Stewart, K.W. 2009. New descriptions of North American *Taenionema* larvae (Plecoptera: Taeniopterygidae). *Illiesia*, 5(12):128-145. Available online: http://www2.pms-lj.si/illiesia/papers/Illiesia05-12.pdf

NEW DESCRIPTIONS OF NORTH AMERICAN *TAENIONEMA* LARVAE (PLECOPTERA: TAENIOPTERYGIDAE)

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ABSTRACT

The larvae of *Taenionema* have been poorly known, with only partial written descriptions and illustrations available for *Taenionema kincaidi* (Hoppe) and *Taenionema pallidum* (Banks), prior to the detailed description of *Taenionema pacificum* (Banks). Larvae of all 13 North American species were associated beginning in 1983, and comparatively studied to test the proposed generic characters, and to determine if they could be separated with external morphological characters. An expanded generic diagnosis, 112 comparative illustrations, and a provisional key to the 13 species are presented. Separation of larvae to species with the key requires a combination of characters of the 9th sternum of males and females, geographic distribution, and the few other species-specific characters.

Keywords: Plecoptera, Taeniopterygidae, *Taenionema*, larvae

INTRODUCTION

The groundwork for studies to increase taxonomic resolution of North American stonefly larvae to the species level was laid by the generic treatments of Stewart & Stark (1988, 2002). They brought together knowledge of the biology, morphology and taxonomy of larvae, provided illustrated keys and diagnoses of the 104 genera, and proposed generic characters based largely on larvae of generotypes and additional correlated species. Species level resolution of stonefly and other insect immatures benefits all aspects of knowledge of their biology, particularly studies of comparative life histories and ecology, and also provides added resolution for their use in biomonitoring.

Zwick (2004) pointed out that although adult stonefly taxonomy is generally well advanced, larvae are little known, and that since many adults can be identified to species only by genital characters, less taxonomic resolution can be anticipated in the further study of immatures. For this reason, the ultimate goal to develop diagnostic illustrated keys to larvae of all species in some stonefly genera may prove to be problematic. This is particularly true in speciose genera such as *Capnia* and *Allocapnia* (Capniidae) and others whose larvae have been little associated, therefore have not been comparatively studied, and are generally known to have few distinctive features and absence of distinctive pigment patterns. In such large genera, the time and resource consuming effort required to rear or otherwise associate larvae for comparative study is monumental (Stewart & Drake 2007), and suggests that initial research efforts might best be directed to regionally defined species within genera that offer a workable sized group. Stark & Lacey (2005) targeted four common *Allocapnia* species in Mississippi for association, and provided descriptions and a

provisional key for them. Similar regionally defined advances have been made made for larvae of western *Isoperla* (Szczytko & Stewart 1979, 2002, 2004, Bottorff et al. 1990), and *Acroneuria, Neoperla* and *Perlesta* (Poulton & Stewart 1991). Some degree of species separation of larvae of smaller genera in North America has been achieved for *Taeniopteryx* (Fullington & Stewart 1980), *Setvena* (Stewart & Stanger 1985), *Isogenoides* (Sandberg & Stewart 2005), and *Strophopteryx* (Earle & Stewart 2008). Other detailed descriptions of larvae since Stewart & Stark (1988, 2002) have been for individual or small numbers of species within genera such as *Megaleuctra* (Stewart & Sandberg 2004), *Sweltsa* (Stark & Stewart 2005), *Calileuctra* and *Haploperla* (Stewart & Drake 2007) and *Malenka, Ostrocerca,* and *Soyedina* (Stewart & Anderson 2008).

This study began in 1983, with my first attempts to collect and rear mature *Taenionema* larvae in California and Oregon, and with the help of colleagues to assemble associated individuals of all North American species for eventual comparative study to determine if they could be separated to species with external morphological characters. An additional, more recent objective, has been to further test the generic characters proposed by Stewart & Stark (1988, 2002) based on their examination of 6 of the then 13 North American species.

Fourteen species are currently placed in genus *Taenionema*; 13 distributed in North America: *Taenionema atlanticum* Ricker & Ross, *Taenionema californicum* (Needham & Claassen), *Taenionema grinelli* (Banks), *Taenionema jacobii* Stanger & Baumann, *Taenionema jeanae* Baumann & Nelson, *Taenionema jewetti* Stanger & Baumann, *Taenionema kincaidi* (Hoppe), *Taenionema oregonense* (Needham & Claassen), *Taenionema pacificum* (Banks), *Taenionema pallidum* (Banks), *Taenionema raynorium* (Claassen), *Taenionema uinta* Stanger & Baumann, *Taenionema umatilla* Stanger & Baumann, and one eastern Palearctic species: *Taenionema japonicum* (Okamoto). A revision and key to adults of 12 of the North American species and *T. japonicum* was provided by Stanger & Baumann (1993), and adults of the additional species, *T. jeanae,* were described by Baumann & Nelson (2007).

The larvae of *Taenionema* have been poorly known, with only partial written descriptions and illustrations available for *T. kincaidi* and *T. pallidum* by Ricker (1943) prior to the detailed description and illustration of *T. pacificum* by Stewart & Stark (1988, 2002).

MATERIAL AND METHODS

Association of larvae with adults of one or more geographic populations was achieved by me or colleagues with at least one of the following methods: (1) rearing in the field or laboratory, (2) field collection of larvae, their exuviae, and adults where no congeners are known from repeated collections of the stream, (3) series containing phaerate, pre-emergent males with diagnostic underlying genitalia and associated late instar male and female larvae, and (4) partially emerged adults with attached larval exuviae.

Reared larvae were collected as pre-emergent individuals and transported in stream water in styrafoam containers kept cool in ice chests containing ice. Some individuals emerged during transport and others were reared in a laboratory stream at temperatures gradually increased from those of home streams at time of collection. Associated field collected specimens and successfully reared individual males and females with their exuviae were preserved in 80% ETOH. The variously associated specimens were studied under a Wild M-5 stereomicroscope, and habitus and specific character drawings made with aid of a Wild Drawing Attachment. Drawings were made by Jean Stanger-Leavitt and me. Scanning electron micrographs of *T. jeanae* mouthparts were taken by Bill Stark of Mississippi College using the procedures outlined by Stark & Stewart (2005).

RESULTS AND DISCUSSION

Generic Diagnosis of Larvae of *Taenionema* Banks

Following is an expanded and updated generic description of the morphology of North American *Taenionema* larvae, from that of Stewart & Stark (2002), using character illustrations of all species from this study. Their proposed diagnostic characters of a combination of brown body color with darker brown mottlings on head and thorax and lack of silky cercal fringe hairs, for separating *Taenionema* from larvae of other taeniopterygid genera are upheld.

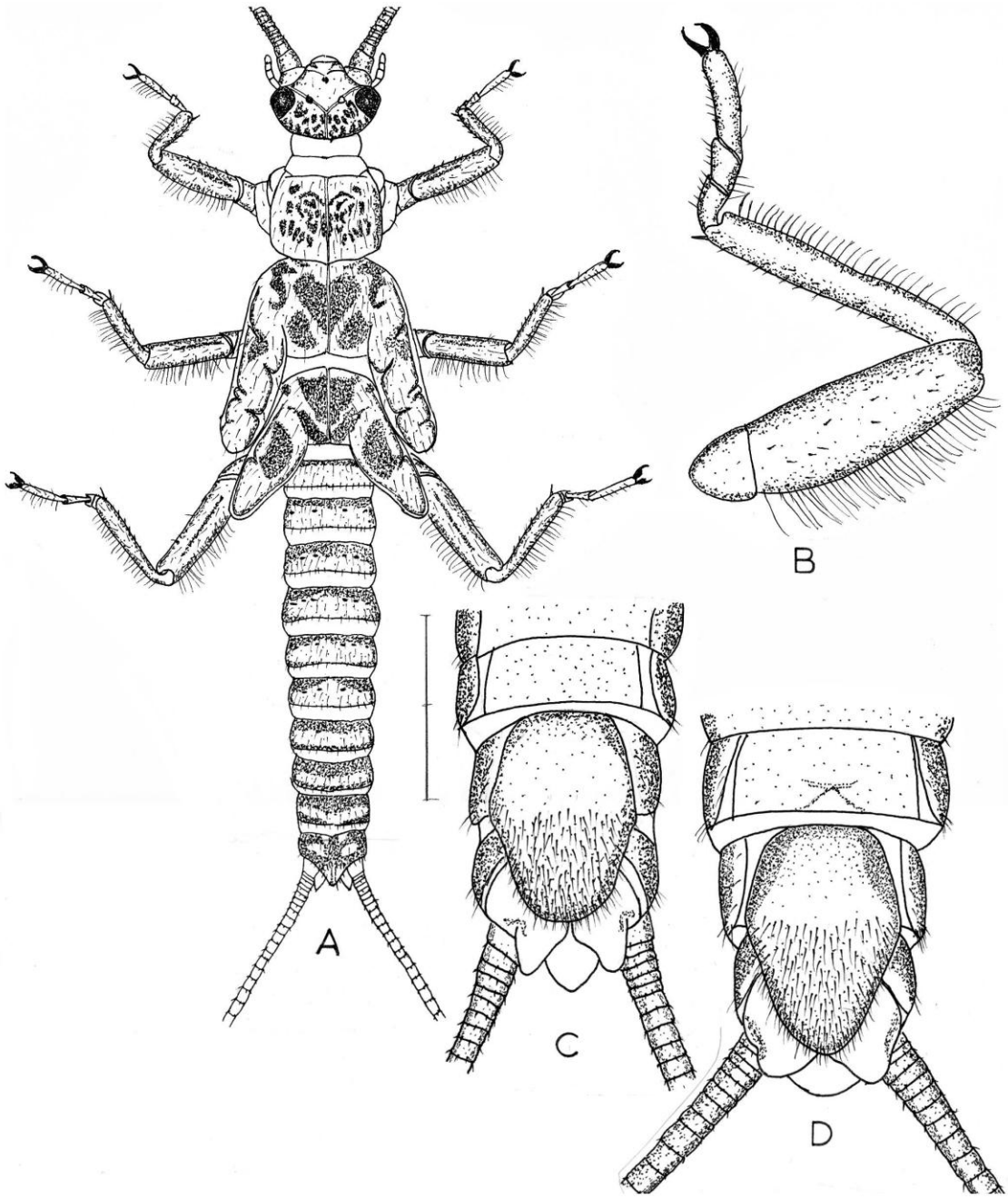
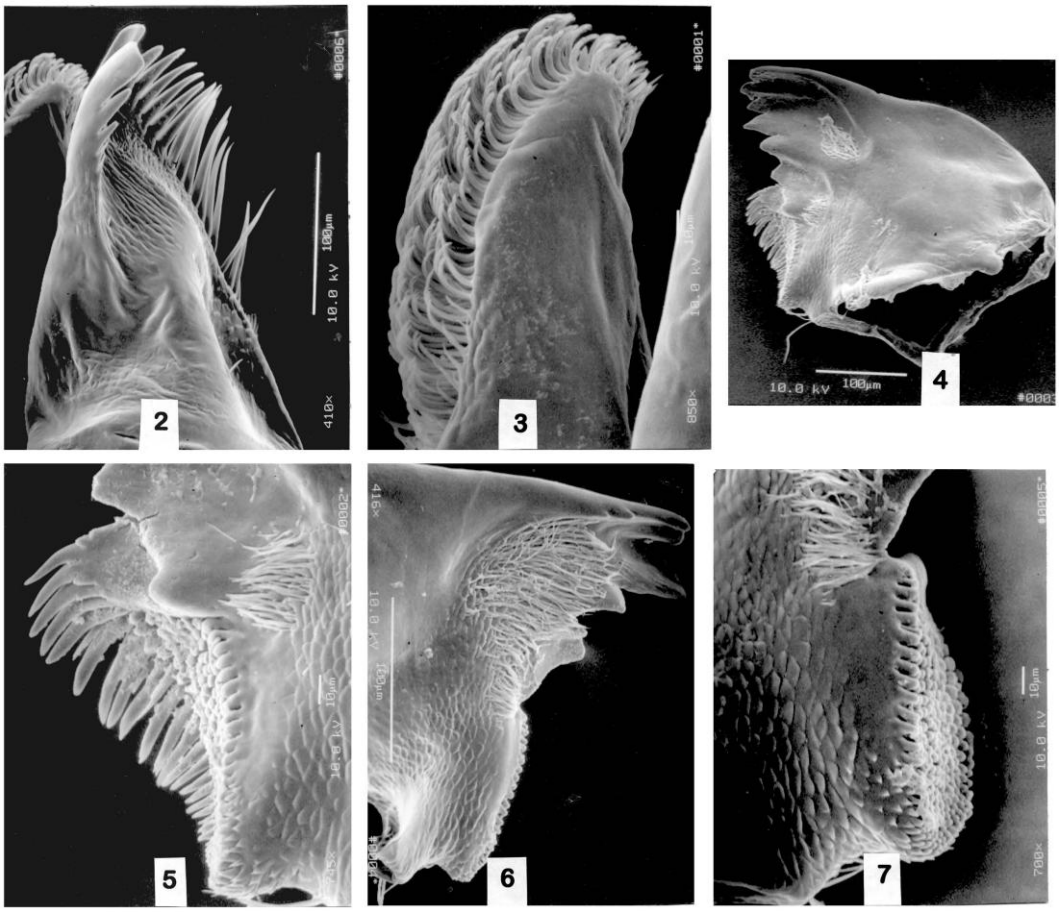


Fig. 1 A-D. *Taenionema jeanae* larva. A. habitus, scale line =2mm. B. right front leg, dorsal. C. male terminalia, ventral. D. female terminalia, ventral.

Larval morphology. Body length 7-11 mm, brown with darker mottlings on head and thorax (Figs. 1A, 8-16). Antennae with 60-74 segments, each with very short apical circlet of hairs or sensillae. Galea with outer, apical surface covered with strongly curved, thick, sharply pointed comblike teeth (Figs. 3, 25-32). (This patch of comblike teeth is similar to that on the galea of *Doddsia*, Fig. 5.4E, Stewart & Stark 2002). Lacinia typical of family, triangular, palmate, with broad apical teeth, well developed ventral comb of

about 5 teeth of decreasing length, and long dorsal comb of about 16-18 teeth; palm mostly devoid of hairs and with a shallow scalloped or striated surface (Fig. 2). Mandibles with unserrated major large apical teeth; left mandible with an outer row of about 20 long, slender, sharp pointed teeth (Figs. 4, 5), and both mandibles with a tuft of bristles at base of apical teeth, and molar area of a dense pad of pegs (Figs. 4-7) (This molar area, drawn from a side profile view of SEM's by Stewart & Stark 1988, 2002, was misinterpreted as a "molar or scraping ridge"; the peg arrangement is also similar in *Doddsia* , Fig. 5.4B of Stewart & Stark 1988, 2002). Head surface with few hairs, except single or pairs near base of antennae and behind eyes (Figs. 17-24). Wingpads divergent and macropterous (Fig. 34), except in *T. uinta* males that are micropterous (Fig. 33). Sides of thorax with few hairs (Figs. 35-39). Legs with continuous dorsal fringe of silky hairs on femur and tibia, usually sparse on tarsus, and with scattered short bristles over dorsal surface (Figs. 1A, B, 46-55). Mesosternal Y-ridge with well developed transverse ridge (Figs. 40-45.) Abdominal terga mostly brown, sometimes darker anteriorly and with a transverse row of indistinct small spots (Fig. 1A). Male abdominal apex (with partially developed underlying epiproct) produced in dorsal and lateral views (Figs. 57-65, 68-75). Male 9th sternal plate in most species more broadly triangulate (Figs. 87-99) than their females (Figs. 100-112), and paraprocts of males (Figs. 87-99) more apically acute than in females (Figs. 100-112). Female 8th sternum variously manifesting the developing genital area surrounding the ovipore (Figs. 100-112). Cerci with 45-58 segments, devoid of silky fringe hairs, and segments with very short apical circlet of hairs or sensillae (Figs. 1A, 66-67).



Figs. 2-7. *Taenionema jeanae* larval mouthparts SEM's. 2. left lacinia, ventral. 3. right galea. 4. left mandible, ventral. 5. left mandible molar pad of pegs. 6. right mandible, ventral. 7. right mandible molar pad of pegs.

Species Accounts of Larvae

The following accounts include: (1) known distribution, (2) larval, exuvia and adult material examined and method of correlation, and (3) description of characters that offer potential specific diagnosis. Particular attention was given to observed differences in the 9th sternum of male and female larvae, and characters not addressed in the generic description of Stewart & Stark (2002). The descriptions and referenced illustrations are based on typical individuals of the single or few populations that were successfully correlated and studied; therefore, they do not address possible variation of characters.

Taenionema atlanticum Ricker & Ross
(Figs. 8, 17, 25, 46, 57, 68, 78, 87, 100)

Distribution. East of the 90th Meridian (Atlantic Canada southward to Tennessee and the Carolinas).

Material examined. New Hampshire: Strafford Co., Mad River, 2 km southwest of Farmington, 20-IV-2008, D.S. Chandler, ♂ and ♀ larvae. West Virginia: Mingo Co., Laurel Creek Public Hunting Area, Laurel Fork of Pigeon Creek, 3.2 km south of Dingess, CR 317, 2-III-1976, R.F. Kirchner, 4♂, 4♀, ♂ and ♀ exuviae.

Characters. Color, pigmentation (Fig. 8), maxillae (Fig. 25), body, leg (Fig. 46) and cercal setation, and sexual dimorphism (Figs. 57, 68, 78) generally typical of genus. Body length ♂ 7 mm, ♀ 8 mm. Antennal segments approximately 64. Cercal segments ♂ 44-48, ♀ 50-54. Male 9th sternum (Fig. 87) ovate behind greatest width, with posterolateral sides convex and apex narrowly rounded; anterior portion ovate with sinuate sides. Female 9th sternum (Fig. 100) narrower than ♂ posteriorly, with less convex sides and anterior portion broadly triangulate with straight sides.

Taenionema californicum (Needham & Claassen)
(Figs. 69, 88, 101)

Distribution. California.

Material examined. California: Alameda Co., Arroyo Mocho Creek, south of Livermore, 19-III-1985, R.W. Baumann & C.R. Nelson, 2♂ and 2♀ larvae, 20+ additional larvae, 26♂ and 34♀ (field correlated; no congeners collected this locality this date or previously).

Characters. Color, pigmentation, maxillae, body, leg and cercal setation, and sexual dimorphism generally typical of genus. Body length ♂ 8-8.5 mm, ♀ 9.5-10 mm. Antennal segments approximately 65. Cercal segments (broken- no count). Both ♂ and ♀ 9th sterna (Figs. 88, 101) triangulate behind greatest width, with posterolateral sides slightly convex and apex narrowly rounded; anterior portion triangulate with straight sides.

Taenionema grinelli (Banks)
(Figs. 9, 19, 26, 40, 47, 58, 70, 79, 89, 102)

Distribution. California.

Material examined. California: Los Angeles Co., Placerita Canyon Creek, Placerita State Park, 21-I-1985, R.W. Baumann & K. Dobry, ♂ and ♀ larvae (no adults were collected at the same time in this intermittent, seasonal creek, but a male and female were collected here 24-IV- 1980, and it is unlikely that congeners are present); 1 vial of S.G. Jewett, Jr. collection with no locality, 1-II-1954, 5♂ larvae and 1♀ larva labeled "*Brachyptera grinelli* (Bks.)"

Characters. Color, pigmentation (Fig. 9), leg (Fig. 47) and cercal setation, and sexual dimorphism (Figs. 59, 70, 79) generally typical of genus. Body (Fig. 19) and legs (Fig. 47) with more surface hairs than other species. Body length ♂ 9mm, ♀ 10-11mm. Antennal segments 62-65. Cercal segments undetermined (broken). Male 9th sternum (Fig. 89) ovate with rounded apex. Female 9th sternum (Fig. 102) distinctively shaped, with posterolateral sides concave.

Taenionema jacobii Stanger & Baumann
(Figs. 48, 90, 103)

Distribution. Southwest; Arizona and New Mexico.

Material examined. New Mexico: Grant Co., Cherry Creek at Hwy. 255 bridge, 14-III-1984, G.Z. Jacobi & D.U. Potter, 4♂ larvae and 5♀ larvae; same data, separate vial, 3♂ larvae and 1♀ larva labeled "holotype 4 N".

Characters. Color, pigmentation, maxillae, body, leg (Fig. 48) and cercal setation, and sexual dimorphism generally typical of genus. Body small, ♂ and ♀ 6-7 mm. Antennal segments ♂ 56-60, ♀ 60-64. Cercal segments ♂ and ♀ 42-44. Male 9th sternum (Fig. 90) broadly triangulate behind greatest width, with broadly rounded apex; anterior portion broadly triangulate with straight sides. Female 9th sternum (Fig. 103) narrowly triangulate behind greatest width, with nearly straight posterolateral sides and anterior portion with slightly convex sides.

Taenionema jeanae Baumann & Nelson
(Figs. 1A-D, 2-7, 49, 91, 104)

Distribution. California.

Material examined. California: Orange Co. Silverado Creek in Silverado Canyon, at gravel low water crossing, 100 m above USFS gate, N 33° 45′ W 117° 35′ (paratype locality; Baumann & Nelson 2007), 6-IV-2004, K.W. Stewart & E.F. Drake, 2 larvae; 9-II-2005, 1♂, 1♀, E.F. Drake; 10-III-2005 and 25-III-2005, 66♂ 22♀, 32 larvae, E.F. Drake; 4-IV-2005, 27♂, 28♀, 1♂ and 1♀ reared, K.W. Stewart & E.F. Drake (field correlated with no congeners and reared).

Characters. Color, pigmentation (Fig. 1A), maxillae (Figs. 2-7), body, leg (Figs. 1B, 49) and cercal setation, and sexual dimorphism generally typical of genus. Body length 9-11mm. Antennal segments ♂ 62-66, ♀ 56-60. Cercal segments ♂ 36, ♀ 38. Male 9th sternum (Figs. 1C, 91) ovate, with broadly rounded apex. Female 9th sternum (Fig. 104) broadly triangulate and narrower than male behind greatest width, with narrowly rounded apex, and anterior portion broadly triangulate with straight sides.

Taenionema jewetti Stanger & Baumann
(Figs. 18, 27, 35, 41, 50, 59, 71, 92, 105)

Distribution. Pacific Northwest; Oregon and Washington.

Material examined. Oregon: Wasco Co., Rowena Dell Creek, Hwy. 30, Mile 6 west of Rowena on Scenic Drive Road, 1-IV-1983, K.W. Stewart, 4♂ larvae, 10♀ larvae, 13♂ (4 reared), 20♀ (5 reared), 24♂ exuvia, 57♀ exuvia. (field correlated and reared).

Characters. Color, pigmentation (Fig. 10), maxillae (Fig. 27), body, leg (Fig. 50) and cercal setation, and sexual dimorphism (Figs. 59, 71) generally typical of genus. Body length ♂ 9 mm, ♀ 10-11 mm. Antennal segments ♂ 58-60. Cercal segments ♂ 44-46. Male 9th sternum triangulate behind greatest width, with nearly straight posterolateral sides and pointed apex; anterior portion broadly U-shaped with nearly straight sides. Female 9th sternum (Fig. 105) similar in shape to male.

Taenionema kincaidi (Hoppe)
(Figs. 11, 20, 28, 36, 42, 51, 80, 93, 106)

Distribution. Alaska, Pacific Northwest (California, Oregon, Washington), western Canada (British Columbia, Yukon), and Lake Tahoe area of Nevada.

Material examined. Nevada: Washoe Co., Third Creek, Hwy. 431, Incline Village, 21-IV-1987, R.W. Baumann, C.R. Nelson, & S. Wells, ♂ and ♀ larvae; 24-VI-1980, 45♂, 38♀; 29-IV-1991, 2♂, 1♀. (field correlated large population, with no congeners collected).

Characters. Color, pigmentation (Fig. 11), maxillae (Fig. 28), body, leg (Fig. 51) and cercal setation, and sexual dimorphism (Fig. 80) generally typical of genus. Body length ♂ 9-10 mm, ♀ 9-11 mm. Antennal segments approximately 64. Cercal segments ♂ 52, ♀ not determined- all broken. Male 9th sternum (Fig. 93) ovate with posterolateral sides slightly angulate; anterior portion broadly U-shaped. Female 9th sternum (Fig. 106) narrowly triangulate posteriorly behind greatest width, with posterolateral sides slightly convex and apex pointed.

Taenionema oregonense (Needham & Claassen)
(Figs. 12, 21, 29, 37, 52, 60, 72, 81, 94, 107)

Distribution. Pacific Northwest (Oregon, Washington).

Material examined. Oregon: Clatsop Co., Nehalem River, 3.2 km southeast of Elsie on Spruce Run Co. Park Road, 1-III-1985, K.W. Stewart, 1♂ larva and 1♀ larva, 13♂, 2♀ (1♂ and 1♀ reared); Clatsop Co., South Fork Quartz Creek, Hwy. 26 bridge, approximately mile 25, 31-III-1983, 2♀ larvae; Clackamas Co., Vic Firewood Road, 6.5 km west of Oregon City, 17-III-1972, S.G. Jewett Jr., 8♂, 8♀.

Characters. Color, pigmentation (Fig. 12), maxillae (Fig. 29), body, leg (Fig. 52) and cercal setation, and sexual dimorphism (Figs. 60, 72, 81) generally typical of genus. Body length 9-9.5 mm. Antennal segments broken (59+). Cercal segments broken (44+?). Male 9th sternum (Fig. 94) broadly triangulate behind greatest width and apically pointed; anterior portion narrowly U-shaped with straight sides.

Taenionema pacificum (Banks)

(Figs. 13, 22, 30, 53, 61, 73, 82, 95, 108)

Distribution. Widespread west of the 100th Meridian (Alberta, Alaska, Arizona, British Columbia, California, Colorado, Idaho, Montana, New Mexico, Oregon, Utah, Washington, Wyoming, Yukon).

Material Examined. Alaska: Chena River near Fairbanks, 4-IV- 1968, Kreizenbeck, 5♂ nymphs, 5♀ larvae; 10-III-1972, E.W. Shallock & W.M. Jinkinson, ♂ reared with exuvium and 1♂ and 4♀ larvae partially emerged with attached exuvia; 3-IV- 1972, E.W. Shallock & W.M. Jinkinson, ♂ reared with exuvium, 2♀ reared with exuvia; 11-IV-1972, E.W. Shallock W.M. Jinkinson, 29♂ larvae, 11♀ larvae, 2♂ reared with exuvia. Montana: Lincoln Co., Kootenai River, 19-III-1970, R.L. Newell, 2♂ larvae. New Mexico: Rio Arriba Co., Rio de las Vallecitos, R. Hassage, 20-III-1986, 4 reared ♂ with exuvia, 2 reared ♀ with exuvia, 1 partially emerged ♀ with exuvium attached.

Characters. Color, pigmentation (Fig. 13), maxillae (Fig. 30), body, leg (Fig. 53) and cercal setation, and sexual dimorphism (Figs. 61, 73, 82) generally typical of genus. Body length ♂ 8.5-10 mm, ♀ 9-11 mm. Antennal segments ♂ 64-68, ♀ 64-68. Cercal segments ♂ 46-58, ♀ 44-58. Male 9th sternum (Fig. 95) ovate with posterolateral sides convex and apex narrowly rounded. Female 9th sternum (Fig. 108) narrower than ♂, triangulate behind greatest width with nearly straight sides, and pointed apex.

Taenionema pallidum (Banks)

(Figs. 14, 23, 31, 38, 54, 62, 74, 83, 96, 109)

Distribution. Widespread west of the 100th Meridian (Alaska, Alberta, British Columbia, California, Colorado, Idaho, Montana, New Mexico, Nevada, Oregon, Utah, Washington, Wyoming, Yukon).

Material examined. Utah: Salt Lake Co., Mill Creek east of Salt Lake City, 11-IV-1966, R.W. Baumann, 3♂ larvae, 2♀ larvae; Mill Creek, 0.8 km above Porter Fork, 27-IV-1981, K.W. Stewart, B.P. Stark, W.D. Shepard, & D.D. Zeigler, 6♂, 3♀, 6♂ larvae, 20 ♀ larvae. Washington: Whatcom Co., North Fork of the Nooksak River, 18-IV- 1988, K.W. Stewart, 1♂ and 1♀ reared with exuvia. (I.D. confirmed by R.W. Baumann).

Characters. Color, pigmentation (Fig. 14), maxillae (Fig. 31), body, leg (Fig. 54), and cercal setation, and sexual dimorphism (Figs. 62, 74, 83) generally typical of genus. Body length ♂ 7.5-8.5 mm, ♀ 8.5-9.5 mm. Antennal segments approximately 64. Cercal segments ♂ and ♀ 52. Male 9th sternum (Fig. 96) ovate, with posterolateral sides convex and rounded apex. Female 9th sternum (Fig. 109) ovate with posterolateral sides slightly convex and narrowly rounded apex.

Taenionema raynorium (Claassen)

(Figs. 15, 24, 39, 55, 63, 75, 84, 97, 110)

Distribution. California.

Material examined. California: El Dorado Co., North Cosumnes River at Capps Crossing, 9.7 km east of Grizzly Flat, 14-IV-1980, R.L. Bottorff, 3♂ larvae, 6♀ larvae (field associated with adults from this site). Siskiyou Co., Shasta River at bridge north of Weed, 2-IV-1983, K.W. Stewart, 2♂, 1♀, 1♂ larva, 2♀ larvae (field associated also with adults collected at this locality listed in Stanger & Baumann 1993).

Characters. Color, pigmentation (Fig. 15), maxillae,

body, leg (Fig. 55) and cercal setation, and sexual dimorphism (Figs. 75, 84) generally typical of genus. Body length ♂ 9- 9.5 mm, ♀ 10-10.5 mm. Antennal segments approximately 74. Cercal segments approximately 56. Male 9th sternum (Fig. 97) broadly triangulate behind greatest width, with posterolateral sides convex; anterior portion broadly U-shaped. Female 9th sternum (Fig. 110) narrowly triangulate behind greatest width, with posterolateral sides slightly rounded and pointed apex.

Taenionema uinta Stanger & Baumann
(Figs. 16, 32, 33, 34, 45, 56, 64, 85, 99, 112)

Distribution. Colorado, Montana, Nevada, Oregon, Utah, Wyoming.

Material examined. Nevada: Eureka Co., Humbolt River at Dunphy, 12-IV-2005, B.C. Kondratieff & R.W. Baumann, 7♂, 5♀, 2♀ larvae. Utah: Wasatch Co., Provo River, Hwy 113 at Midway, 19-III-1981, J. Stanger & S. Clarke, 2 ♂ larvae and 1 ♀ larva (field correlated with many adults collected in the Provo River listed in Stanger & Baumann 1993 and brachyptery of ♂ nymph wingpads).

Characters. Color, pigmentation (Fig. 16), maxillae (Fig. 32), body, leg (Fig. 56), and cercal setation, and sexual dimorphism (Figs. 64, 85) generally typical of genus. Body length ♂ 9-10 mm, ♀ 9-10 mm. Antennal segments ♂ 62-54, ♀ 62-64. Male wingpads (Fig. 33) brachypterous, as in wings of adult, and ♀ wingpads (Fig. 34) macropterous. Cercal segments ♂ 44, ♀ 44. Male 9th sternum (Fig. 99) narrowly triangulate in posterior half with pointed apex; anterior half narrowly U-shaped. Female 9th sternum (Fig. 112) broader than ♂ in posterior half, and with rounded apex.

Taenionema umatilla Stanger & Baumann
(Figs. 65, 66, 67, 76, 77, 86, 98, 111)

Distribution. Idaho, eastern Oregon.

Material examined. Oregon: Umatilla Co., Meachum Creek, Hwy 84 bridge at Meachum (type locality), 1-IV-1983, 1♀ larva, K.W. Stewart (stream iced over); 26-IV-2004, 1♂, 1♀, 1 reared ♂ with exuvium, 2 reared ♀ with exuvia, 2♀ larvae, K.W. Stewart & B. Armitage.

Characters. Color, pigmentation, maxillae, body, leg, and cercal (Figs. 66, 67) setation, and sexual dimorphism (Figs. 65, 76, 77) generally typical of genus. Body length (♂ exuvium) 8.5 mm, ♀ 9 mm. Antennal segments 56-58. Cercal segments undetermined (broken). Male 9th sternum (Fig. 98) wide behind greatest width and broadly rounded (nearly truncate) apically. Female 9th sternum (Fig. 111) narrowly triangulate in apical half with narrowly rounded apex.

Provisional Key to Late Instar *Taenionema*

Larvae

This key is tentative, since (1) only single or few populations, and in some instances only small numbers, of larvae were correlated for study, and they display few distinctive external features with untested possible variation, and (2) a combination of characters of male and female 9th sterna, the few diagnostic features of some species, and distribution is required for arriving at an identification. The combination of shapes of male-female 9th sterna, that appear to be diagnostic for species, are difficult to express verbally, and are best recognized by comparing specimens with the figures of males (87-99) and females (100-112).

1 Distribution east of the 90th Meridian; male 9th sternum ovate, with rounded apex (Fig. 87) and female 9th sternum narrower (Fig. 100)… ……..… *atlanticum*
1′ Distribution west of the 100th Meridian; male and female 9th sterna variable …….... 2
2 Male wingpads brachypterous (Fig. 33), female wingpads macropterous (Fig. 34); male and female 9th sterna both narrowly triangulate posteriorly (Figs. 99, 112) …… *uinta*
2′ Male and female wingpads macropterous …… 3
3 Male and female 9th sterna both narrowly triangulate posteriorly (Figs. 88, 92; 101, 105) … 4
3′ Male 9th sternum (Figs. 89-91, 93-98) wider in posterior half than female (Figs. 102-104, 106-111) ……5

4 Distribution: California ..... *californicum*
4′ Distribution: Oregon and Washington ..... *jewetti*
5 Galea with a dense patch of curved, comb-like teeth covering apical, outer surface (Fig. 26); male 9th sternum ovate (Fig. 89); female 9th sternum distinctly subtriangulate in posterior half, with posterolateral sides concave (Fig. 102); distribution California ..... *grinelli*
5′ Galea with less prominent comb-like teeth (Figs. 25, 27-32); male 9th sternum variable in shape; posterolateral sides of female 9th sternum straight or convex; distribution variable 6
6 Distribution Idaho and western Oregon; male 9th sternum broadly rounded, nearly truncate, apically (Fig. 98); female 9th sternum narrowly triangulate posteriorly (Fig. 111) ..... *umatilla*
6′ Distribution variable 7
7 Rare, small species, presently known only from few localities in Arizona and New Mexico; male 9th sternum broadly rounded in apical half (Fig. 90); female 9th sternum narrowly triangulate in apical half (Fig. 103); body length of both sexes 6-7 mm ..... *jacobii*
7′ Distribution variable; body length of both sexes greater than 7mm 8
8 Distribution Pacific Northwest (Oregon, Washington); male 9th sternum broadly triangulate in posterior half and apically pointed; female 9th sternum narrowly triangulate in posterior half (Fig. 107) ..... *oregonense*
8′ Distribution California or widespread 9
9 Distribution California 10
9′ Distribution widespread 11
10 Male 9th sternum ovate, with broadly rounded apex (Figs. 1C, 91); female 9th sternum broadly triangulate in apical half, with narrowly rounded apex (Fig. l04) ..... *jeanae*
10′ Male 9th sternum broadly triangulate in apical half (Fig. 97); female 9th sternum narrowly triangulate in apical half (Fig. 110) ..... *raynorium*
11 Male 9th sternum ovate, with posterolateral sides angulate (Fig. 93); female 9th sternum narrowly triangulate in posterior half (Fig. 106); distribution California, Pacific Northwest northward to Alaska and Yukon ..... *kincaidi*
11′ Posterolateral sides of male 9th sternum not angulate (Figs. 95, 96); widespread western North America 12
12 Male 9th sternum ovate, with narrowly rounded apex (Fig. 95); female 9th sternum narrowly angulate, with posterolateral sides nearly straight, and a pointed apex (Fig. 108) ..... *pacificum*
12′ Male 9th sternum with broadly rounded apex (Fig. 96); female 9th sternum ovate, with posterolateral sides convex, and a narrowly rounded apex (Fig. 109) ..... *pallidum*

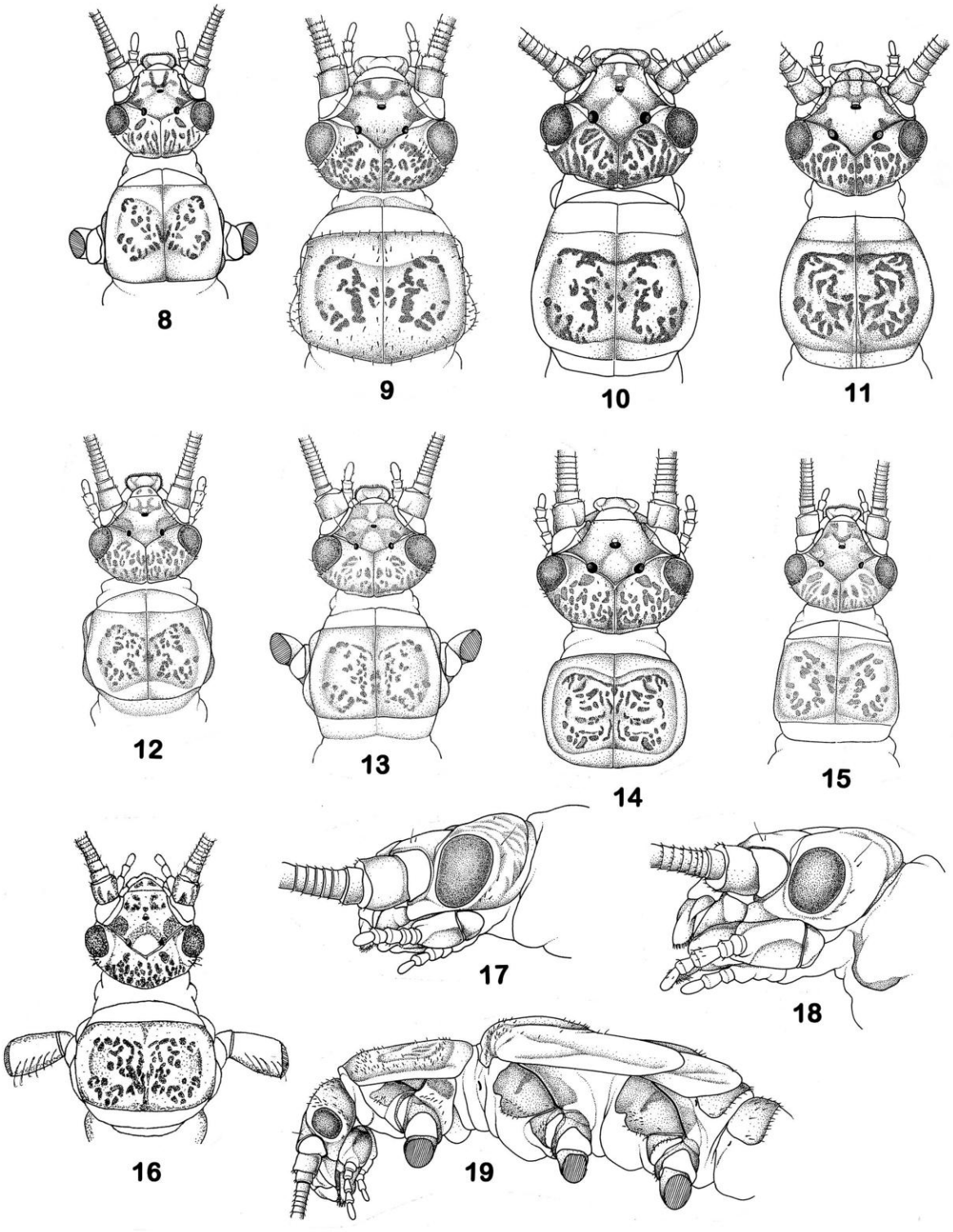
GENERAL DISCUSSION

These larval descriptions in essence become an atlas of illustrations of the 13 species, based on single or few populations, and in some species small numbers of correlated individuals. Stewart & Drake (2007) pointed out the logistical difficulties and resource allocation required for obtaining suitable correlated larvae of more speciose genera for the undertaking of species level larval taxonomy. Museum collections of correlated larvae for the diverse species of these genera do not exist.

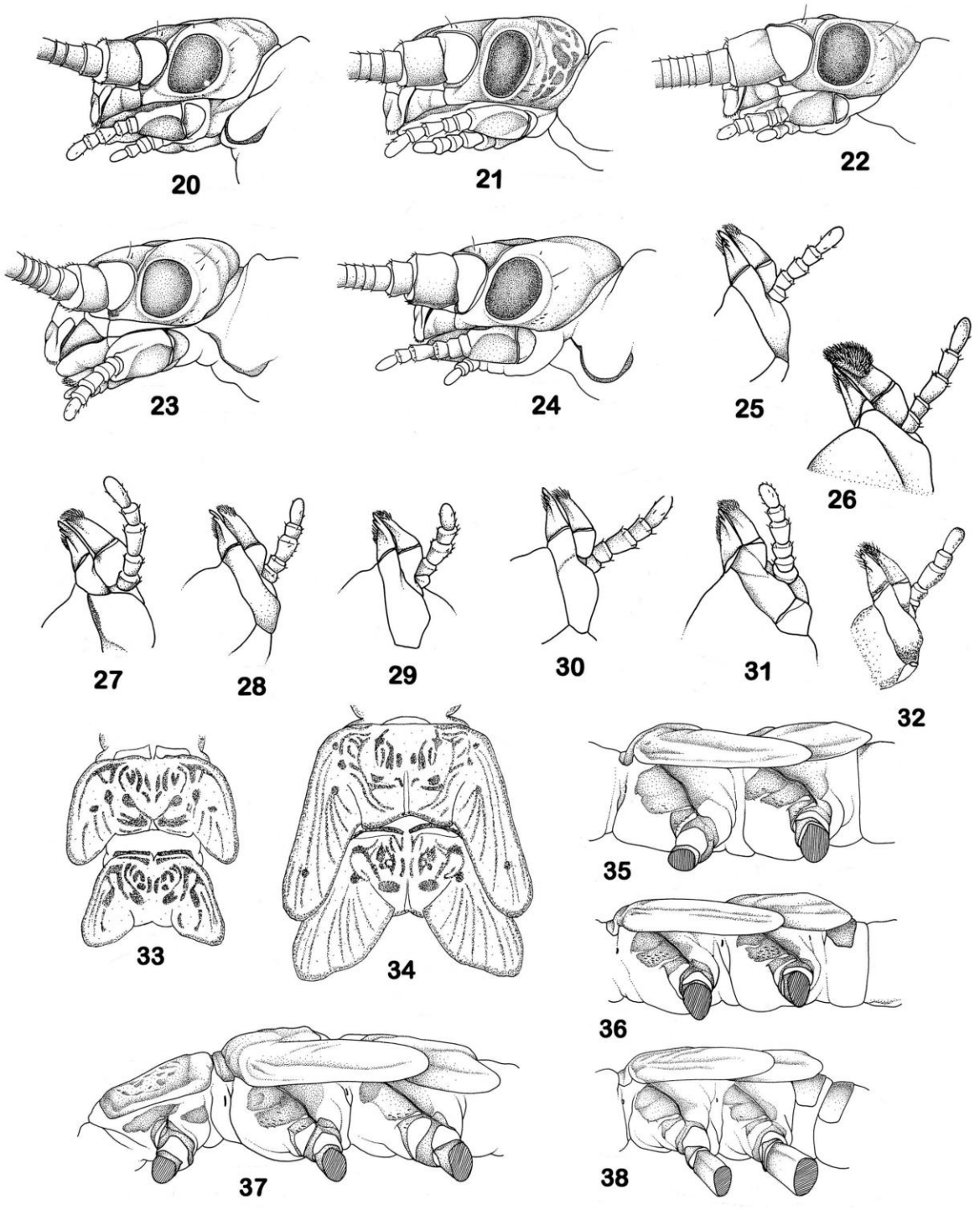
The narratives, illustrations and key therefore are most useful in: (1) expanding the generic description of *Taenionema* larvae, (2) affirming the generic characters proposed by Stewart & Stark (1988, 2002), and (3) serving as a beginning of comparative morphological information to aid in species level resolution of larvae, to build upon with further study.

ACKNOWLEDGEMENTS

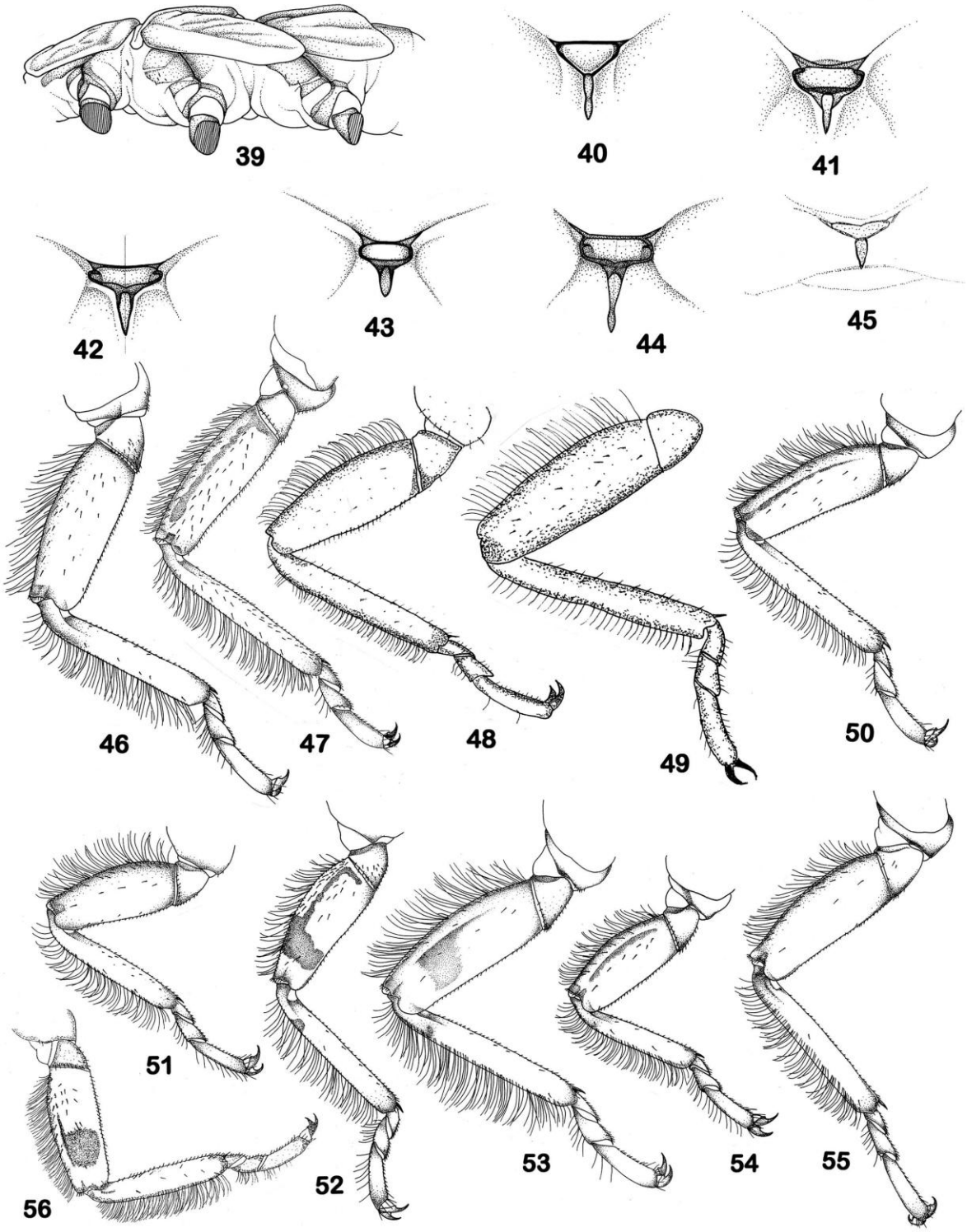
This study was supported in part during earlier years by National Science Foundation Grants DEB 7812565 and BSR 8308422, and grants from the University of North Texas Faculty Research Fund. I am indebted to artist Jean Stanger-Leavitt, who, under my employ during support by these grants, prepared many of the illustrations. I thank Richard Baumann, Richard Bottorff, Gerald Jacobi, Ralph Kirchner, and Boris Kondratieff for providing correlated specimens of various species for study, and Eugene Drake, Bill Shepard, Bill Stark and David Zeigler for help with field collections. Also, special thanks are extended to Brian Armitage for scanning my plated illustrations to provide electronic versions for publication, and to Bill Stark for preparing SEM's of the mouthparts of *T. jeanae* larvae.



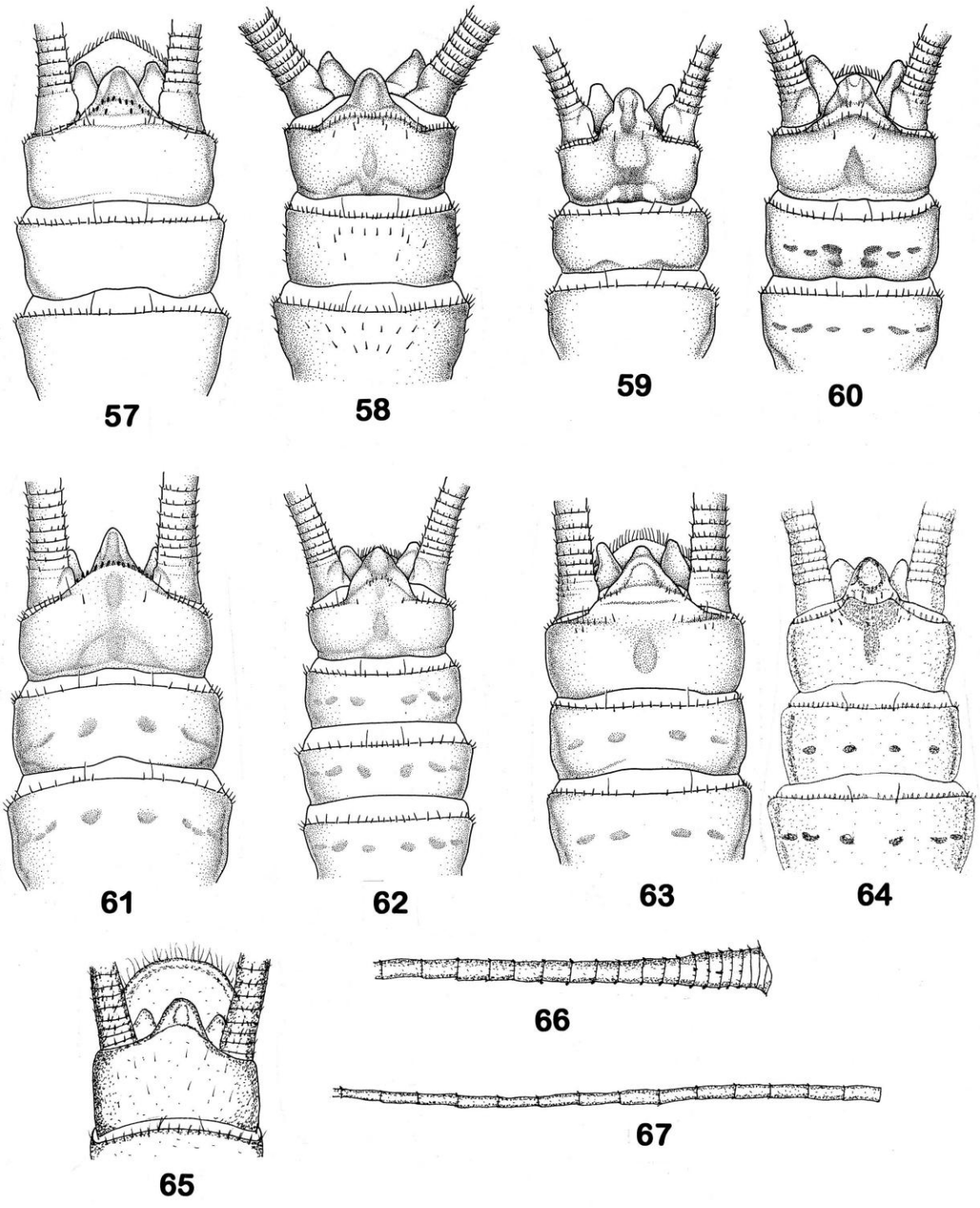
Figs. 8-19. *Taenionema* larvae. 8-16. head-pronotum pigmentation. 8. *T. atlanticum.* 9. *T. grinelli.* 10. *T. jewetti.* 11. *T. kincaidi*. 12. *T. oregonense.* 13. *T. pacificum***.** 14. *T. pallidum.* 15. *T. raynorium.* 16. *T. uinta.* 17-19. side views of head. 17. *T. atlanticum*. 18. *T. jewetti*. 19. *T. grinelli*.



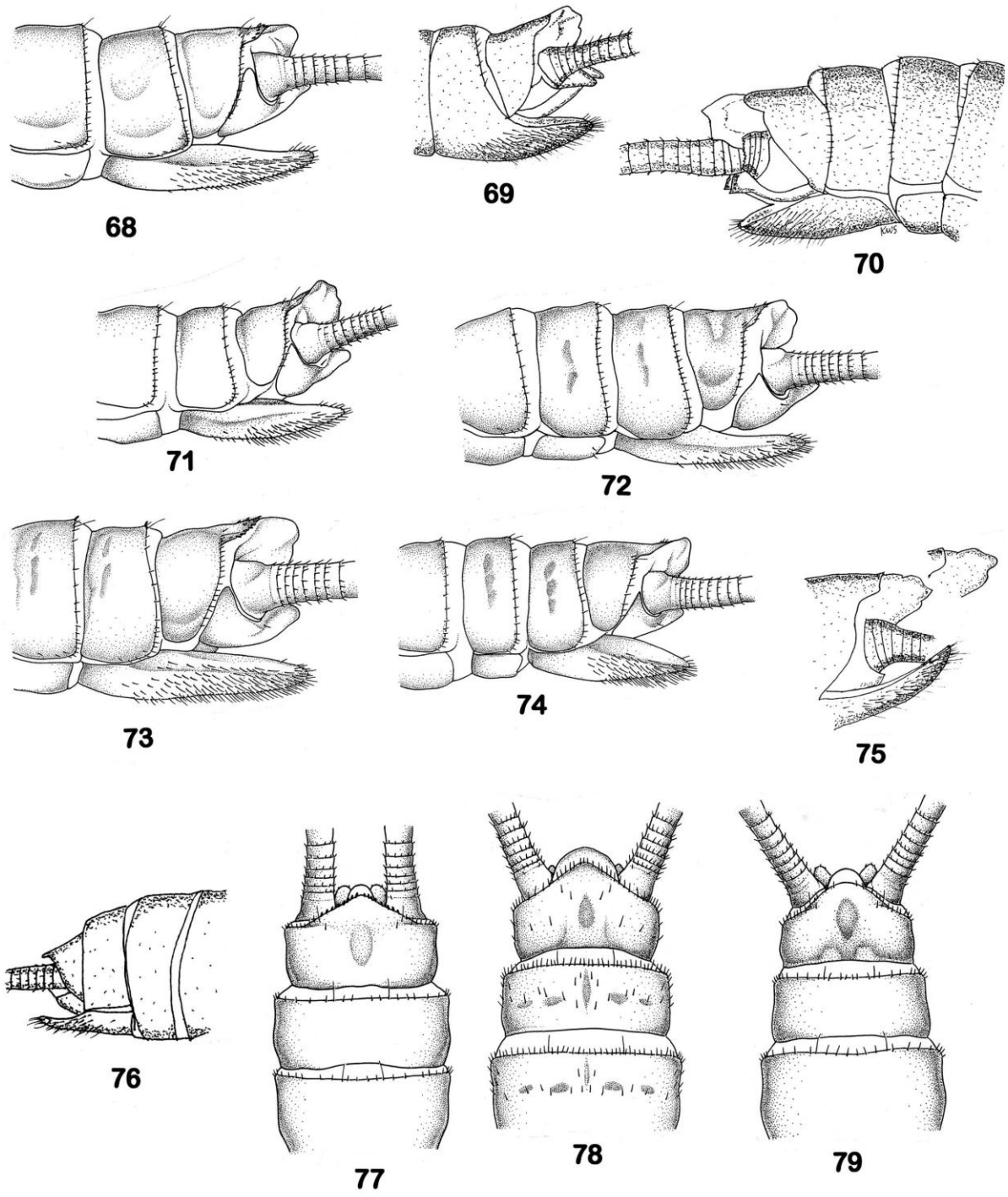
Figs. 20-38. *Taenionema* larvae. 20-24. side views of head. 20. *T. kincaidi*. 21. *T. oregonense*. 22. *T. pacificum*. 23. *T. pallidum*.24. *T. raynorium*. 25-32. maxillae. 25. *T. atlanticum*. 26. *T. grinelli*. 27. *T. jewetti*. 28. *T. kincaidi*. 29. *T. oregonense*. 30. *T. pacificum*. 31. *T. pallidum*. 32. *T. uinta*. 33-34. Wingpads. 33. *T. uinta* male. 34. *T. uinta* female. 35-38. 35. *T. jewetti*. 36. *T. kincaidi*. 37. *T. oregonense*. 38. *T. pallidum*.



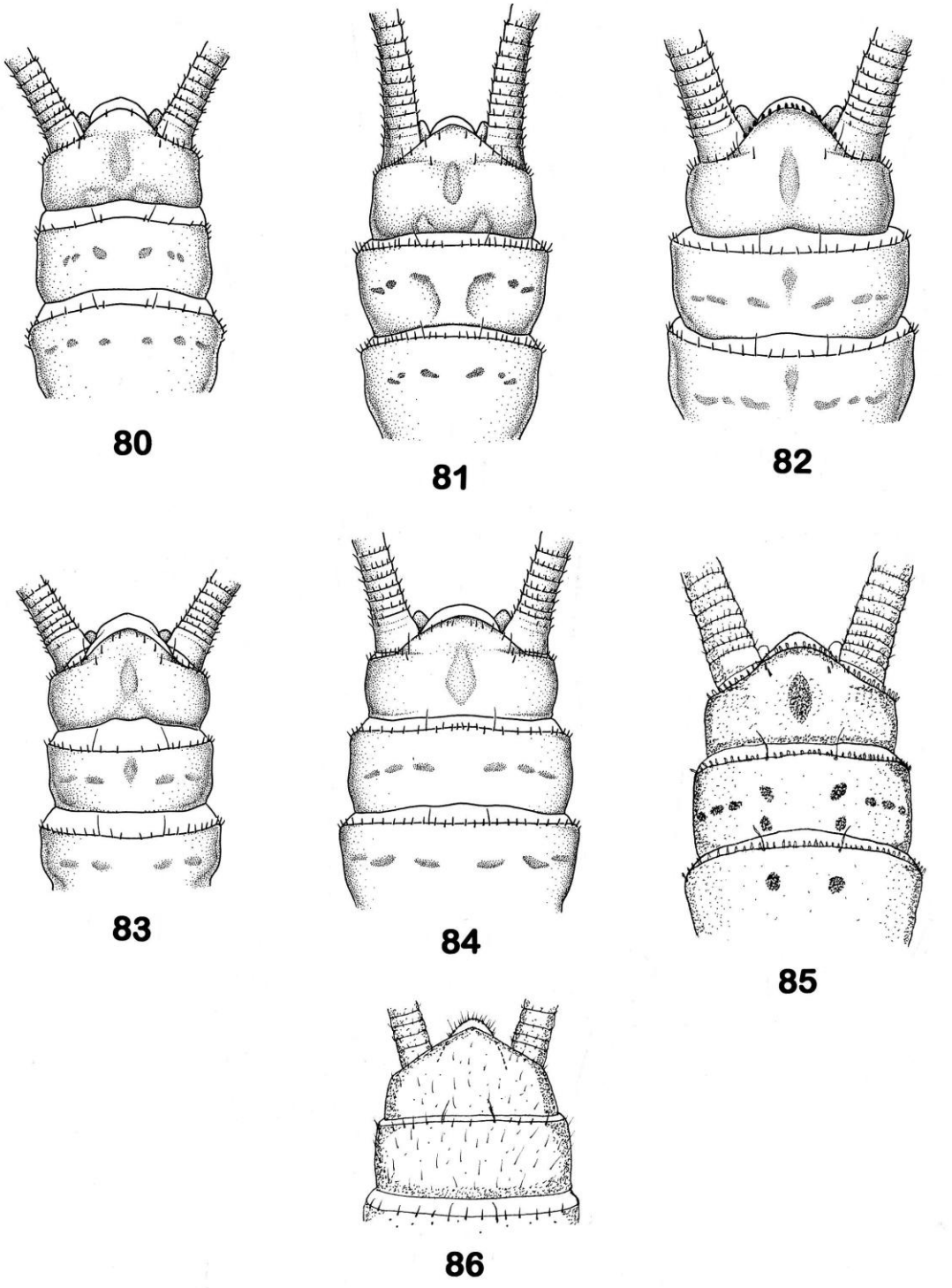
Figs. 39-55. *Taenionema* larvae. 39. side view *T. raynorium* thorax. 40-45. mesosternal Y-pattern. 40. *T. grinelli*. 41. *T. jewetti*. 42. *T. kincaidi*. 43. *T. pallidum*. 44. *T. raynorium*. 45. *T. uinta.* 46-55. right front legs, dorsal. 46. *T. atlanticum*. 47. *T. grinelli*. 48. *T. jacobii*. 49. *T. jeanae*. 50. *T. jewetti*. 51. *T. kincaidi*. 52. *T. oregonense*. 53. *T. pacificum*. 54. *T. pallidum*. 55. *T. raynorium*. 56. *T. uinta.*



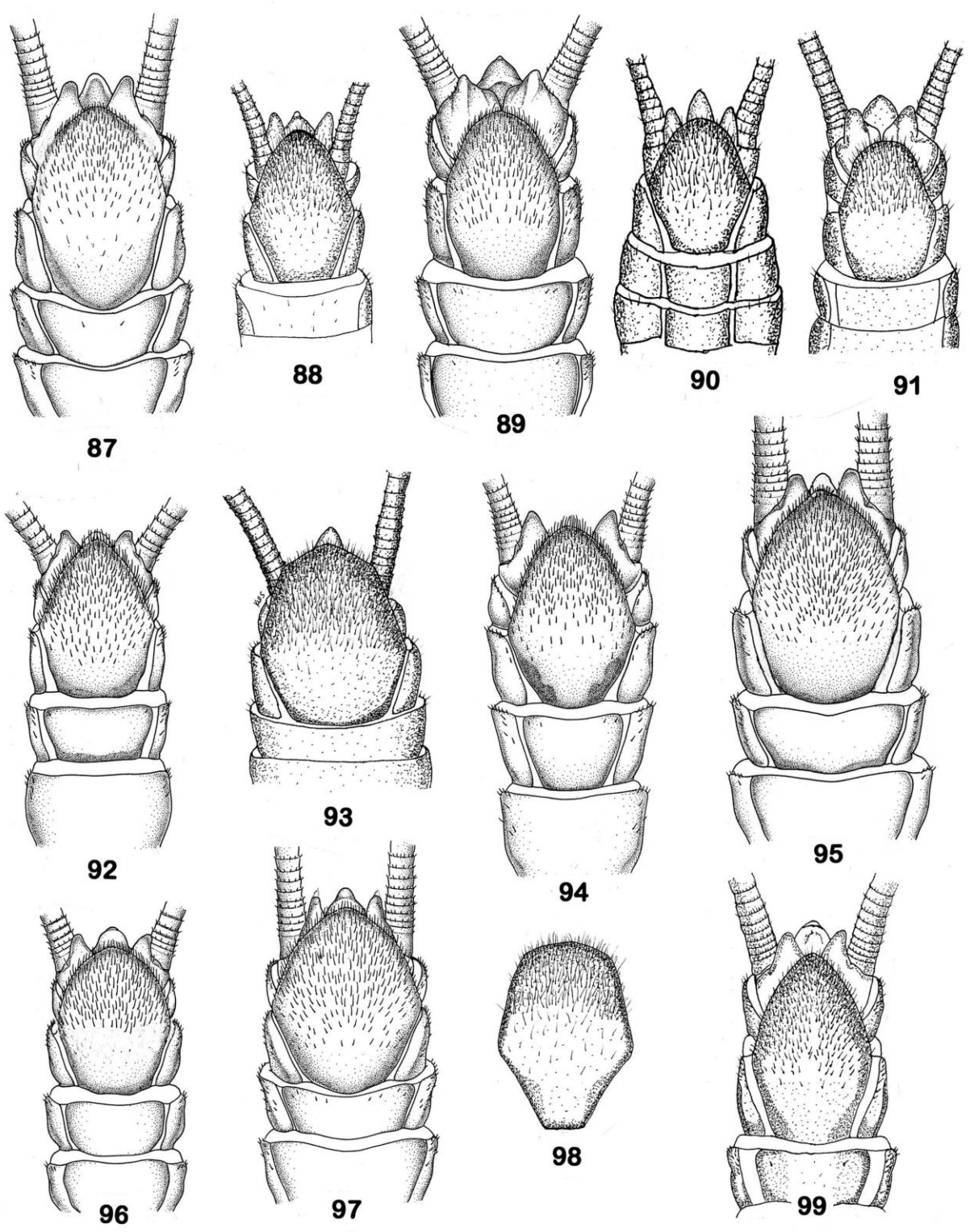
Figs. 57-67. *Taenionema* larvae. 57-65. male terminalia, dorsal. 57. *T. atlanticum*. 58. *T. grinelli*. 59. *T. jewetti*. 60. *T. oregonense*. 61. *T. pacificum*. 62. *T. pallidum*. 63. *T. raynorium*. 64. *T. uinta*. 65. *T. umatilla*. 66. *T. umatilla*. basal cercal segments. 67. *T. umatilla* middle cercal segments.



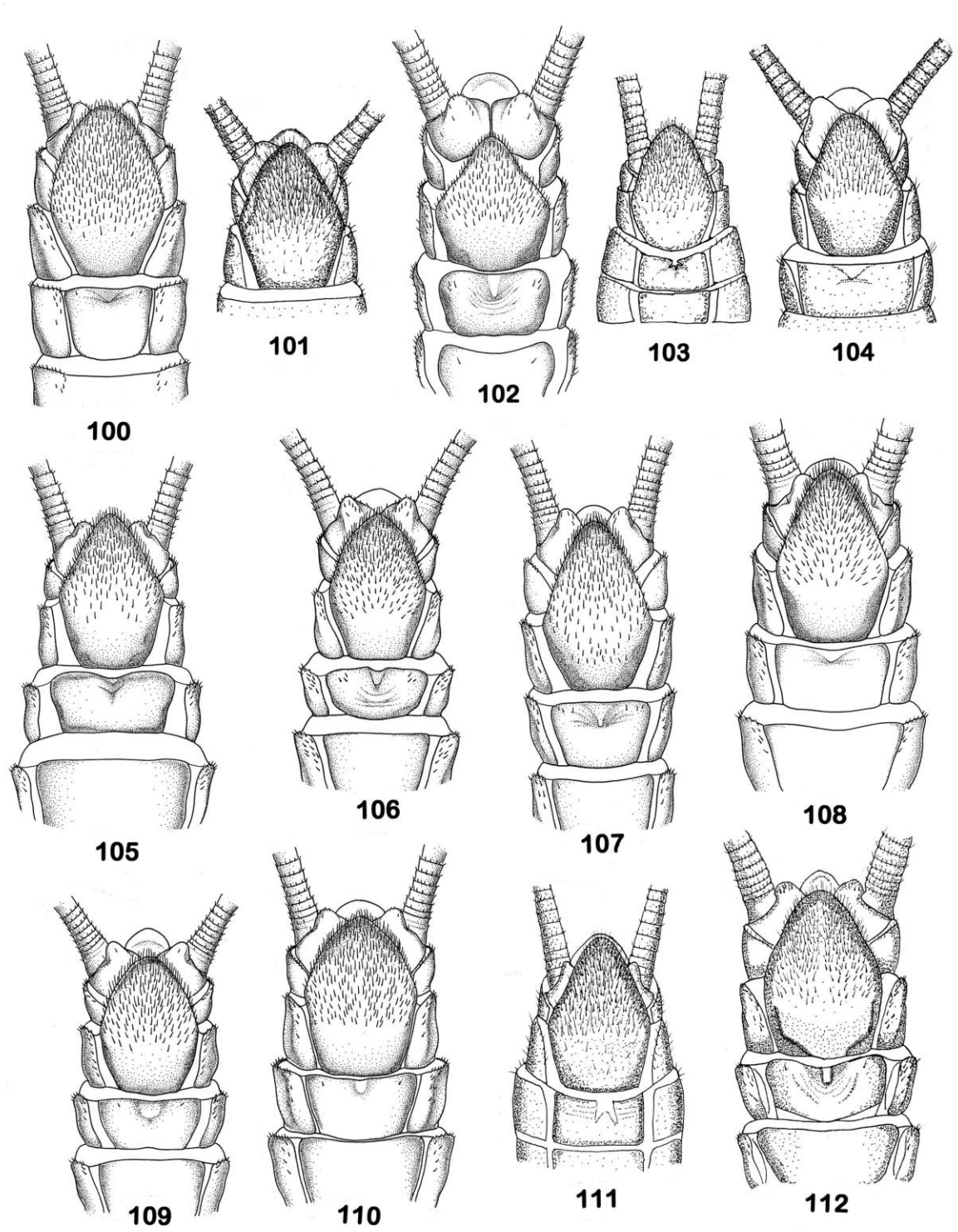
Figs. 68-79. *Taenionema* larvae. 68-75. side views of male terminalia. 68. *T. atlanticum*. 69. *T. californicum*. 70. *T. grinelli*. 71. *T. jewetti*. 72. *T. oregonense*. 73. *T. pacificum*. 74. *T. pallidum*. 75. *T. raynorium*. 76. *T. umatilla* side view of female terminalia. 77-79. female terminalia, dorsal. 77. *T. umatilla*. 78. *T. atlanticum*. 79. *T. grinelli*.



Figs. 80-86. Female *Taenionema* nymph terminalia, dorsal. 80. *T. kincaidi*. 81. *T. oregonense*. 82. *T. pacificum*. 83. *T. pallidum*. 84. *T. raynorium*. 85. *T. uinta*. 86. *T. umatilla*.



Figs. 87-99. Male *Taenionema* larval terminalia and 9th sterna, ventral. 87. *T. atlanticum*. 88. *T. californicum*. 89. *T. grinelli*. 90. *T. jacobii*. 91. *T. jeanae*. 92. *T. jewetti*. 93. *T. kincaidi*. 94. *T. oregonense*. 95. *T. pacificum*. 96. *T. pallidum*. 97. *T. raynorium*. 98. *T. umatilla*. 99. *T. uinta*.



Figs. 100-112. Female *Taenionema* nymph terminalia and 9th sterna, ventral. 100. *T. atlanticum.* 101. *T. californicum*. 102. *T. grinelli*. 103. *T. jacobii*. 104. *T. jeanae*. 105. *T. jewetti*. 106. *T. kincaidi*. 107. *T. oregonense*. 108. *T. pacificum*. 109. *T. pallidum*. 110. *T. raynorium*. 111. *T. umatilla*. 112. *T. uinta*.

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Received 22 April 2009, Accepted 6 May 2009, Published 26 August 2009