Isoperla longiseta Banks, collected in 1939 by H. H. and J. A. Ross near El Paso, be reexamined in light

of Frison's (1942) "reluctant" identification, the brachypterous condition of males and its similarities to mormona that he mentioned.

Stewart et al. (1974) found four species of Taeniopteryx occurring in small streams and swampy areas of East Texas. One nymph of what "appeared to be" T. burksi was found in Hamilton County, west of the blackland prairie. Adults of that western population have recently been collected from adjacent Coryell County and were found to be an undescribed species, Taeniopteryx starki (Stewart and Szczytko, 1974).

The unique geographic position of Texas, discussed by Stewart et al. (1974), and climate changes during and since the Pleistocene, have lent special interest and interpretive value to its stonefly fauna. The relict population of Mesocapnia frisoni (Baumann and Gaufin) and the El Paso Isoperla (Isoperla jewetti New Species) are western in origin, and at least three species, Taeniopteryx starki Stewart and Szczytko, Zealeuctra arnoldi Ricker and Ross, and Zealeuctra hitei Ricker and Ross and possibly the new species reported herein, Isoperla coushatta, are endemic to Texas. All other Texas stoneflies are eastern in origin.

The biology of only one Texas species, Neoperla clymene (Newman), is well known (Vaught and Stewart, 1974). The factors controlling distribution of stoneflies, such as flow, turbidity, substrate type, water temperature, concentration of dissolved gases, and food availability, mentioned by Brinck (1949), are undoubtedly in operation for species requiring permanent streams in East and Central Texas, and their western distribution limits in the state correspond generally with water permanence. The north-south band of blackland prairie in Central Texas, with its intermittent, turbid streams, probably represents a dispersal barrier to eastern species of low vagility but otherwise capable of tolerating conditions of more permanent streams on the Edwards Plateau. The endemic Zealeuctra arnoldi, Zealeuctra hitei and Taeniopteryx starki of the plateau probably derived from ancestors able to move westward during the Pleistocene, when the blackland prairie was non-existent and the area was dominated by more mesic forests.

Perlesta placida, Neoperla clymene, Perlinella drymo and Hydroperla crosbyi are more vagile species and are apparently still capable of traversing the blackland prairie, as indicated by their rather extensive occurrence

west of the prairie, and their believed wide tolerances to physical and chemical limiting factors and capability to survive unfavorable, even intermittent, stream conditions as diapausing (aestivating) eggs and/or nymphs. Only Perlesta placida is found in turbid streams on the prairie itself.

The current study was needed in order to bring together all the current knowledge of the stonefly fauna of Texas, and to clarify the taxonomic position of Texas species of the genus Isoperla. Primary objectives were therefore (1) to expand knowledge of the occurrence and distribution of Plecoptera within the state, (2) to provide an illustrated key to Texas stonefly adults and known nymphs, and (3) to intensively collect, rear, and study the Isoperla fauna. Data derived from such a regional study of Isoperla should prove very useful when the monumental task of revision of that very large and widely distributed genus is undertaken. Due to morphological similarity, inadequate distributional knowledge, and the "piecemeal" nature of previous taxonomic descriptions, the genus is in much need of revision. Several plecopterists have expressed interest in or actually begun a revision of the genus Isoperla, but no active attempt is current.

Dr. J. F. Hanson, University of Massachusetts, and S. G. Jewett, retired, both have large collections of Isoperla, but have abandoned active revisionary work.

CHAPTER II

MATERIALS AND METHODS

Extensive collecting trips were made to East Texas in the spring of 1972, 1973, and 1974, to the Edwards Plateau during the winters of 1973 and 1974, and through central and West Texas in June, 1973. In addition, local collections in north-central Texas and other collections by myself and other graduate students of our NTSU Aquatic Insect Laboratory were utilized in updating occurrence and distribution of Plecoptera within the state. Standard collecting methods were employed, including sweeping vegetation, collecting in streams with kick nets, actively searching among rocks and debris along stream margins, and use of fluorescent and black lights at night. Some collecting trips traversed over 1,000 miles and all streams encountered were collected.

Specimens of Plecoptera from Texas were borrowed from all colleges and universities in Texas and from collections of the University of Utah and Smithsonian Institution. Other major collections, including those of the Illinois Natural History Survey, Texas A & M University,

and Smithsonian Institution, and personal collections of W. E. Ricker, S. G. Jewett, and others had been checked by Stewart et al. (1974). A complete review of Plecoptera literature was made in search of Texas records.

Six vials of Isoperla longiseta from near El Paso, Texas were obtained from S. G. Jewett and the Illinois Natural History Survey. The aedeagus of one male had been apparently extruded and fixed at time of collection in 1939. Adult specimens, and eggs dissected from one female were compared with those of typical Isoperla longiseta from the Green River in Utah. The one brachypterous male from La Veta Pass, Colorado, mentioned by Frison (1942), was also examined. The aedeagii of several males from Utah were extruded using the following technique: (1) specimens were cleared in a 5% solution of KOH, which was heated to hasten clearing and softening, (2) the aedeagus was everted by gently pressing the abdomen with forceps.

Special attention was given to comparisons of the male aedeagii, color patterns, male paraprocts, female subgenital plates, and any other potentially diagnostic characters. The four nymphal exuviae of the El Paso collection were compared with nymphs from Green River, Utah (the nymphs of longiseta are undescribed).

Nymphs of East Texas Isoperla were collected during emergence in March of 1972, 1973, and 1974, and reared in styrofoam cups containing stream water from their respective collection sites, in order to correlate nymphs with adults. Aedeagii of reared males and of field-emerged males were extruded by gently squeezing their abdomens while alive and then fixing them in 75% ethanol.

All specimens of Isoperla were compared with paratypes of Isoperla mohri Frison, Isoperla namata Frison and Isoperla richardson Frison borrowed from the Illinois Natural History Museum. These species were deemed the closest to Texas specimens. Nymphs of Texas populations were compared with nymphs of the above three species, and slides of their mouthparts were made for diagnosis. The labrum, maxillae, mandibles, and labium from several nymphs were mounted in Turttox CMC. Photographs of Isoperla aedeagii and nymphal parts were made using a Nikon Microflex semi-automatic shutter adapter mounted respectively on a Wild M-5 Stereomicroscope and an AO Microstar microscope. Drawings of whole nymphs and aedeagii were made from the prepared slides using a Wild Camera Lucida mounted on the Wild M-5 Stereomicroscope, and drawings of nymphal mouthparts were made from prepared slides using a Bausch and Lomb Bioscope.

CHAPTER III

RESULTS AND DISCUSSION

List of Texas Stoneflies

Suborder Filipalpia
(Euholognatha Zwick 1973)

Family Taeniopterygidae

Genus Taeniopteryx Pictet 1841

1. Taeniopteryx maura (Pictet) 1841
2. Taeniopteryx burksi Ricker and Ross 1968
3. Taeniopteryx lonicera Ricker and Ross 1968
4. Taeniopteryx lita Frison 1942
5. Taeniopteryx starki Stewart and Szczytko 1974

Family Leuctridae

Genus Zealeuctra Ricker 1952

6. Zealeuctra arnoldi Ricker and Ross 1969
7. Zealeuctra claasseni (Frison) 1929
8. Zealeuctra hitei Ricker and Ross 1969

Family Capniidae

Genus Allocapnia Claassen 1928

9. Allocapnia malverna Ross 1964
10. Allocapnia granulata (Claassen) 1924

Genus Mesocapnia Raušer 1968

11. Mesocapnia frisoni (Baumann and Gaufin) 1970

Family Nemouridae

Genus Amphinemura Ris 1902

12. Amphinemura nigritta (Provancher) 1876

Suborder Setipalpia
(Systellognatha Zwick 1973)

Family Perlodidae

Subfamily Isogeninae

Genus Hydroperla Frison 1935

13. Hydroperla crosbyi (Needham and Claassen) 1925
14. Hydroperla fugitans (Needham and Claassen) 1925

Subfamily Isoperlinae

Genus Isoperla

15. Isoperla jewetti NEW SPECIES
16. Isoperla mohri Frison 1935
17. Isoperla coushatta NEW SPECIES
18. Isoperla sp.
19. Isoperla irregularis (Klapálek) 1923b

Family Perlidae

Subfamily Acroneurinae

Genus Anacroneuria Klapálek 1909

20. Anacroneuria sp. (Needham and Broughton) 1927

Genus Acroneuria Pictet 1841

21. Acroneuria arenosa (Pictet) 1841
22. Acroneuria arida (Hagen) 1861
23. Acroneuria mela Frison 1942

Genus Perlesta Banks 1906

24. Perlesta placida (Hagen) 1861

Genus Perlinella Banks 1900

25. Perlinella drymo (Newman) 1839

Genus Neoperla Needham 1905

26. Neoperla clymene (Newman) 1839

Genus Paragnetina Klapálek 1907 f

27. Paragnetina fumosa (Banks) 1902

Key to the Families, Subfamilies and Genera

Adults ¹

1. Paraglossae and glossae about equal in length (Fig. 21) Suborder Filipalpia. (2)
Paraglossae much longer than glossae (Figs. 54, 55, 58, 59) Suborder Setipalpia. (6)
2. Second tarsal segment approximately as long as the first (Fig. 19), male cerci one-segmented (Figs. 22, 24) TAENIOPTERYGIDAE. (P. 25) Taeniopteryx
Second tarsal segment much shorter than the first (Fig. 20). (3)
3. Wings lying nearly flat when at rest, 2nd anal vein of the forewing forked (Fig. 4), cerci one-segmented NEMOURIDAE (P. 59) Amphinemura
Wings either rolled around sides of abdomen when at rest, or flat and with the second anal vein of the forewing simple; cerci either one-segmented or with more than four segments. (4)
4. Wings rolled around the abdomen at rest, 2nd anal vein of the forewing forked (Fig. 13); more than 5 intercubital cross veins in the forewing (Fig. 13); cerci one-segmented (Figs. 32-37) LEUCTRIDAE (p. 40) Zealeuctra
Wings lying flat when at rest; 2nd anal vein of the forewing simple; one or rarely 2 intercubital cross veins in the forewing (Fig. 15 & 16); male cerci with four or more segments. CAPNIIDAE . . . (5)
5. R1 of the forewing bent abruptly upward at its origin; first anal vein of forewing bent abruptly caudal at its junction with cu-a and then curved outwardly again (Fig. 16);. . . . (P. 57). Mesocapnia

1. Adapted largely from Ricker (1943, 1952).

R1 of the forewing not bent abruptly upward at its origin first anal vein of the forewing not bent abruptly caudal at its junction with cu-a; Sc ending much before the cord (Fig. 15); supra-anal process of the male double. (P.48). Allocapnia

6. Remnants of gills at lower angles of the thorax, cubitoanal cross vein of the forewing usually either in the anal cell or distant from it by no more than its own length (Figs. 9-12), except Neoperla clymene (Fig. 5), (Texas Isoperla, Fig. 2, 6, 7, improperly fit here).
 PERLIDAE. (8)
 Remnants of gills absent from the thorax; cubitoanal cross vein absent (Fig. 8) or if present usually distant from the anal cell by more than its own length (all Texas Isoperla, Figs. 2, 6, 7, are exceptions, and for this character only will improperly key to Perlidae.
 PERLODIDAE. (7)
7. Male 10th tergum completely cleft; supra anal process of male genitalia broadly and irregularly U-shaped in side view; surrounded by a fleshy cowl which is slit dorsally and usually with 2 lateral stylets inserted on it.
 ISOGENINAE. (P.62). Hydroperla
 Male 10th tergum entire or at most slightly notched; male paraprocts produced into erect or recurved hooks (Fig. 64 & 71) ventral lobe usually present of the posterior margin of male 8th sternum (Figs. 63, 65, 73).
 ISOPERLINAE (P.67). Isoperla
8. Males with paraprocts produced inward and upward, sharply pointed or hooked, middle of the hind margin to the 10th tergum not cleft; a definite raised knob or hammer usually present on the 9th sternum (absent in Perlesta); dorsal prolongations of the hind margin of the 10th tergum usually absent; if present they are developed from its lateral angles rather than from the sides of a median cleft. ACRONEURINAE. . . (9)

9. Anal area of the forewing with a row of cross veins (Fig. 10); pronotum with a dark median band.(P.103) Perlinella
 Anal area of the forewing without a row of cross veins pronotum without a median dark band (10)
10. Costal margin of forewing and base of R3 and M yellowish contrasting with brownish veins, male without a hammer or raised knob on the 9th abdominal sternum(P.98) Perlesta
 Costal margin of forewing dark, and almost unicolorous with the rest of the wing; 9th abdominal sternite with a distinct hammer in the middle of the posterior portion.(P. 93) Acroneuria
11. With only two ocelli set close together(P.106) Neoperla
 With three ocelli normally placed.(P.109) Paragnetina

Nymphs

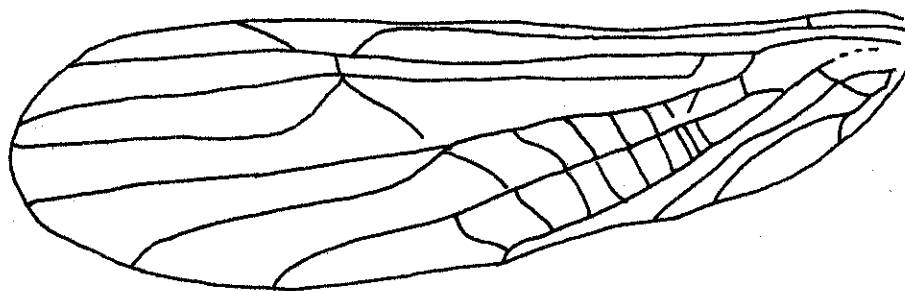
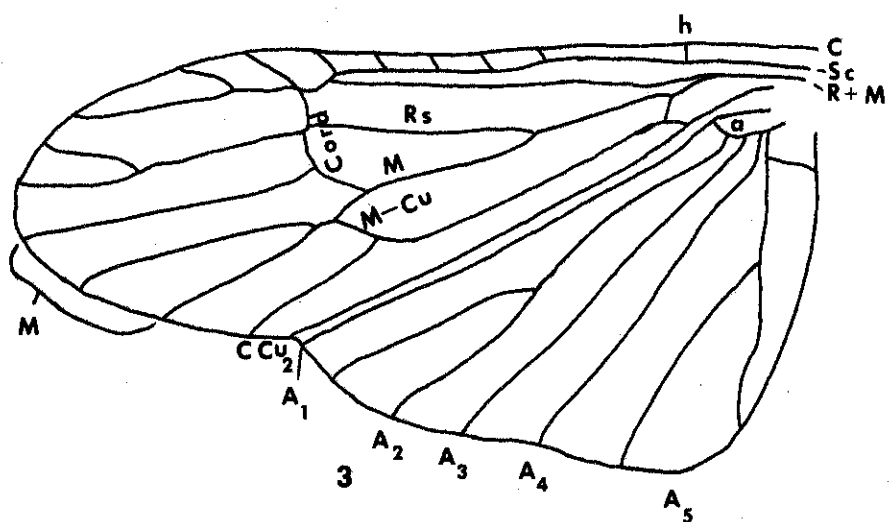
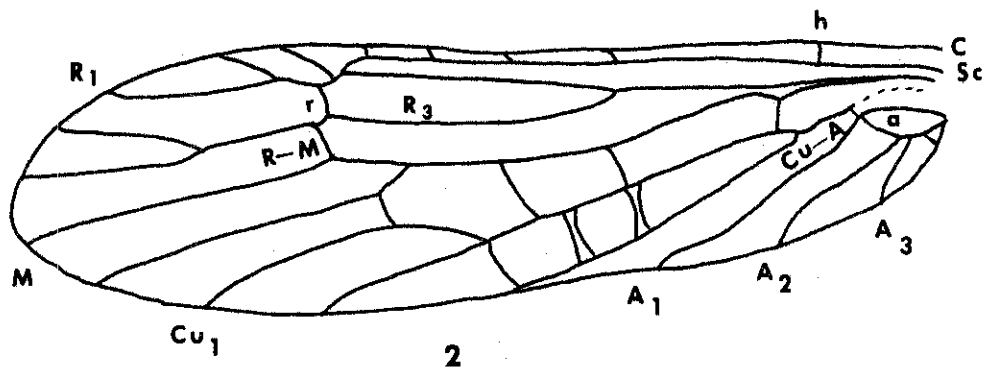
1. Paraglossae and glossae of about equal length (Fig. 21) SUBORDER Filialpia. (2)
 Paraglossae much longer than glossae (Figs. 54, 55, 58, 59) SUBORDER Setipalpia. . (6)
2. Second tarsal segment at least as long as the first, each coxae bearing a finger-like gill (Fig. 19) TAENIOPTERYGIDAE.(P.25) Taeniopteryx
 Second tarsal segment much shorter than the first, coxae without finger-like gills (Fig. 20).(3)
3. Cylindrical elongate body with hind wing pads nearly parallel with the axis of the body, and no cervical gills(4)
 Stout bodied nymphs with hind wing pads strongly diverging from the axis of the body; cervical gills present.(P.59) Amphinemura

4. Abdominal segments 1 to 9 divided by a membranous fold laterally CAPNIIDAE. (5)
 Only the first seven abdominal segments divided laterally by a membranous fold
 LEUCTRIDAE. (P.40) Zealeuctra
5. Inner margin of the hind wing pad with a notch about half way from the base to the tip. (P.57) Mesocapnia
 Inner margin of the hind wing pad notched very close to the tip if at all
6. Branching gills absent from the lower angles of the thorax. PERLODIDAE. (7)
 Branching gills present on the lower angles of the thorax. PERLIDAE. (8)
7. Submental gills present, mature nymphs usually over 10mm in length, longitudinal stripes absent from the dorsum of the abdomen. ISOPERLINAE . . (P.62) Hydroperla
 Submental gills absent, mature nymphs usually less than 10mm in length; dorsum of abdomen usually with longitudinal stripes (Fig. 1) ISOPERLINAE. . (P.67). Isoperla
8. Eyes located much anterior to the hind margin of the head (Fig. 67) . . (P.103). Perlinella
 Eyes located close to the hind margin to the head. (9)
9. A transverse occipital ridge present on the posterior margin of the head (10)
 A transverse occipital ridge absent from the posterior margin of the head(P.93). Acroneuria
10. Three ocelli normally placed (11)
 Two ocelli set close together. . . (P.106). Neoperla
11. Dorsum of the abdomen with distinct freckle-like spots (P.98). Perlesta
 Dorsum of the abdomen without distinct freckle-like spots (P.109). Paragnetina

Fig. 2. Left forewing of Isoperla mohri male. M-media, Cu-cubitus, h-humeral cross-vein, r-radial cross-vein R-M-radio-medial cross-vein, M-Cu-medio-cubital cross-vein, a-anal cross-vein, R-radius, Sc-subcosta, Rs-radial sector, Cu-A-cubital-anal cross-vein.

Fig. 3. Left hindwing of Isoperla mohri male.

Fig. 4. Left forewing of Amphinemura nigritta male.



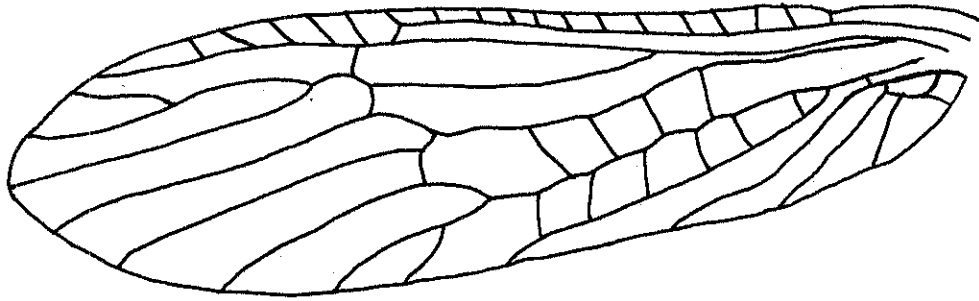
4

Fig. 5. Left forewing of Neoperla clymene male.

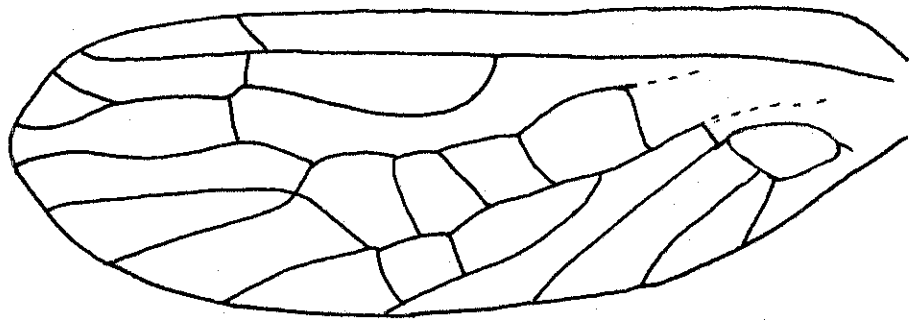
Fig. 6. Left forewing of Isoperla jewetti male.

Fig. 7. Left forewing of Isoperla couthatta male.

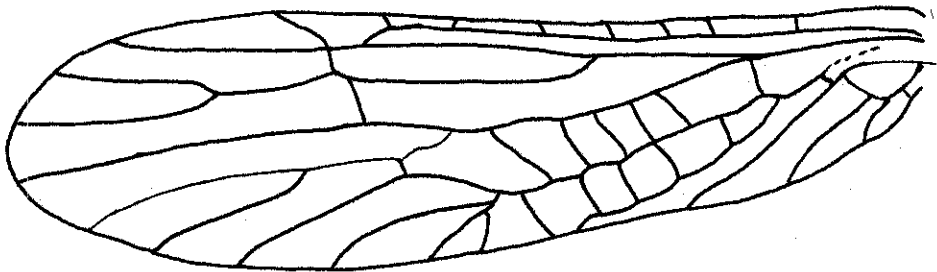
Fig. 8. Left forewing of Hydroperla crosbyi male.



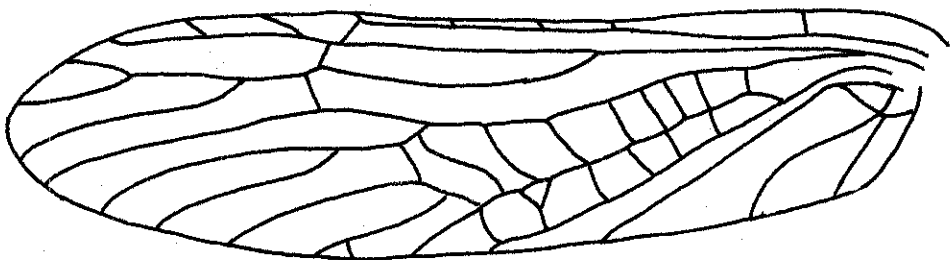
5



6



7



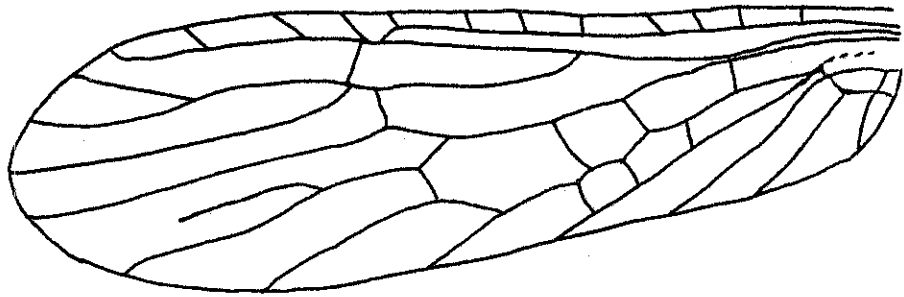
8

Fig. 9. Left forewing of Perlesta placida male.

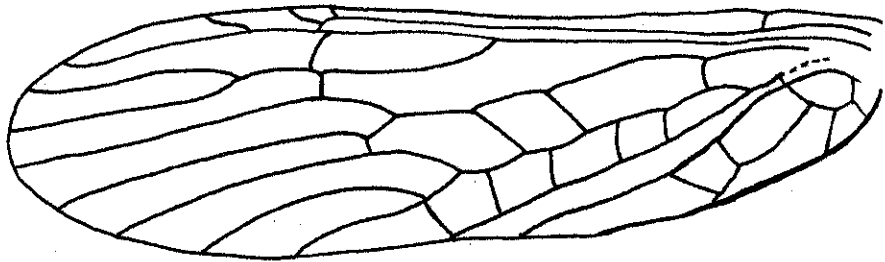
Fig. 10. Left forewing of Perlinella drymo male.

Fig. 11. Left forewing of Acroneuria arenosa male.

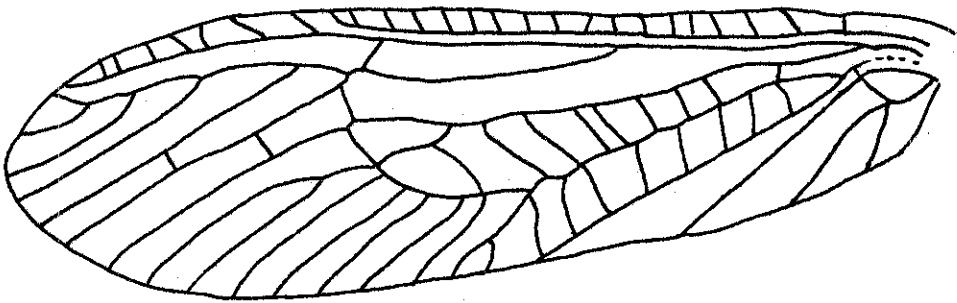
Fig. 12. Left forewing of Paragnetina fumosa male.



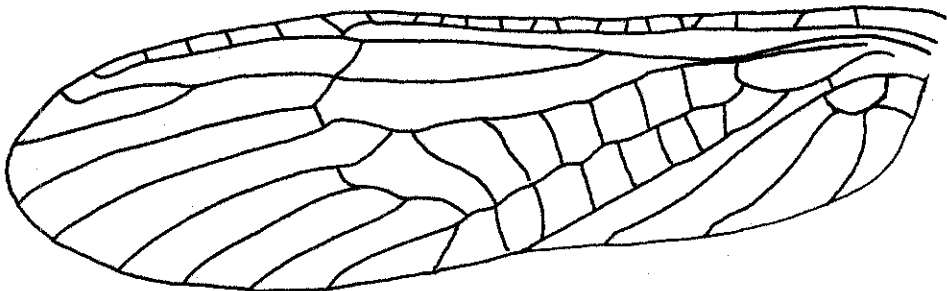
9



10



11



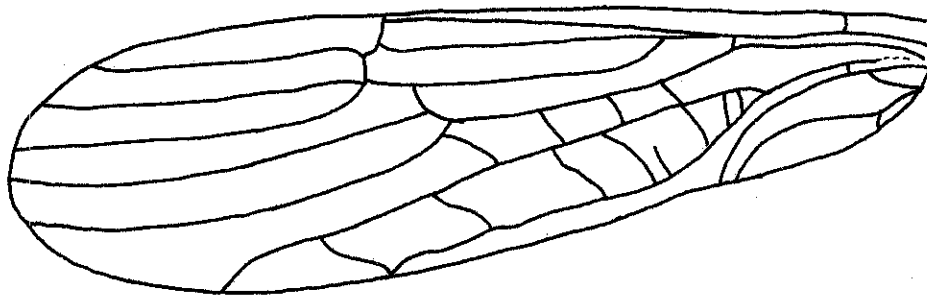
12

Fig. 13. Left forewing of Zealeuctra hitei male.

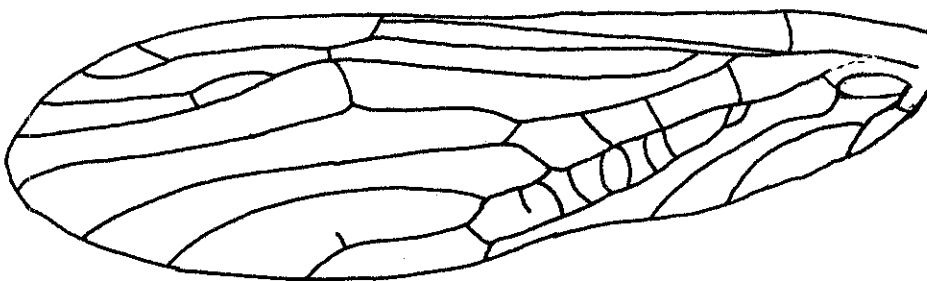
Fig. 14. Left forewing of Taeniopteryx starki male.

Fig. 15. Left forewing of Allocapnia malverna male.

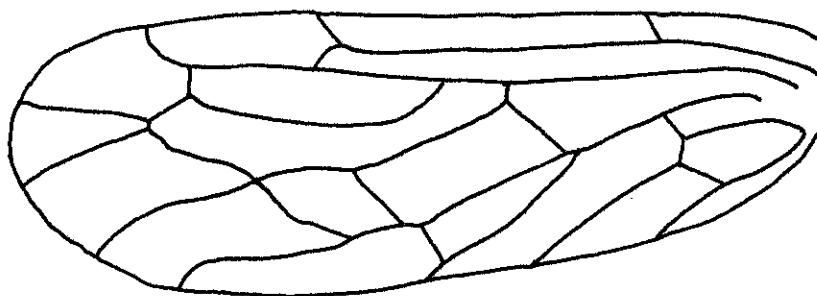
Fig. 16. Left forewing of Mesocapnia frisoni male.



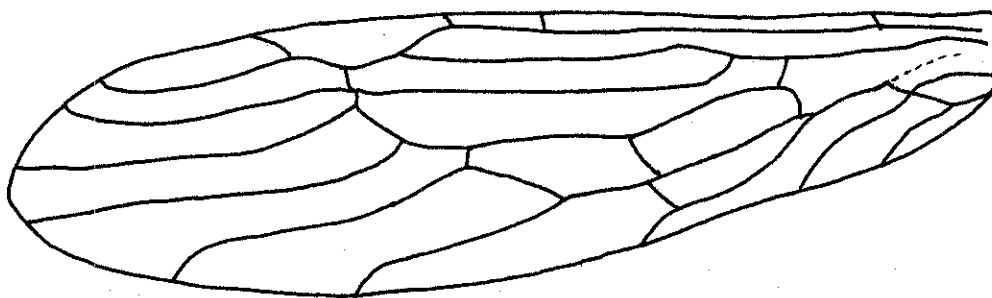
13



14



15



16

Genus TAENIOPTERYX Pictet 1841

Adults of this genus bear a membranous circular area on each coxa, and a remnant of nymphal coxal gills. All males have single segmented cerci, paraprocts concealed beneath the 9th sternum, and there may or may not be a vesicle present on the 9th sternum. The female subgenital plate is much reduced, and there are usually two membranous lobes behind the subgenital plate.

Both nymphs and adults have the first and second tarsal segments approximately equal in length. The nymphs possess a three segmented coxal gill which is telescopic (Fig. 19). Harper and Hynes (1971) described the nymphs of T. burksi and T. maura, but since nymphs of the other Texas species are undescribed, they cannot be presently separated.

Type of genus - Phryganea nebulosa Linnaeus

Key to the Species of Texas Taeniopteryx

1. Ventral lobe present on the 9th sternum
(sometimes absent in T. burksi outside Texas
Ricker and Ross, 1968). (2)
Ventral lobe absent (3)
2. Hind femora with a spur occurring medially;
its length being equal to one-half or more
the width of the femora (Fig. 17). . . . (P. 32) 1. maura
Hind femora without a spur, or with some
thickening being equal to less than half the
width of the femore (Fig. 18). (P. 34) 2. burksi
3. Cerci (dorsal view) no longer than the breadth
of their base; 9th sternum elevated pale and
membranous. (4)
Cerci (dorsal view) longer than the breadth
of their base, appearing twisted (Fig. 23);
postero-ventral surface of the 9th sternum
only slightly connate, not membranous though
sometimes lighter in color than the rest of
the sternum; paraprocts as in Fig. 27. (P. 36) 3. lonicera
4. Dorso-lateral lobes of the aedeagus well
developed; dorso-lateral processes of the
male cerci deeply grooved inside giving
the process a toothed appearance (Fig. 22);
paraprocts as in Fig. 25. (P. 37) 4. lita
Dorso-lateral lobes of the aedeagus reduced;
dorso-lateral processes of the male cerci
not so deeply grooved inside (Fig. 27);
paraprocts as in Fig. 26. 10th tergum
bearing pair of slightly elevated heavily
sclerotized meso-posterior knobs. (Fig. 24)
. (P. 39) 5. starki

Females

1. Anterior edge of central sclerotized plate (subgenital plate) of 8th sternum not notched but broadly concave (Fig. 30 & 31). (P. 39). 5. starki
Anterior edge of central sclerotized plate of 8th sternum notched (Figs. 28 & 29) (2)

2. Notch of the 8th sternum margined by only normal sclerotization or by a narrow V-shaped dark marginal band; sides of the notch, if produced inward and forward, meet at an obtuse angle (P. 32, 34) 2. burksi and 1. maura
Notch of the 8th sternum deep, margined by a broadly U-shaped band of heavy sclerotization (Figs. 28 & 29) (P. 36, 37) 4. lita and 3. lonicera

Fig. 17. Hind femur of Taeniopteryx maura male.

Fig. 18. Hind femur of Taeniopteryx burksi male.

Fig. 19. Hind leg of Taeniopteryx burksi nymph.

Fig. 20. Hind leg of Zealeuctra hitei nymph.

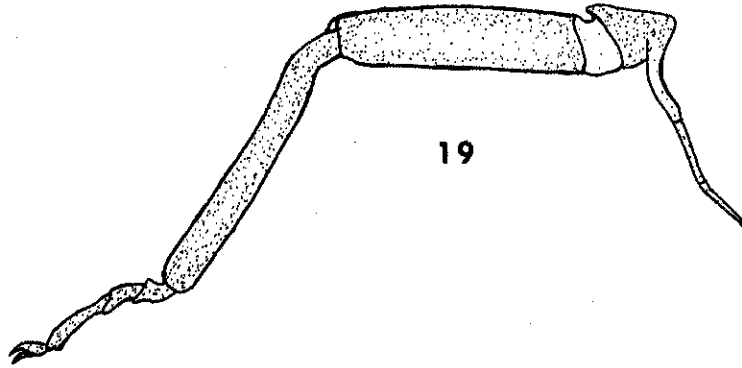
Fig. 21. Labium of Taeniopteryx burksi nymph.



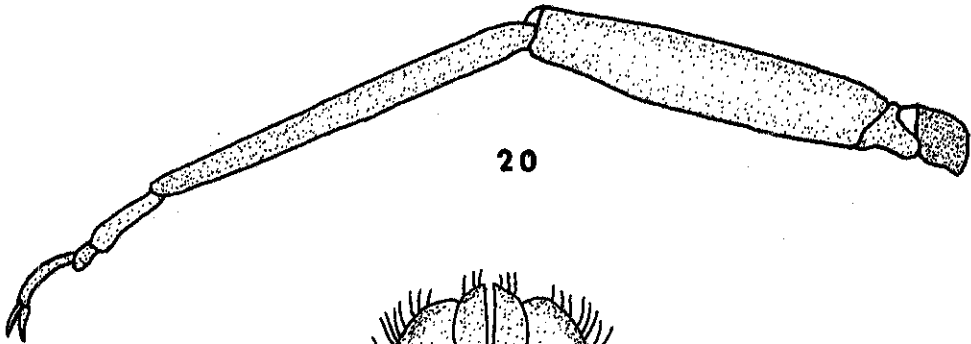
17



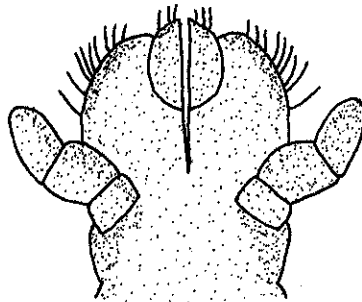
18



19

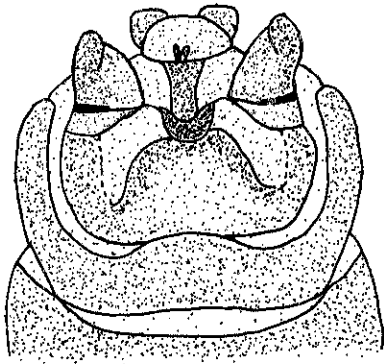


20

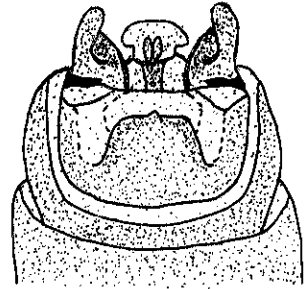


21

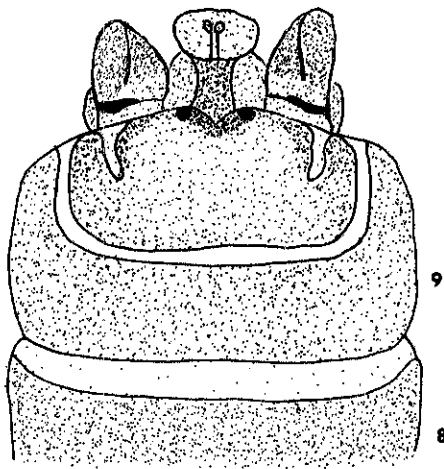
- Fig. 22. Taeniopteryx lita male.
- Fig. 23. Taeniopteryx lonicera male.
- Fig. 24. Taeniopteryx starki male.
- Fig. 25. Left paraproct of Taeniopteryx lita male.
- Fig. 26. Left paraproct of Taeniopteryx starki male.
- Fig. 27. Left paraproct of Taeniopteryx lonicera male.
- Fig. 28. Central plate of female 8th abdominal segment
Taeniopteryx lonicera.
- Fig. 29. Central plate of female 8th abdominal segment
Taeniopteryx lita.
- Fig. 30. Central plate of female 8th abdominal segment
Taeniopteryx starki.
- Fig. 31. Central plate of female 8th abdominal segment
Taeniopteryx starki.



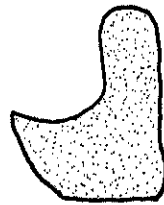
22



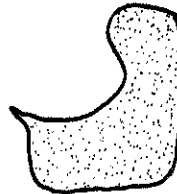
23



24



25



26



27



28



29



30



31

1. Taeniopteryx maura (Pictet) 1841

- 1841 Nemoura maura - Pictet, Histoire générale et particulière des insectes Néuroptères. Famille des Perlides. 423 p.
- 1925 Taeniopteryx maura - Needham & Claassen, Thomas Say Foundation. 2: 397 p.
- 1942 Taeniopteryx maura - Frison (in part). In 1942 Frison used this same name to include maura, burksi, and nivalis. Bull. Ill. Natur. Hist. Surv. 22(2): 233-355.
- 1952 Taeniopteryx maura - Harden and Mickel, Techn. Bull. 201:12.
- 1960 Taeniopteryx maura - Jewett, Bull. Calif. Ins. Surv. 6:151.
- 1966 Taeniopteryx maura - Illies Cat.: 73.
- 1968 Taeniopteryx maura - Ricker and Ross, J. Fish. Res. Bd. Can. 25(7): 1423-1439.
- 1974 Taeniopteryx maura - Stewart, Baumann and Stark, Trans. Amer. Entomol. Soc. (99): 507-546.
- 1974 Taeniopteryx maura - Hitchcock, State Geo. & Natur. Hist. Surv. Conn. 107: 1-262.

Type locality - Pennsylvania. The type is missing.

Geographic range - Alabama, Arkansas, Connecticut, District of Columbia, Georgia, Indiana, Kentucky, Maryland, Minnesota, Mississippi, New Brunswick, New York, North Carolina, Nova Scotia, Ohio, Oklahoma, Ontario, Pennsylvania, Tennessee, Texas and Virginia.

Distribution in Texas - Two counties (Fig. 74).

Published Records - Cherokee Co., Neches River.

New Records - Gregg Co., unnamed stream.

Biology - This species is tolerant of 21°C water temperature (Nebeker and Lenke, 1968) and pH of 3.25 (Bell and Nebeker 1969). Gaufin (1958) also mentioned its high tolerance to polluted waters and explains why all species of Taeniopteryx in Texas are found in sluggish, highly silted habitats, as well as in small spring-fed streams.

In Kentucky emergence occurs from the middle of Dec. to the middle of March (Ricker and Ross, 1968). Adults have been taken in Texas toward the end of January.

Since T. maura is very close to T. burksi, and separation of the two species depends upon the length of a hind femoral spur, some doubt is placed upon its occurrence in Texas. The callus, or small spur exhibited by some Texas T. burksi closely approached half the width of the hind femur.

2. Taeniopteryx burksi Ricker and Ross 1968
- 1925 Taeniopteryx nivalis - Needham and Claassen (in part not Fitch 1847), Thomas Say Foundation 2: 397 p.
- 1929 Taeniopteryx nivalis - Frison, Bull. Ill. Natur. Hist. Surv. 20(4): 281-471.
- 1942 Taeniopteryx maura - Frison, (in part not Pictet, 1841) Bull. Ill. Natur. Hist. Surv. 22(2): 233-355.
- 1945 Taeniopteryx maura - Ricker (in part all the Indiana specimens listed are burksi, except a few of those from Warsaw), Proc. Ind. Acad. Sci., Brookville, 54: 225-230.
- 1968 Taeniopteryx burksi - Ricker and Ross, J. Fish. Res. Bd. Canada, 25(7): 1425-1426.
- 1973 Taeniopteryx burksi - Zwick Cat.: 305.
- 1974 Taeniopteryx burksi - Stewart, Baumann, and Stark, Trans. Amer. Entomol. Soc., (49): 507-546.
- 1974 Taeniopteryx burksi - Hitchcock, State Geo. Natur. Hist. Surv. of Conn. 107: 117.

Type locality - Urbana Illinois. The type is deposited in the Illinois Natural History Survey Museum.

Geographic Range - Alabama, Arkansas, Connecticut, District of Columbia, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Maine, Maryland, Michigan, Missouri, New Brunswick, New Hampshire, New York, North Carolina, Nova Scotia, Ohio, Oklahoma, Ontario, Pennsylvania, Quebec, Rhode Island, Tennessee, Texas, Virginia, West Virginia, and Wisconsin.

Distribution in Texas - Eight counties (Fig. 74).

Published Records - Cherokee Co., Mud Creek; Nacogdoches Co., Angelina River; Gregg Co., unnamed stream; San Augustine Co., Attoyac River; Upshur Co., unnamed stream.

New Records - Cass Co., unnamed stream; Jasper Co., Sandy Creek; Marion Co., Big Cypress Creek.

Biology - This species emerges from late December into February in Texas (Fig. 77). Harper and Magnin (1969) reported emergence as late as April in Quebec. Frison (1929) noted that adults feed on Protococcus. Although the life cycle has not been studied in Texas, Harper and Hynes (1970) indicated that in Canada, eggs hatch quickly and nymphs undergo a diapause until the following fall; rapid growth is then resumed until emergence (Harper and Magnin, 1969).

Nymphs occur in sandy-bottomed streams east of the blackland prairie in Texas. They are primarily debris-inhabitators and probably feed on detritus and diatoms (Frison, 1929). Nymphs were described by Harper and Hynes (1971).

3. Taeniopteryx lonicera Ricker and Ross 1968

1968 Taeniopteryx lonicera - Ricker and Ross, J. Fish.

Res. Bd. Canada, 25(7): 1427.

1973 Taeniopteryx lonicera - Zwick Cat. :306.

1974 Taeniopteryx lonicera - Stewart, Baumann, and Stark,

Trans. Amer. Entomol. Soc. (99): 507-546.

1974 Taeniopteryx lonicera - Hitchcock, State, Geo.

Natur. Hist. Surv. Conn. 107:118.

Type locality - Laurel Fork, south of Blountsville, Alabama.

The type is deposited in the Illinois Natural History Survey Museum.

Geographic Range - Alabama, Georgia, Maryland, Mississippi, North Carolina, Tennessee, Texas.

Distribution in Texas - Four counties (Fig. 74).

Published Records - Cherokee Co., Mud Creek; Montgomery Co., East Fork of the San Jacinto River; Polk Co., Big Creek.

New Records - Tyler Co., Boykin Springs.

Biology - This species has been collected only in southeastern counties in January and February (Fig. 77).

It emerges primarily in December in Alabama and as late as March in North Carolina and Tennessee (Ricker and Ross, 1968).

Nymphs are debris-inhabitators in a wide range of permanent flowing waters to sluggish bayous. It appears to be associated with habitats where "roadsides are made fragrant in summer by vine honeysuckle", as reported by Ricker and Ross (1968).

Nymphs of the species are undescribed and females cannot with certainty be separated from T. lita; however, the continuity of the sclerotized posterior margin of the latero-posterior lobes of the central plate (subgenital plate) of the 5th abdominal sternum of the female appears to be diagnostic (Fig. 28) (Stewart and Szczytko, 1974).

4. Taeniopteryx lita Frison 1942

1929 Taeniopteryx parvula - Frison (in part not Banks, 1918). The specimens from Elizabethtown and Grayville are lita. Bull. Ill. Natur. Hist. Surv. 18(2): 340-409.

1935 Taeniopteryx parvula - Frison (in part). The specimens from Elizabethtown, Galconda and Grayville

are lita. Bull. Ill. Natur. Hist. Surv. 20(4):
281-471.

- 1942 Taeniopteryx lita - Frison (in part) Description
and records from Illinois (type locality), Arkansas,
and Indiana. The paratypes from Maryland and
Mississippi are of the species lonicera. Bull.
Ill. Natur. Hist. Surv. 22(2): 233-355.
- 1945 Taeniopteryx lita - Ricker, Proc. Ind. Acad. Sci.
54:226.
- 1966 Taeniopteryx lita - Illies Cat.: 73.
- 1974 Taeniopteryx lita - Stewart, Baumann, and Stark,
Trans. Amer. Entomol. Soc. 99: 507-546.
- 1974 Taeniopteryx lita - Hitchcock, State Geo. Natur.
Hist. Surv. Conn. 107: 118.

Type Locality - Elizabethtown, Illinois. The type is
deposited in the Illinois Natural History Survey Museum.

Geographic Range - Alabama, Arkansas, Illinois, Indiana,
Kentucky, Mississippi, North Carolina, Tennessee, Texas.

Published Records - Upshur-Smith Co. line, Sabine River.

New Records - Smith Co., unnamed stream.

Biology - Adults appear in January and February in a very
restricted two-county area of East Texas (Fig. 77).

Morphological differences between males and those of

T. lonicera and T. starki are not great, and are discussed by Ricker and Ross (1968) and Stewart and Szczytko (1974). Females of the three species need further study. Comparison of allotypes (Stewart and Szczytko, 1974) indicated that they probably can be separated by differences in the subgenital plates (Figs. 28-31). The nymphs of this species are undescribed and the life cycle is unknown.

5. Taeniopteryx starki Stewart and Szczytko 1974
1974 Taeniopteryx starki - Stewart and Szczytko, J.
Kans. Entomol. Soc. 47(4): 451-458.

Type locality - Leon River, in the town of Gatesville, Coryell County, Texas. The type is deposited at USNM #73057.

Geographic Range - Texas.

Distribution in Texas - Two counties (Fig. 74).

Published Records - Coryell Co., Leon River; Hamilton County, unnamed stream.

Biology - Emergence occurs in January (Fig. 77). Stewart et al. (1974) reported that Taeniopteryx nymphs from Hamilton County were probably burksi. I now consider them to be starki, since the type locality of the since-described T. starki is in adjacent Coryell county, and both

populations are isolated far to the west of the East Texas burksi, lonicera and lita populations. The nymphs are undescribed, and the life cycle of this endemic species is unknown. Males are easily distinguished from those of T. lonicera, but without extrusion of the soft aedeagus they are difficult to distinguish from T. lita.

GENUS ZEALEUCTRA Ricker 1952

The genus Zealeuctra is very similar in wing venation and in the form of prosternal sclerites to the genus Paraleuctra. Zealeuctra differs from Paraleuctra in that the presternum is completely rather than partially separated from the basisternum (Ricker, 1952).

Zealeuctra males have a lobe on the posterior portion of the 9th sternum, the 9th tergum is cleft, and the 10th tergum has a deep median depression in which the stout supra-anal process lies (Figs. 32-34).

The female 8th sternum is unsclerotized centrally except near the anterior margin (Figs. 35-37). Except for Z. claasseni (Frison, 1929) the nymphs of this genus are undescribed.

Ricker and Ross (1969) recently revised the genus and provided keys to males and females. Z. arnoldi and

Z. hitei are endemic to the Edwards Plateau area of Texas and the widespread Z. claasseni is found in extreme North-Central Texas.

Type of Genus - Leuctra claasseni Frison.

Key to the Species of Texas Zealeuctra

Males

1. Sclerotized margins of ninth tergum broadly rounded anteriorly (Fig. 34), epiproct with a small spine or hump anterior to the main spine (Fig. 39). (P. 42). 6. arnoldi
Sclerotized margins of ninth tergum at least moderately convergent anteriorly (Figs. 32 & 33), epiproct simple with one spine (Figs. 38 & 41). (2)
2. Sclerotized margins of the 9th tergum with minute serrations (Fig. 32), spine of the epiproct usually tapering along its length (Fig. 40). (P. 45). 7. claasseni
Sclerotized margins of the 9th tergum with no minute serrations (Fig. 33), spine of the epiproct parallel for approximately one half of its length (Fig. 38). (P. 47). 8. hitei

Females

1. Posterior portion of the 7th sternum without a central notch (Figs. 35 & 36) (2)
Posterior portion of the 7th sternum with a central notch (Fig. 37). (P. 42). 6. arnoldi
2. Eighth sternum with anterior sclerotized patches quadrangular in shape and larger than the posterior lobe of the seventh sternum, anterior patches separated from the posterior portion of the eighth by a fine line or not at all (Fig. 35). (P. 45) 7. claasseni

6. Zealeuctra arnoldi Ricker and Ross 1969
- 1969 Zealeuctra arnoldi - Ricker and Ross, Can. J. Zool.
47: 114.
- 1973 Zealeuctra arnoldi - Zwick Cat. : 412.
- 1974 Zealeuctra arnoldi - Stewart, Baumann, and Stark,
Trans. Amer. Entomol. Soc. 99: 507-546.

Type Locality - Sorrel Creek 1 mile south of Hancock,
Comal county Texas. The type is deposited in the Illinois
Natural History Survey Museum.

Geographic Range - Texas.

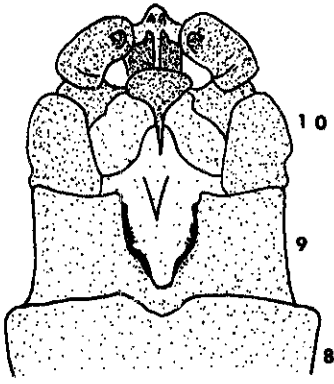
Distribution in Texas - Five counties (Fig. 74).

Published Records - Blanco Co., unnamed stream; Comal Co.,
Canyon Dam, Fischer, Sorrel Creek; Hays Co., unnamed
stream, Upper Blanco River; Kendall Co., Curry Creek.

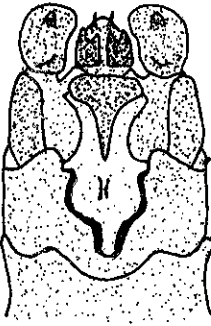
New Records - Williamson Co., North fork of San Gabriel
River.

Biology - Adults emerge from December until the middle
of March (Fig. 77). Their range is restricted to the
southeastern edge of the Edwards Plateau, and they
occupy intermittent, limestone-substrate streams that
are often dry during summer, and sometimes even in winter
months (Stewart et al., 1974). Nymphs are undescribed and

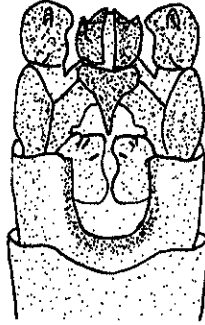
- Fig. 32. Terminal dorsal segments of Zealeuctra claasseni male.
- Fig. 33. Terminal dorsal segments of Zealeuctra hitei male.
- Fig. 34. Terminal dorsal segments of Zealeuctra arnoldi male.
- Fig. 35. Terminal ventral abdominal view of Zealeuctra claasseni female.
- Fig. 36. Terminal ventral abdominal view of Zealeuctra hitei female.
- Fig. 37. Terminal ventral abdominal view of Zealeuctra arnoldi female.
- Fig. 38. Epiproct of Zealeuctra hitei.
- Fig. 39. Epiproct of Zealeuctra arnoldi.
- Fig. 40. Epiproct of Zealeuctra claasseni.



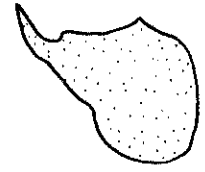
32



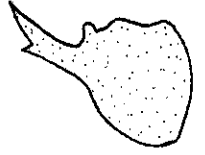
33



34



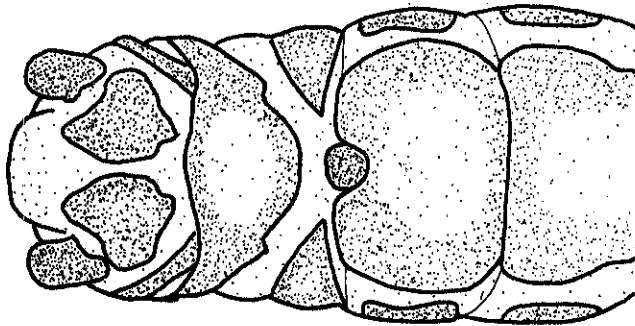
40



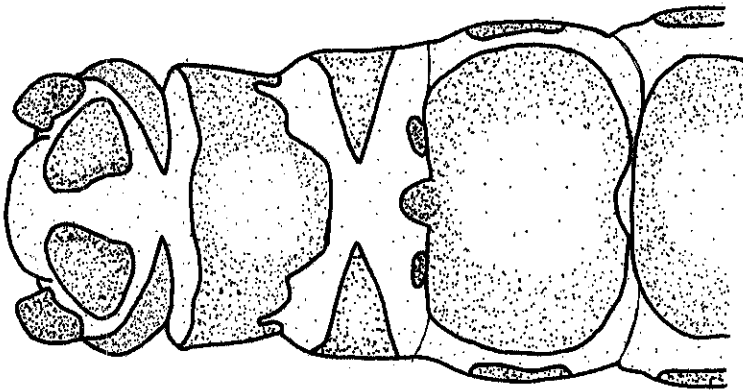
39



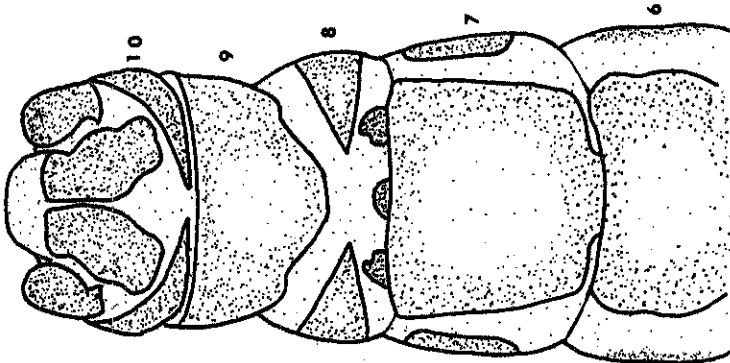
38



37



36



35

the life cycle is unknown, although it is apparent that eggs and/or nymphs must undergo an extended diapause or aestivation. Only on the North fork of the San Gabriel River have both arnoldi and hitei populations been found together.

7. Zealeuctra claasseni (Frison) 1929

- 1929 Leuctra claasseni - Frison, Bull. Ill. Natur. Hist. Surv. 18:404.
- 1935 Leuctra claasseni - Frison (in part), Bull. Ill. Natur. Hist. Surv. 20(4): 354.
- 1940 Leuctra claasseni - Claassen Cat.: 77.
- 1941 Leuctra claasseni - Hanson, Bull. Brooklyn Entomol. Soc. 36(2): 57.
- 1942 Leuctra claasseni - Frison, Bull. Ill. Natur. Hist. Surv. 22: 256.
- 1945 Leuctra claasseni - Ricker, Proc. Ind. Acad. Sci. 54: 227.
- 1952 Leuctra (Zealeuctra) claasseni - Ricker, Ind. Univ. Publ., Sci. Ser., 18: 173.
- 1956 Leuctra (Zealeuctra) claasseni - Jewett, in Usinger Aquat. Ins. Calif.: 168.
- 1966 Zealeuctra claasseni - Illies Cat.: 120.

- 1969 Zealeuctra claasseni - Ricker and Ross, Can. J. Zool.
47: 1115.
- 1973 Zealeuctra claasseni - Zwick Cat.: 412.
- 1974 Zealeuctra claasseni - Stewart, Baumann and Stark,
Trans. Amer. Entomol. Soc. 99: 507-546.
- 1974 Zealeuctra claasseni - Hitchcock, State Geo. Natur.
Hist. Surv. Conn. 107: 87-89.

Type Locality - Bushy Fork, Herod, Illinois. The type is deposited in the Illinois Natural History Survey Museum.

Geographic Range - Arkansas, Illinois, Indiana, Kentucky, Missouri, Oklahoma, Texas, Virginia.

Distribution in Texas - Three counties (Fig. 74).

Published Records - Cooke Co., unnamed stream; Jasper Co., Boykins Spring; Nacogdoches Co., unnamed stream.

Biology - Adults are present from late October through February (Fig. 77). The serrations on the margins of the Ab_9 cleft, and the more slender spine of the epiproct (Fig. 38) distinguish males from those of hitei. Frison (1929) described the nymph but made no mention of the fact that mature males exhibit the $AB_{9,10}$ cleft and median depression. The anal gills were later illustrated by Frison (1935). Nymphs occur in intermittent habitats similar to those described for Z. arnoldi.

Frison (1929) found decaying vegetation in nymphal guts, and in 1935 suggested that they are "undoubtedly herbivorous". Other details of the life cycle are unknown.

8. Zealeuctra hitei Ricker and Ross 1969

1969 Zealeuctra hitei - Ricker and Ross, Can. J. Zool.
47: 1117.

1973 Zealeuctra hitei - Zwick Cat.: 413.

1974 Zealeuctra hitei - Stewart, Baumann, and Stark, Trans.
Amer. Entomol. Soc. 99: 507-546.

Type Locality - Johnson City, Blanco County Texas. The type is deposited in the Illinois Natural History Survey Museum.

Geographic Range - Texas.

Distribution in Texas - Eleven counties (Fig. 74).

Published Records - Blanco Co., unnamed stream; Bosque Co., Meridian Creek; Coryell Co., Cowhouse Creek; Gillespie Co., unnamed stream; Hamilton Co., Cowhouse Creek, Lampasas River; Hays Co., South Onion Creek, unnamed creek; Lampasas Co., unnamed stream.

New Records - Bosque Co., Cedron Creek, South fork of Rocky Creek; Blanco Co., Little Blanco River; Hays Co. Blanco River; Williamson Co., North fork of San Gabriel

River; Palo Pinto Co., Brazos River; Wise Co., unnamed stream.

Biology - This species is widespread in small, intermittent, limestone-substrate streams west of the blackland prairie and on the Edward's Plateau. Adults have been collected from the middle of November to the end of March (Fig. 77). They are found in leaf debris near the stream margins early in the morning, late in the evening and on cold days, and appear to move several feet away from the streams to low lying vegetation during warmer, sunny periods.

Nymphs have not been described, but last-instar males exhibit the same characteristic anteriorly-narrowed sclerotized margins of the cleft of the 9th tergum as adult males. They inhabit primarily stony substrates, but sometimes are also found in submerged leaf debris when ready to emerge.

GENUS ALLOCAPNIA Claassen 1928

Allocapnia is characteristic of the family Capniidae in general features, and appears closest to some species of Capnia, especially the vidua group (Ross and Ricker, 1971). The 38 species of the genus are restricted to

eastern North America, with some species extending as far west as Texas and Oklahoma.

Adults of this genus are distinguished by lack of praescutal sutures on the meso- and metanotum. Males all possess a distinctive, double epiproct and their wings are highly variable in length within and among species, with most being brachypterous. The hind wings of both sexes have a well-developed anal area. Females of some species also have short wings. Emergence in southern states occurs November-January, and in Canada in March and April (Ross and Ricker, 1971). In Texas, adults may be found from December into early April.

The nymphs of granulata (Claassen), illinoensis Frison, recta (Claassen) and vivipara (Claassen) (Frison, 1929) and pygmaea (Burmeister) (Claassen, 1931), have been described but due to morphological homogeneity within the genus and no descriptions of the other 33 species, nymphs of the species are essentially indistinguishable at this time.

Hanson (1946) discussed the comparative morphology of the genus. Ricker and Ross (1971) provided an extensive treatment of the classification, evolution and dispersal for the genus. Harper and Hynes (1971) constructed a key for males and females of 10 species, and also provided

a preliminary key to the nymphs of a species of Canadian Allocapnia. Harper and Hynes (1972) described the life histories of three species from Canada. Harper and Hynes (1970) reported that nymphs of granulata, pygmaea and vivipara undergo a diapause in the summer.

Adults of Allocapnia vivipara, mystica Frison, recta, and granulata feed on blue-green algae (Frison, 1942). Claassen (1924) reported vivipara to be viviparous, but Frison (1942) dissected fifteen females and found no nymphs. The eggs found in the dissected females were in a rather advanced stage indicating that the eggs probably hatched soon after oviposition.

Members of this genus emerge in winter months.

Type of genus - Capnella granulata Claassen.

Key to the Species of Texas Allocapnia

Males

1. Process on dorsum of 8th tergum not cleft (Fig. 45), dorsal process produced only moderately upward (Fig. 46). . . . (P. 54). 9. malverna
- Process on dorsum of 8th tergum cleft (Fig. 47), with dorsal view appearing U-shaped, dorsal process produced greatly upward (Fig. 43) (P. 55). 10. granulata

Females

1. Posterior margin of 8th sternum concave in shape and with a small lobe inserted medially, 8th sternum not separated from the 9th sternum by a wide membranous area (Fig. 42) (P. 54). 9. malverna
- Posterior margin of 8th sternum not concave in shape and with the median portion narrowed and almost spearhead shaped, 8th sternum separated from the 9th sternum by a wide membranous area (Fig. 41). (P. 55). 10. granulata

Fig. 41. Terminal ventral abdominal view of Allocapnia granulata female.

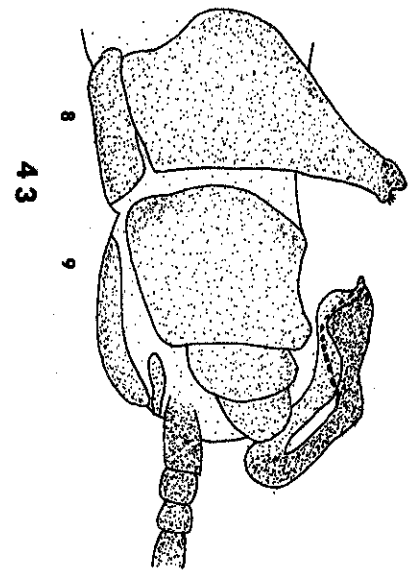
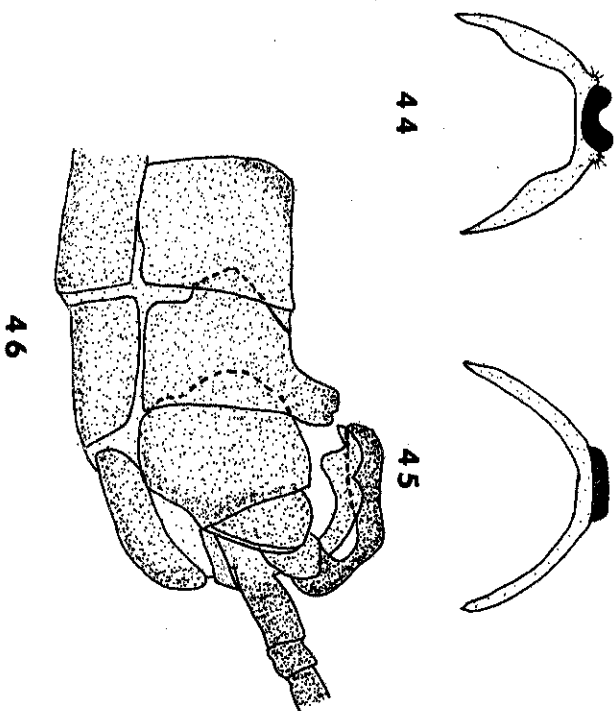
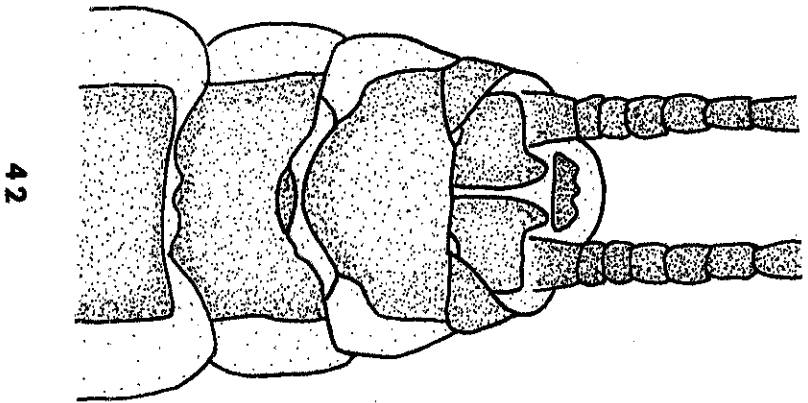
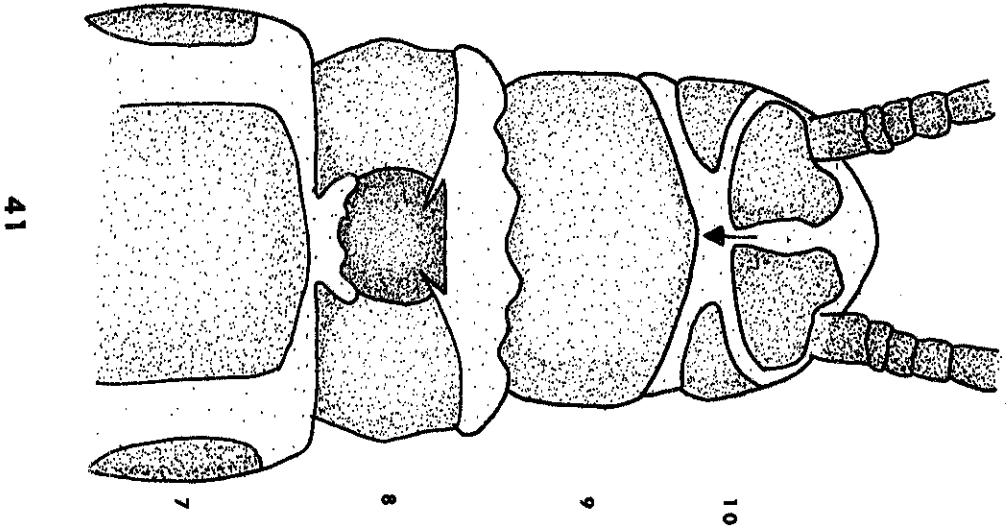
Fig. 42. Terminal ventral abdominal view of Allocapnia malverna female.

Fig. 43. Terminal lateral view of Allocapnia granulata male.

Fig. 44. Dorsal process of Allocapnia granulata male.

Fig. 45. Dorsal process of Allocapnia malverna male.

Fig. 46. Terminal lateral view of Allocapnia malverna male.



41

42

44

45

43

7

8

9

10

8

9

9. Allocapnia malverna Ross 1964

- 1964 Allocapnia malverna - Ross, Entomol. News. 75:170.
1966 Allocapnia malverna - Illies Cat.: 124.
1971 Allocapnia malverna - Ross and Ricker, Ill. Biol.
Monographs 45: 22.
1973 Allocapnia malverna - Zwick Cat.: 364.
1974 Allocapnia malverna - Stewart, Baumann and Stark,
Trans. Amer. Entomol. Soc. 99: 507-546.

Type Locality - Malvern, Hot Springs County, Arkansas.

The type is deposited in the Illinois Natural History
Survey Museum.

Geographic Range - Arkansas, Louisiana, Oklahoma, Texas.

Distribution in Texas - ten counties (Fig. 74).

Published Records - Gregg Co., unnamed stream; Nacogdoches
Co., unnamed stream; Smith Co., Mill Branch, unnamed
stream; Tyler Co., unnamed stream; Upshur Co., Sabine River.

New Records - Bowie Co., unnamed stream; Cass Co., unnamed
stream; Cherokee Co., unnamed stream; Marion Co., unnamed
stream; Trinity Co., unnamed stream.

Biology - This species is restricted to an area east of
blackland prairie. Ross and Ricker (1971) reported the
first specimens taken in Texas by K. W. Stewart in Gregg
County.

Males are brachypterous, and females are fully winged. The females at this time cannot be separated from females of mohri and mystica (Ross and Ricker, 1971).

Emergence occurs from late December to the end of March (Fig. 77); adults are found resting on woody vegetation in leaves and under rocks near the water. The life cycle is unknown and nymphs are undescribed.

10. Allocaupnia granulata (Claassen) 1924

- 1924 Capnella granulata - Claassen, Can. Entomol. 56: 44.
- 1940 Allocaupnia granulata - Claassen, Cat.: 89.
- 1945 Allocaupnia granulata - Ricker, Proc. Ind. Acad. Sci. 54: 227.
- 1952 Allocaupnia granulata - Harden and Mickel, Tech. Bull. 201: 29.
- 1958 Allocaupnia granulata - Gaufin, Ohio J. Sci., 58: 205.
- 1966 Allocaupnia granulata - Illies Cat.: 123.
- 1971 Allocaupnia granulata - Ross and Ricker, Ill. Biol. Monographs 45: 28.
- 1973 Allocaupnia granulata - Zwick Cat.: 362.
- 1974 Allocaupnia granulata - Stewart, Baumann and Stark, Trans. Amer. Entomol. Soc. 99: 507-546.
- 1974 Allocaupnia granulata - Hitchcock, State Geo. and Natur. Hist. Surv. of Conn. 107: 52.

Type Locality - Johnstown, New York. The type specimen is deposited at Cornell University.

Geographic Range - Arkansas, Canada, District of Columbia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, New Jersey, New York, Ohio, Oklahoma, Ontario, Pennsylvania, Quebec, Tennessee, Texas, Virginia, West Virginia, Wisconsin.

Distribution in Texas - One county (Fig. 74).

Published Records - Denton Co., Clear Creek.

Biology - Frison (1942) stated that this species is confined to large streams and rivers that do not dry up in the summer, but the Clear Creek locality in Texas is sometimes intermittent during summer months. It has the most extensive range of any species in the genus, suggesting a high degree of adaptability. Ross and Yamamoto (1967) reconstructed the probable dispersal of the species and discussed variations exhibited in the genitalic structures and wings of males between eastern and western populations. Harper and Hynes (1970) reported that this stonefly in Canada undergoes a larval diapause in the summer. Other details of the life cycle and biology in southern parts of its range are unknown. Emergence

in Denton County occurs in January and February. The nymph was described and illustrated by Frison (1929) and parts illustrated by Frison (1935) and Harden and Mickel (1952). Harper and Hynes (1971) provided a preliminary key to nymphs of nine Allocapnia species, including A. granulata.

Genus Mesocapnia Raušer 1968

This genus was first proposed by Rauser in 1968. Zwick (1973) enlarged the genus to include members of the Capnia projecta complex of western North America. Its species are distributed in the eastern Palearctic and western Nearctic regions.

Only one species of this genus, Mesocapnia frisoni, is represented by relict populations on the high plains in the Texas Panhandle.

Type of Genus - Mesocapnia silvatica Raušer.

11. Mesocapnia frisoni (Baumann and Gaufin) 1970.
 1962 Capnia projecta - Gaufin and Jewett, Wasmann J. Biol. 20(1): 69-71.
 1964 Capnia projecta - Gaufin, (in part), Proc. Utah Acad. Sci., Arts and Letters 41(2): 221-227.
 1966 Capnia projecta - Gaufin, Nebeker and Sessions,

- (in part) Univ. of Utah Biol. Ser. 14(1): 45, 48.
- 1966 Capnia projecta - Illies Cat. : (in part): 145.
- 1967 Capnia projecta - Nebeker and Gaufin, (in part), J.
Kans. Entomol. Soc. 40(3): 417, 419-420.
- 1968 Capnia projecta - Nebeker and Gaufin, (in part),
Trans. Amer. Entomol. Soc. 94: 3, 19.
- 1970 Capnia frisoni - Baumann and Gaufin, Trans. Amer.
Entomol. Soc. 96: 441.
- 1973 Mesocapnia frisoni - Zwick Cat.: 386.
- 1974 Capnia frisoni - Stewart, Baumann and Stark, Trans.
Amer. Entomol. Soc. 99: 507-546.

Type Locality - Ash Creek at Anderson Junction, Washington
County, Utah. The type is deposited at the USNM.

Geographic Range - Colorado, New Mexico, Texas, and Utah.

Distribution in Texas - One county (Fig. 74).

Published Records - Randall Co., Palo Duro Canyon,
Prairie Dog Town Fork of the Red River, Currie Ranch
15 mi N.E. of Canyon, Texas.

Biology - Gaufin and Jewett (1962) reported this species
as C. projecta, and prior to 1970 all Capnia specimens from
the southern Rocky Mountains were called C. projecta.

This complex of species was separated into 11 distinct
species, by Baumann and Gaufin (1970) including M. frisoni.

Nymphs have been taken from slow moving creeks and rivers at low elevations near mountains in other states (Baumann and Gaufin, 1970). They occur in Texas as a relict population in the Palo Duro Canyon area. This indicates that some cordilleran species were distributed as far southeastward as Texas during the later Pleistocene glaciations (Stewart et al., 1974).

Genus Amphinemura Ris 1902

This Holarctic and Oriental genus was, until recently (Illies, 1966), considered a subgenus of Nemoura. It is distinct in having the subanal lobes (paraprocts) divided almost to the base; one or both parts may be spinulose.

Baumann and Gaufin (1972) separated Amphinemura venusta into six species. Of the eleven Nearctic species, only the nymphs of A. nigritta (Claassen, 1931), and A. linda, A. delosa and A. wui (Harper and Hynes, 1971) have been described. Nymphs of A. nigritta and A. delosa inhabiting the same stream in Canada could not be separated (Harper, 1973).

Stewart et al. (1974) reported A. delosa from Texas, but closer examination of those and more recently collected specimens indicates they are closer to A. nigritta, but

but most likely will prove to be a new species (R. W. Baumann, personal correspondence).

Harper (1973) described the life cycles of A. linda, A. delosa and A. nigritta. A. linda emerges in August-September (Harper, 1973). The other two species emerge in the spring.

Type of Genus - Nemoura sulcicollis (Stephens).

11. Amphinemura nigritta (Provancher) 1876
- 1876 Nemoura nigritta - Provancher, Nat. Canad., 8: 217.
- 1897 Nemoura venosa - Banks, Trans. Amer. Entomol. Soc. 24: 21.
- 1920 Nemoura stylata - Banks, Bull. Mus. Comp. Zool., 64: 324.
- 1940 Nemoura nigritta, venosa - Claassen Cat.: 60, 66.
- 1952 Nemoura venosa - Harden and Mickel, Tech. Bull. 201: 20.
- 1952 Nemoura (Amphinemura) nigritta - Ricker, Ind. Univ. Publ. Sci. Ser., 18: 25.
- 1956 Nemoura nigritta venosa - Gaufin, Ohio J. Sci. 56: 322.
- 1966 Amphinemura nigritta - Illies Cat.: 183-184.
- 1974 Nemoura (Amphinemura) nigritta - Hitchcock, State Geo. Natur. Hist. Surv. of Conn. 107: 100, 102-103.

Type Locality - Near Quebec City, Quebec. The type specimen is deposited in the Quebec Provincial Museum.

Geographic Range - Canada, Connecticut, Florida, Illinois, Indiana, Mackenzie, Maine, Massachusetts, Minnesota, New Brunswick, New York, North Carolina, Nova Scotia, Ohio, Ontario, Pennsylvania, Quebec, Texas, Virginia, West Virginia, Washington.

Distribution in Texas - Eight counties (Fig. 75).

New Records - Anderson Co., Saddler Creek; Cass Co., Hughes Creek; Cherokee Co., unnamed stream; Nacogdoches Co., Yseleta Creek, Naconiche Creek; Newton Co., Yellow Bayou; Polk Co., Bear Creek; Sabine Co., unnamed stream; Tyler Co., unnamed stream.

Biology - This species emerges May to mid-June in Connecticut (Hitchcock, 1974), and in Texas in March and April (Fig. 75). Adults have been collected by sweeping low-lying vegetation, knocking them off overhanging vegetation into the water, and netting them in open flight near the stream. Hitchcock (1974) indicated they could also be collected with blacklight traps at night.

Nymphs were described and illustrated by Claassen (1931) and Harper and Hynes (1971). Harper (1973)

gave details of the life cycle, including incubation, nymphal development and oviposition.

Genus Hydroperla Frison 1935

This genus is very closely allied to Isogenus. Adults of Hydroperla are characterized by having no crossveins in the anal area of the forewing, but with a series of median and cubital crossveins (Fig. 8), and no gill remnants on the thorax. Nymphs have submental gills, but no thoracic gills.

Species of this genus are medium-sized stoneflies usually more than 13mm in length, and dark in color. The tenth tergum of the adult male is deeply cleft (Frison, 1925).

Needham and Claassen (1925) reported Austin, Texas as the type locality of Hydroperla fugitans. However, extensive collections made in recent years in Texas have included only Hydroperla crosbyi. The genus is endemic to the Nearctic region and adults emerge in the spring. Type of genus - Perla crosbyi Needham and Claassen .

Key to the Species of Texas Hydroperla

Males and Females

1. Epiproct ending in a large hook which is bent completely downward; female subgenital plate

- produced no more than one fourth the length
of the 8th sternum.(P. 64) crosbyi (13)
- Epiproct not ending in a large hook but
bluntly pointed, female subgenital plate
produced approximately one half the length
of 8th sternum.(P. 66). fugitans (14)

Nymphs

1. Anterior half of each abdominal tergum dark
in color, the posterior half light in color
.(P. 64). crosbyi (13)
- Anterior half of each abdominal tergum light
in color except for a row of 6-8 small dots
.(P. 66). fugitans (14)

13. Hydroperla crosbyi (Needham and Claassen) 1925
 1925 Perla crosbyi - Needham and Claassen, *Plec. Amer. North Mex.*, 79.
- 1940 Hydroperla crosbyi - Claassen *Cat.*: 104.
- 1945 Hydroperla crosbyi - Ricker, *Proc. Ind. Acad. Sci.*, 54: 229.
- 1952 Isogenus (Hydroperla) crosbyi - Ricker, *Ind. Univ. publ., Sci. Ser.* 18: 105.
- 1966 Hydroperla crosbyi - Illies *Cat.*: 363.
- 1974 Hydroperla crosbyi - Stewart, Baumann and Stark, *Trans. Amer. Entomol. Soc.*, 99: 507-546.
- 1974 Isogenus (Hydroperla) crosbyi - Hitchcock, *State Geo. Natur. Hist. Surv. of Conn.* 107: 216-217.

Type Locality - Missouri. The type specimen is deposited at Cornell University.

Geographic Range - Arkansas, Illinois, Indiana, Missouri, Oklahoma, and Texas.

Distribution in Texas - Fourteen counties (Fig. 75).

Published Records - Bosque Co., Meridian Creek; Comanche Co., Sabanna River; Denton Co., Clear Creek and Elm Fork Trinity River; Hamilton Co., Leon River; Kendall Co.,

Guadalupe River; Lampasas Co., Lampasas River; Liberty Co., unnamed stream; Nacogdoches Co., unnamed stream; Trinity Co., White Rock Creek; Williamson Co., San Gabriel River; Wise Co., West Fork of Trinity River.

New Records - Cherokee Co., unnamed stream; Cooke Co., Trinity River; Coryell Co., unnamed stream McLennan Co., Bosque River.

Biology - The nymphs of this species are not usually found in swift water in Illinois but rather in heavily silted streams in agricultural areas Frison (1935). In Texas they are found in a much wider variety of habitats, including those with sand and stony substrates. At times, these habitats are intermittent during the summer, suggesting that eggs and/or nymphs undergo a diapause or aestivation. Nymphs have been found both in the gravel of riffles and inhabiting debris. Maki et al. (1973) determined oxygen consumption of laboratory-held nymphs, and the effects of sublethal dosages of the organophosphate Dibrom on their respiration. He found that nymphs consumed significantly greater quantities of oxygen in the presence of 8 ppb Dibrom, than those of comparable size in controls.

Adults emerge in Texas in February and March (Fig. 75); Frison (1935) gave notes on the life cycle, but detailed knowledge of its biology is unavailable.

14. Hydroperla fugitans (Needham and Claassen) 1925
 1925 Perla fugitans - Needham and Claassen, *Plec. Amer. North Mex.*: 85.
- 1935 Hydroperla harti - Frison. *Bull. Ill. Natur. Hist. Surv.* 20: 423; 324, 326 (Synonym Ricker, 1952: 105).
- 1940 Hydroperla harti - Perla fugitans - Claassen *Cat.*: 104-137.
- 1945 Hydroperla harti - Ricker, *Proc. Ind. Acad. Sci.*, 54: 229.
- 1952 Isogenus (Hydroperla) fugitans - Ricker, *Ind. Univ. Publ., Sci. Ser.* 18: 105.
- 1966 Hydroperla fugitans - Illies *Cat.*: 363.
- 1974 Hydroperla fugitans - Stewart, Baumann and Stark, *Trans. Amer. Entomol. Soc.* 99: 507-546.
- 1974 Isogenus (Hydroperla) fugitans - Hitchcock, *State Geo. Natur. Hist. Surv. of Conn.* 107: 221-222.

Type Locality - Austin, Texas. The type is reported missing, but the vial that contained the holotype is at

Cornell University with a note indicating that the type has been missing since 1941

Geographic Range - Arkansas, Illinois, Indiana, Oklahoma, Tennessee, and Texas

Distribution in Texas - One county (Fig. 75).

Published Records - Travis Co., Austin.

Biology - My collecting efforts have failed to produce any specimens of fugitans. Frison (1935) has found that this species is restricted to large rivers in Illinois. The adults of H. fugitans are diurnal and mating has been observed during the day. It is thought that the nymphs are carnivores (Frison, 1935).

The two male specimens from Austin were collected on March 1, 1903.

Genus Isoperla Banks 1906

This Holarctic genus with over 110 described species and over 45 Nearctic species is a member of the subfamily Isoperlinae. It is thought they diverged from some ancestral Isogenus by (1) reduction and eventual loss of the epiproct, (2) movement of the ventral lobe from the seventh sternum to the eighth sternum, and (3) modification of the paraprocts into hook-like processes.

The genus Calliperla is thought to represent an evolutionary stage in the transition from Isogenus to Isoperla (Ricker, 1952).

Members of this genus totally lack gills or any remnants of them. Nymphs of Isogenus and Hydroperla possess only submental gills. Nymphs usually have a distinct head pattern and longitudinal stripes on the abdomen. The subgenital plate of most females is less produced than those of Isogenus.

Frison (1935) indicated that Isoperla species are univoltine, and that most species (exceptions: I. bilineata and I. richardsoni) are diurnal. He reported I. minuta fed on pollen and nymphal food habits varied with species. Harper (1973) detailed the life cycles of four Canadian Isoperla, confirming the one-year life cycle. All emerged in May and June and exhibited a slow life cycle. Schwarz (1970) showed I. goertzi in Germany exhibited a semi-voltine cycle in a spring-fed stream. Hilsenhoff (1970) indicated that the seventeen species in Wisconsin emerge May-July and exhibit one-year life cycles. Hilsenhoff (1973) provided a key to nymphs and adults of fourteen Wisconsin species, and illustrated the mouth-parts of the nymphs. Richardson and Gaufin (1971)

found that the diets of Isoperla fulva nymphs from Utah and Colorado were made up of 70% animal and 30% plant matter.

Since this genus represents such a homogenous group, most nymphs and adults have not been correlated nor their life cycles elucidated, and the genus is in great need of revision.

Stewart et al. (1974) listed all Texas Isoperla tentatively as I. namata and stated they were close to namata and mohri and that much more study was needed. I compared Texas material with paratypes of namata, richardsoni and mohri from the Illinois Natural History Museum.

Type of genus - Sialis bilineata Say.

Key to the Species of Texas Isoperla

1

Males

1. Lobe of the 8th sternum broadly rounded (Fig. 63), 9th and 10th tergum with areas of distinct spinules (Fig. 64), wings brachypterous, aedeagus with a distinct finger process dorsally (Fig. 62) (P. 76) 15. jewetti
- Lobe of the 8th sternum not broadly rounded (Figs. 65 and 73), 9th and 10th tergum without areas of distinct spinules, wings normal, and aedeagus without finger process dorsally (Figs. 66, 71-73). (2)

2. Aedeagus with a distinct sclerotized spine posteriorly below which is a double row of sclerotized interdigitated fingers (Fig. 66), distinct rows of longitudinal dots present on dorsum of abdomen, paraprocts reduced, not curving upward over the 10th tergum (P.81). 16. mohri
- Aedeagus entirely membranous, with no sclerotized spine nor interdigitated fingers, dots absent from dorsum of abdomen, paraprocts produced, curving over the 10th tergum (P. 89). 17. coushatta

Females

1. Subgenital plate of the 8th sternum elongate-truncate; its width equal to approximately one-half the width of the 9th sternum (Fig. 68). (P. 76). 15. jewetti
- Subgenital plate of the 8th sternum shorter much wider than one-half the width of the 9th sternum (Figs. 69-70). (2)
2. Subgenital plate broadly rounded, sometimes with a slight emargination in the middle of the posterior margin, produced far backward covering most of the 9th sternum (Fig. 70) (P. 81). 16. mohri
- Subgenital plate produced triangularly, not covering more than one-third of the 9th sternum (Fig. 69) (P. 89) 17. coushatta

Nymphs

1. Lacinia with one apical tooth, hairs present along the entire length of inner margin and continuing around the outer margin (Fig. 53), mandibles deeply cleft with serrations on the inside margin of outer tooth (Fig. 60) paraglossae with a distinct nipple apically (Fig. 54) and with glossae projecting upward, labrum as in Fig. 49 (P. 81). 16. mohri

- Lacinia with two teeth, one apical and one subapical, hairs found only along inner margin of lacinia, mandibles not so deeply cleft and with no serrations on outer tooth, paraglossae without a nipple, and glossae not projecting upward. (2)
2. Lacinia with hairs found only in a small tuft directly below the subapical tooth (Fig. 50), head and abdomen concolorous, mandibles, and labrum as in Figs. 56, 47 . . . (P.92) 18. I. sp. A¹
Lacinia with hairs found along the entire length of inner margin, head and abdomen with a distinct pattern. (3)
3. Lacinia with apical tooth slender, evenly tapering throughout its length (Fig. 52), mandibles larger, with two prominent lobes on inner margin below bristles (Fig. 57), labium as in Fig. 58. (P.76) 15. jewetti²
Lacinia with apical tooth stouter, sides nearly parallel for most of length (Fig. 51), mandibles with single lobe on inner margin below bristles (Fig. 61) (P.89) 17. coushatta

¹Adults unknown

²Known only from exuvia

Fig. 47. Labrum of Isoperla Sp. A. nymph

Fig. 48. Labrum of Isoperla coushatta nymph

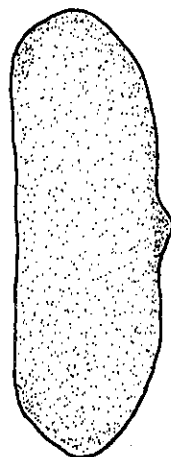
Fig. 49. Labrum of Isoperla mohri nymph

Fig. 50. Lacinia of Isoperla Sp. A. nymph

Fig. 51. Lacinia of Isoperla coushatta nymph

Fig. 52. Lacinia of Isoperla jewetti nymph

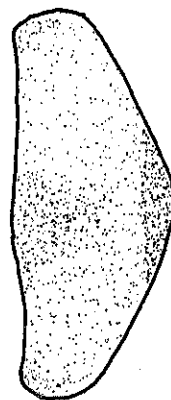
Fig. 53. Lacinia of Isoperla mohri nymph



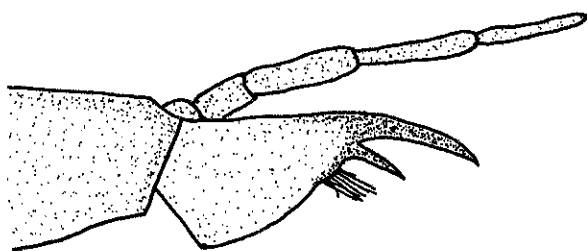
47



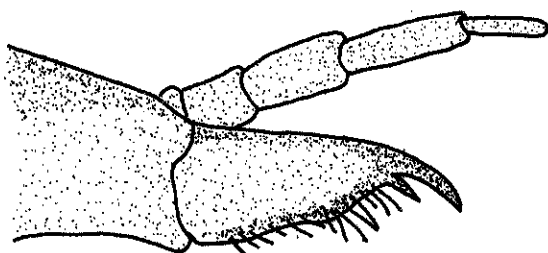
48



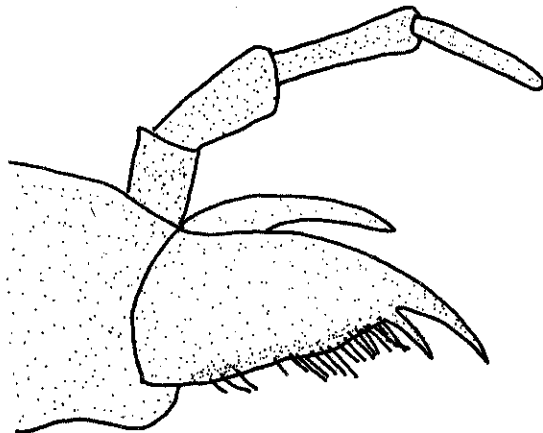
49



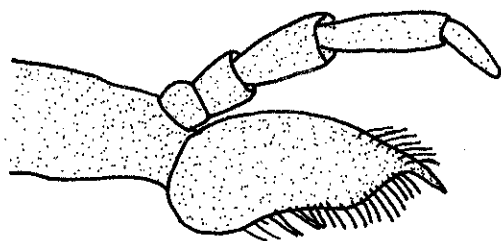
50



51



52



53

Fig. 54. Labium of Isoperla mohri nymph

Fig. 55. Labium of Isoperla couchatta nymph

Fig. 56. Right mandible of Isoperla Sp. A. nymph

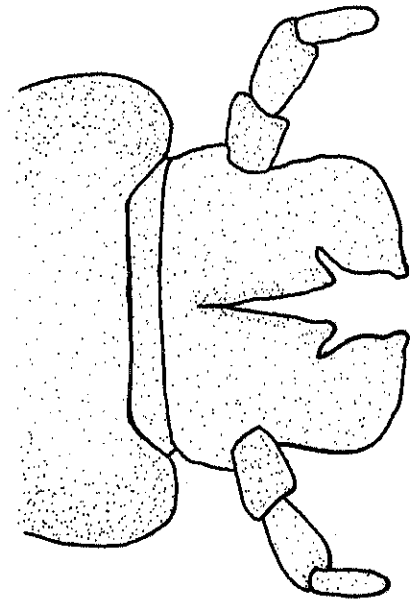
Fig. 57. Right mandible of Isoperla jewetti nymph

Fig. 58. Labium of Isoperla jewetti nymph

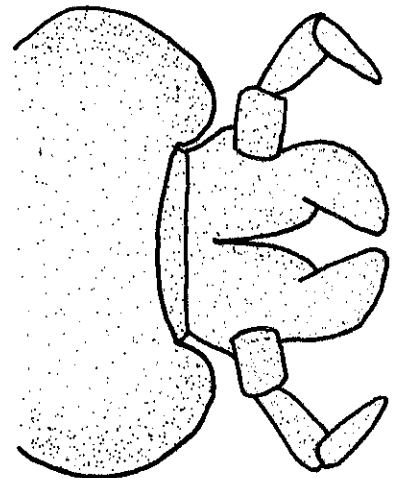
Fig. 59. Labium of Isoperla Sp. A. nymph

Fig. 60. Right mandible of Isoperla mohri nymph

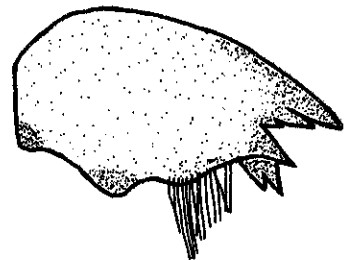
Fig. 61. Right mandible of Isoperla couchatta nymph



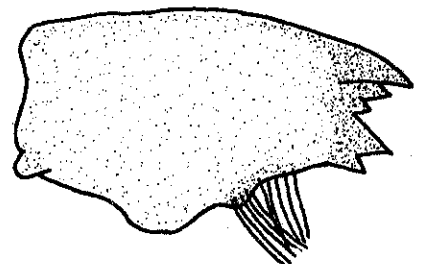
54



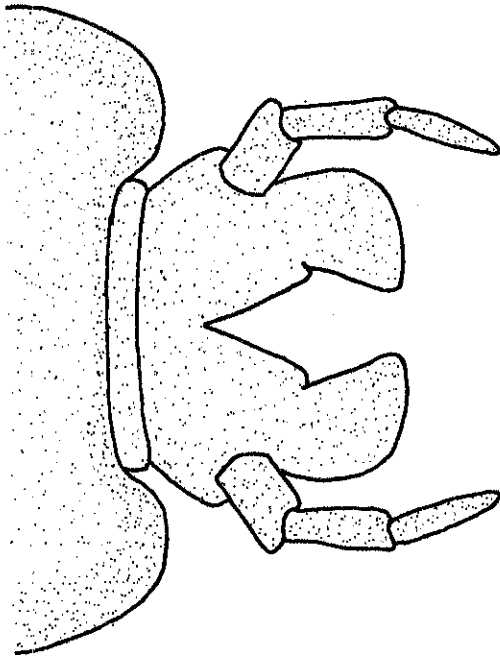
55



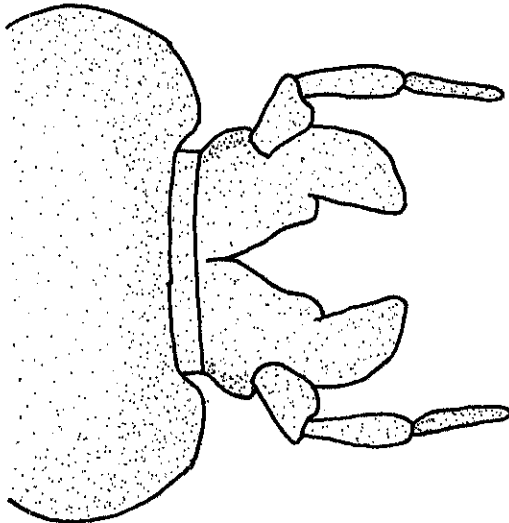
56



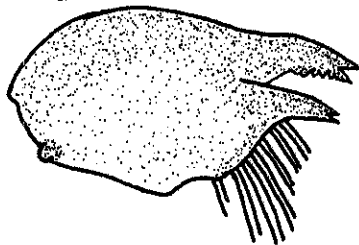
57



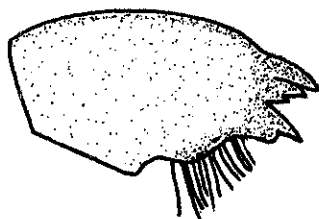
58



59



60



61

15. Isoperla jewetti New Species

1942 Isoperla longiseta - Frison, Bull. Ill. Natur.

Hist. Surv. 22: 318-320.

1974 Isoperla longiseta - Stewart, Baumann and Stark,

Trans. Amer. Entomol. Soc., 99: 507-546.

Species Description -

Male - Length of body 6.12 - 6.72 mm, to tip of wings 3.80 - 4.20 mm; ninth sternum with a broadly rounded lobe (Fig. 63). Paraprocts short, stubby much like I. mormona. Ninth and tenth tergum with patches of spines (Fig. 64). Aedeagus membranous with a long finger process dorsally (Fig. 62).

Female - Length of body - 6.84 mm - 9.12 mm, to tip of wings 8.04 - 10.44 mm. Eighth sternum produced posteriorly into an elongate-truncate subgenital plate, only slightly produced over the ninth sternum (Fig. 68).

Nymphs - The nymphs of this species are unknown. Frison (1942) illustrated a nymph, redrawn from exuviae and mouthparts. Mouthparts (Figs. 52, 57, 58) were also drawn from exuvia. Lacinia with apical and subapical teeth, apical tooth slender, evenly tapering throughout its length (Fig. 52). Mandibles with two prominent lobes on inner margin below bristles (Fig. 57).

Paraglossae stout, truncate apically; prementum with wide, V-shaped cleft (Fig. 58). This species is very close to I. longiseta. All specimens from Texas were collected by J. A. and H. H. Ross, April 22, 1939. Frison (1942) identified this species with some hesitation as Isoperla longiseta, indicating that there were differences in the paraprocts, and color pattern of the head, in addition to the brachypterous nature of the males. S. G. Jewett for whom the species is named, examined one of two vials of specimens some time after Frison and indicated that they were closely related to I. longiseta. The single brachypterous male specimen from La Veta Pass, Colorado discussed by Frison (1942) was also examined and determined to be I. jewetti.

Males can be separated from longiseta by shorter, stubbier paraprocts, and presence of the finger process dorsally on the aedeagus. The paraprocts of longiseta are long and slender, and the aedeagus has two dorsal lobes with a short process between them. Only the holotype of this new species has the aedeagus extruded. I attempted to manually evert the aedeagus of two other males, but found them too fragile due to long time in preservative. I found no characters sufficient to separate females of jewetti from longiseta.

The nymph of longiseta is unknown and Frison (1942) illustrated the nymph of jewetti from the exuviae. He also illustrated the male and female of jewetti (as longiseta).

The eggs of I. jewetti from preserved females are smaller (.0054 mm width and .0080 mm length) than those of longiseta (.0070 mm width and .0102 mm length) and sculpturing of the chorion is different.

Type locality - El Paso, Texas. The holotype, allotype, 5 male and 16 female paratypes and two exuviae are deposited in the Illinois Natural History Survey Museum. One male and one female paratype and one exuvium are deposited in the USNM and in the North Texas State University Collection.

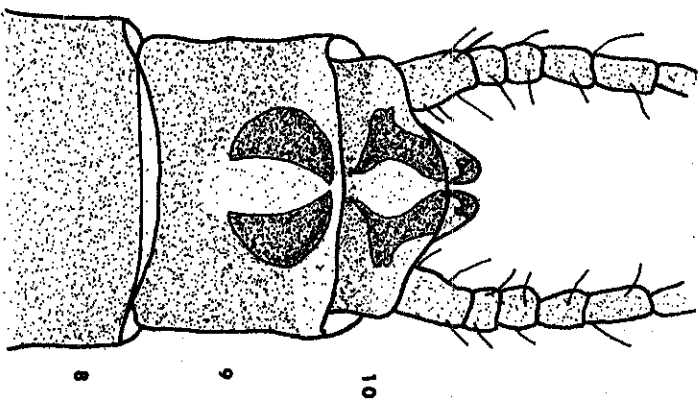
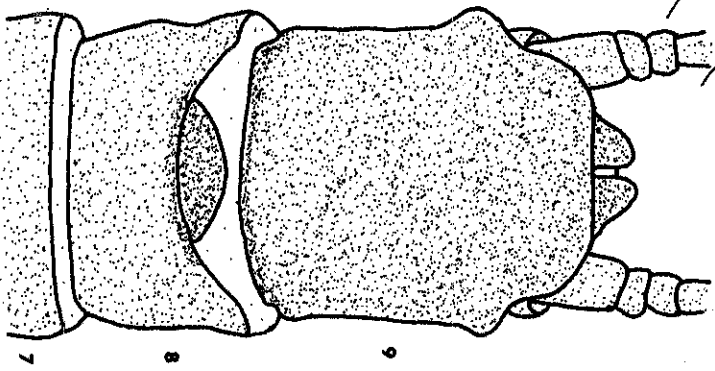
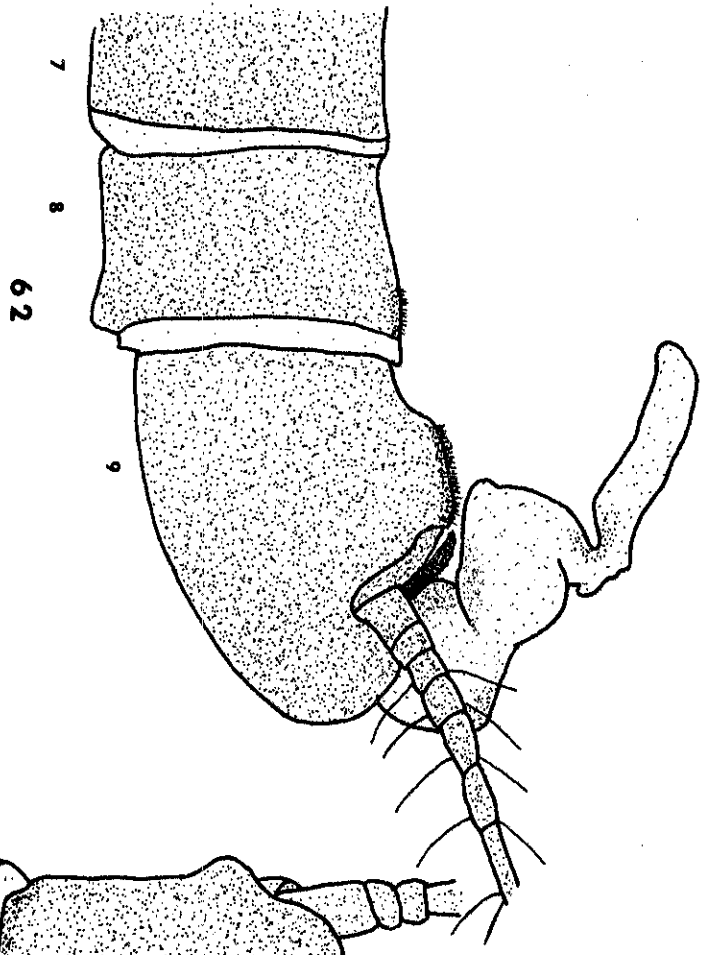
Geographic Range - Texas, and Colorado (La Veta Pass).

Distribution in Texas - El Paso Co., 5-10 mi south of El Paso on road to Marathon in Tamarix along irrigation ditch (1939). I have attempted without success to collect additional specimens. This population is probably now extinct due to the heavy use of pesticides in the irrigation ditches and canals in that area.

Fig. 62. Lateral view of Isoperla jewetti aedeagus

Fig. 63. Terminal ventral view of Isoperla jewetti male

Fig. 64. Terminal dorsal view of Isoperla jewetti male



63

64

62

16. Isoperla mohri Frison 1935

1935 Isoperla mohri - Frison, Bull. Ill. Natur. Hist. Surv. 20: 455.

1940 Isoperla mohri - Claassen Cat.: 203.

1966 Isoperla mohri - Illies Cat.: 409-410.

1974 Isoperla mohri - Hitchcock, State Geo. Natur. Hist. Surv. of Conn. 107: 203-204.

Type Locality - Watson Illinois. The type specimen is deposited in the Illinois Natural History Survey Museum.

Geographic Range - Illinois, Missouri, Oklahoma, and Texas.

Distribution in Texas - Eleven counties (Fig. 75).

New Records - Bowie Co., unnamed stream; Cass Co., Frazier Creek; Cherokee Co., Mud Creek, unnamed stream Harrison Co., unnamed stream; Houston Co., White Rock Creek, Collins Creek; Red River Co., Cuthand Creek, unnamed creek; Sabine Co., unnamed creek; Shelby Co., Huana Creek, unnamed stream, Murvual Creek; Smith Co., Mud Creek; Trinity Co., Piney Creek; Walker Co., West Fork of San Jacinto River.

Biology - Frison (1935) found insect remains in the guts of nymphs. He noted that adult mandibles were flabby and did not appear to be functional, and that the species was restricted to very small streams in Illinois. The mandibles of Texas adults are as described by Frison.

All Texas specimens have been compared with paratypes of I. mohri from the Illinois Natural History Survey and found to be the same species. The aedeagus is highly diagnostic having a patch of sclerotized interdigitated finger-like processes below a stout spine (Fig. 66).

The species is very similar to I. irregularis as described by Klapálek (1923b). Ricker (1938) examined Klapálek's type in the Vienna Museum and indicated that the specimens fit Frison's description of I. mohri very well, except for some minor differences in color. Klapálek's type was moved from the Vienna Museum sometime after Ricker examined it and is presently unavailable for comparison (personal communication, Dr. R. W. Baumann). It is therefore very possible that Isoperla irregularis Klapálek, type locality "Texas", and Isoperla mohri Frison are synonyms. This problem cannot be resolved until the type of I. irregularis is found and can be compared with that of I. mohri.

This species is found mostly in small sandy-substrate streams in east Texas. Several female specimens have been dissected, but no eggs have been found. Females reared in the laboratory and allowed to live for six days failed to produce any eggs. Harper (1973) indicated that adults

Fig. 65. Terminal ventral view of Isoperla mohri male.

Fig. 66. Terminal lateral abdominal view of Isoperla mohri with aedeagus extruded.

Fig. 66A. Posterior view of Isoperla mohri aedeagus.

Fig. 67. Head of Perlinella drymo nymph.

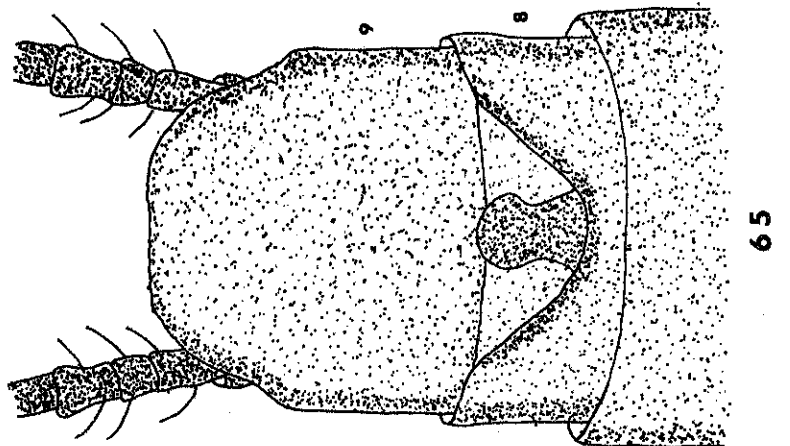
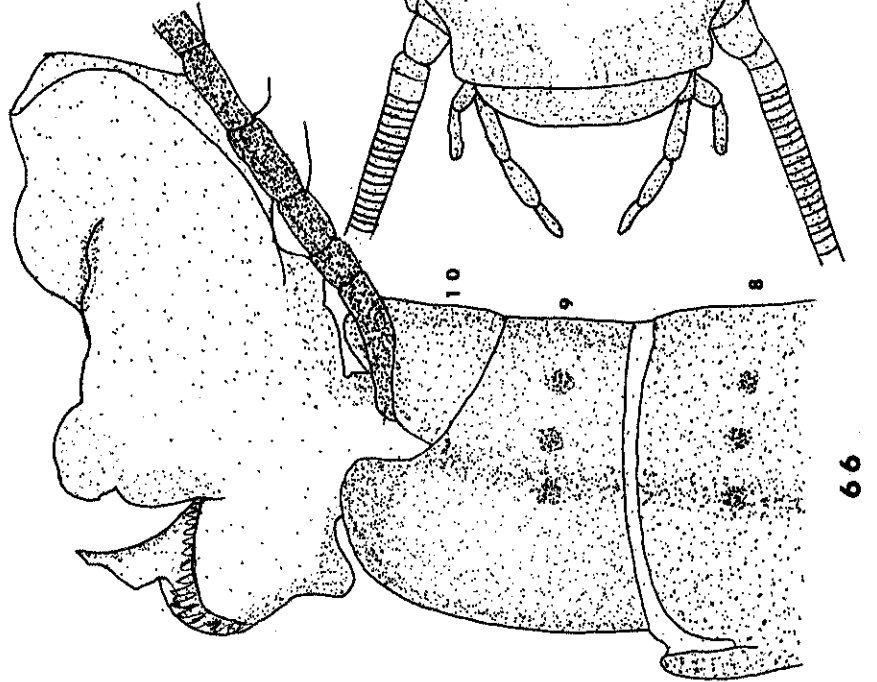
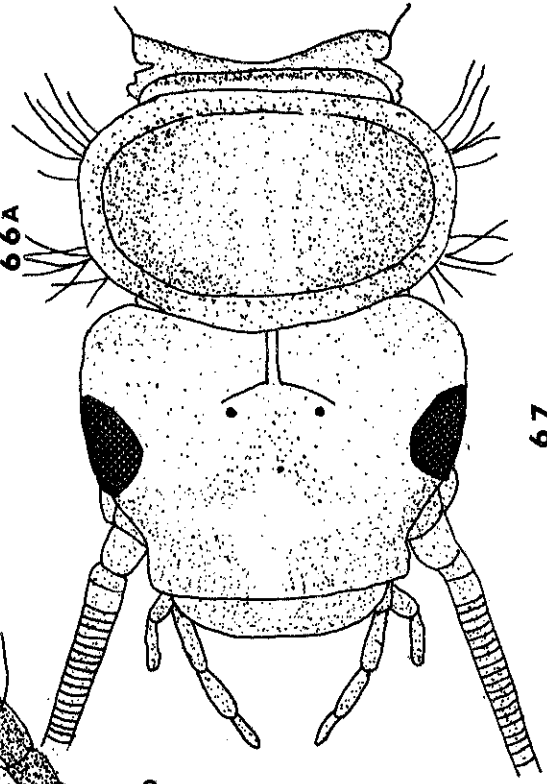
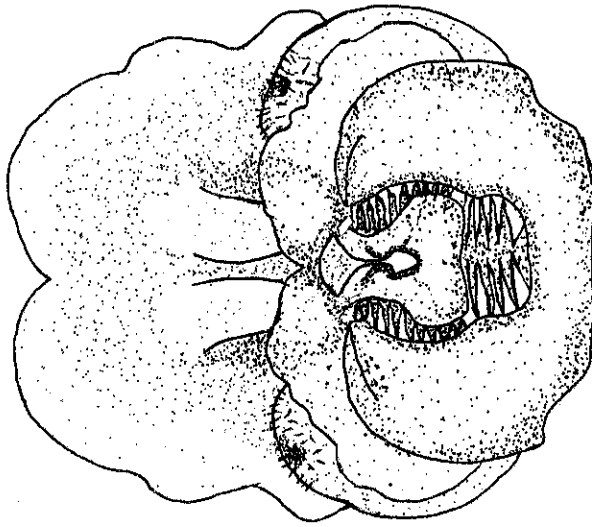
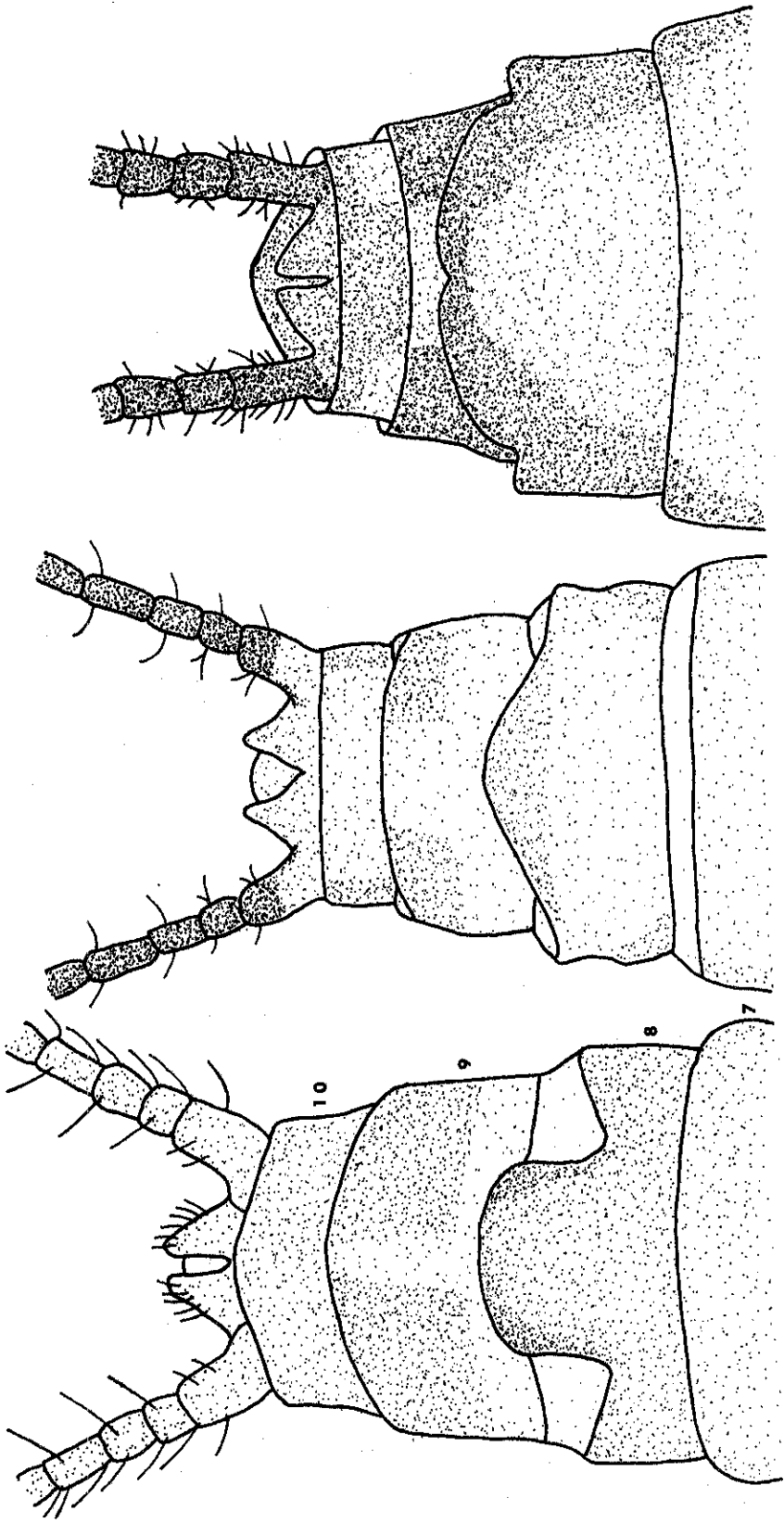


Fig. 68. Female subgenital plate of Isoperla jewetti.

Fig. 69. Female subgenital plate of Isoperla coushatta

Fig. 70. Female subgenital plate of Isoperla mohri.



70

69

68

10

9

8

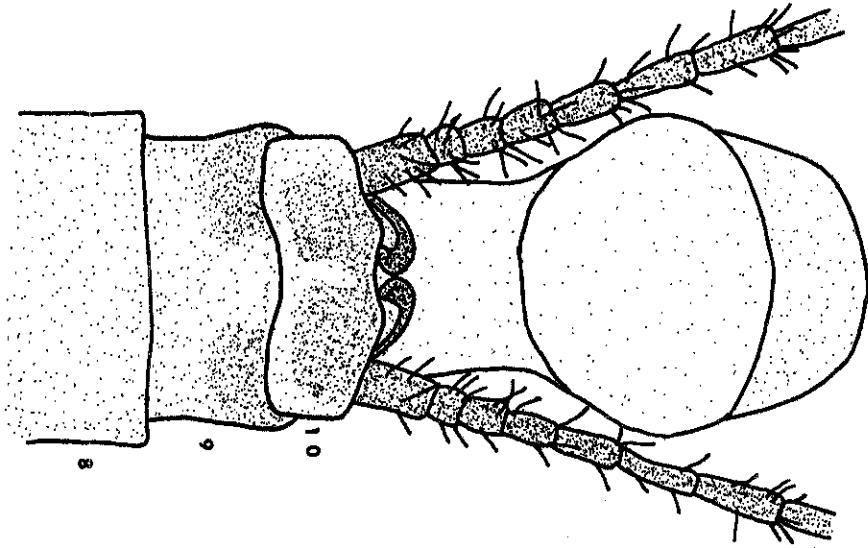
7

Fig. 71. Terminal dorsal abdominal view of Isoperla
coushatta with aedeagus extruded.

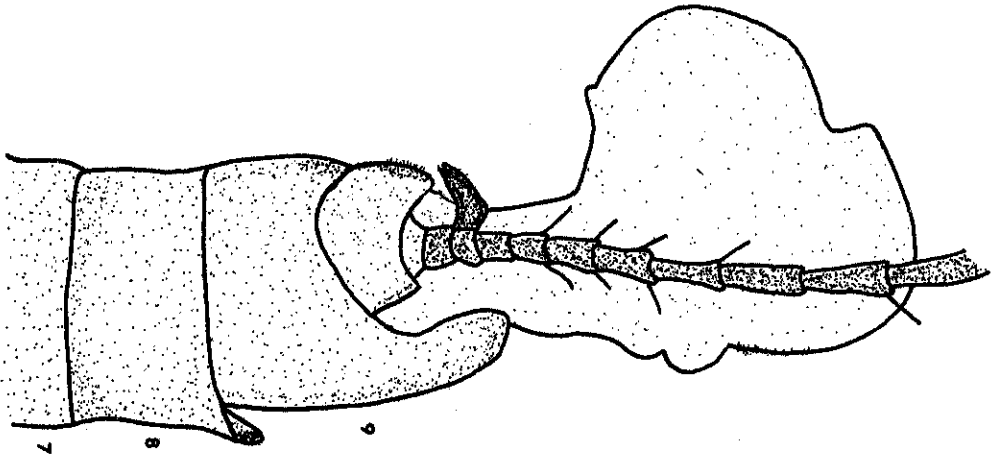
Fig. 72. Terminal lateral abdominal view of Isoperla
coushatta with aedeagus extruded.

Fig. 73. Terminal ventral abdominal view of Isoperla
coushatta with aedeagus extruded.

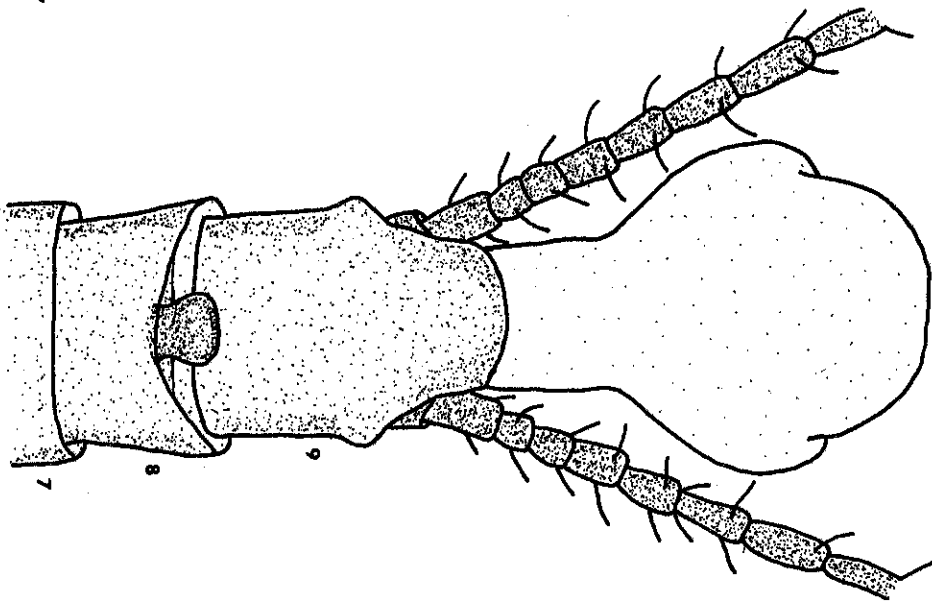
71



72



73



of I. clio did not attempt to mate before 3-5 days after emergence, and that eggs were not extruded until 7 or 8 days. Apparently, I have collected females near the streams soon after emergence, and prior to egg maturation. The life cycle of this species is unknown; nymphs were described by Frison (1935). Adults have been collected from late March through mid-May.

17. Isoperla couthatta NEW SPECIES

Species Description -

Male - Length of body 6.00 mm - 6.84 mm, to tip of wings 8.7 mm - 9.36 mm. Middle of the posterior portion of the 9th sternum with a ventral lobe (Fig. 73). Paraprocts recurring upward and inward only to the height of the 10th tergum (Fig. 71). Aedeagus stalked, entirely membranous with one small double lobe ventrally, and a very large dome-shaped lobe dorsally (Fig. 71-73). Abdomen very light in color contrasting with the very dark cerci. Color pattern of the head and pronotum variable, very similar to that of mohri as described by Frison (1935).

Females - Length of body to the tip of the abdomen 7.5 mm - 8.64 mm, to tip of wings 9.60 mm - 10.68 mm.

Eight sternum produced posteriorly into a triangular-shaped subgenital plate (Fig. 69), which covers not more than one third of the 9th sternum. Color patterns same as male.

Nymphs - Dorsum of the abdomen with three predominate longitudinal stripes two lateral and one median, with two lighter colored longitudinal stripes between each lateral dark stripe and the median stripe (Fig. 1). Head and pronotum pattern typical as that described for I. mohri Frison (1935). Lacinia with two teeth, the subapical tooth being about one fourth to one half as long as the apical tooth. Hairs continuing the entire length of the inner margin of the lacinia (Fig. 51). Labrum with a median swelling (Fig. 48). Mandibles and labium as in Figs. 61, 55.

Isoperla coushatta was named in honor of the Alabama-Coushatta Indian Tribe who resided in Polk County Texas, one of the first counties in which the species was collected.

Males can be distinguished from mohri by the shape of the ventral lobe (Figs. 65, 73), shape and lack of the sclerotized interdigitated fingers (Figs. 66 a, b, 71-73) of the aedeagus, the longer slenderer paraprocts and lack of paired dots on the dorsum of abdomen. They differ

from namata by paraprocts, lack of paired dots on the dorsum of abdomen, and color patterns of the head ventral lobe. Females differ from mohri and namata by the shape of the subgenital plate (Figs. 69, 70 namata not illustrated). Mature nymphs can be distinguished from mohri and namata by lack of paired dots and presence of 5 rather than 3 dorsal longitudinal abdominal stripes (Fig. 1), with the median stripe being wider. Nymphs of coushatta differ from mohri also in that the lacinia has two rather than one apical teeth and the hairs are only on the inner margin of the lacinia.

Type Locality - holotype male, Saddler Creek, Anderson County Texas, S. W. Szczytko and K. W. Stewart, 30-III-1974; Caney Creek, allotype female, Montgomery County, Texas, K. W. Stewart, 20-III-1974. Holotype and allotype deposited in USNM along with two paratypes of each sex and five nymphs. Paratypes also deposited in the North Texas State University Museum.

Distribution in Texas - Fifteen counties (Fig. 75).

Anderson Co., unnamed stream, Saddler Creek (type locality); Cass Co., unnamed stream, Hughes Creek, Henderson Creek, Frazier Creek; Cherokee Co., unnamed stream, Keys Creek; Hamilton Co., unnamed stream; Houston Co., White Rock Creek; Jasper Co., Boykin Spring; Liberty Co., East Fork

of San Jacinto River; Montgomery Co., Caney Creek; Nacogdoches Co., Naconiche Creek, Yselata Creek, unnamed stream; Newton Co., Little Cow Creek, Big Cow Creek; Panola Co., Murvaul Creek; Polk Co., Bear Creek, Big Creek; Sabine Co., unnamed stream; Shelby Co., unnamed stream, Huana Creek; Tyler Co., unnamed stream, Big Cypress Creek.

Biology - This species and I. mohri were tentatively referred to as I. namata by Stewart et al. (1974).

It is restricted to forests east of the blackland prairie.

Nymphs occur in decaying leaves of small sandy-bottomed streams. I have found no eggs in females up to six days of age. Males and females reared in the lab did not mate. Emergence occurs from mid-March to mid-April.

19. Isoperla irregularis (Klapálek) 1923

1923 Chloperla irregularis - Klapálek, Ann. Soc. Entomol.

Belaique 63: 28.

1938 Isoperla irregularis - Ricker, Trans. Roy. Can. Inst.

22: 129-156.

1940 Isoperla irregularis - Claassen Cat.: 203.

1966 Isoperla irregularis - Illies Cat.: 407.

1974 Isoperla irregularis - Stewart, Baumann and Stark,

Trans. Amer. Entomol. Soc., 99: 507-546.

Type Locality - Texas. The type specimen is unavailable.

Geographic Range - Texas.

Distribution in Texas - No locale records available.

Biology - When Ricker (1938) examined this species in the Vienna Museum the label read Boll Texas. Apparently Boll is not the locality but the collector. Jacob Boll was a naturalist who did intensive collecting in Texas in the late 1800's for the Museum of Comparative Zoology at Harvard.

Ricker (1938) stated that this species was closely related to I. mohri and that the species would key down to mohri using Fridon's 1935 key to the Isoperla. Perhaps when the type becomes available for close examination of the genitalia mohri might be found a synonym of irregularis.

Genus Acroneuria Pictet 1841

This Holarctic genus contains large stoneflies which are predacious as nymphs. Acroneuria was first proposed as a subgenus of Perla by Pictet (1841). Klapalek revised the genus in 1909. Needham and Claassen (1925) reported 17 species of Acroneuria from North America, including two, A. arida and A. pumila (now Hesperoperla pacifica) from Texas.

Most adults are nocturnal and can be collected with light traps near the streams in which the nymphs are found. The mouth parts of the adults are not well developed, and it is thought that they do not feed (Frison, 1935).

Nymphs are carnivorous, inhabit streams of moderate to large size, and some may require 2 to 3 years to develop.

Members of this genus usually emerge in early summer.

Type of genus - Perla arenosa Pictet.

Key to the Species of Texas Acroneuria
Males

- 1. Anal area of hindwing with many branches, approximately 12.(P. 95). 20. arenosa
Anal area of hindwing with, at most, 6 branches (2)
- 2. Remnants of subanal gills absent, paraprocts notched on inside near tip.(P. 97).21. arida
Remnants of subanal gills present, paraprocts without apical notch(P.96). 22. mela

Females

- 1. Anal area of hindwing with many branches, approximately 12.(P. 95).20. arenosa
Anal area of hindwing with, at most, 6 branches (2)

2. Remnants of subanal gills absent, subgenital plate of 8th sternum narrowed greatly at the base.(P.97). 21. arida
 Remnants of subanal gills present, subgenital plate of 8th sternum. (P.96). 22. mela

Nymphs

1. Subanal gills present, head without transverse occipital ridge, median ocellus separated from clypeus by a dark area, abdomen uniformly dark, no light M-shaped band on head.(P.96). 22. mela

21. Acroneuria arenosa (Pictet) 1841

- 1841 Perla arenosa - Pictet, Perlides: 178.
 1842 Perla pennsylvanica - Rambur, Hist. Natur. Ins.
 (synonym, Ricker, 1938a: 139).
 1852 Perla trijuncta - Walker, Cat. Neur. Inst. Brit.
 Mus. 1:53 (synonym, Ricker, 1938a: 140).
 1940 Acroneuria arenosa, trijuncta - Claassen Cat.: 172, 176.
 1946 Acroneuria pennsylvanica - Ricker, Trans. R. Canad.
 Inst. 26:7.
 1948 Acroneuria arenosa - Berner, Fla. Entomol. 31: 23.
 1964 Acroneuria arenosa - Ricker, Gew. U. Abw. 34/35.
 1966 Acroneuria arenosa - Illies Cat.: 306.
 1974 Acroneuria arenosa - Hitchcock, State Geo. and Natur.
 Hist. Surv. of Conn. 107: 150-151.

¹ Nymphs of arenosa and arida are not known at this time.

Type Locality - Philadelphia, Pennsylvania. The type is deposited in the Zoologisches Museum der Universitat, Berlin.

Geographic Range - Canada, Columbia, Connecticut, Florida, Georgia, Maine, Manitoba, Massachussetts, New York, North Carolina, Pennsylvania, Tennessee, Texas, Virginia.

Distribution in Texas - Three counties (Fig. 76).

New Records - Jasper Co., Sandy Creek; Newton Co., Big Cow Creek, Little Cow Creek; Polk Co., unnamed stream.

Biology - Nymphs occur in swift, sandy-bottomed streams in longleaf pine forest of southeast Texas, where they are often associated with Paragnetina fumosa.

This species was reported as Acroneuria lycorias (Stewart, et al., 1974), but further study, especially of the aedeagus has confirmed that all Texas specimens are arenosa (Personal communication, B. P. Stark).

Adults are nocturnal and can be collected with fluorescent light traps. Arnold (1964) reported that adults were able to release drops of blood from the coxal joints when disturbed. Nymphs are unknown, as are details of the life cycles. Adults emerge in Texas during May and June.

22. Acroneuria arida (Hagen) 1861

1861 Perla arida - Hagen, Syn. Neur. North America: 18.

- 1906 Perla valida - Banks, Trans. Amer. Entomol. Soc.
32: 4. (Synonym, Needham and Claassen 1922).
- 1940 Acroneuria arida - Claassen Cat.: 172.
- 1942 Acroneuria arida - Frison, Bull. Ill. Natur. Hist.
Surv. 22:272.
- 1947 Acroneuria arida - Walker, Ohio J. Sci., 47: 135.
- 1956 Acroneuria arida - Gaufin, Ohio J. Sci., 56: 324.
- 1966 Acroneuria arida - Illies Cat.: 306-307.
- 1973 Acroneuria arida - Zwick Cat.: 268.
- 1974 Acroneuria arida - Stewart, Baumann, and Stark,
Trans. Amer. Entomol. Soc. 99: 507-546.

Type Locality - Philadelphia, Pennsylvania. The type specimen is deposited in the Museum of Comparative Zoology, Harvard University.

Geographic Range - Arkansas, Columbia, Georgia, Illinois, Indiana, New York, North Carolina, Ohio, Pennsylvania, Tennessee, Texas.

Distribution in Texas - Presence of this species in Texas is based entirely on the record published by Claassen (1925) from Kampers Bluff, Victoria County.

23. Acroneuria mela Frison 1942

- 1925 Acroneuria evoluta - Needham and Claassen, Plec. Amer.
North Mexico: 185.

- 1931 Acroneuria arida - Claassen, Plec. Nymphs Amer.: 81.
(Synonym, Frison 1942b: 274).
- 1942 Acroneuria mela - Frison, Bull. Ill. Natur. Surv.
22: 274.
- 1945 Acroneuria mela - Ricker, Proc. Ind. Acad. Sci.,
54: 228.
- 1956 Acroneuria mela - Gaufin, Ohio J. Sci., 56: 324.
- 1966 Acroneuria mela - Illies Cat.: 310.
- 1974 Acroneuria mela - Hitchcock, State Geo. Natur. Hist.
Surv. 107: 157.

Type Locality - Petersburg, Indiana. The type is deposited in the Illinois Natural History Survey Museum.

Geographic Range - Georgia, Illinois, Indiana, Kansas, Ohio, Oklahoma, Tennessee, Texas.

Distribution in Texas - Two counties (Fig. 76).

New Records - Montgomery Co., near Conroe (USNM collection);

Nacogdoches Co., Nacogdoches (University of Kansas Collection).

Biology - Adults have been taken in May and June.

Genus Perlesta Banks 1906

This Holarctic genus is typical of the subfamily Acroneuriinae in that nymphs possess thoracic gills, and the 10th tergum of the male is not cleft; it is atypical of the subfamily because the males lack a hammer on the 9th tergum.

Specimens of this genus have the costal margin of the forewing a distinct yellowish-white color, and the nymphs possess freckle-like spots on the dorsum of the abdomen.

This is a rather small genus, having only four species. Two species are found in North America, and P. placida is the only one that occurs in Texas.

24. Perlesta placida (Hagen) 1861

1861 Perla placida - Hagen, Syn. Neur. North Amer.: 28.

1862 Perla decipiens - Walsh, Proc. Acad. Natur. Sci., Philadelphia, 13: 364 (synonym, Needham and Claassen, 1925: 158).

1862 Perla brunneipennis - Walsh, Proc. Acad. Natur. Sci. Philadelphia 13: 367, (synonym, Needham and Claassen, 1925: 158).

1898 Chloroperla virginica - Banks, Trans. Amer. Entomol. Soc. 25: 199, (synonym, Needham and Claassen 1925: 158).

1905 Perlinella cinctipes - Banks, Psyche, 12: 56, (synonym, Needham and Claassen, 1925: 158).

1914 Isoperla texana - Banks, Proc. Acad. Natur. Sci. Philadelphia 66: 611. (synonym Needham and Claassen 1925: 158).

- 1914 Isoperla texana - Banks, Proc. Acad. Natur. Sci. Philadelphia 66: 611 (synonym Needham and Claassen 1925: 158).
- 1921 Perlesta costalis - Klapálek, Ann. Soc. Entomol. Belgique, 61: 150 (synonym Needham and Claassen 1925: 158).
- 1925 Perlesta placida - Needham and Claassen, Plec. of No. Amer: 158.
- 1931 Perlesta placida - Claassen, Plec. Nymphs of Amer.: 77.
- 1935 Perlesta placida - Frison, Bull. Ill. Natur. Hist. Surv. 20: 386.
- 1940 Perlesta placida - Claassen Cat.: 147.
- 1942 Perlesta placida - Frison, Bull. Ill. Natur. Hist. Surv., 22: 271.
- 1948 Perlesta placida nitida - Banks, Psyche, 55: 115.
- 1952 Perlesta placida - Harden and Mickel, Tech. Bull. 201: 57-58.

Type of Genus - Perla placida Hagen

Type of Locality - Washington, D.C. The type is deposited in the Museum of Comparative Zoology, Harvard University.

Geographic Range - Alabama, Canada, Connecticut, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Manitoba, Maryland, Massachusetts, Michigan, Minnesota, New Brunswick, New Jersey, New York, North Carolina, Nova Scotia, Ohio, Oklahoma, Pennsylvania, Texas, Vermont, Virginia, Washington,

West Virginia, Wisconsin.

Distribution in Texas - Forty-Two counties (Fig. 76).

Published Records - Bandera Co., Medina River, Bandera Creek; Bell Co., Little River; Blanco Co., Pedernales River, Miller Creek; Brazos Co., Cedar Creek, unnamed stream; Caldwell Co., San Marcos River; Comal Co., Cypress Creek; Collin Co., unnamed stream; Cherokee Co., Mud Creek; Cooke Co., unnamed stream; Denton Co., Clear Creek; Hardin Co., Cypress Creek; Hays Co., Blanco River; Ben McCulloch State Park; Jasper Co., Sandy Creek; Kendall Co., Guadalupe River; Marion Co., Carney Canal, unnamed stream; Nacogdoches Co., Angelina River; Newton Co., Big Cow Creek; Panola Co., Murvaul Creek, Palo Pinto Co., Brazos River (light traps), Polk Co., unnamed stream; Robertson Co., Mineral Creek, Cedar Creek; Rusk Co., Murvaul Creek; Smith Co., Mud Creek; Travis Co., Colorado River; Trinity Co., White Rock Creek; Victoria Co., unnamed stream; Walker Co., West Fork of San Jacinto River; Williamson Co., San Gabriel River; Wise Co., Catlett Creek.

New Records - Anderson Co., unnamed stream Bexar Co., Cibola Creek; Bowie Co., Mud Creek, unnamed stream; Cass Co., John's Creek, Black Cypress Creek; Hughes Creek, Henderson Creek; Coryell Co., Coryell Creek; Cherokee Co., Keys Creek; Harrison Co., Harrison Creek, Houston Co., White Rock Creek, Hurricane Creek; Denton Co., Denton Creek,

Hickory Creek, Elm Fork Trinity River; Montgomery Co., unnamed Creek, West Fork San Jacinto River, Caney Creek, San Jacinto River; Newton Co., Yellow Bayou; Panola Co., Nail Creek; Polk Co., Bear Creek; Red River Co., unnamed stream, Cuthand Creek; Rusk Co., Scoober Creek, Walker Creek; Sabine Co., Borregas Creek unnamed stream; Shelby Co., Huana Creek, unnamed Creek, Tenana Creek; Tarrant Co., unnamed stream; Trinity Co., Brownlee Creek, Tyler Co., unnamed stream.

Biology - The nocturnal adults emerge from late March through July in Texas. They are collected by sweeping vegetation during the day or around lights at night. Their reproductive morphology, mating behavior and egg adaptations were described by Stewart et al. (1969).

Nymphs occur in debris and in stony substrates in a wide variety of habitats, from spring-fed streams to intermittent creeks and rivers. It is the only stonefly in Texas that occurs in the silty streams of the black-land prairie. Frison (1935) and Harden and Mickel (1952) also reported the species from a wide variety of habitats, including intermittent situations.

Their emergence is spring and early summer, yet initial appearance of very small nymphs in December-

January, suggest an egg and/or nymphal aestivation through the summer, then very rapid spring development. Frison (1935) reported nymphs to be carnivorous, feeding mainly on chironomid larvae.

Genus Perlinella Banks 1900

This Nearctic genus is relatively small with only three species, distributed in eastern and midwestern states. Members have a single row of crossveins in the anal area of the fore wing (Fig. 10). Males possess a hammer on the 9th sternum, and the paraprocts are modified into sharply pointed recurved hooks.

Zwick (1971) revised the genus and reported the aedeagus of the male to be highly diagnostic. P. ephere exhibits either two or three ocelli.

Type of genus - Isogenus drymo Newman.

25. Perlinella drymo (Newman) 1839

1839 Isogenus drymo - Newman, Mag. Natur. Hist. 3: 86.

1862 Perla elongata - Walsh, Proc. Acad. Natur. Sci.

Philadelphia 13: 366, (synonym, Needham and Claassen 1925: 164).

1895 Perla trivittata - Banks, Trans. Amer. Entomol. Soc.

- 22:313 (synonym, Needham and Claassen, 1925: 164).
- 1935 Perlinella drymo - Frison, Bull. Ill Natur. Hist. Surv. 20(4): 380-381.
- 1940 Perlinella drymo - Claassen Cat.: 148.
- 1945 Perlinella drymo - Ricker, Proc. Ind. Acad. Sci. 54: 229.
- 1952 Perlinella drymo - Harden and Mickel, Tech. Bull., 201: 58.
- 1956 Perlinella drymo - Gaufin, Ohio J. Sci., 56: 324.
- 1966 Perlinella drymo - Illies Cat.: 348-349.
- 1971 Perlinella drymo - Zwick, Fla. Entomol. 54(4): 317.
- 1973 Perlinella drymo - Zwick Cat.: 279.
- 1974 Perlinella drymo - Stewart, Baumann, and Stark, Trans. Amer. Entomol. Soc., 99: 507-546.
- 1974 Perlinella drymo - Hitchcock, State Geo. Natur. Hist. Surv. of Conn. 107:163.

Type Locality - Georgia. The type specimen is deposited in the British Museum.

Geographic Range - Connecticut, Florida, Georgia, Illinois, Indiana, Maine, Massachusetts, Minnesota, New Hampshire, New Jersey, New York, North Carolina, Nova Scotia, Oklahoma, Ohio.

Distribution in Texas - Five counties (Fig. 76).

Published Records - Bosque Co., Meridian Creek; Denton Co., Clear Creek; McLennan Co., Middle Bosque River.

New Records - Bosque Co., Cedron Creek; Nacogdoches Co., unnamed stream, Newton Co., Little Cow Creek; Coryell Co., unnamed stream, Sabine Co., unnamed stream.

Biology - The nymphs are carnivorous, and adults are diurnal (Frison, 1935). In Texas the nymphs occupy debris or gravelly substrates in a wide variety of streams. In aquaria they exhibit a territorial behavior, swinging the cerci into approaching nymphs, then turning and biting at them. The nymph was described by Claassen (1931) and Frison (1935). Details of the life cycle are unknown. Adults emerge in Texas and Illinois (Frison 1935) in March and April.

Genus Neoperla Needham 1905

This Holarctic, Ethiopian and Oriental genus is characterized by having two ocelli set close together in the nymph and adult. Nymphs are typical of the family Perlidae in that they possess thoracic gills. Males do not have a hammer on the 9th sternum, and the tenth tergum is divided.

Only two species, N. clymene and N. hubbsi are currently known from North America. N. hubbsi from Kansas is a

questionable species (personal communication, B. P. Stark).
 N. Clymene exhibits considerable morphological variation,
 and the genus in North America is currently under revision
 by B. P. Stark of the University of Utah.

Type of genus - Chloroperla clymene Newman 1892

26. Neoperla clymene (Newman) 1839

- 1839 Chloroperla clymene - Newman, Mag. Natur. Hist. 3: 87.
 1841 Perla occipitalis - Pictet, Perlides: 254 (synonym
 Needham 1925: 134).
 1940 Neoperla clymene - Claassen Cat.: 158.
 1948 Neoperla clymene ssp. mainensis - Banks, Psyche 55: 124.
 1952 Neoperla clymene - Harden and Mickel, Techn. Bull. 201:52.
 1966 Neoperla clymene - Illies Cat.: 269.
 1973 Neoperla clymene - Zwick Cat.: 258.
 1974 Neoperla clymene - Stewart, Baumann and Stark,
 Trans. Amer. Entomol. Soc., 99: 507-546.
 1974 Neoperla clymene - Vaught and Stewart, Ann. Entomol.
 Soc. Amer. (67) 2: 167-178.
 1974 Neoperla clymene - Hitchcock, State Geo. Natur. Hist.
 Surv. Conn. 107: 143-144.

Type Locality - Georgia. The type specimen is deposited in the British Museum.

Geographic Range - Arizona, Canada, Connecticut, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Maine, Maryland, Michigan, Minnesota, Mississippi, Missouri, New Jersey, New York, North Carolina, Nova Scotia, Ohio, Oklahoma, Pennsylvania, Quebec, Tennessee, Texas, Vermont.

Distribution in Texas - Nineteen counties (Fig. 76).

Published Records - Bastrop Co., unnamed stream; Bell Co., Little River; Caldwell Co., San Marcos River; Colorado Co., unnamed stream; Dallas Co., unnamed stream; Gonzales Co., Palmetto State Park; Guadalupe Co., Guadalupe River, McLennon Co., unnamed stream; Montgomery Co., Caney Creek; Palo Pinto Co., Brazos River; San Jacinto Co., unnamed stream; Somervell Co., Brazos River, Upshur-Smith Co., Sabine River; Victoria Co., Guadalupe River, unnamed stream.

New Records - Coryell Co., Cowhouse Creek; Hamilton Co., Cowhouse Creek; Nacogdoches Co., unnamed stream; Newton Co., Big Cow Creek; San Augustine Co., unnamed stream.

Biology - Frison (1935) found insect remains, mostly chironomid larvae, in the guts of nymphs. Vaught and Stewart (1974) reported the detailed life cycle in the

Brazos River, Texas, including nymphal food habits and development. They found the species was univoltine and exhibited a typically "slow" (Hynes, 1961, 1970) seasonal growth cycle. Major food items included Trichoptera eggs and larvae (Cheumatopsyche), chironomid larvae, leptophlebiid mayfly nymphs and Simulium larvae. The emergence period was very long, from late April to September, leading to considerable brood overlap in nymphs. Frison (1935) reported emergence in Illinois occurred from early June through August. Mating has been observed at night (Vaught and Stewart, 1974) and it is thought that oviposition is at night.

Genus Paragnetina Klapálek 1907

This genus belongs to the subfamily Perlinae of the family Perlidae. Members of the genus have the posterior portion of the 10th tergum deeply cleft in male specimens; the hammer is absent from the 9th sternum, and the paraprocts are not modified into sharp hooks as in the subfamily Acroneuriinae.

Ricker (1940) revised the genus and provided a key to the males and females. Paragnetina is distributed in the Nearctic and Palearctic Regions. P. fumosa is the only species found in Texas.

Type of genus - Perla tinctipennis McLachlan

25. Paragnetina fumosa (Banks) 1902

1902 Perla fumosa - Banks, *Canad. Entomol.*, 34: 123.

1940 Perla immarginata - Claassen *Cat.*: 138.

1949 Paragnetina fumosa - Ricker, *Ann. Entomol. Soc.*
42: 284.

1966 Paragnetina fumosa - Illies *Cat.*: 283.

1974 Paragnetina fumosa - Stewart, Baumann and Stark,
Trans. Amer. Entomol. Soc., 99: 507-546.

Type Locality - Washington (U. S. A.). The type specimen is deposited in the Museum of Comparative Zoology at Harvard University, #11322.

Geographic Range - Alabama, District of Columbia, Georgia, Texas.

Distribution in Texas - Three counties (Fig. 76).

Published Records - Jasper Co., Sandy Creek; Newton Co., Big Cow Creek.

New Records - Montgomery Co., Caney Creek; Newton Co., Little Cow Creek.

Biology - This species is restricted to three counties in the southeast part of the state. It is usually found in streams with moderate to high flow, with sandy bottoms, in long leaf pine forests. Emergence occurs from late March to late May.

FIG. 74. DISTRIBUTION OF FALL-WINTER STONEFLIES

TAENIOPTERIGIDAE

Taeniopteryx lita

- Published county records (1)
- New county records (1)

Taeniopteryx burksi

- Published county records (5)
- New county records (3)

Taeniopteryx maura

- Published county records (1)
- New county records (1)

Taeniopteryx lonicera

- Published county records (3)
- New county records (1)

Taeniopteryx starki

- Published county records (1)

LEUCTRIDAE

Zealeuctra arnoldi

- ▲ Published county records (4)
- ▲ New county records (1)

Zealeuctra hitei

- Published county records (7)
- New county records (4)

Zealeuctra claasseni

- ▲ Published county records (3)

CAPNIIDAE

Allocapnia granulata

- ▼ Published county records (1)

Allocapnia malverna

- ▼ Published county records (5)
- ▼ New county records (4)

Mesocapnia frisoni

- Published county records (1)

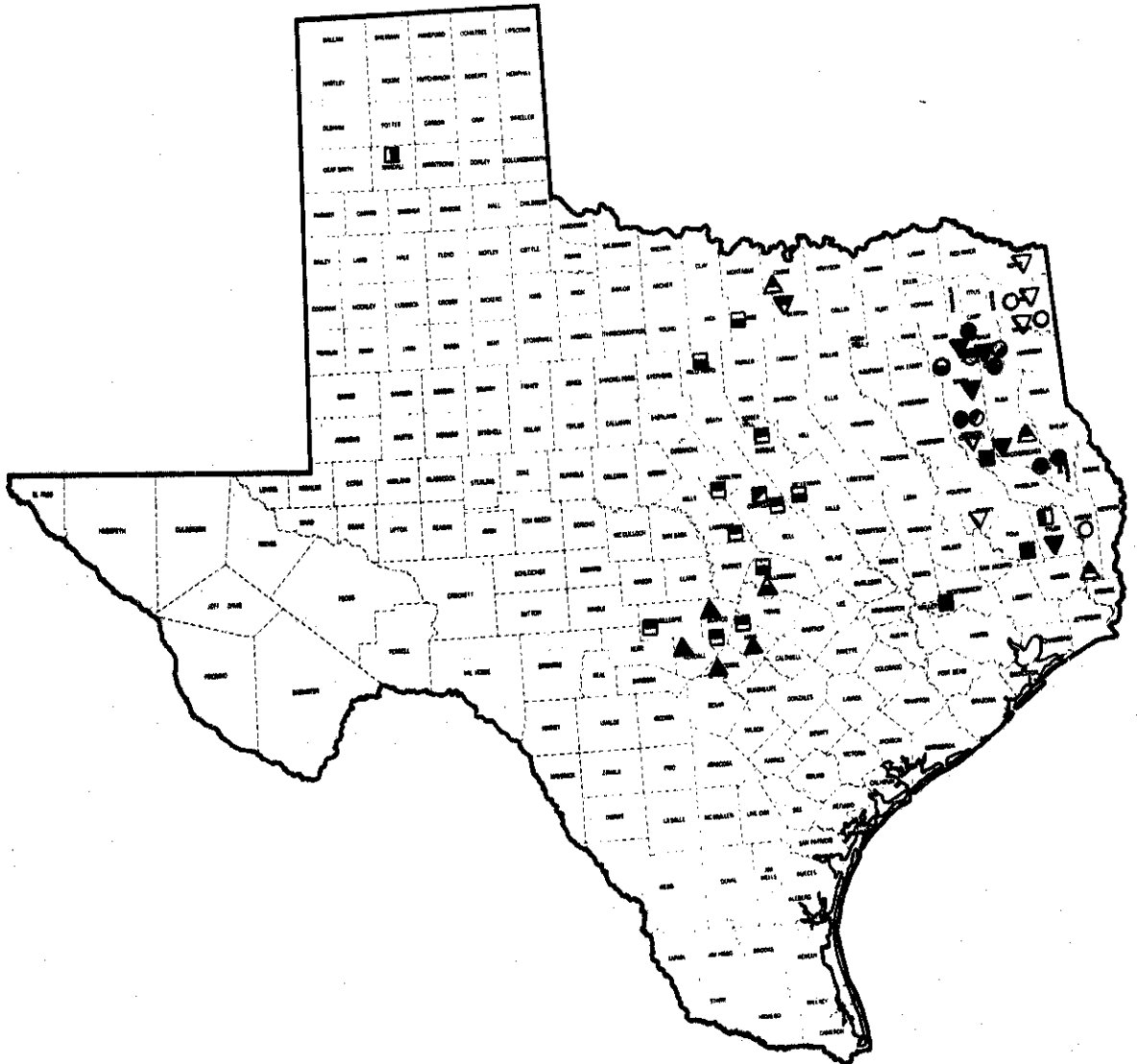


Fig. 75. Distribution of Spring-Summer Stoneflies

Perlodidae

Hydroperla crosbyi

- Published county records (11)
- New county records (4)

Hydroperla fugitans

- Published county records (1)

Isoperla mohri

- New county records (11)

Isoperla coushatta

- ▲ New county records (15)

Isoperla jewetti

- ▼ New county records (1)

Isoperla sp.

- ▲ New county records (1)

Nemouridae

Amphinemura nigritta

- New county records (8)

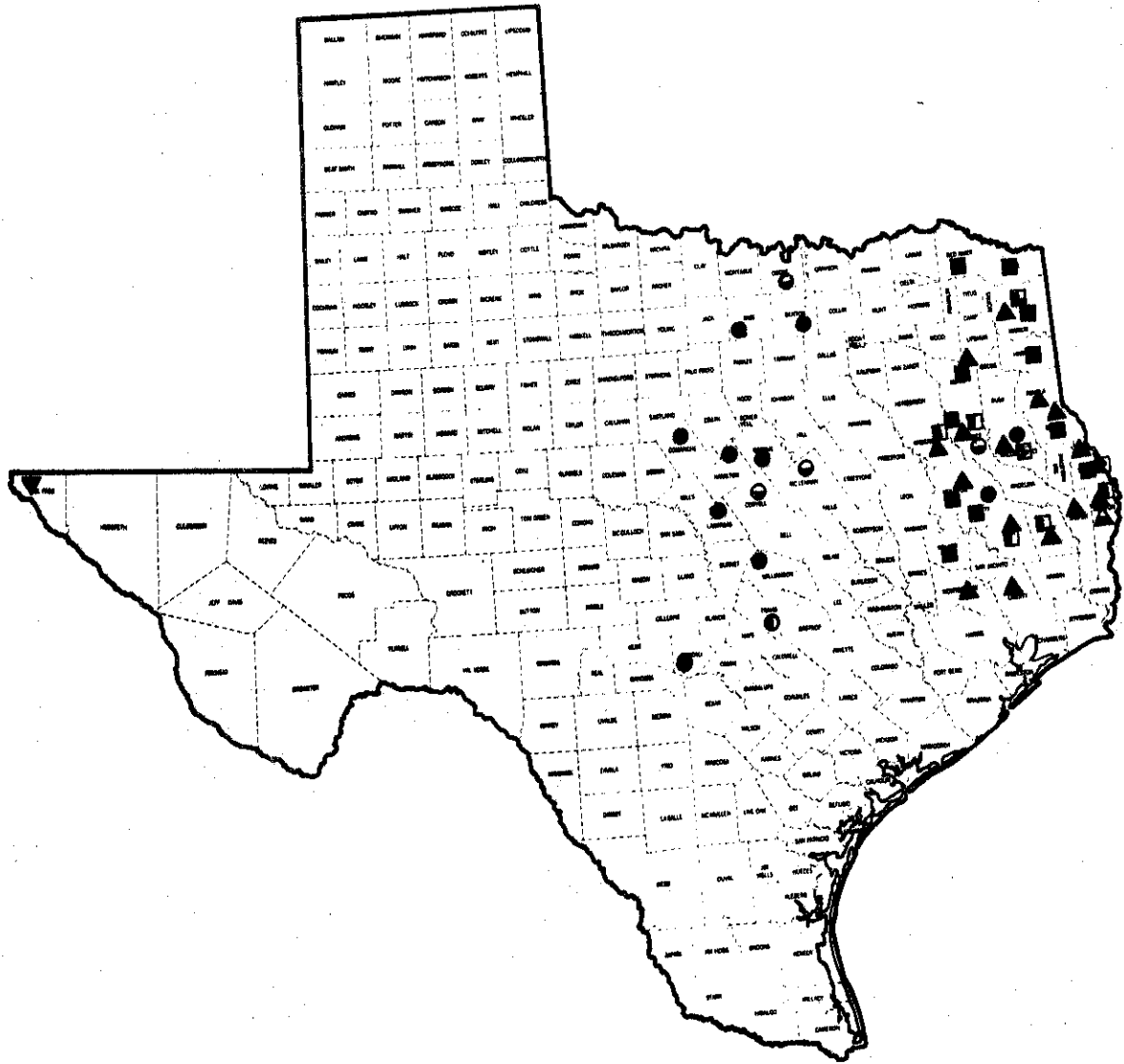


Fig. 76. Distribution of Spring-Summer Stoneflies

Perlidae

Neoperla clymene

- Published county records (14)
- New county records (5)

Paragnetina fumosa

- Published county records (2)
- New county records (1)

Acroneuria arida

- Published county records (1)

Acroneuria mela

- New county records (2)

Acroneuria arenosa

- New county records (3)

Perlesta placida

- ▲ Published county records (29)
- ▲ New county records (13)

Perlinella drymo

- ▼ Published county records (3)
- ▼ New county records (4)

Questionable Records

Four species of Plecoptera, Pteronarcys californica Newport, Hesperoperla pacifica (Banks), Acroneuria mela Frison and Phasganophora capitata (Pictet), uncovered during the study, are not included in the foregoing species list.

One vial in the insect collection of Stephen F. Austin State University contains a male Pteronarcys californica, dated 19-X-1963, from Nacogdoches County, Texas. These data indicate that this is a mislabeled specimen from some other locality. Any Pteronarcys present in East Texas would be expected to be dorsata rather than the cordilleran californica, and the normal emergence time for californica is in spring.

Stewart et al. (1974) discussed the doubtful status of Hesperoperla pacifica (Banks), listed from Texas as Acroneuria pumila Banks by Claassen (1925). The absence of pumila from Texas (among the five vials under that name) in the Cornell University collection and no mention of the Texas record in Claassen's personal manuscript and notes cast serious doubt as to its occurrence in Texas.

An African student, David Olanaran, in 1967 gave two vials of stoneflies to the North Texas State University Collection. One contained three adult males of Acroneuria mela, and the other nymphs of Phasganophora capitata. The collection locality listed was Plainview, Texas, Hale county, on the High Plains, and the collection date was December 28, 1967. It is obvious that the locality, where there are no suitable stream habitats for these two species, and the collection dates are erroneous, therefore placing these specimens in the very doubtful category as legitimate Texas records.

The literature record of Anacroneuria sp. (Needham and Broughton, 1927) and subsequent attempts to collect representatives of this central and South American genus in Texas by several workers were discussed by Stewart et al. (1974).

Seasonal Emergence

The seasonal distribution of adult stoneflies in Texas (Fig. 77) presents an interesting pattern. Only the widely distributed hardy species, Perlesta placida and Neoperla clymene extend their emergence from early spring into the generally hot and dry months of July and August. N. clymene inhabits larger, permanent rivers and P. placida

appears to undergo an egg or early nymphal aestivation during this unfavorable period.

There do not appear to be any true autumnal-emerging stoneflies in Texas. Two species of Zealeuctra, arnoldi and hitei, begin emerging in late November and continue through the winter until late March-April. Zealeuctra claasseni adults appear in late November and are gone by late January. Other winter emerging species, primarily occurring in January and February, include all five Taeniopteryx, Mesocapnia frisoni, and the two Allocaepnia.

Truly spring-emerging species include Amphinemura nigritta, Hydroperla crosbyi, the three species of Isoperla and Perlinella drymo (Fig. 77). Their appearance corresponds generally with the setting of deciduous hardwood leaves and blooming of such plants as the flowering dogwood. These events begin in early March in southern Texas and in late March in northern parts of the state.

Acroneuria arenosa and Acroneuria mela begin emerging in May and continue into June.

Fig. 77. Seasonal Distribution of Adult Plecoptera in Texas.

CHAPTER IV

SUMMARY

1. There are currently twenty-seven known stonefly species occurring in Texas, including Anacroneuria sp. Two species, Mesocapnia frisoni (Baumann and Gaufin) and Isoperla jewetti New Species, are western in origin, and at least three others, Taeniopteryx starki Stewart and Szczytko, Zealeuctra arnoldi Ricker and Ross and Zealeuctra hitei Ricker and Ross are endemic to Texas. Two others, Isoperla jewetti New Species and Isoperla couchatta New Species are at present known only from Texas. The remaining nineteen species (excluding Anacroneuria) are typically eastern species.
2. Based on morphology of the male aedeagus, brachypterous wings of males, male paraprocts and egg size, a series of Isoperla collected by H. H. and J. A. Ross in 1939 near El Paso and "reluctantly" identified by T. H. Frison (1942) as Isoperla longiseta is named a new species, Isoperla jewetti, in honor of plecopterist Stanley G. Jewett. Descriptions of adult males and females, and the exuviae are made and illustrations of diagnostic characteristics presented.

3. A new species, Isoperla coushatta, was discovered from East Texas and reared, and all life stages except the egg were described. The nymph and diagnostic male and female characters are illustrated.
4. Corrections of previous stonefly records for Texas are made. The previously listed Amphinemoura delosa, Acroneuria lycorias, and Isoperla namata are not apparently present in Texas and new state records include Amphinemoura nigritta (possibly an undescribed species), Acroneuria arenosa, Acroneuria mela, and the two new species of Isoperla described in this paper.
5. An illustrated key to the adults, and known nymphs of Texas Plecoptera is provided. Species accounts, including geographic distribution within Texas and biological notes, are given.
6. Emergence of stoneflies in Texas occurs mostly in the late fall, winter, and spring. Except for Perlesta placida and Neoperla clymene there is a conspicuous absence of summer-emerging and autumn-emerging species.

LITERATURE CITED

- Banks, N. 1895. New Neuropteroid insects. Trans. Amer. Entomol. Soc., Philadelphia, 22:313-316.
- Banks, N. 1897. Perlidae In: New North American Neuropteroid Insects. Trans. Amer. Entomol. Soc. 24:21-22.
- Banks, N. 1898. Perlidae In: Descriptions of new North American Neuropteroid insects. Trans. Amer. Entomol. Soc. 25:199-200.
- Banks, N. 1900a. New genera and species of Nearctic Neuropteroid Insects. Trans. Amer. Entomol. Soc. Philadelphia, 26:239 bis 259.
- Banks, N. 1902. Notes and descriptions of Perlidae. Canol. Entomol., Toronto U. London, 34:123-125.
- Banks, N. 1905c. New genera and species of Perlidae. Psyche J. Entomol., Cambridge (Mass.), 12: 55-57.
- Banks, N. 1906a. Descriptions of new nearctic Neuropteroid insects. Trans. Amer. Entomol. Soc. 32:1-20.
- Banks, N. 1914a. Perlidae. In: New Neuropteroid insects, native and exotic. Proc. Acad. Natur. Sci., Philadelphia, 66:608-611.
- Banks, N. 1920. Perlidae In: New Neuropteroid insects. Bull. Harvard Coll. Mus. Comp. Zool., Cambridge (Mass.), 64:314-325.
- Banks, N. 1948. Notes on Perlidae. Psyche. J. Entomol., Cambridge (Mass.), 55:113-130.
- Baumann, R. W. & A. R. Gaufin. 1970. The Capnia projecta complex of western North America (Plecoptera: Capnidae). Trans. Amer. Entomol. Soc. 96:435-468.

- Baumann, R. W. and A. R. Gaufin. 1972. The Amphinemura venusta complex of Western North America (Plecoptera: Nemouridae). Natur. Hist. Mus. Los Angeles Co. Contrib. Sci. 226:1-16.
- Bell, H. L. and A. V. Nebeker. 1969. Preliminary studies on the tolerance of aquatic insects to low pH. J. Kans. Entomol. Soc. 41:413-418.
- Brinck, P. 1949b. Studies on Swedish Stoneflies (Plecoptera) Opusc. Ent., Suppl., Lund, 10:177-183.
- Claassen, P. W. 1924. New species of North American Capniidae (Plecoptera). Canad. Entomol., Toronto u. London.
- Claassen, P. W. 1928. Additions and corrections to the monograph on the Plecoptera of North America. Ann. Entomol. Soc. Amer., Columbus (Ohio), 21:667-668.
- Claassen, P. W. 1931. Plecoptera nymphs of America (north of Mexico). Thomas Say Found. of Entomol. Soc. Amer. 3:199 pp.
- Claassen, P. W. 1940. A catalogue of the Plecoptera of the world. Mem. Cornell Univ. Agri. Exp. Sta., Ithaca (N. Y.), 232:1-235.
- Frison, T. 1929. Fall and winter stoneflies or Plecoptera of Illinois. Ill. Nat. Hist. Surv. Bull. 18:343-409.
- Frison, T. 1935. The stoneflies or Plecoptera of Illinois. Ill. Nat. Hist. Surv. Bull. 20(4):281-471.
- Frison, T. 1942. Studies on the North American Plecoptera with special reference to the fauna of Illinois. Ill. Nat. Hist. Surv. Bull. 22(2):233-235.
- Gaufin, A. R. 1956. An annotated list of the stoneflies of Ohio (Plecoptera). Ohio J. Sci., Columbus, 56:321-324.
- Gaufin, A. R. 1958. The effects of pollution on a midwestern stream. Ohio J. Sci. 58:197-208.

- Gaufin, A. R. and S. G. Jewett, Jr. 1962. New Capnias from Utah (Plecoptera). Wasman Jour. Biol. 20(1): 69-71.
- Gaufin, A. R. 1964. Systematic list of Plecoptera of the intermountain region. Proc. Utah Acad. Sci. Arts and Letters, 41(2):221-227.
- Gaufin, A. R., A. V. Nebeker and J. Sessions. 1966. The stoneflies (Plecoptera) of Utah. Univ. of Utah Biol. Ser. 14(1):1-93.
- Hagen, H. A. 1861. Synopsis of the Neuroptera of North America. 1-347.
- Hanson, J. 1941b. Records and descriptions of North American Plecoptera Pt. I. Species of Leuctra of the eastern United States. Amer. Midl. Natur. Notre Dame (Indiana). 26:14-178.
- Hanson, J. F. 1946. Comparative morphology and taxonomy of the Capniidae (Plecoptera). Amer. Midl. Natur. Notre Dame (Indiana), 35:193-249.
- Harden, P. H. and C. E. Mickel. 1952. The stoneflies of Minnesota (Plecoptera). Tech. Bull. Univ. Minn., Minneapolis, 201:1-82.
- Harper, P. P. 1973. Emergence, reproduction, and growth of setipalpiian Plecoptera in southern Ontario. Oikos 24:94-107. Copenhagen.
- Harper, P. P. and E. Magnin. 1969. Cycles vitaux de quelques Plécoptères des laurentides (insects). Can. J. Zool. Ottawa 47:483-494.
- Harper, P. P. and H. B. N. Hynes. 1971 b. The Capniidae of Eastern Canada (Insecta; Plecoptera) Can. J. Zool. 49(6):921-940.
- Harper, P. P. and H. B. N. Hynes 1970. Diapause in the nymphs of Canadian winter stoneflies. Ecology 51: 925-927.
- Harper, P. P. and H. B. N. Hynes. 1971 c. The nymphs of

- the Taeniopterygidae of eastern Canada. Can. J. Zool. 49:(6):941-947.
- Harper, P. P. and H. B. N. Hynes. 1972. Life-histories of Capniidae and Taeniopterygidae (Plecoptera) in Southern Ontario. Arch. Hydrobiol., Suppl. 40: 274-314.
- Hitchcock. S. W. 1974. Guide to the insects of Connecticut. Pt. VII. The Plecoptera or stoneflies of Connecticut. State Geological and Natur. Hist. Sur. of Conn., Dept. of Envir. Prot. Bull. 107:1-262.
- Hilsenhoff, W. L. 1970. Key to Genera of Wisconsin Plecoptera (Stonefly) Nymphs Ephemeroptera (Mayfly) Nymphs, Trichoptera (Caddisfly) Larvae. Dept. of Natur. Resources Res. Rep. 67:1-68.
- Hilsenhoff, W. L. and S. J. Billmyer. 1973. Perlodidae (Plecoptera) of Wisconsin Grt. Lakes Entomol. 6(1): 1-14.
- Holdsworth, R. D. Jr. 1941b. Additional information and a correction concerning the growth of Pternarcys proteus. Newman (Pternoarcidae: Plecoptera). Ann. Entomol. Soc. Amer. 34:714-715.
- Hynes, H. B. N. 1941. The taxonomy and ecology of the nymphs of Britain Plecoptera with notes on the adults and eggs. Trans. R. Entomol. Soc., London, Vol. 91, Pt. 10, London.
- Hynes, H. B. N. 1970. The Ecology of Running Waters. University of Toronto Press. Great Britain. 1-555.
- Hynes, H. B. N. 1961a. The invertebrate fauna of a Welsh mountain stream. Arch. Hydrobiol. 57:344-88.

- Illies, J. 1966. Katalog der rezenten Plecoptera. Das Tierreich, Berlin 82: I-XXX; 1-632.
- Jewett, S. G. 1956. Plecoptera in aquatic insects of California by Usinger, etc. al., pp. 155-181. Univ. of Calif. Press.
- Jewett, S. G. 1960b. The stoneflies (Plecoptera) of California. Bull Calif. Ins. Surv., Berkeley and Los Angeles, 6:125-177.
- Jewett, S. G. 1963a. A stonefly aquatic in the adult stage. Science (Wash., D. C.), 139:484-485.
- Jewett, S. G. 1965. Four new stoneflies from California and Oregon. Pan. Pac. Entomol. 41:5-9.
- Khoo, S. G. 1968a. Experimental studies on diapause in Stoneflies, I. Nymphs of Capnia bifrons (Newman). Pro. R. Entomol. Soc., London, (A)43:40-48.
- Khoo, S. G. 1968c. III. Eggs of Brachyptera risi (Morton). Pro. R. Entomol. Soc., London, Ser. A. Ges. Entomol. 43:141-146.
- Klapálek, F. 1907f. Japonské druhy podčeledi Perlinae-Rozpravy České Akad., Praha, (2):1631:1-28.
- Klapálek, F. 1909a. Revision der gattung Acroneuria. Pict. Bull. Inter. Acad., des Sci. de L'Empereur Francios Joseph I, XIV. Anne, November, pp. 234-247. 10 figs.
- Klapalek, F. 1921. Plécoptères nouveaux. Anne. Soc. Entomol. Beligique, Bruxeles, 61:57 bis 67, 146-160, 320, 327.
- Klapalek, F. (1923b): Plécoptères nouveaux - Ann. Soc. Entomol. Belgique, Bruxelles, 63:21-29.
- Maki, A. E., K. W. Stewart and J. K. G. Silvey. The Effects of Dibrom on Respiratory Activity of the Stonefly,

- Hydroperla crosbyi, Hellgrammite, Cordalus Cornutus and in the Golden Shiner, Notemigonus crysoleucas.
Trans. Amer. Fish. Soc. 102(4):806-815.
- McLellan, I. 1967. New gripopterygids (Plecoptera) of New Zealand. Trans. R. Soc. (N. Z.), 9:1-15.
- McLellan, I. 1968. A revision of the genus Notonemura (Plecoptera: Notonemourinae). Trans. R. Soc. (N. Z.), 10:133-140.
- Miller, A. 1939. The egg and early development of the stonefly Pteronarcys proteus. Newman (Plecoptera).
- Nebeker, A. V. and A. R. Gaufin. 1967a. Geographic and seasonal distribution of the family Capniidae of western North America (Plecoptera). Jour. Kan. Entomol. Soc. 40(3):415-421.
- Nebeker, A. V. and A. R. Gaufin. 1968. The winter stoneflies of the Rocky Mountains (Plecoptera Capniidae). Trans. Amer. Entomol. Soc. 99:1-24.
- Nebeker, A. V. and A. E. Lemke. 1968. Preliminary studies on the tolerance of aquatic insects to treated waters. J. Kans. Entomol. Soc. 41:413-418.
- Needham, J. G. 1905. New genera and species of Perlidae. Proc. Biol. Soc. Washington, 18:107-110.
- Needham, J. G. and E. Broughton, 1927. Central American stoneflies, with descriptions of new species (Plecoptera) J. New York Entomol. Soc., 35:109-120.
- Needham, J. G. and P. W. Claassen. 1925. A monograph of the Plecoptera or stoneflies of America north of Mexico. Entomol. Soc. Amer., Thomas Say Found., Lafayette (Indiana), 2:1-397.
- Newman, E. 1839. On the synonymy of Perlites, together with brief characters of the old and of a few new species. Ann. Mag. Nat. Hist., London (2)3:32-37, 84-90.
- Pictet, F. J. 1841a. Histoire naturelle générale et particulière des insectes Névroptères. Famille des

- Perlidaes, I Partie 1-423, Kessmann Geneve.
- Provancher, L. 1876b. Petite faune entomologique du Canada les Néuroptères. Naturaliste Canad., Quebec, 8:177-191, 209-218.
- Rambur, J. P. 1842. Tribu des Perlides in: histoire naturelle des insectes. Névroptères, 449-462. Roret, Paris.
- Raušer, J. 1968. 67. Plecoptera. Ergebnisse der zoologischen Forschungen von Dr. Z. Kaszab in der Mongolei. Entomol. Abh. Mus. Tierk. Dresden, 34 5:329-398.
- Retzius, A. J. 1783. Caroli de Geer genera et species insectorum 1-220. Cruse, Lipsiae.
- Richardson, J. W. and A. R. Gaufin. 1971. Food habits of some western stonefly nymphs. Trans. Amer. Entomol. Soc. (97):91-121.
- Ricker, W. E. 1938a. Notes on specimens of American Plecoptera in European collections. Trans. R. Canad. Inst., Toronto, 22:129-156.
- Ricker, W. E. 1943. Stoneflies of Southwestern British Columbia. Indiana Univ. Publ. Sci. Ser., Bloomington, 12:1-145.
- Ricker, W. E. 1945. A first list of Indiana stoneflies (Plecoptera). Proc. Indiana Acad. Sci., Brookville, 54:225-230.
- Ricker, W. E. 1946. Some prairie stoneflies (Plecoptera) Trans. R. Canad. Inst., Toronto, 26:3-8.
- Ricker, W. E. 1949. The North American species of Paragnetina (Plecoptera, Perlidae). Ann. Entomol. Soc. Amer. Columbus (Ohio), 43:279-288.
- Ricker, W. E. 1952. Systematic studies in Plecoptera. Ind. Univ. Publ. Sci. Ser. 18:1-200.
- Ricker, W. E. 1964. Distribution of Canadian stoneflies. Gewasser u. Abwasser, Dusseldorf, 34/35:50-71.

- Ricker, W. W. and H. H. Ross. 1968. North American Species of Taeniopteryx (Plecoptera, insecta). J. Fish Res. Bd. Canada, Ottawa, 25-7:1423-1439.
- Ricker, W. E. and H. H. Ross. 1969. The genus Zealeuctra and its position in the family Leuctridae (Plecoptera, Insecta). Canad. J. Zool., 47(6):1113-1127.
- Ris, F. 1902. Die schweizerischen Arten der Perliden-Gattung Nemoura. Mitt. Schweiz. Entomol. Ges., Lausanne. 10 (1897 bis 1903):378-405, 432.
- Ross, H. H. 1964. New species of winter stoneflies of the genus Allocapnia (Plecoptera, Capniidae). Entomol. News. Philadelphia, 75:169-177.
- Ross, H. H. and W. E. Ricker. 1971. The classification, evolution and dispersal of the winter stonefly genus Allocapnia. Ill. Biol. Monogr. Urbana., 45:1-166.
- Ross, H. and Yamamoto. 1967. Variations in the winter stonefly Allocapnia granulata as indicators of Pleistocene faunal movements. Ann. Entomol. Soc. Am. 60:447-458.
- Schwarz, P., 1970. Autökologische Untersuchungen zum Lebenszyklus von Setipalpia-Arten (Plecoptera). Arch. Hydrobiol., 67:103-172.
- Schoenemund, E. 1912a. Zur Biologie and Morphologie einiger Perla-Arten. Zool. Jb., Anat., Munster, 34: 1-56.
- Smith, L. 1913. The biology of Perla immarginata. Say. Ann. Entomol. Soc. Amer. 6:203-211.
- Stewart, K. W., G. L. Atmar and B. M. Solon. 1969. Reproduction Morphology and mating behavior of Perlesta placida (Plecoptera, Perlidae). Ann. Entomol. Soc. Amer., Philadelphia, 62(6):1433-1438.
- Stewart, K. W. and S. W. Szcztko 1974. A new species of Taeniopteryx from Texas (Plecoptera; Taeniopterygidae). J. Kan. Entomol. Soc. (47) 4:451-458.
- Stewart, K. W. R. W. Baumann, and B. P. Stark. 1974.

The Distribution and Past Dispersal of Southwestern United States Plecoptera. Trans. Amer. Entomol. Soc. 99:507-546.

Vaught, G. L. and K. W. Stewart. 1974. The life history and ecology of the stonefly Neoperla clymene. Ann. Entomol. Soc. Amer. (67):2:167-178.

Wü, Ch. F. 1923. Morphology, anatomy and ethology of Nemoura. Bull. Lloyd Library. Bull. Mo. 23, Entomol. Ser. No. 3.

Walker, F. 1852. Perliades in: catalogue of the specimens of Neuropterous insects in the collection of the British Museum. Part I. (Phryganides - Perlides): 136 bis 192, London.

Walker, J. N. 1947. List of the stoneflies (Plecoptera) known to occur in southeastern Ohio. Ohio J. Sci. Columbus, 47(3):134-136.

Walsh, B. N. 1862. Perla In: list of the Pseudoneuroptera of Illinois, etc., Proc. Acad. Nat. Sci. Philadelphia, 1862:363-367.

Wisley, B. 1953. Two wingless alpine stoneflies (order Plecoptera) from southern New Zealand. Bull. Rec. Cant. Mus. Christchurch 6:219-231.

Zwick, P. 1971. Notes on the genus Perlinella and a generic synonymy in North American Perlidae (Plecoptera). Florida Entomologist, Gainesville, 54(4):315-320.

Zwick, P. 1973. Insecta: Plecoptera Phylogenetisches System und Katalog. Das Tierreich, Berlin 94:I-XXXII; 1-465.