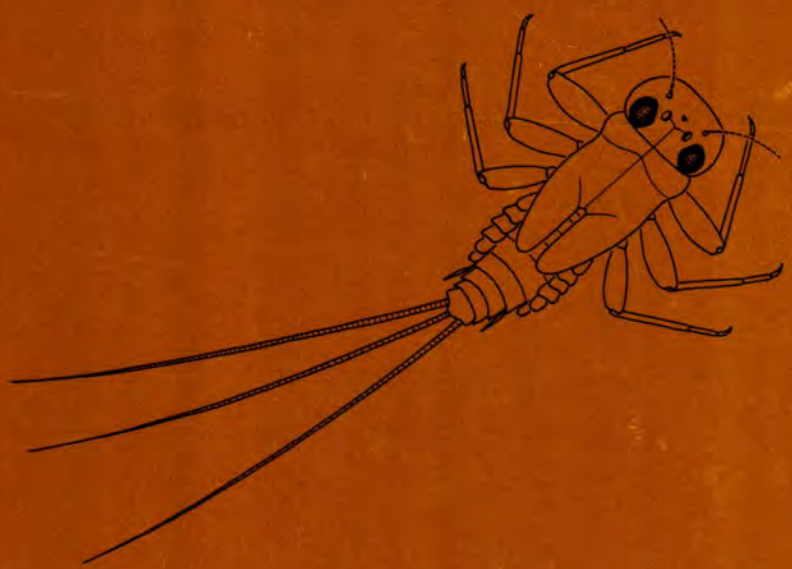
Canadian Bulletin of Fisheries and Aquatic Sciences

Biosystematic Revision of the Genus *Stenonema* (Ephemeroptera: Heptageniidae)



A.F. Bednarik • W.P. McCafferty

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Canadian Bulletin of Fisheries and Aquatic Sciences

(formerly *Bulletin of the Fisheries Research Board of Canada)*

The name of the *Bulletin* series will change to the *Canadian Bulletin of Fisheries and Aquatic Sciences* beginning with No. 201. We regret any inconvenience this change may cause and would like to explain briefly why such a decision was made.

Recently, a Bill was passed by the Federal Government which repealed the Fisheries Research Board (FRB) Act and all elements of the FRB were incorporated into the Department of Fisheries and Oceans. Because the FRB no longer existed, it was decided that a new title was necessary.

Bulletin canadien des sciences halieutiques et aquatiques

(Anciennement *le Bulletin de l'office des recherches sur les pêcheries du Canada)*

À compter de numero 201, la série des *Bulletins* changera de nom et s'appellera *Bulletin canadien des sciences halieutiques et aquatiques*. Ce changement causera des inconvénients que nous regrettons. Je voudrais donc vous exposer brièvement les raisons d'une telle décision.

Le governement fédéral adoptait récemment un bill annulant la Loi sur le Conseil de recherches sur les pêcheries (Office des recherches sur les pêcheries, ORP) et tous les éléments de l'ORP furent incorporés au Ministère des Pêches et des Océans. L'ORP n'étant plus, il fallait un titre nouveau.

Biosystematic Revision of the Genus *Stenonema* (Ephemeroptera: Heptageniidae)

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BULLETIN 201

Biosystematic Revision of the Genus *Stenonema* (Ephemeroptera: Heptageniidae)[1,2]

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Abstract

BEDNARIK, A. F., AND W. P. MCCAFFERTY. 1979. Biosystematic revision of the genus *Stenonema* (Ephemeroptera: Heptageniidae). Can. Bull. Fish. Aquat. Sci. 201: 73 p.

The genus *Stenonema* Traver has been revised, based on study of variability from throughout species ranges, and application of a biological definition of species. Illustrated keys to larvae, male adults, and female adults are presented. Fifteen nominal species and two subgenera are recognized. For each nominal species, a complete synonymy, descriptions, figures, distribution, biology and ecology, and a discussion of taxonomy are included. Newly discovered synonyms are: *S. exiguum* Traver (= *S. quinquespinum* Lewis n.syn.); *S. mediopunctatum* (McDunnough) (= *S. nepotellum* (McDunnough) n.syn.); *S. modestum* (Banks) (= *S. annexum* Traver, *S. rubromaculatum* (Clemens), *S. rubrum* (McDunnough) n.syns.); *S. terminatum* (Walsh) (= *S. ares* Burks, *S. bipunctatum* (McDunnough), *S. lepton* Burks n.syns.); and *S. vicarium* (Walker) (= *S. fuscum* (Clemens) n.syn.).

The evolution of the sister genus *Stenacron* and the two subgenera *Stenonema (Stenonema)* and *Stenonema (Maccaffertium)* from a common ancestor with a *Heptagenia*-like precursor is hypothesized. Four phyletic species clusters within *Maccaffertium* are proposed, based on points of divergence relative to deducible ancestors: Cluster I — *S. vicarium, S. sinclairi, S. pudicum, S. carlsoni, S. ithaca*; Cluster II — *S. mediopunctatum, S. luteum;* Cluster IIIA — *S. pulchellum, S. terminatum, S. exiguum, S. meririvulanum*; Cluster IIIB — *S. modestum, S. smithae, S. integrum.* Based on phyletic evidence and present distribution a relatively recent Appalachian origin for *Maccaffertium* is indicated.

Key words: Stenonema, Heptageniidae, mayflies, classification, revision, biosystematics, evolution

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Résumé

BEDNARIK, A. F., AND W. P. MCCAFFERTY. 1979. Biosystematic revision of the genus *Stenonema* (Ephemeroptera: Heptageniidae). Can. Bull. Fish. Aquat. Sci. 201: 73 p.

Nous révisons le genre *Stenonema* Traver à la lumière d'une étude de variabilité dans les aires des espèces et application d'une définition biologique des espèces. Nous donnons des clés illustrées pour l'identification des larves, des adultes mâles et des adultes femelles. On reconnaît quinze espèces nominales et deux sous-genres. Pour chaque espèce nominale, nous donnons synonymie complète, description, figures, distribution, biologie et écologie, ainsi qu'une analyse de la taxonomie. Les synonymes nouvellement découverts sont: *S. exiguum* Traver (= *S. quinquespinum* Lewis n.syn.); *S. mediopunctatum* (McDunnough) (= *S. nepotellum* (McDunnough) n.syns.); *S. modestum* (Banks) (= *S. annexum* Traver, *S. rubromaculatum* (Clemens), *S. rubrum* (McDunnough) n. syns.); *S. terminatum* (Walsh) (= *S. ares* Burks, *S. bipunctatum* (McDunnough), *S. lepton* Burks n.syns.); et *S. vicarium* (Walker) (= *S. fuscum* (Clemens) n.syn.).

Nous formulons une hypothèse concernant l'évolution du genre soeur *Stenacron* et des deux sous-genres *Stenonema (Stenonema)* et *Stenonema (Maccaffertium)* à partir d'un ancêtre commun avec un précurseur ressemblant à *Heptagenia.* Nous proposons quatre groupes phylogéniques d'espèces au sein de *Maccaffertium*, fondés sur les points de divergence par rapport à des ancêtres qui peuvent être déduits : Groupe I — *S. vicarium, S. sinclairi, S. pudicum, S. carlsoni, S. ithaca*; Groupe II — *S. mediopunctatum, S. luteum*; Groupe IIIA — *S. pulchellum, S. terminatum, S. exiguum, S. merrivulanum*; Groupe IIIB — *S. modestum, S. smithae, S. integrum.* Des indices phylogéniques et l'actuelle distribution font croire à une origine appalachienne de *Maccaffertium.*

Introduction

Background

Stenonema mayflies are often the most abundant benthic insects in streams and rivers of eastern North America; some species are also found along lake shores. Although most common east of the Mississippi River, the genus is known from western North America (Edmunds 1951), Mexico, and Central America (Edmunds et al. 1976). The negatively phototactic and positively thigmotactic larvae (Berner 1950) are primary consumers of encrusted algae, diatoms, and detritus and are important as fish food (Leonard and Leonard 1962). Microhabitat and zoogeography of *Stenonema* populations vary considerably (Lewis 1974b). Moreover, the variable ranges of pollution tolerance reported for the genus are potentially useful data in water quality assessment (Cairns et al. 1973).

The genus *Stenonema* was erected by Traver (1933a) to include several North American heptageniids formerly placed in *Heptagenia, Ecdyurus*, and *generis incerti* by Eaton (1883–88); *Heptagenia* by Banks (1910), Needham (1901, 1905), Clemens (1913, 1915), and Ulmer (1920a); and *Ecdyonurus* by Ulmer (1920a), McDunnough (1924, 1925a, b, 1930, 1933), and Ide (1930). Traver (1933a) used structural variability in the larval gills and male penes to divide the 20 species then recognized into three groups: "*tripunctatum*," "*vicarium*," and "*interpunctatum*." Traver (1935) described eight new species and redescribed all male imagos.

Species taxonomy in *Stenonema* has been confused in part due to widespread reliance on narrow typological color characteristics for diagnoses. Spieth (1938) indicated that coloration in all stages varies with geographic location, temperature, and type of substrate. Spieth (1947) used statistical analysis of the ratio of the lengths of the second to first fore tarsal segments, and the ratio of the fore wing length to length of the first fore tarsal segment in male adults, to synonymize eight species and reduce seven others to subspecies.

Another problem in species taxonomy has been the exclusive use of adult characters in descriptions. Burks (1953) redescribed known larvae and adults, synonymized four species, named three new species chiefly on adult characters, and divided *Stenonema* into seven species groups based exclusively on adult characters.

Berner (1950) first used larval mouthpart characters in *Stenonema* species descriptions. Lewis (1973) used larval mouthpart characters in describing 3 previously unknown larvae, in naming 3 new species (Lewis 1974a), and in his review of the genus (Lewis 1974b), in which he recognized 31 species.

On the basis of phyletic analysis, Jensen (1974) erected the genus *Stenacron* to include those species formerly in the *interpunctatum* group.

Several other authors described species presently placed in *Stenonema*. Early workers included Say (1823), Walker (1853), Hagen (1861), and Walsh (1862). Descriptions or discussions of *Stenonema* species have often been part of regional taxonomic works and/or have dealt with *Stenonema* from a restricted area. These include eastern United States (Banks 1910); Canada (Clemens 1913, 1915); New York (Clemens and Leonard 1924); eastern Canada (McDunnough 1925a, b, 1926, 1930, 1933); Ontario (Ide 1930); Minnesota (Daggy 1945); Illinois (Burks 1946, 1953); North Carolina (Traver 1933a); southeastern United States (Traver 1937); Florida (Berner 1950); Michigan (Leonard and Leonard 1962); Idaho (Jensen unpublished data); Wisconsin (Flowers and Hilsenhoff 1975); Mexico and Central America (Allen and Cohen 1977); Virginia (Carle 1977); West Virginia (Faulkner and Tarter 1977); Arkansas (McCafferty and Provonsha 1978); and Kansas (Liechti 1978). Lewis (1974b) discussed the genus in toto but concentrated on forms found in the Ohio River valley.

As a result of this focus on rather narrow geographic areas, authors have usually neglected considerations of the overall variation in the genus; thus there is difficulty in identifying specimens collected from throughout geographic ranges of the species.

Few autecological studies have focused specifically on *Stenonema* or *Stenacron*, partly because of the confusing taxonomy. The most useful works include Spieth (1938, 1947) on color variation related to ecology, Huff and McCafferty (1974) and McCafferty and Huff (1974) on parthenogenesis, Lyman

(1955) on tactic responses, McCafferty and Huff (1978) on life cycles in *Stenacron*, Richardson and Tarter (1976) on life cycles in two *Stenonema* species, McDunnough (1933) on life cycles and variation in some Canadian species, and Traver (1935) on the life cycle of *Stenonema vicarium*. Lewis (1974b) briefly outlined the known ecology of most species and reviewed previous studies, mentioning the effects of pollution on *Stenonema* and *Stenacron* species and the potential value of these mayflies in water quality assessment.

Study

This research was undertaken (1) to develop a realistic and utilitarian species classification, and provide comprehensive descriptions of species and usable keys for identification; (2) to investigate variability and its sources in *Stenonema* and to apply these data to recognizing and delineating biological species rather than phenotypes; (3) to develop hypotheses regarding the evolutionary history of *Stenonema* based on phyletic analysis; and (4) to provide insights into the time and place of origin of *Stenonema* and possible species dispersal routes.

The first phase involved the study of morphological variability in specimen series from throughout the distributional ranges of *Stenonema*, and a comparison of type material. Distributions are based largely on material examined (see Appendix A). Additional records are based on the many sources cited previously under regional taxonomic works, and from Allen and Edmunds (1956) and Edmunds (1951), western United States; Lehmkuhl (1976), Saskatchewan, Canada; and Berner (1977), southeastern United States. Reared series were relied on heavily to establish specific larval associations. Variant identification correlated with geography provided the basis for initial hypotheses of related species.

These hypothetically related species were then analyzed to develop a phylogeny using phyletic methodology essentially after Ross (1937, 1974) and Hennig (1950, 1966). The final research phase involved the interpretation of paleodispersal by correlating the phyletic model, present species distribution, and ecology when possible.

Of the several thousand specimens or slide preparations examined, over 1000 were analyzed in morphological detail and cataloged. In all instances, material used by authors in previously published descriptions and redescriptions, and all available type specimens were examined.

Characters and Terminology

Much of the historical difficulty in *Stenonema* taxonomy is attributable to a paucity of reliable specific characters, especially in adults. This is probably due to the relatively recent origin of the genus and a lack of divergent selection pressure on the short-lived adults. A poor understanding of the range of color characters variability has resulted in accordance of specific status to many color variants. Moreover, as a relatively young group with a presumed high percentage of common genetic material, *Stenonema* often exhibits parallel character states, and those consistent in one species may be variable in another.

In the generic description, some character states listed are from Jensen (unpublished data). In species descriptions, some data (especially involving color) are after Traver (1935), Burks (1953), and Lewis (1974b), in addition to original descriptions. Diagnostic character states are italicized. We have found the following systematic characters to be applicable.

Larva

All mouthparts (Fig. 14, see Appendix B) except the mandibles and maxillae are remarkably invariable between species. On the mandibles (Fig. 15, 16), numbers of toothlike projections on the inner margin of the outer incisors (that become smaller proximally) are of some use. Ranges in total numbers indicate intraspecific variability.

The maxillae (Fig. 17–20) are very useful, although there has been some confusion about the armature on the crown of the galea–lacinia (Fig. 18). The structures herein designated as spinelike setae were called pectinate spines by Lewis (1973, 1974a, b) and plumose setae by Jensen (1974). The homology of the spinelike setae is uncertain; they may or may not be fundamentally different from the "pectinate spines" in *Stenacron* and *Heptagenia* (Jensen 1974). In *Stenonema*, at least, these structures are movable and are not true spines. Their number in *Stenonema* is always reduced relative to *Stenacron*. Because such setae are subject to breakage, sockets were counted.

With regard to maxillary crown hair setae, two consistent character states occur in the subgenus *Maccaffertium*. Those species possessing hair setae (Fig. 20) have 10 or more (almost always many more). Species normally without hair setae (Fig. 19) may rarely have a few (1–9) such setae present on one or both maxillae (2 specimens of over 800 examined possessed more than 5 but less than 9). Although diagnostically significant, this character is weak phyletically because of convergent losses.

The number of setae in the submedial row on the galea–lacinia (Fig. 18) is of some diagnostic use.

Spinelike setae and hair setae are always present on the posterior margins of the fore femora. The extent of such armature on the anterior margins is variable but may be of use in some species. Armature on the dorsal surfaces of the fore femora varies interspecifically, and consists of acute spinelike setae (Fig. 9), elongate, paddle-shaped setae (Fig. 10), and oval, scalelike setae (Fig. 11).

Fore tarsal claws may be denticulate (Fig. 8) or adenticulate (Fig. 7). This character is more variable than earlier authors realized. In a given population, denticles may be present in early instars only, thus, all data given in our accounts refer to mature larvae. Claw denticles are easily broken and worn and may sometimes be misinterpreted.

The number of abdominal segments with lateral abdominal projections, and often the relative lengths of such projections, are important characters. Those species with projections on segments 3–9, 4–9, or 5–9 are defined as having anterior lateral abdominal projections (Fig. 59); those with projections on segments 6–9 or 7–9 only are defined as lacking anterior lateral projections (Fig. 68). These latter species rarely have some individuals possessing a minute projection on segment 6. We concur with earlier workers who referred to these projections as spines; however, the use of the term "spines" has led to occasional misinterpretation of this character. The exoskeleton must extend beyond the posterior segment margin adjacent to the projection dorsally and ventrally (Fig. 12) for a projection to be considered present.

If the posterolateral sternal corners are acute and there is a slight incurving of the exoskeleton ventrally but not dorsally in this area (Fig. 13), then these are not true projections but may have been viewed as minute spines by some earlier workers. They are not to be confused and, in questionable cases, the sternum should be gently compressed to determine if the lateral exoskeleton actually extends past the posterior margin of the segment. If still unclear, the gills should be removed and the segment viewed dorsally.

All *Stenonema* have setae on the mesal margins of the cerci. In some, setae may be present, absent, or present in portions of the outer margins. As for most other characters, setae are variable in some species and consistent in others.

Total length may be useful if mature specimens are used. In larvae (and male adults) lengths are expressed in millimeters and are measured dorsally from the anterior margin of the head to the base of caudal filaments on the midline.

Male Imago

The compound eyes are never contiguous but variation occurs in the degree of dorsal separation. This degree is given relative to the maximum width of a lateral ocellus, and two major character states occur. In Type I (Fig. 21, 24), the compound eyes are separated by a distance less than or equal to the width of a lateral ocellus. In Type II (distance greater than the width of lateral ocellus), the relative separation is variable, ranging from that in Fig. 27 (Type IIA) to that in Fig. 30 (Type IIB). We have chosen to distinguish between these two subdivisions of Type II because some species, especially those constant in size through the species range, are consistent in degree of separation. Other species show all possible graduations between Type IIA and Type IIB. We believe there is no fundamental difference between Type II species in this character, and the designation is for convenience only.

The ventral extension of the transverse shelf (Fig. 22, 23), seen in some *Stenonema*, seems directly correlated with the prior size of the larval mouthparts.

Foreleg ratios of femur to tibia, femur to tarsus, and tibia to tarsus, as well as the relative lengths of tarsal segments, are not species specific. The ratio of the lengths of the second fore tarsal to the first fore tarsal segment (hereafter referred to as the fore tarsal ratio) is variable in some species and relatively constant in others and, therefore, is usually expressed as a range.

The number of crossveins, and their relative crowding in the bulla region interspaces of the fore wings, varies with species. Crossveins are either not crowded (Fig. 37), slightly or moderately crowded (Fig. 36), or crowded (Fig. 34). The number of crossveins in the first interspace distal to the bulla region is subject to intraspecific variability but ranges may be useful. *Stenonema* adults never possess the dark pigmentation of the third bulla interspace characteristic of *Stenacron* (Fig. 33).

Past authors have attempted to use male genitalia, especially the penes, in delineating species. Lewis (1974b) relied heavily on penal lobe armature, especially relative sizes and locations of the apical and distal spines (Fig. 38) (distal spines = discal, terminal, and subterminal spines of Lewis). We view these characters skeptically. The size and location of distal spines is subject to extensive intraspecific variability in *Stenonema*; in a given specimen, armature may differ on the left and right penial lobes. For example, commonly the distal spine appears large on one lobe and is either bifurcate or present as two smaller spines on the other. For most species, genital armature is of little use taxonomically. However, in a few species with geographically restricted populations, armature is homogeneous.

Most penes in *Stenonema* are similar in form, appearing somewhat "boot-shaped" (Fig. 41). Earlier workers have distinguished between several types of penes based on shape: for example, L-shaped (Fig. 43), or less L-shaped (Fig. 44), or intermediate. These have invariably been subjective judgments based primarily on the length of the penial lobe posterior margin relative to the medial margin (see Fig. 38), the "straightness" of the posterior margin, and the angle the posterior margin forms with the medial margin. We have found this supposed difference in shape to be directly correlated with size of the individual. Increase in size of the penes corresponding to increased overall individual size is reflected in a lengthening of the posterior margin of the penes relative to the medial margin. Thus a small individual of a given species might have penes shaped as in Fig. 44; a larger specimen of the same species might have penes as in Fig. 43 or 45. In certain cases, especially when a species or subspecies is constant in body length, penial lobe shape can be diagnostic.

Extreme caution must be used in examining slide preparations as both spines and general shape are subject to distortion in standard mounting techniques. For example, a spine may appear distinct or indistinct depending on the angle at which the viewer sees the spine (compare Fig. 43a, b). Because of the three dimensional nature of the penes, shape may be misinterpreted depending on focus. When slide mounts are necessary, we suggest use of well slides or a technique that involves a raised coverslip.

Female Imago

Structural species characters for females are almost nonexistent. We have attempted to utilize the shape of the posterior margin of the subanal plate (Fig. 50–55); however, this seems subject to variation in most species. Although we do not include it as a key character, the extent of variation is indicated in the species accounts.

Egg characters may eventually provide the best means of identifying adult females. Koss (1968) studied the eggs of a few species of *Stenonema*; however, he did not sample variability and stated that his species descriptions were tentative at best. We have chosen not to incorporate his species data because of the possibility of misapplication. Nevertheless, some important generic and subgeneric characters are recognized, especially in the study of phylogeny.

Use of Color

There is often little alternative to the use of color differences for determinations, especially for adults. Previous tendencies to define species within narrow limits based on color differences, with little recognition of intraspecific variability, has led to species splitting and general taxonomic confusion.

In adults, color intensity often reflects ecological and life cycle attributes. For example, in species with long emergence periods, spring emergents may be darker than later emergents. When dark individuals occur later in the year, they have often developed in relatively cold water regimes (Spieth

1947). Such differences may be related to length of the developmental period (McCafferty and Huff 1978). Also, widespread species with greater ecological tolerances tend to be more color variable.

The outer margin of the hind wing is darkened in some species and is usually a reliable character state; in a few species variability does occur, however. We have seen species, which do not normally have darkened hind wing outer margins, with varying degrees of pigmentation present in individuals emerging in mountain streams or early in the season. The presence or absence of abdominal spiracular markings is subject to the same type of variability in some species.

In a single species, the narrow dark posterior transverse line on the abdominal terga (Fig. 90) may sometimes be reduced to a pair of submedian dashes (Fig. 91) or a short transverse median dash (Fig. 87). Such variation (previously considered species specific) is widespread throughout *Stenonema* and, based on the consistency of symmetrical reduction in both cases, is possibly due to a single pair of alleles (simple dominance–recessiveness).

Two general types of adult abdomens occur. The first type (Fig. 81, 82, 83, 84, 85) is extensively shaded; the second (Fig. 86, 89, 94, 95, 96, 97) is primarily hyaline or light colored. Interestingly, most darker species are primarily montane or northern in distribution. When light colored species occur in the mountains, some additional shading may occur (Fig. 88).

Mature larvae usually have more extensive pale markings and, thus, more discernable color patterns than younger individuals. However, the converse has been reported in at least one species (Flowers and Hilsenhoff 1975). Distinctive abdominal patterns are found in some species but structural characters should always be examined as some color variability occurs in all species (more so in widespread species). Many color patterns are variations on a common theme (a reflection of a high percentage of common genetic material in the genus). At the extreme, we have seen individuals of two distinctive species with identical ventral abdominal maculation typically not found in either.

Use of Keys

In the larval key, we have employed structural characters whenever possible and used color characters conservatively. We key out color variable species more than once when necessary. Further, the key is based on mature larvae (wing pads more than ½ final length); younger individuals may be difficult or impossible to identify to species. Individual morphological figures exemplify typical individuals and do not represent the range of variability in any species. The reader is cautioned against attempting to match an individual specimen to an illustration without examining other character states and taking into account stated variability.

The adult male key is reliable for almost all individuals likely to be encountered. However, because of adult color variability and the paucity of other reliable characters, it has been necessary again to key several species at more than one point.

Adult females remain difficult to identify to species. A brief key is provided that, hopefully, can be expanded with future use of egg characters.

Whenever absolute identifications are essential, the user is strongly urged to rear material for complete verification. With larval–adult associations, species identification in *Stenonema* can be greatly simplified.

Systematic Accounts and Keys

Genus *Stenonema* Traver

Generis incerti of *Ecdyurus* type, nymphs No. II. Eaton, 1883–88: 262
Ecdyurus (in part) Eaton 1883–88: 278
Heptagenia (in part) Eaton 1883–88: 298; Ulmer 1920a: 141
Nameless, Eaton 1883–88: pl. 58
Heptagenia, Banks 1910: 197; Clemens 1913: 247; 1915: 131; Ulmer 1939: 570
Ecdyonurus (in part) Ulmer 1920a: 143; Spieth 1933: 330

Ecdyonurus, McDunnough 1924: 117
Stenonema (in part) Traver 1933a: 173; 1933b: 113; 1935: 295; Spieth 1947: 87; Berner 1950: 57; 1959: 52; Burks 1953: 154; Koss 1968: 704; Landa 1969: 299; Lewis 1974b: 4
Stenonema, Jensen (unpublished data); Jensen and Edmunds 1973: 83; Edmunds et al. 1976: 202; Bednarik 1979: 190

Type species: *Heptagenia tripunctata* Banks (= *Stenonema femoratum* (Say)), by original designation (Traver 1933a)

Distribution — *Stenonema* is primarily restricted to the Nearctic region with one species extending into the Neotropical region.

LARVA

Length (mature specimens) of body 6–20 mm; caudal filaments 12–27 mm.

Head — Head capsule 1.25–1.50 times wider than length; anterior margin entire, convex, or with slight median emargination, sparsely to moderately setaceous; lateral margins convex or straight, subparallel; posterior margin straight, convex, or slightly emarginate medially. Labrum (Fig. 14) approximately ½ width of head capsule and 3 times wider than length; anterior margin with shallow, broad emargination and with long setae and oblique row of spinelike setae on ventral surface. Maxillae (Fig. 14, 18, 19) each with 2-segmented palpus with apex of apical segment acute, and 1.5–2.0 times length of basal segment; armature on galea–lacinial crown consisting of 2–9 spinelike setae and 0–50 hair setae; inner lacinial margin with 2 dense setal rows, 3 distal denticles, several long proximal setae, and ventral submedial row of setae. Left mandible (Fig. 15) with outer incisor serrate on inner margin and 1 large apical tooth and 1 large subapical tooth; inner incisor with 3 large apical teeth; inner incisor about ⅞ as long as outer incisor with lacinia mobilis present. Right mandible (Fig. 16) similar to left except inner incisor with apical tooth sharply acute and lacinia mobilis absent. Labium (Fig. 14) with V- or Y-shaped glossal separation; paraglossae moderately expanded laterally; apical segment of each palpus variable in length relative to basal segment. Hypopharynx (Fig. 14) with lingua conical apically, superlinguae developed laterally.

Thorax — Prothoracic notum widest anterolaterally. Fore femora usually with short spinelike setae and sparse, short hair setae on anterior margins; dorsal surfaces with setae acute, elongate, and/or oval (Fig. 9–11); fore tibiae and tarsi with small spinelike setae and sparse to dense hair setae; tibiae 0.9–1.1 times length of femora; tarsi 0.3–0.4 times length of femora, 0.3–0.4 times length of tibiae. Middle and hind legs similar to forelegs; armature usually denser. Fore tarsal claws denticulate (Fig. 8) or not (Fig. 7).

Abdomen — Pair of gills on abdominal segments 1–6 (Fig. 3, 5) with lamellae rounded or truncate at apices; fibrilliform portions well developed. Pair of gills on abdominal segment 7 (Fig. 4, 6) with lamellae reduced to slender filaments, fringed with setae and with tracheae present or absent; fibrilliform portions absent. Lateral abdominal projections on segments 3–9, 4–9, 5–9, 6–9, or 7–9. Cerci and median terminal filament present and well developed, with spines usually present at segment articulations; setae variable in extent.

Internally, ventral tracheae anastomosed in abdominal segments 8 and 9; ventral nerve cord with ganglia in abdominal segments 2–7; nerve cord fused between posterior 4 ganglia.

MALE IMAGO

Length of body 5–15 mm; fore wing 5–17 mm.

Head — Compound eyes variable (Fig. 21–32), separated dorsally by distance slightly less than, equal to, or greater than width of lateral ocellus; frontal margin of head variably produced ventrally. Antennae each with approximately 25 segments, pedicel longer than scape; segments of flagellum slender.

Thorax — Forelegs slightly shorter to longer than body; fore tibiae equal to or slightly longer than femora; fore tarsi longer than femora; fore tarsi longer than tibiae; first fore tarsal segment 0.25–0.80

times longer than second (fore tarsal ratio 1.2–4.0); second and third fore tarsal segments approximately equal in length; fourth usually shorter than third; fifth shorter than fourth. Hind legs with tibiae slightly shorter than femora; tarsi less than ½ length of femora; tarsi approximately ½ length of tibiae; fifth hind tarsal segment longer than other segments; first, second, and third hind tarsal segments variable in relative lengths; fourth hind tarsal segment shorter than other segments. Tarsal claws of all legs dissimilar. Fore wings (Fig. 34) with typical heptagenine venation; basal costal crossveins well developed, stigmatic crossveins straight or slightly slanted; crossveins in bulla region sometimes crowded. Hind wings each with obtuse costal projection; hind wing approximately ⅓ length of fore wing.

Abdomen — Abdomen with 10 segments; genitalia (Fig. 38) with pair of 4-segmented forceps; penes each more or less L-shaped, often separated to base and expanded laterally at apex; small spines present apically and distally; pair of well-developed curved median spines present. Pair of cerci present, variable in length.

Female Imago

Similar to male in overall appearance. Compound eyes smaller than male and more widely separated dorsally; posterior margin of head slightly emarginate. Fore femora equal to or slightly shorter than fore tibiae; fore tarsi slightly shorter than fore tibiae, fore tarsal segments approximately subequal; hind legs similar to male. Posterior margin of subanal plate variable.

Egg

Shape ovoid to nearly circular; chorion usually with tubercles; tubercles often arranged in reticular pattern; polar cap absent; adhesive layer for attachment structure. Micropyle linear; sperm guide appearing as elongate break in adhesive layer, often with basal hood.

Key to Mature Larvae

1 Gill lamellae on abdominal segments 1–6 rounded at apices (Fig. 3); gill 7 tracheated (Fig. 4) ..... (subgen. *Stenonema*) ..... *S. femoratum*

Gill lamellae on abdominal segments 1–6 truncate at apices (Fig. 5); gill 7 untracheated (Fig. 6) ..... (subgen. *Maccaffertium*) 2

2 Lateral projections present on abdominal segments anterior to 6 (Fig. 59) 3

Lateral projections absent on abdominal segments anterior to 6 (Fig. 74) 11

3 Each maxillary crown with less than 10 (usually 0) hair setae 4

Each maxillary crown with 10 or more hair setae 5

4 Ventral abdominal pattern consisting of dark bands extending obliquely or transversely (Fig. 63, 64, 65); fore tarsal claws with or without denticles; 0–9 maxillary crown hair setae present; length of mature larva 10 mm or less ..... *S. mediopunctatum*

Abdomen without distinct ventral crossbands as above; fore tarsal claws without denticles; 0 maxillary crown hair setae present; length of mature larva 12 mm or more ..... *S. carlsoni*

5 Ventral abdominal pattern consisting of dark bands (occasionally interrupted medially) extending transversely across posterior margins of at least sterna 5–8 (Fig. 59, 60, 61); 2–5 spinelike setae on maxillary crown 6

Ventral abdominal segments without dark posterior crossbands on sterna 5–8; sterna 5–8 with maculations variable (Fig. 78, 79) or absent; 2–8 spinelike setae on maxillary crown 7

6 Posterior band on sternum 8 narrowest medially, gradually widening sublaterally (Fig. 61); fore tarsal claws with denticles; lateral projections on abdominal segment 9 shorter than on 8; 2–4 spinelike setae on maxillary crown; setae sparse or lacking on outer margins of cerci; armature on dorsal surfaces of fore femora often predominately oval-shaped setae (Fig. 11); mature larva 9–10 mm long ..... *S. luteum* (in part)

Posterior band on sternum 8 approximately same width across most of segment (Fig. 59, 60); fore tarsal claws without denticles; lateral projections on abdominal segment 9 usually as long as or longer than on 8; setae usually dense over much of outer margins of cerci; armature on dorsal surfaces of fore femora predominately acute spinelike or elongate setae (Fig. 9, 10); mature larva 10–18 mm long ..... *S. vicarium* (in part)

7 Ventral abdominal segments with maculations near anterior margins on at least sterna 5–8 as in Fig. 78 or 79; fore tarsal claws without denticles ..... *S. pudicum* (in part)

Ventral abdominal segments 4–8 pale or without distinct maculations as above; fore tarsal claws with or without denticles 8

8 Abdominal terga 2–7 with distinct crossbands on posterior ¼ of segments forming a sharp contrast with pale areas (Fig. 58) ..... *S. vicarium* (in part)

Abdominal terga 2–7 not exactly as above; posterior bands much narrower or absent 9

9 Fore tarsal claws with denticles; 2–4 spinelike setae on maxillary crown; mature larvae 9–10 mm long. Distribution p. 25 ..... *S. luteum* (in part)

Fore tarsal claws without denticles; 2–8 spinelike setae on maxillary crown; mature larvae 10–14 mm long. Distribution p. 33 or 37 10

10 Maxillae each with 5–8 spinelike setae on crown; mature larva 11–14 mm long; mandibles usually with more than 10 teeth on inner margin of outer incisors. Distribution p. 33 ..... *S. pudicum* (in part)

Maxillae each with 3 (rarely 4) spinelike setae on crown; mature larva 10–12 mm long; mandibles with 8–10 teeth on inner margin of outer incisors. Distribution p. 37 .... *S. sinclairi*

11 Maxillary crown with less than 10 (usually 0) hair setae 12

Maxillary crown with 10 or more hair setae 18

12 Distinctive pale V-shaped areas on abdominal terga 5 and either 7 or 8 or 7–9 (Fig. 77); mandibles with 9–16 teeth on inner margin of outer incisors; mature larva 10–16 mm long; fore tarsal claws not denticulate ..... *S. meririvulanum*

Abdominal terga without pale V-shaped areas; mandibles with 4–8 (rarely 9) teeth on inner margin of outer incisors; mature larva 7–11 mm long; fore tarsal claws denticulate or not denticulate 13

13 Mesonota with conspicuous large pale spots or complete pale band at wing pad bases (Fig. 75) ..... *S. exiguum*

Mesonota without large pale spots or complete pale band at wing pad bases 14

14 Maxillary crowns with 1–8 hair setae ..... *S. terminatum* (in part)
Maxillary crowns with 0 hair setae 15

15 Terminal sternum with brown posterior margin (Fig. 72) ..... *S. terminatum* (in part)

Terminal sternum with pale posterior margin 16

16 Abdominal sterna 4–7 with brown lateral longitudinal markings and anterior stripes or dashes extending obliquely laterad (Fig. 71); abdominal tergum 7 mostly dark ..... *S. terminatum* (in part)

Abdominal sterna 4–7 without above dark markings (Fig. 74); abdominal tergum 7 variable in color 17

17 Abdominal tergum 7 mostly white (Fig. 73); fore tarsal claws with denticles; maxillae each with 5 or 6 spinelike setae on crown ..... *S. pulchellum*

Abdominal tergum 7 mostly dark (Fig. 70); fore tarsal claws with or without denticles (usually without); maxillae each with 2–6 spinelike setae on crown... *S. terminatum* (in part)

18 Abdominal terga 7, 8, and 9 with distinct V-shaped pale mark (Fig. 76); maxillae each with 2 or 3 spinelike setae on crown ..... *S. integrum*

Abdominal terga 7, 8, and 9 without V-shaped pale mark; maxillae each with 3–7 (rarely 3) spinelike setae on crown 19

19 Abdominal sterna 3–8, 4–8, 5–8, or 6–8 with distinct pattern of oblique crossbars (Fig. 62, 66) 20

Abdominal sterna without above pattern, if crescent-shaped crossbars present, then on 7 and/or 8 only 22

20 Fore tarsal claws not denticulate; maxillae each with 15–35 hair setae on crown ..... *S. ithaca* (in part)

Fore tarsal claws denticulate; maxillae each with 15–50 hair setae on crown 21

21 Maxillae each with 30 or less hair setae on crown ..... *S. ithaca* (in part)

Maxillae each with more than 30 hair setae on crown ..... *S. modestum* (in part)

22 Abdominal sternum 8 with anteromedian brown area (Fig. 68), sometimes expanded to form crescent-shaped maculations on sternum 8 and occasionally 7 (Fig. 67) ..... *S. modestum* (in part)

Abdominal sterna 8 and 7 without above markings, either pale or with variable median or submedian dots, or with dashes or lateral longitudinal streaks or with any combination of the above 23

23 Distribution Florida and Alabama. Abdominal sterna usually with dark markings (Fig. 69) ..... *S. smithae* (in part)

Distribution north of Georgia. Abdominal sterna variable in maculation ..... *S. modestum* (in part)

Distribution Georgia 24

24 Maxillae each with 30 or more hair setae on crown ..... *S. smithae* (in part)

Maxillae each with less than 30 hair setae on crown ..... *S. modestum* (in part)

Key to Male Imagos

1 Posterior margins of abdominal terga 3–8 each with median dot and pair of transverse submedian dashes (Fig. 80); fore wings with crossveins crowded in at least first 3 interspaces of bulla region (Fig. 34) ..... (subgen. *Stenonema*) ..... *S. femoratum*

Posterior margins of abdominal terga 3–8 without above markings; fore wings with crossveins crowded or not crowded in first 3 interspaces of bulla region ....(subgen. *Maccaffertium*) 2

2 Compound eyes separated dorsally by distance equal to or less than maximum width of lateral ocellus (Fig. 21, 24) 3

Compound eyes separated dorsally by distance greater than maximum width of lateral ocellus (Fig. 27, 30) 10

3 Fore wings (Fig. 35) with crossveins crowded in at least first 6 interspaces of bulla region; hind wings broadly darkened on outer margins 4

Fore wings (Fig. 34, 36, 37) with crossveins either crowded in first 3 interspaces of bulla region, or not crowded at all; hind wings with outer margins not darkened 5

4 Abdominal terga brown in posterior ¼ or more; brown areas extending forward especially in middorsal area, often forming saggittate middorsal areas (Fig. 84) ..... *S. pudicum*

Abdominal terga with posterior brown bands not extending forward in middorsal areas (Fig. 85) ..... *S. carlsoni*

5 Fore tarsal ratio 3.5 or more 6

Fore tarsal ratio less than 3.5 7

6 Penes with distinctive shape (Fig. 42). Limited distribution (p. 37) ..... *S. sinclairi*

Penes more or less boot-shaped as in Fig. 40. Widespread (p. 44) ..... *S. vicarium* (in part)

7 Transverse shelf of face below antennae extending well below compound eyes (Fig. 22, 23) ..... *S. vicarium* (in part)

Transverse shelf of face below antennae extending only to level of compound eyes or slightly beyond (Fig. 25, 26) 8

8 Fore tarsal ratio 3.0 or more ..... *S. vicarium* (in part)

Fore tarsal ratio less than 3.0 9

9 Mesonota and/or abdominal terga with reddish brown cast; posterior margins of abdominal sterna narrowly to broadly darkened, resulting in more or less annulate appearance ..... *S. ithaca*

Mesonota and abdominal terga brown; abdominal sterna immaculate or with variable brown patches and shading but posterior margins not as above ..... *S. vicarium* (in part)

10 Longitudinal middorsal lines on abdominal terga 3 and 6 (Fig. 94); penes rounded (Fig. 49); fore wing with cells distal to bulla region often somewhat elongate (Fig. 36) ..... *S. integrum* (in part)

No dark longitudinal middorsal lines on abdominal terga 3 and/or 6; penes variable; fore wings variable 11

11 Spiracular marks absent 12

Spiracular marks present 17

12 Hind wings with outer margins darkened 13

Hind wings with outer margins not darkened 15

13 Abdominal terga 3–6 with short median transverse lines at posterior margins; caudal filaments with pigmented segment articulations ..... *S. integrum* (in part)

Abdominal terga 3–6 with posterior transverse lines extending across segments; caudal filaments without pigmented segment articulations 14

14 Penes shaped as in Fig. 48; fore tarsal ratio 1.3–1.9; distinct reddish tinge in stigmatic area; median band on mid and hind femora ..... *S. exiguum* (in part)

Penes shaped as in Fig. 46 (less rounded); fore tarsal ratio less than 1.5; faint reddish tinge in stigmatic area; median band absent or faint on mid and hind femora ..... *S. terminatum* (in part)

15 Crossbands present at posterior margins of abdominal terga 2–7, sometimes enclosing narrow dashes (Fig. 92, 93) ..... *S. terminatum* (in part)

Narrow crosslines (Fig. 89) or pairs of narrow submedian transverse dashes (Fig. 91) present at posterior margins of abdominal terga 2–7 16

16 Narrow crosslines present at posterior margins of abdominal terga 2–7 (Fig. 89) .... *S. luteum*

Submedian transverse dashes present at posterior margins of abdominal terga 2–7 (Fig. 91) ..... *S. terminatum* (in part)

17 Caudal filaments 3.75–5.1 × length of body ..... *S. meririvulanum*

Caudal filaments not more than 3.3 × length of body 18

18 Abdominal terga 2–7 with short median transverse lines at posterior margins (Fig. 87) 19

Abdominal terga 2–7 with posterior transverse lines extending across segments (Fig. 97)... 20

19 Thorax deep black-brown; caudal filaments entirely white ..... *S. mediopunctatum* (in part)

Thorax pale brownish or clay colored; part of caudal filaments with alternate segment articulations pigmented ..... *S. modestum* (in part)

20 Hind wings with darkened outer margins 21

Hind wings without darkened outer margins 22

21 Penes shaped as in Fig. 44. Range limited to extreme southern United States (p. 39). Fore wings with 2 or 3 crossveins present in each of interspaces 2 and 3 of bulla region ..... *S. smithae*

Penes shaped as in Fig. 48. Widespread distribution (p. 19). Fore wings with 2 crossveins present in each of interspaces 2 and 3 of bulla region ..... *S. exiguum* (in part)

22 Fore wings with 2 or 3 crossveins in each of first 3 bulla interspaces .. *S. modestum* (in part)

Fore wings with 1 or 2 crossveins in each of first 3 bulla interspaces (if 3 present in third interspace then 1 crossvein in first interspace) 23

23 Thoracic nota deep brown to black; penes shaped as in Fig. 44; body length 7 mm or less 24

Thoracic nota pale yellowish brown; penes shaped as in Fig. 43 or 45; body length 8 mm or more 26

24 Mesoscutellum brown; fore tarsal ratio 1.1–1.3 ..... *S. modestum* (in part)

Mesoscutellum white or white tipped; fore tarsal ratio 1.4 or more (usually 1.7 or more).... 25

25 Mesoscutellum entirely white; fore wings with 1 or 2 crossveins in each of interspaces 2 and 3 of bulla region; abdominal terga generally white ..... *S. pulchellum*

Mesoscutellum white tipped; fore wings with 2 or 3 crossveins in at least 2 of first 3 interspaces of bulla regions; abdominal terga slightly infumated ..... *S. modestum* (in part)

26 Fore wings with stigmatic areas opaque-white, without reddish stain ..... *S. modestum* (in part)

Fore wings with distinct reddish stain in stigmatic areas 27

27 Mesoscutellum with median pale area tinged with pigmentation; compound eyes usually as in Fig. 30; penes shaped as in Fig. 45 ..... *S. modestum* (in part)

Mesoscutellum white, never tinged with pigmentation; compound eyes as in Fig. 27; penes shaped as in Fig. 43 28

28 Abdominal tergum 8 nearly entirely shaded with pinkish brown; mesonotum ocher-brown; fore tarsal ratio less than 2.0 ..... *S. mediopunctatum* (in part)

Abdominal tergum 8 with medial longitudinal pinkish brown shading only; mesonotum light clay colored; fore tarsal ratio usually more than 2.0 ..... *modestum* (in part)

Key to Female Imagos

1 Abdominal terga 2–8 each with median black dot and pair of transverse submedian dashes (Fig. 80) ..... (subgen. *Stenonema*) ..... *S. fermoratum*

Abdominal terga 2–8 without above markings ..... (subgen. *Maccaffertium*) 2

2 Fore wings each with crossveins crowded in first 6 or more interspaces of bulla region (Fig. 35) 3

Fore wings each with crossveins crowded in first 3 interspaces of bulla region or not crowded at all (Fig. 34, 36, 37) 4

3 Abdominal terga 2–7 each with middorsal longitudinal saggitate mark (Fig. 84)... *S. pudicum*

Abdominal terga 2–7 without middorsal longitudinal saggitate mark (Fig. 85) .... *S. carlsoni*

4 Abdominal terga 2–7 each with broad brown transverse band on posterior ¼ or more of terga and/or dark middorsal band (Fig. 81, 82, 83) .....
..... *S. vicarium, S. ithaca, S. sinclairi*

Abdominal terga 2–7 variable but without markings as above 5

5 Longitudinal middorsal lines on abdominal terga 3 and 6 (Fig. 94) ..... *S. integrum*

Longitudinal middorsal lines lacking on abdominal terga 3 and 6 6

6 Spiracular marks absent 7

Spiracular marks present (Fig. 86) 8

7 Abdominal terga 2–7 with transverse band only, band enclosing pair of short, submedian dashes, or with pair of short, submedian dashes only on posterior margin (Fig. 91, 92, 93) .... *S. terminatum* (in part)

Abdominal terga 2–7 with narrow, transverse lines on posterior margins (Fig. 89, 90) ....*S. terminatum* (in part), *S. exiguum* (in part), *S. luteum*

8 Abdominal terga 2–7 with short median transverse dashes on posterior margins (Fig. 87) ..... *S. mediopunctatum* (in part), *S. modestum* (in part)

Abdominal terga 2–7 with narrow transverse lines on posterior margins (Fig. 95, 96, 97) .....*S. mediopunctatum* (in part), *S. modestum* (in part), *S. meririvulanum, S. pulchellum, S. smithae, S. exiguum* (in part)

Subgenus *Stenonema* s.s.

Type Species: *Heptagenia tripunctata* Banks (= *Stenonema femoratum* (Say)), by original designation (Traver 1933a)

Larva

Mandibles each with 2–5 teeth on inner margin of outer incisor; maxillae (Fig. 18) each with hair setae present on crown. Fore tarsal claws denticulate (Fig. 8). *Gills on abdominal segments 1–6 (Fig. 3) rounded apically; gills on 7 (Fig. 4)* reduced to slender filaments, fringed with setae, and *with tracheation present.* Lateral projections on abdominal segments 3–9.

Male Imago

Fore wings with crossveins crowded in at least first 3 bulla interspaces (Fig. 34). Genitalia (Fig. 38) with medial margins of penes incurved.

Stenonema femoratum (Say)

Baetis femorata Say, 1823: 162; Hagen 1861: 48; 1863: 169
Heptagenia tripunctata Banks, 1910: 199; Clemens 1913: 253; 1915: 137
Ecdyonurus femoratus (Say), McDunnough 1925b: 190
Ecdyonurus tripunctatus (Banks), Ide 1930: 230; McDunnough 1933: 19 (discussion of *Ecdyonurus rubromaculatus*)
Stenonema femoratum (Say), Traver 1933a: 174; 1935: 311; Burks 1953: 169; Koss 1968: 706 (egg); Lewis 1974b: 22
Stenonema tripunctatum (Banks), Traver 1933a: 176; 1935: 332; Burks 1953: 168; Leonard and Leonard 1962: 103; Koss 1968: 708 (egg)

Stenonema birdi Traver, 1935: 306
Stenonema scitulum Traver, 1935: 330; Lewis 1973: 65
Stenonema femoratum femoratum (Say), Spieth 1947: 98 (new status)
Stenonema femoratum tripunctatum (Banks), Spieth 1947: 99 (new status)
Stenonema femoratum scitulum Traver, Spieth 1947: 100 (new status)
Stenonema tripunctatum tripunctatum (Banks), Lewis 1974b: 35
Stenonema tripunctatum scitulum Traver, Lewis 1974b: 35

LARVA

Length 8–12 mm.

Head — Brown or light brown with pale markings; freckled, pale dots present; pair of sublateral spots usually present on anterior margin; anteromedian pale spot sometimes present. *Mandibles each with 4–8 (usually 5–8) teeth on inner margin of outer incisor; maxillae (Fig. 18) each with 2–5 (usually 2–4) spinelike setae and 2–30 (usually 10–30) hair setae on crown,* and 20–45 (usually 25–40) setae in submedial row.

Thorax — Brown to light brown with variable yellow or white spots. Fore femora with spinelike setae over most of dorsal surfaces; posterior margins of fore femora with spinelike setae and hair setae; anterior margins with spinelike setae, usually lacking hair setae. Tarsal claws denticulate (Fig. 8).

Abdomen — Dorsally brown or light brown, ventrally pale. *Terga 8, 9, part of 7, and often anterior portion of 10 with large, conspicuous, X-shaped pale area*; tergum 5 with smaller medial, pale, more or less X-shaped area (Fig. 56). Sterna 2–8, 3–8, 4–8, or 5–8 each with pair of sublateral dark spots in anterior half; terminal sternum with pair of entire, or broken, brown areas on lateral margins, sometimes connected posteriorly (Fig. 57). *Lateral projections on segments 3–9; those on segment 9 approximately as long as on segment 8 and longer than ventral lateral margins posterior to projection bases.* Caudal filaments yellow basally, apically with alternating light and dark segments.

MALE IMAGO

Length 8–11 mm.

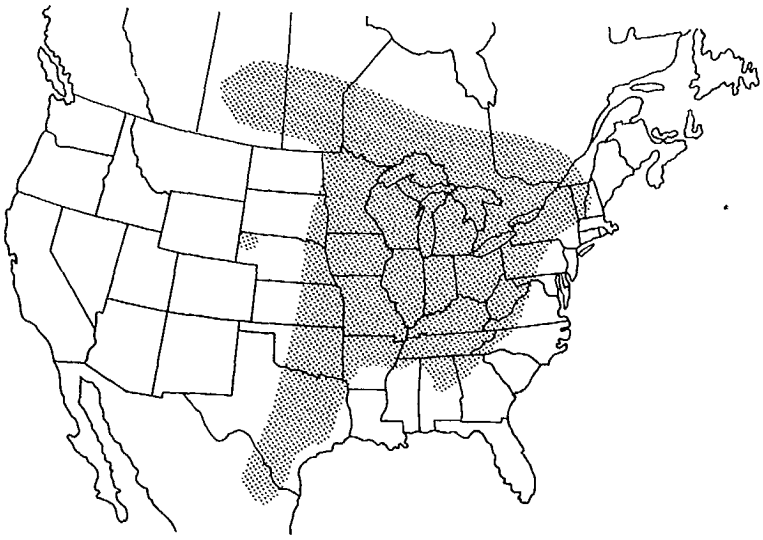
Head — Pale yellow to reddish brown. Compound eyes dorsally separated by distance less than or equal to width of lateral ocellus (similar to Fig. 21).

Thorax — Pale yellow or creamy to red-brown; mesoscutellum paler than remainder of mesonotum, at least apically. Fore tibiae yellow with apices dark; fore tarsal ratio 1.5–2.8. Fore wings hyaline with longitudinal veins yellow to brown; crossveins usually darker than longitudinal veins, sometimes dark margined especially in bulla area; red-brown, reddish, or purple stain in stigmatic area; *3, 4, or 5 crossveins in each of first 3 bulla interspaces, crowded (Fig. 34), crossvein crowding sometimes continuing through first 6 bulla interspaces*; 10–20 crossveins in first interspace distal to bulla region. Hind wings with variable darkening on outer margins.

Abdomen — Hyaline or semihyaline-white or -yellow, sometimes with brown shading. Terga 8–10 darker, similar in color to thorax. *Terga 2–7 each with median transverse black dash and pair of dashes laterad on posterior margins* (Fig. 80); spiracular dots present. Caudal filaments pale; segment articulations pigmented; alternate articulations darker. Penial shape similar to Fig. 38; median posterior margins incurved.

FEMALE IMAGO

Subanal plate — Posterior margin usually similar to Fig. 50 or 55.



Distribution of *S. femoratum.*

Biology and Ecology

Stenonema femoratum is found in various aquatic environments; larvae are common in small, cool streams and under rocks in lakes. Lyman (1956) reported that *S. femoratum* did not require distinctly rocky areas in lakes and tolerated shallow water, and considered these to be factors influencing the relative abundance of this species in certain situations. Lewis (1974b) indicated that *S. femoratum* was highly pollution tolerant.

In some parts of its range, *S. femoratum* exhibits a long emergence period extending from early spring through much of the summer (Spieth 1947). In a study in West Virginia, Richardson and Tarter (1976) found that its life cycle (as *S. tripunctatum*) takes 1 yr to complete. Lyman (1955) noted three distinct emergence peaks in *S. femoratum* in Douglas Lake, Michigan (also see discussion below).

McCafferty and Huff (1974) reported the existence of parthenogenesis in *S. femoratum.* In the population studied, the percent of parthenogenetic hatch was 1.23. Based on a preliminary estimate of a one to one sex ratio, McCafferty and Huff considered parthenogenesis to be facultative and deuterotokous.

Discussion

Stenonema femoratum was extensively studied by Spieth (1947), and we refer the reader to that work for a complete account of the variation in this species.

Burks (1953) and Lewis (1974b) recognized *S. femoratum* and *S. tripunctatum* as valid species. Lewis (1973, 1974b) described the larvae of *S. tripunctatum scitulum.* This subspecific status was based on the number of maxillary crown spinelike setae (= pectinate spines of Lewis) and the lack of crowding of crossveins in bulla interspaces 4, 5, and 6. As defined by Lewis (1974b), *S. femoratum* larvae have 2 maxillary crown spinelike setae, and *S. t. tripunctatum* and *S. t. scitulum* have 3 or more. We have seen individuals with 2 spinelike crown setae on 1 maxilla and 3 on the other.

Lewis (1974b) also referred to distinct differences in the eggs of *S. femoratum* and *S. tripunctatum* described by Koss (1968). Our examination of females identified by Koss for his study has shown that he used the name *S. femoratum* in the sense of Burks (1953); therefore, Koss' *S. femoratum* is equivalent to *S. t. scitulum* of Lewis.

Based on the above, variation observed in large series of specimens examined, and Spieth's (1947) detailed evidence of intraspecific variation, we regard *S. tripunctatum* and *S. scitulum* as junior synonyms of *S. femoratum*.

There is no evidence that intraspecific differences are genetic. Also, because of the presence of many intermediate individuals in populations and lack of geographic isolation, we do not recognize subspecies in this group. Spieth (1947) suggested that variation may be due to nongenetic factors. It seems likely that differences are correlated with life cycle and/or ecological variation. A relationship of phenotype and time and conditions of larval growth, similar to that reported for *Stenacron interpunctatum* (Say) by McCafferty and Huff (1978) may be present.

Larvae and adults of *S. femoratum* can be easily distinguished from other *Stenonema* by key characters. Very rarely, tracheation in the 7th gills may be unclear in some individuals.

Subgenus *Maccaffertium* Bednarik, 1979

Type Species: *Heptagenia integer* McDunnough (= *Stenonema integrum* (McDunnough)), by original designation (Bednarik 1979)

Larva

Mandibles each with 4–16 teeth on inner margin of outer incisor; maxillae (Fig. 19, 20) each with hair setae present or absent on crown. Fore tarsal claws denticulate or not. *Gills on abdominal segments 1–6 (Fig. 5) truncate apically; gills on 7 (Fig. 6)* reduced to slender filaments, fringed with setae, *and with tracheation absent.* Lateral projections on abdominal segments 3–9, 4–9, 5–9, 6–9, or 7–9.

Male Imago

Fore wings with crossveins crowded or not crowded in first 3 bulla interspaces. Genitalia (Fig. 40-49) with medial margins of penes not incurved or only slightly incurved.

Stenonema carlsoni Lewis

Stenonema pudicum (Hagen) ?, Traver (nec Hagen, 1861) 1933a: 187
Stenonema pudicum (Hagen) (in part), Traver 1935: 327
Stenonema carlsoni Lewis, 1974a: 347; 1974b: 21

Larva

Length 12–14 mm.

Head — Dark brown with pale markings; freckled, pale dots present; large pale areas laterad of compound eyes each divided by brown band extending from eye to lateral margin. *Mandibles each with 8–12 (usually 8–10) teeth on inner margin of outer incisor; maxillae each with 6–9 (usually 7 or 8) spinelike setae and 0 hair setae on crown* and 25–45 (usually 30–40) setae in submedial row.

Thorax — Dark brown; pronotum with pair of pale lateral areas extending most of length of lateral margins; fore femora with armature on apical ⅔–¾ dorsal surfaces; posterior margins of fore femora with spinelike setae and long hair setae; anterior margins usually with shorter and sparser armature. Fore tarsal claws not denticulate (Fig. 7).

Abdomen — Dorsally tan to brown, ventrally pale. Terga 4, 5, 7, 8, and sometimes 9 with pair of pale submedian areas, sometimes confluent near middorsal line posteriorly; 6 and 10 predominately brown. Sterna 2–8 entirely pale or with faint submedian dots and oblique lines anteriorly; 9 often darkened on lateral margin. *Lateral projections on segments 3–9 or 4–9; those on segment 9 shorter than on 8 and usually slightly shorter than ventral lateral margins posterior to projection bases.* Caudal filaments tan; spinous at segment articulations; setae extremely sparse or lacking on outer margins of cerci.

MALE IMAGO

Length 10–12 mm.

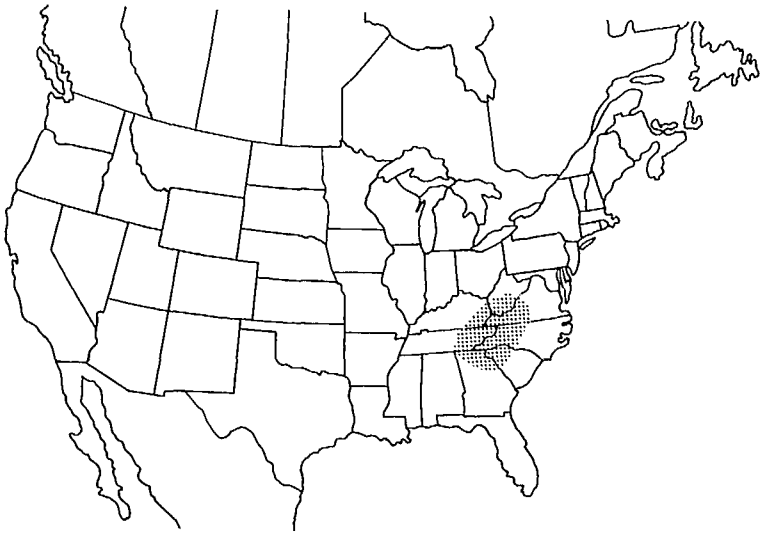
Head — Yellowish brown or reddish brown. Compound eyes dorsally separated by distance approximately equal to or less than width of lateral ocellus (similar to Fig. 21).

Thorax — Brown to reddish brown or yellowish brown; mesoscutellum dark brown. Fore tibiae tan with apices dark; fore tarsal ratio 1.4–2.0. Fore wings hyaline with longitudinal veins brown; crossveins brown, often margined; reddish brown stain in stigmatic area; *2–4 crossveins in each of first 3 bulla interspaces, crowded in first 6–8 bulla interspaces (Fig. 35), forming curved streak*; 11–18 (usually 13–16) crossveins in first interspace distal to bulla region. *Hind wing outer margins broadly darkened.*

Abdomen — Hyaline-brown to brown. Terga 1–7 with posterior transverse bands; 8–10 often with middorsal white areas; spiracular marks obscure (Fig. 85). Caudal filaments yellow to cream; segment joints darkened; alternate joints darker over most of lengths of filaments. Penes shaped as in Fig. 41.

FEMALE IMAGO

Subanal plate — Posterior margin similar to Fig. 52.



Distribution of *S. carlsoni.*

Biology and Ecology

Stenonema carlsoni is primarily an upland stream species. No information is available on pollution tolerance, but to date it has been collected in relatively clean streams (Lewis 1974b).

Discussion

Stenonema carlsoni is closely related to *S. pudicum* but has a more southern distribution. In the northern part of its range, it is sympatric with *S. pudicum* (see discussion of *S. pudicum*).

The presence of lateral projections on anterior abdominal segments, lack of maxillary crown hair setae, and absence of distinctive ventral abdominal maculation easily distinguish *S. carlsoni* larvae.

Male adults are also readily identifiable using wing venation (Fig. 35) and abdominal maculation (Fig. 85).

Stenonema exiguum Traver

Stenonema exiguum Traver, 1933a: 201; 1935: 310; Daggy 1945: 374; Berner 1950: 70; Lewis 1974b: 22
Stenonema alabamae Traver, 1937: 79
Stenonema integrum, Leonard and Leonard (nec McDunnough, 1924) 1962: 109
Stenonema quinquespinum Lewis, 1974a: 353; 1974b: 32 (n.syn.)

Larva

Length 9–11 mm.

Head — Brown with pale markings; freckled, pale dots present; large pale areas laterad of compound eyes each divided by brown band extending from eye to lateral margin. *Mandibles each with 4–9 (usually 6–8) teeth on inner margin of outer incisor; maxillae each with 4–9 (usually 5 or 6) spinelike setae and 0 hair setae on crown* and 15–34 setae in submedial row.

Thorax — Brown; pronotum with scattered, pale dots and pair of large anterior pale spots, halfway between lateral margin and middorsal line; mesonotum with row of large pale maculae or complete pale band across wing pad bases (Fig. 75). Fore femora with scattered armature over most of dorsal surfaces; posterior margins of fore femora with long spinelike setae and hair setae; anterior margins with armature sparse or absent. Fore tarsal claws usually denticulate.

Abdomen — Dorsally brown with large pale areas; ventrally pale. Terga 1–3 usually pale; 4 and 5 with pale and brown areas approximately equal in extent; 6, 8, and 10 mostly brown; 7 mostly pale or pale medially and brown laterally; 9 variable, often pale medially (Fig. 75). Sterna 1–7 pale; 8 entirely pale, with lateral brown areas, or with lateral brown areas and anteromedian brown spot; 9 usually somewhat like 8, sometimes with brown areas on lateral margins extending to posterior margin. *Lateral projections on segments 7–9; those on segment 9 shorter than on 8 and shorter than ventral lateral margins posterior to projection bases.* Caudal filaments with alternating dark and light segments; setae often very sparse basally on outer margins of cerci.

Male Imago

Length 5–9 mm.

Head — Pale, white, or yellow; vertex sometimes with red or orange shading. Compound eyes dorsally separated by distance greater than width of lateral ocellus (similar to Fig. 30).

Thorax — Pale creamy white to yellowish brown, pink or orange shading sometimes present on pleuron near coxal bases; *mesoscutellum white.* Fore tarsal ratio 1.3–1.9 (usually 1.6–1.8). Fore wings hyaline with costa, subcosta, and radius yellowish brown; other longitudinals generally pale; crossveins brown; reddish stain in stigmatic area; usually 1 or 2 crossveins in each of first 3 bulla interspaces, not crowded (Fig. 37); 6–12 (usually 8 or 9) crossveins in first interspace distal to bulla region. *Hind wings dark, usually narrowly, on apical portions of outer margins.*

Abdomen — Segments 1–7 hyaline-white; 8–10 opaque, creamy, or white in middorsal regions. Terga 2–7 with narrow, dark transverse lines at posterior margins (Fig. 97); spiracular markings variable, if present, often small oblique dashes. Caudal filaments white; segment joints sometimes darkened. Penes shaped as in Fig. 48, usually somewhat rounded.

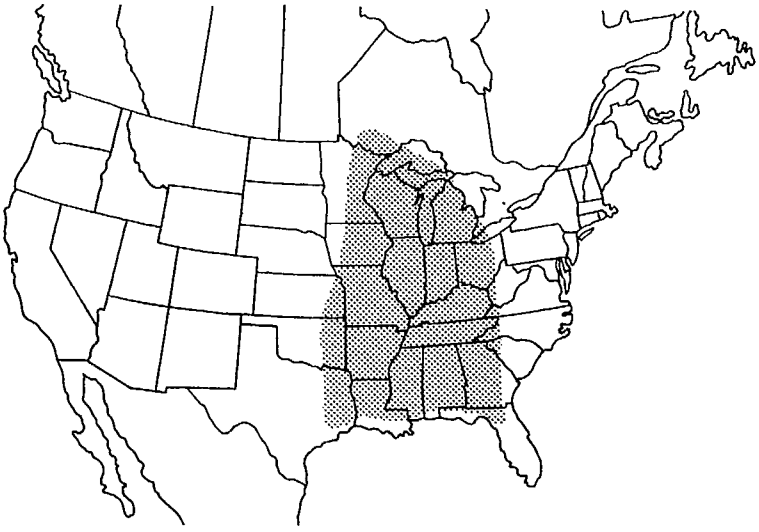
Female Imago

Subanal plate — Posterior margin usually similar to Fig. 50.

Biology and Ecology

Stenonema exiguum larvae prefer medium to large streams and rivers where they occur on rocks and debris (Lewis 1974b; Flowers and Hilsenhoff 1975). Larvae tolerate moderate organic pollution (Lewis 1974b).

The life history of *S. exiguum* in Florida, according to Berner (1950), is similar to *S. smithae* (see discussion of that species) except for a slightly shorter subimaginal period.



Distribution of *S. exiguum.*

Discussion

Our examination of type material has indicated that Lewis (1974b) was correct in synonymizing *S. alabamae* with *S. exiguum.* Shape of the penes and fore tarsal ratio in *S. alabamae* are within the range of variability encountered in *S. exiguum.*

Stenonema quinquespinum was described by Lewis (1974b) on the basis of supposed differences from *S. exiguum* in claw denticulation, penial lobe armature, and coloration — all characters found to be variable intraspecifically in related species. Flowers and Hilsenhoff (1975) found *S. exiguum* and *S. quinquespinum* to be indistinguishable in Wisconsin. We place *S. quinquespinum* as a junior synonym of *S. exiguum.* Individuals described as *S. quinquespinum* are variants differing in the extent of pale banding on the larval mesonotum. All banding forms have been taken from the same stream, and, in fact, banding is absent in all immature *S. exiguum,* developing only in later instars.

Mature larvae of *S. exiguum* are rather easily distinguished from similar species by the thoracic pale markings (Fig. 75). Immature larvae (wing pads less than ½ total length) do not have these markings and are difficult to identify.

The darkened outer margin of the hind wings, and, to some extent, the shape of the penes (Fig. 48) are useful in identifying most male adults. Occasionally, individuals have been confused with *S. integrum,* probably because of their small size; however, the latter species is easily distinguishable on the basis of the longitudinal middorsal lines on abdominal terga 3 and 6 (Fig. 94), which are absent in *S. exiguum.*

Stenonema integrum (McDunnough)

Heptagenia integer McDunnough, 1924: 9
Stenonema bellum Traver, 1933a: 202; 1935: 305
Stenonema integrum (McDunnough), Traver 1933a: 175; 1935: 317; Burks 1953: 176; Lewis 1973: 68; 1974b: 25
Stenonema wabasha Daggy, 1945: 378
Stenonema metriotes Burks, 1953: 174
Stenonema mexicana, Allen and Cohen 1977: 411 (nec Ulmer, 1920b) (larva)

LARVA

Length 7–8 mm.

Head — Brown with pale markings; freckled, pale dots present; small median pale spots on anterior and posterior margins; pair of large lateral pale spots on anterior margin; large pale areas extending most of length of lateral margins, each divided by brown band extending from compound eye to lateral margin. *Mandibles each with 5–8 teeth on inner margin of outer incisor; maxillae each with 2 or 3 spinelike setae and 30–50 hair setae on crown* and 15–27 (usually 19–25) setae in submedial row.

Thorax — Brown; pronotum with median pale stripe extending length of pronotum, attenuated on mesonotum; pronotum with pair of large pale areas on lateral margin and pair of smaller pale spots mesad of large lateral pale areas. Fore femora with rather sparse armature on dorsal surfaces often restricted to pigmented areas; posterior margins of fore femora with spinelike setae and hair setae; anterior margins usually without hair setae. Fore tarsal claws usually not denticulate.

Abdomen — Dorsally brown, ventrally pale. Terga 2–7 with pale submedian dashlike marks near anterior margins, often expanded into larger submedian pale maculae on 4 and 5, usually with large pale areas laterad of submedian dashes; *posterior terga with pale V-shaped area with vertex on posterior portion of 9 or anterior of 10, extending anteriorly to 8 or part of 7* (Fig. 76). Sterna 2-8 variable in maculation, sometimes entirely pale or pale with dark brown lateral streaks or with pair of submedian dots anteriorly; pair of dark patches laterad of dots and dark lateral streaks (similar to Fig. 69); sternum 9 usually with pair of dark areas on lateral margins often connected anteriorly forming V-shaped mark open posteriorly. *Lateral projections on segments 7–9; those on segment 9 shorter than those on 8 and shorter than ventral lateral margins posterior to projection bases.* Caudal filaments with alternating pattern of 3 dark segments to 1 pale segment or 2 dark segments to 2 pale segments for most of length; setae sparse, especially basally, on outer margins of cerci.

MALE IMAGO

Length 5–7 mm.

Head — White; vertex white or yellowish white. Compound eyes dorsally separated by distance greater than width of lateral ocellus (similar to Fig. 30).

Thorax — Mesonotum yellowish to creamy or chalky white; mesoscutellum entirely white. Fore tibiae yellowish white to yellow with apices brown to tan; fore tarsal ratio 1.4–2.1. Fore wings hyaline with costa, subcosta, and radius yellow or yellow-brown; other longitudinal veins usually paler; crossveins brown; tan, reddish brown, or brown stain usually present in stigmatic area; 1, 2, or 3 crossveins in each of first 3 bulla interspaces, slightly crowded to moderately crowded; 6–11 (usually 7–9) crossveins in first interspace distal to bulla region; crossveins below and distal to bulla region often arranged serially, often forming elongate cells (Fig. 36). *Hind wings usually narrowly darkened on outer margins.*

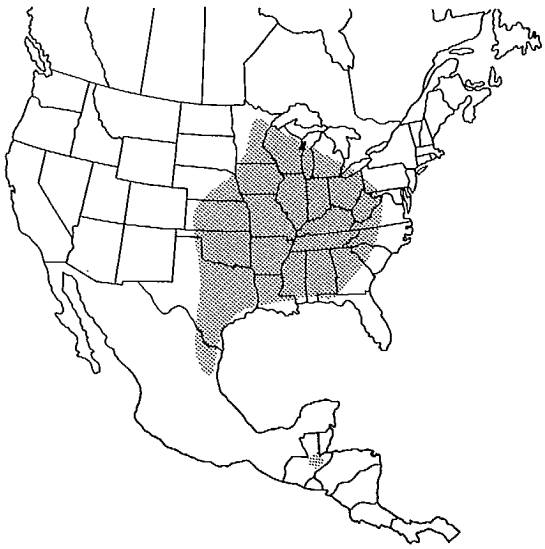
Abdomen — Terga 1–7 hyaline; 8–10 opaque, creamy to yellowish white. Terga 1–9 with narrow transverse lines at posterior margins, sometimes reduced to median transverse dashes on 2–6 and interrupted medially on 7 and 8; *3, 6 and sometimes 2 and 7 with middorsal longitudinal grey lines; oblique spiracular streaks often present* (Fig. 94). Caudal filaments whitish; alternate segment articulations usually darkened. Penes shaped as in Fig. 49, moderately to greatly rounded.

FEMALE IMAGO

Subanal plate — Posterior margin similar to Fig. 50 or 51.

Biology and Ecology

Stenonema integrum can be found in nearly any type of stream but prefers large deep rivers. It appears relatively pollution tolerant (Lewis 1974b).



Two larvae in rather poor condition for which the collecting label reads "Central America: Gualah" are tentatively identified as *S. integrum*. This locale is likely a transposition error, and the collecting area is probably Gualan in Guatemala. Moreover, larvae from Guatemala called *S. mexicana* by Allen and Cohen (1977) are actually referable to *S. integrum*.

Discussion

Previous workers (Burks 1953; Lewis 1974b) listed *S. bellum* and *S. wabasha* as synonyms of *S. integrum*. Lewis (1974b) synonymized *S. metriotes* with *S. integrum*. Our observations of extensive variability in maculation throughout the range of *S. integrum* confirm the above synonymies. Also, occasional individuals that agree with the description of *S. wabasha* by Daggy (1945) were found throughout much of the range. These represent geographically scattered color variants and, therefore, do not even warrant subspecific status as in Lewis (1974b).

Allen and Cohen (1977) tentatively transferred *Heptagenia mexicana* Ulmer to *Stenonema* based on Ulmer's (1920b) figure of male genitalia; however, these authors had not examined the adults of *H. mexicana*. Furthermore, based solely on geographic proximity to the type locality of *H. mexicana* in southern Mexico, Allen and Cohen (1977) identified *Stenonema* larvae from Guatemala as *S. mexicana*. We have examined other *Stenonema* larvae from Guatemala that match the dorsal color pattern described for Allen and Cohen's material. Mouthpart structures, which Allen and Cohen evidently did not examine, clearly indicate that the Guatemalan larvae are *S. integrum*. We have studied additional material of *S. integrum* from Texas and Mexico.

We do not recognize the actions by Allen and Cohen (1977) of generic recombination of *H. mexicana* and the association of *Stenonema* larvae with that species. The actions are based on such superficial evidence that they represent mere supposition. The genitalia of *H. mexicana* as drawn by Ulmer (1920b) are not indicative of *Stenonema*. Larvae that have not been reared, but are clearly *Stenonema*, cannot be associated at the species level with adults that have not been examined and remain very poorly known, even to the point of their generic placements. Interestingly, if the two species do prove to be synonymous, *mexicana* will have nomenclatural priority over *integrum*.

Although *S. integrum* is extremely variable in larval ventral abdominal maculation and in some adult color characters, there are distinctive and consistent color characters for the species. In larvae, the pale V-shaped dorsal pattern on the abdomen is characteristic (Fig. 76), and the low number of spinelike setae and high number of hair setae on the maxillary crown are often diagnostic. In adults, penes are small and rounded (Fig. 49) and often distinctive, the middorsal longitudinal markings on terga 3 and 6 (Fig. 94) are useful, and the nature of the fore wing venation (Fig. 36) is helpful for many

specimens. Occasionally, abdominal maculation is reduced particularly in males, and diagnostic markings are lacking. However, sampling of such populations often reveals some "typical" individuals.

Stenonema ithaca (Clemens and Leonard)

Heptagenia ithaca Clemens and Leonard, 1924: 17
Ecdyonurus ithaca (Clemens and Leonard), Ide 1930: 229; McDunnough 1933: 23 (discussion of *Ecdyonurus nepotellus*)
Stenonema ithaca (Clemens and Leonard), Traver 1933a: 174, 178, 199; 1935: 218; 1937: 40; Burks 1953: 173; Lewis 1974b: 27 (adults)
Stenonema allegheniense Carle, 1977: 711 (n.syn.)

Larva

Length 9–14 mm.

Head — Brown with pale markings; freckled, pale dots present; large pale areas laterad of compound eyes each divided by brown band extending from eye to lateral margin. *Mandibles each with 6–13 (usually 8–11) teeth on inner margin of outer incisor; maxillae each with 4–6 spinelike setae and 15–35 (usually 20–30) hair setae on crown,* and 18–35 (usually 20–30) setae in submedial row.

Thorax — Brown to grey-brown; pronotum with 2 or 3 pairs of anterior pale markings and pair of pale lateral areas extending most of length of lateral margins. Fore femora with armature in apical ½–⅔ dorsal surfaces; posterior margins of fore femora with spinelike setae and hair setae; anterior margins with variable armature; hair setae, if present, shorter than hair setae on posterior margins. Fore tarsal claws usually not denticulate.

Abdomen — Dorsally light brown to greyish brown, ventrally pale yellow with dark maculations. Terga with variable pale areas; at least some with lateral pale areas. *Sterna 2–8, 3–8, 4–8, or 5–8 with median, sinuate posterolaterally directed, transverse maculations with vertices reaching anterior margins of segments only on posterior sterna*; transverse maculations often reduced on anterior sterna; 9 with pair of sublateral to lateral, oblique, dark brown bands, often connected anteriorly on 9, forming an inverted-U (Fig. 62). *Lateral projections on segments 7–9 (rarely 6); those on segment 9 shorter than on 8 and shorter than ventral lateral margins posterior to projection bases.* Caudal filaments yellow basally, apically often with alternating light and dark segments; setae sparse or lacking basally on outer margins of cerci.

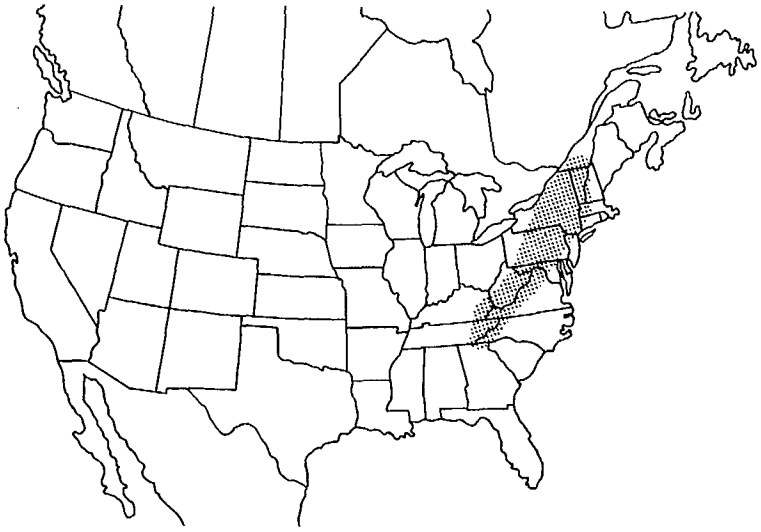
Male Imago

Length 9–13 mm.

Head — Red-brown to orange-brown. Compound eyes dorsally separated by distance equal to or less than width of lateral ocellus (similar to Fig. 24).

Thorax — Dark brown to red-brown, lighter on pleura; *mesoscutellum usually dark brown,* sometimes lighter laterally but with apex dark. Fore tibiae yellow to yellow-tan or red-yellow with apices dark; fore tarsal ratio 2.0–2.6 (usually 2.0–2.3). Fore wings hyaline with longitudinal veins yellow to red-brown, often darkening distally; crossveins dark red-brown to black; reddish or yellow-brown stain in stigmatic area; 1, 2, or 3 (rarely 4) crossveins in each of first 3 bulla interspaces, slightly crowded to moderately crowded; 8–16 (usually 11–14) crossveins in first interspace distal to bulla region. Hind wings not darkened on outer margins.

Abdomen — Dorsally dark brown or red-brown, ventrally usually light brown. Terga 1–8 with wide red-brown bands on posterior margins and with dark shading usually extending nearly to anterior margins, limiting paler areas to anterior margins especially sublaterally; 1–8 or 1–9 with middorsal red-brown stripe, sometimes divided on middorsal line by longitudinal, narrow pale line (Fig. 82, 83); spiracular markings absent or obscured by brown shading, forming pale oval areas surrounded by



Previous records from Minnesota and Michigan are unconfirmed and are likely due to misidentifications.

darker shading (Fig. 84); 9, 10 and usually 8 opaque, reddish with yellow or orange tinge; 8–10 or 9 and 10 yellow or white laterally. Sterna 1–7 with posterior margins somewhat darker, sometimes appearing annulate. Caudal filaments pale; segment articulations pigmented with alternate articulations darker. Penes shaped as in Fig. 41.

FEMALE IMAGO

Subanal plate — Posterior margin similar to Fig. 50 or 51.

Biology and Ecology

Stenonema ithaca prefers riffle areas of small to large streams, and small rivers with slow to moderate current, and occurs less frequently in large rivers (Lewis 1974b). This species tolerates slight enrichment (Carle 1977).

Discussion

Examination of reared material from New York, North Carolina, and Quebec and topotypical specimens, including a larva from Clemens' type lot, has revealed that, contrary to Lewis' (1974b) description, *S. ithaca* has maxillary crown hair setae. Based on this discovery, *S. allegheniense* (Carle 1977) falls within the range of variability of *S. ithaca*, and we place it as a junior synonym of the latter.

Stenonema ithaca is more widespread (Fig. 101) than reported by Lewis (1974b), who regarded the species as restricted to central New York. We agree with Traver (1933a) that *S. ithaca* is one of the most common mountain species of *Stenonema* in North Carolina.

Larvae of *S. ithaca* are distinguished by their lack of lateral abdominal projections on anterior segments and the consistent ventral abdominal maculation (Fig. 62). Other species with similar larval patterns are *S. m. mediopunctatum* (Fig. 63), which differs in extent of lateral abdominal spines and maxillary armature, and an occasional dark color variant of *S. modestum* (Fig. 66). The latter are not common and can usually be distinguished by the presence of fore tarsal claw denticles. However, Carle (1977) found that *S. allegheniense* (= *S. ithaca*) may have denticles in early instars and not in mature larvae, a phenomenon also reported in *S. terminatum* (Flowers and Hilsenhoff 1975). We have observed one *S. ithaca* larval cast with denticles. Therefore, if a specimen has denticles, the number of

maxillary crown hair setae, geographic region, and/or seasonal occurrence must be employed to identify *S. ithaca* (see key).

Adult male *S. ithaca* are readily distinguished from most *Stenonema* by the relatively small dorsal separation of the compound eyes relative to the width of a lateral ocellus (Fig. 21, 24). This character state can be used to easily separate *S. ithaca* and dark forms of *S. modestum*. In addition, dark *S. modestum* have distinct spiracular markings that are always obscured by brownish shading in *S. ithaca* (Fig. 82, 83). Occasionally, *S. vicarium* males resemble *S. ithaca*, but these can be distinguished by color characters in the key.

Stenonema luteum (Clemens)

Heptagenia lutea Clemens, 1913: 252; 1915: 135
Ecdyonurus luteus (Clemens), McDunnough 1933: 34
Stenonema luteum (Clemens), Traver 1935: 319; Burks 1953: 175; Leonard and Leonard 1962: 109; Lewis 1974b: 28

Larva

Length 9–10 mm.

Head — Brown with pale markings; large pale areas laterad of compound eyes; pale median spot usually present on posterior margin. *Mandibles each with 6–9 (usually 6–8) teeth on inner margin of outer incisor; maxillae each with 2–4 (usually 3 or 4) spinelike setae and 20–40 (usually 20–35) hair setae on crown* and 15–30 (usually 18–26) setae in submedial row.

Thorax — Brown with many pale spots; pronotum with pair of pale areas extending most of length of lateral margins. Fore femora with armature on apical ⅔ dorsal surfaces, sometimes absent in ¼ near articulations with fore tibiae; posterior margins of fore femora with spinelike setae and often long hair setae; anterior margins with armature sparse or lacking. Fore tarsal claws denticulate (Fig. 8).

Abdomen — Dorsally brown with pale areas, ventrally pale with brown maculations. Terga 1, 2, and 3 light; 4–10 with dark and pale areas variable; 6 and 7 often entirely brown; 9 usually light. Sterna 8 at posterior margin and 9 at level of bases of posterolateral projections with sublateral brown maculations, usually connected, forming irregular bands (Fig. 61). *Lateral projections on segments 3–9, those on segment 9 shorter than on 8 and nearly as long as ventral lateral margins posterior to projection bases.* Caudal filaments tan basally, apically with alternating light and dark segments; setae very sparse or lacking on outer margins of cerci.

Male Imago

Length 9–11 mm.

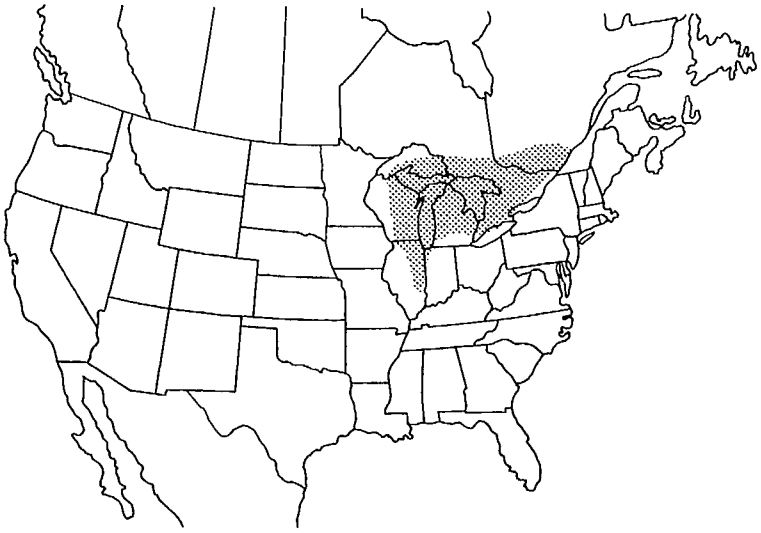
Head — Light yellow; vertex yellow to yellow-brown or orange-red. Compound eyes dorsally separated by distance greater than width of lateral ocellus (similar to Fig. 27 or 30).

Thorax — Pale yellow, often becoming light brown posteriorly; mesoscutellum creamy white. Fore tibiae pale amber with apices dark; fore tarsal ratio 1.6–2.1 (usually 1.7–2.1). Fore wings hyaline with costa, subcosta, and radius dark amber; other longitudinal veins and crossveins blackish; light reddish tan stain in stigmatic area; 1 or 2 crossveins in each of first 3 bulla interspaces, not crowded; 9–17 (usually 9–13) crossveins in first interspace distal to bulla region. *Hind wings without darkened outer margins.*

Abdomen — Hyaline-yellow or hyaline-white. Terga 8–10 opaque, creamy white to tan, often with pink shading; dark narrow posterior crosslines on terga 1–7; *spiracular marks absent* (Fig. 89). Caudal filaments pale yellow; segment articulations faintly darkened. Penes shaped as in Fig. 43 or 44.

Female Imago

Subanal plate — Posterior margin usually similar to Fig. 52.



Published records of *S. luteum* from outside the given range are referrable to *S. terminatum*.

Biology and Ecology

Stenonema luteum is primarily an open water species found on lake shores but also occurs in river rapids (McDunnough 1933). It has been tentatively regarded as a clean water species by Lewis (1974b).

Discussion

Although ventral abdominal maculation (Fig. 61) in *S. luteum* is somewhat variable, larvae have lateral abdominal projections on anterior segments and maxillary crown hair setae, a combination not found in other species with similar adults. However, previous misidentifications of both stages have frequently occurred when reared material was not available.

The key characters will clearly identify larvae. The absence of characteristic ventral abdominal markings in *S. luteum* larvae from Wisconsin as reported by Lewis (1974b) has also been observed by us in *S. vicarium* from Virginia, and cannot be regarded as unique to *S. luteum* if it does occur.

Male adult *S. luteum* are distinguished by the narrow transverse lines at the posterior tergal margins and the lack of spiracular markings (Fig. 89). They rarely resemble some specimens of *S. terminatum, S. integrum*, or *S. exiguum* but can always be distinguished from these superficially similar forms by their unpigmented hind wing outer margins.

Lewis (1974b) reported a male *S. luteum* from Wisconsin with oblique spiracular markings reared from one of the unbanded larvae previously mentioned. We have seen no such specimens, and Flowers and Hilsenhoff (1975) did not find *S. luteum* in Wisconsin. If such variants exist, they could be distinguished from similar *S. integrum* by their unpigmented hind wing outer margin.

Stenonema mediopunctatum (McDunnough)

Ecdyonurus mediopunctatus McDunnough, 1926: 191
Ecdyonurus nepotellus McDunnough, 1933: 20
Stenonema mediopunctatum (McDunnough), Traver 1935: 321; Burks 1953: 174; Lewis 1974b: 29; Flowers and Hilsenhoff 1975: 215
Stenonema nepotellum (McDunnough), Traver 1935: 322; Burks 1953: 177; Leonard and Leonard 1962: 111; Koss 1968: 706 (egg); Lewis 1974b: 30 (n.syn.)

LARVA

Length 7–10 mm.

Head — Brown with pale markings; freckled, pale dots present; large pale areas laterad of compound eyes each usually divided by brown band extending from eye to lateral margin. *Mandibles each with 5–9 (usually 7 or 8) teeth on inner margin of outer incisor; maxillae each with 4–8 (usually 5 or 6) spinelike setae and 0–8 (usually 0, almost always 5 or less) hair setae on crown* and 16–40 (usually 18–30) setae in submedial row.

Thorax — Brown with pale markings. Fore femora extensively armed, often in apical ⅘ dorsal surfaces; posterior margins of fore femora with spinelike setae and long hair setae; anterior margins with spinelike setae and hair setae present but armature shorter and sparser. Fore tarsal claws variable, usually denticulate.

Abdomen — Dorsally light brown to dark brown and white, ventrally pale with brown maculations. Terga variable; 1–4, 6, 8, and 10 usually darker; 5, 7, and 9 with pale areas. *Sterna 2–8 with variable maculation (Fig. 63, 64, 65)*; 9 with lateral pair of brown bands usually connected anteriorly to form an inverted U. *Lateral projections on segments 3–9, 4–9, or 5–9; those on segment 9 shorter than on 8, and usually as long as or longer than ventral lateral margins posterior to projection bases.* Caudal filaments pale to light brown, often with alternating light and dark segments apically; setae present, usually over entire length of outer margins of cerci.

MALE IMAGO

Length 8–10 mm.

Head — Pale; vertex creamy to light brown. Compound eyes separated dorsally by distance greater than width of lateral ocellus (similar to Fig. 27 or 30).

Thorax — Ochre-brown to dark brown; mesoscutellum whitish or black-brown with apex paler, light brown. Fore tibiae whitish or light amber with dark apices; fore tarsal ratio 1.5–2.2 (usually 1.6–2.0). Fore wings hyaline with longitudinal veins and crossveins amber to blackish brown; amber to purple-red stain in stigmatic area; 1 or 2 (very rarely 3) crossveins in each of first 3 bulla interspaces, not crowded to slightly crowded; 8–13 (usually 9–11) crossveins in first interspace distal to bulla region. Hind wings not darkened on outer margins.

Abdomen — Terga 1–7 hyaline-white or hyaline, pale yellow-white; 8–10 opaque, whitish with brown or pinkish brown shading. Terga 2–7 with narrow black posterior transverse lines, each sometimes reduced to narrow posterior medial dash (Fig. 86–88); spiracular dots present. Caudal filaments pale; segment articulations not darkened or narrowly darkened. Penes shaped as in Fig. 43 or 44.

FEMALE IMAGO

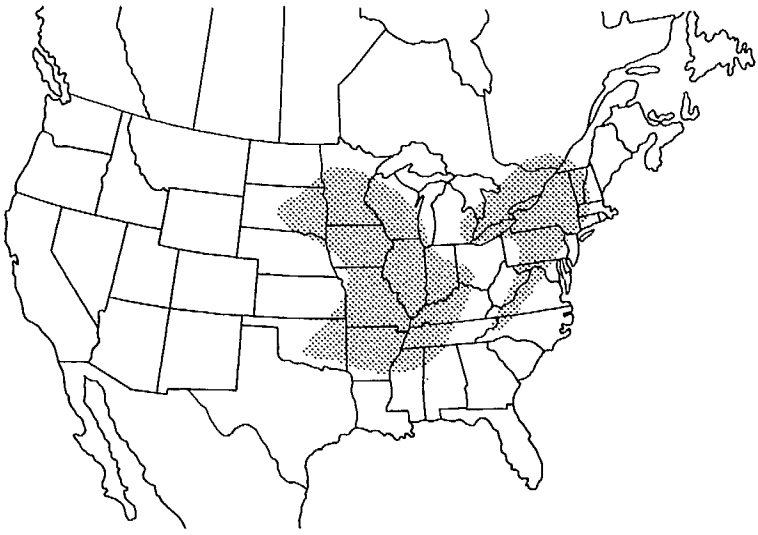
Subanal plate — Posterior margin usually similar to Fig. 50.

Stenonema mediopunctatum mediopunctatum (McDunnough)

Larval sterna 2–8, 3–8, or 4–8 with bands extending obliquely from anteromedial area posterolaterad (Fig. 63). Otherwise as for *S. mediopunctatum.*

Stenonema mediopunctatum arwini new subspecies

Larval sterna 2–8, 3–8, or 4–8 with bands extending more or less transversely at anterior margins (Fig. 65). Otherwise same as *S. m. mediopunctatum.* Intermediate forms (*S. m. mediopunctatum* × *arwini*) with maculation similar to Fig. 64.



Distribution of *S. mediopunctatum*.

Biology and Ecology

Stenonema mediopunctatum prefers medium to large streams with moderate current. Larvae are moderately tolerant of enrichment (Lewis 1974b).

Discussion

Examination of type material of *S. mediopunctatum* and *S. nepotellum* has indicated they are virtually identical as adults, differing slightly in intensity of color and lateral extent of transverse lines on the posterior margins of abdominal terga. Such a shortening of transverse lines is rather common in many *Stenonema* and results from a simple symmetrical deletion of some pigment on each side (see discussion of characters). Both character states are sometimes present in a single population.

The larvae previously described by Lewis (1974b) as *S. mediopunctatum* had not been reared and were distinguished by absence of fore tarsal claw denticles (a character state known to vary in other species), and the presence of 1–5 maxillary crown hair setae. Species that usually completely lack these setae often have a very low proportion of individuals possessing some hair setae (see discussion of characters). Based on all the above, we place *S. nepotellum* as a junior synonym of *S. mediopunctatum*.

When McDunnough (1933) originally described *S. nepotellum*, he indicated that the larvae greatly resembled *S. ithaca* (Fig. 62) in ventral abdominal maculation. However, ventral maculation in reared larvae (Fig. 65) from Indiana closely approximate Lewis' (1974b) description (which is unlike *S. ithaca*).

By examining large series throughout the species range including associated material from New York and topotypical larvae mentioned in McDunnough's (1933) original description, we have found that ventral abdominal maculation in larvae in the eastern portion of the range (above, Fig. 63) differ consistently from those in the midwest (above, Fig. 65). They are identical in other respects, and adults demonstrate similar ranges of variability in both areas. Interestingly, at areas of range contact of these two forms (example: northeastern Indiana, eastern Tennessee, and Alabama) larvae with intermediate ventral color patterns (Fig. 64) have been found. These are identical with the other two forms in all other respects. The midwestern pattern appears to represent a simple anterior shift of the lateral portions of the darkened area, so that the more or less obliquely directed pattern in eastern larvae is expressed as an anterior crossbar.

Because of geographic integrity in these larval variants, we recognize two corresponding subspecies. As original descriptions of both *S. mediopunctatum* and *S. nepotellum* are referable to the eastern

subspecies, we apply *S. m. mediopunctatum* to this subspecies, and "*nepotellum*" is not available as a subspecific epithet. We name the midwestern subspecies *S. mediopunctatum arwini* in honor of Mr Arwin V. Provonsha. The few larvae with intermediate color pattern may be designated as *S. mediopunctatum mediopunctatum* × *arwini.*

Stenonema mediopunctatum arwini larvae can be quickly identified by the ventral abdominal color pattern (Fig. 65). *Stenonema mediopunctatum mediopunctatum* larvae are recognizable by the elongate ninth lateral abdominal projection (also see key).

Adult males with complete tergal transverse lines posteriorly are similar to some *S. modestum* and may need to be identified by a combination of characters. *Stenonema mediopunctatum* males are consistent in size and, therefore, dorsal separation of eyes (Fig. 27) and shape of the penes (Fig. 43) are consistently unlike the more variable *S. modestum.* Some specimens can be identified with the above characters but often wing venation and color must be used.

Stenonema meririvulanum Carle and Lewis

Stenonema sp. No. 3, Traver 1933: 204
Stenonema meririvulanum Carle and Lewis, 1978: 285

Larva

Length 10–16 mm.

Head — Light brown with pale markings; thickly freckled, pale dots present, especially frontally; large pale areas present laterad of compound eyes, shaded with light brown, especially anteriorly. *Mandibles each with 9–16 teeth on inner margin of outer incisor; maxillae each with 7–10 spinelike setae and 0 hair setae on crown,* and 30–50 setae in submedial row.

Thorax — Brown; pronotum with 3 pairs of pale areas anteriorly and largely pale lateral margins. Fore femora with armature on approximately apical ¾ dorsal surfaces; posterior margins with spinelike setae and hair setae; anterior margins with hair setae sparse or absent. Fore tarsal claws not denticulate (Fig. 7).

Abdomen — Dorsally brown with numerous pale areas, ventrally pale. Terga 1–4 or 1–5, 6, 10, and sometimes 9 with submedian pale spots; *7 and 8, and sometimes 5 and/or 9 with submedian pale areas expanded to form V-shaped markings*; 1–7 or 1–8 with sublateral pale areas; 8 pale laterally (Fig. 77); sterna without distinct markings. *Lateral projections on segments 7–9 (rarely 6); those on segment 9 somewhat shorter than on 8 and shorter than to almost as long as ventral lateral margins posterior to projection bases.* Caudal filaments light brown basally, darker apically; segment articulations spinous; setae absent on outer margins of cerci.

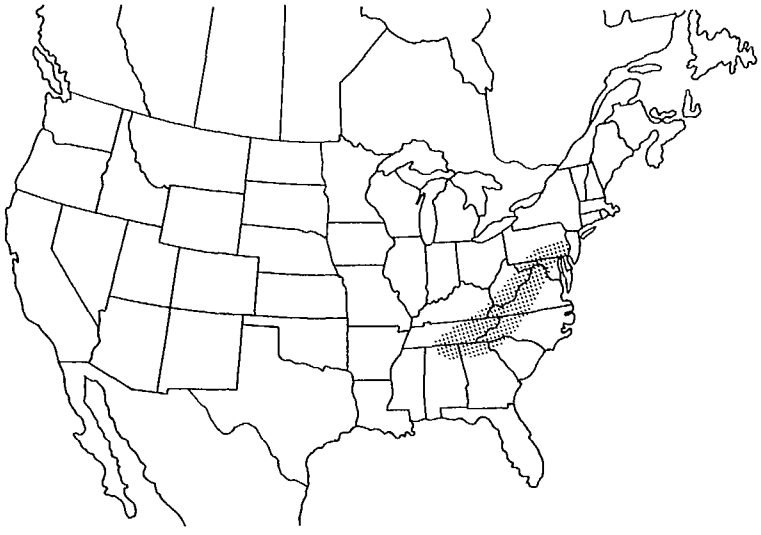
Male Imago

Length 9–12 mm.

Head — Yellow, often with brown shading; vertex yellowish white with median and lateral pale areas. Compound eyes separated by distance greater than width of lateral ocellus (similar to Fig. 30).

Thorax — Yellowish white, sometimes with purple or brown markings; at least apex of mesoscutellum white. Fore tibiae light brown, darker at apices. Fore tarsal ratio 1.8–2.2. Fore wings hyaline with longitudinal veins yellowish brown to brown; costal and subcostal crossveins usually darker than remaining crossveins; yellow, pink, or orange stain in stigmatic area; usually 1, 2, or 3 crossveins in each of first 3 bulla interspaces, not crowded or slightly crowded; 13–17 crossveins in first interspace distal to bulla region. Hind wings narrowly darkened on outer margins.

Abdomen — Segments 1–7 hyaline, sometimes with brown shading; 8–10 dorsally mostly white. Terga 1–7 with dark posterior transverse lines; 8 with diffuse posterior line, 10 often brown posteriorly; spiracular dots on terga 1–7 large, often reaching level of posterior lines on terga 1–4 or 1–5 (Fig. 96). Caudal filaments greyish with segment articulations pigmented; alternate articulations darker; *caudal filaments very long, approximately 3.5–5.0 times length of body.* Penes shaped as in Fig. 44 or 46.



Distribution of *S. meririvulanum.*

FEMALE IMAGO

Subanal plate — Posterior margin similar to Fig. 53.

Biology and Ecology

Carle and Lewis (1978) reported that *S. meririvulanum* is restricted to pools and riffles of small spring-fed streams and is known from larger streams only near the mouth of small tributaries. *Stenonema meririvulanum* is intolerant of pollution (Carle and Lewis 1978).

Behavior is interesting in that subimagos emerge from the larval skin beneath the water surface (Carle and Lewis 1978).

Discussion

The ecology of *S. meririvulanum* may account in part for its relatively recent description. Individuals were rare in the many large collections of *Stenonema* examined. Traver (1933a) originally reported individuals of this species of *Stenonema* from North Carolina although she collected insufficient material to evaluate their specific status.

The lack of anterior lateral abdominal projections, absence of hair setae on the maxillary crown, and dorsal abdominal maculation (Fig. 77) are very distinctive for the larvae. The long caudal filaments and color characters given in the description distinguish adults.

Stenonema modestum (Banks)

Epeorus modestus Banks, 1910: 202
Heptagenia flavescens, Clemens (nec Walsh, 1862) 1913: 252; 1915: 134
Heptagenia rubromaculata Clemens, 1913: 256; 1915: 138
Iron modestus (Banks), McDunnough 1924: 129; Traver 1935: 406
Ecdyonurus ruber McDunnough, 1926: 192; 1933: 33
Ecdyonurus rubromaculatus (Clemens), McDunnough 1930: 61; 1933: 16; Ide 1930: 230
Stenonema rubromaculatum (Clemens), Traver 1933a: 175; 1935: 329; Burks 1953: 178; Koss 1968: 706 (egg); Lewis 1974b: 33 (n.syn.)

Stenonema annexum Traver, 1933a: 179; 1935: 304; Lewis 1974b: 19 (n.syn.)
Stenonema varium Traver, 1933a: 192; 1935: 333
Stenonema ruber (McDunnough) ?, Traver 1933a: 190
Iron modestus, Traver (nec Banks, 1910) 1933b: 118
Stenonema rubrum (McDunnough), Traver 1935: 330; Burks 1953: 178; Leonard and Leonard 1962: 111; Lewis 1974b: 34 (n.syn.)
Stenonema modestum (Banks), Burks 1953: 155; Lewis 1974b: 30

LARVA

Length 8–11 mm.

Head — Brown or reddish brown with variable pale markings; freckled, pale dots usually present; pale areas laterad of compound eyes each usually divided by brown band extending from eye to lateral margin. *Mandibles each with 6–11 (usually 6–9) teeth on inner margin of outer incisor; maxillae each with 4–7 (usually 4–6) spinelike setae and 15–50 (usually 20–40) hair setae on crown* and 15–40 (usually 20–30) setae in submedial row.

Thorax — Brown or reddish brown, often with many pale dots; pronotum often with pair of anterior submedian pale areas and pair of pale lateral areas extending much of length of lateral margins, sometimes extending to anterior portions of mesonotum forming pair of small pale spots at anterolateral margins of wing pad bases. Fore femora with armature in apical ½–⅔ dorsal surfaces; posterior margins of fore femora with spinelike setae and hair setae; anterior margins with variable armature; hair setae sparser than on posterior margins. Fore tarsal claws denticulate (Fig. 8).

Abdomen — Variable, dorsally brown to reddish brown with pale areas, ventrally pale, white to yellow with variable maculation. Terga with variable pale areas, sometimes freckled with pale dots; darker median longitudinal stripe often present; 7 often pale or with pale submedian areas. Sterna extremely variable; 1–7 pale, often with 1 or 2 pairs of submedian dots and/or 1 pair of dots posterolaterad, or with crescent-shaped maculations extending obliquely and laterad from anteromedian area; pair of faint, lateral, longitudinal streaks often present; 8 as above or with anteromedian spot (Fig. 66, 67, 68); 9 with pair of lateral dark maculations, often slightly oblique, usually connected anteriorly forming an inverted U. *Lateral projections on segments 7–9; those on segment 9 shorter than on 8 and usually shorter than ventral lateral margins posterior to projection bases.* Caudal filaments pale tan or brown basally, apically often with alternating pairs of light and dark segments; setae variable on outer margins of cerci, usually sparse at least basally.

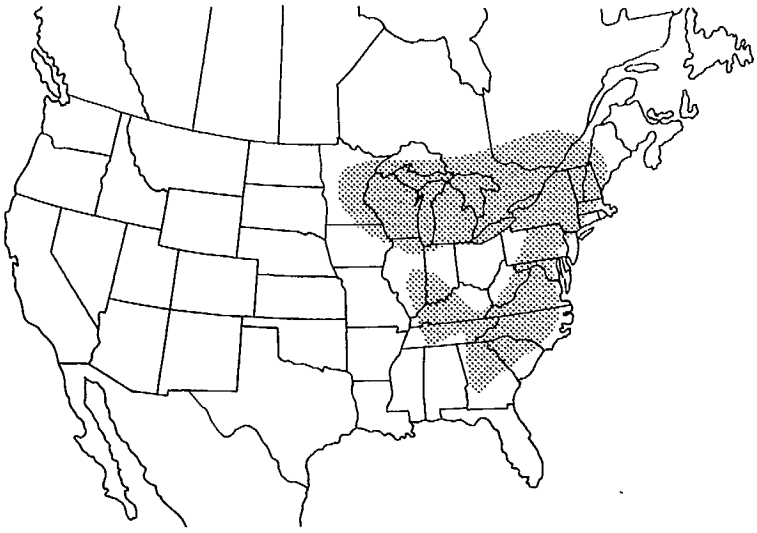
MALE IMAGO

Length 6–9 mm.

Head — White or pale brown; vertex variable, pale creamy yellow, orange-brown, or dull purplish brown. Compound eyes somewhat variable in relative size but always dorsally separated by distance greater than width of lateral ocellus (similar to Fig. 27 or 30).

Thorax — Pale brown, pale clay, or light olive-gray to brown or red-brown, sometimes tinged with pink or purple; mesoscutellum variable, usually brown with restricted white or pale areas on median line or apex, sometimes entirely brown or white. Fore tibiae mostly pale or faint amber, darkened at apices; fore tarsal ratio 1.1–2.3 (usually 1.5–2.1). Fore wings hyaline with longitudinal veins yellowish to orange-brown; crossveins usually somewhat darker, usually pink to red stain in stigmatic area; 1, 2, or 3 crossveins in each of first 3 bulla interspaces, not crowded or moderately crowded; 8–14 (usually 9–12) crossveins in first interspace distal to bulla region. *Hind wings not darkened on outer margins.*

Abdomen — Hyaline-light yellow to hyaline-white. Terga 1–7 with dark posterior crosslines (Fig. 95) sometimes reduced laterally to form medial dashes, occasionally with brown shading on posterior half of terga; 8–10 opaque, reddish yellow, brown, or white with pinkish brown shading; distinct spiracular marks present. Caudal filaments pale; segment articulations darkened; alternate articulations usually darker. Penes shaped as in Fig. 43, 44, or 45.



Records from Arkansas (McCafferty and Provonsha 1978) are unconfirmed as they are based on adults only.

FEMALE IMAGO

Subanal plate — Posterior margin similar to Fig. 50 or 51.

Biology and Ecology

Stenonema modestum larvae are found in small to large streams with medium to fast current (Lewis 1974b). In Michigan, Leonard and Leonard (1962) reported some preference for shallow water on gravel substrate, although larvae have been collected on bedrock and rubble (Bell 1969). Lewis (1974b) reported larvae in 1 in. of water so at least a tolerance, but not necessarily a preference, for shallow water is indicated.

Discussion

Stenonema modestum is an extremely variable species in all stages. This variability has resulted in a great deal of taxonomic confusion, at least in forms from eastern North America. *Stenonema modestum* is known only from two adults collected in 1910. These and the nominal types of *S. rubrum* differ slightly in the fore tarsal ratios; however, we have found that the ratio in *S. rubrum* (sensu Lewis 1974b) is more variable than previously reported. Also, reportedly distinguishing genital armature is not species specific (see discussion of characters). Furthermore, since 1910, *S. rubrum* larvae (sensu Lewis 1974b) have been frequently collected from the same vicinity as the type locality of *S. modestum*. On the basis of the above, we place *S. rubrum* as a junior synonym of *S. modestum*.

Other synonyms represent size and color variants of *S. modestum*. Lewis (1974b) synonymized *S. varium* with *S. rubrum* but indicated that the type genitalia were missing. We have found and examined the holotype genitalia (Fig. 45) and agree with his synonymy. *Stenonema varium* represents a slightly larger form, usually with somewhat more extensive ventral abdominal maculation in the larvae. Both color forms (Fig. 67, 68) are found in the Appalachian uplands.

We place *S. annexum* as a junior synonym of *S. modestum* because it represents a commonly found variant occurring at relatively lower elevations. Male adults are similar in body length and penial shape to those described as *S. varium* by Traver (1933a), and larvae differ only in reduction of ventral abdominal maculation. Such larvae, however, also occur occasionally in mountainous regions and do not represent a discrete population.

It is likely that *S. smithae* represents a southern lowlands form derived from an *S. modestum*-like progenitor similar in larval ventral abdominal maculation to individuals formerly known as *S. annexum* (see discussion of *S. smithae*).

The most perplexing species problem in *Stenonema* has been the status of *S. rubromaculatum*. This species was reported by McDunnough (1933) to have two seasonal forms in both larvae and male adults. Adults are superficially extremely similar to *S. nepotellum* (sensu McDunnough 1933). Larvae have been confused because of an error in assessment of lateral abdominal spination. Both Burks (1953) and Lewis (1974b) described larvae with projections on segments 3–9. However, our examination of a slide of the larval cast skin of the holotype, larvae identified by McDunnough and cited (1933) in his redescription of the species, and reared material from Pennsylvania and Maine, has indicated that lateral projections are not present on anterior segments. Collection data recorded by Clemens (1913, 1915) and McDunnough (1933) indicate that *S. modestum* (as *S. rubrum*) and *S. rubromaculatum* occur in the same streams; the light form of *S. rubromaculatum* larvae predominates in the spring and precedes the dark form of the larvae (Fig. 66) and *S. modestum* in adult emergence. The light form of *S. rubromaculatum* falls well within the range of larval maculation of *S. modestum* (Fig. 67, 68), and the dark form (Fig. 66) is a simple extension of maculation producing a pattern common in other *Stenonema.*

McDunnough (1933) noted that the early light larvae gave rise to darker adults. We have seen this phenomenon in specimens of *S. modestum* from Virginia also.

The adults of *S. rubromaculatum* usually differ from other *S. modestum* (see *S. rubrum* of Lewis 1974b) in dorsal separation of the compound eyes (Fig. 27) and slightly in penes shape (Fig. 43). Traver (1933a, 1935) noted that the genitalia of her *S. varium* (Fig. 45) were intermediate between the *pulchellum* (= *rubrum* = *modestum*) and *rubromaculatum* types (Fig. 44, 43 respectively). Examination of both *S. varium* and *S. annexum* types indicates that the shape of the penes varies and includes the typical "*S. rubromaculatum*-like shape." Also, the compound eyes vary in dorsal separation. Because male *S. varium*-like, *S. rubromaculatum*-like, and frequently *S. annexum*-like individuals tend to be slightly larger than other *S. modestum* adults, it would seem that eye separation and penial shape are characters influenced by size of the individual (see discussion of characters).

Clemens' (1913) description of *S. rubromaculatum* indicated that larvae of this species are distinctly hairy. Traver (1933a) recorded the presence of some larvae of *S. varium* as "... more hairy ..." than others.

All the above evidence indicates that *S. rubromaculatum* is a simple variant form of *S. modestum*, and we place *S. rubromaculatum* as a junior synonym of *S. modestum*. Apparently, in Canada, in spring, most *S. modestum* larvae are light (= *S. rubromaculatum* of McDunnough). Later both dark (= *S. rubromaculatum* of McDunnough) and light (= *S. rubrum* of McDunnough) larvae are present. Both these summer forms give rise to light adults varying only as indicated above.

Larvae of *S. modestum* are variable in ventral maculation, but can be distinguished from most *Stenonema* by the presence of maxillary crown hair setae and the absence of anterior lateral abdominal projections. The occasional dark form encountered may be confused with *S. ithaca* (see discussion of that species).

Male adults are somewhat variable in size, color intensity, and shape of penial lobes. On one extreme they may be confused with *S. pulchellum* and on the other with some *S. mediopunctatum*. Careful use of the key should enable identification.

Stenonema pudicum (Hagen)

Ephemera pudica Hagen, 1861: 39
Ecdyonurus vicarius (Walker) (in part), Eaton 1883–88: 280
Ecdyonurus pudicus (Hagen), McDunnough 1925b: 191
Stenonema pudicum (Hagen), Traver 1933a: 174, 187, 200; 1935: 326; 1937: 40; Burks 1953: 171; Lewis 1974b: 31

LARVA

Length 11–14 mm.

Head — Dark brown with pale markings; thickly freckled, pale dots present; large pale areas laterad of compound eyes each divided by brown band extending from eye to lateral margin. *Mandibles each with 8–15 (usually 10–12) teeth on inner margin of outer incisor; maxillae each with 4–8 (usually 5 or 6) spinelike setae and 15–40 (usually 20–30) hair setae on crown* and 20–45 setae in submedial row.

Thorax — Dark brown with variable pale markings; pronotum with pair of pale areas extending most of length of lateral margins, and often with anteromedian dark triangular area. Fore femora with armature in apical ¾–⅘ dorsal surfaces; posterior margins of fore femora with spinelike setae and hair setae; anterior margains with spinelike setae and hair setae present but shorter than those on posterior margins. *Fore tarsal claws not denticulate* (Fig. 7).

Abdomen — Brown, ventrally yellow to yellowish brown. Terga 1–5 and 7 with variable pale areas especially laterally; 6 and 8–10 predominately dark brown. Sterna 4–8 mostly pale with brown markings varying from faint submedian dots and oblique dashes near anterior margins to median broad brown areas near anterior margins (Fig. 78); 7 and 8 sometimes with brown maculation expanded to cover much of anterior parts of segments (Fig. 79); 9 with brown lateral bands often connected or nearly so by brown crossband on anterior of sternum. *Lateral projections on segments 3–9, 4–9, or 5–9; those on segment 9 slightly shorter than on 8 and nearly as long as or as long as ventral lateral margins posterior to projection bases.* Caudal filaments yellow to light brown, spinous at segment articulations; spines somewhat denser at alternate segment articulations apically; setae lacking or very sparse on outer margins of cerci.

MALE IMAGO

Length 10–13 mm.

Head — Brown to reddish brown; vertex with black shading. Compound eyes dorsally separated by distance equal to or less than width of lateral ocellus (similar to Fig. 21).

Thorax — Brown to reddish brown or yellowish brown; *mesoscutellum dark brown or blackish brown.* Fore tibiae reddish brown to olive-brown with apices dark; fore tarsal ratio 1.6–2.0. Fore wings more or less hyaline with costa, subcosta, and radius amber, thicker than other longitudinal veins; crossveins dark, thicker than longitudinal veins; definite reddish brown stain in stigmatic area; *usually 3–5 crossveins in each of first 6 interspaces of bulla region, crowded in at least first 6 interspaces and forming a curved streak* (Fig. 35); 11–19 (usually 13–16) crossveins in first interspace distal to bulla region. *Hind wings broadly darkened on outer margins*; longitudinal veins and crossveins of hind wings brown.

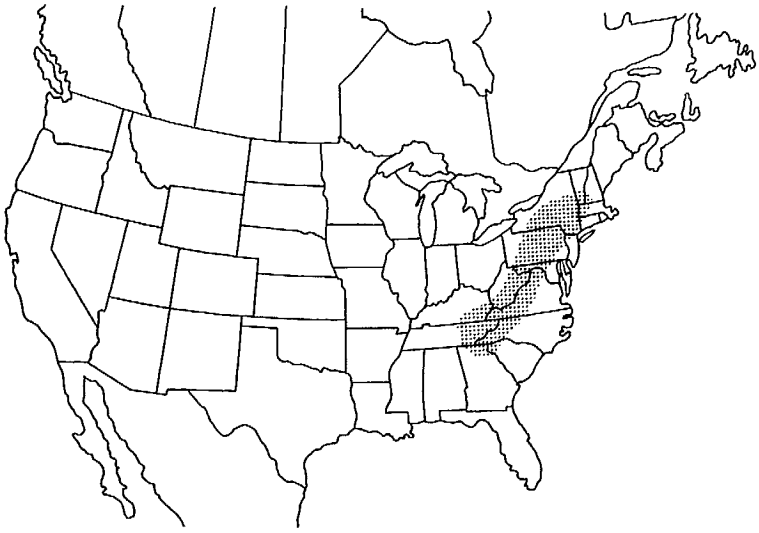
Abdomen — Dorsally yellowish brown to dark brown, ventrally yellowish. Terga 2–8 with dark brown bands at posterior margins; bands widest on anterior terga, covering ½ (or more) anterior terga; 2–8 each with sagittate dark median mark from posterior margin to at least center of tergum; lateral regions usually predominately brown except for pale oval areas; 9 and 10 often uniformly dark brown (Fig. 84); spiracular markings obscure; sterna with dark shading at anterior and lateral margins. Caudal filaments greyish white; segment articulations pigmented, more widely on alternate articulations. Penes shaped as in Fig. 41.

FEMALE IMAGO

Subanal plate — Posterior margin somewhat variable (similar to Fig. 50, 51, or 54).

Biology and Ecology

This primarily montane species (Traver 1933a) is considered intolerant of pollution (Lewis 1974b).



Distribution of *S. pudicum*.

Discussion

Stenonema pudicum is a distinctive species phyletically related to *S. carlsoni*. It is the more northerly distributed of the two but is sympatric with *S. carlsoni* in the southern part of its range (Fig. 99, 107). In the area of overlap no intermediates are found and as the two forms differ in several character states, two species are obviously present. We regard the adult abdominal maculation in these two species as a reliable character (Fig. 84, 85).

Some variation in intensity of ventral abdominal maculation has been observed in *S. pudicum* larvae. The typical markings (Fig. 78) are occasionally absent but more commonly are obscured by more extensive brown shading (Fig. 79).

Larvae of *S. pudicum* are distinguished from *S. carlsoni* by the presence of maxillary crown hair setae. Ventral abdominal maculation is not as extensive as *S. vicarium* (Fig. 59, 60), even in the darkest *S. pudicum*. Rarely a dark color variant of *S. modestum* may resemble *S. pudicum*, but we have found the lack of claw denticles in the latter to be reliable in this case. Also, *S. pudicum* larvae can almost always be distinguished from *S. modestum* dark variants by the extremely sparse setation on the outer margins of the cerci.

Adults of *S. pudicum* are easily identified by crowding of crossveins in the bulla region of the fore wing (Fig. 35). The only other species with similar wings are *S. carlsoni* and some *S. femoratum*, and both are readily identifiable using dorsal abdominal maculation (see key).

Stenonema pulchellum (Walsh)

Palingenia pulchella Walsh, 1862: 375
Heptagenia luridipennis, Clemens (nec Burmeister, 1839) 1913: 258; 1915: 139
Ecdyonurus pulchellus (Walsh), McDunnough 1926: 193 (discussion of *Ecdyonurus ruber*); 1933: 23
Stenonema pulchellum (Walsh), Traver 1933a: 175; 1935: 327; Burks 1953: 179; Leonard and Leonard 1962: 112; Lewis 1974b: 32

LARVA

Length 7–9 mm.

Head — Brown with pale markings; freckled, pale dots present; large pale areas laterad of compound eyes; smaller pale area mesally at posterior margin. *Mandibles each with 5–8 (usually 6 or*

7) teeth on inner margin of outer incisor; maxillae (Fig. 11) each with 5 or 6 spinelike setae and 0 hair setae on crown and 17–30 (usually 20–30) setae in submedial row.

Thorax — Brown; pronotum with pair of large pale areas extending most or all of length of lateral margins. Fore femora with armature on approximately apical ⅔ dorsal surfaces; posterior margins of fore femora with long spinelike setae and hair setae; anterior margins with armature sparse or absent. Fore tarsal claws denticulate (Fig. 8).

Abdomen — Dorsally brown and white, ventrally white. Terga 4, 5, 7, and 9 predominately white with brown markings; 6, 8, and 10 predominately brown, forming rather characteristic pattern (Fig. 73). Sterna 8 and 9, or 9 only, sometimes with anteromedian, brown spot; 9 with oblique, brown areas laterally (Fig. 74). *Lateral projections on segments 7–9; those on segment 9 shorter than on 8 and shorter than ventral lateral margins posterior to projection bases.* Caudal filaments tan or brown basally, apically with alternating pattern of dark and light areas; setae somewhat sparser basally on outer margins of cerci.

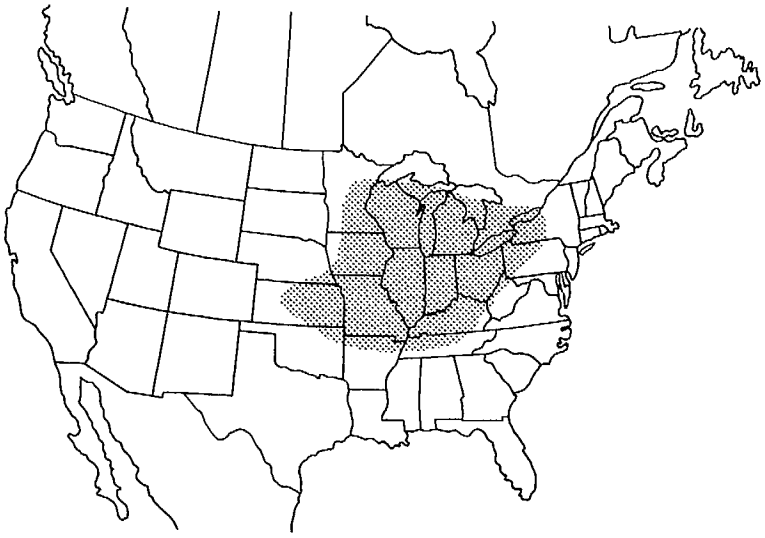
Male Imago

Length 6–8 mm.

Head — White or yellow; vertex with white and reddish brown or pink areas. Compound eyes dorsally separated by distance greater than width of lateral ocellus (similar to Fig. 30).

Thorax — Mesonotum dark brown to brownish black, often with reddish areas; *mesoscutellum white*; pleural regions yellow, creamy, or white, often with pink tinges anterior to fore wing bases. Forelegs light tan to yellow; fore tibiae with brown apices; fore tarsal ratio 1.4–2.3 (usually approximately 2.0). Fore wings hyaline with most of costa, subcosta, and radius yellow; other longitudinal veins and crossveins brown; brown stain in stigmatic area; *usually 1 or 2 crossveins in each of first 3 bulla interspaces, not crowded* (Fig. 37); 10–14 (usually 11 or 12) crossveins in first interspace distal to bulla region. Hind wings not darkened on outer margins.

Abdomen — Segments 1–7 hyaline; 8–10 opaque, dorsally brown to reddish brown, often with pink tinges, laterally and ventrally paler. Terga 1–7 with narrow brown or black transverse lines at posterior margins; spiracular dots present on segments 3–7 (Fig. 97). Caudal filaments white; segment articula-



Distribution of *S. pulchellum*.

tions pigmented, alternate articulations more intensely so for most of length of filaments. Penes shaped as in Fig. 44.

FEMALE IMAGO

Subanal plate — Posterior margin similar to Fig. 50 or 51.

Biology and Ecology

Stenonema pulchellum inhabits medium to large streams in moderate current, commonly on rocks but also driftwood (Leonard and Leonard 1962). It is relatively tolerant to pollution (Lewis 1974b).

Discussion

Stenonema pulchellum is relatively homogeneous morphologically and must be considered a valid species. There is no concrete evidence of interbreeding even though *S. pulchellum* occurs in the same rivers as the closely related *S. exiguum.*

Problems in larval identification usually result from age variability in color pattern and intensity in the similar species, *S. exiguum* and *S. terminatum.* Mature larvae should be used when possible. Although some ventral abdominal variations in maculation occur in *S. pulchellum* (Fig. 74), key characters will enable individuals from throughout the species range to be identified.

Adult male *S. pulchellum* superficially resemble some *S. modestum* individuals. In similar *S. modestum* the mesoscutellum is entirely brown or has only some rather restricted white areas; in *S. pulchellum* the mesoscutellum is white. In addition, the fore wings in *S. pulchellum* have one or two crossveins in each of the first three bulla interspaces (Fig. 37), whereas similar *S. modestum* sometimes have three in at least one interspace (Fig. 36).

Stenonema sinclairi Lewis

Stenonema sinclairi Lewis, 1979: 321

LARVA

Length 10–12 mm.

Head — Brown with pale markings; freckled, pale dots present; large pale areas laterad of compound eyes, extending from posterolateral margins to anterior of eyes, divided by brown bands extending from eyes to lateral margins. *Mandibles each with 8–10 teeth on inner margin of outer incisor; maxillae each with 2–4 (usually 3) spinelike setae and 30–50 hair setae on crown* and 25–40 setae in submedial row.

Thorax — Light brown; pronotum with pair of large pale spots half way between median line and lateral margins, pair of smaller pale spots laterad of first pair, and pair of large pale areas extending most of length of lateral margins; mesonotum with large pale medial area. Fore femora with armature on apical ⅔-¾ dorsal surfaces; posterior margins of fore femora with spinelike setae and long hair setae; anterior margins with very sparse, short hair setae or with hair setae lacking. Fore tarsal claws not denticulate (Fig. 7).

Abdomen — Dorsally brown and white, ventrally pale. Terga 1-9 with narrow, brown posterior margins and variable brown dots; 1, 2, 4, 7, and 8 mostly white; 5 and usually 9 approximately equally brown and white; 3, 6, and 10 usually brown with white areas. Sterna pale; 4–7 occasionally with faint shading; 9 often with posterolateral brown areas. *Lateral projections on segments 3–9 or 4–9; those on segment 9 as long as or nearly as long as on 8 and often as long as or longer than ventral lateral margins posterior to projection bases.* Caudal filaments usually light brown; alternate articulations spinous; setae lacking on outer margins of cerci.

Stenonema sinclairi is known only from tributaries of the Sequatchee River in southeastern Tennessee.

MALE IMAGO

Length 10–12 mm.

Head — Greyish white to tan; vertex dark brown. Compound eyes separated dorsally by distance about the same as or less than the width of lateral ocellus (similar to Fig. 24).

Thorax — Light brown anteriorly, darkening posteriorly; *mesoscutellum dark brown.* Fore tibiae yellow to grey with apices usually narrowly darkened; fore tarsal ratio 3.5. Fore wings hyaline with costa, subcosta, and radius yellowish brown; other longitudinal veins and crossveins brown; whitish tinge in stigmatic area; 1, 2, or occasionally 3 crossveins in each of first 3 bulla interspaces, not crowded; 15–18 crossveins in first interspace distal to bulla region. Hind wings not darkened on outer margins.

Abdomen — Dorsally mostly brown; ventrally pale with brown shading. Terga 1–8 sometimes with light lateral and anterior areas, delimiting wide middorsal dark bands, or with reddish brown shading over entire dorsal parts of segments; 1–8 with narrow dark posterior margins; 9 and 10 yellowish brown; discrete spiracular marks absent. Caudal filaments light brown with segment articulations pigmented. Penes shaped as in Fig. 42; distal spines often large, broad at base.

FEMALE IMAGO

Subanal plate — Posterior margin similar to Fig. 53.

Biology and Ecology

Stenonema sinclairi has been collected only in small, cold, soft water streams with slow current in an area formerly strip mined. Substrate in these streams consists of smooth stones and sand over sandstone (Lewis 1979).

Discussion

Stenonema sinclairi is known from relatively few specimens collected in southeastern Tennessee. Because such a restricted distribution is inexplicable geographically and is not characteristic of the

genus, we feel it is either a collection artifact or is an indication that these specimens are variants of *S. vicarium*. Despite the dubious value of male genitalia as a species character (see discussion of characters), the shape of the penes (Fig. 42) in the material we have examined appears distinctive for *Stenonema*. Until larger series of specimens prove otherwise, *S. sinclairi* is considered a valid species.

Larvae of *S. sinclairi* should be identified by a combination of characters: maxillary crown armature, lateral abdominal projections, and ventral abdominal maculation (see key).

The wing venation easily separates *S. sinclairi* adults from *S. pudicum* and *S. carlsoni*. The high fore tarsal ratio and shape of the penes distinguish *S. sinclairi* from *S. ithaca*. As overlap in fore tarsal ratio occurs with some *S. vicarium*, shape of the penes should be used. Any minor deviations from the precise penes type described for *S. sinclairi*, especially if similar in shape to *S. vicarium* penes, will necessitate a reevaluation of the validity of the species.

Stenonema smithae Traver

Stenonema smithae Traver, 1937: 77; Berner 1950: 59; Lewis 1974b: 34

Larva

Length 7–9 mm.

Head — Brown with pale markings; freckled, pale dots present, especially frontally; pair of pale markings between lateral ocelli and compound eyes, extending posteriorly somewhat, and each usually with small brown spot posterior to ocelli; large pale areas laterad of compound eyes each divided by brown band extending from eye to lateral margin. *Mandibles each with 6–10 (usually 7 or 8) teeth on inner margin of outer incisor; maxillae each with 3–6 (usually 4 or 5) spinelike setae and 25–40 (usually more than 30) hair setae on crown* and 16–30 setae in submedial row.

Thorax — Red-brown; pronotum with median longitudinal pale line, pair of small anterior pale areas submedially, and pair of pale lateral areas extending most of length of lateral margins; mesonotum with median longitudinal pale line. Fore femora with armature on pigmented and nonpigmented areas in apical dorsal surfaces; posterior margins of fore femora with spinelike setae and hair setae; anterior margins without armature. Fore tarsal claws denticulate (Fig. 8).

Abdomen — Dorsally brown, ventrally pale yellow. Terga 1–5 with pale lateral areas; 6, 8, 9, and 10 mostly dark; 7 sometimes with submedian pale areas of variable size; 2–8 or 3–8 often with small, submedian, brown dots. Sterna 1–8 often with small, submedian, round and/or linear markings, and lateral longitudinal linear markings of varying lengths; 9 with brown areas extending length of lateral margins, also often with small, anteromedian, brown spot and/or pair of transverse streaks extending laterad from anterior medial area (Fig. 69). *Lateral projections on segments 7–9; those on segment 9 shorter than on 8 and shorter than ventral lateral margins posterior to projection bases.* Caudal filaments brown basally, apically with alternating pattern of 3 dark segments to 1 pale segment; setae sparse or lacking basally on outer margins of cerci.

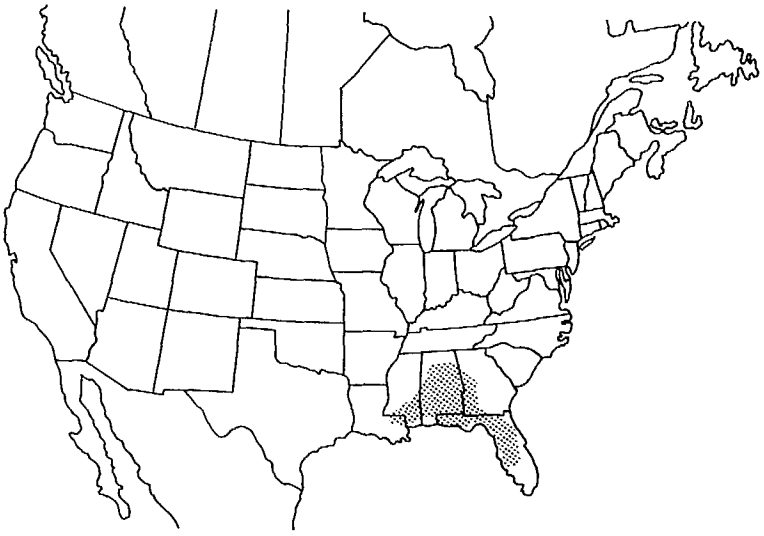
Male Imago

Length 7–8 mm.

Head — Head pale. Compound eyes dorsally separated by distance greater than width of lateral ocellus (similar to Fig. 30).

Thorax — Pale yellowish white to flesh colored; mesoscutellum white. Fore tibiae yellow with apices dark; fore tarsal ratio 1.6–2.1. Fore wings hyaline with costa, subcosta, and radius yellow; other longitudinal veins brown or yellowish brown; crossveins brown; faint reddish or reddish brown tinge in stigmatic area; 1, 2, or 3 crossveins in each of first 3 bulla interspaces, not crowded to slightly crowded; 7–11 (usually 8–10) crossveins in first interspace distal to bulla region. *Hind wings very narrowly dusky on apical portions of outer margins.*

Abdomen — Pale hyaline-yellow or hyaline-white. Terga 8–10 sometimes slightly more flesh colored; dark narrow posterior transverse lines on terga 1 or 2 to at least 7 (Fig. 95), often reduced



Specimens reported from Pennsylvania and Maine by Lewis (1974b) are based on misidentifications and are actually *S. modestum* variants superficially similar to *S. smithae.*

laterally and appearing as medial dashes; spiracular dots present. Caudal filaments yellowish or whitish; alternate segment articulations narrowly darkened. Penes shaped as in Fig. 44.

FEMALE IMAGO

Subanal plate — Posterior margin similar to Fig. 51 or 53.

Biology and Ecology

Berner (1950) discussed the ecology of *S. smithae* in Florida in detail. Individuals occur on all types of submerged objects in virtually any permanently flowing body of water, regardless of current velocity or water depth. This species tolerates wide pH ranges (below 4.0–7.8) and wide water temperature variance.

Emergence is year round in Florida, merely slowing during colder periods. In the laboratory, eggs hatch 11–15 days after oviposition (Berner 1950). In the field, both emergence of subimagos and mating of imagos have been observed in late afternoon. The imaginal molt occurs in 20–24 h; adult females live for about 2½ days (Berner 1950).

Discussion

Stenonema smithae is closely related to *S. modestum* and likely arose from lowland populations of the latter species to the north of the present range of *S. smithae.* It is not clear whether these southeastern forms have achieved reproductive isolation or whether *S. smithae* and *S. modestum* represent species in *statu nascendi.* Until range overlap areas are strictly defined and studied, *S. smithae* should be considered a valid, geographically restricted species (also see discussion of *S. modestum*).

Although populations of *S. smithae* are relatively consistent morphologically, some variation has been noted. The range in number of maxillary crown hair setae is greater than previously reported. Also, ventral larval abdominal maculation is quite variable, probably due to the wide range of habitat exhibited by this species.

Caution should be exercised in identification of adults, particularly those preserved in alcohol, because the darkening of the apical portion of the hind wing outer margin may occasionally be difficult to see. Nevertheless, nearly all individuals can be identified by key morphological features; less than 5% of specimens must be placed on a geographical basis.

Stenonema terminatum (Walsh)

Palingenia terminata Walsh, 1862: 376; 1863: 203; Hagen 1863: 177
Heptagenia placita Banks, 1910: 199
Ecdyonurus bipunctatus McDunnough, 1926: 191
Ecdyonurus terminatus (Walsh), McDunnough 1926: 193 (discussion of *Ecdyonurus ruber*)
Ecdyonurus placita (Banks), McDunnough 1926: 193 (discussion of *Ecdyonurus ruber*)
Stenonema bipunctatum (McDunnough), Traver 1933a: 175; 1935: 306; Daggy 1945: 374; Burks 1953: 169; Lewis 1974b: 19; Flowers and Hilsenhoff 1975: 213 (n.syn.)
Stenonema terminatum (Walsh), Traver 1933a: 175; 1935: 331; Edmunds 1951: 162; Lewis 1973: 67; 1974b: 35; Flowers and Hilsenhoff 1975: 216
Stenonema placitum (Banks), Traver 1933a: 175; 1935: 324
Stenonema lepton Burks, 1946: 614; 1953: 176; Koss 1968: 706 (egg); Lewis 1974b: 28 (n.syn.)
Stenonema ares Burks, 1953: 170; Lewis 1974b: 19 (n.syn.)
Stenonema terminatum (Walsh), Burks 1953: 175
Stenonema sp., Edmunds 1954: 64; Allen and Edmunds 1956: 86
Stenonema placitum (Banks), Lewis 1974b: 31

LARVA

Length 9–10 mm.

Head — Brown with numerous pale dots, pale areas laterad of compound eyes. *Mandibles each with 4–7 (usually 5–7) teeth on inner margin of outer incisor; maxillae each with 2–6 (usually 3 or 4) spinelike setae and 0 (rarely 1–5) hair setae on crown* and 15–27 setae in submedial row.

Thorax — Brown to light reddish brown with variable pale areas. Fore femora with armature in apical ½–⅔ dorsal surfaces, sometimes lacking near junction with fore tibiae; posterior margins of fore femora with spinelike setae and hair setae; anterior margins with spinelike setae and hair setae both usually present but sparse. Fore tarsal claws denticulate or not; denticles sometimes present only in early instars.

Abdomen — Dorsally pale brown to reddish brown, ventrally pale. Terga 1–8 (Fig. 70) pale without consistent pattern, occasionally with submedian posterior dashes of adult visible; 9 often with pair of pale submedian areas; 10 mostly dark. Sterna 2–7 variable, sometimes with pair of submedian oblique dashes; 9 and sometimes 8 with pair of brown lateral maculations, often continuing along posterior margins (Fig. 71, 72). *Lateral projections on segments 7–9; those on segment 9 shorter than on 8 and shorter than ventral lateral margins posterior to projection bases.* Caudal filaments generally pale, often with alternating light and dark segments apically; setae present on outer margins of cerci, sparser basally.

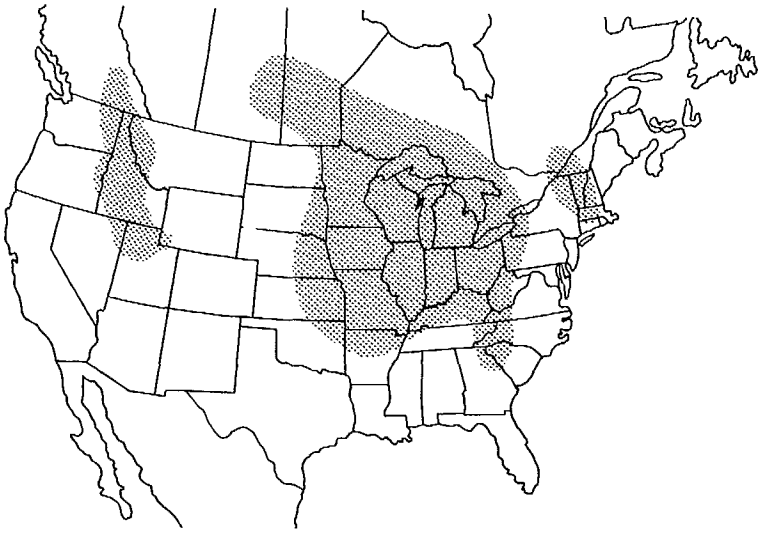
MALE IMAGO

Length 6–9 mm.

Head — White or yellow; vertex often with orange or reddish brown shading. Compound eyes separated by distance greater than width of lateral ocellus (similar to Fig. 30).

Thorax — Variable, mesoscutellum either entirely white or white in apical region. Fore tibiae tan to yellow with apices dark; fore tarsal ratio 1.2–2.4 (usually 1.4–2.2). Fore wings hyaline with longitudinal veins and crossveins yellow to brown; usually faint reddish brown stain in stigmatic area; 1 or 2 crossveins in each of first 3 bulla interspaces, not crowded (Fig. 37); 7–16 (usually 9–12) crossveins in first interspace distal to bulla region. Hind wings without dark outer margin or rarely with extremely narrow shading apically.

Abdomen — Hyaline-white. Terga 1–7 with only brownish transverse bands at posterior margins (Fig. 93), bands containing pair of short black submedian dashes (Fig. 92), pair of short submedian



This is the only western species of *Stenonema*, found primarily in the Snake River drainage and also known from Wyoming, Utah, and northeastern Nevada.

dashes only (Fig. 91), or dashes expanded to form narrow black posterior transverse lines (Fig. 90); 8–10 opaque with tan, brown, red-brown, or orange shading; spiracular markings absent. Caudal filaments white or pale; segment articulations with variable pigmentation, often not darkened. Penes shaped as in Fig. 46 or 47.

FEMALE IMAGO

Subanal plate — Posterior margin similar to Fig. 50 or 51.

Stenonema terminatum terminatum (Walsh)

Male imago as in species account except thorax white or yellowish, occasionally shaded with orange; posterior tergal margins as in Fig. 90–93; if bands present (Fig. 93), not as wide as *S. t. placitum*. Penes shaped as in Fig. 46.

Stenonema terminatum placitum (Banks) (new status)

Male imago as above except thorax dark olive-brown with reddish tinges to red-brown; posterior tergal margins with wide red-brown bands. Penes shaped as in Fig. 47.

Biology and Ecology

S. terminatum is most commonly found in rivers and medium to large streams on rocks or debris, coarse sand or gravel in moderate or occasionally swift current (Lewis 1974b; Flowers and Hilsenhoff 1975). In the western United States, *S. terminatum* is found in slow to moderately flowing, silted rivers, streams, and canals on rocks and aquatic vegetation (Edmunds 1951; Jensen unpublished data).

Discussion

Like other geographically widespread species in the genus, *S. terminatum* is highly variable. Many problems have resulted from previous naming of species from adults only, and from restrictive definitions of species based on variable characters.

In the adult, *S. terminatum* (sensu Lewis 1974b) is distinguished by a brown band on the posterior margins of abdominal terga (Fig. 93). When McDunnough (1926) described *S. bipunctatum,* he stated that it was very similar to *S. terminatum,* but could be distinguished chiefly by the paired submedian black dashes on the posterior margins of abdominal terga (Fig. 91).

Daggy (1945) first described the larva of *S. bipunctatum* but did not indicate whether material had been reared. Lewis (1974b) noted that *S. bipunctatum* had not been reared, but essentially followed Burks' (1953) description of the larva. Flowers and Hilsenhoff (1975) found larvae generally matching the description of *S. bipunctatum* but were not clear about whether their material had been reared. They did report, however, that adults reared from larvae matching the description of *S. terminatum* had paired dashes typical of *S. bipunctatum.*

We have reared *S. bipunctatum* from larvae in the Wabash River at West Lafayette, Indiana, and can confirm Lewis' (1974b) analysis of color (Fig. 72) in *S. bipunctatum.* Also, larvae matching this description from Wisconsin and Indiana have the paired tergal dashes of the adult visible through the larval integument.

Our examination of lateral abdominal projections (see discussion of characters) has indicated that adults reared from *S. bipunctatum* larvae possess lateral abdominal projections on posterior segments only (like *S. terminatum*). Lewis (1974b) had obviously misinterpreted this character in his *bipunctatum.* (This may be a common error (see discussion of characters)). Maxillary crown hair setae are absent or limited to one or two. We have also observed adult tergal submedial dashes through the integument of *S. terminatum* larvae. Finally, the two forms occur together in the same streams. On the basis of all the above, *S. bipunctatum* represents a simple variant form, and we place it as a junior synonym of *S. terminatum.*

In populations of *S. terminatum* larvae, we have also reared adults matching the description of *S. ares,* another simple variant in which the posterior bands on the adult abdomen include *bipunctatum*-like dashes (Fig. 92). Contrary to Burks' (1953) account, we have found that adult males of *S. ares* possess distal penial lobe spines (Fig. 46) similar to *S. terminatum.* Therefore, we place *S. ares* as a junior synonym of *S. terminatum.*

Examination of type material of *S. lepton* has indicated this form also has genitalia similar to *S. terminatum,* contrary to Burks' (1946) description. Larvae have not been reported, but *S. lepton* is known from Illinois in areas where *S. terminatum* is regularly found. Also, the fore tarsal ratio of *S. terminatum* is more variable than originally indicated so that *S. lepton* is not distinct in this regard (see discussion of characters). We place *S. lepton* as a junior synonym of *S. terminatum.* It represents only a color variant in which the dorsal abdominal tergal dashes are expanded to form a narrow crossline at the posterior segment margins (Fig. 90), and in which the hind wing is narrowly darkened at the outer margin (not shaded as in other *Stenonema* spp.). We regularly found this variant represented in series of predominately "typical" *S. terminatum* adults.

Stenonema terminatum has the westernmost distribution of any species of *Stenonema.* Past authors have described specimens from British Columbia and the western United States as *S. terminatum* or closely related to *S. terminatum.* We have examined series of specimens from the west, particularly the Snake River drainage, and found no significant differences from *S. terminatum* in the midwest. Therefore, we feel subspecific status is not warranted for these western populations. It is still uncertain whether these western populations are geographically disjunct from the midwestern populations or whether presently known distribution is a collection artifact. Formal descriptions of exclusively western populations have never been published and any references to the manuscript name, *Stenonema reesi,* (a name that presently has no nomenclatural status but appeared in a Master's thesis (Jensen unpublished data)) are incorrect and are assignable to *S. terminatum.*

Stenonema placitum is known only from eastern Canada, New York, and New England. Generally, specimens are similar to *S. terminatum,* although shape of the penes is slightly different (Fig. 47) and individuals are somewhat darker. This species was synonymized with *S. terminatum* by Burks (1953) but was revived by Lewis (1974b). We do not regard the slight genitalia differences and color intensity as good species characters (see discussion of characters) and, therefore, agree with Burks' specific synonymy. However, because the slight differences in penes shape and coloration appear

consistent and because these forms are all restricted to the east and allopatric (Fig. 111), we assign them subspecific status as *S. terminatum placitum*. All other populations constitute the subspecies *S. t. terminatum*.

In the Wabash River (Indiana), we have noted that *S. terminatum* (sensu Lewis 1974b) occurs through much of the spring and summer. Within this population, *ares*-like and *bipunctatum*-like individuals tend to predominate during certain periods. Also, Flowers and Hilsenhoff (1975) noted a restricted emergence time for *S. bipunctatum*. Further study may indicate that variants in *S. terminatum* are a result of larval developmental period, a phenomenon already documented in *Stenacron interpunctatum* (McCafferty and Huff 1978) and hypothesized by us for other *Stenonema* spp.

Most *S. terminatum* larvae can easily be distinguished by the key. Occasionally some difficulty may occur in distinguishing immature (wing pads less than ½ last instar length) larvae from *S. pulchellum*. Unlike most *Stenonema*, young larvae of *S. terminatum* are paler than mature larvae (Flowers and Hilsenhoff 1975). Fore tarsal claw denticulation is not reliable in this species as denticles may be present or absent, or present in early instars only.

The absence of spiracular markings aids in identifying adult male *S. terminatum*. Because of the variation in adult abdominal maculation, adults may superficially resemble several other species. All forms will key out.

Stenonema vicarium (Walker)

Baetis vicaria Walker, 1853: 565
Baetis tesselata Walker, 1853: 566
Heptagenia fusca Clemens, 1913: 254; 1915: 136
Ecdyonurus fusca (Clemens), McDunnough 1925a: 222
Ecdyonurus vicarius (Walker), McDunnough 1925a: 222
Ecdyonurus fuscum (Clemens), McDunnough 1933: 35
Ecdyonurus rivulicolus McDunnough, 1933: 40
Stenonema vicarium (Walker), Traver 1933a: 174; 1935: 334; Burks 1953: 172; Leonard and Leonard 1962: 104; Koss 1968: 708 (egg); Lewis 1974b: 36
Stenonema fuscum (Clemens), Traver 1933a: 174; 1935: 314; Burks 1953: 173; Leonard and Leonard 1962: 105; Koss 1968: 708 (egg); Lewis 1974b: 24 (n.syn.)
Stenonema rivulicolum (McDunnough), Traver 1935: 328

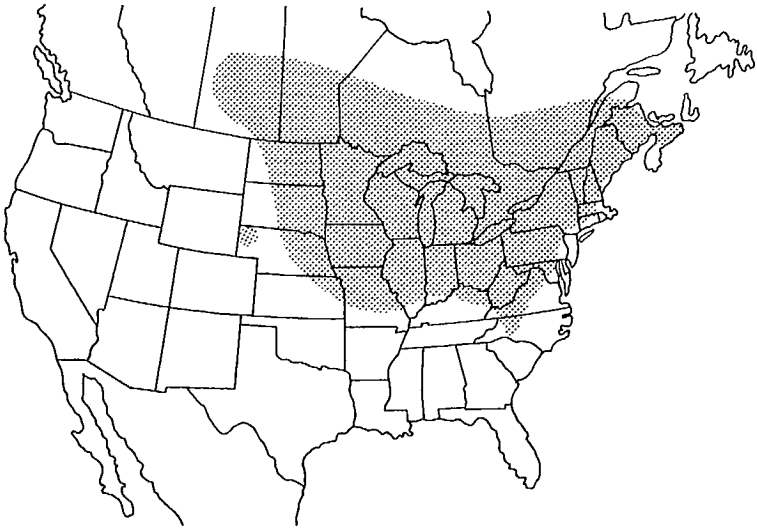
Larva

Length 10–18 mm.

Head — Brown with pale markings; freckled, pale dots present; large pale areas laterad of compound eyes extending to posterior margin each divided by brown band extending from eye to lateral margin. *Mandibles each with 5–10 (usually 7 or 8) teeth on inner margin of outer incisor; maxillae each with 2–5 (usually 2–4) spinelike setae and 12–40 (usually 20–35) hair setae on crown* and 15–35 setae in submedial row.

Thorax — Brown; pronotum with pair of small anterior pale areas submedially, pair of small pale areas laterad of submedial pair, and pair of large pale areas extending most of length of lateral margins. Fore femora with armature in apical ⅔–¾ dorsal surfaces; posterior margins of fore femora with spinelike setae and hair setae; anterior margins with shorter, sparser armature or with armature nearly absent. Fore tarsal claws not denticulate (Fig. 7).

Abdomen — Dorsally and ventrally brown with paler areas. Terga variable from brown anteriorly with darker posterior margins to paler anteriorly with middorsal longitudinal dark bands and/or distinct, usually continuous, dark transverse bands at posterior margins (Fig. 58); 5 and 6 often entirely brown even on paler specimens; 8 and 9 with posterior transverse dark bands sometimes discontinuous medially. Sterna 1–8 with dark transverse bands at posterior margins; *8 with posterior transverse band of continuous width across sternum;* 9 variable with pair of brown posterolateral areas or brown in entire posterior half or intermediate (Fig. 59, 60); pair of pale areas often present at bases of developing cerci in males. *Lateral projections on segments 3–9; those on segment 9 about as long as on 8, and about as long as ventral margins posterior to projection bases.* Caudal filaments tan to yellow basally,



Distribution of *S. vicarium.*

apically usually with alternating pattern of light and dark segments; setae occasionally lacking but usually sparse basally becoming denser apically on outer margins of cerci.

MALE IMAGO

Length 9–14 mm.

Head — Yellowish brown or brown; vertex brown, yellowish brown, or reddish brown. Compound eyes dorsally separated by distance approximately equal to or slightly less than width of lateral ocellus (similar to Fig. 21, 24).

Thorax — Mesonotum dark brown or light brown with yellowish tinge; mesoscutellum dark brown with black apical margin or with pale areas with dark apical margin or with small reddish yellow area on middorsal apical margin. Fore tibiae light amber to reddish; fore tarsal ratio 1.7–3.7. Fore wings hyaline with longitudinal veins and crossveins yellowish brown to brown; yellowish brown or reddish stain in stigmatic area; usually 2 or 3 crossveins in each of first 3 bulla interspaces, not crowded to slightly crowded; 10–17 (usually 12–14) crossveins in first interspace distal to bulla region. *Hind wings not darkened on outer margins.*

Abdomen — Dorsally brown with pale areas, ventrally variable. Terga 1–7 or 1–8 usually with dark transverse bands on posterior ⅓–½ segments or with dark areas on most of terga, with irregular paler anterior margins, or rarely generalized brown shading over entire terga with little contrast between pale and dark areas; 1–7 with dark middorsal bands usually present (Fig. 81); 8–10 opaque, reddish yellow to brown; 9, 10, and sometimes posterior of 8 sometimes with white border laterally; spiracular marks absent or obscure. Sterna 1–7 creamy to creamy yellow; immaculate, or with scattered, small brown patches, or with distinct dark brown lateral patches on posterior margins, attenuated sublaterally about half way between anterior and posterior margins of sterna. Caudal filaments amber to olive-brown, alternate segment articulations usually darkened. Penes shaped as in Fig. 40.

FEMALE IMAGO

Subanal plate — Posterior margin similar to Fig. 50 or 51.

Biology and Ecology

Stenonema vicarium prefers medium to fast current in moderate to large streams and rivers but has been collected in most types of lentic habitats. Pollution tolerance is uncertain; larvae are generally found in relatively clean waters, but Leonard (1965) found them in polluted streams (Lewis 1974b).

Richardson and Tarter (1976) studied the life cycle of *S. vicarium* (sensu Lewis 1974b) in a West Virginia stream. One size class was present in the population and early instars were first collected in June. Largest growth rate was from September through November, with mature larvae present from March to May. Emergence occurred in May. Thus, in the southern part of its range, *S. vicarium* requires 1 yr to complete its life cycle (Richardson and Tarter 1976).

Discussion

Stenonema vicarium has been a major source of taxonomic confusion because of the range of variability in larvae and adults. McDunnough (1933) in describing *S. rivulicolum,* and Traver (1935) in her discussion of this species, indicated it was intermediate between *S. vicarium* and *S. fuscum.* Interestingly, Burks (1953) synonymized *S. rivulicolum* with *S. vicarium,* and Lewis (1974b) reduced *S. rivulicolum* to a subspecies of *S. fuscum.* Lewis also recognized *S. vicarium* as a valid species. Flowers and Hilsenhoff (1975) reared larvae fitting the description of *S. vicarium* but called them *S. fuscum rivulicolum* because Lewis (1974b) stated that *S. vicarium* did not occur west of the Appalachians.

We have examined specimens from a single stream reflecting the three color variations previously thought to be exclusively applicable to *S. vicarium* (Fig. 60), *S. fuscum fuscum* (Fig. 59), or *S. f. rivulicolum.* Furthermore, male larvae of Lewis' typical *S. vicarium* often have lightened areas at the bases of developing genitalia and could be confused with typical *S. fuscum.*

Adults of *S. vicarium* and *S. fuscum* have been separated by size, minor differences in wing venation, and penial lobe armature. We have seen larvae matching the description of *S. fuscum* that (1) reared to adults with *vicarium*-like genitalia, (2) reared to *rivulicolum*-like adults, and (3) reared to adults with both *fuscum*- and *vicarium*-like genitalia. This indicates that character states are random in *S. rivulicolum,* and this form is not a genetic intermediate. In addition, Koss (1968) could find very little difference in eggs of *S. vicarium* and *S. fuscum.*

Based on these data, we place *S. fuscum* and *S. rivulicolum* as junior synonyms of *S. vicarium. S. rivulicolum* represents a typological concept defined by drawing an arbitrary line midway through the range of variability of a single species delimited by *vicarium*-like forms near one extreme and *fuscum*-like forms near the other.

Larvae of *S. vicarium* are easily distinguished by the presence of anterior lateral abdominal projections and maxillary crown hair setae, and ventral abdominal banding (Fig. 59, 60) on posterior margins of segments 3–8 (also see discussion of *S. luteum*).

Adult males are readily identifiable by key characters. Occasionally, individuals may resemble *S. ithaca* but are separable on key characters.

Evolutionary Biology

Phylogeny

Generic and Subgeneric Relationships

Stenonema is on a phyletic line containing the most apomorphic genera of the Heptageniinae (Jensen and Edmunds 1973). The evolution of the sister genus *Stenacron* and the two subgenera of *Stenonema* are outlined in Fig. 98. Hypothetical ancestors are given upper case letter designations.

The hypothetical *Heptagenia*-like precursor to the immediate common ancestor (A) of *Stenacron* and *Stenonema* may be described in terms of ancestral states of characters useful in inferring the

phylogeny of *Stenonema*. In the larva: the body was dorsally flattened; the left mandible possessed incisors subequal in length; the right mandible possessed an inner incisor somewhat shorter than the outer incisor; the maxillae possessed spines or spinelike setae but not hair setae on the crown (Fig. 17); the lamellae of gills 1–6 were somewhat truncate; gill 7 was similar in shape to the preceding gills, and was tracheated and not fringed with setae; lateral abdominal projections were absent on segments anterior to 6; and the fore tarsal claws were adenticulate. In the adult male, penes were probably shaped somewhat as in Fig. 39 but lacked lateral spines; and the compound eyes were separated dorsally by a distance less than or equal to the width of a lateral ocellus. The eggs lacked polar caps and had tagenoform micropyles (each micropylar canal situated at one side of an oval sperm guide) (see Koss 1968; Koss and Edmunds 1974).

The monophyletic group consisting of *Stenacron* and *Stenonema* came into existence with the origin of ancestor A, which retained the ancestral characters listed above except gill 7 was reduced to a slender, tracheated filament (Fig. 2), and the mandibular inner incisors were somewhat shortened on the left mandible and greatly shortened on the right mandible (Fig. 15, 16).

Ancestor A gave rise to two lineages. In that leading to *Stenacron*, gill lamellae 1–6 developed acute points (Fig. 1), penes acquired lateral spines (Fig. 39), and eggs developed unique polar caps consisting of loose threads encircling each pole. Except for these uniquely derived character states, the lineage retained the plesiomorphic character states of ancestor A.

In the evolution of *Stenonema* from ancestor A, gill 7 acquired a fringe of hair setae (Fig. 4, 6), maxillary crowns developed hair setae in addition to spinelike setae, which were reduced in number (Fig. 18), lateral abdominal projections (Fig. 57) developed on segments anterior to 6, and linear micropyles evolved in the eggs. This type of egg structure, in which the micropylar canal is acutely angled with the chorion and the sperm guide is lacking or elongate, is a uniquely derived character state within the Heptageniidae. These derivations delineate ancestor B.

Two distinct lineages were derived from ancestor B, each leading to a monophyletic grouping (subgenera of *Stenonema*). In that leading to the subgenus *Stenonema*, gill lamellae 1–6 became rounded (Fig. 3), fore tarsal claw denticles developed (Fig. 8), and an incurving of the medial margin of the penes occurred (Fig. 38). The ancestral tracheated condition of gill 7 (Fig. 4) was retained in *Stenonema* s.s. (as in *Stenacron* (Fig. 2)). In the subgenus *Maccaffertium* (ancestor C), the tracheation of gill 7 was lost (Fig. 6).

Species Relationships

Species phylogeny within the subgenus *Maccaffertium* cannot be completely deduced due to a lack of reliable phyletic characters. This may primarily be a reflection of the relatively recent evolution of the genus (also see biogeography discussion). Further, selection for reproductive isolation is not commonly reflected in morphological differences; it appears that isolation may often be achieved through ecological and/or behavioral differences. Characters that do vary, often do so intraspecifically depending on size, time of emergence, etc. (see discussion of characters), and are probably an indication of a high percentage of common genetic material within *Maccaffertium*.

Uniquely derived character states on a single lineage are the rule in this subgenus. This is also an indication of the relatively recent origin of the genus and the common genetic base. The presence of monoapomorphy rather than synapomorphy prevents cladistic inferences in many cases.

The evolution of *Maccaffertium* is outlined in Fig. 98. Species clusters are based on points of divergence relative to deducible ancestors. Where possible, common ancestors within species clusters are defined.

Cluster I consists of *S. vicarium*, *S. sinclairi*, *S. pudicum*, *S. carlsoni*, and *S. ithaca*. These species originated subsequent to ancestor C, but none share ancestor D with other *Maccaffertium* species. They are morphologically similar as adults with penes shaped as in Fig. 40 or 41 (except *S. sinclairi* (Fig. 42) which may represent an isolated population derived from an *S. vicarium*-like ancestor), extensive dark dorsal abdominal maculation, and compound eyes separated by a distance less than the width of a lateral ocellus (Fig. 21, 24). Larvae are similar in the retention of anterior lateral abdominal projections (except *S. ithaca*, which we regard as an independent loss).

For the most part, sibling relationships and the exact points of phyletic origin of cluster I species cannot be ascertained because of the lack of identifiable synapomorphy; and the cluster, as a whole, may or may not be monophyletic. However, *S. pudicum* and *S. carlsoni* are apparently sibling species (in the sense of McCafferty and Chandler (1974)) as both possess uniquely derived, crowded crossveins

in the first interspaces of the bulla region (Fig. 35). Unlike all other members of cluster I, *S. carlsoni* larvae lack maxillary crown hair setae and likely represent a species derived from an *S. pudicum*-like ancestor that dispersed southward (see biogeography discussion).

Ancestor D evolved compound eyes in the male adults that became separated dorsally by a distance greater than the width of a lateral ocellus (Fig. 27, 30) (see discussion of characters). This derived character state is common to all *Maccaffertium* other than cluster I and defines a monophyletic group.

Cluster II includes *S. mediopunctatum* and *S. luteum*. These species originated subsequent to ancestor D but do not share ancestor E with other *Maccaffertium* species. Both species possess anterior lateral abdominal projections in the larvae but differ in extent of maxillary crown hair setae. They may share an immediate common ancestor or may have originated independently prior to the origin of ancestor E.

Ancestor E lost the anterior lateral abdominal projections and is common to species of cluster III. Within cluster III, we recognize two divisions: IIIA and IIIB. Cluster IIIA includes *S. pulchellum, S. terminatum, S. exiguum*, and *S. meririvulanum*. This is a monophyletic group of species that share an immediate common ancestor (F), as deduced from the commonly derived loss of maxillary crown hair setae (see discussion of characters). Shape of the penes (Fig. 48) in *S. exiguum* and elongate caudal filaments in adult *S. meririvulanum* are uniquely derived character states. Precise relative points of origin of species within cluster IIIA cannot be ascertained at this time.

Cluster IIIB includes *S. modestum, S. smithae*, and *S. integrum*. These species retain maxillary crown hair setae and so do not share ancestor F. Their exact phyletic relationship to each other is unknown. Based on phenetic similarity it is probable that *S. smithae* evolved from an *S. modestum*-like ancestor in the southern part of the latter species' range. Penial lobe shape in *S. integrum* (Fig. 49) is a uniquely derived character state which parallels a superficially similar condition in *S. exiguum*.

Biogeography

Despite the difficulty in establishing phyletic relationships within species clusters, several hypotheses concerning place and time of origin and subsequent dispersal can be made based on several kinds of evidence. These include phyletic relationships between species clusters, present distribution, and ecological data.

In addition to the phyletic evidence previously cited, present distribution of *Stenonema* indicates a relatively recent origin for the genus. McCafferty and Provonsha (1978) in their study of mayflies of the Ozark–Ouachita area of northwestern Arkansas indicated mayfly fauna in that area is composed of two elements. The first faunal element consists of species with Appalachian affinities. These species probably dispersed via the unglaciated Illinois Ozarks corridor (Pliocene) from the Appalachians. No *Stenonema* species of strictly Appalachian affinities have been documented in the Ozark–Ouachita region.

Species of *Maccaffertium* occurring in the Ozark–Ouachita region are all representative of McCafferty and Provonsha's (1978) second faunal category (species that are widely adapted and range into the midwest). These include *S. exiguum, S. integrum, S. mediopunctatum, S. modestum, S. pulchellum*, and *S. terminatum*. This distribution indicates that the subgenus is certainly no older than early Pleistocene and probably no older than late Pleistocene.

Spieth's (1947) conclusion that components of what we now consider *S. femoratum* (*Stenonema* s.s.) were present at the time of maximum Pleistocene glaciation can be supported indirectly by our phyletic conclusion of relatively early origin for this subgenus.

By our restricted definition, *S. smithae* (see discussion of that species) is no longer considered part of the Ozark–Ouachita fauna and, therefore, confirms McCafferty and Provonsha's (1978) hypothesis that there is little continuity between mayfly fauna of the Coastal Plain and Mississippi Abayment and that of the Ozark–Ouachita area, except continentally widespread species.

Present species distributions correlated with phyletic data indicate an Appalachian origin for the subgenus *Maccaffertium*. Cluster I, the most plesiomorphic cluster, is primarily of Appalachian affinity. *Stenonema pudicum* and *S. ithaca* are the most common species of *Stenonema* in the mountains (Traver 1933a), *S. sinclairi* occurs in a mountain drainage area, and *S. vicarium* is a montane species that has dispersed north and west and is now found through Canada and New England, across the midwest in the northern tier of states.

The distribution of *Maccaffertium* cluster II (*S. mediopunctatum* and *S. luteum*) is interesting because it illustrates a common pattern in *Stenonema*. *Stenonema mediopunctatum mediopunctatum* is restricted to eastern North America and its distribution is similar to many Appalachian species; *S. mediopunctatum arwini* is widespread in the midwestern United States. This pattern is interesting as many species in the relatively apomorphic cluster III have distributions similar to *S. m. arwini*. It is possible that *S. m. mediopunctatum* gave rise to *S. m. arwini* in the southern Ontario or Michigan area, where *S. m. mediopunctatum* × *S. m. arwini* individuals are most frequent. Populations of *S. m. arwini* may have then spread to the west and south. At points of range contact (Tennessee, Alabama) in the south, *S. m. mediopunctatum* × *S. m. arwini* individuals are also found.

Based solely on ecological preference, we hypothesize that *S. luteum* represents a population derived from *S. m. mediopunctatum*, which adapted to lake shore environments where it is now most commonly found (restricted generally to the Great Lakes area (p. 27)).

Maccaffertium cluster III includes the most widespread species in the subgenus. Of these, only *S. modestum* and *S. meririvulanum* are widespread in the Appalachians; the latter species is the only member of this cluster found exclusively in this region. *Stenonema meririvulanum* is ecologically restricted to small spring-fed streams and may represent an early offshoot in this cluster. *Stenonema modestum*, although common in the Appalachians, occurs through eastern Canada and the northern tier of midwestern States. A northern dispersal is postulated for this species with populations spreading westward through Canada. Populations in southern Indiana and Illinois are enigmatic; either a northward dispersal from older southern Appalachian populations or a more recent southward dispersal from Canadian stock is possible. Ecological tolerance is broad in *S. modestum* and offers no clues in deciphering dispersal routes. *Stenonema smithae* is the only species of *Stenonema* restricted to the southeastern United States and likely originated relatively recently from coastal plain populations of *S. modestum* to the north.

Stenonema exiguum (p. 19), *S. pulchellum* (p. 35), *S. integrum* (p. 21), and *S. terminatum* (p. 41) have similar present distributions. All are common in the midwest but relatively rare or absent from the Appalachian area. The distribution of these relatively apomorphic species further supports the hypothesized Appalachian origin of *Maccaffertium*. *Stenonema terminatum* is the only species of *Stenonema* found in the western United States (p. 41). A western dispersal through Canada is likely, based on present distributional data, with population of *S. terminatum* dispersing southward through the Snake and Columbia River drainages. *Stenonema integrum* and *S. exiguum* are found in eastern Texas; in either case, Texas populations could have resulted from dispersal southward of northern populations or westward from Gulf Coast populations. In Texas, both species occur east of mountainous areas that may form a barrier for further westward expansion. *Stenonema integrum* also occurs in eastern Mexico and probably eastern Guatamala (p. 21). These populations presumably came from eastern Texas stock.

The tentative biogeographic postulates given above are subject to revision as interspecific phyletic relationships within species clusters become clearer. We are cognizant of the inherent dangers involved in interpreting dispersal without complete phyletic information. Nevertheless, several important generalizations regarding *Maccaffertium* seem valid. The subgenus is recent in origin, no older than early Pleistocene, and probably considerably younger; glacial extent had little impact in establishing dispersal routes; and the subgenus originated in the present Appalachians, with the most plesiomorphic species still most common there.

The distributions of some species, particularly *S. vicarium* (p. 44), are enigmatic. Such species occur in formerly glaciated areas, and species boundaries through most of the range correspond to maximum glacial extent. It is possible that this is a collection artifact. However, the westernmost distribution of *Stenonema* in the northern United States may result from competition with species of other genera occupying formerly unglaciated areas. *Stenonema* may be able to disperse rapidly in the north where competitive genera are not present. This may also explain the northern dispersal route hypothesized for *S. terminatum* in reaching the western United States.

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Appendix A — Material Examined

Species are listed in alphabetical order. For each species, type material examined is given first. Thereafter, nontype specimens examined are listed by States in alphabetical order, followed by provinces of Canada and entries from Central America and Mexico. In State records where counties are listed for part of the material only, county records follow other material examined for that State whenever clarity dictates. When more than two collectors are listed, the first two names (or the first only if no other collectors are listed) are given followed by "et al." All years listed with 2 digits only refer to the 20th century. Abbreviations are employed for collections, frequently used collector's names, and sex and stage of specimens as indicated below:

SEX AND STAGE

M — male imago
F — female imago
L — larva
S — subimago (sex indicated by F or M)

COMMON COLLECTORS

AVP	— A. V. Provonsha
GFE Sr.	— G. F. Edmunds Sr.
GFE	— G. F. Edmunds Jr.
GSW	— G. S. Walley
JMD	— J. McDunnough
JRT	— J. R. Traver
LD	— L. Dersch
WPM	— W. P. McCafferty

COLLECTIONS

CNC	— Canadian National Collection, Biosystematics Research Institute, Ottawa, Ontario
CU	— Cornell University, Ithaca, New York
EPA	— U.S. Environmental Protection Agency, P. Lewis Collection, Cincinnati, Ohio
FAMU	— Florida Agricultural and Mechanical University Entomology Museum, Tallahassee, Florida
FSCA	— Florida State Collection of Arthropods, Gainesville, Florida
INHS	— Illinois Natural History Survey, Urbana, Illinois
JRC	— Stroud Water Research Center, J. Richardson Collection, Avondale, Pennsylvania
MCZ	— Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts
MSU	— Michigan State University, East Lansing, Michigan
PU	— Purdue University Entomological Research Collection, West Lafayette, Indiana
ROM	— Royal Ontario Museum, Toronto, Ontario
UK	— University of Kansas, Snow Entomological Museum, Lawrence, Kansas
UMI	— Museum of Zoology, University of Michigan, Ann Arbor, Michigan
UMO	— University of Missouri Entomology Museum, Columbia, Missouri
UN	— University of Nebraska State Museum, Lincoln, Nebraska
USNM	— U.S. National Museum, Washington, D.C.
JU	— University of Utah, Salt Lake City, Utah
UW	— University of Wisconsin, Madison, Wisconsin
VPI	— Virginia Polytechnic Institute and State University, Blacksburg, Virginia

S. carlsoni

HOLOTYPE of *Stenonema carlsoni* Lewis: 1M, SOUTH CAROLINA: Pickens Co.: Wildcat Cr., 26-VII-68 Carlson, (FAMU); PARATYPES of *Stenonema carlsoni*: Lewis: 1L, KENTUCKY, Bell Co.: Pine Mt. St. Pk., brook, 18-VI-58 Peters, (FAMU); 4L, SOUTH CAROLINA, Anderson Co.: 18 mi Cr., Rt. 56, 1-VI-66 Prins, (FAMU); 1L, SOUTH CAROLINA, Pickens Co.: Wildcat Cr., 11-III-67 Carlson, (FAMU); 3F, same data, 6-IV-68 Carlson, (EPA); 6M, 3F, same data, 13-V-68 Carlson, (FAMU); 2M, same data, 19-V-68 Carlson, (EPA); 1M, same data, 22-V-68 Carlson, (EPA); 1M, same data, (FAMU); 2M, same data, 24-V-68 Carlson, (FAMU); 1M, same data, 25-VII-68 Carlson, (EPA); 1M, same data, 27-VII-68 Carlson, (EPA); 1M, same data, ?-?-68 Carlson, (EPA).

GEORGIA, Athens, Small Cr., Univ. farm, 1L, 2F, 2-IV-49 Ricker, Scott, (PU); KENTUCKY, Cumberland Falls St. Pk., 1L, 12-V-39 Frison, Ross, (INHS); SOUTH CAROLINA, Clemson Coll., 1M, 11-II-32 Dunavan, (CU); Pickens Co.: Wildcat Cr., 5.5 mi NW Clemson, 2L, 1F (reared), 8-V-68 Carlson; same data, 3F, 11-IV-68 Carlson; same data, 1F, 7-II-67 Carlson, (FAMU); TENNESSEE, Gatlinburg, 3L, 13-VI-40 Frison et al., (INHS); VIRGINIA, Skyline Dr., Big Meadows, 2L, 1-I-39 Frison, Burks; Speedwell, 1L, 22-III-40 Frison, Mohr et al., (INHS).

S. exiguum

HOLOTYPE of *Stenonema exiguum* Traver: 1M, NORTH CAROLINA, Catawba R. nr. Woodlawn, 6-VII-30 JRT, (CU), PARATYPES of *Stenonema exiguum* Traver: 6F, GEORGIA, Atlanta, Chattahoochee R., 10-VI-32 Fattig, (CU); 1F, GEORGIA, Rome, Etowah R., 16-VIII-31 Fattig, (CU); 1M, 1F, same data, (CNC).

Holotype of *Stenonema alabamae* Traver: 1M, ALABAMA, Sheffield, 4-VII-36 JRT, Thomsen, (CU); Paratypes of *Stenonema alabamae* Traver: 11F, same data, (CU); 2F, same data, (CNC); Holotype of *Stenonema quinquespinum* Lewis: 1L, 1M (reared), OHIO, Clermont Co.: E Fork Little Miami R., Williamsburg, 1-16-V-72 Lewis, (FAMU); Paratypes of *Stenonema quinquespinuum* Lewis: 3L, 1M, same data, 1-V-72 Lewis, (FAMU).

ARKANSAS, Montgomery Co.: Ouachita R. at Rocky Shoals Bt. Camp, U.S. Hwy. 270, 1M, 1-VI-74 WPM, AVP et al.; YELL Co.: Petit Jean R. at St. Rd. 7, 3 mi S Centerville, 2L, 29-V-74 WPM, AVP et al., (PU); FLORIDA, Gadsden Co.: Rocky Comfort Cr., dirt rd. at bridge 6 mi S Hwy. 268, 1L, 29-III-68 Peters, Tsui et al.; Jackson Co.: Blue Spring Run, 2L, 26-X-62 Beck; Okaloosa Co.: Blackwater R., Kennedy Bridge, 6 mi W Blackman, 2M, 1-V-70 Peters, Peters et al.; Blackwater R., Bryant Bridge, 2.5 mi W Holt, 3L, 29-V-70 Peters, Peters et al., (FAMU); GEORGIA, Atlanta, Chattahoochee R., 1M, 10-VI-32 Fattig, (CU); ILLINOIS, Erie, Rock R., 1L, 5-VI-40 Mohr, Burks, (INHS); INDIANA, Elkhart Co.: 1 mi SE Millersburg at bridge, 3L, 21-V-72 WPM, AVP; Elkhart R. 1 mi SE Millersburg, 3L, 25-V-73 AVP, Black; Elkhart R. at Hwy. 33, 1L, 11-VI-74 LD, Tyler; Fulton Co.: Mud Cr. at Hwy. 14, 5 mi W Rochester, 2L, 25-V-73 AVP, Black; LaGrange Co.: Pigeon Cr. at 1100 E, Pigeon R. St. Pk., 3L, 24-V-73 AVP, Black; Martin Co.: White R. at Hindostan Falls Pub. Fish. Sgt., 2 L, 6-V-74 AVP, LD; same data, 4L, 20-VI-74 AVP, LD; Lost R. at Windom, 1L, 3-VII-74 AVP, LD et al.; Marshall Co.: Bean Blossom Cr. at Hwy. 37, N Bloomington, 1L, 31-VIII-73 Finni, AVP; Montgomery Co.: Sugar Cr. 1 mi N Darlington, 2L, 1-VI-73 AVP, Black et al.; Newton Co.: Iroquois R. at Hwy. 41, 5 mi N Kentland, 1L, 26-VII-73 Black; Owen Co.: White R. at Freedom, 4L, 6-V-74 AVP, LD; Posey Co.: Wabash R. at Old Dam, New Harmony, 2L, 12-VIII-74 AVP, Minno; Pulaski Co.: Tippecanoe R. at Tippecanoe R. St. Pk., 2L, 2-VII-73 AVP, Huff et al.; Shelby Co.: Big Blue R. 2 mi N Marion, 3L, 3M (reared), 22-VIII-75 AVP, Black; Tippecanoe Co.: Wabash R., West Lafayette, 3L, 2M (reared), 29-VII-75 AVP, Minno; Warren Co.: Big Pine Cr. 3 mi SW Rainsville, 4L, 16-VII-73 AVP, Black, (PU); KENTUCKY, Cumberland Falls St. Pk., 1L, 12-V-39 Frison, Ross, (INHS); LOUISIANA: Baton Rouge, Amite R., 2L, 7-III-37 no collector listed, (INHS); MINNESOTA, Minneapolis, 1M, 1-VIII-39 Daggy, (UU); TEXAS, Jasper Co.: Small stream at bridge on Farm Rd. 256, 10 mi SE Colmesneil, 1L, 4-V-77 WPM, AVP et al.; Neches R. at U.S. Hwy. 69, 1M, 4-V-77 WPM, AVP et al., (PU); WISCONSIN, Manitowish R., Boulder Jct., 1L, 25-VIII-37 Ross, (INHS).

S. femoratum

Holotype of *Stenonema birdi* Traver: 1M, OKLAHOMA, Comanche Co., 28-II-32 Bird, WCC, (CU); Paratypes of *Stenonema birdi* Traver: 3F, same data, 18-II-32 Bird, (CU); 9F, 10M, same data, 28-II-32 Bird, WCC, (CU); 2M, same data, 28-II-32 Bird, WCC, (CNC); Holotype of *Stenonema scitulum* Traver: 1M, OKLAHOMA, Latimer Co., 10-VI-31 Bird, (CU); Paratypes of *Stenonema scitulum* Traver: 5F, 12M, same data, 10-VI-31 Bird, (CU); 3M, same data, 10-VI-31 Bird, (CNC); Types of *Stenonema tripunctatum* (Banks): 1M, WISCONSIN, Milwaukee Co., 22-VII-08 Graenicher, (MCZ); 1M, NEW YORK, Westfield, 13-VI-05 Woglam, (MCZ).

ALABAMA, Morgan Co.: 2 mi S Hartselle, 1L, 13-VI-73 Stark, (UU); Winston Co.: Stream, Hwy. 278, 3.8 mi W Addison, 2L, 16-IV-56 Hynes, Berner, (FSCA); ARKANSAS, Montgomery Co.: Little Missouri R., 2M, 30-V-74 WPM, AVP et al., (PU); Polk Co., 1M, 21-VIII-28 Beamer, (UK); Mine Cr., For. Rd. 25, 8 mi SE Dallas, 1M, 1F, 1-VI-74 WPM, AVP et al., (PU); GEORGIA, Swamp Cr., Dalton, 2M, 24-VIII-31 Fattig, (CU); ILLINOIS, Antioch, Channel L., 1L, 1M (reared), 22-V-48 Ross, Burks, (INHS); INDIANA, Dearborn Co.: S Fk. Hogan Cr., 1L, 16-V-74 AVP, LD; Trib. Tonners Cr., 1M, 16-V-74 AVP, LD; Jefferson Co.: Clifty Cr., St. Rd. 56, 2L, 1F, 2M (reared), 13-VII-73 Huff, Black; same data, 1M, 16-VI-77 AVP, Minno et al.; Monroe Co.: Bryant Cr., 1L, 12-III-75 AVP, Harris; Perry Co.: Poison Cr., 5 mi NW Derby, 1L, 15-V-75 AVP, LD et al.; Ripley Co.: Laughery Cr., 1M, 18-V-73 WPM, AVP et al., (PU); IOWA, Milford, W Okoboji L., 2L, 30-V-31 Parsons, (CU); KANSAS, Pottawatomie Co.: Westmorland, 2L, 10-VI-56 Peters; Wabaunsee Co.: L. Wabaunsee, 1M, 10-VI-56 Peters, (FAMU); KENTUCKY, Bath Co.: Trib. Salt L. Cr., Clear Cr., 1M, 4-VI-73 WPM, AVP et al., (PU); Green Co., 1L, 9-VI-46 Cook, (UU); MICHIGAN, Kalamazoo Co.: Gull L. Bio. Sta., 1M, 26-VI-65 Fisher; Keweenaw Co.: Copper Harbor, 1M, 24-VI-57 Hodges; Isle Royale, 1M, 14-VIII-57 Hodges, (MSU); MINNESOTA, New Brightilon, 1L, 22-IX-29 Hodson, (CU); Nisswa, Pelican L., 2M, 12-VII-12 Bruner, (UN); MISSOURI, Moniteau R., 1L, no date, Selgeby; Westphalia, 1M, no date, Parshall; Osage Co.: Loose Cr., 1L, 9-IV-62 Redmond, (UMO); NEW YORK, nr. Enfield, 1L, 24-IV-32 JRT, (CU); NORTH CAROLINA, nr. Spero, 1L, 1M (reared), 28-II-30 JRT, (CU); OHIO, Shayler Run, Union Twnshp., 1L, 13-VI-69 no collector listed, (INHS); Trib. E Br. Chagrin R., Kirtland, 2L, 25-VIII-30 JRT; same data, 1L, 1F (reared), 11-IX-31 JRT; same data, 1L, 1M (reared), 9-VIII-32 no collector listed, (CU); Green Co.: Little Miami R., 1F, 29-VI-66 Donahue, (MSU); Ottawa Co.: L. Erie, Put-in-Bay, 2L, 2M, 7-8-VII-75 Peters, (FAMU); OKLAHOMA, Bartlesville, 1F, 10-VI-60, Eickwort, (PU); same data, 2F, (MSU); Comanche Co., 3L, 28-II-32 Bird, (CU); McCurtain Co.: Narrows, 1M, 2F, 6-IV-31 Bird; Murray Co., 1L, 22-III-31 Bird; 1MS, 2-IV-31 Bird, (CU); TENNESSEE, Fentress Co.: Burrville, 1F, 15-V-56 Benesh; Lincoln Co.: Fayetteville, 1M, 22-VII-56 Hynes; same data, 3L, 23-VII-56 Hynes; Moore Co.: Hwy. 55, 6.8 mi S Moore-Coffee Co. line, 2L, 17-IV-56 Hynes, Berner; Robertson Co.: 2.1 mi W Springfield, 2L, 16-VI-54 Hynes, (FSCA); TEXAS, W Brackettville, 1L, 17-IV-39 Ross, Ross; W Palo Pinto, 1L, 12-VI-43 Frison, (INHS); Rancho de Palmas, Neuces R., 1L, 5-III-36 Needham, (UU); Austin Co.: San Bernard R. at I-10, 1L, 2F (reared), 9-V-77 WPM, AVP et al.; Blanco Co.: U.S. Hwy. 281, 2 mi S Blanco, 1M, 6-V-77 WPM, AVP et al., (PU); Hays Co.: R. S Dripping Springs, 2L, 21-VII-76 Flowers, (FAMU); Kendall Co.: Guadaloupe R., 1L, 1M, 7-V-77 WPM, AVP et al., W Sister Cr., 1L, 1F, 7-V-77 WPM, AVP et al., (PU); VIRGINIA, Montgomery Co.: Rt. 701, Price Mt., 2M, 16-IV-77 Kondratieff, (VPI); WEST VIRGINIA, Shinns Run, Shinnston, 1L, 2-IV-33 Bowman, (CU); Wayne Co.: Twelve-Pole Cr., 0.5 mi from Booton, 1L, 6-II-70 Tarter, (FAMU); CANADA, MANITOBA, Cedar L., 1M, ?-VI-36 Carpenter, Parsons, (MCZ); NEWFOUNDLAND, 1M, 29-VI-61 Alexander, (UU); ONTARIO, Algonquin Pk., Kearney L. Outlet, 3L, 1-VI-59 Peterson; Algonquin Pk., Wildlife Res. Sta., 1M, 2-VIII-55 Peterson, (UU); Isl. 144, Go Home Bay, 2L, 20-VI-32 GSW; Pelee Isl., 1M, 2-VII-31 Brown, (CNC); Pt. Elgin, L. Huron, 2M, 26-VI-33 George; same data, 1M, 29-VI-33 George, (CU); QUEBEC, Knowlton, Knowlton Cr., 1L, 1F (reared), 16-VI-30 Milne; Vaudreuil, 1M, 24-VI-30 GSW, (CNC).

S. integrum

HOLOTYPE of *Stenonema integrum* (McDunnough): 1M, ILLINOIS, Alton at light, 27-VIII-13 JMD, (INHS); PARATYPES of *Stenonema integrum* (McDunnough): 2M, same data, (INHS); 2M, same data, (CNC).

Holotype of *Stenonema bellum* Traver: 1M, NORTH CAROLINA, Penrose, French Broad R., 19-VII-30 JRT, (CU); Paratype of *Stenonema bellum* Traver: 1F, NORTH CAROLINA, Penrose, 19-VII-30 JRT, (CNC); Holotype of *Stenonema metriotes* Burks: 1M, ILLINOIS, East Dubuque, light, 3-VII-46 Burks, Sanderson, (INHS); Paratypes of *Stenonema metriotes* Burks: 1M, ILLINOIS, East Dubuque, 3-VII-46 Burks, Sanderson, (INHS); 1M, ILLINOIS, Oregon, 4-VII-46 Mohr, Burks, (INHS); 1M, ILLINOIS, Prophetstown, Rock R., 24-25-VII-47 Burks, Sanderson, (INHS); 2M, ILLINOIS, Quincy, 24-VI-48 Stannard, (INHS); 1M, ILLINOIS, Shawneetown, 14-VII-48 Mills, Ross, (INHS).

ALABAMA, Dallas Co.: Selma, lighted store windows, 2M, 23-VI-56 Hynes, (FSCA); ARKANSAS, Benton Co., 1L, 23-V-66 no collector listed, (PU); Yell Co.: Arkansas R., Dardanelle, 2M, 8-VIII-57 Peters, Eberhart, (FAMU); FLORIDA, Okaloosa Co.: Blackwater R., Bryant Br. 2 mi W Holt, 2L, 29-V-70 Peters, Peters et al.; FAMU Biol. Sta., 4.5 mi NW Holt, 1F, 23-VIII-74 Peters, Peters, (FAMU); GEORGIA, Clarksville, Sogue R., 1M, 1-VII-39 Fattig, (FSCA); Ruiggold, Cucumangari, 1M, 24-VII-31 Fattig, (CU); Vienna, 2M, 23-VII-30 Spieth, (UMI); INDIANA, Gibson Co.: White R. at Cunningham's Ferry, 5 mi NW Patoka, 3L, 11-VII-73 WPM, Black; Knox Co.: White R. at Cunningham's Ferry, 2L, 21-VI-74 AVP, LD; Martin Co.: E Fork White R. at Hindostan Falls Pub. Fish. Sgt., 2L, 20-VI-74 AVP, LD; same data, 2M, 2-VII-74 AVP, LD et al.; Posey Co.: Wabash R. at Old Dam, New Harmony, 4L, 2M, 2F, 12-VIII-74 AVP, LD; Wabash R. at Hwy. 460 bridge, New Harmony, 4L, 13-VIII-74 AVP, LD; Tippecanoe Co.: West Lafayette, Wabash R., 1M, 13-VII-73 AVP; same data, 1L, 18-VII-74 AVP, LD; West Lafayette, 1M, 25-VI-74 AVP; same data, 4M, 31-VII-74 AVP, (PU); IOWA, Blackhawk Co.: Cedar Falls, 1M, 3-VIII-73 Knudtson, (PU); KANSAS, Lawrence, 2M, 1-VIII-30 Brown, (CNC); Lawrence, 3M, no data, (CU); Wyandotte Co.: Bonner Springs, 5M, 20-VII-57 Peters, Eberhart, (FAMU); KENTUCKY, Pineville, 1M, 24-VI-38 Frison, Frison, (INHS); LOUISIANA, East Baton Rouge Co.: Baton Rouge, business district, 2M, 4-VI-56 Hynes, Berner, (FSCA); MISSISSIPPI, Adams Co.: Natchez, business district, 8M, 5-VI-56 Hynes, Berner; Lowndes Co.: Columbus, 1M, 11-VI-56 Hynes, Berner, (FSCA); NORTH CAROLINA, Rockingham Co.: Cr., N.C. Hwy. 150, 1 mi S Jct. 87, Benata R., 1M, 2-VII-55 Hynes, (FSCA); SOUTH CAROLINA, Cherokee Co.: Secondary Rd., 1.7 mi N Jct. Secondary 105, 2M, 15-VI-55 Hynes, (FSCA); Clemson Coll., 1F, 26-VI-35 Dunavan, (CU); Laurens Co.: Enoree R., Hwy. S.C. 101, 3M, 2F, 16-VI-55 Hynes, (FSCA); TENNESSEE, Sevier Co.: Pigeon Forge, U.S. 441, 2M, 4-VIII-56 Hynes; Shelby Co.: Memphis, business district, 3M, 1F, 7-VI-56 Hynes, Berner, (FSCA); TEXAS, Austin Co.: San Bernard R. at I-10, nr. Sealy, 1L, 2F (reared), 9-V-77 WPM, AVP et al.; Brazos R., Austin St. Hist. Prk., 2L, 10-V-77 WPM, AVP et al., (PU); Brazos Co.: Navasota R. at Hwy. 6, 1L, 1M, 2F (reared), 10-VIII-69 Richardson, (JRC); Victoria Co.: Guadalupe R. at Victoria, 2M, 8-V-77 WPM, AVP et al., (PU); WEST VIRGINIA Pendleton Co.: Smoke Hole, 1M, 7-VIII-30 no collector listed, (CU); CENTRAL AMERICA, Gualah, 2L, ?-I-05 Williamson, (UU); MEXICO, Tamaulipas, Rio Frio, 5L, 24-XII-39 Berner, (UU).

S. ithaca

HOLOTYPE of *Stenonema ithaca* (Clemens and Leonard): 1M, NEW YORK, Ithaca, Cass Cr., 24-VI-13 Clemens, (CNC); PARATYPE of *Stenonema ithaca* (Clemens and Leonard): 1F, NEW YORK, Ithaca, 28-VI-13 Clemens, (CNC).

Paratypes of *Stenonema allegheniense* Carle: 1L, 1M (reared), VIRGINIA, Giles Co.: Spruce Cr., 3-IV-76 Carle, (EPA); 2L, same data, 13-V-76 Carle, (EPA); 1M, VIRGINIA, Giles Co.: Spruce Run, 13-IV-77 Carle, (VPI).

KENTUCKY, Jackson Co.: War Fk. Sta. Camp Cr., 2M, 8-VI-73 WPM, AVP et al., (PU); MASSACHUSETTS, Pelham, Orient Spgs., 1M, 31-V-41 JRT, (UU); Hampshire Co.: N Amherst, Mill R. nr Puffer's Pd., 2L, 12-14-VI-66 Koss, Koss, (MSU); NEW JERSEY, Sussex Co., 2M, 9-VI-73 Jacques, (PU); NEW YORK, Chicago, Beaver Cr., 2L, 2M (reared), 12-20-VI-32 JRT; Chicago, Bog Str., 1L, 1M (reared), 15-VI-32 JRT, (CU); Enfield, 1L, 12-VII-14 no collector listed, (CNC); Freeville, Bear Cr., 2M, 12-20-VI-32 JRT, (CU); Ithaca, Cass Cr., 3M, 26-VI-14 Clemens; same data, 1M, 1F, 7-VI-? no collector listed, (CNC); Ithaca, Cascadilla Cr., 1L, 19-V-33 JRT, (CU); Ithaca, Six Mile, 2L, 8-VII-13 Clemens, (CNC); Ithaca, Fish Hatchery, 2M, 16-VI-31 Sadler; Mclean Bogs, 1L, 26-V-37 JRT; Mclean Res., Sphaerium Br., 5L, 23-VII-24 no collector listed, (CU); NORTH CAROLINA, Laurel R., 1L, 29-VI-30 JRT; Pisgah For., 1M, 16-VI-36 JRT, (CU); Pisgah For., Davidson R., 1M, 19-VI-36 Thomsen; Swannahoa, Swannahoa R., 1L, 2M (reared), 12-VII-30 JRT, (UU); Woodlawn, 2L, 23-V-40 Frison, Mohr et al., (INHS); Macon Co.: Stream nr. Cullassaja R., 6-7 mi W Highlands, 1M, 27-VI-55 Hynes; Swain Co.: Great Smoky Mt. Nat. Pk., Couches Cr., 1M, 26-VI-57 Hynes; TENNESSEE, Polk Co.: Tenn. Hwy. 30, 1.7 mi N Jct. U.S. 64, 1M, 11-VIII-56 Hynes (FSCA); VERMONT, Windhams Co.: N Br., W edge Wilmington, 4L, 20-VI-76 WPM, AVP et al., (PU); VIRGINIA, Floyd Co.: Little R., Rt. 615, 1L, 1M (reared), 21-V-77 Kondratieff; Giles Co.: Sinking Cr., Newport Pk., 1L, 1M (reared), 29-IV-77 Kondratieff; Grayson Co.: Bruch Cr., Rt. 221, 1M, 19-VI-77 Kondratieff; New R., Rt. 58, 1M, 19-VI-77 Kondratieff; Montgomery Co.: Mill Cr., Rt. 785, 2M, 12-III-77 Kondratieff; same data, 1M, 29-III-77 Kondratieff, (VPI); CANADA, QUEBEC, Covey Hill, 2M, 23-VI-27 GSW; same data, 2L, 2-VII-27 GSW, (CNC); Covey Hill, Allen Br., 2L, 1-VII-66 Koss, Koss; same data, 1L, 1M (reared), 1-6-VII-66 Koss, Koss; same data, 1M, 5-VII-66 Koss, Koss; same data, 2L, 1M, 19-VI-67 Koss, Koss, (PU); Knowlton, Knowlton Cr., 2M, 7-VI-30 GSW; same data, 3L, 28-VI-30 Milne; Waterloo, Waterloo Cr., 2M, 27-VI-29 JMD, (CNC).

S. luteum

LECTOTYPE of *Stenonema luteum* (Clemens): 1M, CANADA, ONTARIO, Go Home Bay, Long Isl., 29-VI-12 Clemens (designated by JMD), (CNC); PARATYPE of *Stenonema luteum* (Clemens): 1F, ONTARIO, Georgian Bay, Muskosk Falls, 3-VII-12 Clemens, (CNC).

ILLINOIS, Momence, 1M, 15-VI-38 Ross, Burks; Mt. Carmel, 1M, 25-VI-36 DeLong, Ross; Oakwood, 1M, 9-VI-26 Frison, Auden; same data, 1M, 5-VI-48 Burks, Sanderson: Rockford, 1M, 12-VI-38 Ross, Burks; Rockton, Rock R., 1M, 25-VI-47 Burks, (INHS); CANADA, ONTARIO, Elgin, L. Huron Pt., 1M, 28-VI-33, (CU); Georgian Bay, Whalen Isl., 1M, 1F, 13-VII-32 GSW; Go Home Bay, Isl. 144, 3L, 20-VI-32 GSW; same data, 1L, 2-VII-32 GSW; Long Isl., 3L, 19-VI-12 Clemens; Musquash R. Rapids, 1L, 9-VI-32 GSW; Ottawa, Rideau R., 1M, 1F, 4-VI-22 JMD; Ottawa, 2M, 1F, 23-VI-27, JMD, (CNC); Port Elgin, 1M, 28-VI-33 Grieve, (CU); QUEBEC, Brome L. Isl., 2L, 11-VI-30 Milne, (CNC); The Bizard, Ottawa and St. Lawrence R., 1M, 24-VI-34 Grieve, (CU).

S. mediopunctatum

HOLOTYPE of *Stenonema mediopunctatum* (McDunnough): IM, CANADA, ONTARIO, Walsh, 10-VII-25 GSW, (CNC); PARATYPES of *Stenonema mediopunctatum* (McDunnough): 1M, same data, (CNC); 1M, ONTARIO, Victoria Harbor, 14-VI-25 Curren, (CNC); 1M, same data, no date, (CNC).

Holotype of *Stenonema nepotellum* (McDunnough): 1M, CANADA, QUEBEC, Fulford, 15-VII-30 Milne, (CNC); Paratypes of *Stenonema nepotellum* (McDunnough): 1M, same data, 2-VII-30 Milne, (MCZ); 1M, 1F, same data, (CNC); 1M, 1F, same data, 13-VII-30 Milne, (CNC); 1F, same data, 15-VII-30 Milne, (MCZ); 1M, same data, 18-VII-30 Milne, (CNC); 1M, same data, 20-VII-30 Milne, (MCZ).

Stenonema mediopunctatum mediopunctatum

CONNECTICUT, Fairfield Co.: Redding, Saugatuck R., 1M, 10-VI-33 Spieth, (UMI); MARYLAND, Montgomery Co.: Potomac R., 4 mi below Monocacy R., 1L, 26-VIII-65 Richard, (UU); MASSACHUSETTS, Amherst, 3M, 2-VI-39 JRT; same data, 3M, 3-VI-40 Barlett, (UU); NEW YORK, Buffalo, 1M, no date; Fall Cr., Varna, 2L, 3M, 3-VII-31 JRT; same data, 2M, 30-VI-32 JRT; same data, 1L, 28-VI-33 JRT; Ithaca, 2M, 13-VII-31 Hardy; Powerplant nr. Varna, 1F, 28-VI-33 Needham et al., (CU); VIRGINIA, Giles Co.: Walker Cr., 1M, 14-VII-55 Lyman, (FSCA); WEST VIRGINIA, Smoke Hole, 2L, 10-VIII-30 no collector listed, (CU); CANADA, ONTARIO, Erin 3M, 6-VIII-34 Ide; Glen Huron, 2M, 22-VII-30 Ide, (ROM); Ottawa, Ottawa R., Island Pk., 3L, 26-VIII-29 Milne; Tillsonburg, 1L, 9-VI-31 GSW, (CNC); QUEBEC, Cascades Pt., 2L, 30-VII-30 Milne; Fulford, Mid-Yamaska R., 4L, 22-VI-29 Milne; Wakefield, La Pechne R., 1L, 23-VII-30 GSW, (CNC).

Stenonema mediopunctatum arwini

ALABAMA, Lauderdale Co.: Stream N Florence, 2L, 18-VII-56 Hynes, (FSCA); ARKANSAS, Boone Co.: Bear Cr., St. Rd. 14, 3 mi W Jct. Hwys. 281-14, 2M, 1F, 28-V-74 WPM, AVP et al.; Montgomery Co.: Ouachita R., Rocky Shoals Boat Camp, 1L, 1-VI-74 WPM, AVP et al., (PU); ILLINOIS, Oakwood, 1M, 4-VIII-39 Burks, Riegel (incorrectly labelled MCZ paratype); Oakwood, Salt Fork R., 4L, 3M, 1F (reared), 10-VIII-39 Frison, Burks; Rock R., Kilbuck Cr., 1L, 4-V-27 no collector listed; Serena, Indian Cr., 2L, 12-V-38 Ross, Burks; same data, 1L, 16-V-38 Ross, Burks; same data, 1L, 27-V-38 Ross, Burks; Spring Grove, Nippersink Cr., 2L, 19-V-38 Ross, Burks; Spring Grove, 1L, 1M (reared), 14-VI-38 Ross, Burks; same data, 1L, 1F (reared), 29-VI-38 Ross, Burks, (INHS); INDIANA, Allen Co.: Cedar Cr., Cedarville, 4L, 30-V-57 AVP, Minno; Fayette Co.: W Fk. Whitewater R., Connersville, 3M, 30-VIII-73 Finni, AVP; Fountain Co.: E Fk. Coal Cr., Hwy. 41, 13 mi S Attica, 1L, 22-V-73 WPM, Black et al.; Fulton Co.: Mud Cr., Hwy. 14, 5 mi W Rochester, 2L, 25-V-73 AVP, Black; Harrison Co.: Little Indian Cr., 3 mi E Corydon, 1M, 10-V-73 AVP, Black; Buck Cr. 1 mi S New Middletown, 2L, 11-V-73 AVP, Black; Blue R., 1 mi E Whitecloud, 1M, 23-VIII-73 AVP, Black; Pulaski Co.: Indian Cr., Pulaski-White Co. line Rd., 5 mi W Thorne Hope, 1L, 2-VII-73 AVP, Huff et al.; Tippecanoe Co.: West Lafayette, 1M, 20-VIII-73 AVP, Huff et al.; same data, 1M, 25-VI-74 AVP; Wabash Co.: Eel R., St. Rd. 16, 1 mi W Roann, 1L, 39-V-75 AVP, Minno; Warren Co.: Little Pine Cr., Highbridge, 3L, 3M (reared), 25-III-72 WPM; same data, 1L, 1M, 16-VIII-73 AVP, Black; Wayne Co.: Greens Fk., Whitewater R., 3 mi S Greens Fk., 1L, 27-VIII-74 AVP, LD; White Co.: Big Cr., Springboro Rd., 1L, 10-V-74 AVP, LD, (PU); MISSOURI, Osage Co.: Maries R., 4L, no date, (UMO); OHIO, Chagrin Falls, 1M, 20-VI-41 Ross; OKLAHOMA, Reagan, 2L, 1-V-39 Ross, Ross, (INHS); SOUTH DAKOTA, Yellowbank R., 3L, no date, Selgeby (UMO); WISCONSIN, St. Croix R., 3L, 20-IV-39 Frison, Burks, (INHS); Burnett Co.: Clam R., 2L, 5-VI-73; Dane Co.: Sugar R., 2L, 19-IV-73; Lafayette Co.: Pecatonica R., 1L, 1-VI-73; Lincoln Co.: Newood R., 1L, 19-VI-73; Sheboygan Co.: Mullet R., 2L, 28-VI-73; Waupaca Co.: Waupaca R., 1L, 18-VII-73; Wood Co.: Yellow R., 2L, 18-VI-74 (no collector listed for preceding specimens), (UW).

Stenonema mediopunctatum mediopunctatum × *arwini*

ALABAMA, Blount Co.: Blount Spr., 2L, 13-VI-73 Stark, (UU); GEORGIA, Ruiggold, Chickmauga Cr., 3L, 31-III-31 Fattig, (CU); INDIANA, LaGrange Co.: Pigeon Cr., 1100 E, E Pigeon R. St. Pk., 2L, 24-V-73 AVP, Black, (PU); TENNESSEE, Sevierville, 3L, 14-V-39 Frison, Ross, (INHS).

S. meririvulanum

PARATYPES of *Stenonema meririvulanum* Carle and Lewis: 3L, 2F, 1M, VIRGINIA, Giles Co.: Little Stony Cr., 5-IV-77 Carle, (VPI).

PENNSYLVANIA, Chester Co.: Unnamed trib. Doe Run Cr., approx. 0.4 mi S Rt. 82 on Wests Rd., West Marlborough Twnshp., 5L, 5M (reared), 22-V-70 Richardson, (JRC); Southern Chester Co.: E Br. White Clay Cr., Stroud Estate, Rt. 926 W Br., 1M, 1F, 22-V-68 Richardson, (UU); VIRGINIA, Allegheny Co.: Laurel Br., 2L, 1M, 1F (reared), 1-V-77 Powell, (VPI); Skyline Dr., Big Meadows, 2L, 18-III-41 Burks, (EPA).

S. modestum

HOLOTYPE of *Stenonema modestum* (Banks): 1M, DISTRICT OF COLUMBIA, Washington, no date, Banks, (MCZ); PARATYPE of *Stenonema modestum* (Banks): 1M, MARYLAND, High Isl., 28-IX-? Banks, (MCZ).

Holotype of *Stenonema rubromaculatum* (Clemens): 1M (+ larval cast), CANADA, ONTARIO, Go Home R., Georgian Bay, 27-VIII-12 Clemens, (CNC); Paratype of *Stenonema rubromaculatum* (Clemens): 1F (+ larval cast), same data, 22-VIII-12 Clemens, (CNC); Holotype of *Stenonema rubrum* (McDunnough): 1M, QUEBEC, Ottawa Golf Cl., 31-VII-24 GSW, (CNC); Paratypes of *Stenonema rubrum* (McDunnough): 1M, ONTARIO, Ottawa, 19-VII-24 Ide, (CNC); 1F, same data, 21-VII-24 GSW, (CNC); 1M, same data, 24-VII-24 Ide, (CNC); 1F, QUEBEC, Aylmer, 5-VII-24 Curren, (CNC); 1F, QUEBEC, Broadview, 28-VII-24 GSW, (CNC), 1F, QUEBEC, Ottawa Golf Cl., 15-VII-25 Ide, (CNC); 1M, same data, 2-VII-24 JMD, (CNC); 1M, same data, 10-VII-24 JMD; 1M, same data, 8-VIII-24 GSW, (CNC); Holotype of *Stenonema annexum* Traver: 1M, NORTH CAROLINA, Goshen Swamp, 11-IV-29 Needham, (CU); Paratypes of *Stenonema annexum* Traver: 1F, NORTH CAROLINA, Ft. Barnwell, Neuse R., 9-IV-30 JRT, (CU); 1L, 5M, 11F NORTH CAROLINA, Goshen Swamp, 11-IV-29 Needham, (CU); 1F, NORTH CAROLINA, Lenoir Co., 11-IV-29 Needham, (CU); Holotype of *Stenonema varium* Traver: 1M, NORTH CAROLINA, Tom's Pl., Big Alamance Cr., 5-IV-30 JRT, (CU); Paratypes of *Stenonema varium* Traver: 1L, 1F, 3M (reared), NORTH CAROLINA, Caraway Cr., nr. Sophia, 8-IV-30 JRT, (CU); 1M, same data, 15-IV-30 JRT, (CU); 4F, same data, 17-IV-30 JRT, (CU); 1F, same data, 27-IV-30 JRT, (CU); 1L, 1M (reared), NORTH CAROLINA, Greensboro, 23-IV-30 JRT, (CU); 2F, same data, 28-IV-30 JRT, (CU); 2L, NORTH CAROLINA, N Greensboro, 10-IV-30 JRT, (CU); 1F, NORTH CAROLINA, Polecat Cr. S Greensboro, 9-IV-30 JRT, (CU); 1M, same data, 16-IV-30 JRT, (CU); 3L, 1M, 1F (reared), NORTH CAROLINA, Tabernacle Ch. S Greensboro, 4-V-30 JRT, (CU); 1F, same data, 9-V-30 JRT, (CU); 1L, NORTH CAROLINA, Tom's Pl., Big Alamance Cr., 7-IV-30 JRT, (CU); 2L, 1F, 1M (reared), same data, 10-IV-30 JRT, (CU); 1L, 1M (reared), same data, 11-IV-30 JRT, (CU); 1L, 1F (reared), same data, 12-IV-30 JRT, (CU); 1M, 1F, same data, 15-IV-30 JRT, (CU); 1F, same data, 17-IV-30 JRT, (CU); 1L, 1F (reared), same data, 28-IV-29 JRT, (CU); 1L, NORTH CAROLINA, Uharie R., nr. Farmer, 3-IV-29 JRT, (CU); 1L, same data, 16-IV-29 JRT, (CU).

ALABAMA, Blount Co.: Blount Sp., 3L, 13-VI-73 Stark, (UU); CONNECTICUT, Fairfield Co.: Redding, Saugatuck R., 1M, 10-VI-33 Spieth, (UMI); GEORGIA, Atlanta, Peachtree Cr., 1M, 26-IX-45 Fattig; same data, 1M, 9-XI-45 Fattig, (INHS); Apalachee R., 9 mi E Monroe, 1M, 29-VI-45 Fattig, (FSCA); Perry, 5.5 mi N Tharpe's Pd., 2M, 31-III-46 Fattig; Swift Cr., 8 mi S Thomaston, 1L, 21-IV-39 Fattig, (INHS); Dougherty Co.: Hwy. 257, 1M, 28-XI-53 Hynes, Berner; Lumplin Co.: Yahoda Cr., 0.25 mi E Dahlonega, 1M, 20-VII-55 Hynes; Worth Co.: Abram's Cr., 1M, 28-XI-53 Hynes, Berner, (FSCA); INDIANA, Harrison Co.: Blue R., 1 mi E White Cloud, 3L, 10-V-73 AVP, Black; Owen Co.: White R. at Spencer Pub. Fish, Sgt. nr. McCormick's Cr. St. Pk., 1L, II-VII-73 WPM, Black et al., (PU); MAINE, Harrison, Carsley Br., 3L, 26-VII-69 Lewis; same data, 2L, 2F (reared), 12-VII-71 Lewis, (EPA); MASSACHUSETTS, Hampshire Co.: N Amherst, Mill R., Mill Hollow Apt., 2M, 4-VII-65 Root; N Amherst, 1M, 5-VI-65 Root, Miller; N Amherst, Mill R. nr. Puffer's Pd., 3L, 12-14-VI-66 Koss, Koss; Worchester Co.: Palmer, 3M, 17-VI-66, Koss, Koss, (MSU); MICHIGAN, Ionia Co.: Galesburg, Krum Pk., 2M, 21-V-66 Koss, Koss; Kalamazoo Co.: Gull L. Bio. Sta., Augusta Cr, 5M 4-VII-66 Fischer; same data, 2M, 9-VII-66 Fischer; Kellogg For., Augusta Cr., 2M, 23-VII-66 Fischer, (MSU); Little Manatee, nr. Irons, 1L, 28-V-39 Frison, Ross, (INHS); Schoolcraft Co., 1M, 18-VII-66 Donahue, (MSU); NEW YORK: Nassau, Kinderhook Cr., 2M, 12-VI-32 Harper, (CU); NORTH CAROLINA, Cape Fear R. nr. Buies Cr., 8L, 1F, 1-IV-30 JRT, (CU); same data 1L, 1-IV-30 JRT, (CNC); Greensboro, 1L, 1M (reared), 13-IV-30 JRT, (CU); Murphy, 1M, 23-IV-33 Spieth, (UMI); N Greensboro, 3L, 1-IV-30 JRT; Polecat Cr. nr. Greensboro, 2L, 8-IV-30 JRT; Tom's Pl., Big Alamance Cr., 2L, 10-IV-30 JRT, (CU); Forsythe Co.: Belews Cr., 2L, 30-IV-71 Hartley, Smack; same data, 2L, 19-VIII-70 Hartley, Smack; same data, 4L, 26-X-70 Hartley, Smack, (FAMU); PENNSYLVANIA, Southern Chester Co.: E Br. White Clay Cr., Stroud Estate, Rt. 926, 1L, 1F (reared), 27-I-70 Richardson; same data, 1L, 1M (reared), 28-I-70 Richardson; same data, 3L, 1F, 2M (reared), 16-IV-70 Richardson; same data, 2L, 1M, 1F (reared), 27-V-70 Richardson; same data, 1L, 1M (reared), 3-V-70 Richardson; same data, 1L, 1F (reared), 22-VII-70 Richardson, (JRC); SOUTH CAROLINA, Florence Co.: Lynch R. S Florence, U.S. 52, 1M, 12-VI-55 Hynes, (FSCA); TENNESSEE, Lincoln Co.: Elk R., 1M, 13-IV-54 Pugh; Sevier Co.: Pigeon Forge, U.S. 441, 2M, 4-VIII-56 Hynes, (FSCA); VIRGINIA, Hanover Co.: North Anna R., Falls, 1M, 2-VI-77 Kondratieff; same data, 1M, 21-VI-77 Kondratieff; same data, 1M, 21-VII-77 Kondratieff; same data, 2M, 4-VIII-77 Kondratieff; same data, 2M, 18-VIII-77 Kondratieff; same data, 1M 1F, 1-IX-77 Kondratieff; same data, 1M, 14-IX-77 Kondratieff; same data, 1L, 1M (reared), 7-XII-77 Kondratieff; same data, 1L, 1M (reared), 17-XII-77 Kondratieff; South Anna R., Rt. 657, 2M, 20-VI-77 Kondratieff; South Anna R., Rt. 522, 1M, 21-VI-77 Kondratieff; Louisa Co.: South Anna R., Rt. 522, 1M, 21-VI-77 Kondratieff; South Anna R., Rt. 657, 1M, 4-VIII-77 Kondratieff, (VPI); Remington, Rappahannock R., 2L, 21-III-40 Frison, Mohr et al., (INHS); CANADA, ONTARIO, Algonquin Pk., 1M, 8-VIII-29 Ide; Bass Cr., L. Nipissing, 2F, 4-15-VI-29 Ide, (ROM); Clear Cr., Miners Bay, 2L, 26-V-31 JMD; Flat Rock Falls, Go Home R., 1L, 21-VI-32 GSW; same data, 1L, 1F (reared), no date; Muskosh Falls, 1L, 30-VI-12 Clemens; Ottawa, Rideau R., 2L, 18-VI-29 GSW; same data, 2M, 18-VI-29 JMD, (CNC); QUEBEC, Cascades Pt., 1M, 4-VIII-30 JMD, GSW; Fulford, Mid-Yamaska R., 2L, 22-VI-29 Milne; same data, 2L, 29-VII-29 Milne; Gauvreau L. Cr., 1L, 30-V-30 JMD; Kazabazua R., 1M, 8-VI-27 JMD; Knowlton, 2L, 1M, 7-V-30 Milne: Knowlton, Foster Power Cr., 3L, 11-VI-30 GSW, (CNC); Montreal, St. Lawrence R., 1M, 5-IX-34 Spieth, (UMI); Ottawa Golf Cl., 1M, 17-VIII-25 no collector listed; South Baton, 1L, 1FS (reared), 20-VI-30 Milne; Wakefield, 1M, 26-VI-27 JMD; same data, 1M, 10-VI-30 JMD, (CNC).

S. pudicum

HOLOTYPE of *Stenonema pudicum* (Hagen): 1S, DISTRICT OF COLUMBIA, ?-?-1858 Hagen, (MCZ).

KENTUCKY, Cumberland Falls St. Pk., 1L, 12-V-39 Frison, Ross, (INHS); MARYLAND, Baltimore Co.: N Baltimore, Jones Falls, Greens Sp., 1L, 17-II-70 Koss; Trib. NE Cove, Loch Raven Res., 1L, 1M (reared), 14-IV-70 Koss; same data, 1L, 1M, 18-IV-70 Koss; Frederick Co.: W Thurmont, Cunningham Falls, Cunningham Falls St. Pk., 2M, 13-VI-70 Koss, (PU); MASSACHUSETTS, S Hadley, Notch, 1M, 27-V-39 JRT, (UU); NEW YORK, Ithaca, Coy's Glen, 1F, 30-V-32 JRT; Ringwood, 3M, 4-VI-32 JRT, (CU); Trib. nr. Brewster, 1L, 4-VIII-36 Needham, (UU); NORTH CAROLINA, Banner's Elk, 1M, 8-V-36 Thomsen, (UU); Cedar Cr., Glenville, 1L, 1M (reared), 19-VI-36 JRT; same data, 1L, 17-VII-30 JRT; same data, 1L, 1M (reared), 14-VIII-30 JRT; Great Smokies Nat. Pk., 20 mi Cr., 2L, 31-V-34 Needham; Valle Crucis, 1L, 1F (reared), 2-VI-36 JRT, (CU); Jackson Co.: Whitewater R., Rt. 107, 2L, 4-XI-65 Prins, (FAMU); Swain Co.: Great Smoky Mt. Nat. Pk., 3L, 18-IV-56 Hynes, Berner, (FSCA); Transylvania Co.: Big Hogback Cr. nr. U.S. 64, 2L, 7-VII-66 Prins et al., (FAMU); PENNSYLVANIA: Chester Co.: E Br. White Clay Cr. at Stroud Estate, Rt. 926, 1M, 1-VI-66 Richardson; same data, 1M, 15-VI-66 Richardson; same data, 1M, 2-VIII-66 Richardson, (UU); Southern Chester Co.: E Br. White Clay Cr., Stroud Estate, Rt. 926, 1L, 1F (reared), 18-XII-69 Richardson; same data, 1L, 1M (reared), 28-I-70 Richardson, (JRC); SOUTH CAROLINA, Oconee Co.: Bearcamp Cr. nr. Mill Cr., 2L, 29-III-66 Prins; Wright Cr., 2L, 22-III-66 Prins, (FAMU); TENNESSEE, Gatlinburg, LeConte Cr., 2L, 14-VI-40 Frison et al., (INHS); Unicoi Co.: Tumbling Cr., Erwin, 2M, 1-VI-61 Bonesch, (FSCA); VERMONT, Windhams Co.: Bill Br. nr. Molly Stark St. Pk., St. Rd. 9, 5L, 20-VI-76 WPM, AVP et al., (PU); VIRGINIA, Falls Ch., 1M, no date, Banks, (MCZ); Giles Co.: White Rocks, Big Stoney Cr., 1L, 1M (reared), 14-VI-77 Powell, (VPI).

S. pulchellum

LECTOTYPE of *Stenonema pulchellum* (Walsh): 1M, ILLINOIS, Rock Island, 1863 Walsh (designated by Banks), (MCZ); SYNTYPE of *Stenonema pulchellum* (Walsh): 1F, same data, (MCZ).

ARKANSAS, Newton Co.: Mill Cr. at St. Rd. 7, 1 mi S Dogpatch, 2L, 29-V-74 WPM, AVP et al., (PU); ILLINOIS, Moline Co.: Rock Island, 1M, 22-VI-54 no collector listed, (UU); Oakwood, 2M, 9-VI-26 Frison, (CNC); Oakwood, 1L, 1M (reared), 24-VII-39 Burks, (INHS); Oregon, 1M, 19-VI-17 JMD, (CNC); Spring Grove, 1L, 1M (reared), 4-VI-38 Ross, Burks, (PU); INDIANA, Delaware Co.: Bell Cr., 2M, 19-VI-74 no collector listed; Montgomery Co.: Sugar Cr., 1 mi N Darlington, 3L, 1-VI-73 WPM, AVP et al.; Ripley Co.: Laughery Cr., Versailles St. Pk., 2L, 18-V-73 WPM, AVP et al.; Wayne Co.: Greens Fk., Whitewater R. 3 mi S Greens Fk., 1L, 27-VIII-74 AVP, LD, (PU); IOWA, Blackhawk Co.: Cedar Falls, 1M, 29-VI-73 Knudtson; same data, 2M, 3-VIII-73 Knudtson, (PU); Davenport, 1M, 5-VII-28 GSW; Pleasant Valley, 3M, 14-VII-28 GSW, (CNC); MINNESOTA, Minneapolis, 1M, 29-VI-39 Daggy, (UU); MISSOURI, Monroe Co.: Middle Fk. Salt R., 3 mi W Florida, 3L, 5-IV-72 Lorenz, (PU); Mullen Cr., Licking, 1L, 12-IX-63 no collector listed, (UMO); NEW YORK, Varna, Fall Cr., 1M, 8-VII-32 JRT, (CU); OHIO, Ottawa Co.: Lake Erie, Put in-Bay, 2L, 2M, 7-8-VII-75 Peters, (FAMU); Wisconsin, Minong, Totogatic R., 1L, 31-IX-39 Burks, (INHS); CANADA, ONTARIO, Sandy Grey Rapids, 1L, 1M, 31-X-? no collector listed; Tillsonburg, 2M, 9-VI-31 GSW; Pelee Isl., 1M, 1F, 3-VII-31 GSW; Go Home R., Flat Rock Falls, 1L, 30-VI-32 GSW; same data, 2L, 6-VII-32 GSW, (CNC); Erindale, Credit R., 2L, 12-VII-66 Koss, Koss, (MSU).

S. sinclairi

HOLOTYPE of *Stenonema sinclairi* Lewis: 1M, TENNESSEE, Sequatchie Co.: Spring Br., Glady Fk. Cr., 30-IV-76 Sinclair, Rossman, (USNM); PARATYPES of *Stenonema sinclairi* Lewis: 1F, TENNESSEE, Sequatchie Co.: Spring Br., Glady Fk. Cr., 30-IV-76 Sinclair, Rossman, (USNM); 1M, 1F, same data, (FAMU); 4L, Bledsoe Co.: Glady Fk. Cr., 10-VII-75 Sinclair, (FAMU).

TENNESSEE, Bledsoe Co.: Glady Fk. Cr., 2L, 10-VII-75 Sinclair; Marion Co.: Kelleys Cr., 2L, 24-X-77 Pennington, (EPA).

S. smithae

HOLOTYPE of *Stenonema smithae* Traver: 1M, ALABAMA, Tuscaloosa, Spencers Mill, 1-VII-36 JRT, (CU); PARATYPES of *Stenonema smithae* Traver: 1F, ALABAMA, Tuscaloosa, Spencers Mill, 3-VIII-36 JRT, (CU); 1F, same data, 8-VII-36 JRT, Smith, (CU); 1F, same data, 30-VI-36 JRT, (CU); 1L, 1M, same data, 2-VII-36 JRT, (CU); 2M, same data, 4-VII-36 JRT, Smith, (CU).

GEORGIA, Crawford-Taylor Co.: S Flint R. at Ga. Hwy. 128, SW Roberta, 2L, 16-IX-71 Gaddis, Walker; Pike Meriwether Co. line: Flint R. at Ga. Hwy. 5738, Flat Shoals, 3L, 18-X-71 Caldwell, Gaddis, (FAMU). FLORIDA, Gadsden Co.: Trib. Little R. 1 mi E Jameson on Hwy. 159, 3L, 19-III-67 Peters, Peters; Monroe Cr. on St. Hwy. 268, 2L, 17-VII-67 Cooper, Jones; Trib. Rocky Comfort Cr. at bridge on St. Hwy. 274, 3 mi S Quincy, 2L, 2-VIII-67 Cooper, Jones; Richlander Cr. at bridge 1 mi S St. Hwy. 268, 3L, 21-IX-67, Jones, Tsui et al.; Rocky Comfort Cr. 6 mi S St. Hwy. 268, 1M, 9-X-69 Jones; Rocky Comfort Cr. at bridge 6 mi S St. Hwy. 268, 1L, 1F (reared), 23-II-70 Jones; same data, 3L, 19-V-71 Hartley, Pescador; Jackson Co.: Rocky Cr. at Hwy. 71, 1M, 2-XI-75 Kaplan, Flowers; Sink Cr. at Hwy. 71, 2L, 2-XI-75 Flowers, Kaplan; Okaloosa Co.: Swift Cr. on Hwy. 285 1 mi NE Niceville, 1L, 16-VIII-67 Peters, Peters et al.; Blackwater R. at Bryant Bridge, 3 mi NW Holt, 3M, 1-2-IV-71 Peters, Peters, (FAMU).

S. terminatum

LECTOTYPE OF *Stenonema terminatum* (Walsh): 1M, ILLINOIS, Rock Island, no date, Walsh (designated by Banks), (MCZ).

Holotype of *Stenonema placitum* (Banks): 1M, NEW YORK, Sacandaga R., 12-VI-10 Alexander, (MCZ); Holotype of *Stenonema bipunctatum* (McDunnough): 1M, CANADA, ONTARIO, Queenston, 28-VII-25 GWS, (CNC); Paratypes of *Stenonema bipunctatum* (McDunnough): 1M, ONTARIO, Niagara Falls, 29-VII-25 GSW, (CNC); 1M same data, 30-VII-25 GSW, (CNC); 1F, ONTARIO, Niagara Glen, 24-VII-25 GSW, (CNC); 2M, 1F, ONTARIO, Queenston, 28-VII-25 GSW, (CNC); Holotype of *Stenonema lepton* Burks: 1M, ILLINOIS, Momence, 22-VI-38 Ross, Burks, (INHS); Paratypes of *Stenonema lepton* Burks: 3M, same data, (INHS); 5M, same data, Kankakee R., 24-VI-39 Burks, Ayars, (INHS); Holotype of *Stenonema ares* Burks: 1M, ILLINOIS, Rockford, 11-VI-48 Burks, Stannard et al., (INHS); Paratypes of *Stenonema ares* Burks: 1M, ILLINOIS, Oregon, 4-VII-46 Mohr, Burks, (INHS); 1M, ILLINOIS, Freeport, 10-11-VI-48 Burks, Stannard et al., (INHS); 1M, ILLINOIS, Prophetstown, Rock R., 25-VI-47 Burks, (INHS); 1M, ILLINOIS, Rockford, 11-VI-48 Burks, Stannard et al., (INHS); 2M, ILLINOIS, Rockton, Rock R., 25-VI-47 Burks, (INHS); 1M, ILLINOIS, Roscoe, Rock R., 25-VI-47 Burks, (INHS); 1M, ILLINOIS, Shawneetown, 14-VII-48 Mills, Ross, (INHS); 1M, ILLINOIS, Sterling 26-VI-47 Burks, (INHS).

Stenonema terminatum terminatum

ARKANSAS, Boone Co.: Tucker Hollow Rec. Area, 1M, 28-V-74 WPM, AVP et al.; Montgomery Co.: Little Missouri R., Albert Pike Rec. Area, 1M, 30-V-74 WPM, AVP et al., (PU); GEORGIA, Gainesville, 1M, 9-V-44 Frison, Ross, (INHS); IDAHO, Boise R., Middleton, 1L, 21-VIII-50 no collector listed; Lewiston, Snake R., 2L, 20-VIII-51 Wilson, (UU); Lewiston, 1M, 8-VIII-31 Rodock; same data, 2M, 30-VIII-31 Rodock, (CU); Nampa, 1F, 23-VIII-47 GFE, Sr.; New Plymouth, 2M, 1F, 20-VIII-47 GFE, Sr.; Snake R., 1L, 30-VIII-51 no collector listed, (UU); Bingham Co.: Snake R., Blackfoot, 1F, 7-VIII-63 GFE; Bonner Co.: Pend Oreille R., U.S. Hwy. 2 at Priest R., 1L, 26-III-65 Nebeker; Owyhee Co.: Brunneau R., 1 mi S Brunneau, 1F, 30-VIII-65 Jensen, Jensen; Payette Co.: New Plymouth, 1F, 26-VIII-47 GFE, Sr.; Payette R., 1L, 24-VIII-50 no collector listed; Payette R., 9.8 mi E Payette, 4L, 22-IX-63 Jensen; Snake R., Payette, 3L, 7-VIII-65 GFE, (UU); Shoshone Co.: Shoshone City Pk., 2M, 2F, 9-VI-73 Allen, (FAMU); ILLINOIS, Alton, 2M, 18-V-32 Ross, Mohr; Aroma, 1M, 4-VI-47 Burks; same data, 1M, 6-VIII-47 Burks, Sanderson; same data, 1M, 8-VIII-48 Ross, Burks; same data, 1M, 11-VI-47 Burks; Aurora, 2F, 1M, 9-VII-25 Frison; Billett, Wabash R., 5M, 15-V-42 Burks, Mohr; Casey, 1M, 29-IV-42 Ross; Dixon, 1M, 27-VI-35 Ross, Ross; Exline, Kankakee R., 4-VI-47 Burks; Grand Detour, Rock R., 4L, 4-V-40 Burks; Grand Tower, 1M, 30-V-35 Ross, Mohr; Greenville, Shoal Cr., 1L, 12-IV-46 Mohr, Burks; Havana, 1M, 1-VI-33 Mohr; Jewett, Muddy Cr., 1L, 17-IV-46 Mohr, Burks; Kankakee, 4M, 9-VII-48 Ross, Burks; Momence, 1M, 16-VIII-38 Ross, Burks; same data, 1L, 16-V-40 Burks; Monticello, Lodge Pk., 1M, 24-V-47 Burks; Oakwood, 2M, 5-VI-48 Burks, Sanderson; same data, 1M, 4-VIII-39 Ross, Riegel; same data, 6M, 23-VI-48 Burks; Oregon, 3M, 9F, 9-VII-25

Frison; same data, 1M, 5-VIII-48 Burks, Sanderson; same data, 3M, 2-VII-46 Burks, Sanderson; Prophetstown, Rock R., 1M, 24-25-VII-47 Burks, Sanderson; Rock Isl., IM, 7-VI-39 Burks, Riegel; Rockford, 1M, 12-VI-38 Ross, Burks; same data, 1M, 29-VI-38 Burks; same data, 8M, 22-V-41 Ross, Burks; same data, 1M, 13-V-42 Ross, Burks; same data, 3M, 1-VI-44 Dubas; Rockton, 3M, 25-VI-47 Burks; same data, 1M, 4-VIII-48 Burks, Stannard; Serena, Indian Cr., 1M, 12-V-38 Ross, Burks; Seymour, 1M, 13-VI-29 Frison, Hottes; Shawneetown, 1M, 14-VII-48 Mills, Ross; S Beloit, 1M, 2-VII-31 Frison, Betten et al.; Spring Grove, 1F, 16-V-38 Ross, Burks; Sterling, 8M, 22-V-41 Ross, Burks; Urbana, 22-VI-47 Ross; Wilmington, 1M, 6-VIII-47 Burks, Sanderson, (INHS); Rock Isl., 1F, no data, (MCZ); INDIANA, Benton Co.: Sugar Cr., St. L. Rd. 3 mi NW Freeland, 1L, 1M (reared), 25-V-76 AVP, Minno; Carroll Co.: Rodgers Farm, Hwy. 18, 1M, 28-VII-74 LD; Cass Co.: Wabash R., Logansport, 3M, 16-VII-73 AVP, Black; Elkhart Co.: Elkhart R., 1 mi SE Millersburo, 1L, 1FS, 25-V-73 AVP, Black; Fayette Co.: W Fk. Whitewater R., Connersville, 2M, 2F, 30-VIII-73 AVP, Finni; Harrison Co.: Blue R., 1 mi E White Cloud, 3M, 23-VIII-73 AVP, Black; Blue R., White Cloud, 1M, 7-V-74 AVP, LD; Johnson Co.: Sugar Cr., Alterbury St. Fish and Wildlife Area, 1M, 21-VIII-75 AVP, Pask; Knox Co.: Vincennes, 2M, 17-V-72 Lawson; LaGrange Co.: Pigeon Cr., 1100 E, 1M, 8-IX-73 AVP; Martin Co.: E Fk. White R., Hindostan Falls Pub. Fish. Sgt., 2M, 20-VI-74 AVP, LD; White R., Hidostan Falls, 2M, 13-VIII-74 AVP, LD; Parke Co.: Raccoon L., 1M, 1F, 24-VI-73 Lawson; Pulaski Co.: Tippecanoe R., Tipp. R. St. Pk., 1M, 1F, 25-V-73 AVP, Black; Tippecanoe Co.: West Lafayette, Wabash R., 2M, 8-VII-73 AVP; same data, 12M, 13-VII-73 AVP; same data, 7M, 20-VIII-73 AVP, Huff et al.; same data, 1M, 1F, 18-VI-74 AVP; same data, 7M, 8-VII-74 AVP; Moots Cr., 4 mi E Battleground, 1L, 1M, 22-V-75 AVP, Harris; Wabash R., 1L, 1F (reared), 14-VI-78 Bednarik, Minno et al.; White Co.: Tippecanoe R., Hwy. 18, 2M, 2F, 25-VII-73 Black, (PU); IOWA, Ames, 1M, 9-VII-48 Nelson; same data, 1M, 14-V-49 Giles, (UN); Blackhawk Co.: Cedar Falls, 1M, 15-VI-73 Knudtson; same data, 1M, 18-VI-73 Knudtson; same data, 2M, 28-VIII-73 Knudtson, (PU); MICHIGAN, Allegan Co.: Allegan, 4M, 14-VII-66 Fisher; Ionia Co.: Galesburg, Krum Pk., 1M, 21-V-66 Koss, Koss; Kalamazoo Co.: Gull L. Bio. Sta., Augusta Cr., 2M, 8-VII-66 Fisher; same data, 2M, 9-VII-66 Fisher; same data, 5M, 17-VII-66 Fisher; Kellogg For., Augusta Cr., 2M, 23-VII-66 Fisher; same data, 4M, 24-VII-66 Fisher, (MSU); MINNESOTA, Fridley, Mississippi R., 1M, 1F, 28-VI-38 Daggy, (UU); MISSOURI, Hollister, 1M, 14-VI-38 Kite, (INHS); Rich Fountain, IL, 8-V-62 Holland, (UMO); Taylor, 2L, 17-V-40 Mohr, Burks, (INHS); Maries Co.: Gasconade, 1L, no data, (UMO); MQNTANA, Flathead Co.: Flathead L., Yellow Bay Cr., 1M, 25-VI-63 Gaufin; Missoula Co.: Blackfoot R., Hwy. 20, W Jct. Hwy. 209, 1M, 8-VII-64 no collector listed, (UU); NEBRASKA, Neligh, 2M, 11-VI-56 Hamilton, (UN); NEVADA, Elko Co.: Humbolt R., Elko, 1L, 29-VIII-65 Jensen, Jensen, (UU); NORTH CAROLINA, Macon Co.: Franklin, 2M, 9-VII-57 Hynes, (FSCA); OHIO, N. Piqua, N Miami R., 3L, 21-VIII-52 no collector listed, (UU); Portsmouth, Scioto R., 1M, 1F, 5-V-70 no collector listed, (INHS); OREGON, Snake R., Huntington, 1M, 5-VI-48 Denning, (UU); SOUTH CAROLINA, Greenville, 1M, 10-V-31 Townes, (CU); UTAH, Salt L. Co.: Kearns 1L, 30-VIII-50 GFE; Utah Co.: Saratoga, 1M, 11-VI-50 GFE; same data, 2M, 29-VI-50 GFE, (UU); VIRGINIA, Giles Co.: Mtn. L., 3M, 20-VII-55 Lyman, (FSCA); WASHINGTON, Asotin Co.: 2 mi SE Asotin, 2M, 23-VII-62 Stecker, (UU); WISCONSIN, Bayfield Co.: White R., 1L, 4-VI-73; Burnett Co.: St. Croix R., 1L, 8-XI-72; Florence Co.: Pine R., 1L, 10-V-68; Lafayette Co.: W Br. Pecatonica R., 8L, 16-V-74; same data, 2L, 28-VII-74; Oneida Co.: Tomahawk R., 5L, 29-V-69 (no collector listed for preceding specimens), (UW); WYOMING, Sweetwater Co.: Blacks Fk. R., 6 mi E Little America 1F, 11-V-73 GFE, Jensen et al., (UU); CANADA, BRITISH COLUMBIA, Okanagan Landing, 2F, 12-VI-33 Gartrell; Summerland, 3M, 8-VII-33 Gartrell; Summerland, Lakeshore, 1L, 22-29-VI-34 Gartrell, (CNC); MANITOBA, Aweme, 1F, 11-VI-23 Criddle; same data, 1M, 11-VI-23 White (Homotype of *S. terminatum*, compared by JMD), (CNC); Gimli, L. Winnipeg, 2M, 22-24-VII-30 Neave, (CU); ONTARIO, Erindale, 1M, 16-VI-32 Ide; same data, 1M, 2-VI-33 Ide; same data, 2M, 11-VI-34 Ide; same data, 1M, 30-VI-34 Ide; same data, 1M, 6-VIII-34 Ide, (ROM); Pelee Isl., 1M, 1F, 3-VII-31 GSW, (CNC).

Stenonema terminatum placitum

MASSACHUSETTS, Sunderland, Connecticut R., 1M, 1F, 11-VI-39 Hanson, (UU); same data, 1M, 1F, 12-VI-39 JRT, (FSCA); CANADA, ONTARIO, Ottawa, 2F, 17-VI-27 JMD, (CNC); QUEBEC, Cascades Pt., 1M, 3-VII-30 JMD, (CNC); The Bizard, Ottawa and St. Lawrence R., 1M, 24-VI-34 Grieve, (CU); Ottawa Golf Cl., 1M, 21-VI-27 JMD; same data, 1M, 24-VI-29 JMD; Vaudreuil, 1M, 23-VI-30 GSW, (CNC).

S. vicarium

Holotype of *Stenonema fuscum* (Clemens): 1M, CANADA, ONTARIO, Sandy Grey Falls, Go Home R., Georgian Bay, 24-VI-12 Clemens, (CNC); Paratypes of *Stenonema fuscum* (Clemens): 1F, same data, 25-VI-12 Clemens, (CNC); 1M, same data, 24-VI-32 Clemens, (CNC); Holotype of *Stenonema rivulicolum* (McDunnough): 1M, CANADA, QUEBEC, Fairy Lake, 30-V-27 GSW, (CNC); Paratypes of *Stenonema rivulicolum* (McDunnough): 1F, 1M, same data, 6-VI-27 GSW, (CU); 1M, same data (CNC); 1M, same data, 30-V-27 GSW, (CNC); 1M, QUEBEC, Ottawa Golf Cl., 11-VI-23 Ozburn, (MCZ); 1M, same data, 12-VI-23 Ozburn, (MCZ); QUEBEC, Broadview, 21-VI-23 Ozburn, (CNC); 1M, QUEBEC, Hull, 29-V-23 Richardson, (CNC).

CONNECTICUT, Fairfield Co.: Redding, Saugatuck R., 1F, 12-VII-33 Spieth, (UMI); ILLINOIS, Alto Pass, Union Spgs., 1M, 15-V-46 Mohr, Burks; Bell Smith Spgs., 1M, 29-IV-49 Stannard, Sanderson; Starved Rk. St. Pk., Clark's Falls, 3L, 25-IV-41 Frison; Utica, Split Rock Cr., 15L, 1-11-41 Frison, Ross et al., (INHS); INDIANA, Franklin Co.: Sanos Cr., St. Rd. 121, 8L, 31-VIII-73 Finni, AVP; LaGrange Co.: Pigeon Cr. at 1100 E, Pigeon R. St. Pk., 2L, 24-V-73 AVP, Black; Turkey Cr. 1 mi S Brushy Prairie, 2L, 20-V-72 Lehman; Lawrence Co.: Trib. Gullets Cr., Washboard Rd., 1 mi N Needmore, 3L, 25-IV-75 AVP, Minno; Fishing Cr. 500 E, 2L, AVP, LD; Monroe Co.: Bryant Cr. below Bryant L., Monroe-Morgan St. For., 1L, 3M, 17-VI-74 Harris, AVP et al.; Stream, Jct. St. Rd. 39-142, 5 mi S Monrovia, 1L, 11-IV-75 AVP, LD, (PU); Montgomery Co.: Turkey Run St. Pk., Trib. Sugar Cr., 3L, 9-IV-40 Frison, (INHS); Owen Co.: Limestone Cr., St. Rd. 67, 1.5 mi W Gosport, 11L, 7M, 6F (reared), 11-IV-75 AVP, LD; Tippecanoe Co.: Burnetts Cr., Hwy. 225, 2L, 3-VIII-73 Black; Wabash Co.: Lagro Cr., Lagro, 4L, 29-V-75 AVP, Minno; Trib. Eel R., St. Rd. 113, 1 mi SW Liberty Mills, 1L, 30-V-75 AVP, Minno; Warren Co.: Little Pine Cr., Highbridge, 2 L, 2M (reared), 25-III-72 WPM; Feeder Stream to Little Pine Cr., 1 mi W Greenhill, 1L, 1F (reared), 25-III-72 WPM; W Br. Kickapoo Cr., 2 mi SE Winthrop, 15L, 31-V-73 AVP, Black; White Co.: Spring Cr., Hwy. 18, Springboro, 1M, 10-V-74 AVP, LD, (PU); MAINE, Orono, 1L, no date, Selgeby, (UMO): MARYLAND, Piney Grove, 5L, 19-IV-38 Ross, Burks, (INHS); MASSACHUSETTS, N Amherst, Mill Hollow Apts., Mill R., 1M, 23-VI-67 Koss, (PU); MICHIGAN, Peacock, Great Sable R., 9L, 28-V-39 Frison, Ross; Pere Marquete R., 1L, 9-10-V-40 Frison, Ross; Rapid R., 3L, 12-V-40 Frison, Ross; Rt. 46 betw. Muskegon and Kent City, Trib. Black Cr., 8L, 9-V-40 Frison, Ross, (INHS); Kalamazoo Co.: Galesburg Krum Pk., Gull Cr., 5L, 2F, 1M (reared), 20-V-66 Koss, (JRC); Augusta Cr., Gull L. Gio. Sta., 1M, 9-VII-66 Fischer, (MSU); NEW HAMPSHIRE, Mt. Washington, Brk. nr. Pinkham Notch Camp, 1M, 22-VI-41 Frison, Ross (INHS); NEW YORK, Ellis, Ellis Cr., 3L, 1M (reared), 5-VI-32 JRT; Mclean Bogs Res., Chicago, 1M, 13-VI-35 Fisher, (CU); same data, 1L, 26-V-37 JRT, (UU); Trenton Falls, 4L, 9-VI-35 Fisher; Varna, Fall Cr., 4L, 1F, 1M (reared), 2-VI-32 JRT, (CU); Thompkins Co.: Varna, Fall Cr., 1M, 11-VI-66 Koss,

(MSU); NORTH CAROLINA, Morganton, 1M, ?-?-1877 Morrison, (MCZ); OHIO, Kirtland, 3L, 19-V-35 Traver, (UU); Pleasant Valley, Chagrin R., 3L, 2M (reared), 14-VIII-32 JRT, (CU); same data, 2L, 1M, 1F, 24-VII-36 JRT, (UU); PENNSYLVANIA, Beavertown, Middle Cr., 2M, ?-VI-39 Wetzel; Williamsport, 1M, 17-VI-48 Bennet, (INHS); Crawford Co.: Woodcock Cr., Erie Wildlife Ref., 2L, 1M (reared), 23-IV-73 no collector listed, (PU); VIRGINIA, Montgomery Co.: N Fk. Roanoke R., 2M, 9-V-51 Hoffman, (FSCA); Tom's Cr., Rt. 555, 3L 3M (reared), 19-IV-77 Kondratieff, (VPI): WEST VIRGINIA, Randolph Co.: Gandy Cr. nr. Spruce Knob, 1M, 22-VI-73 Tarter, (FAMU); WISCONSIN, Gordon, St. Croix R., 8L, 20-IV-39 Frison, Burks; Millston, 1L, 28-IV-39 Frison, Burks, (INHS); Adams Co.: Big Roche Cr., 3L, 22-V-74; Douglas Co.: St. Croix R., 3L, 15-XI-73; Dunn Co.; Eau Galle R., 3L, 16-XI-73; same data, 1L, 1F (reared), 10-V-73; Price Co.: Little Jump R., 1L, 1M (reared), 23-V-73; Sauk Co.: Otter Cr., 2F, 16-VI-73; same data, 3L, 24-V-74; Sheboygan Co.: Mullet R., 2L, 21-V-74; Waushava Co.: Mecan R., 2L, 22-V-73 (no collector listed for preceding specimens), (UW); CANADA, MANITOBA, Churchill, 1M, 6-VII-37 Brown, (CNC); NEW BRUNSWICK, Nelson, Carding Mill St., 1L, 31-V-51 no collector listed, (UU); Waweig, Waweig R., 1L, 4-VI-38 Freeman; NOVA SCOTIA, Antigonish, Cape George, 1L, 19-VI-36 JMD, (CNC); ONTARIO, Algonquin Pk., W Cr. Smoke L., 2M, 8-VIII-29 Ide, (ROM); Algonquin Pk., Autopsy Pit Wildlife Res. Sta., 2L, 6-V-60 Peterson, (UU); Dundas, 3L, 31-V-31 GSW, (CNC); Erindale, 1M, 11-VI-34 Ide; Glen Huron, 1M, 8-VIII-30 Ide; same data, 1M, 18-VI-32 Ide, (ROM); Musquash R., 3L, 1M, 1F (reared), 15-VI-32 GSW; Ottawa, Rideau R., 2M, 13-VI-27 JMD; same data, 2L, 17-V-28 Adams, Brown; Sandy Grey Falls, Go Home R., 5L, 16-VI-12 Clemens; Silver Cr., Orillia, 1M, 25-VI-27 Curren; Tillsonburg, 1L, 28-V-29 GSW; Tillsonburg, Waterworks Cr., 1L, 1-VI-31 GSW; Westboro, 1L, 25-VI-37 GSW, (CNC); QUEBEC, Broadview, 1M, 27-VI-32 Ide, (ROM); Cascades, 1L, 3-VI-30 Milne; Cascades Pt., 1L, 29-VI-30 GSW; Fulford, Mid-Yamaska R., 2L, 22-VI-29 Milne; Fulford, 1M, 20-VI-30 GSW; Hull, Fairy L. Cr., 1M, 1F, 30-V-27 GSW; same data, 3L, 1-VI-27 GSW; Kazubazua, 1L, 9-VI-27 JMD; Lachine Rapids, 1L, 11-VI-26 Ide; Ottawa Golf Cl., 2M, 15-V-27 JMD; same data, 1M, 16-VI-27 JMD; same data, 2L, 17-V-30 GSW; Ottawa Golf Cl. Cr., 1M, 28-V-30 Milne; St. Lambert, 1M, 13-VI-27 GSW; Vaudreuil, 1M, 24-VI-30 GSW, (CNC).

Appendix B — Figures

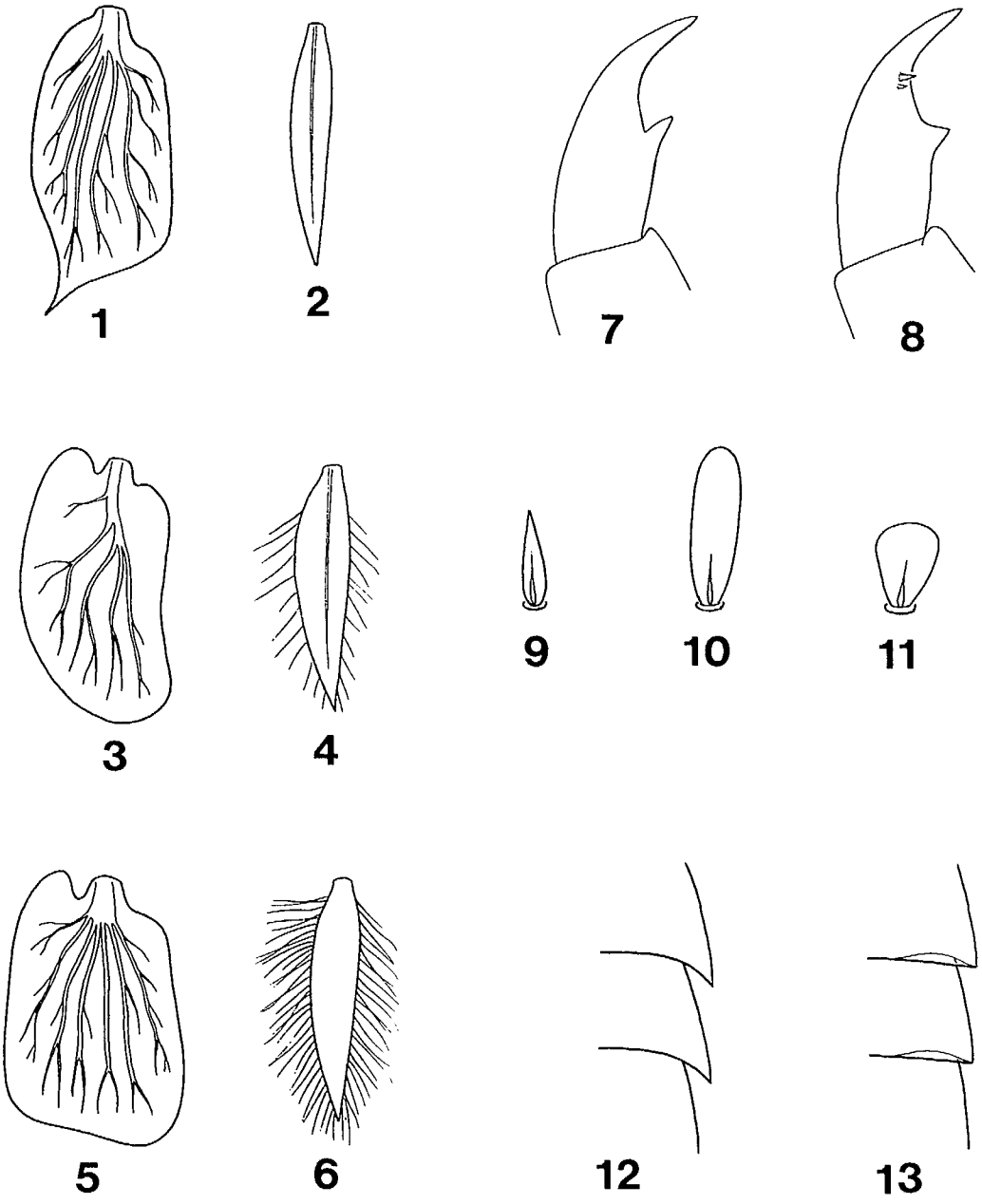


FIG. 1–13. Larval characters. 1–6 gills: 1) gill 4, *Stenacron* sp., 2) gill 7, *Stenacron* sp., 3) gill 4, *Stenonema femoratum*, 4) gill 7, *S. femoratum*, 5) gill 4, *S. (Maccaffertium)* sp., 6) gill 7, *Stenonema* (*Maccaffertium*) sp. 7–8 fore tarsal claws: 7) *S. vicarium*, 8) *S. pulchellum*. 9–11 fore femur setal types: 9) acute, spinelike, 10) elongate, paddle shaped, 11) oval, scalelike. 12–13 posterolateral margin of sternum 5, ventral view, *Stenonema* sp.: 12) with projection, 13) without projection.

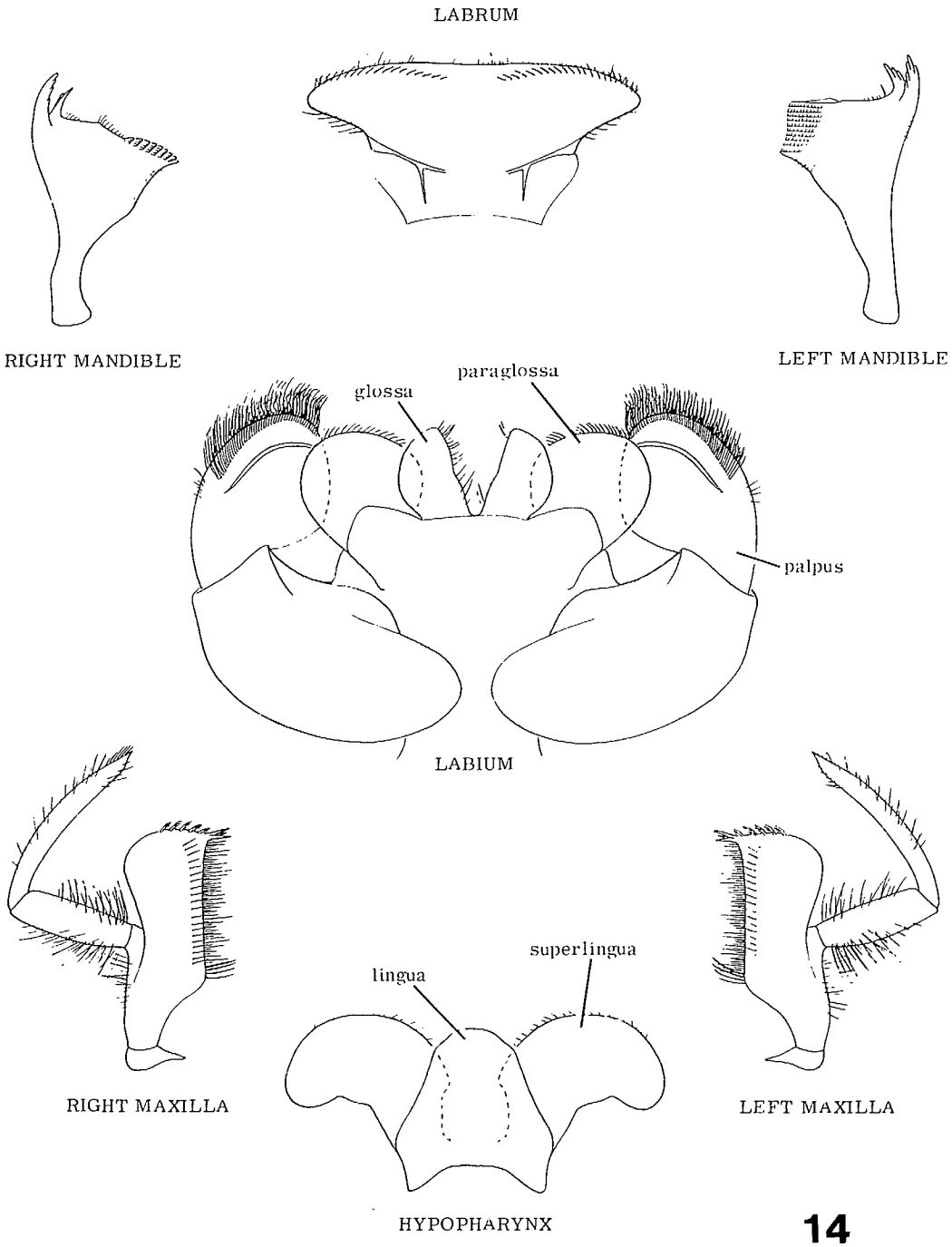


FIG. 14. Generalized mouth parts, *Stenonema* sp.

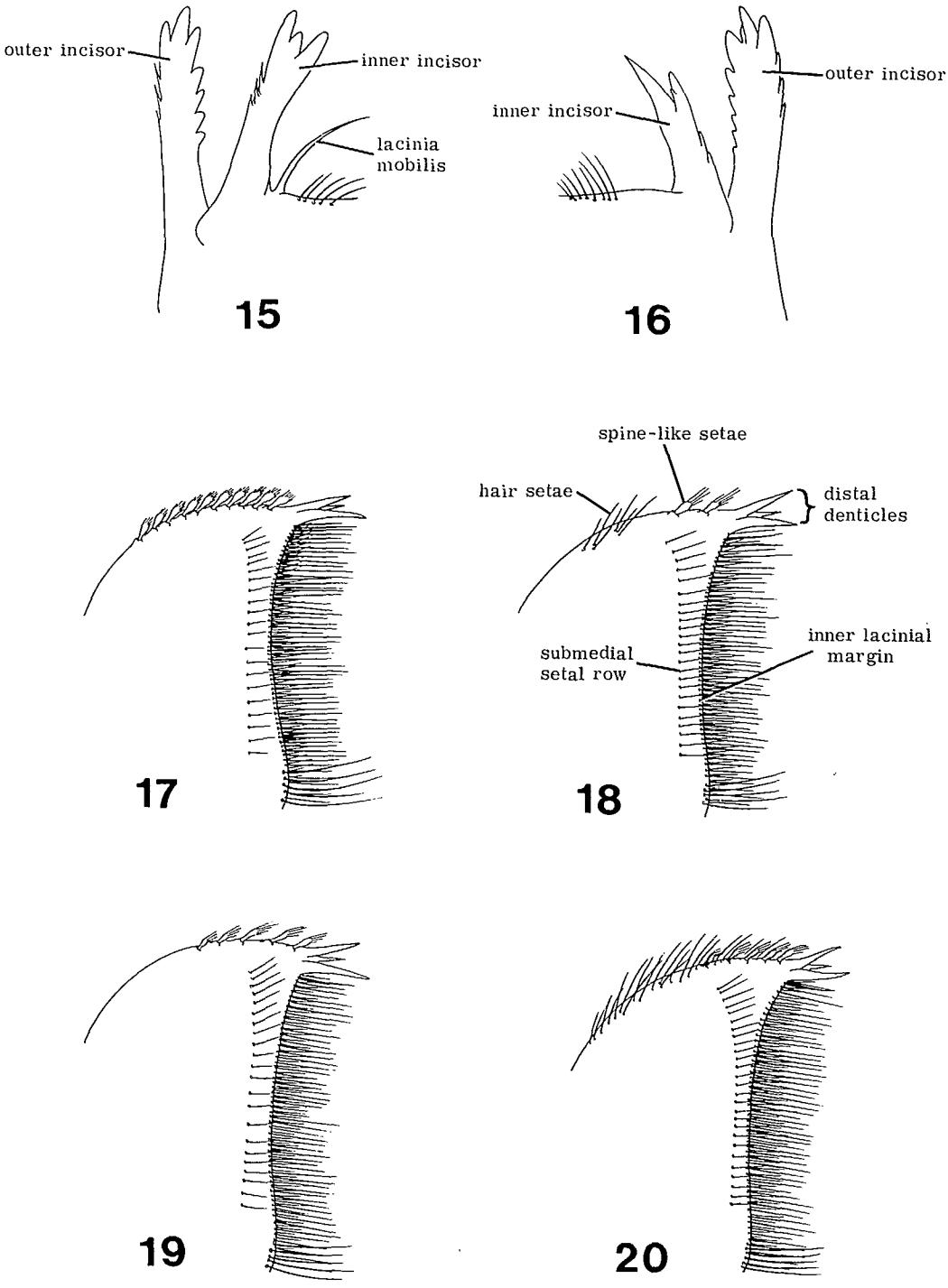


FIG. 15–20. Larval mouth part characters. 15–16 mandibular incisors, *Stenonema* sp.: 15) left, 16) right. 17–20 maxillary galea–laciniae, ventral view: 17) *Stenacron interpunctatum*, 18) *Stenonema femoratum*, 19) *S. pulchellum*, 20) *S. modestum*.

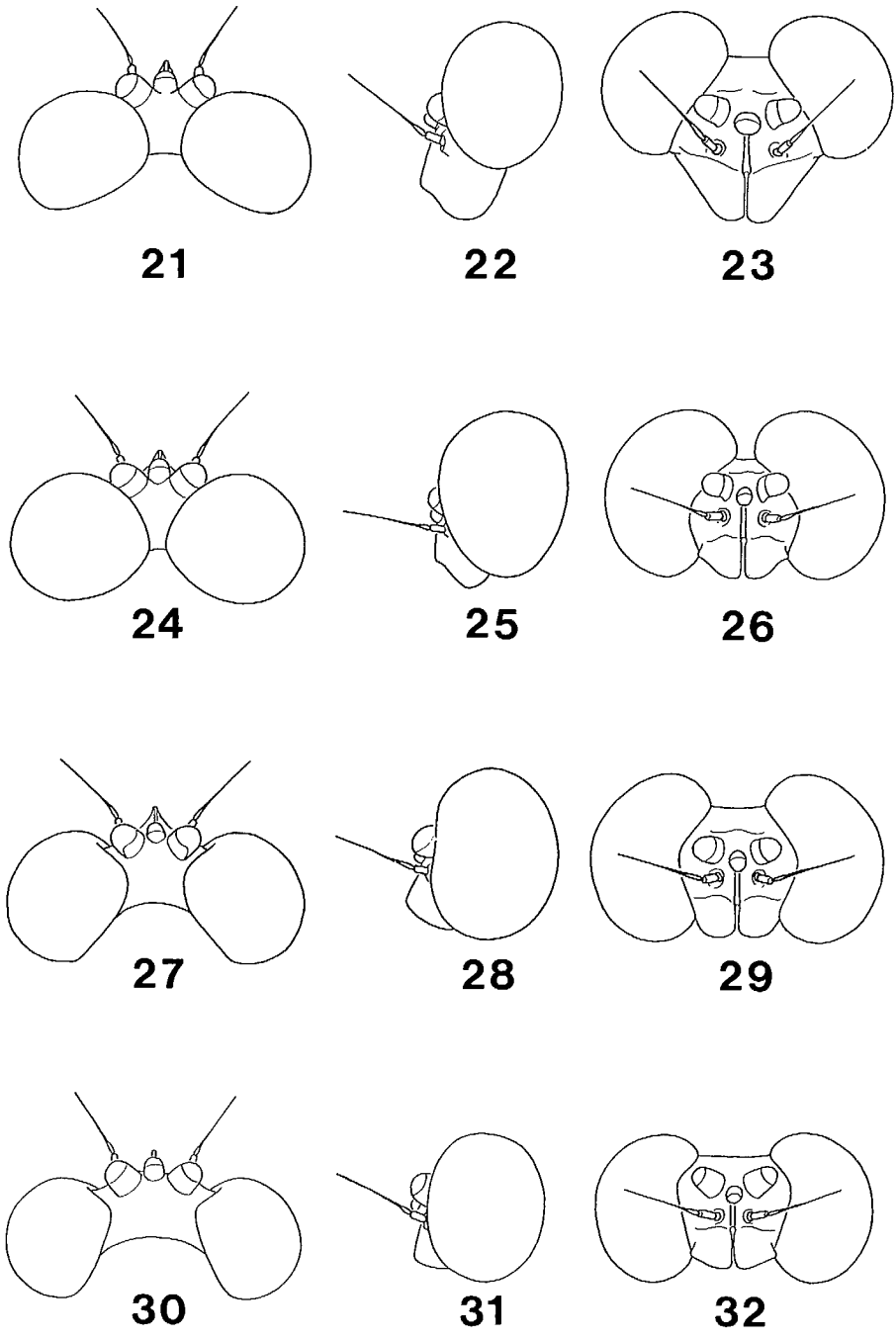


FIG. 21–32. Heads, adult male *Stenonema*. 21–23 *S. vicarium* (Type I): 21) dorsal view, 22) lateral view, 23) frontal view. 24–26 *S. vicarium* (Type I): 24) dorsal view, 25) lateral view, 26) frontal view. 27–29 *S. mediopunctatum* (Type IIA): 27) dorsal view, 28) lateral view, 29) frontal view. 30–32 *S. integrum* (Type IIB): 30) dorsal view, 31) lateral view, 32) frontal view.

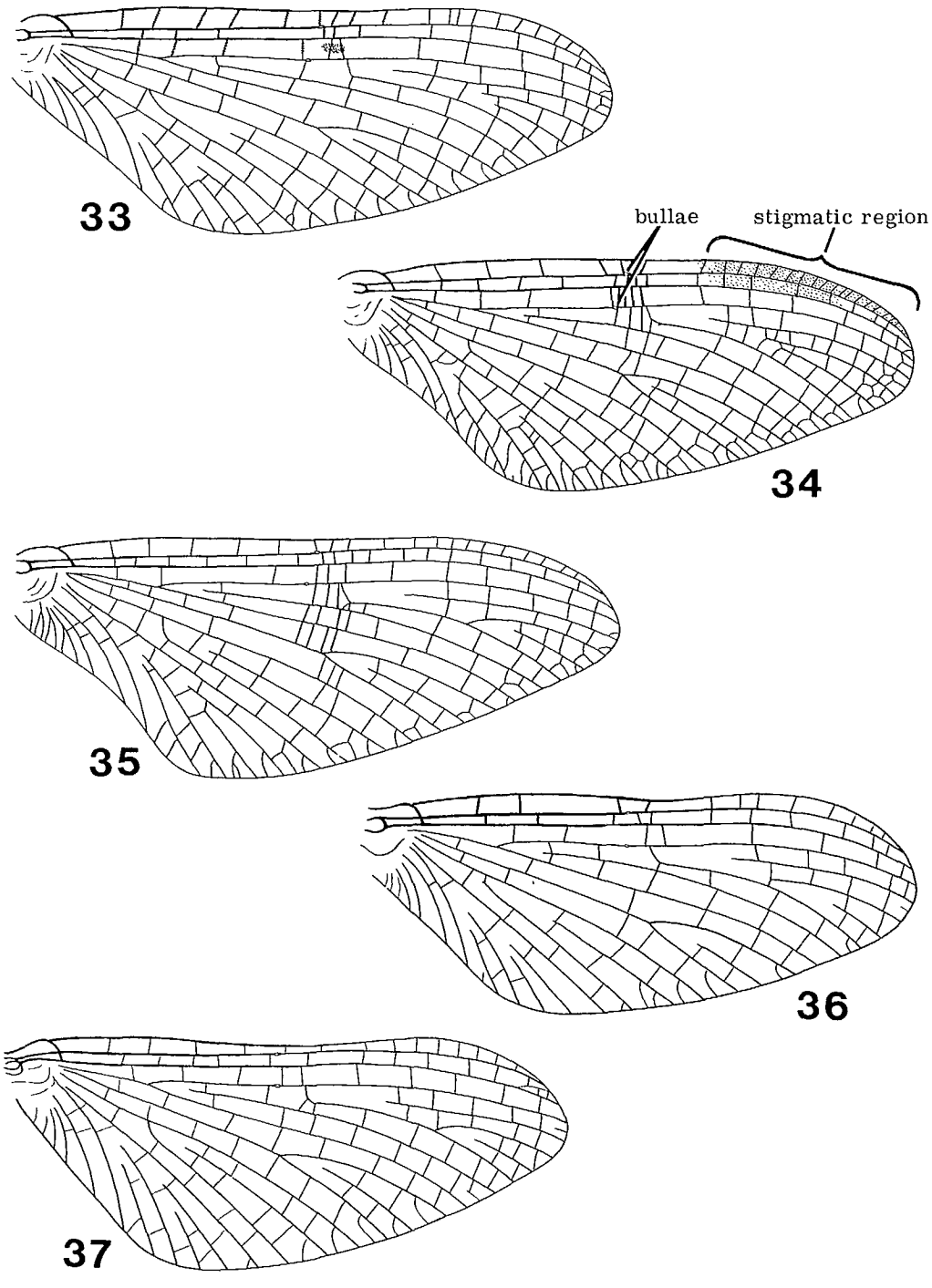
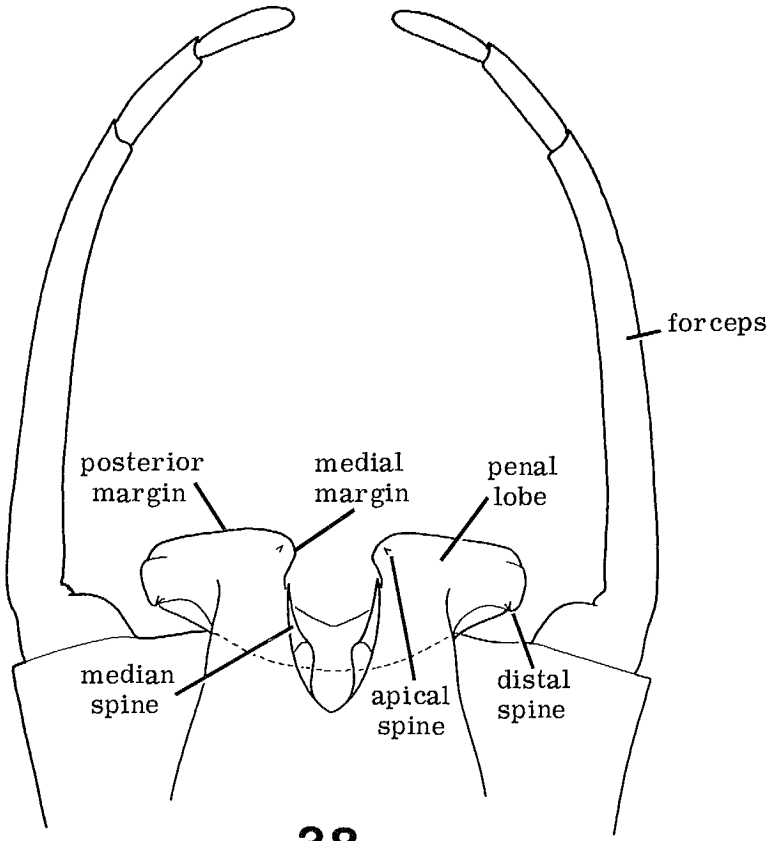


FIG. 33–37. Fore wings. 33 *Stenacron* sp. 34–37 *Stenonema*: 34) *S. femoratum*, 35) *S. pudicum*, 36) *S. integrum*, 37) *S. terminatum*.



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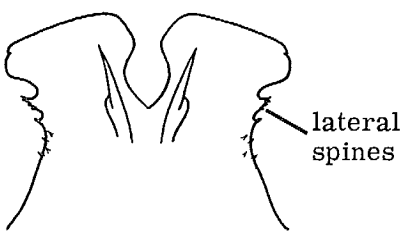

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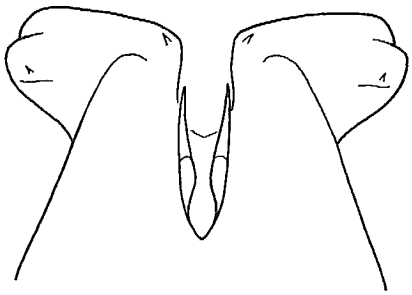

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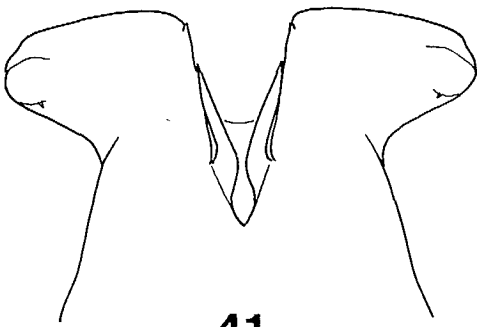
FIG. 38–40. Male terminalia, dorsal view. 38 genitalia, *Stenonema femoratum*. 39–40 penial lobes: 39) *Stenacron* sp., 40) *Stenonema vicarium*.



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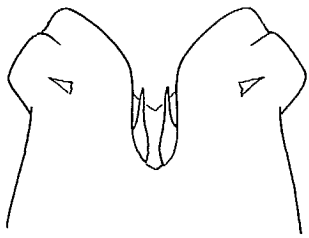

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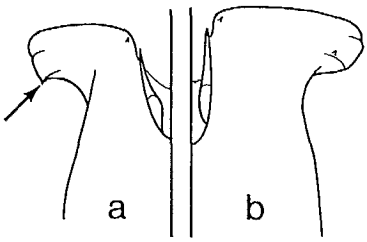
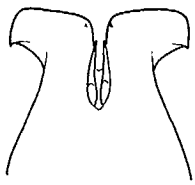


43



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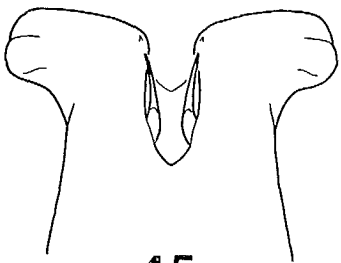

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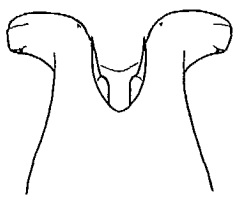

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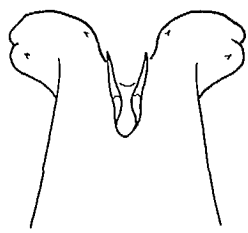

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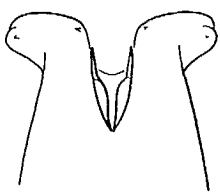

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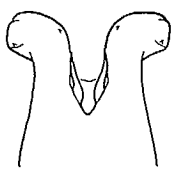

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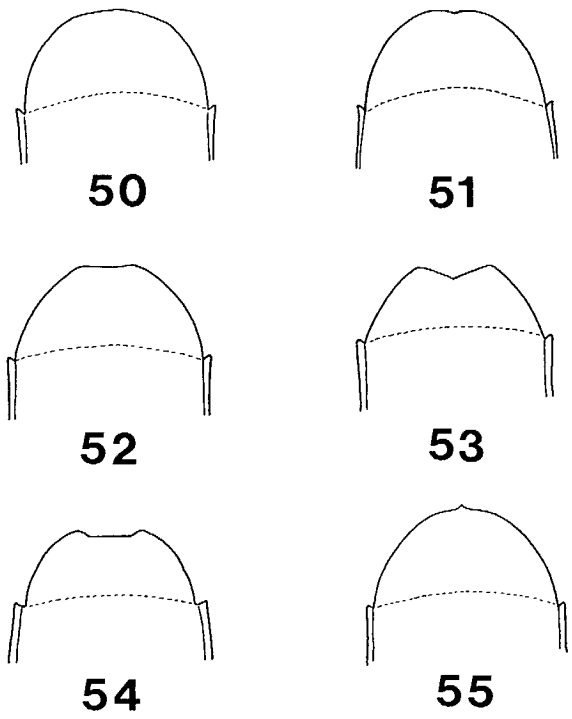

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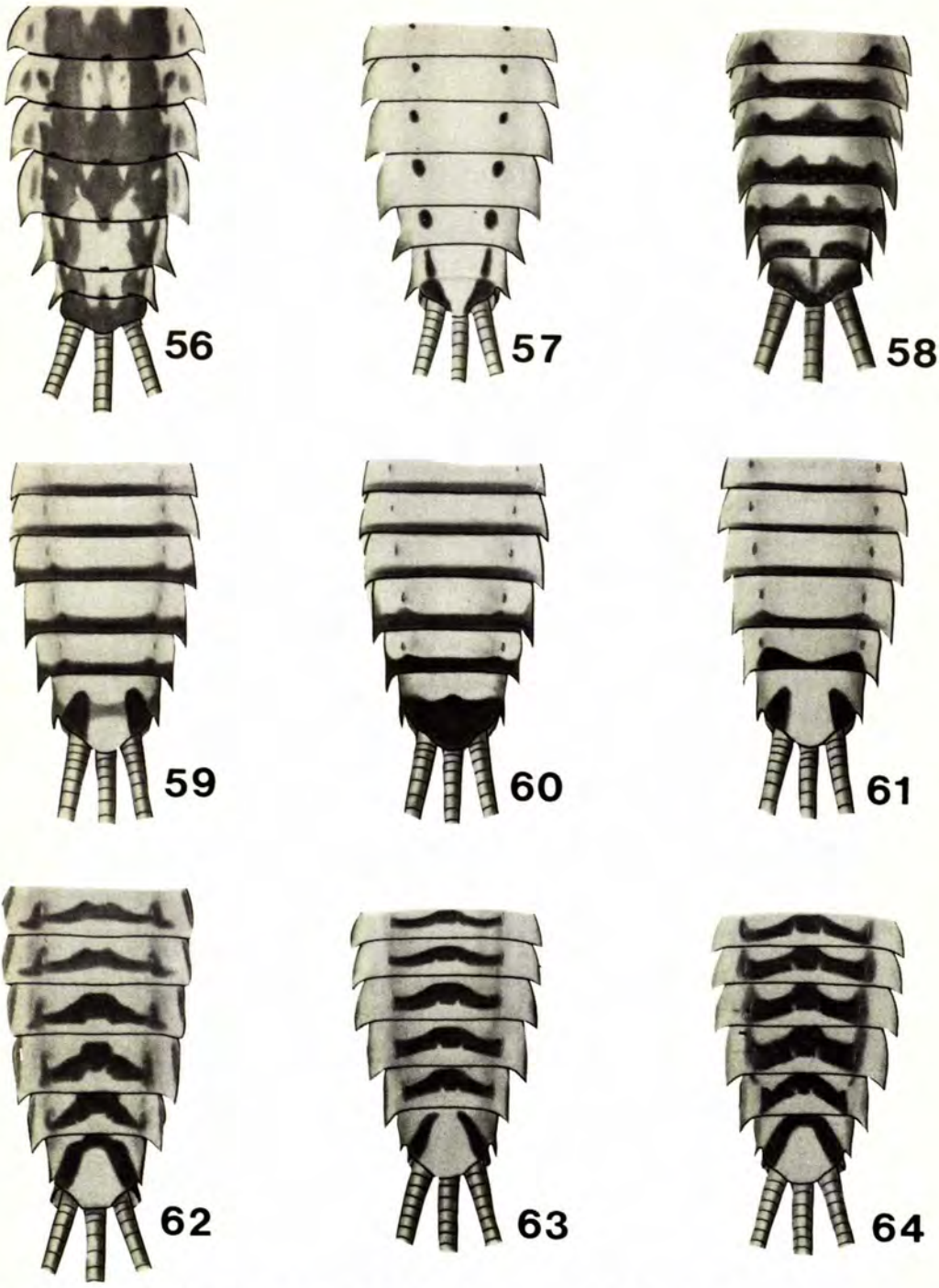

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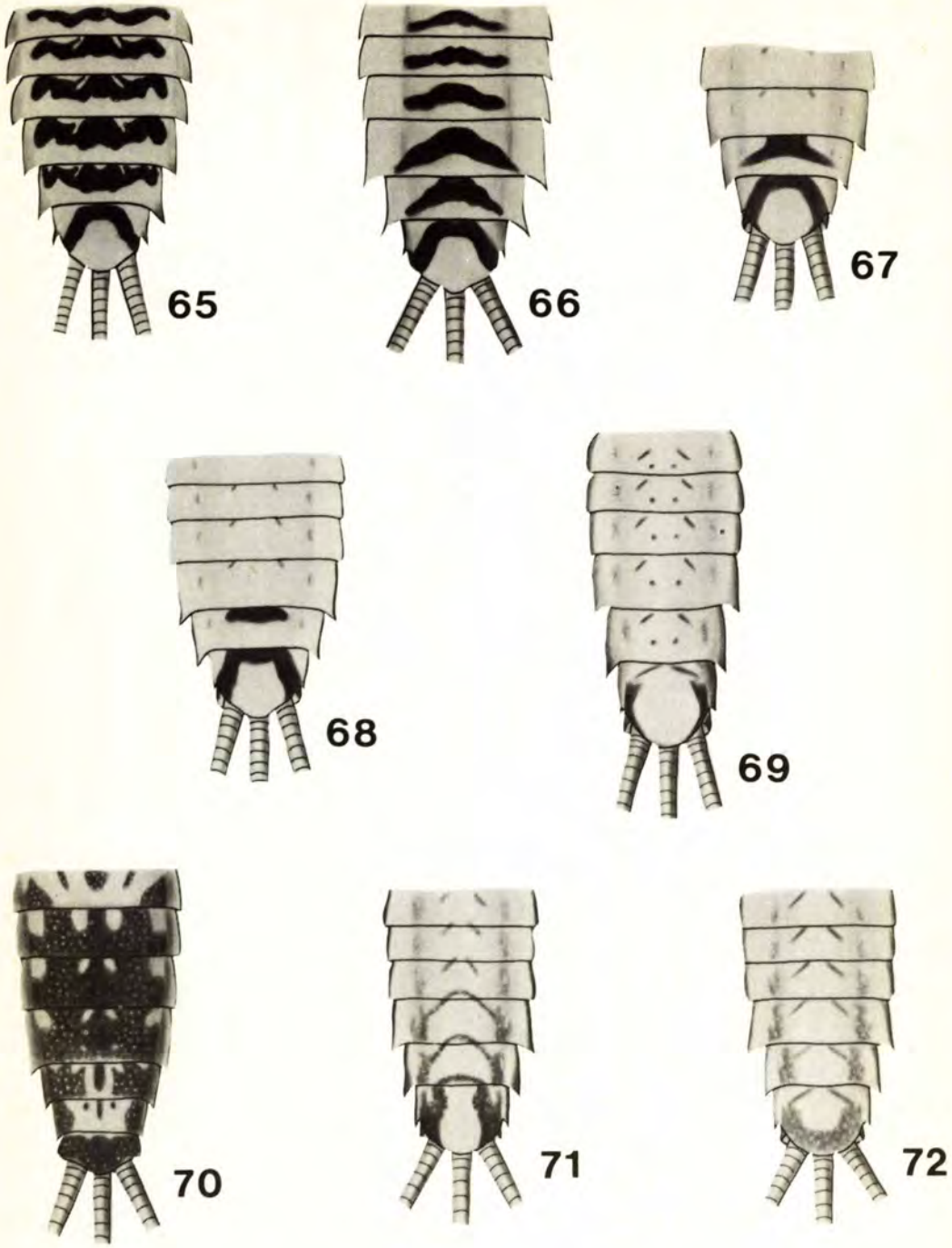

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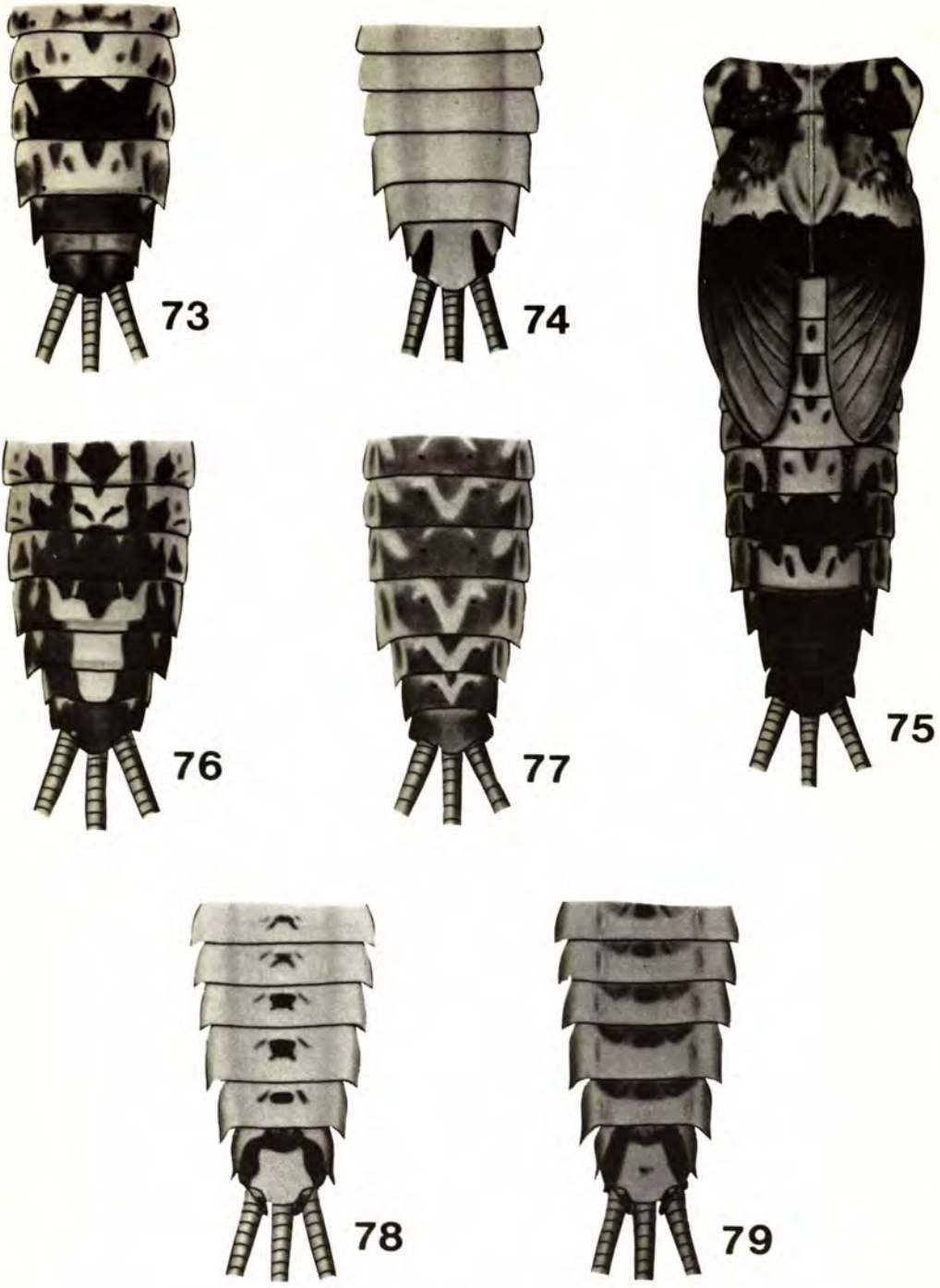

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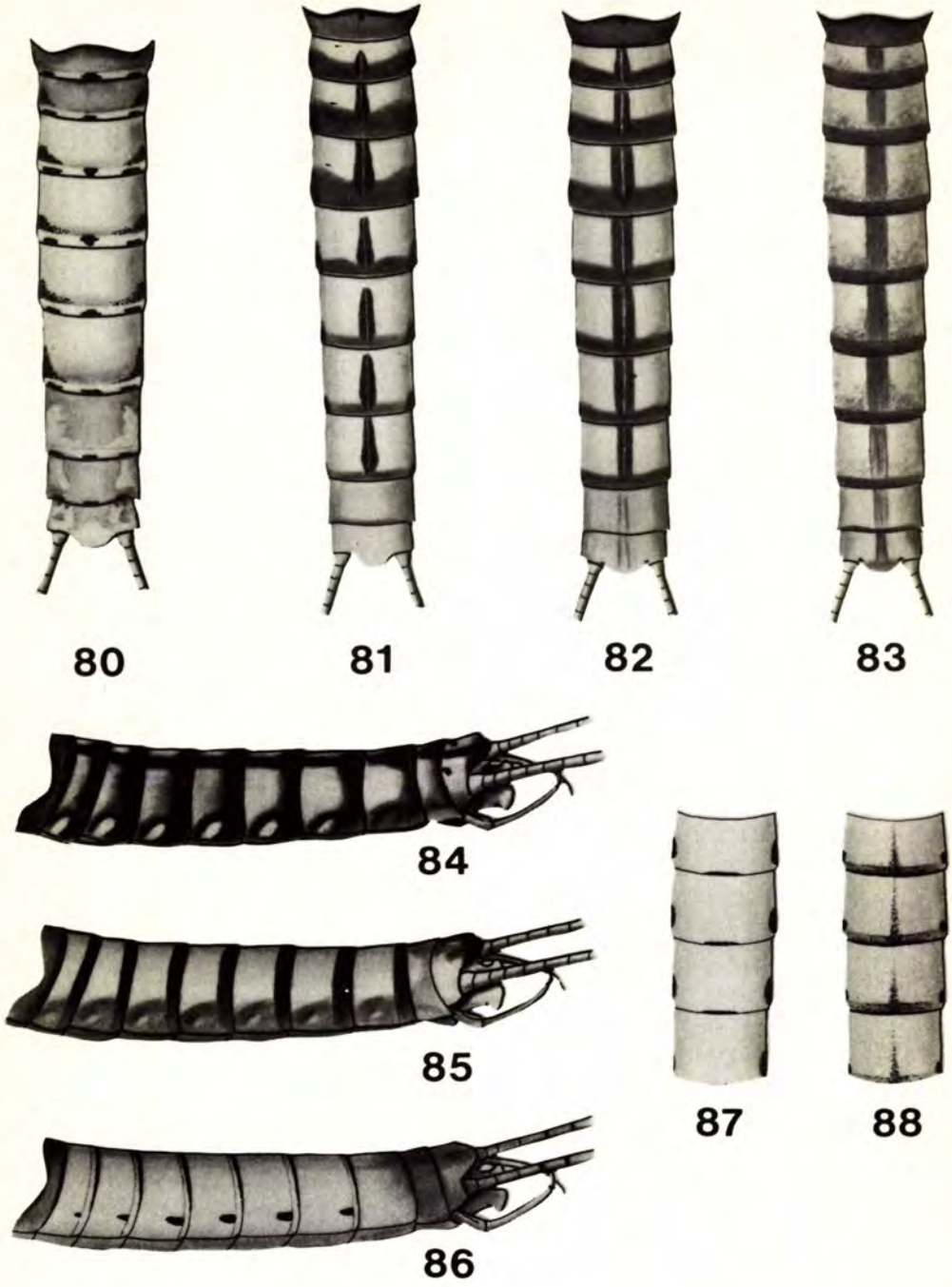

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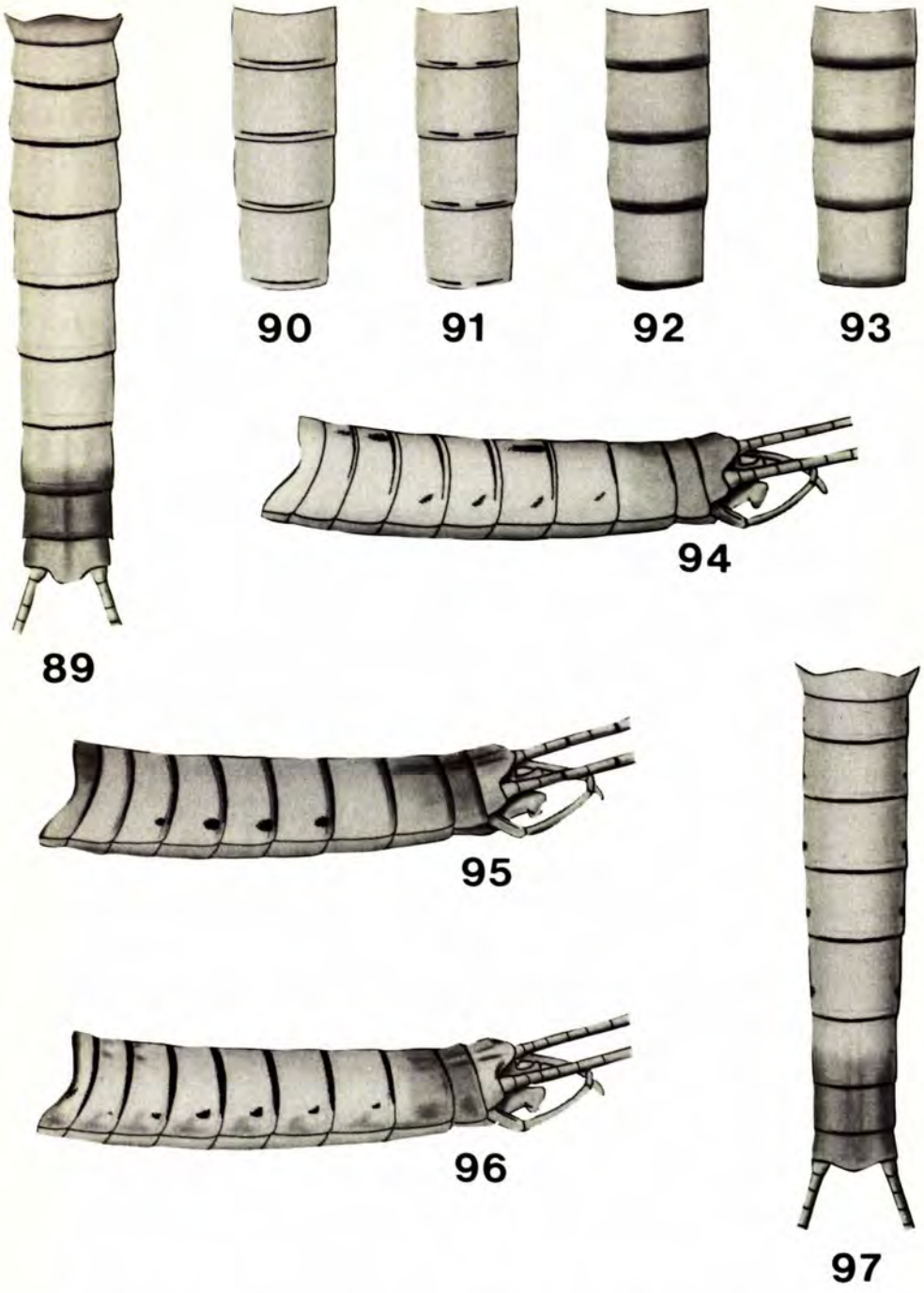

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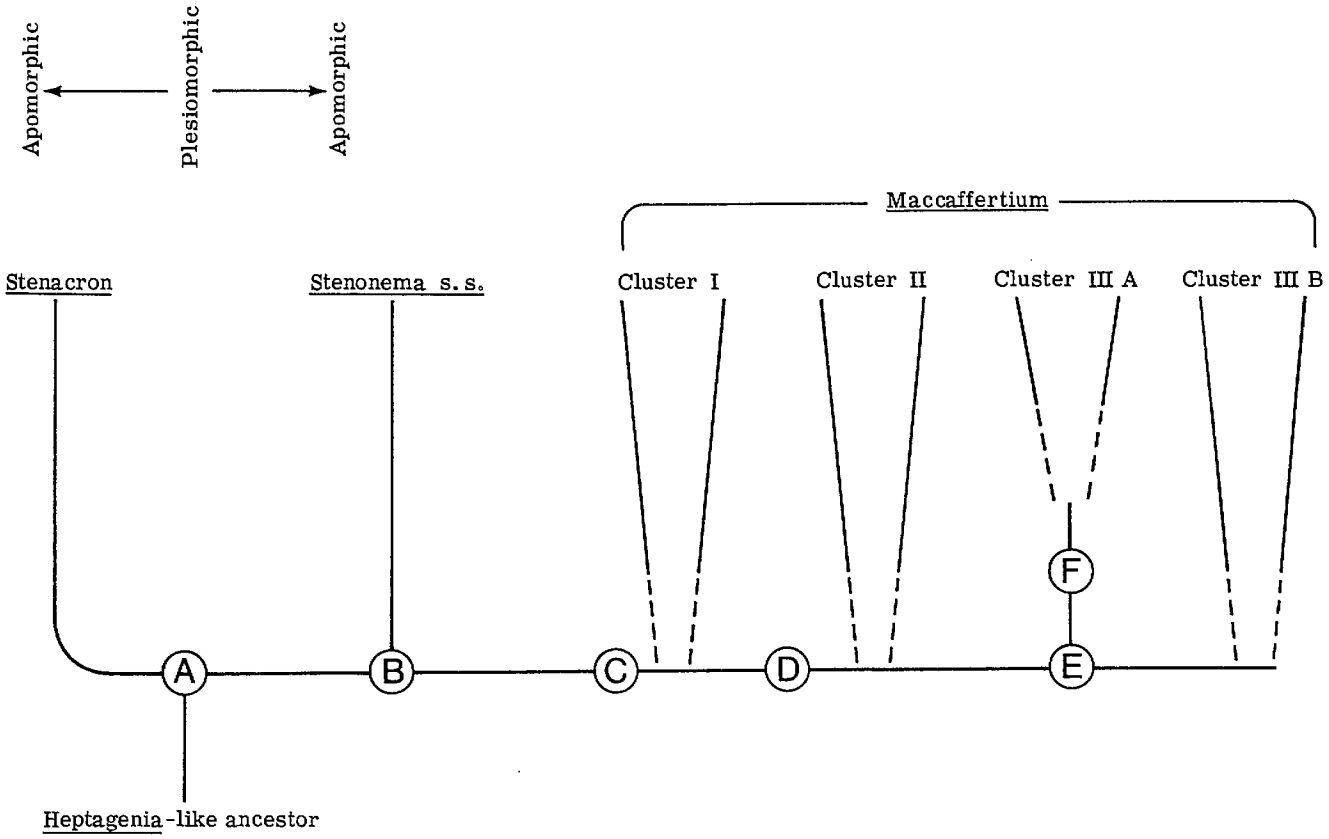

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