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MAYFLIES OF NORTH CAROLINA

PART III. THE HEPTAGENINAE

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PLATE 15

In previous papers (Jour. Elisha Mitchell Sci. Soc. **47**: Nos. 1 and 2) I have recorded the species of mayflies of the subfamilies Ephemerinae and Baetinae, which I have taken in North Carolina. The remaining subfamily, Heptageninae, is treated in like manner here. In the keys presented at the beginning of this faunistic study (op. cit., p. 101), these three subfamilies were characterized. Further study has led me to believe that I was in error in following the traditional identification of some of the genera of this last subfamily. A more extended account of my present conception of this subfamily will appear in the near future, in the Journal of the N. Y. Ent. Society. I give here, therefore, merely a brief summary of that portion of the article which immediately concerns the North Carolina species, with a correction of my previous errors, and with revised keys to the North Carolina genera of this subfamily.

The word Heptagenia, as used in my previous paper (op. cit., p. 101), should be changed to Stenonema, and the word Ecdyonurus to Heptagenia. Examination of specimens of the type species of Ecdyonurus has convinced me that this word has been misapplied to those North American species which I now call Stenonema. I believe now that none of my North Carolina species belong to the genus Epeorus, but that all should be referred to Iron. I refer the reader to the more ex-

tended article in the JOURNAL, where I have set forth in detail my reasons for the above changes. The revised and corrected keys to the subfamily Heptageninae are as follows.

Key to the male imagoes

1. First joint of fore tarsus considerably shorter than second joint (never more than $\frac{2}{3}$ of second, often much shorter).....2
 First joint of fore tarsus equal to second joint, or slightly exceeding it in length.....*Iron*
2. First joint of fore tarsus very short ($\frac{1}{3}$ to $\frac{1}{2}$ of second).....3
 First joint of fore tarsus longer ($\frac{1}{3}$ to $\frac{2}{3}$ of second).....*Stenonema*
3. Lobes of penes separated from one another very near the base, thus appearing as two long narrow projections. Cross veins in stigmatic region tend to anastomose.....*Rhithrogena*
 Lobes of penes joined together except near apex; broad, often somewhat angular laterally and distally; never as above. Cross veins of stigmatic region not anastomosed.....*Heptagenia*

Key to the nymphs

1. Tails two, in mature nymph.....*Iron*
 Tails three, in mature nymph.....2
2. Gills of seventh pair tapered threads or spines; tracheae, if present in these, without lateral branches.....*Stenonema*
 Gills of seventh pair flat and plate-like; tracheae always present in these, and with lateral branches.....3
3. Gills of first and last pairs much enlarged, converging beneath the body.....*Rhithrogena*
 Gills of first and last pairs not as large as some of central pairs; directed laterally, not converging beneath body.....4
4. Postero-lateral margins of pronotum prolonged backwards into epaulet-like extensions.....*Ecdyonurus*
 Postero-lateral margins of pronotum not prolonged backwards.....*Heptagenia*

GENUS HEPTAGENIA Walsh 1863

Although twenty-seven species of this genus have been described from North America, only six species appear in my collections from North Carolina. Two of these are new. It should be noted here that those species previously described or listed from North Carolina by Eaton and Banks, as *Heptagenia*, now fall into the genus *Stenonema*.

No representatives of this genus were found in the coastal plain region. The following keys may be useful in distinguishing the nymphs and imagoes of these species.

Key to male imagoes—Heptagenia—North Carolina species

1. Genitalia of the *maculipennis* type (see Fig. 15). Basal costal cross veins, sometimes other cross veins, margined with brown or black.....2
Genitalia not of the *maculipennis* type. Basal costal cross veins not dark-margined.....3
2. All veins in posterior half of forewing colorless. Abdominal tergites unmarked except dark posterior margins.....*juno*
Cross veins in posterior half of forewing brown. Abdominal tergites marked laterally with broad brown patches.....*aphrodite*
3. Veins colorless. Size under 6 mm.....*spinosa*
Veins brown. Size 7 mm. or over.....4
4. Genitalia of the *flavescens* type (see Fig. 8). Abdomen with black oblique lateral stripes, no dark median dorsal band.....*marginalis*
Genitalia of the *elegantula* type (see Fig. 1). Abdomen with broad dark median dorsal band, no black lateral stripes.....*julia*

Key to nymphs—Heptagenia—North Carolina species

1. Filaments present on gills of seventh pair. Pronotum widest at anterior margin.....2
Filaments absent from gills of seventh pair. Pronotum widest at middle...3
2. Abdomen with oblique black lines on each side of tergites. Very short lateral spines on segments 6 and 7.....*marginalis*
Abdomen without oblique black lateral lines. No lateral spines on segments 6 and 7.....*julia*
3. Three small light spots on each side of frontal margin of head. Tergite 8 and anterior half of 9, largely white.....*aphrodite*
No light spots on frontal margin of head. Tergites 8 and 9 without such a prominent white blotch.....4
4. Sternites 8 and 9 with dark transverse bars.....*juno*
Sternites 8 and 9 without dark transverse bars.....sp?

*From the piedmont region***Heptagenia marginalis** Bks.

This was the most common species of *Heptagenia* in the piedmont, although not abundant at any place. Mature nymphs were collected and reared from several stations, so that the identity of the species and the correct association between nymph and imago was established. Collections were as follows. Near Denton, May 14, 1929; Caraway Creek near Sophia, May 11-17, and Sept. 29, 1929, and May 20, 1930; Big Alamance Creek, Sept. 30 to Oct. 14, 1929; and Little Alamance Creek, Sept. 8, 1929.

Heptagenia aphrodite McD.

Nymphs of this species were taken from two stations and nymphs reared from them. On Oct. 1, 1929, a female was reared from Big Alamance Creek. Nymphs were likewise reared from Caraway Creek near Sophia on May 1, 1929; Sept. 28, 1929; and May 11-24, 1930. I present the following description of the nymph.

Nymph

Size—Body 6-6½ mm.; tails broken, in all specimens.

General color—Dorsally, brown with cream-white markings. Ventrally, creamy white to light tan.

Head—Many small round brown spots (or papillae?) along frontal border. Light-colored bar from outer anterior margin of eye to lateral border. Small white spot anterior to each ocellus. On margin of frons, three small white spots on each side, the posterior ones larger. Three white spots on each side of vertex near inner margin of eye. Base of antenna light brown, greyish white distally. Mouthparts very similar to Eaton's figure of a nameless North American nymph (Monograph, Pl. 59). The labrum, however, is slightly emarginate in front, and its lateral extensions do not turn downward so sharply. Right mandible with 4 long slender hairs on upper margin at base of inner canine; 3 such hairs on left mandible. 15 to 16 pectinate spines on crown of maxilla.

Thorax—Pronotum widest at middle. Lateral margins colorless. White mark like an inverted L, its base on anterior margin, on each side. Between this and the colorless margin, a brown bar followed by a light one. Curving white mark along center of posterior margin. Many small irregular white marks on mesonotum, including an L-shaped mark between the wing roots, and a round spot anterior to each wing root.

Legs—Femur white at base and tip, with white extensions into main brown portion from basal area. Two round white spots on hind margin, two smaller ones on forward margin, and two in central area. Hind margin fringed with long tawny hairs. Many small brown to orange spines on upper surface. Femoral flange short (not extending out beyond remainder of femur). Tibia light brown, with wide median and apical white bands. Hind margin fringed with hairs. Tarsus light brown basally, white apically. Claw with usual median spine on inner margin, less well developed than in *marginalis*. In addition, three slender teeth or spines near tip (i.e., claw is pectinate).

Abdomen—Lateral margins of 3-7 extended. Postero-lateral spines present on 3-8; very short on 3, increasing in length to 6; 7 somewhat shorter than 6; 8 shorter than 7 but longer than 3. Dorsally, segment 1 largely white, with narrow brown transverse band near posterior margin, and brown laterally. Segments 2, 3, 8, and 10 largely brown. White submedian marks on 2, 3, and 6, and other white marks near posterior margin and nearer the lateral border. Anterior half of lateral border white. Segment 10 is narrowly lighter on anterior margin and on each side of dark median line. Segments 4, 5, and 7 have large white central areas bordered on all sides by irregular brown blotches. Lateral margins as in 2-3; irregular brown longitudinal band parallel to lateral margin. Segment 8 and anterior half of 9 dark brown. Ventrally, immature nymphs are creamy white, mature ones light tan, with faint traces of darker longitudinal bars on each side.

Gills—Seventh gill lacks lower filamentous portion. Filaments of lower portion of other gills not as well developed as in *marginalis*. Plate-like parts greyish to light purple; tracheae and filaments purple.

Tails—Light tan at base, becoming somewhat lighter distally. Joinings dark brown, alternate joinings wider.

Heptagenia juno McD.

This species was found in one locality only. Nymphs collected on May 3, 1930, at the Cascades, near Danbury, in the Sauratown Mts., transformed from May 4 to May 19. Several specimens of both sexes were reared. The description of the nymph follows. In general structural characters it agrees with *aphrodite*, both species belonging to the *maculipennis* group.

Nymph

Size—Body of female, 6½ to 7 mm.; tails 11 mm.

General color—Light reddish brown dorsally, creamy white to pale yellowish ventrally.

Head—Small white dots along frontal margin, less prominent than in *aphrodite*. Small white spot anterior to each ocellus. Narrow white bar from outer anterior margin of each eye to lateral margin of head. Small light spot on each side of vertex, about at middle. Antenna reddish brown. Mouthparts very similar to *aphrodite*. 8 slender hairs at base of inner canine on right mandible, 7 on left mandible. About 20 pectinate spines on crown of maxilla.

Thorax—Pronotum widest at middle. Narrow colorless area on lat-

eral margins. Median line narrowly white. Rounded white blotch on each lateral anterior margin. Smaller hour-glass-shaped white mark near middle on each side. Mesonotum with several irregular white marks; a horse-shoe-shaped mark near wing roots; between wing roots a wedge-shaped mark, its base directed posteriorly, enclosing a small dark spot. White blotch at wing roots.

Legs—Femur narrowly whitish at base and apex. One round and one oblong white mark near, but not on, hind border. One to three small rounded marks in central area. One to three small light marks along fore border. Hind border fringed with long hairs. Spines on upper surface longer than in *aphrodite*. Tibia and tarsus reddish brown, no white marks. Tibia fringed with hairs on hind margin. Claw very similar to that of *aphrodite*. Femoral flange projects beyond main body of femur.

Abdomen—Postero-lateral spines as in *aphrodite*. Dorsally, segments 9 and 10 entirely brown. Segments 3 and 6 almost entirely brown, with small light marks only in lateral margins, and a white triangle on each side near the posterior margin halfway between median line and lateral border. Segment 1 largely white. Segments 2, 4, and 5 with white marks as on 3 and 6, and in addition two larger submedian marks, confluent apically, arising from posterior margin. Segments 7 and 8 quite similar to 4 and 5, but white submedian marks are shorter and broader. Ventrally pale yellow on apical segments, whitish on proximal ones. Segment 9 with dark brown lateral margin and transverse brown bar on anterior margin, usually discontinuous on median line. Two dark brown submedian spots on anterior margin of sternite 8, connected by a brown bar. Traces of similar marks on 7 are sometimes present. Extreme edge of lateral margins of all segments dark brown.

Gills—Structurally as in *aphrodite*. An area posterior to center of each plate-like portion purple, the margins light grey. Tracheae not distinct. Filaments light grey.

Tails—Amber yellow to light tan. Joinings reddish brown, alternately wide and narrow.

From the mountain region

Heptagenia marginalis Bks.

While not as common as *H. julia* n. sp., *marginalis* was quite well represented throughout the mountainous portion of the state. Collections from this area are listed. Davidson River, June 18, 1929; Ocona

Lufty River, June 22, 1930; Cullasaja River near Franklin, July 3, 1929; South Toe River at Micaville, July 6, 1930; Bald Creek near Burnsville, July 6, 1930; Spring Creek near Hot Springs, July 11, 1930; Little River near Penrose, July 12, 1930; and Toxaway River near the falls, July 16, 1930.

Specimens were reared in May, and again in September and October, from the piedmont. In the mountains, July was the time of emergence.

Since the nymph of this species does not seem to have been described, I give a description of it, as well as a figure of the male genitalia (Fig. 8). The species would seem to be rather close to *flavescens* Wlsh., the genotype, if similarity in structure of genitalia is any criterion, as I believe it to be. Since the nymph of the genotype is not known, it is not possible to compare this species with it, but I do not doubt that the two will be found quite similar in structural details.

Nymph

Size—Body of male, $9\frac{1}{2}$ –10 mm.; female, 11 mm. Tails of female, 22 mm.

General color—Light brown dorsally, creamy white ventrally.

Head—White spots laterad of each lateral ocellus and between the ocelli. Smaller white spot anterior to median ocellus. Small white spot anterior to each compound eye, another at inner margin. Epicranial suture white. Small light spot at middle of vertex. Antenna brown. Mouthparts very similar to figures by Eaton (Monograph, Pl. 61) for a species listed as *Ecdyonurus*.

Thorax—Pronotum widest at anterior margin. White spots (1) at middle of lateral margin; (2) at center of anterior margin; (3) irregularly along posterior margin; and (4) large area at middle of segment on each side of median line. Black longitudinal lines and scroll-like markings enclose the central white area. Oval white spot at middle of mesonotum on each side of median line, and another anterior to wing roots. Wing-cases brown, whitish at roots.

Legs—Femur brown, with three zigzag transverse bands, at middle and near each end. Femoral flange prominent, rounded apically. Upper surface of femur thickly set with short spines. Hind margin fringed with relatively long hairs. Tibia brown with distal and median white bands. (One specimen, entire distal half white.) Hairs on hind margin. Tarsus brown, lighter distally. Claw white, its tip orange. Usual median spine on inner margin, but no teeth at tip (i.e., not pectinate).

Abdomen—Dorsally, each segment narrowly black on posterior margin. Segment 1 largely white. Segments 2-8 with a longitudinal black stripe midway between median line and lateral margin, on each side. On 2-7, white submedian dash on each side near middle of segment. Lateral margins white, except for brown postero-lateral angles. Round white spot between lateral margin and longitudinal black stripe (very small on 5). Large irregular creamy white blotch on middle area of segment 8. Smaller light spot at middle of 9, on each side of brown median bar. White streak on each side of brown median line on 10. Lateral margins of 1-7 expanded, with very short postero-lateral spines. Ventrally creamy white, tinged with yellow on apical segments.

Gills—Filamentous lower portion present on all gills, well developed. Upper plate-like portion light grey with purple tracheae. Filaments purple.

Tails—Brown. Alternate segments with creamy white joinings. Except near base, a white blotch covering one or two segments alternates with three or four brown segments. Pale amber at extreme tip.

Heptagenia aphrodite McD.

A male and several females were taken in flight as subimagos over Flat Creek, at Black Mountain, on June 30, 1930. These transformed to imagos. Nymphs taken from this stream were similar to those reared from the piedmont. A somewhat darker male, taken in flight near Waynesville, is tentatively referred to this species, but may belong with the female listed as *Heptagenia* sp. Nymphs were found likewise at Laurel River not far from Hot Springs on June 29, 1930.

Heptagenia sp.? (*maculipennis* group)

A female nymph, taken in a tributary of the Pigeon River four miles west of Hazelwood, transformed on July 24, 1929. Although this species is a member of the *maculipennis* group, the nymph differs from *juno* and also from *aphrodite*. Another nymph of this species was taken in Hominy Creek near Canton on July 18, 1930.

Female imago

Size—Body $7\frac{1}{2}$ mm.; wing $8\frac{1}{2}$ mm.

Head—Margin of clypeus dark.

Thorax—Pronotum marked with greyish brown. Remainder of thorax yellowish, with a few lateral brown marks.

Legs—Pale. Fore femur with median brown band and brown at distal end. Black streak on distal third, on inner margin.

Wings—Three basal costal cross veins, two at bulla, and three sub-costals at bulla, brown-margined. Other veins dark brown.

Abdomen—Largely orange brown, paler ventrally. Each tergite has an irregularly rhomboidal dark lateral patch, rather as in *aphrodite*, but more extensive. Tergites 2 and 3 dark. 4-6 have large light median patches, and short submedian dark marks. Tails white, unmarked.

Nymph

Head and thorax very similar to *juno*.

Legs—Femur pale, with three dark transverse bands. Fringed on hind margin with long hairs. Short spines on upper surface. Tibia light brown, tarsus darker brown, both unmarked. Three pectinations on claw.

Abdomen—Tergites 2, 3, 6, and 9 largely brown, the two latter very dark. Tergite 1 largely pale. Remaining tergites brown basally, whitish in apical half. Apical margin of brown area irregularly scalloped. Ventral surface unmarked except for narrow brown lateral border on sternite 9. Gills much as in *juno*. Tails yellow, joinings dark brown.

? *Male imago*

It is possible that the dark male taken at Waynesville on July 17, and tentatively listed as *aphrodite*, may really belong to this species. Genitalia of this male are very similar to *aphrodite* (see Fig. 15).

Somewhat similar nymphs were taken from the Oona Lufty River on June 2, 1930, and from the Rocky Broad River at Lecky Gap on June 23, 1930. None were reared. These may represent still another species of the *maculipennis* group.

Heptagenia julia, sp. nov.

This species is close to *pulla* Clem., but smaller. I had at first considered it to be *pulla*, but think now that it is a distinct species. Thorax reddish brown dorsally. Abdomen pale yellowish, semi-hyaline, the tergites purplish along median line. Segments 8-10 deeper yellow, opaque.

Male imago

Size—Body 7-8½ mm.; wing 7½-8¼ mm.; tails 12-19 mm.

Head—Pale yellowish, tinged with reddish brown on vertex. Narrow

black transverse line on each side of front, extending out from compound eye. Antenna pale yellowish brown. Bases of ocelli black.

Thorax—Pronotum light reddish brown, with lateral purplish brown area. Posterior margin narrowly black at center. Meso- and meta-nota darker reddish brown, the tips of the spines very dark. Pleura yellowish. Conspicuous round black spot above fore coxa. Black line on mesonotum anterior to and below wing roots. Black lines anterior to middle and hind coxae; purplish line posterior to each. Pale yellow ventrally, except posterior half of mesosternum, which is yellowish brown.

Legs—First fore tarsal joint about $\frac{1}{4}$ of second. Fore leg dusky. Fore femur with indistinct purplish median band. Distal end purplish brown. Remainder of leg tinged with same color. Black streak on inner margin of distal fourth of fore femur. Tibio-tarsal joining and joinings of tarsus narrowly darker. Black streak on inner margin of first tarsal joint. Femora of other legs pale yellowish with indistinct dusky tinge; narrowly darker at distal end. Tibiae and tarsi dusky.

Wings—Semi-hyaline. Stigmatic area opaque. All veins light brown, the three large veins of the costal margin somewhat yellowish.

Abdomen—Segments 1-7 pale yellowish, semi-hyaline. Segments 8-10 yellowish red, paler ventrally; opaque. Posterior margins of all tergites narrowly purplish black. Tergites 1-4 with wide median purplish band, becoming wider posteriorly on each tergite. Median purplish band on tergites 5-7 also, but somewhat narrower. Whitish submedian blotches within this purple band, on each tergite. In tergites 1 and 2, these are based on anterior margin, but are nearer the center on tergites 3-7. Minute black line at stigma in each segment. Unmarked ventrally.

Tails—Dusky at base, becoming pale yellowish brown distally. Joinings dull purplish, except three or four at base which are pale. These purple bands alternately wide and narrow in basal third.

Genitalia—Of the *elegantula* type. Very close to *pulla* Clem., but distinguished by smaller size and slight structural differences. Forceps and penes dusky, subanal plate yellowish. See Fig. 11. The apical projections of the penes are more acute than in *pulla*, and the two central pairs of spines differ as follows. In *pulla*, the lower pair is very long and stout, the upper pair shorter and somewhat curved. In *julia*, both pairs of spines are nearly alike in size and shape. The second joint of the forceps of *pulla* is likewise longer relatively than in *julia*. I figure also the genitalia of *pulla* (Fig. 1). This is a camera lucida sketch from

a slide which Dr. McDunnough kindly lent me for comparison with *julia*.

Female imago

Very similar to male imago. Somewhat paler. Abdomen opaque, flushed with pink before eggs are deposited. Body 7-8½ mm.; wing 8-10 mm.; tails 13-16 mm.

Nymph

Size—Body of female, 8-9 mm.; tails 15-17 mm.

General color—Dark reddish brown dorsally, creamy white to pale yellow ventrally.

Head—Large white spot anterior to each ocellus. Small white spot on each side of vertex, posterior to each lateral ocellus. Another white spot on median line at center of vertex. Epicranial suture white. Narrow white line from outer anterior margin of eye to lateral border of head. Basal sclerite of antenna white. Filament pale brown basally, whitish distally. Mouthparts very similar to *marginalis* Bks.

Thorax—Pronotum widest at anterior margin. Somewhat crescent-shaped white area at center of anterior margin of pronotum. White spot in each anterior lateral angle. Irregular L-shaped white mark at middle of each side. Lateral margins narrowly colorless. Mesonotum with white streak on median line, widest at anterior margin. Small white spot anterior to each wing root. Slender elongate or oblong white mark on each side between wing roots, near median line. Laterad of this, another small oval white spot.

Legs—Femur narrowly light at base. Three rather irregular light bands, at middle and near each end, often not extending the width of the femur. Narrow white border, wider at each end, along basal half of hind margin. Two brown blotches on lower surface, at hind margin. Femoral flange projects beyond body of femur; rounded apically. Femur fringed with rather long hairs on hind margin. Upper surface with short brown spines. White band on tibia just before the middle, another at distal end. Hind margin fringed. Tip of tarsus white. Claw orange at tip, elsewhere white. Not pectinate.

Abdomen—Lateral margins of 1-7 slightly produced, but lacking definite spines. Each tergite with purplish black posterior margin. Rather broad dark band on median line of tergites 1-7, and basal half of 8. White submedian marks on each tergite, also a small white spot at middle on each side, halfway to lateral margin. Large white blotch

at center of lateral margin. In some specimens the submedian marks on 4 and 8 (not 4-8) are connected posteriorly, thus resembling *pulla* Clem. In many other specimens this is not the case. Tergite 10 has only the submedian light marks. Ventrally creamy white to pale yellow, the apical segments more often tinged with yellow. Sternites 8 and 9 with dark brown lateral border, forming a wide bar on 9. Traces, more or less distinct, of a dark longitudinal line parallel to lateral margin, on each side of body.

Gills—Seventh pair with filaments. Gill plates grey, tracheae and filaments purple.

Tails—Light brown at base, becoming darker distally. Joinings darker. Except at base and tip, each alternate two (or three) segments are dark, the next two lighter. Tip lighter brown, no such alternating dark and light patches.

Holotype—Male imago, reared. North Fork of Swannanoa River near Black Mountain, N. C., July 3, 1930. No. 1114.1 in Cornell University collection.

Allotype—Female imago, reared. Tributary of Pigeon River four miles west of Hazelwood, N. C., July 21, 1930. No. 1114.2 in Cornell collection.

Paratypes—8 male imagoes, 17 female imagoes. Waynesville, N. C., July 20-26, 1929; Allen's Creek near Hazelwood, July 18 and 24, 1929; Flat Creek at Black Mountain, July 2, 1930; Rocky Broad River at Lecky Gap, July 2 and 6, 1930; tributary of Pigeon River west of Hazelwood, July 27 and Aug. 2, 1930; tributary of Davidson River in Pisgah Forest, July 17, 1930; and tributary of the French Broad River at Selica, July 15, 1930. No. 1114.3-27.

This species differs from *pulla* Clem. (1) in its smaller size; (2) in structural details of penes as already noted; (3) darker color of legs and tails of imagoes; (4) the presence of a black line in the stigma of each tergite; and (5), the slight color differences in the pattern of the nymph. (One specimen was noted in which legs and tails were as light in color as in *pulla*.) Its habitat likewise is different. Clemens writes of *pulla* (Canad. Ent. 45: 33), "the nymphs were found along the very stony, exposed shores of small islands three and four miles out in the open bay" (Georgian Bay). Nymphs of *julia*, on the contrary, were the commonest species of *Heptagenia* in the mountains of the state, found in practically all the streams, both large and small, of that area. The

wide distribution of the species in the state is indicated by the following localities (other than those listed for the types): Swannanoa River at Black Mountain; Catawba River near Andrews Geyser; small stream near Fairview; tributary of the Rocky Broad at Bottomless Pools; Davidson River and one of its tributaries; tributary of the Cullasaja River near Franklin; tributary of the Tuckasegee River on Cowee Mountain; tributary of Laurel River near Hot Springs; tributary of the Nantahala River near Topton; Wayah Creek near Franklin; Bald Creek near Burnsville; tributary of the North Fork of the Catawba River near Woodlawn; Conestee Creek; Little River near Penrose; Little River at Cedar Mountain; tributary of Allen's creek at Hazelwood; Scott's Creek; and Cedar Creek near Glenville. Collections were made at the above-mentioned stations during June and July of the summers of 1929 and 1930.

Heptagenia spinosa, sp. nov.

A small species, represented by three male imagoes only. The genitalia differ from those of all known North American species, in bearing lateral spines on the penes. Hence the specific name. Thorax reddish brown dorsally. Abdomen whitish, semi-hyaline, last three segments opaque, yellow. Broad purplish dorsal stripe.

Male imago

Size—Body 5-5½ mm.; wing 5½-6 mm.; tails 11 mm.

Head—Pale yellow without distinct marks. Bases of antennae white; filament dusky. Ocelli black-ringed at base.

Thorax—Pale reddish brown dorsally. Pleura and sternum creamy white to pale yellow; without markings. Pronotum purplish brown on median line and at center of posterior margin. Metanotum darker than remainder of thorax. Purplish on posterior margin, and at center a transverse purplish line.

Legs—Pale whitish with faint yellowish tinge. Fore leg more yellowish than others. Fore femur light purple at femoro-tibial joining, and with faint dark stripe on distal inner margin. Other legs with faint darker ring at distal end of femur. First fore tarsal joint between $\frac{1}{4}$ and $\frac{1}{3}$ of second.

Wings—Hyaline. All veins colorless.

Abdomen—Segments 1-7 whitish, semi-hyaline. Segments 8-10 yellow dorsally, creamy white ventrally; opaque. Broad purplish dorsal band on 1-8, leaving lateral margins widely white. Whitish

submedian streaks within this dark band, and mid-dorsal line narrowly white. Posterior margin of each tergite narrowly dark purple, along extent of dark median band. On tergites 1-5, the purple band is lighter posteriorly, and darker from this light area forward to center of tergite.

Tails—White, tinged with yellow at base. Joinings narrowly purplish in basal third; remaining portion unmarked.

Genitalia—Forceps faintly smoky; penes pale yellow. Penes of a different type from any other species of this genus in North America. Forceps long and slender, the two terminal points together as long as the second joint (as in the *lucidipennis* group). Penes united, bearing a pair of stout blunt spines on the median line, and several short spines on each lower lateral margin. (See Figs. 6 and 7.)

Holotype—Male imago. North Fork Swannanoa River, N. C., June 30, 1930. No. 1115.1 in Cornell University collection.

Paratypes—Two male imagoes, same data. No. 1115.3-4 in Cornell collection.

These three males were taken as subimagoes, at the lights of the automobile, about 9.30 p.m. the evening of June 30, on the banks of the North Fork of the Swannanoa River. They transformed into imagoes the following day. Females and nymphs of this species not known.

Genus ECDYONURUS Eaton 1868

I have recently had the opportunity to study nymphs and imagoes of the genotype of *Ecdyonurus*, *E. venosus* Fab. These specimens were kindly sent to Prof. Needham by Prof. M. E. Mosely of S. Kensington, England. It would seem from these specimens that *Ecdyonurus* is a valid genus, distinct from true *Heptagenia* on the one hand and from *Stenonema* on the other, and one which has not been reported from North America. (Species listed as *Ecdyonurus* by Dr. McDunnough and others, now fall in the genus *Stenonema*.)

Nymphs of *Ecdyonurus*, as described and figured by Eaton (Monograph, Pl. 62, Figs. 1-23) possess an epaulet-like postero-lateral extension of the pronotum. Schoenemund (*Zool. Anz.* 90: 45. 1930) uses this character as the basis for separating nymphs of *Heptagenia* from those of *Ecdyonurus*. North American nymphs of the genus *Stenonema* are probably not known to him. In his account of the

mayflies of Germany (Die Tierwelt Deutschlands, 19 Teil, 1930) moreover, Schoenemund includes in the genus *Heptagenia* the species *gallica*, *coerulans*, and *flava*, nymphs of which (op. cit. 78, figs. 129 and 132) are quite different from any known North American species of *Heptagenia*. Regarding gill structures, spines on the abdominal segments, and pectination of claws, the specimens of *E. venosus* differ very little from the North American *Heptagenia* nymphs of the *maculipennis* group. The hypopharynx of *E. venosus* is not quite similar to that of any North American Heptagenine I have studied, but otherwise the mouthparts resemble *Heptagenia*.

Among my North Carolina specimens are a few nymphs which resemble those of *E. venosus* in the peculiar posterior extension of the pronotum. In all other characters they are so similar to *Heptagenia* nymphs of the *maculipennis* group as to lead me to think that they belong to that genus rather than to *Ecdyonurus*. Since, however, none of these nor similar nymphs were reared, the genus cannot be definitely determined. I place them tentatively in the genus *Ecdyonurus*, because of the structure of the pronotum.

These nymphs were taken from the Toxaway River just above the big falls, on July 16, 1930, and from the Paolet River at Tryon, July 14, 1930. Nymphs which show a very slight development of the hind angles of the pronotum occurred in the Rocky Broad River at Lecky Gap and in the tributary of the Pigeon River west of Hazelwood in June and July. The following description is based on the specimens from the Paolet River.

? *Ecdyonurus* sp?

Size—Body 7 mm.; tails broken (on Toxaway River specimen, 10 mm.)

General color—Light reddish brown dorsally, pale ventrally.

Head—Very small white spot anterior to median ocellus and laterad of each lateral ocellus. Narrow white line from outer edge of eye to margin of head. Frontal portion of head very large. A few indistinct brown dots on frons, as in *Heptagenia* nymphs of the *maculipennis* group. Mouthparts very similar to *H. aphrodite* and *juno*, the outer margin of the mandibles rather more strongly incurved. Five long hairs at base of inner canine, on each mandible.

Thorax—Pronotum widest at middle, its postero-lateral margins extended backwards in a short, rounded projection. Irregular white

marks on anterior margin, near middle of each side. Mesonotum marked irregularly with creamy white. Pale whitish ventrally.

Legs—Coxae and ante-coxal pieces marked with dark brown. Femur brown, its basal and apical ends white. White median transverse bar, another near distal end. Small white spot in central area, between base and median bar. Hind margin fringed with long hairs. Upper surface with many small dark spines. Large brown spot on ventral surface at distal end. Femoral flange prominent. Tibia pale dusky brown in basal two-thirds, pale distally. Hind margin white. Cap-like basal portion adjoining femur, and fore margin, narrowly black. Tarsus and claw brown, unmarked. Claw pectinate.

Abdomen—Postero-lateral spines on segments 3–8, long except on 3. Tergite 1 largely whitish. Tergites 2, 3, 9, and 10 largely brown; 2 and 3 with black marks. Tergites 4–8 creamy white posteriorly, dark brown basally. Three roughly triangular brown areas, with black markings, on anterior margin, projecting backwards into light area; their edges irregular. Tergite 6 wholly brown at center. Tergites 5, 7, and 8 with wide white blotches on each side of narrow dark median line. Ventrally pale creamy white, apical sternites yellow-tinged. Sternites 8 and 9 with brown lateral margins, wider on 9.

Gills—Filaments absent from seventh gill. Gill plate mainly dark purplish grey, light grey on basal portion of outer margin. Only main trachea distinct. Filaments light purplish grey.

Tails—Dusky brown. Basal third of each segment white, distal portion brown. Joinings dark brown, alternately wide and narrow. Circle of spines at each joining, as in *Heptagenia*. Distally, dark joinings less prominent.

Genus IRON Eaton 1883

Mature nymphs of the *Epeorus*—Iron group are two-tailed, a character which distinguishes them from all other eastern *Heptageninae*. I am considering all known species of this group from eastern North America, with the exception of *Epeorus albertae* McD., as belonging to the genus Iron. For a further discussion of this question, I refer the reader to my paper on the subfamily *Heptageninae* (Journ. N. Y. Ent. Soc.):

Several species of Iron were taken in North Carolina. These may be divided, on structural characters, into two groups. Group I has the following characters. (1) Gills of first pair shorter than others, and broader at base, produced into a short lobe on the anterior margin.

These gills do not approach one another closely beneath the body of the nymph. (2) Head not noticeably wider at front margin than elsewhere, usually widest at or near middle. (3) Outer postero-lateral spines of abdominal segments long and sharp-pointed. Those of the central segments usually as long as or longer than one-half the length of their respective segments, and about three times as long as their own width at base. Inner spines usually about one-half as long as outer ones. (4) Femoral flange of the last two pairs of legs sharp-pointed at apex. (5) Five short teeth or spines near tip of each claw, on inner margin.

Group II is characterized thus. (1) Gills similar to those of Group I. (2) Head definitely widest anterior to middle, usually near the front margin. Hind margin relatively very narrow. Eyes small for size of head. (3) Outer postero-lateral spines usually short and rather blunt. Those of central segments not longer than one-fourth of the length of their respective segments, and about as long as their own width at base. Inner spines about as long as outer ones. (4) Femoral flange of second and third pairs of legs rather short and blunt at apex. (5) Four short teeth or spines on inner margin of each claw, near the tip.

While Group I has the nymphal characters usually assigned to the genus *Epeorus*, the male imagoes of the one reared species of this group have dissimilar fore claws. (In *Epeorus* the fore claws of the male are similar and blunt.) Group II, however, does not have the characters usually assigned to *Iron*, as the gills of the first and last pairs are not greatly enlarged, and do not meet beneath the body of the nymph. The genitalia of the male imagoes are very similar to those of Group I, and the fore claws of the males are dissimilar. Group II is thus intermediate between *Epeorus* and *Iron*, as these genera were characterized by Eaton. As stated before, I consider all these forms as members of the genus *Iron*.

At least four species of Group I and two species of Group II were collected in the state. Of these, complete life histories were obtained for two, both of which proved to be new species. Female imagoes alone were reared from nymphs of a third species. The two new species are described. The unreared nymphs, and the species with incomplete life history, are indicated by number only. The latter may also be new. Very little attempt is made to describe the unreared nymphs, as they are very similar one to another. Aside from the one species listed as No. 1, which was taken at two different places in the piedmont, all were found in the mountain area of the state.

Iron rubidus, sp. nov.

A species of Group I. Very close to *humeralis* Morgan. Gills of nymph distinctly reddish. Wings semi-hyaline, longitudinal veins very faintly brownish. Male whitish. Abdominal tergites with narrow dark posterior borders, black medio-dorsal line, indistinct dark lateral streaks and faint dark stigmatic marks.

	SIZE		
	BODY	WING	TAILS
Male imago.....	8 - 9	8-9	25
Female imago.....	9½-11	11	17

Male imago

Head—Pale yellowish. Small brown spot on each side of median carina, between antennae. Brown streak on each side of face, at corner of eye. Posterior margin of vertex brown at center. Base of antennae pale; filament faintly dusky, tip pale. Eyes of living insect bright green.

Thorax—Pale yellowish brown. Lateral and posterior margins of pronotum brown; brown streak on each side of median line, from middle to posterior margin. Mesonotum with four small dark marks between wings. Scutellum orange-brown, posterior margin black, with white lateral areas. Metanotum whitish anteriorly; posterior half orange-brown, purplish laterally. Pleura pale. Several purplish black marks on coxae and above each leg. Ventrally pale yellowish.

Legs—First joint of fore tarsus very slightly shorter than second joint. Legs pale yellowish. Each femur yellow, with usual prominent dark median band, and narrowly dark at apex. Fore femur slightly dusky. Tip of fore tibia purplish. Claws of all legs dissimilar.

Wings—White, semi-hyaline. Longitudinal veins very faintly yellowish brown. Humeral cross vein black in half next to subcosta. Stigmatic area opaque white.

Abdomen—Segments 1-7 white, semi-hyaline. 8-10 yellowish brown, paler ventrally; opaque. Each tergite with narrow purplish black posterior margin, faint at center. Medio-dorsal line purplish black in posterior half of tergites 3-9. On 1 and 2, a black median dot only. Purplish mark in stigmatic area of each tergite, and traces of dark

lateral marks on each side. Sternite 1 opaque, pale yellowish. Venter pale, unmarked.

Tails—White, unmarked.

Genitalia—White. Very similar to *humeralis* Morgan, but short lateral projections on penes less prominent. Second joint of forceps slightly longer, relatively, than in *humeralis*. See Fig. 9.

Female imago

Very similar to male. Abdomen rose to salmon-red, due to color of eggs. Lateral and stigmatic marks very faint, also posterior margins less well-marked than in male. Cross veins of stigmatic area of fore wing light brown. In living insect, eyes are bright green. Fore part of head and pronotum deep orange. Pleura marked with orange.

Nymph

Very similar to that of *humeralis*, but differs from it in (1) the reddish color of the gills; (2) whole body definitely reddish to yellowish brown (in *humeralis*, greenish brown); (3) legs barred with reddish brown (in *humeralis*, with greyish brown); and (4) branches of tracheae in gills much less numerous, also less prominent, being dull purplish instead of black in color. Abdomen dorsally yellowish brown. Each tergite with a black median line, and two dark brown subdorsal spots surrounded by light areas. The light areas especially prominent on 6. Ventrally white, as opposed to the distinct yellow ventral surface of *humeralis*. The latter has also purplish transverse markings on the venter of the thorax, which are not present in *rubidus*. Outer canines of mandibles rather longer and more slender than in *humeralis*.

Holotype—Male imago, reared. Flat Creek at Black Mountain, N. C., June 16, 1929. No. 1116.1 in Cornell collection.

Allotype—Female imago, reared. Same location, June 15. No. 1116.2 in Cornell collection.

Paratypes—5 male imagoes, 11 female imagoes. Flat Creek, June 15-19, 1929, and June 29, 1930; Ocona Lufty River, June 22, 1930; Pacolet River at Tryon, July 14, 1930; and Hazelwood July 20, 1930. Nos. 1116.3-18 in Cornell collection.

Imagoes of *humeralis* Morgan have definite orange or brown markings on the venter of the thorax, usually paler in the female. The abdominal tergites, while showing a considerable variation in color, usually have a

rather wide brown band on the posterior margin, widest laterally. The fore femora of the male imago have a distinctly orange or reddish apical band; the foretarsal joinings are black, the tip of the tibia widely black. Mesonotum paler than in *rubidus*. Wings more transparent, veins almost invisible. Eyes of male much larger than in *rubidus*.

This species was found only in the mountain area of the state. Other locations from which it was collected during June and July of 1929 and 1930 are listed below. Swannanoa River; North Fork of Swannanoa River; Rocky Broad River at Lecky Gap; Wayah Creek, near Franklin; Spring Creek, near Hot Springs; and the Pigeon River near Woodrow. Two males, one from Calatoochee Creek, and the other from Allen's Creek near Hazelwood, are probably of the same species but are not included among the paratypes.

Three other species of nymphs of Group I were taken in the state. These I designate as Iron sp. Nos. 1, 2, and 3.

Iron sp. No. 1

The only species of Iron found in the piedmont. Collected from the stream at Cascades, another stream near Danbury, and from a small tributary of the Uharie River. Almost mature nymphs were found by the middle of May. Female nymph 12 mm. in length; male 9 mm. Light reddish brown dorsally when mature. Markings very similar to the nymph of *rubidus*. Gills grey, very faintly tinged with lavender. Tracheae not distinct. White ventrally, the apical abdominal segments faintly washed with yellow.

Iron sp. No. 2

Another species from the mountain region. Taken at Cedar Creek, near Glenville, in late June and early July. Female nymph 12 mm. in length; male, 10 mm. The four large white blotches on the frontal margin very prominent. Rather dark reddish brown when mature. A wide dark brown mid-dorsal band is present on tergites 3-5 and 7-8. Black median line and dark brown subdorsal markings, as in previous species. Gills light grey, sometimes with purplish tinge. Tracheae not distinct. Bands on femora not as distinct as in *rubidus*. White ventrally, apical abdominal segments yellowish. One nymph shows traces of brown longitudinal marks parallel to lateral margin. In this species, the outer postero-lateral spines are considerably shorter than in others of Group I, but still noticeably longer and more pointed than those of Group II.

Iron sp. No. 3

Taken from a tributary of the Pigeon River at Waynesville, in late July. Seems distinct from *rubidus*, but has very similar markings. Female nymph 12 mm. in length, male 10 mm. Gills light purplish in color; tracheae dull purple, about as distinct as in *rubidus*. Ventrally pale; apical segments faintly yellow.

Iron dispar, sp. nov.

A representative of Group II. Nymph chestnut brown dorsally, yellowish ventrally. Wing veins of imagoes distinctly brown in apical half. Abdomen of male pale, semi-hyaline. Thorax yellowish brown. Purplish brown markings. Fore tibia dark brown washed with purple.

	SIZE		
	BODY	WING	TAILS
Male imago.....	9	9	23
Female imago.....	11-11½	11-12½	23-29

Male imago

Head—Pale yellowish brown. Margin of clypeus, edge of median carina, and streak at inner corner of eye, purple. Small purplish dots between antennae, and below base of each. Vertex with purple spot at center of posterior margin. Eyes about same size as *rubidus*. Base of antenna pale; filaments dusky, tips pale.

Thorax—Yellowish brown. Pronotum purple on anterior margin and at center of posterior margin. Purple subdorsal line on each side. Mesonotum with somewhat darker median band, bordered by pale yellow. Mesonotal spine dark brown. Metanotum dark brown, somewhat paler laterally. Pleura yellowish. Purple streak on anterior coxa and antecoxal pieces. Purple marks on other coxae, also before and behind each coxa. Venter pale yellow; mesosternum pale brown.

Legs—Fore femur yellowish brown. Usual purple median spot; apical marking pale. Tibia purplish brown, darker apically. Tarsus pale yellow, joinings widely purplish. Last tarsal segment dusky. Other legs pale yellowish white, with purplish femoral spot, and very narrowly darker at apex of tibiae and at tarsal joinings. Claws of all legs dissimilar.

Wings—Veins and cross veins in apical half of fore wing light brown; those of basal half almost colorless. In hind wing, apical subcostal cross veins and a few intercalaries on outer margin very light brown, other veins colorless. Stigmatic area of fore wing opaque white. Humeral cross vein purplish black in half next to subcosta.

Abdomen—Segments 2-7 yellowish white, semi-hyaline. Tergite 1, and segments 8-10 yellow, opaque. Posterior margin of each tergite purplish, widest at center. Purplish black mid-dorsal line on posterior half of tergites 1-9. Lateral purplish streak on each, between median line and lateral margin. Purple mark at stigma. Lateral markings on tergites 1 and 2 more extensive than elsewhere. Ventrally unmarked, except for two short purple transverse bars on each side of median line on anterior margin of sternite 2.

Tails—Dusky; faintly tinged with yellow. Unmarked.

Genitalia—Penes quite similar to *humeralis* and *rubidus*, but completely lacking lateral projections. In this respect, similar to *punctatus* McD. Apical margin of subanal plate of a different type from any North American species thus far figured. See Figs. 10 and 13.

The male paratype lacks the lateral purple streaks on the tergites, and the transverse marks on sternite 2, and is also paler than the holotype, from which the description is drawn.

Female imago

Quite similar to male. All veins distinctly dark brown. Humeral cross vein dark purple its entire length. Abdomen orange, paler ventrally. Stigmatic marks often very faint. Posterior margins of tergites as in male, but on tergites 1 and 2 supplemented by another purplish red band just anterior to the margin. Apical extension of sternite 7 pale brown, margined with purplish. Some of the paratypes are much paler on head, thorax, legs, and tails, and lack the brown mark on sternite 7.

Nymph

Chestnut brown dorsally, pale yellow ventrally.

Head—White median streak runs forward from median ocellus. Frontal margin pale, no darker markings.

Legs—Femoral markings consist of the usual purplish black median spot, and four brown longitudinal streaks, two in basal and two in apical portions. Tibiae wholly pale, except for narrow blackish distal mark. Tarsi pale brown basally; purplish in apical third.

Abdomen—Lateral margins widely white. Posterior margins of tergites narrowly dark. Dark mid-dorsal line, and brown sub-dorsal spots. Pale areas surround subdorsal spots only on tergite 6. Tergites 9 and 10 pale yellowish, darker only beside median line.

Gills—Light grey, frequently tinged with purple. Tracheae indistinct.

Holotype—Male imago. Allen's Creek, near Hazelwood, N. C., July 24, 1929. No. 1117.1 in Cornell collection.

Allotype—Female imago. Tributary of Pigeon River west of Hazelwood, N. C., July 25, 1929. No. 1117.2 in Cornell collection.

Paratypes—One male imago, eight female imagoes; reared. Allen's Creek, July 24, 1929; small stream on Cowee Mountain, July 4–10, 1929, and July 28, 1930; Waynesville, July 16–20, 1929; and Scott's Creek near Balsam, July 23, 1929. No. 1117.3–11.

This species was also collected in the Pigeon River near Woodrow, and in a tributary of the Swannanoa River flowing through the Blue Ridge assembly grounds. Two males, not included in the paratypes because the wing veins are almost wholly pale, have very similar genitalia. These specimens were taken at Waynesville and Penrose, N. C., in July.

Iron sp. No. 4

Another representative of Group II. Collected by Professor Needham from Forney's Creek, Great Smoky National Park, August 26, 1931. Nymph more slender and darker in color than *dispar*. General color dark reddish brown. Body of female, 10–12 mm.; tails 14 mm. Male, 8–8½ mm. in length. Pale median streak anterior to median ocellus. Legs with usual median purple spot on femora. Mainly dark smoky brown in color; light areas limited to base, apex, and lateral streak on femur, and apex of tibia. Thorax pale ventrally; two purple transverse bars on anterior and posterior margins of mesosternum. Abdomen dark reddish brown dorsally. Each tergite has the posterior margin blackish; black mid-dorsal streak and dark brown subdorsal spots. These spots, on 6, surrounded by lighter area. Tergite 9 pale in posterior half. Ten has a pale mark on each side of median line. All tergites tend to become darker laterally, but leaving lateral extensions light. Ventrally pale; in female, usually flushed with pink. Posterior margins often very narrowly dark. One specimen has faint brown lat-

eral blotches. Gills olive-brown with distinct purple tinge. Tracheae quite numerous; very dark purple.

GENUS RHITHROGENA Eaton 1881

Six species of this genus are represented in my North Carolina material. Of these, one was found in the piedmont, at one location only; the other five occurred in the mountain area. As far as I am able to determine, all of these are new species. The size alone would seem to indicate this. All six are relatively small species, smaller than *im-personata* McD. and barely as large as *anomala* McD. and *jejuna* Etn. There remains the possibility that one of the North Carolina species may be *jejuna* Etn. Two of these forms I designate by number, as they are represented only by nymphs.

Although nymphs of four of the North Carolina species were fairly abundant, it was very difficult, in some cases impossible, to rear them. Careful comparative study of these nymphs shows a remarkable structural similarity in all six species. Color differences are practically the only means of distinguishing one from another. In life, these color differences are much more striking than in alcoholic specimens. Unfortunately, my field notes on the color of the living nymphs are too brief to be of much value.

Structural characters of the nymphs of this genus have been discussed in my paper on the Heptageninae of North America. I might add that, in all the seven species studied, three teeth are found on the inner margin of the claw near the tip, and one larger tooth or spine near the base. Postero-lateral angles of the abdominal segments are not prolonged into spines. The posterior margin of the pronotum is more or less emarginate, sometimes quite deeply cut. Irregular scroll-like markings are present on each side of the pronotum, and usually on the mesonotum as well.

In the following key, I have endeavored to distinguish these six species, by color alone, in the nymphal stage. No attempt is made to distinguish the imagoes, as too few are known fully in that stage.

Key to *Rhithrogena* nymphs—N. C. species

1. Tergites 1-8 pale yellow, unmarked.....sp. No. 1
Tergites 1-8 not entirely pale, usually central and apical ones darker..... 2
2. Tergites 7-9 yellow, contrasting sharply with central and apical dark tergites..3
Tergites 7-9 not differing markedly in color from central tergites although usually somewhat lighter.....4

3. Tergites 1-6, and basal half of 7, dark reddish brown. Middle portion of head dark brown.....*fuscifrons*
 Tergites 1 and 2 pale yellow, 3-6 dark reddish brown, 7 wholly pale. Middle of head yellow, or shaded with very light brown.....*exilis*
4. Dorsum of abdomen light chestnut or cinnamon brown.....*uhari*
 Dorsum of abdomen orange or orange brown.....5
5. Tergites 4-8 dark brown basally, with pale posterior margins, thus appearing to be banded.....*fasciata*
 Tergites of 4-7 entirely dark brown; 8 and 9 yellowish brown, with yellow subdorsal marks. Do not appear to be banded.....sp. No. 2

From the piedmont area

Rhithrogena uhari, sp. nov.

This species was found only in the piedmont, in Caraway Creek. This stream, which is a tributary of the Uharie River, flows through the Uharie Mountains. Collections were made not far from the small town of Sophia, in April and May of 1929 and 1930.

Nymph

Size—Body of male nymph, 5-6 mm.; of female 6-7 mm. Tails 4 mm.

General color—In life, light chestnut to cinnamon brown dorsally, without conspicuous markings. Gills forming a prominent grey fringe around the abdomen.

Head—Ocelli black-ringed, eyes black. A light area near each ocellus. Antennae yellowish. Indistinct light transverse bar near center of vertex. Seven pectinate spines on crown of maxilla.

Thorax—Indistinct brownish scroll-like markings on pronotum, and a more or less distinct dark transverse band near center. Very faint markings on mesonotum. Anterior margin of mesonotum, and a small spot at each side of median line, dark brown. Ventrally pale whitish.

Legs—Pale yellowish white. Femora faintly washed with brown; usually not banded nor barred. Very faint round purplish spot near center of each femur, and numerous small brown spines on upper surface. Tarsus yellowish brown at each end. All joinings dark brown.

Abdomen—Each tergite very narrowly brown on both anterior and posterior margins. In general, uniformly chestnut brown in color. Faint traces of an oblique light mark on each side of median line at anterior margin, and of a small light spot on each side of median line near center of tergite. Tergite 10 often slightly darker than others.

(One specimen has tergites 8 and 9 yellowish.) Ventrally, pale yellowish white.

Gills—Light grey. Filaments same color.

Tails—Pale yellow.

Female imago

Size—Body 6 mm.; forewing 7 mm.; tails 8 mm.

General color—Pale yellowish; the anterior abdominal tergites banded with purplish.

Head—Black mark below each antenna. Base of antenna white. Basal portion of filament dark, remainder light brown. Faint brownish markings above frontal margin.

Thorax—Pronotum and mesonotum pale yellowish. Small dark spot near center of lateral margin of pronotum. Faint purplish shadings near wing roots, on mesonotum. Brown shading on each side of mesonotal spine. Metanotum yellowish brown, darker posteriorly. Pleura paler than notum. Purplish marks below each wing root, and faint dark lines above middle and hind legs. Ventrally pale, the mesosternum washed with yellow.

Legs—Pale whitish. Small round black spot at center of each femur. Tarsi somewhat smoky, with black spot dorsally at each joining. Claws black at base and tip, and narrowly along upper margin.

Wings—Semi-hyaline, whitish (tending to look distinctly milky). Pterostigmatic area with milky cloud. All veins white.

Abdomen—Dorsally light yellowish brown. Tergites 1-5 with purplish posterior margins. Tergites 6-10 more washed with yellow, not banded. Pleural fold whitish. Ventrally pale yellow, unmarked. Apical extension of 9th sternite very slightly emarginate at center.

Tails—Pale yellow, unmarked. Joinings opaque.

Holotype—Female imago, reared. Caraway Creek, the Uharie Mountains, N. C., May 13, 1929. No. 1118.1 in Cornell collection.

Paratypes—Female subimago, reared. Same data. 20 nymphs, same location, April 20, 1929. No. 1118.3-23 in Cornell collection.

Nymphs that seem similar to those from Caraway Creek were collected near Hillsville, Va., on May 4, 1929. No others were found at any other station in North Carolina.

From the mountain region

Rhithrogena exilis, sp. nov.

Nymph

Size—Body of male nymph, $4\frac{1}{2}$ –5 mm.; of female, 5–6 mm. Tails 4 mm.

General color—Pale yellow with dark brown markings and bands.

Head—Frontal and lateral margins pale whitish. Central area between eyes yellow. In a few specimens, head shaded with light brown. Antennae very pale yellow. Lateral ocelli long, roughly comma-shaped. Nine pectinate spines on crown of maxilla.

Thorax—Pronotum deeply emarginate on posterior margin. Dark brown, with few scroll-like yellow markings. Meso- and metanota, and wing cases, yellow. Faint brown marks on each side of median line, on anterior margin of mesonotum. Few faint irregular brown marks anterior to wing roots, and at joinings of wing-cases to one another. Ventrally pale yellowish white.

Legs—Pale yellowish white, marked with dark brown. Each femur has customary dark median spot, and two wide dark brown transverse bands, one near each end. Spines on upper surface also dark brown. Tibia and tarsus rather smoky, the tarsus somewhat darker. Basal end of tibia dark.

Abdomen—Tergites 1 and 2 pale yellow, unmarked. Tergites 3–6 dark reddish brown, unmarked; lateral extensions yellow. Tergites 7–9 yellow, unmarked. Tergite 10 brown in apical half. Ventrally, sternites 1 and 2 pale; 3–6 light brown; 7–9 pale, the latter tinged with yellowish brown apically. Some nymphs have brown marks at anterior margins of central segments, and posterior margins narrowly dark.

Gills—White or very pale grey. Filaments light purplish grey.

Tails—Pale yellow. Narrowly light brown at joinings.

Female imago

Size—Body 6 mm.; forewing 7 mm.; tails broken.

General color—Body yellow. Abdomen tinged with pink.

Head—Black half-ring at base of each antenna. Black spot on each side, underneath clypeus.

Thorax—Purplish black irregular mark laterally on pronotum. Faint darker markings on pleura. Ventrally unmarked.

Legs—Purplish black median mark on each femur. No other markings.

Wings—Semi-hyaline. Cross veins of stigmatic area show some anastomosis, as is usual. Veins colorless.

Abdomen—Posterior margins of tergites 2-4 narrowly dull purple. Segments 2-6 flushed with ink or orange. Venter pale, unmarked.

Tails—White, unmarked.

Male subimago

General color—Orange-brown.

Head—Marked as in female.

Thorax—Dark brown comma-shaped mark on each side of mesonotum, just anterior to spine. Brown lines run forward from these marks. Pleura with dark marks above each leg. Mesosternum margined with dark brown.

Legs—Dark mark on each coxa, and at each joining of foreleg, as well as median femoral mark.

Abdomen—Dark orange-brown, the posterior half of each tergite somewhat darker.

Wings and tails dark smoky brown. Genitalia not sufficiently developed to be certain of their form.

Holotype—Female nymph. North Fork of Swannanoa River, N. C., June 14, 1929. No. 1119.1 in Cornell collection.

Paratypes—Female imago, reared. Flat Creek, at Black Mountain, N. C., June 13, 1930; 3 female subimagoes, reared, same location June 22-24, 1930; male subimago, reared, same location, June 20, 1929; 20 nymphs, same location, June 17, 1930. Nos. 1119.3-27 in Cornell collection.

A nymph which seems similar to those taken at the above stations was found in the Cullasaja River near Franklin, N. C., on July 3, 1929.

Rhithrogena fuscifrons, sp. nov.

Nymph

Size—Body 5-5½ mm.; tails 6 mm.

General color—Very similar to preceding species. Reddish brown patch in center of head.

Head—Dark reddish brown in central portion, from ocelli to front margin, and on vertex. Lighter brown between vertex and ocelli. Lateral areas, anterior to compound eyes, pale yellowish white. Lateral ocelli V-shaped; the arms of the V black, the space between them dark grey. Antennae pale. 8-9 pectinate spines on crown of maxilla.

Thorax—Dorsally yellowish brown with dark brown markings on each side of pronotum, between wing bases and anterior to wing roots. Pronotum deeply emarginate on posterior border. Wing buds orange brown. Ventrally pale yellowish white. In some nymphs, the general dorsal color is somewhat darker brown.

Legs—Pale yellowish. Coxae brown. Femora with usual purplish median spot, rather small. Fore margin of femur brown, and brown band near apical end. More or less shaded with brown in basal half and sometimes along hind margin. Spines brown, not present on apical half. Tibia pale. Tarsus pale smoky.

Abdomen—Segments 1-6, and basal half of 7, dark reddish brown; paler ventrally. Apical half of 7, and 8-10, yellow. In some specimens, apical half of 10 tinged with light brown. Lateral extension orange-brown.

Gills—White. Filaments light purplish grey.

Tails—Yellowish, narrowly dark brown at joinings.

Female imago

Size—Body 5 mm.; forewing $7\frac{1}{2}$ mm.; tails 8 mm.

General color—Light orange-brown.

Head—Small black spot at base of each antenna. Posterior margin of head brown. Antennae dark brown basally, the tips lighter.

Thorax—Posterior margin of pronotum, and its lateral areas, tinged with purplish. Spines of meso- and metanota, and lateral margins of these spines, tinged with purplish. Pleura paler with a few purplish marks, and a dark streak above the fore and middle legs. Pale ventrally, the posterior portion of the mesosternum as dark as the notum.

Legs—Yellowish, the tibiae and tarsi somewhat smoky. Usual dark purple mark near center of each femur. All joinings dark brown.

Wings—Semi-hyaline. Veins pale yellow, cross veins faint.

Abdomen—Tinged with purplish brown dorsally, darker on tergites 2-6. Posterior margin of tergites very narrowly dark purplish. Pale ventrally.

Tails—Pale whitish. Joinings very narrowly dark.

Holotype—Female nymph. Tributary of Pigeon River, four miles west of Hazelwood, N. C., July 21, 1930. No. 1120.1 in Cornell collection.

Paratypes—Eight nymphs. Same data as holotype; Rocky Broad River at Bat Cave, N. C.; tributary of the Ocona Lufty River, July 12, 1929; tributary of the Cullasaja River near Franklin, N. C., June 24, 1929. No. 1120.3-10.

Immature nymphs were also taken from the Ocona Lufty River on June 22, 1930, and from the Cullasaja River on July 3, 1929.

I had at first taken this species to be identical with the preceding one. But the quite constant color differences, as well as the difference in the time of maturing, lead me to believe that this species is distinct.

Rhithrogena fasciata, sp. nov.

Nymph

Size—Body $5\frac{1}{2}$ –7 mm.; tails 5–7 mm.

General color—Orange, marked with dark brown. In life, appears orange and black.

Head—Dark orange-brown, laterally somewhat lighter orange. Four small white spots on vertex, much as in sp. No. 2. Antennae light brown, 10 pectinate spines on crown of maxilla.

Thorax—Pronotum very deeply emarginate on posterior margin. Pronotum shaded with orange. Remainder of notum rather smoky brown. Irregular lighter marks, also darker brown ones, on pro- and mesonota. Ventrally, pale yellowish. Narrow black transverse bar on mesosternum.

Legs—Pale yellowish white. Femora marked with light brown; darker at apex. Tibiae whitish. Tarsi slightly smoky.

Abdomen—Reddish brown marked with yellow. Lateral extensions dark brown. Large yellow area next to dark margin, bounded on inner side by another dark streak. Triangular brown lateral areas on each tergite, extending inward to median line on tergites 1–3. Tergites 4 and 7 dark brown in basal two-thirds, yellow apically. Tergites 5 and 6 all brown except narrow yellow dorsal line and narrow posterior margin. Anterior tergites thus appear to be banded, 8 and 9 yellow except for narrow dark band on anterior margin; 10 dark brown, with narrow yellow anterior margin. Ventrally, light yellowish brown. Each sternite narrowly dark brown on posterior margin. Traces of lateral and oblique subventral lighter streaks on each sternite.

Gills and filaments silver-white.

Tails—Yellowish white. Joinings narrowly dark brown.

Male imago

Size—Body 6 mm.; forewing 6 mm.; tails 10 mm.

General color—Pale yellowish.

Head—Pale yellow. Edge of clypeus colorless, transparent. Small

black spot at base of antenna. Small black spot beneath clypeus on each side. Purplish area around base of antenna. Base of antenna white. Filament smoky, tip white.

Thorax—Pronotum deeply emarginate posteriorly. Yellowish orange in color. Mesonotum pale yellow. Brown area on each side of mesonotal spine. Metanotum brown. Pleura pale with ochreous markings. Venter pale ochreous, the posterior half of the mesosternum distinctly tinged with brown.

Legs—Yellowish brown, femora deeper brown. Round purplish spot at center of each femur; not elongate (thus resembling *anomala* McD.). All joinings narrowly dark purplish.

Wings—Semi-hyaline. Longitudinal veins yellowish to yellowish brown; cross veins colorless. Cross veins in stigmatic area show some anastomosis.

Abdomen—Pale smoky, with ochreous tinge on some segments. Segments 1 and 2 pale, very faintly smoky. Segments 3-6 deeper smoky, with definite lavender tinge. Posterior margins of all tergites dull pale lavender, thus giving a banded appearance. Indistinct lighter subdorsal dashes and a light median line on tergites 2-7. Segments 7-10 tinged with pale ochreous. Paler ventrally. Ganglionic area colorless; banding not apparent.

Genitalia—Pale brown in color. In form, quite close to *anomala* McD., but differing in minor details. See Fig. 5.

Tails—Whitish; unmarked.

Holotype—Male imago. Waynesville, N. C., July 17, 1929. No. 1121.1 in Cornell collection.

Paratypes—Four male subimagoes, reared. Same location, July 16, 1929; and 12 nymphs, same data. No. 1121.3-18.

This species was found also at Flat Creek near Black Mountain; in the Cullasaja River; in Bald Creek, west of Burnsville; and in a tributary of the Rocky Broad River near Bat Cave.

Rhithrogena sp. No. 1

Nymph

Size—Body 5 mm.; tails 4 mm. (immature nymph).

General color—Pale yellow with dorsum of thorax and tergites 9 and 10 dark brown.

Head—Pale, except posterior margin of vertex and posterior portion of lateral margins, which are brown. Ocelli as in *fuscifrons*. Antennae pale. 7-8 pectinate spines on crown of maxilla.

Thorax—Brown dorsally, unmarked. Ventrally pale greyish. Pronotum very slightly emarginate on posterior border; much less deeply cut than in *exilis* or *fuscifrons*.

Legs—Pale. Usual small purplish spot on femora I and II; absent or very indistinct on femur III. Femora faintly brown apically. Narrow black line near basal end of tibia. Small brown spines present on basal half of femur.

Abdomen—Segments 1-8 pale yellow; 9 and 10 dark brown.

Gills—White. Filaments very pale grey.

Tails—White. Joinings very narrowly yellowish brown.

I have only nymphs of this species, and these not yet fully mature. It is much less common than any of the preceding species. Nymphs were found in the Ocona Lufty River on July 12, 1929; in a tributary of the Davidson River, July 9, 1929; and in the Laurel River near Hot Springs on June 29, 1930. In each case, only one or two nymphs were seen.

Rhithrogena sp. No. 2

Nymph

Size—Body 7 mm.; tails broken.

General color—In life, bright orange dorsally. Alcoholic specimens orange-brown.

Head—Dark orange-brown. Four small white spots on vertex, two on each side of center. Anterior pair wider apart than others. White line from corner of compound eye to outer margin of head. Antennae light brown.

Thorax—Pronotum rather deeply emarginate on posterior margin. Orange-brown dorsally. Few scroll-like brown markings on pronotum, and on mesonotum between wing buds. Dark brown transverse band across center of pronotum. Anterior margin of mesonotum dark brown, also dark brown at wing joinings. Ventrally pale.

Legs—Femora brown, with prominent white longitudinal streak, near apical end of which is the usual purplish spot. Brown spines present in basal half. Apical end of each femur darker brown. Tibiae much paler, rather smoky brown, with narrow dark band near basal end. Tarsi and claws similar in color to femora.

Abdomen—Orange brown dorsally, the lateral extensions paler brown. Tergites 4-7, and 10 except at base near median line, darker brown than others. Tergites 8 and 9 yellowish brown, each with two yellow subdorsal streaks. Faint indications of these streaks occur on 4-7. Ventrally pale brown, sternite 9 darker. Posterior margins of sternites narrowly dark brown. Traces of pale lateral lines and oblique subventral dashes.

Gills—Greyish, with faint lavender tinge at base. Filaments purplish grey.

Tails—Yellowish brown, joinings narrowly dark brown.

Nymphs of this species were taken from the Rocky Broad River at Lecky Gap on June 23, 1930. A quite similar nymph, probably of the same species, was found in the Laurel River on June 29, 1930. No adults of this species were obtained. The species is not common, only a few nymphs being found in each location named.

Genus STENONEMA,* gen. nov.

Of all the Heptagenine mayflies of the state, the members of this genus were by far the most common. In numbers of species found, it also exceeds all others in this group. Representatives of the genus were taken in each of the three regions of the state, and many species were reared from the nymphs. My collection from North Carolina includes 16 species, distributed as follows: from the coastal plain, 2 species; from the piedmont, 9 species; and from the mountains, 9 species.

As stated in my paper on the Heptageninae of North America, the species of this group appear to fall into three distinct groups. These groups I have termed the *interpunctatum* group, the *vicarium* group, and the *tripunctatum* group. At the time of writing the above-mentioned Heptageninae paper, the nymph of *carolina* was not known to me. Recently I have reared this species from nymphs taken in the vicinity of Ithaca, N. Y. This nymph is so similar in structural details to those of the *interpunctatum* group that I do not now consider this species as

* The word *Stenonema* is neuter gender. It has reference to the thread-like character of the 7th gill of the nymph. The genus includes those North American species formerly placed in *Ecdyonurus*.

In the male imago, the first fore tarsal joint is $\frac{1}{3}$ to $\frac{2}{3}$ the length of the second. Genitalia somewhat resemble those of species of the European genus *Ecdyonurus*. Cross veins of the stigmatic area of the fore wing are not anastomosed, thus differing from *Ecdyonurus*. The seventh gill of the nymph is a slender tapered thread or filament.

I designate *tripunctatum* Bks. as the type of the genus.

representing a fourth group within the genus, a possibility I had suggested because of the genitalic differences of the male.

There are, however, good grounds for the belief that the *interpunctatum* group is quite widely remote from the other two groups, which are rather closely related. When Eaton figured the nymphs of this genus in the Revisional Monograph, he placed the nymph of the *interpunctatum* group (Pl. 57) in a separate genus from the nymph of the *vicarium* group (Pl. 58). It is quite possible that further study of this difficult but interesting genus will show that the *interpunctatum* group is indeed worthy of generic rank apart from the *vicarium-tripunctatum* groups. For the present, I leave all these three groups in the one genus.

The *interpunctatum* group may be subdivided into (1) species related to *interpunctatum* and *frontalis*, and (2) into species allied to *carolina*. The *vicarium* group, likewise, may be subdivided into (1) those species resembling *vicarium* and *pubicum*, and (2) those related to *pulchellum*, *terminatum*, and *integer*. If I am correct in the belief that *luteum* Clem. is a member of the *tripunctatum* group, that group will also show two divisions: (1) the species allied to *tripunctatum*, and (2) those allied to *luteum*.

The characters of these groups and their subdivisions may be summarized as follows:

I. *Tripunctatum* group (*tripunctatum* Bks., *femoratum* Say, probably also *luteum* Clem. and perhaps *medio-punctatum* McD.).

Nymphs—Claws with two pectinations. Gill of 7th pair with trachea present, its outer margin hairy. Gills 1-6 rounded at tip. Spines on abdominal segments 5 and 6 about equal in length to that on 7. Spine on segment 9 equal to or longer than that on 7.

Imagoes—Genitalia of the *tripunctatum* type (see Fig. 14). Many cross veins of the fore wing often heavily infuscated, especially at and below the bulla. At bulla, cross veins of costal, subcostal, and radial spaces closely crowded together, some often rather oblique. Hind wing dark-bordered, in first two species. In male foretarsus, 1st joint equals 5th, 1st is one-half or more of 2nd, 3rd slightly longer than 2nd, 4th equals 2nd.

II. *Vicarium* group.

A. *Vicarium* division (*vicarium* Wlk., *pubicum* Hagen, *fuscum* Clem., *ithaca* Clem. and Leon.).

Nymphs—Claws without pectinations. No trachea in gill of 7th pair, its margin very hairy. Gills 1-6 oblong or truncate at tip. Spines on abdominal segments 5 and 6, if present, very short—always shorter than that on 7. Spine 9 variable in length in relation to that on 7.

Imagoes—Genitalia of the *pudicum* or *vicarium* type (see Fig. 12). Few to many cross veins in fore wing infuscated, usually most at and below bulla. Cross veins of first three or more spaces crowded together at bulla. Hind wing may be dark-bordered. Venter of abdomen may be marked. In male foretarsus, 1st joint equals 5th, 1st equals $\frac{1}{2}$ of 2nd, 3rd equals 2nd, 4th about $\frac{2}{3}$ of 3rd.

B. *Pulchellum* division (*pulchellum* Wlsh., *ruber* McD., *bipunctatum* McD., *terminatum* Wlsh., *placitum* Bks., *rubromaculatum* Clem., *varium* n. sp., *annexum* n. sp., *exiguum* n. sp., *bellum* n. sp., and perhaps *subaequalis* Bks.

Nymphs—Claws with two pectinations. Spine of segment 9 equal to, or shorter than, that on 7. Otherwise similar to nymphs of *vicarium* group.

Imagoes—Genitalia of *pulchellum* or *terminatum* type (see Figs. 16 and 4). Only a few veins, or none, in fore wing, infuscated, not noticeably more so at bulla than elsewhere. No crowding of cross veins at bulla. Foretarsus of male similar to that of *vicarium* group, except that 1st joint may be $\frac{1}{3}$ to $\frac{1}{2}$ of 2nd, or more than $\frac{1}{2}$ of 2nd, and 4th may be $\frac{3}{4}$ of 3rd. In *integer* and *exiguum*, hind wing is narrowly dark-bordered. Genitalia of *pulchellum*, *ruber*, *annexum*, *varium*, and *rubromaculatum* are of the *pulchellum* type; other species have genitalia of the *terminatum* type.

III. *Interpunctatum* group.

A. *Interpunctatum* division (*interpunctatum* Say, *canadensis* Wlk., *frontalis* Bks., *affine* n. sp., *pallidum* n. sp.)

Nymphs—Claws without pectinations. Trachea present in gill of 7th pair, apparently not forked. Fine hairs on margin of 7th gill. Gills 1-6 pointed at tip. No spines on abdominal segments 1-6. Spine on segment 9 longer than that on 7 which is very short.

Imagoes—Genitalia of the *interpunctatum* type (see Fig. 3). Several cross veins in basal portion of costal, subcostal and radial spaces thickened at center, or in costal space, near costal margin. At bulla, these margined cross veins fully or almost connected by black transverse dash.

Intercalaries in 3rd or 4th space at apical margin may be thickened. Hind wing always dark on outer margin, marginal intercalaries usually black. In male foretarsus, 1st joint equal to or longer than 5th; 1st joint $\frac{1}{3}$, $\frac{1}{2}$ or more than $\frac{1}{2}$ of 2nd; 2nd and 3rd about equal; 4th a little more than $\frac{1}{2}$ of 3rd.

B. *Carolina division* (*carolina* Bks.)

Nymphs—Trachea in 7th gill forked at base, thus giving appearance of two longitudinal tracheae. Otherwise similar to nymphs of preceding group.

Imagoes—Genitalia of the *carolina* type (see Fig. 2). No black transverse bar connecting margined cross veins at bulla. A few basal cross veins of costal and radial spaces thickened, those in costal space always thicker at costal margin. In male foretarsus, 1st joint somewhat longer than 5th; 1st equals $\frac{1}{2}$ of 2nd; 4th a little more than $\frac{1}{2}$ of 3rd and about equal to 1st.

Subaequalis Bks. is known to me only by the published description. I am unable to find among my North Carolina material any specimen which meets all the specifications for this species. Because of points mentioned in the original description, the species would seem to be of the *pulchellum* group, although differing from others of that group in the relative lengths of the joints of the male foretarsus.

Specimens in the Cornell University collection which seem to fit descriptions of *luteum* Clem., *mediopunctatum* McD., and *rubromaculatum* Clem. indicate that the first two species are members of the *tripunctatum* group, while the third species is of the *pulchellum* division. Since, however, I have not seen type material of any of these three species, my tentative identifications may be in error.

Key to male imagoes, genus Stenomema—North Carolina species

1. Cross veins in costal and radial spaces, before and at bulla, thickened at center (or in costal space near costal margin) by black marginings. 2
Cross veins in these spaces, if margined, are thickened equally along entire length. 6
2. Radial cross veins at bulla connected along center line by a continuous black streak; spinous processes present on outer lateral margins of penes. 3
Black marginings along center of radial cross veins at bulla very thick and prominent, but not connected to form a continuous line; no spinous processes on outer lateral margins of penes. *carolina*
3. Prominent black longitudinal streak on each side of pronotum. 4
No such black lateral streak on pronotum. *affine*

4. Black mark of dash present under antenna..... 5
 No dark mark under antenna..... sp. No. 2
5. Median band present on hind femur—no thickening of 3rd and 4th intercalaries at apex of forewing..... *pallidum*
 Median band not present on hind femur—3rd and 4th intercalaries at apex of forewing thickened..... *interpunctatum*
6. Cross veins in three or more spaces at bulla crowded together and heavily infuscated..... 7
 Cross veins not more crowded at bulla than elsewhere, and not infuscated... 9
7. Cross veins in seven spaces at and below bulla crowded together, widely infuscated, and more or less connected by a zigzag brown cloud; hind wing widely darkened on outer apical margin..... *pubidum*
 Cross veins at bulla crowded and infuscated in first three spaces only, not connected by a brown cloud; hind wing may or may not be somewhat darkened on outer apical margin..... 8
8. Posterior half to two-thirds of abdominal tergites 1-7 largely dark brown; sternites marked with dark transverse bands; hind wings not darkened on outer margin..... *vicarium*
 Abdomen largely white, with a median row of dark spots on posterior margin of tergites; sternites unmarked; hind wings may be faintly darkened on outer margin..... *tripunctatum*
9. Hind wing darkened on outer margin, especially near apex; small species, wing under 7 mm.; tails not marked..... *exiguum*
 Hind wing not darkened on outer margin; species varying in size; tails distinctly ringed at joinings..... 10
10. Abdominal tergites largely reddish or purplish brown..... *ithaca*
 Abdominal tergites largely pale..... 11
11. Small species, wing under 9 mm..... 12
 Larger species, wing 10 mm. or over..... 13
12. Thorax wholly pale; oblique dark streak at stigma of each abdominal segment..... *bellum*
 Thorax reddish brown dorsally; stigmatic dots (not streak) present on segments 3-6..... *ruber*
13. Red stigmatic stain present in forewing; dark posterior margins of tergites widest at mid-dorsal line..... *annexum*
 No red stigmatic stain in forewing; dark posterior margins of tergites even in width..... *varium*

Key to Stenonema nymphs—North Carolina species

1. Gills 1-6 pointed at tip; spines present on posterolateral angles of abdominal segments 7-9 only..... 2
 Gills 1-6 rounded or truncate at tip; spines present on posterolateral angles of abdominal segments 5-9..... 6
2. Wide pale submedian longitudinal streaks on dorsum of abdomen..... 3
 Dorsum of abdomen unicolorous except for very narrow pale submedian pencillings..... 5
3. Large nymphs, 9-11 mm. in length; yellowish brown or grey in color, the dorsal abdominal markings yellow..... *carolina*

- Smaller nymphs, about 7 mm. in length; reddish brown in color, the abdominal markings whitish. 4
4. Only two pale longitudinal streaks on dorsum of abdomen. sp. No. 2
Two wide submedian and two narrower lateral pale streaks on dorsum of abdomen. *affine*
5. Nymphs 9-11 mm. in length. sp. No. 1
Nymphs smaller, 6-7 mm. in length. *pallidum*
6. Gills 1-6 rounded at tip; trachea present in 7th gill. *tripunctatum*
Gills 1-6 truncate at tip; no trachea present in 7th gills. 7
7. Claws with two pectinations. 8
Claws not pectinate. 10
8. Large stout nymphs, 10½ mm. or more in length. 9
Smaller nymphs, under 10 mm in length. *ruber*
9. Abdomen dark reddish brown dorsally, with conspicuous pale lateral patches on middle segments; venter usually unmarked, except for lateral streaks on 9. *annexum*
Abdominal tergites 6 and 10 largely dark, others with many pale markings; conspicuous black markings usually present on sternites 8 and 9. *varium*
10. Abdominal segments with conspicuous wide black posterior border, extending completely around each segment. *vicarium*
No such continuous black border on abdominal segments. 11
11. Nymphs usually not over 10 mm. in length. Conspicuous black crescentic markings on sternites 4-9; tergites 6, and 8-10, largely dark, others with many pale markings. *ithaca*
Larger nymphs, 12 mm. or more in length. Ventral markings inconspicuous; tergites dark reddish brown, none conspicuously darker than others. 12
12. No conspicuous white markings on abdominal tergites; white bands on femora discontinuous. *pudicum*
Conspicuous white V-shaped markings at median line of tergites 5, 7, 8 and 10; femora with continuous white transverse bands at center and near distal end. sp. No. 3

From the coastal plain

Stenonema interpunctatum Say ?

These specimens are larger than indicated for *interpunctatum* in Say's original description, and vary somewhat in marking from those which I am considering closest to the true *interpunctatum*. However, as I do not yet know how much variation, both in size and coloration, may occur in this species, I place these specimens tentatively in *interpunctatum*. Males of this species measure 8½ to 9 mm.; wing same; tails 26 mm. Vertex of head reddish yellow, marked with black on median line, and with a dark spot on each side. Black spot at center of median carina; a black dash below the antenna; very small black spot at lower corner of each eye. Bar in wing continuous over 2 or 3 cross

veins (except in one specimen, where the bar is absent). Fourth intercalary in apical margin somewhat thickened. Tails indistinctly banded with pale brown at joinings. No stigmatic dots. Other characters as indicated in Say's description. Genitalia shown in Fig. 3.

These specimens were taken in flight by Prof. Needham on April 11, 1929; several individuals were captured from Goshen Swamp in Duplin County and others from Chicod Swamp in Pitt County.

Stenonema annexum, sp. nov.

Somewhat resembles *rubromaculatum* Clem.; in abdominal markings, much like *mediopunctatum* Md. Distinguished from the latter by the type of genitalia, the distinctly banded tails, the pale thorax, in details of color of legs and wings, and in having fewer cross veins in wings. Somewhat larger than *rubromaculatum*. The description of that species is too inadequate, however, to be certain whether or not this species is synonymous with it.

Size—Body of male imago, $8\frac{1}{2}$ –9 mm.; wing 10–11 mm.; tails 22–27 mm. Body of female, $8\frac{1}{2}$ –10 mm., wing 11–13; tails 17.

Male imago

Head and thorax pale brownish to clay-colored. Abdomen hyaline whitish except last three segments, which are opaque and tinged with yellow. Reddish stigmatic area.

Head—Indistinct narrow dark line across center of median carina (not present on one specimen). Vertex dull purplish brown, often with a dark brown spot on each side. Antennæ faintly dusky.

Thorax—Geminate dark purplish brown median line on pronotum. Fore and hind margins narrowly purplish black. Purple streak on pleura, extending down on base of foreleg. Ochreous markings on pleura. Wide median whitish band on mesonotum, including scutellum. Dark brown lateral shading on metanotum. Dark brown patch on fore coxa; another wide oblique brown streak just back of foreleg.

Legs—Fore femur dusky, tinged distinctly with yellow. Other legs yellowish white. All femora with median and apical purplish bands. Fore tibia widely black at apex, others narrowly ringed with black apically. All tarsal joinings narrowly yellowish brown. Claws dark brown basally. First foretarsal joint about $\frac{1}{2}$ the length of the second (not more than $\frac{1}{2}$ its length).

Wings—Hyaline, iridescent. Longitudinal veins yellowish, especially

those on the costal border. Cross veins thicker than longitudinal; dark reddish brown in color. Humeral cross vein particularly thickened. 5-6 costal cross veins before the bulla, about 11 beyond. At bulla, 2 cross veins in costal space, 2 or 3 in subcostal space. Stigmatic area with reddish stain in most specimens. Veins of hind wing almost colorless.

Abdomen—Distinct stigmatic dots present on tergites 2-8 (less prominent on 2 and 8). Tergites 1-6 with very narrow dark posterior margins, thickest at the median line, thus giving the appearance of dark transverse median dorsal marks. These most prominent on tergites 3-6. Venter pale, unmarked.

Genitalia—See Fig. 16.

Tails—White. Alternate segments narrowly ringed with purplish black, except at base, where the first 6 or 7 segments are often not marked.

Female imago

In general, similar to male, except for usual differences of sex. Posterior margins of tergites somewhat more distinctly and regularly dark than in male.

Nymph

Size—Body (female) $10\frac{1}{2}$ – $11\frac{1}{2}$ mm.; tails 17–18 mm.

General appearance—Dark reddish brown dorsally; legs and tails distinctly lighter in color than body. Head and abdomen with numerous tiny light dots on dark areas.

Head—Frontal area dark reddish brown; margin fringed with hairs. Lateral margins colorless except for a narrow dark band from eye to outer margin. Vertex and occiput lighter brown, with white areas next to eyes, and a large whitish diamond-shaped area at center.

Thorax—Two dark brown longitudinal bands on each side of pronotum. One extends obliquely forward on each side of median line. The other and outer band, quite irregular in outline, lies near the outer margin and extends forward so that its anterior end almost touches the inner band. Lateral margin pale yellowish. White blotches laterad of the outer dark band, and between the two dark bands. A few small light marks near wing bases, on mesonotum.

Legs—Pale yellowish. Femora with 3 irregular dark brown transverse bands and a small dark spot near center of band nearest base of leg. Two dark bands on each tibia. Tarsi light brown in basal half. Tips of claws brown. Claws with 2 small pectinations.

Abdomen—Dark reddish brown dorsally; tiny dots most numerous on lateral areas. Dark median stripe extends length of dorsum. Tergites 2-7 have a blackish spot on each side, half-way to lateral margins, and posterior to the middle of each tergite. Anterior to this dark spot is a large white area, bounded by dark brown, extending forward and outward. Thus the sides of the tergites next to the gills appear white-blotched, with dark dots below. Anterior margins of 4-5 and 8-10, irregularly and narrowly white. Lighter area on each side of dark median line on tergites 4-5 and 7-9. Short lateral spines on 7-9; the spine on 9 shorter than on 8. Ventrally pale yellowish red. One specimen shows faint lateral brown streaks on each sternite, faint dark median marks at anterior margin of each, and an oblique brown mark on each side of 9. All other nymphs are unmarked ventrally.

Gills—Light greyish purple. Thread-like seventh gill unusually long and slender.

Tails—Pale greenish yellow; in mature nymph, shaded basally with light brown.

Holotype—Male imago. Goshen Swamp, N. C., April 11, 1929.

Collector, Prof. J. G. Needham. No. 1122.1 in Cornell University collection.

Allotype—Female imago. Same data. No. 1122.2 in Cornell collection.

Paratypes—3 male imagoes, 9 female imagoes; 2 male sub-imagoes, 3 female subimagoes. Goshen Swamp and Chicod Swamp, April 11, 1929. Same collector. No. 1122.3-19 in Cornell collection.

Included among the paratypes are a male and female imago, slightly smaller and paler than the others, and in which the stigmatic area is opaque whitish with no trace of red. In other details they are similar to the remainder of the paratypes. Nymphs were collected from several small tributaries of the Cape Fear River near the little village of Buies Creek, and from tributaries of the Neuse River near Ft. Barnwell, in April 1930. Two female imagoes reared from these nymphs seem similar to those from Goshen and Chicod Swamps.

From the piedmont

Stenonema pallidum, sp. nov.

A small slender species from the Cascades, near Danbury. Nymphs were collected on May 12, 1929, and on May 18, 1930. Several imagoes of both sexes were reared. This species is close to the one I am calling

interpunctatum Say, but is considerably paler, and the third femur has a distant median band.

Male imago

Size—Body $6\frac{1}{2}$ –7 mm.; wings $7\frac{1}{2}$ –8; tails 20–22 mm.

Head—Pale yellowish. Black dash below each antenna. Small reddish spot in center of vertex. Base of antenna white. Basal portion of filament faintly dusky, tip pale.

Thorax—Notum pale, yellow to yellowish brown. Pleura slightly deeper yellowish. Black longitudinal stripe on each side of pronotum. No other markings. Yellowish ventrally, with deeper orange area at each side near base of third leg.

Legs—Yellowish white. Fore femur yellowish brown with conspicuous purplish black median and apical marks. Similar but paler marks on 2nd and 3rd femur. Fore tibia purplish black at apex. Joinings of fore tarsus very faintly brownish, as is apex of last tarsal joint of other legs. One claw brownish, on all legs. Fore leg about as long as body.

Wings—Hyaline, iridescent. Basal cross veins of costal, subcostal, and radial spaces, and a few beyond bulla in same spaces, black and thickened. Other cross veins rather dark brown, those in basal half of wing rather pale. Dark dash in wing short, dumb-bell-shaped, including one or two cross veins. Fourth apical intercalary narrowly darker than others. 4 to 5 cross veins in costal space, before bulla; 2 oblique ones at bulla, and about 12 beyond. The first two of these are widely separated. Outer intercalaries of hind wing dark.

Abdomen—Whitish. 1–7 semi-hyaline, 8–10 opaque, faintly yellowish dorsally. Each tergite rather widely margined posteriorly with purplish black. No stigmatic dots. Unmarked ventrally.

Genitalia—Very similar to those of the species I believe to be the true *interpunctatum* Say. A small protuberance on each side of the inner margin of the penes, present in all species of *Stenonema*, seems to be turned outward occasionally, as is the case in the specimens of this species.

Tails—Pale, unmarked.

Female imago

Size—Body 6– $7\frac{1}{2}$ mm.; wing 9–10; tails 17.

Cross veins of forewing somewhat darker and more prominent than in the male, especially in the basal half. Small black dot on face at lower

corner of each eye, as well as black dash below antenna. On vertex, a black spot on each side, in addition to central reddish dot. Otherwise similar to male.

Nymph

Size—Body 6–7 mm.; tails 10–11 mm.

General appearance—Slender light reddish brown nymph. Abdomen paler dorsally than head and thorax. Abdominal tergites narrowly dark-ringed. Median pale streak on dorsum of abdomen.

Head—Bright reddish brown, especially in central area anterior to ocelli. A narrow, light line from outer corner of eye to lateral margin; epicranial suture also narrowly white. Anterior to median ocellus a small white spot, and a somewhat larger one laterad of each lateral ocellus. Antennae pale brown.

Thorax—Notum bright reddish brown. Antero-lateral angles of pronotum pale, also one or two small spots on each side. Mesonotum also mottled with small light spots. In mature nymph, a black bar on each side of pronotum is evident. Median suture of mesonotum pale. Ventrally, pale yellowish. Narrow dark line at posterior margin of mesosternum; small brown spots at each side between 2nd and 3rd legs.

Legs—Yellow to pale yellowish brown. Femur with brown median band and darker apex. Tibia smoky, paler at each end. Tarsus dusky, apex pale. Claw dark-tipped.

Abdomen—Pale reddish brown dorsally. Each tergite narrowly purplish black on posterior margin. Central paler median streak, bounded on each side by a very narrow paler line, shaped thus: (). No other dorsal markings. Short postero-lateral spines on 8 and 9, about equal in length. Anterior segments pale laterally, beneath gills. Ventrally pale yellowish. Lateral margins of 7–9 pale brown; no other markings.

Gills—Dark greyish purple; tracheae distinctly dark purple.

Tails—Pale yellowish brown. Near base, short dark spines at every joining; beyond base, spines at every 2nd or 4th joining. No spines in distal half. In central part, alternate joinings narrowly darker.

Holotype—Male imago, reared. The Cascades, near Danbury, N. C.

May 21, 1929. No. 1123.1 in Cornell University collection.

Allotype—Female imago, reared. Same locality, May 21, 1930. No. 1123.2 in Cornell collection.

Paratypes—2 male imagoes; 1 female imago; 5 male sub-imagoes; 5 female sub-imagoes; 8 nymphs. Same locality, May and early June, 1929 and 1930. Nos. 1123.3-23. In Cornell collection.

Stenonema sp. No. 1.

Nymphs very similar in color pattern and general appearance to those of *S. pallidum*, but about $\frac{1}{3}$ longer, and relatively more slender, were taken at the Cascades in May, 1930. Females only were reared. These are very much like females of *S. pallidum*, but slightly larger, and with no black mark beneath the antennae. Cross veins of the wings are somewhat less numerous. Body of female imago, 10-11 mm.; wings 11 mm.; tails 25 mm. Nymphs measure 9-11 mm., tails 14 mm. In most of these nymphs, no dark posterior border is present on the tergites. In alcohol, they are pale reddish brown in color, but in life appeared much darker brown.

Stenonema affine, sp. nov.

A pale species, lacking the dark dash beneath the antennae and the dark stripe on the pronotum. No median band on femur of second leg.

Male imago

Size—Body 7-8 mm.; wing 8-9 mm.; tails 18 mm.

General appearance—Pale whitish, the thorax and tip of abdomen creamy yellow.

Head—Pale yellowish. No dark spot on face below antenna. Small dark spot at lower corner of each eye. No dark spot on median carina. Vertex with a small central reddish spot and two dark lateral dots. Antennae dusky.

Thorax—Entirely pale creamy yellow with faint pinkish tinge. No dark lateral streaks on pronotum. Some of the sutures of the notum and pleura are *very narrowly* darker.

Legs—Whitish, the fore leg tinged faintly with yellowish brown. Fore femur with median band and black marks at apex. Other femora lacking the median band, and the apical markings very faint. Apex of fore tibia, and last foretarsal joint, brown. Claws and tarsal joinings of all legs pale brown.

Wings—Semi-hyaline. Costal cross veins slightly thickened, especially toward the costa. 4 or 5 before the bulla, 13 or 14 beyond it;

of these, the first two are widely separated, the next five close together, the remainder more evenly spaced. 3 subcostal and 2 radial cross veins at bulla, the latter connected by the customary dark dash. Fourth intercalary on apical margin not thickened. All longitudinal veins pale. Cross veins brown, paler in basal half of wing.

Abdomen—Segments 1-8 semi-hyaline, white; 8-10 opaque, tinged with yellowish. Posterior margins of tergites narrowly purplish black. No stigmatic dots.

Genitalia—Differ but slightly from the coastal plain species.

Tails—White basally, the extreme distal portion very faintly smoky. Unmarked.

Female imago

Similar to male except for usual differences. Costal and radial cross veins before the bulla rather more widely margined than in the male. Body 7 mm.; wing 9 mm.; tails 12 mm. (may be broken at tip).

Nymph

Size—Body 7 mm.; tails 15 mm.

General appearance—Small slender nymph. Light reddish brown color, the head particularly reddish. Abdomen dorsally with 6 longitudinal white stripes.

Head—Bright red-brown. Anterior to median ocellus, a large white mark shaped like a mayfly's hypopharynx. Another large white mark laterad of each lateral ocellus. Lateral margins pale yellowish, with narrow central brown band. Small light dot on each side of frontal border. A median and two lateral light spots on occiput. Antennae pale brown.

Thorax—Wide pale mid-dorsal band the length of the thorax; widest at anterior margin of pronotum. Pronotum white on lateral margins except anterior angle, which is brown. Remainder of pronotum brown except for three parallel transverse white dashes on each side. Few small light marks on mesonotum near wing roots. Ventrally whitish, with transverse brown band across the mesosternum.

Legs—Pale brown. Femur pale yellowish at each end, and with a pale central band. Tibia white apically, and a white band near basal end. Apical half of tarsus white.

Abdomen—A wide longitudinal white band the length of the abdomen on each side of the brown median dorsal streak. These pale bands somewhat irregular, since the brown median streak is widest at center of

each tergite. A narrow light line on each side close to the lateral border, and between this and the central wide light bands, another narrow light line. Postero-lateral spines on 8 and 9, about equal in length. Ventrally yellow, prominently bordered and marked with reddish brown. Sternite 9 brown except a semi-circular area on anterior margin at median line, and a narrow light area on each side. Wide brown band extends longitudinally on each side of venter, its inner margin widest near center of each sternite. On 6 and 7, inner extensions of these lateral brown bands meet, forming a more or less complete transverse band near center of each of these sternites.

Gills—Light greyish purple. Tracheae distinctly dark purple.

Tails—Brown for short distance at base; remainder yellowish, very narrowly dark brown at alternate joinings. A circle of stout dark spines at each pale joining.

Holotype—Male imago, reared. Caraway Creek, Uharie Mountains, N. C., near Sophia, April 23, 1930. No. 1124.1 in Cornell University collection.

Allotype—Female imago, reared. North Fork of Potomac River at the Smoke Hole, W. Va., Aug. 9, 1930. No. 1124.2 in Cornell University collection.

Paratypes—2 male imagoes, Smoke Hole, W. Va., Aug. 8, 1930; 2 male subimagoes, Caraway Creek, N. C., May 21, 1930; 3 nymphs, Caraway Creek, May 20, 1930; 2 nymphs, Smoke Hole, W. Va., Aug. 7, 1930. No. 1124.3-11.

Nymphs of this species were found also in small streams near Denton, N. C., on June 10, 1929, and near Spero, N. C., on April 29, 1929. The markings of the head and pronotum of the nymph, and its bright reddish brown color, serve to distinguish it from other species having the abdomen prominently striped.

Stenonema tripunctatum Bks.?

Two nymphs, not quite typical of *tripunctatum* Bks. but very similar, were taken from a small stream near Spero, on Feb. 18, 1930. These nymphs possess the row of dark spots on each side of the venter of the abdomen, but the spots are lacking on sternite 9. A male imago was reared from one of these nymphs. Its abdomen, while marked as in typical *tripunctatum* specimens, is washed with brown much as in

femoratum Say. The hind wings are distinctly dark bordered. Genitalia are typical for *tripunctatum* Bks. See Fig. 14. A female nymph similar to those taken at Spero was found in the Uharie River near Farmer. It transformed on April 7, 1929. The brownish wash of the abdomen and the dark-bordered hind wings are present on this specimen also.

Stenonema vicarium Wlk.

Nymphs which seem to be those of *vicarium* Wlk. were taken at four different localities in the piedmont. Dates of collection are as follows. From a small stream near Spero, mature nymphs were taken on Feb. 21, 1930, and on March 1 and 29, 1929; from the Uharie River near Farmer, on April 3, 1929; from Caraway Creek near Sophia, April 13, 1930; and from a stream near Asheboro, in middle April, 1929. Two female and male imagoes were reared from these nymphs. The imagoes are considerably paler than typical *vicarium* imagoes which I have reared from the vicinity of Ithaca, N. Y., so much so that I had thought them to be of a different species. Careful comparisons of the North Carolina material with nymphs and imagoes of the New York specimens lead me to believe, however, that my North Carolina species is in reality a light-colored form of *vicarium*. The venation is considerably paler in the Carolina specimens, the cross veins being dark brown only in the costal margin, and light brown elsewhere in the wing. In the New York specimens, on the other hand, all cross veins are so dark a brown as to appear almost black. Other characters, both of nymphs and imagoes, are very similar for the two forms, aside from the lighter color already noted, of the southern specimens. The genitalia are likewise very similar.

Stenonema pudicum Hag.?

Female imagoes, captured as they flew over the water while ovipositing, are in my collection from the Cascades near Danbury. These females were taken on May 3, 1930. The stream which flows through the Cascades is apparently a tributary of the Dan River, cutting a small gorge through a portion of the Sauratown Mountains. From nymphs collected in this stream on May 18, 1929, and May 3 and 18, 1930, several other females were reared, also one male imago and two sub-imagoes. The males are unusually small for the size of the females, and much paler in color.

The nymphs differ somewhat in color pattern from nymphs of *pudicum* Hag. taken in the mountain area of the state. I had thought that the Cascades specimens represented a different species. However, there are so few differences, both in nymphs and imagoes, between these and the mountain specimens which Dr. McDunnough has kindly identified as the true *pudicum* Hag., that for the present I place all of them in this species. As the nymph of *pudicum* does not seem to have been described, I present a description of it. In listing the species from the mountain localities, the differences between the nymphs will be indicated. I make brief mention also of the differences found between the imagoes of the piedmont and mountain regions.

Nymph (from Cascades)

Size—Body (female) 12–14 mm.; tails 18–20 mm.

General appearance—A smooth-appearing nymph, rather stout. Reddish brown dorsally, without conspicuous markings. Ventrally pale, the apical segments yellow, and marked with dark brown.

Head—Numerous small light dots sprinkled over dark areas. Lateral areas light, with rather wide brown central band from eye to outer margin. Paler spot in front of each ocellus; a small dark spot behind each lateral ocellus. A pale area on each side of the posterior margin of occiput; small light area on median line. Basal segment on antenna largely light; next two dark brown, remainder light brown.

Thorax—Dark brown triangular area, its base on margin, occupies center of anterior margin of pronotum. On each side of this, a narrow white strip, then another dark brown area extending almost to the lateral margin. Enclosed in this dark area is an oblong white patch. Lateral margins pale except for brown streak in central portion. Posterior border narrowly dark, widest at median line. A small light comma-shaped mark is often present on each side, near posterior border. Mesonotum with four darker patches on anterior margin. Irregularly marked with small light and dark areas. Ventrally pale yellowish, sutures light brown.

Legs—Femur largely reddish brown, with three zigzag white bands, often incomplete. Each end is light in color. Tibia reddish brown except for white apical band. Base and apex of tarsus pale; central area dark brown. Tips of claws dark. Claws not pectinate. In fully-mature nymph, a purplish spot in center of each femur.

Abdomen—Each tergite narrowly dark on posterior margin. Dark area along anterior half of median line, on most tergites. A white

sub-median streak on each side of this dark portion, most evident on 5 and 7-10. Irregular light area along anterior margin of each tergite. On 1 and 2, this occupies most of the tergite. A lateral dark patch on each side of each tergite, adjoining the gills. Usually some small white areas near this. Postero-lateral spines present on 3-9, short on 3-6, longer on 7-9; longest on 8. Spine on 9 almost as long as that on 7. Ventrally yellow, this color deepening apically. Faint brown lateral streak on each side of venter. Sternite 9 has a wide dark brown longitudinal streak on each side, extending the length of the segment. Anterior ends of these bars usually connected by a transverse band, which dips down slightly at median line. Oblique dark brown subventral dashes on all sternites. Areas between these filled in with solid brown, in shape of a sector of a circle, on sternites 6-8, and faintly on 4-5.

Gills—Dark purplish grey.

Tails—Greenish yellow, becoming brown basally in fully-mature nymph. Distal half barred with dark brown, these bars being 2 to 3 segments in width. Tail segments very short, especially near base. Joinings dark brown. Circle of long dark spines at each joining basally; in middle of tail, spines at alternate joinings; none present in distal half.

Imagoes

Female imagoes differ from the mountain specimens of the species as follows. Head not so definitely bordered with purple on the posterior margin. Thorax more ruddy before the forewing, and sometimes lacking the cream-colored area next to the mesonotal spine. Tergites of abdomen entirely lacking the median dark sagittate streak. Their posterior margins narrowly and regularly dark, without the purplish wash on the posterior half of the segment, as found in the mountain specimens. Wings somewhat longer and slightly wider, the cross veins slightly darker and more prominent.

Male imagoes are much smaller in size, much paler, and in general differ from the mountain forms as do the females, except that the venation is definitely paler. Genitalia very similar to the mountain specimens.

In addition to the specimens taken at the Cascades, others of the same species were found near Greensboro. Both nymphs and imagoes from this locality resemble the mountain forms much more closely than do those from the Cascades. Nymphs are much less prominently marked ventrally, often having only the oblique dark subventral dashes.

Specimens were collected in April, 1929, and several female imagoes reared.

Stenonema ruber McD.?

This species is not quite identical either with *ruber* McD. or *pulchellum* Walsh, according to specimens of each of these species which Dr. McDunnough has kindly sent me for comparison. In some respects it is intermediate between the two, but in the appearance of the wings in particular it is closer to *ruber* McD. Nymphs, while very similar to those of *ruber*, show some rather constant differences in color pattern. It does not seem advisable to describe these specimens as a new species, however, but rather to place them tentatively in *ruber*, which species they most resemble.

A comparison with typical specimens of *ruber* McD. is added below.

Male imago—Somewhat smaller in size. Paler in color, particularly the thorax and terminal segments of abdomen. Abdomen usually semi-hyaline white, without smoky tinge. Stigmatic area of forewing opaque white, no trace of reddish stain. Purplish streak running down on base of foreleg, usually present. Tails in some specimens without dark joinings. Stigmatic dots and dark bands on posterior margins of tergites usually present, but one or both may be absent. Cross veins in costal area of forewings slightly thicker and darker than in *ruber*. Veins of hind wing, and of outer margin and lower portion of forewing often almost colorless. Other cross veins brown, very similar to *ruber* and less numerous than in *pulchellum*. Legs pale yellowish white, only the fore femur slightly deeper yellow, and much paler than in either *ruber* or *pulchellum*. Brownish or purple tinge at distal end of each femur. Distal ends of 1st and 2nd tibiae dark brown. Median purplish band on femur sometimes indistinct or absent on hind leg. In fore tarsus the first joint varies in length in different specimens from about $\frac{1}{3}$ of 2nd joint to $\frac{1}{2}$ or almost $\frac{2}{3}$ of the second. It may thus vary on the two fore legs of the same insect. In many males of this species, the fore leg is long in proportion to the body, sometimes exceeding it slightly in length.

Nymph—Considerable variation in amount of pigmentation of dorsal surface, which is either light yellowish or dark reddish brown. Extent of the dark ventral markings is also variable. A typical nymph of the yellowish brown variety, well-marked ventrally, compares with a typical *ruber* nymph as follows. Gills very faintly grey (in *ruber*, dark purplish

grey). Hind margins of femora and tibiae bear much shorter hairs than in *ruber*. Abdominal spines and pale ventral surface similar in both. In typical *ruber* a very dark U-shaped mark is present on sternite 9, and a somewhat mushroom-shaped dark mark on 8; all other sternites unmarked. North Carolina nymph has same marks on 9 and 8, likewise a faintly dark dash at center of anterior margin and an oblique sub-ventral streak on each side, on sternites 4 to 7. The mark on 8 is rather that of an inverted mushroom, and the U-shaped mark on 9 is often incomplete on the anterior margin.

Many nymphs of this species were collected, and many imagoes reared. So much variation was noted among these reared imagoes that 25 of the darker specimens were selected for special examination. Of these, 12 were males. Nymphs of these 25 specimens were so similar as to preclude the possibility of two species being involved. Presence or absence of stigmatic dots; of dark bands on the tergites, posteriorly; of dark joinings on the tails; of the color of the thoracic notum; and of the median band on the femur, were the points observed. Results are as follows. One male and 1 female show no slightest trace of dark banding at the tail joinings and in 4 others the banding was very pale. One male has a yellow thoracic notum. Five females show no indications of stigmatic dots, which are very faint on 12 other specimens, of which 5 are males. In 1 male and 2 females, no median band is present on the hind femur. In 1 male and 2 females (same specimens) there is almost no indication of dark borders on the tergites. In several other males, not included in the above specimens, the entire thorax is yellowish clay-color. In most males the terminal segments of the abdomen are yellowish brown, with no trace of darker reddish brown.

So much variation accounts for the great difficulty experienced in determining species accurately when the main characters used to distinguish these species are such variables as darker bands at the tail joinings, stigmatic dots and dark borders on the tergites. Yet it is by a combination of such characters that most species in the *pulchellum* group must be separated. Much rearing work must be done, both in this and the *interpunctatum* group, before the limits of variability can be determined, and species accurately defined.

Specimens of this species were collected from several localities in the piedmont. Imagoes emerged during April and May, likewise in September and early October. No collecting was done in this area between early June and mid-September. The largest number of specimens were found in Caraway Creek, in the Uharie Mountains near Sophia. Other

localities are as follows. Big Alamance Creek, in three different places; Little Alamance Creek at Troxler's Mill; a small stream in the outskirts of Greensboro; a small stream near Spero; the Uharie River near Farmer; Middle Below Creek; and at the Cascades near Danbury, in the Sauratown Mountains.

Stenonema varium, sp. nov.

A rather large species of the *pulchellum* group. Imagoes vary considerably in the amount of dusky tinge present on the abdomen, some being almost wholly pale. Stigmatic dots usually present. Tails white, joinings dark. Abdominal tergites dark on posterior margins.

Male imago

Size—Body 9–11 mm.; wing 10–11 mm.; tails 28–35 mm.

Head—Pale yellowish brown. No marks on frons. Filament of antenna pale brown. Faint orange dot at center of vertex; on each side of this a short curved dusky mark, quite faint.

Thorax—Yellowish brown, darkest on metathorax and on each side of mesothoracic scutellum. Broad whitish areas anterior to wing roots, on pleura between 2nd and 3rd leg, and at base of fore leg. Scutellum of mesothorax white except for a narrow brown median line. Narrow white area immediately anterior to scutellum, and on each side of metathoracic spine. Anterior and posterior margins of pronotum narrowly purplish black. Double median black line on pronotum. Principal sutures of thorax very narrowly dark brown. Sternum very similar in color to notum, slightly darker than pleura.

Legs—Antecoxal pieces brown, coxa and trochanter pale. A purplish streak extends upward on the thorax from the base of the fore leg. Femora pale yellowish, with median and apical purplish brown bands. Tibiae paler than femora, purplish brown at apex. Fore tarsus pale, the joinings very narrowly darker. (In some specimens, entire tarsus faintly dusky.) Other tarsi pale yellowish, the joinings narrowly brown (last joint and claw dusky, in some specimens). First joint of fore tarsus one-half or slightly more than one-half the second joint.

Wings—Semi-hyaline. Both wings have a pale brown cloud near the point of attachment, with pale areas at the extreme costal and anal regions. Brown bands extend forward along the costa and subcosta as far as the humeral cross vein, which is heavily infuscated. No noticeable crowding of cross veins at bulla. Stigmatic area opaque

whitish, without red stain. Costa, subcosta, and radial sector of fore wing yellow. Other longitudinal veins pale yellowish brown. Cross veins dark reddish brown, thicker than the longitudinals. Hind wing very similar, except for entirely pale veins in anal region. 4-5 costal cross veins before bulla, about 8 beyond.

Abdomen—Tergite 1 largely dull purplish grey. Segments 2-6, and basal half of 7, semi-hyaline, white. Apical half of 7, and 8-10, opaque, pale yellowish brown. All tergites with purplish black posterior margins, becoming somewhat wider on the anterior sclerites. Stigmatic dots present on 2-7. On 2-5, a narrow purplish black transverse streak extends from the stigmatic dot laterally almost to the median line, running parallel and close to the dark posterior margin. Median line of tergites 1-3 a dull purplish grey streak, with lateral extensions on each side near the anterior margin. Venter unmarked, the ganglionic track opaque white.

Tails—White. Joinings narrowly purplish brown, alternate joinings wider. Becoming faintly dusky at tip.

Genitalia—Similar in form to others of this group. Forceps silvery white; penes and forceps base pale yellowish brown.

Variations in color pattern—

(a) Abdominal tergites 1-4 largely dull purplish grey, except for pale areas in the anterior lateral angles and a pale band on the anterior margin. Median line bifurcate. Faint dusky area on each tergite bordering the pale pleural joinings. Pale opaque submedian streaks on each tergite may be evident.

(b) Abdomen much paler, the greyish markings of tergites 1-3 or 1-4 almost wholly obsolete. Thoracic notum a somewhat deeper reddish brown. Fore femora, and all segments of other legs, pale yellowish brown. No dusky marks on vertex of head.

(c) Pale specimen, the stigmatic dots practically wanting.

(d) Markings on abdominal tergites 2-3 consist of a grey median line and grey spots on each side of this, in addition to the transverse streak from the stigmatic dot. Faint dusky spot on each side of median carina of face.

(e) Resembles variation (a), but the dusky markings occur on tergites 1-7, although less extensive on 7 and 8 than on the anterior tergites. The purplish median line extends to the tip of the abdomen. Stigmatic dots very small, and directly anterior to each is a pale area

enclosed by a yellowish brown circle. Faint dusky stain on each side of medioventral line, near center of each sternite.

Female imago

Body and wing, 11-12 mm.; tails 28 mm. Head and thorax pale yellowish. No dusky curved marks on vertex. Faint purplish black pencillings above base of each leg. Legs pale yellowish white, marked as in the male. Abdomen pale. Posterior margins of tergites 1-5 narrowly dark; remaining tergites wholly pale. Stigmatic dots present but faint. No median or lateral greyish markings on any tergites. Bases of wings lack the pale brown cloud present in the male. Joinings of tails faintly dark, but paler than in the male.

Variation (a). All tergites narrowly dark on posterior margins. A pale brownish mediodorsal line extends the length of the abdomen. Tergites 1-5 with pale purplish brown shading on each side of median line.

Nymph

Size—Body 9-12 mm.; tails 15 mm.

General appearance—Reddish brown, the abdomen paler than the thorax, and having a banded appearance.

Head—Reddish brown, sprinkled with many minute pale dots. Light areas anterior to median ocellus; laterad of each lateral ocellus; at antero-lateral angles of each eye; and along the lateral margin of the head. Small light areas also at center and on each side of the posterior margin.

Thorax—Reddish brown. Lateral margin of pronotum colorless, except for the brown antero-lateral angle. This pale area extends inward into the surrounding brown border in one or two round emarginations. A large pale spot near center of pronotum on each side. Toward the median line from this spot is a dark area, and a transverse black line passes through the light spot. Young nymphs may have other light areas near the median line at the anterior margin. Pale narrow median line on pro- and mesonotum, widest at anterior margin of mesonotum. A few pale spots on mesonotum near wing roots.

Legs—Pale yellowish. Femora with two wide brown transverse bands, one on each side of middle, and a narrower dark band near each end. Tibia has a brown basal band and another beyond the middle. Tarsus narrowly pale at base and more widely pale at apex, the remaining portion brown. Claws amber, tipped with reddish brown. Each has two pectinations, not very prominent.

Abdomen—Tergites 1-4 very pale yellowish brown, with dark median line in anterior half of each. A dark brown comma-shaped mark, the tail directed anteriorly, is present on each side of the median line near the center, in tergites 3-5, and 7. Tergite 5 like 4, but more yellowish. Tergites 6, 8, and 10 largely dark reddish brown, each with yellow submedian streaks in anterior half. Tergite 8 is likewise yellow on the posterior margin, at center. Tergites 7 and 9 with yellow background and many irregular reddish brown markings. These include a dark median triangle in the anterior half; a variation of the comma-shaped mark; brown lateral margins; and an irregularly triangular brown area occupying a considerable portion of the remainder of each side. Postero-lateral spines are present on segments 3-9; weak on 3 and 4, better developed on 5 and 6, longest on 7-9. Of the latter, that on 8 is slightly the longest.

Ventrally yellow, paler on the anterior sternites. Anterior margin of each sternite very narrowly dark. Postero-lateral extensions brown. Prominent blackish brown markings on the posterior sternites, varying considerably in extent and shape. Typically, a dark brown crescent is present on 9, extending forward to the anterior margin. A median spot occurs at the anterior margin of 8, sometimes divided into two portions connected at the center. On each side of this, a dark spot. In all other sternites, faint brownish oblique submedian streaks arise from the anterior margin, and at the outer end of each (i.e., near center of sternite on each side) is a dark brown dot. Between these and nearer the median line, another faint dot may occur. General appearance is thus of a row of dark dots on each side, in addition to the markings on 8 and 9.

Tails—Greenish in immature nymphs, brown in mature specimens. In distal half to two-thirds of each, groups of 2 to 3 dark segments are interspersed between groups of 2 or 3 pale segments, thus presenting a distinct banded appearance. In basal half, each joining is encircled by stout spines, longer on alternate joinings. Rather long hairs also arise from these joinings.

Genitalia of mature male nymphs dark brown.

Variations in color pattern—

(a) Ventral markings may consist of two dark brown oblique lateral bands on sternite 9, these bands not meeting at the top nor attaining the anterior margin. The rows of dark spots in the other sternites may be faintly indicated, or entirely absent. Dark spot on 8 may be entirely lacking.

(b) Crescentic mark present on 9, and a two-branched mark on 8, but rows of dots on other sternites absent or extremely faint.

(c) The dark mark on 9 may be straight along the anterior margin, thus appearing angular rather than crescentic. Mark on 8 may have the form of an inverted mushroom.

(d) The mark on 8 may be somewhat crescentic, that on 9 likewise a crescent, and another faint crescent may be present on 7.

Holotype—Male imago, reared. Big Alamance Creek at Tom's Place, south of Greensboro, N. C., April 5, 1930. No. 1125.1 in Cornell collection.

Allotype—Female imago, reared. Same locality, April 12, 1930. No. 1125.2 in Cornell collection.

Paratypes—11 male imagoes, 14 female imagoes, all reared. Big Alamance Creek at Tom's Place, April 10–17, 1930; and April 28, 1929; Caraway Creek near Sophia, April 15–27, 1930; near Tabernacle church south of Greensboro, May 1–9, 1930; Greensboro, N. C., April 23–28, 1930; Polecat Creek south of Greensboro, April 9–16, 1930. Also 13 nymphs, from the above localities during April 1929 and 1930; also from the Uharie River near Farmer, N. C., and from a stream 12 miles north of Greensboro. No. 1125.3–40.

This species was more common in the piedmont than any other of the Heptagenine group. In addition to the localities listed for the type material, this species was taken in the following places. Near Spero, N. C., April 29, 1929; at the lake near Liberty, April 23, 1929; near Denton, May 2, 1929; and at Asheboro, April 3, 1929.

Stenonema varium would seem to be rather closely related to *S. rubromaculatum* Clem. Judging by Clemen's description, *varium* may be distinguished from his species by (1) the absence of a red stain in the stigmatic area of the forewing, (2) the larger size, and (3) the greyish median and lateral markings of the anterior abdominal tergites. The nymph is paler, has a more distinct dorsal color pattern, and lacks the extreme hairiness and the granular appearance said to be characteristic of the nymph of *rubromaculatum*.

Included among the typical *varium* nymphs taken at Polecat Creek are some others which are distinctly more hairy. In these, also, the ventral markings of the abdomen are reduced to rows of indistinct dots on all sternites but 9. On this latter sternite, markings consist only of

a lateral dark streak on each side, which is broken up into an anterior and a posterior portion, of which one or the other may be entirely absent. Dorsal markings, while somewhat darker in color, are very similar to those of more typical nymphs, with the addition, in some specimens, of an almost continuous dark median line on the abdomen. Imagoes reared from some of these nymphs are similar to pale specimens of the typical form.

Stenonema exiguum, sp. nov.

See description under species from the mountain area.

A single female imago was taken at the lights of the auto near Hamburg Lake, on June 1, 1929.

Mountain region

Stenonema sp. No. 2.

A single male imago, reared on July 30 from a nymph taken in the Ocona Luffy River, differs from specimens of *S. pallidum* in lacking the dark dash below the antennae. In this respect it is similar to *Stenonema* sp. No. 1 from the Cascades. The nymph is dark reddish brown in color, the lateral areas of the middle abdominal segments being conspicuously pale. The pale irregular subdorsal lines on the tergites are wider, especially on the anterior segments, very much as in nymphs of *S. affine*. Body of male imago measures 7 mm.; wing $8\frac{1}{2}$ mm.

Stenonema sp.

Very elongate dark reddish brown nymphs were found in the Ocona Luffy River on June 22, 1930. No imagoes were reared. These nymphs are somewhat larger and much darker in color than nymphs of *Stenonema* sp. No. 1 from Cascades, and the pale subdorsal lines are almost obsolete. Length 10 to 11 mm.

Stenonema carolina Bks.

A single female imago of this species was caught in flight in the Blue Ridge Assembly grounds near Black Mountain, on June 18, 1929. A tributary of the Swannanoa River flows through the assembly grounds. Another female imago was captured at a small stream on the State Test Farm near Swannanoa on June 18, 1930. An immature nymph, probably of this species, was found in this same small stream. I have

recently reared imagoes of this species from nymphs taken in the vicinity of Ithaca, N. Y. A description of the mature nymph follows. For the genitalia of the male imago, see Fig. 2. The specimen from which the mount of the genitalia was made, was taken from the North Fork of the Swannanoa River, N. C., on May 31, 1912, by Dr. Beutenmuller, and presented to the Cornell collection.

Nymph

Size—Body (male) 9–10 mm.; tails 10 mm.

General appearance—Slender yellowish brown nymph, the brown definitely tinged with grey. Yellow longitudinal stripes on dorsum of abdomen.

Head—Dark reddish brown. Lateral margin yellowish white. A conical white spot anterior to the median ocellus, and another light spot laterad of each lateral ocellus. Posterior margin of head pale, except for narrow dark border on each side of median line. Epicranial suture white. Antennae purplish grey at base; remainder pale greyish white.

Thorax—Lateral margins of pronotum pale. Large pale circular spot at antero-lateral angle, in which is a small dark spot on anterior margin. Large yellowish white transverse mark on each side of pronotum, widest laterally. Median line pale. Pale spot at median line on posterior margin, another small curved light spot on each side. A black mark may be present on each side near the posterior margin. Mesonotum with pale median streak, widest anteriorly. Few pale marks near wing roots. Pale ventrally, with brown areas in center of prosternum, anterior to bases of 2nd and 3rd legs, and on antecoxal pieces.

Legs—Pale with smoky tinge. Coxa and trochanter each with a brown blotch. Femur pale near each end, and with a narrow irregular median band; otherwise greyish brown. A smoky longitudinal streak near fore margin. Tibia yellowish, with two smoky transverse bands. Tarsus pale distally, basal half pale smoky brown. Claws rather stout; no pectinations near tip, but usual median spine at center on inner margin. Claws tipped with orange-brown.

Abdomen—Dark smoky brown median stripe on dorsum, margined on each side by yellow stripe, which is narrow on tergites 1–6, and progressively wider on 7–10. On 8–10, presents appearance of yellow background with narrow dark median stripe. Lateral margins pale on 1–6. On 7–10, dark brown at extreme margin, with yellow stripe next to brown. Wide rhomboidal brownish grey patches occupy most of the

remainder of each tergite. In each dark patch is an incomplete yellow streak, and at postero-lateral angles of each, a darker brown spot. General effect is of greyish abdomen with four complete and two incomplete yellow longitudinal stripes. Posterior margins of tergites brown. Long postero-lateral spines on 8 and 9, and shorter spine on 7. Ventrally, pale yellowish white, with lateral brown stripes, widest on sternites 8 and 9. A brown transverse band across the center of sternite 9 connects the two lateral stripes. Posterior margin of 9 brown; anterior margin narrowly brown at middle.

Gills—Pale greyish lavender. Tracheae prominently dark purple. Seventh gill with median trachea and short lateral fringes.

Tails—Yellow with greenish tinge. Alternate joinings narrowly darker. Near base, each joining with a circle of stout dark spines. Further out, spines only at pale joinings. No spines toward tip. Tails fringed with rather long hairs.

Stenonema carolina Bks.?

These two specimens are probably pale forms of *carolina* Bks., as is evidenced by the structure of the genitalia. I found one male at the Blue Ridge Assembly grounds on June 18, 1929. Another very similar specimen was captured by Prof. Needham at Mt. LeConte, Great Smoky National Park, on Aug. 14, 1929. Both males are paler than is typical for *carolina*, somewhat resembling members of the *pulchellum* subdivision. The Blue Ridge specimen has white tails. There are 5 costal cross veins before the bulla, 2 at the bulla, and 11 beyond. Veins brown in the entire forewing. The Mt. LeConte specimen does not have the typical brownish tinge on the costal border of the fore wing, and the veins are much paler in the posterior half of the wing. In both specimens, only two margined radial cross veins are present at the bulla. In both, the first fore tarsal joint is more than $\frac{1}{3}$ but less than $\frac{1}{2}$ the length of the second. Neither specimen has the dark posterior margins of the tergites continued on the sternites, to form continuous dark bands around the abdomen, as is the case in *carolina*. In other respects these males resemble *carolina*.

The body of the Blue Ridge specimen measures 9 mm.; wing 10 mm.; tails 25 mm. The LeConte specimen is slightly larger and stouter.

Stenonema ithaca Clem.

This species and *S. pudicum* Hag. were more common in the mountains than any other species of the genus. Nymphs of *ithaca* were collected

from many stations, and many imagoes were reared. The Carolina specimens are smaller than the spring and early summer nymphs near Ithaca, N. Y., and the imagoes lighter in color; but both nymphs and imagoes are very similar to the mid-summer forms from that locality. Collections were made during June and July of 1929 and 1930. Following is the list of localities from which this species was taken. North Fork of the Swannanoa River near Black Mountain; the Swannanoa River at Black Mountain, and its tributaries in the Blue Ridge Assembly grounds and another near Swannanoa; Flat Creek, another tributary of the Swannanoa; Pigeon River at Cruso; a small tributary of the Pigeon at Waynesville; Davidson River in the Pisgah National Forest; Cullasaja River south of Franklin; French Broad River near Rosman; a small stream near Fairview; Bald Creek west of Burnsville; Laurel River and its tributary near Hot Springs; Spring Creek near Hot Springs; Little River near Penrose; Little River at Cedar Mountain; Ocona Lufty River at Cherokee; Pacolet River at Tryon; Ivy River at Forks of Ivy; and South Toe River at Micaville.

Stenonema pudicum Hag.

Another species which was very abundant in the mountain region. Many nymphs were collected and several imagoes reared. This species was taken at each of the following localities. Pacolet River near Tryon; Little River at Cedar Mountain; a small stream at Waynesville; a tributary of the Pigeon River west of Hazelwood, and another tributary near Waynesville; Ocona Lufty River near Cherokee; Cedar Creek near Glenville; another tributary of the Tuckaseegee River near Glenville; a tributary of the Nantahala River near Wesser; a tributary of the Rocky Broad at Bat Cave, and another near Chimney Rock; Scott's Creek near Sylva; a tributary of the North Fork of the Catawba River near Woodlawn; the Catawba River at Andrews Geysers; Flat Creek at Black Mountain; a small tributary of the Tennessee River at Franklin; two small streams on Cowee Mountain, draining to the Tuckaseegee River; Cullasaja River south of Franklin; and Rock Creek, west of Brevard. They were perhaps most numerous at Cedar Creek near Glenville. Several imagoes were reared from nymphs taken in this stream.

As noted in recording this species from the piedmont, the nymphs and imagoes taken in that region differ somewhat from the mountain specimens, which I believe to be the true *pudicum*. The piedmont

specimens may be varieties, or may perhaps represent a different species. The imagoes from both regions have been contrasted (p. 189). Nymphal differences are noted here.

Nymph (from Cedar Creek)

Differs from nymphs described from the Cascades mainly in the ventral markings, which are much less extensive and less sharply defined in the mountain specimens. Structural features and other color markings are very similar in both forms.

Venter of abdomen reddish brown, darker on the apical segments, especially sternite 9. Rather indistinct brown lateral line the length of the venter, on each side. Oblique dark brown subventral dashes extend outward from the middle of the anterior margin, on each sternite, but the space between these dashes is not filled in solidly with brown, as in the Cascades nymph. Some nymphs show a faint indication of dark brown areas on each side of the midventral line, connected to the oblique dashes anteriorly, on sternite 8. A very dark brown patch occupies the postero-lateral angles of sternite 9, but is not extended into wide longitudinal bars on each side, as in the piedmont specimens. In some nymphs, the distal half of the tail is not barred.

Stenonema ruber McD.?

Nymphs which are apparently identical with those from the piedmont which I am calling *ruber* McD., were collected at two different localities in the mountain and male imagoes reared. The imago from Flat Creek at Black Mountain emerged on June 17, 1930. The other, from a small stream at Camp Carolina near Brevard, emerged July 23, 1930.

Stenonema exiguum, sp. nov.

A species close to *S. integer* McD. Tails unmarked, no stigmatic dots.

Male imago

Size—Body 5½ mm.; wings 6 mm.; tails 15 mm.

Head—Pale whitish, unmarked except for a faint reddish dot at center of vertex. Antennal filament dusky at base.

Thorax—Pale creamy white, unmarked.

Legs—Pale creamy white. Femora with median and apical rose-colored or lavender bands. Tibiae of second and third legs with rose-colored spot near basal end. On fore leg, tibiotarsal joint distinctly

purplish black; tarsal joinings narrowly dark. First tarsal joint slightly more than $\frac{1}{2}$ as long as second. Claws and distal half of last tarsal joint, on all legs, distinctly dusky.

Wings—Hyaline, iridescent. Stigmatic area opaque, with pale but distinct red stain. Cross veins of fore wing prominent, very dark brown. Longitudinal veins on costal margin yellowish brown, remainder pale yellow. Humeral cross vein purplish black. About $\frac{4}{5}$ costal cross veins before bulla, 8–9 beyond. Hind wing narrowly dark brown on outer apical margin. All veins colorless.

Abdomen—White. Segments 1–7 semi-hyaline, 8–10 opaque and washed with pale yellow. All tergites with narrow but distinct purplish black posterior margins. No stigmatic dots. Ventrally unmarked, but ganglionic areas distinctly opaque.

Tails—White; unmarked.

Genitalia—Very similar to *S. integer*. See Fig. 4.

Female imago (from Georgia specimen)

Similar to male, except for usual differences. Cross veins of fore wing relatively darker in color, and longitudinal veins paler, than in male. Body $5\frac{1}{2}$ –7 mm.; wings 7–8 mm.; tails 14–15 mm.

Holotype—Male imago. Caught in flight near Woodlawn, N. C., July 16, 1930. No. 1126.1 in C. U. collection.

Allotype—Female imago, Chattahoochee River, Atlanta, Ga., June 10, 1932. Collector, Prof. P. W. Fattig. No. 1126.2 in C. U. collection.

Paratypes—2 male imagoes, Etowah River, Rome, Ga., Aug. 16, 1931. Collector, Prof. P. W. Fattig. 22 females, Chattahoochee River, Atlanta, Ga., June 10, 1932. Prof. Fattig, collector. Nos. 1126.3–26 in C. U. collection.

The holotype, collected near Woodlawn, N. C., probably came from the Catawba River, which is not far distant. The allotype and paratypes, while collected in Georgia by Prof. Fattig during June and August, are so similar to the holotype that there seems no doubt but that they are of the same species. Descriptions and measurements of the male imago are drawn from the holotype.

Stenonema bellum, sp. nov.

Related to *integer* McD., but lacking the dark-bordered hind wing of that species. Oblique dark marks in place of stigmatic dots. A pale whitish species.

Male imago

Size—Body $6\frac{1}{2}$ mm.; wing 7 mm., tails 14 mm.

Head—Pale whitish. A small black dot at inner lower corner of eye, opposite antenna. A narrow reddish line beneath each antenna. Antennae wholly pale. A V-shaped reddish mark on vertex between lateral ocelli. On each side of head near the posterior margin, a large dusky triangular spot.

Thorax—Creamy white. On each side of pronotum, a somewhat oblique purplish red streak, its posterior end continued laterally as a reddish line parallel to the hind margin of the segment. A black line in postero-lateral angle. Prominent oblique purplish black line on pleura of pronotum, extending down to coxa of fore leg. Black pencilings on pleura of meso- and metathorax, anterior and posterior to second and third legs, and extending up between them. Oblique purplish marks on each side of metanotum.

Legs—Pale yellowish white, femora distinctly washed with yellow. Median and apical purplish rose bands on all femora. Purplish rose streak near basal end of each tibia. Tibio-tarsal joining of fore leg faintly dusky. Claws pale brownish yellow.

Wings—Longitudinal veins of costal margin yellowish, all others pale. Cross veins of fore wing dark brown, paler along inner margin. Hind wing wholly pale, without dark outer margin; all veins pale.

Abdomen—Segments 1-7 white, semi-hyaline; 8-10 opaque, yellowish. All tergites narrowly purplish black on posterior margins. Oblique purplish black line near stigmatic region on each side of each tergite, extending forward from each end of the black posterior margin. A double (bifurcate) purplish streak on mid-dorsal line of tergites 3 and 6, in posterior $\frac{2}{3}$ of these segments. Faint indications of such a streak on tergites 2 and 7, and a black median dot on posterior margin of tergite 4. Venter unmarked, but ganglionic areas opaque white.

Tails—White. Alternate joinings narrowly ringed with purplish black.

Genitalia—Pale yellowish. Quite similar to those of *exiguum* sp. nov. Forceps relatively longer, both in this species and in *exiguum*, than in *integer* McD.

Female imago

Size—Body $6\frac{1}{2}$ -7 mm.; wings 8 mm.; tails 12 mm.

Similar to male except as noted. A small black dot on each side of

median carina, connected to line beneath antenna in one specimen. Laterad of base of antenna, a very small black dot. Markings on vertex and occiput less extensive than in male. On abdominal tergites the black median streaks are wider than in the male. All longitudinal veins pale. Cross veins of costal to median spaces of fore wing pale brown, all others colorless.

Holotype—Male imago. Taken at auto lights, from French Broad River, Penrose, N. C., July 19, 1930. No. 1127.1 in Cornell University collection.

Allotype—Female imago. Same data. No. 1127.2 in C. U. collection.

Paratype—Female imago. Same data. No. 1127.3 in C. U. collection.

Stenonema sp. No. 3.

A species evidently related to *pubicum*, but with a very pale imago. Nymph has a distinctive color pattern. As only females were reared, the species is designated by number only.

Female imago

Size—Body 11 mm.; wing 11–12 mm.; tails 26 mm.

General color—Pale yellowish white.

Head—No markings on frons. Small orange spot at center of vertex, near posterior margin. Small dark mark at inner edge of each eye, near posterior margin.

Thorax—Entirely pale, except for narrow black markings above and in front of the base of the 2nd and 3rd leg, and another above the base of the fore leg.

Legs—Pale creamy white. Indistinct median and apical purplish bands on femora, the median band very faint on the third leg. Apex of tibia, and all tarsal joinings narrowly dark reddish brown. Last tarsal joint dusky.

Wings—Humeral cross vein quite heavily infuscated. Slight crowding of subcostal and radial cross veins at bulla. Stigmatic area opaque white. Longitudinal veins of costal margin yellow; all others pale yellowish brown. Cross veins reddish brown, very distinct and much thicker than the longitudinals. Those of the basal half narrowly infuscated. Cross veins numerous. Usually 5 costals before bulla, and 14–17 beyond. Hind wing rather widely stained with brown on apical portion of outer margin. Veins pale except along costal and apical margins.

Abdomen—Segments 1-8 semi-hyaline, pale creamy white. Segments 9 and 10 opaque, tinged with yellow. Eggs, when present, give yellow tinge to abdomen. Each tergite with rather broad purplish brown posterior margin. Stigmatic dots present on 3-6. Venter pale, unmarked. Subanal plate broad, with a broad shallow emargination on its apical margin.

Tails—White. Joinings narrowly dark purplish brown.

Nymph

Size—Body 11-12 mm.; tails 19 mm.

General color—Reddish brown, paler ventrally.

Head—Reddish brown. Pale marks anterior to median ocellus and laterad of lateral ocelli. A narrow pale strip from outer anterior margin of eye to lateral border. Postero-lateral angles yellowish.

Thorax—Lateral borders of pronotum pale. A round light spot near center of each side; another at anterior margin on each side of median line; a third paler spot near posterior margin on each side of median line. A rather large pale oblong mark on each side of mesonotum, between median line and wing roots. On each side of this, toward the wing roots, a smaller light spot.

Legs—Femur reddish brown with a median pale transverse band; also pale areas at each end on the hind margin, and basally on the front margin. A small light dot near center in basal half of each femur. Tibia pale, with basal dark brown band and another between middle and apex. Tarsi dark reddish brown except for a narrow pale basal area. Claws pale, tipped with amber. Without pectinations.

Abdomen—Postero-lateral spines on 5-9. Short on 5 and 6. Those on 7 and 9 somewhat longer, and about equal in length. Spine on 8 longest. Reddish brown dorsally, paler on lateral margins of gill-bearing segments. Tergites 1-3, and 9 and 10, largely reddish brown; 10 usually pale along anterior margin, and 9 may have indistinct pale submedian streaks. Tergite 6 reddish brown with pale oblique submedian marks from the anterior margin. Tergites 4 and 5, and 7 and 8, each with a distinctive white V-shaped mark at median line. Point of V is on or near the posterior margin at the median line. Its arms diverge and extend forward on each side of the median line to the anterior margin, becoming somewhat wider anteriorly. In 4 and 5, the anterior end of each arm of the V is extended laterally as a short white transverse mark parallel to the anterior margin. On tergites 5 and 8, the point of the V may be obsolete. Ventrally yellowish to pale yellowish brown.

Sternite 9 may be shaded with brown on the lateral margins. Gills dark purplish grey.

Tails—Greenish yellow tinged with brown. Stout spines encircle the joinings in the basal half, being stouter at alternate joinings except very near the base. In distal half, where the segments are longer than at the base, each segment is crossed by a white transverse band at about the middle of its length.

Five females of this species were reared. Three of these are from nymphs taken in a small stream on Cowee Mountain, between Dillsboro and Franklin. These females transformed on July 8 and 12, 1929. Another is from Franklin, on July 10, 1929, while the fifth, from a small stream near Swannanoa, transformed June 15, 1930.

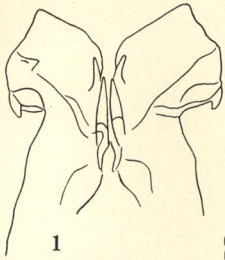
Nymphs were likewise collected, during June and early July of the summers of 1929 and 1930, from Black Mountain; the Little River at Cedar Mountain; the Catawba River near Andrews Geyser; and a little stream near Balsam. Immature nymphs were taken by Prof. Needham near Stump House Mountain, S. C., and Highlands, N. C., on April 5, 1929. A spent female was caught in flight a few miles west of Selica, near an old mill, on July 13, 1930.

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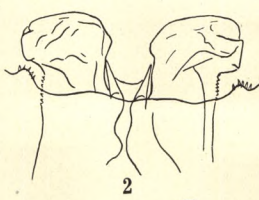
EXPLANATION OF PLATE 15

- Fig. 1. *Heptagenia pulla* Clem. Details of penes. (Genitalia of *elegantula* type.)
 Fig. 2. *Stenonema carolina* Bks. Details of penes.
 Fig. 3. *Stenonema interpunctatum* Say. Details of penes. (From Goshen Swamp specimen.)
 Fig. 4. *Stenonema exiguum*, sp. nov. Details of penes. (Genitalia of *terminatum* type.)
 Fig. 5. *Rhithrogena fasciata*, sp. nov. Details of penes.
 Fig. 6. *Heptagenia spinosa*, sp. nov. Details of one side of penes.
 Fig. 7. *Heptagenia spinosa*. Genitalia.
 Fig. 8. *Heptagenia marginalis* Bks. Genitalia. (Genitalia of the *flavescens* type.)
 Fig. 9. *Iron rubidus*, sp. nov. Genitalia.
 Fig. 10. *Iron dispar*, sp. nov. Genitalia.
 Fig. 11. *Heptagenia julia*, sp. nov. Details of penes.
 Fig. 12. *Stenonema pudicum* Hag. Details of penes.
 Fig. 13. *Iron dispar*. Details of penes.
 Fig. 14. *Stenonema tripunctatum* Bks. Details of penes.
 Fig. 15. *Heptagenia aphrodite* McD. Details of penes. (Genitalia of *maculipennis* type.)
 Fig. 16. *Stenonema annexum*, sp. nov. Details of penes. (Genitalia of *pulchellum* type.)

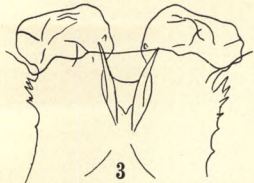
PLATE 15



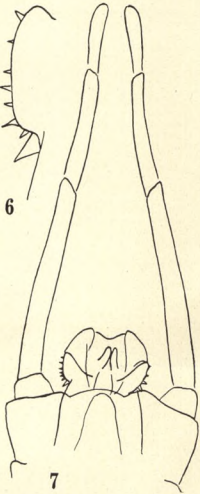
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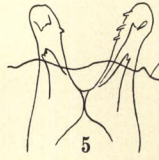
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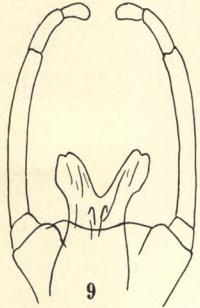
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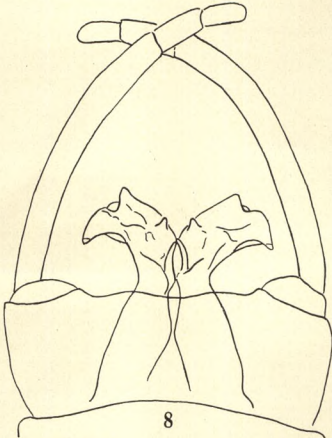
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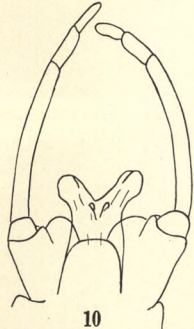
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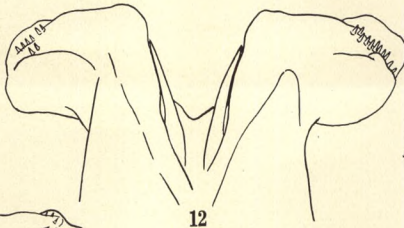
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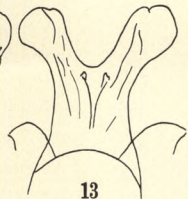
10



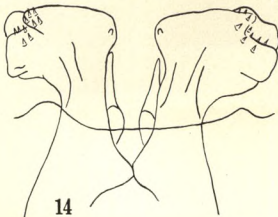
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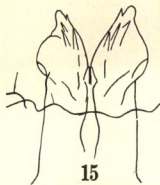
12



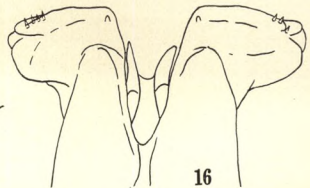
13



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