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DISTRIBUTION OF *NEOPERLA* (PLECOPTERA: PERLIDAE) IN NORTH CAROLINA, WITH NEW STATE RECORDS FOR THREE SPECIES

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ABSTRACT

Three new state records of *Neoperla* were collected as adults, *N. catharae*, *N. coosa*, and *N. stewarti*. Mapping of nymphal data (at the genus level) indicated that *Neoperla* occurs throughout most of the state, but it is absent from the mountains and the northern upper coastal plain. *Neoperla* occurs mainly in smaller streams in the western Piedmont ecoregion, but occurs mainly in rivers in the eastern part of the state. Up to three species were found to coexist at some sites.

Keywords: Plecoptera, Perlidae, *Neoperla*, state records, North Carolina, distribution.

INTRODUCTION

Early work on the genus *Neoperla* (Needham & Claassen 1925, Frison 1935, Ricker 1952) assumed that all Nearctic records pertained to one variable species, *N. clymene* (Newman). This changed when Stark & Baumann (1978) recognized eight species of Nearctic *Neoperla*, adding the descriptions of six new species placed in two groups: the *clymene* group (*clymene*, *freytagi* Stark & Baumann, *mainenesis* Banks, and *stewarti* Stark & Baumann) and the choctaw group (*choctaw* Stark & Baumann, *catharae* Stark & Baumann, *carlsoni* Stark & Baumann and *gaufini* Stark & Baumann). Later, Stark (1990) synonymized *N. freytagi* with *N. occipitalis* (Pictet). Other recent *Neoperla* descriptions (see Stark 2004) have added

seven more species, mostly from the Gulf Coast or from the Ozark and Ouachita Mountains. Stark & Baumann's (1978) original revision of *Neoperla* has called into question all "*Neoperla clymene*" records from North Carolina prior to 1978.

Identification of *Neoperla* adults requires the close examination of the aedeagus in the male plus the internal genitalia and egg of the female (Stark 2004). Additionally, many *Neoperla* species emerge in the summer months, much later than most southeastern Plecoptera adult activity. Although *Neoperla* nymphs are easily identified to the genus level, few complete descriptions are available at the species level, and several species are still undescribed as nymphs. Furthermore, some species apparently occur both as

“light” and “dark” forms, with distinct differences in color patterns (see Figures 305-306 in Frison 1935). This same dichotomy has been observed by us in *N. clymene* nymphs reared from the Cape Fear River near Erwin, North Carolina, May 2004. It is however, encouraging that Poulton and Stewart (1991) were able to provide a key to the nymphs of six *Neoperla* species occurring in the Ozark and Ouachita Mountains.

Kondratieff et al. (1995) presented a list of stonefly species for both North and South Carolina. They presented records for only one *Neoperla* species in North Carolina (*N. clymene*), although an additional four species were listed as occurring in neighboring states. The following distribution of these additional species is taken from Stark (2004):

-*N. carlsoni* Stark & Baumann. This species occurs in nine states along the Gulf and southern east coast, including records from Alabama, Florida, South Carolina, and Virginia. An incomplete diagnosis of the nymph was given in Stark & Gaufin (1979). Given the known distribution of this species, it is certain to occur in the Coastal Plain of North Carolina. Poulton & Stewart (1991) indicated this species is most likely to occur in “slow moving, murky streams, some with intermittent flow”.

-*N. catharae* Stark & Baumann. This species occurs in eight states in the central and eastern US, including records from Kentucky, Tennessee, and Virginia. Poulton & Stewart (1991) illustrated the nymph and found that this species emerges later than other *Neoperla* species, with adults still found until early October. In North Carolina, this species was expected to occur in the western part of the state.

-*N. occipitalis* (Pictet). This species occurs in 10 eastern states (and two Canadian provinces), including records in Alabama, Kentucky, Mississippi, South Carolina, Virginia, and Tennessee. The nymph is undescribed. Given the known distribution of this species, it was predicted to occur in North Carolina.

-*N. stewarti* Stark & Bauman. This species has been recorded from 10 states in the central and eastern US, including records from Alabama, Kentucky, Tennessee, and Virginia. The nymph was photographed by Stark et al. (1998).

We have been conducting annual collecting trips in North Carolina for several years, but a growing interest in the distribution of *Perlesta* species in North and South Carolina (Kondratieff et al. 2006; Kondratieff et al. 2008) resulted in collections in June and/or July from 2004-2008. This provided an opportunity to examine the distribution of *Neoperla* species within North Carolina. The objectives of this paper are to provide the known distribution of *Neoperla* in North Carolina, and include new state records for three species.

MATERIAL AND METHODS

Adult material was collected by the authors from 2004-2008 using beating sheets, light traps, and rearing. This material is housed in the C. P. Gillette Museum of Arthropod Diversity, Colorado State University, Fort Collins, Colorado. Additionally, the North Carolina Department of Environment and Natural Resources (NCDENR, Raleigh, North Carolina) has macroinvertebrate collections from most streams and rivers in the state. Nymphal records (either as *Neoperla* sp or *Neoperla clymene*) were mapped to show the state-wide distribution of *Neoperla* at the genus level. This nymphal data were also classified according to stream size: small streams (3-9 m wide), large streams (10-19 m wide) and rivers (20+ m wide). This genus-level distribution was used to guide the choice of sampling sites, making sure that collections were taken within each ecoregion. The ecoregions use for this study included Mountains, Piedmont, Slate Belt, Sand Hills and Coastal Plain, following boundaries established by Griffith et al. (2002).

RESULTS AND DISCUSSION

Three new state records of *Neoperla* were collected as adults, *N. catharae*, *N. coosa*, and *N. stewarti*. The distribution map for *Neoperla* nymphs showed several interesting patterns (Fig. 1). There were no records from the North Carolina Mountains, although some records were seen in the foothills region. This suggested that some of the species recorded from the mountains of Kentucky, Tennessee and Virginia may not be recorded in North Carolina. There also were few records from the northern coastal plain, an area of slow-moving rivers, swamp streams and low-dissolved oxygen concentrations.

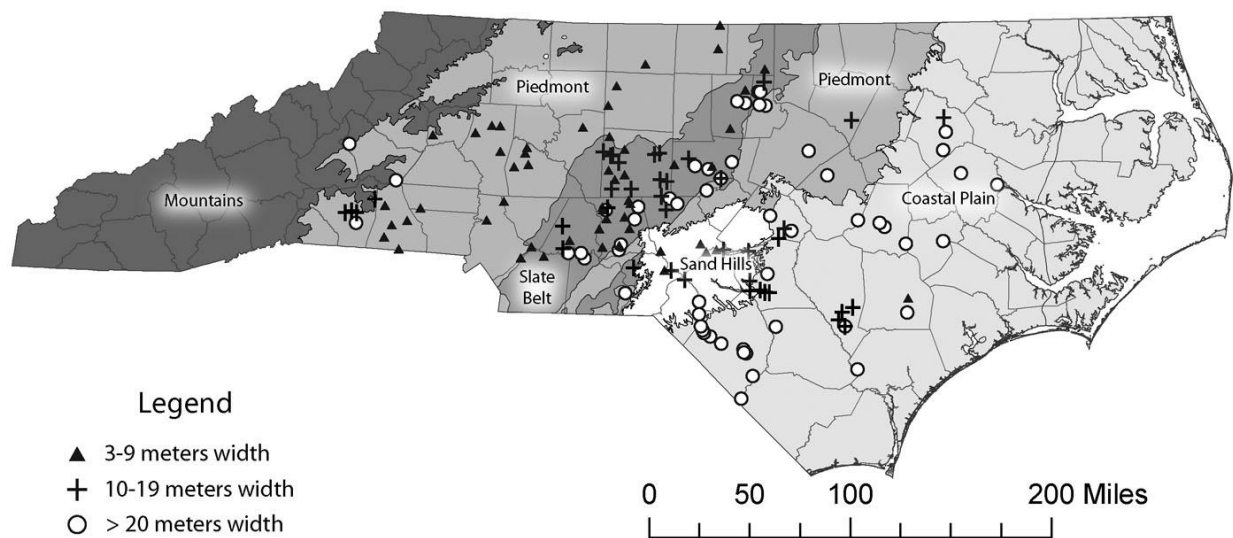


Fig. 1. Map of North Carolina and the distribution of *Neoperla* nymphs among ecoregions and stream size. Data provided by the North Carolina Department of Environment and Natural Resources.

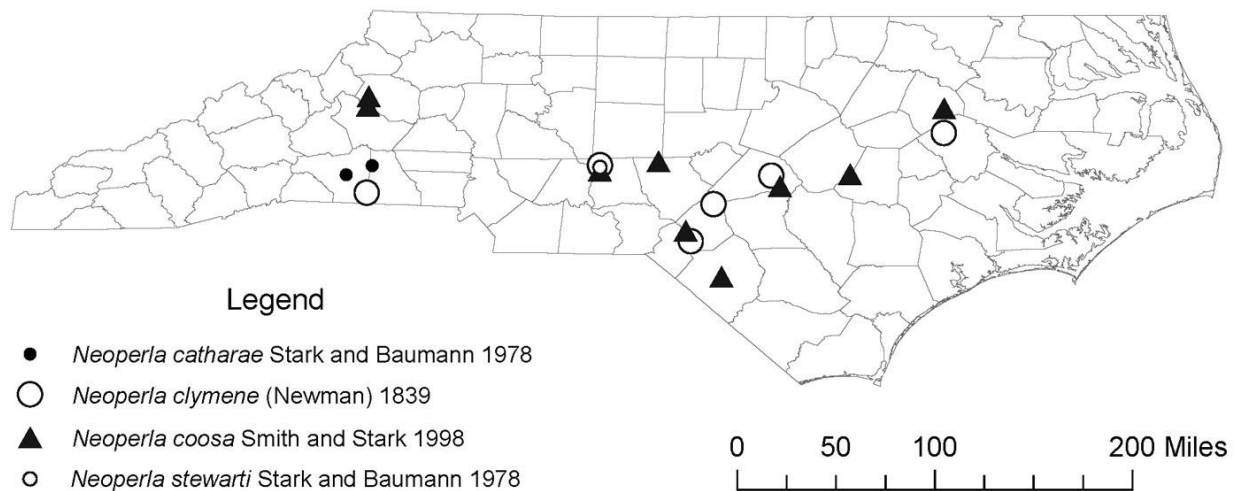


Fig. 2. Distribution map of four *Neoperla* species known from North Carolina.

The distribution of *Neoperla* nymphs by stream size was affected by ecoregion. Within the western Piedmont, *Neoperla* was most often found in streams less than 10 m wide. Within the Slate Belt and Sand Hills, however, *Neoperla* occurred in all stream sizes, and within the Coastal Plain this genus was most common in rivers and larger streams.

Adult records indicated that at least four species of *Neoperla* occur in North Carolina. It was not uncommon for two species to occur at some sites, with the Uwharrie River site having three species.

Neoperla catharae.

Foothills: Broad River Basin (Fig. 2): First Broad River, Cleveland Co., Mt. Zion Church Rd., 13 July 2007; 1♂, 2♀; Second Broad River, Rutherford Co., Whiteside Rd., 13 July 2007, 1 ♂.

Neoperla clymene.

As expected, this species was the most widespread *Neoperla* in North Carolina, being most abundant at riverine sites in the Slate Belt and Coastal Plain ecoregions (Fig. 2).

Piedmont: Cape Fear River, Harnett Co., Wildlife Rd, 18 May 2004, 3♂, 5♀.

Slate Belt: Barnes Creek, Montgomery Co., Ophir Rd., 18 May 2004, 2♂, 1♀.

Sand Hills: Little River, Harnett/Cumberland Co. line, Hwy 401, 18 May 2004, 11♂, 9♀; 30 May 2006, 20♂, 20♀; 9 July 2007, 32♂, 23♀; Little River, Hoke/Moore Co. line, Morrison Bridge Rd., 18 May 2004, 19♂, 15♀; 4 May 2005, 19♂, 15♀, Lumber River, Hoke/Scotland Co., line, Hwy 401, 1♂, 3♀.

Coastal Plain: Tar River, Pitt Co. Hwy 222, 30 May 2007, 2♂.

Neoperla coosa.

This species was originally described from Alabama (Smith and Stark 1998), with a single record published from Tennessee (Stark 2004) suggesting that this species might be more widespread. It is apparently a common *Neoperla* species in North Carolina (Fig. 2).

Foothills: Wilson Creek, Caldwell Co., Brown

Mountain Beech Rd, 13 July 2007, 1♂, 6♀; 12 July 2008, 2♀.

Piedmont: Cape Fear River, Harnett Co., Hwy. 217, 9 July 2007, 2♂, 12♀.

Slate Belt: Barnes Creek, Montgomery Co., Ophir Rd., 8 July 2007, 2♂; Uwharrie River, Montgomery Co., Hwy 109, 18 May 2004, 8 July 2007, 1♂, 1♀.

Sand Hills: Lumber River, Hoke/Scotland Co. line, Turnpike Rd., 8 July 2007, 1♂, 6♀; Robeson Co., Chicken Rd., 10 July 2008, 1♀; 14 July 2008, 6♀.

Coastal Plain: Tar River, Edgecombe Co., Hwy 222, 9 July 2007, 1♂, 11♀.

Neoperla stewarti.

Slate Belt : Uwharrie River, Montgomery Co., Hwy 109, 18 May 2004, 2 ♂.

CONCLUSIONS

Four species of *Neoperla* have been recorded in North Carolina, although this genus is largely absent in the mountains and the northern Coastal Plain. *Neoperla clymene* and *N. coosa* are relatively widespread, with records in the Coastal Plain (rivers only), the Piedmont, the Slate Belt and the Foothills. *Neoperla catharae* was found only in the Broad River basin (Foothills) and *N. stewarti* was found only in the Uwharrie River (Slate Belt). It was not unusual for two species to be recorded from a single site, with three species from the Uwharrie River. Two more species are likely to occur in the state, as they have been recorded from both South Carolina and Virginia: *N. carlsoni* (slow-moving Coastal Plain sites) and *N. occipitalis* (Mountains or Foothills?).

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