ILLINOIS
NATURAL
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SURVEY

The Winter Stoneflies of Illinois (Insecta: Plecoptera): 100 Years of Change

Donald W. Webb

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Photo by Mark J. Wetzel, INHS.

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Acknowledgments

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I would also like to thank the curators of entomology at Eastern Illinois University, Southern Illinois University, Western Illinois University, and the Field Museum of Natural History for the loan of specimens relative to this study. My thanks also go out to Mitch Harris and Ed DeWalt for their assistance in collecting winter stoneflies and to Frank Hutto for his assistance in preparing the distribution maps for this study.

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ABSTRACT

Winter stoneflies (Insecta: Plecoptera) are an aquatic group of insects whose adults emerge in Illinois from late November to early April. Twenty-one species have been reported from Illinois. Extensive collections of winter stoneflies were made in Illinois during the 1920s and 1930s by Frison, the 1960s by Ross and "the winter stonefly club", and the 1990s by Webb. These specimens are housed in the Insect Collection of the Illinois Natural History Survey and allowed for an evaluation of the current status of these species following a century of environmental change.

Over the past century (1900–2000), the species diversity of winter stoneflies averaged 2.5 species per county with species reported from every county but 3 (Carroll, DuPage, Ford) and with 10 counties recording 5 or more species. Pope County (13 species) reported the greatest species diversity. During the recent resurvey (1976–2000), species diversity average 1.9 species per county with specimens not collected in 11 counties, and only 3 counties (Hardin, Pope, and Saline) exhibited 5 or more species.

Four species are considered extirpated from Illinois: *Allocapnia illinoensis, Nemocapnia carolina, Paracapnia angulata*, and *Taeniopteryx parvula.* Seven species were found to be common (known from more than 15 localities): *Allocapnia forbesi*, *A. granulata*, *A. mystica*, *A. rickeri*, *A. vivipara*, *Taeniopteryx burksi*, and *T. nivalis*. Four species are considered uncommon (known from 4–15 localities): *Allocapnia recta, Strophopteryx fasciata*, *Taeniopteryx metequi* and *Zealeuctra claasseni*. Six species are considered rare (known from 1–3 localities): *Allocapnia nivicola*, *A. smithi*, *Prostoia completa*, *Taeniopteryx lita*, *Zealeuctra fraxina*, and *Z. narfi*. Significantly reduced patterns of distribution were noted in three species: *A. granulata*, *A. mystica*, and *Strophopteryx fasciata.* Only *Taeniopteryx nivalis*, previously rare, is now spreading its distribution across northern Illinois.

There has been a modest decline during the past century in the diversity of stonefly species within various counties. Also, a trend was observed toward an increase in pollution-tolerant, "generalist" species with a decrease in pollution-sensitive, habitat "specialists."

INTRODUCTION

Historical Background

Since its inception as the Natural History Society of Illinois in 1858, the Illinois Natural History Survey (INHS) has established a strong commitment to identifying and preserving the fauna and flora of Illinois (Mills 1958). This has been particularly true with regard to insects. At present, the INHS Insect Collection houses over 6 million specimens from throughout the world, but is most strongly focused on the central United States. Early INHS entomologists were encouraged to undertake faunal studies (mayflies, Burks 1953; leafhoppers, DeLong 1948; stoneflies, Frison 1929, 1935; damsel-flies, Garman 1917; pentatomids, Hart 1919; earwigs, grasshoppers and crickets, Hebard 1934; plant-lice, Hottes and Frison 1931; mirids, Knight 1941; midges, Malloch 1915; deerflies and horseflies, Pechuman *et al.* 1983; sialids, Ross 1937; caddis flies, Ross 1944; mosquitoes, Ross 1947; scorpionflies, Webb *et al.* 1975) which focused on Illinois, but were considerably broader in their geographic scope. Such was the case for the stoneflies (Plecoptera) of Illinois. Early in his career, Theodore H. Frison loved to collect on the hillsides along the Salt Fork of the Vermilion River south of Oakwood. It was here that Frison observed that "...in some of the very small streams, the smallest of the stonefly nymphs kept increasing in size as winter approached." From this observation arose his "...abiding interest in and love of stoneflies which continued through the rest of his life" (Ross 1958). Through the 1920s, Frison collected and reared a diverse array of stoneflies, culminating in his study of the "Fall and Winter Stoneflies, or Plecoptera, of Illinois" (Frison 1929). With the assistance of H. H. Ross, collecting continued through the 1930s and was broadened beyond the borders of Illinois. Frison completed a faunal study of "The Stoneflies, or Plecoptera, of Illinois" in 1935; a "Study of Nearctic Insects. II. Descriptions of Plecoptera, with special reference to the Illinois Species" in 1937; and culminated his interest in stoneflies in his "Studies of North American Plecoptera, with special reference to the fauna of Illinois" in 1942. All of the material collected by Frison and Ross during those years was deposited in the collections

of the Illinois Natural History Survey. In the 1960s, H. H. Ross and W. E. Ricker established the "Winter Stonefly Club" which enlisted the assistance of over 200 enthusiasts to collect winter stoneflies throughout eastern North America. The dedication of these individuals to brave the winter environs in search of small, black, creepy-crawly things that ventured over the snow and ice and seemed to seek pleasure in running across the railings of bridges or crawling out to the tips of branches in search of the warm sunlight, again added a multitude of specimens to the INHS collections. Through the diligence of the club members, Ross and Ricker were able to revise three genera of the winter stoneflies, *Taeniopteryx* (Ricker and Ross 1968), *Zealeuctra* (Ricker and Ross 1969), and *Allocapnia* (Ross and Ricker 1971).

Environmental Change in Illinois

With the arrival of European settlers into Illinois during the 1820's, significant changes began to take place in the landscape and waterways of Illinois. At that time, 61.2% of Illinois was dominated by prairie, 38.2% by forest, and 0.6% water (Iverson 1991). In the following 100 years the forests of Illinois were reduced to 22% of what had existed in 1820. There has been some recovery in the reforestation of Illinois, but all of this is secondary growth (Iverson 1991). The desire for tillable land drastically altered all of the prairies of Illinois (Anderson 1991). For many years broad hedgerows of multiflora rose (*Rosa multiflora*) separated farm boundaries, providing abundant habitat for small game, but also acting as a significant barrier to soil runoff. Over the past 30 years this practice has changed significantly with hedgerows being removed, allowing farmers to cultivate row crops from property line to property line. The buffer strips of vegetation along Illinois' streams were greatly reduced, adding significantly to the sediment load borne by our waterways. Streamside riparian buffer strips are an integral part of rivers and streams. They stabilize stream banks, reduce erosional input, filter agricultural runoff of sediments, and protect streams from excessive nutrient loading (Illinois Department of Energy and Natural Resources, IDENR 1994). Only now are we attempting to modify our views on how close we can cultivate along our waterways.

Illinois possesses over 42,000 km of flowing water (IDENR 1994). These waterways have been drastically altered since presettlement times. Dams have been constructed to control water levels for navigation along the Mississippi, Illinois, and Ohio rivers. Many of Illinois' smaller rivers have been dammed for flood control and water supplies and the added attraction of water recreation. In our efforts to improve and stabilize agricultural production, most fields in Illinois are criss-crossed with drainage tiles to lower groundwater levels and increase the availability of tillable land. Increased runoff from agricultural land with its inherent sediment load has required the need to channelize many streams and ditches of Illinois. This channelization has drastically altered the flow and bottom substrates of many streams as we attempt to move water more rapidly downstream. Stream channelization drastically reduces the habitat diversity for aquatic macroinvertebrates and fish, while increasing stream bank erosion and sediment transportation (IDENR 1994). Generally, following channelization there has been a reduction in the biodiversity and abundance of aquatic macroinvertebrates and fish (Henegar and Harmon 1973, Hortle and Lake 1982), and many of these effects may persist for some time (Arner *et al.* 1976). Currently, less than 1% of the original landscape of Illinois remains in its natural state, as defined by criteria established for an inventory of the natural areas of Illinois (White 1978). Because of this manipulation, streams in the agricultural areas of Illinois are perhaps now more homogeneous than presettlement times (IDENR 1994, Ross 1944).

Stoneflies present an excellent group of aquatic macroinvertebrates for examining environmental change over time because many species are intolerant to environmental perturbations. Hynes (1993) warned that stoneflies are probably the insect order most threatened by human activity. The diversity and abundance of stoneflies reflects the physical, chemical, and biological nature of a stream (Surdick and Gaufin 1978). Because of the intensive agricultural practices, deforestation, and industrial and suburban development over the past 100 years, stream quality in Illinois has undergone significant change (Page and Jeffords 1991).

Increased public awareness of the environment and the use of stoneflies as important indi-

cators of stream quality (Harper 1984, Hynes 1972; Jones *et al.* 1981; Resh and Unzicker 1975, Stewart and Harper 1996) stress the need for up-to-date knowledge of Illinois stoneflies. Major refinements in North American stonefly systematics, in conjunction with the scope and historical value of the INHS collections, provide us with a unique opportunity to re-examine the systematics and distribution of the Illinois fauna in light of environmental change within stream systems.

In Illinois, species of winter stoneflies are found in the families Capniidae, Leuctridae (in part), Nemouridae (in part), and Taeniopterygidae, and collected from November through early April (Table 1). When Frison (1929) published research on the winter stoneflies of Illinois, he included five genera and nine species. By 1935, 11 species were listed, and 14 in 1942. Overall, his work covered 137 sites in 54 counties. Ricker and Ross (1968, 1969, 1975) and Ross and Ricker (1971) and the collections of "the winter stonefly club" further contributed to our knowledge of Illinois winter stoneflies with specimens collected at 121 sites in 46 counties from 1946 to 1975. By this time, seven genera and 21 species of winter stoneflies were known from Illinois.

During the past 10 years, winter stoneflies were sought at 1,259 sites in all 102 counties of Illinois. These recent collections allow us to assess the historical changes in species diversity and distribution during the "Frison" era (1900–1945); the "Ross and Ricker" era (1946–1975) and the "Present" (1976–2000). These records are especially important today with government mandates to protect aquatic habitats and their biota, and state agencies actively working to identify high- quality streams and populations of stream-dependent species at risk of extirpation (Page *et al.* 1992).

Present Habitat in Illinois

Although the general perception of Illinois may be field after field of corn and soybean extending south from the metropolitan area of Chicago, its north-south alignment offers a varied physiography. Large rivers (Wabash, Ohio, and Mississippi) surround two-thirds of Illinois with another broad river (Illinois River) running diagonally across the state from Chicago southwest to Alton. Within its boundaries lies a northern boreal region of natural lakes and tamarack bog (Lake and McHenry counties); finger-like remnants of the eastern deciduous forest still project into its eastern border (Vermilion County); a broad Appalachian-Ozark corridor spans the southern fourth of the state composed of limestone and sandstone hills with numerous small, pristine, gravel streams (Fig. 1A&B); a coastal plain with lowland marshes and tupelo-bald cypress swamps (Alexander, Massac, Pulaski counties); and a driftless (unglaciated) area in northwestern Illinois (Carroll and Jo Daviess counties). Schwegmann (1973) has divided Illinois into 14 natural divisions (Fig. 2).

Within Illinois, 25 major river drainages have been outlined (Page *et al.* 1992) (Fig. 3). For these drainages Hite and Bertrand (1989) developed an index from "A" to "E" to identify biologically significant streams in Illinois based on fish populations, water quality, and aquatic macroinvertebrates. A stream segment categorized as "A" was a high-quality stream. Page *et al.* (1992) expanded this list of biologically significant streams by considering additional information on biodiversity, in particular, information on endangered and threatened species, and Mollusca and crustacean diversity. Within these drainages, the Illinois Water Quality Report (IEPA 1990, 1996) describes water quality conditions in terms of the degree waters attain designated uses such as:

Full Support: The water quality meets the needs of all designated uses protected by applicable water-quality standards.

Full Support/Threatened: Water quality is presently adequate to maintain designated uses, but if a declining trend continues, only partial support may be attained in the future.

Partial Support/Minor Impairment: Water quality has been impaired, but only to a minor degree. There may be minor exceedences in applicable water- quality standards or criteria for assessing the designated use attainment.

Partial Support/Moderate Impairment: Water-quality conditions are impaired to a greater degree inhibiting the waterbody from meeting all the needs for that designated use.

Nonsupport: Water quality is severely impaired and not capable of supporting the designated use to any degree.

These conditions give the most recent assessment of the general health of drainage basin.

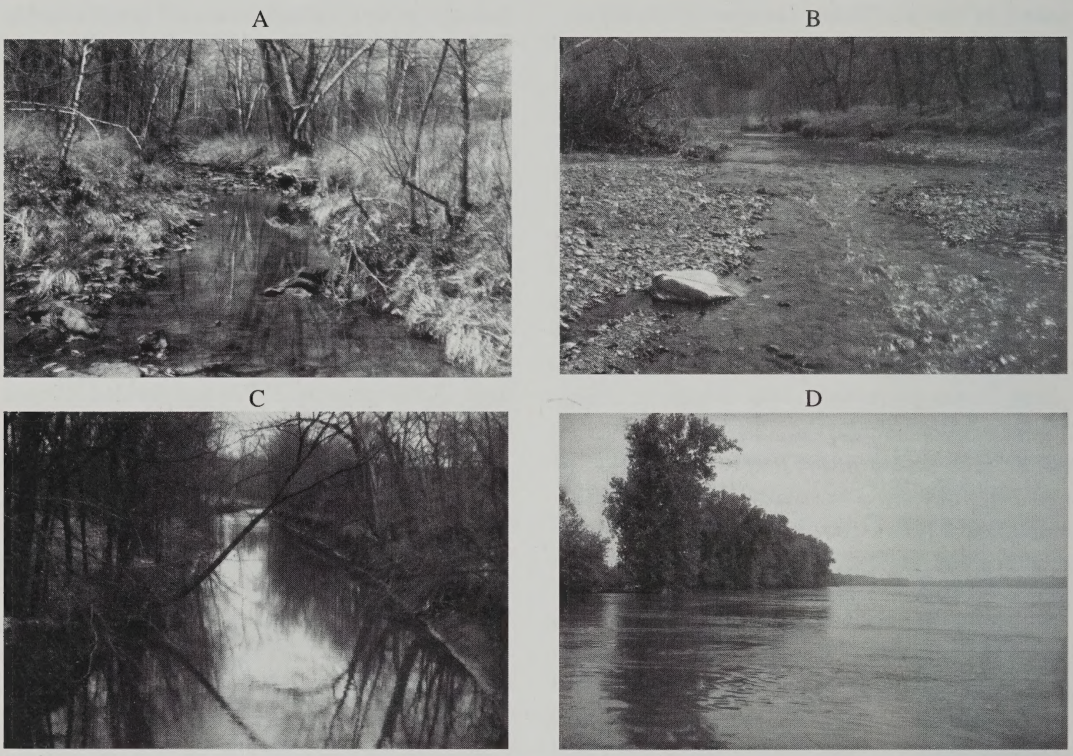

Figure 1. Winter stonefly habitats. (A). Ephemeral stream. (B). Gravel riffles. (C). Tributary of Sangamon River. (D). Mississippi River. Photos by Donald W. Webb, INHS.

Biology of Stoneflies

Winter stoneflies (Table 1, Fig. 4) play a vital role in the energy and production of these streams (Stewart and Stark 1988). They undergo univoltine (one year) or semivoltine (two or more years) life cycles. These cycles may be heterodynamic (Wigglesworth 1974, Butler 1984) in having an egg or nymphal diapause, or homodynamic, and having no regular period of dormancy (Stewart and Stark 1988). Species with heterodynamic development cycles are referred to as fast (short-term development) and those with homodynamic cycles as slow (development over most of the required generation time) (Stewart and Stark 1988). Stewart and Stark (1988) and Ernst and Stewart (1985) found that *Allocapnia rickeri* exhibited a univoltine, fast cycle in Oklahoma, whereas it exhibited a univoltine, slow cycle in southern Canada (Harper 1973). Krueger and Cook (1981) noted a longer developmental time for *A. rickeri* in Minnesota with small nymphs appearing in July, growing rapidly until December, slowing growth in December-January, then resuming growth until a March-April emergence. Snellen and Stewart (1979) reported an interesting example of indeterminate voltinism for *Zealeuctra* species in intermittent Texas streams. Their continuous field and laboratory study during the period November 1974 to April 1977 showed that given cohorts of both *Z. claasseni* and *Z. hitei* were able to undergo both univoltine cycles from nondiapausing and short-term diapausing eggs in wet and normal rainfall years, and semivoltine cycles from diapausing eggs following at least two years of drought. Both nondiapausing and diapause eggs from given adult cohorts were confirmed with laboratory incubation experiments. Small numbers of adults were reared from the nondiapausing eggs in the laboratory to corroborate the univoltine aspect of the cycle. This is perhaps a good example in stoneflies of the "relict seed phenomenon" (Giesel 1976), in which adults effectively prolong their reproductive effort by producing eggs with delayed and asynchronous development (Stewart and Stark 1988).

Eggs: In some stoneflies several matings may occur and several batches of eggs laid (Hitchcock 1974). Capniids apparently lay only a single

Figure 2. The Natural Division of Illinois (Schwegman 1973). See Table 3 for division names.

Figure 3. The drainage basins of Illinois (Page *et al.* 1992). See Table 4 for drainage names.

batch of 100–700 eggs (Coleman and Hynes 1970, Khoo 1964).

Egg development: There appear to be four basic patterns of embryonic nymphal development (Stewart and Stark 1988): short term, synchronous (3–8 weeks) in homodynamic species; optional short- to long-term in homodynamic species; long-term, synchronous, or asynchronous (5>24 months) in diapausing eggs of heterodynamic species; and a combination of short-term nondiapausing eggs and long-term, synchronous or asynchronous diapausing eggs. In the long-term pattern, development to the advanced eyespot protonymph stage may be (a) short-term, within about four weeks or (b) long-term, requiring most of the diapause period.

Nymphal growth and development: First instar nymphs open the chorion by pushing with an egg tooth located on, or consisting of, the frons (DeGrange 1957; Khoo 1968a, 1968b; Hynes 1976). The shell splits into two halves (Komatsu 1971, Brittain 1973, Hynes 1976)

The first instars are consistent in being unpigmented, without ocelli, and having antenna:cercal segment formulae of 8-11:3-5; compound eyes of 2–4 ommatidia; gills absent, reduced, or represented only by knobs or stubs, generally few hairs compared with later instars; and three tarsal segments, the first two short and together subequal to the longer third (Snellen and Stewart 1979, for *Zealeuctra claasseni*). Harper (1979) observed that first instars of Ontario euholognathan species began feeding immediately after eclosion.

Nymphal diapause has been reported in a variety of winter stoneflies: Capniidae: *Allocapnia granulata* (Harper and Hynes 1970, Pugsley and Hynes 1985), *A. pygmaea* (Coleman and Hynes 1970, Harper and Hynes 1972, Pugsley and Hynes 1985) and *A. vivipara* (Coleman and Hynes 1970, Pugsley and Hynes 1985); Nemouridae: *Prostoia completa* (Ernst and Stewart 1985); and Taeniopterygidae: *Strophopteryx fasciata* (Harper and Hynes 1970,

Table 1. Winter Stoneflies of Illinois (Harris and Webb 1995)

Capniidae
- ***Allocapnia***
  - *forbesi* Frison
  - *granulata* (Claassen)
  - *illinoensis* Frison
  - *mystica* Frison
  - *nivicola* (Fitch)
  - *recta* (Claassen)
  - *rickeri* Frison
  - *smithi* Ross and Ricker
  - *vivipara* (Claassen)
- ***Nemocapnia***
  - *carolina* Banks
- ***Paracapnia***
  - *angulata* Hanson

Leuctridae
- ***Zealeuctra***
  - *claasseni* (Frison)
  - *fraxina* Ricker and Ross
  - *narfi* Ricker and Ross

Nemouridae
- ***Prostoia***
  - *completa* (Walker)

Taeniopterygidae
- ***Strophopteryx***
  - *fasciata* (Burmeister)
- ***Taeniopteryx***
  - *burksi* Ricker and Ross
  - *lita* Frison
  - *metequi* Ricker and Ross
  - *nivalis* (Fitch)
  - *parvula* Banks

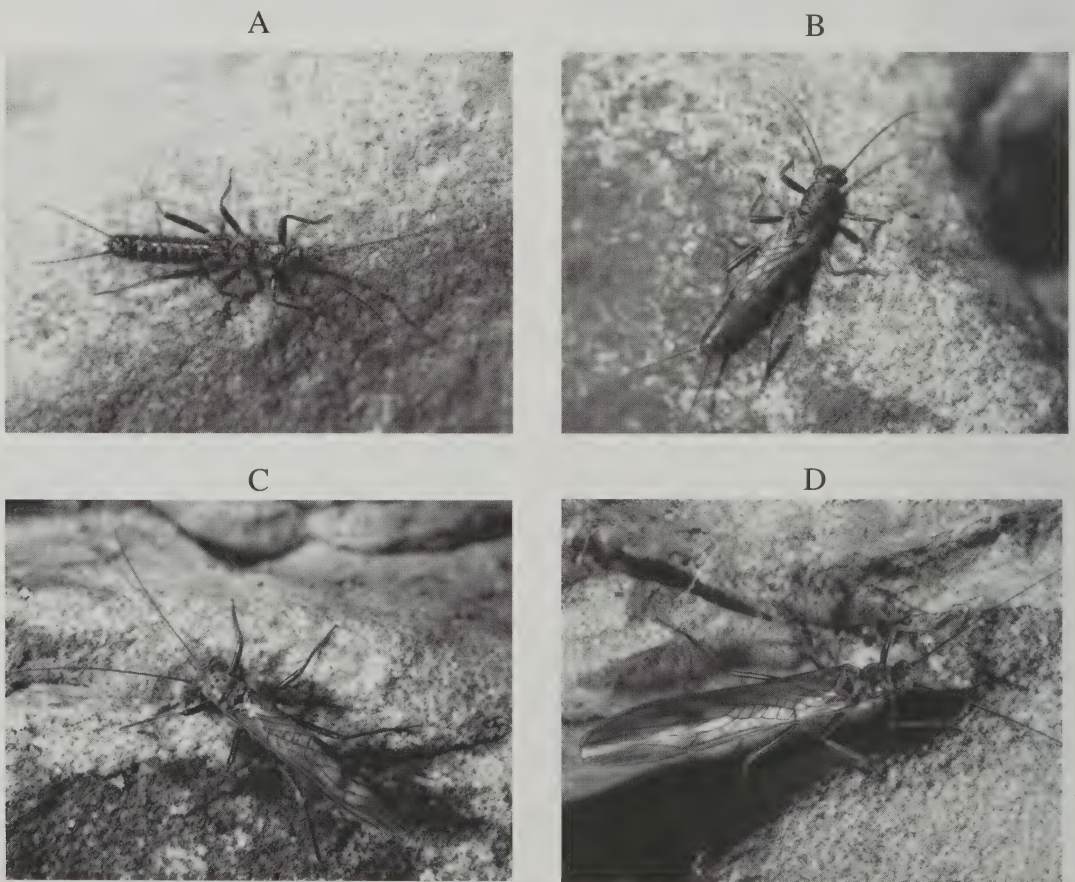

Figure 4. *Allocapnia vivipara*, male (A), female (B). *Taeniopteryx burksi,* male (C), female (D). Photos by Michael Jeffords, INHS.

1972), *Taeniopteryx burksi* and *T. nivalis* (Harper and Hynes 1970, 1972, Pugsley and Hynes 1985).

Instar number varies within many species (Hitchcock 1974, Hynes 1976, Butler 1984, Jop and Szczytko 1984) and is relatively large, 10–22 plus (Butler 1984, Sephon and Hynes 1982).

Winter- and most early-spring-emerging euhologhnathan families grow fastest in cold water (Stewart and Stark 1988). Nymphs crawl out of the water on objects, plant their claws, and adults emerge from the nymphal skin, often over a surprisingly short period of time (i.e., 5 minutes, Stewart and Stark 1988) to several hours. Winter species, particularly capniids, emerge under surface ice (Harper and Hynes 1972).

Food habits: Stoneflies have diversified their food habits so that the different species fill about every conceivable major food niche in streams (Stewart and Harper 1996, Stewart and Stark 1988). They generally fall into three feeding groups: phytophagous, feeding strictly on algae and organic detritus (Brinck 1949, Frison 1929, Hitchcock 1974, Hynes 1941, Jones 1950, Wu 1923); polyphagous or omnivorous, feeding on plant and animal material; and carnivorous, feeding strictly on aquatic invertebrates, predominately chironomids (Fuller and Stewart 1977, Hitchcock 1974, Richardson and Gaufin 1971, Short and Ward 1980).

Natural enemies: Hitchcock (1974) reported hunting spiders attacking winter stoneflies and found an immature of *Pityohyphantes phrygianus* feeding on *Taeniopteryx burksi.* He also reported on a few records of birds, odonates, frogs and bats feeding on adult stoneflies and Hamilton (1932) reported bluejays feeding on stoneflies. In contrast, Hitchcock (1974) cited numerous references where stonefly nymphs were fed upon by fish, water shrews, turtles, water dippers, *Cinclus mexicanus*, salamanders, crayfish, and other aquatic insects. He also cites a few references of parasites inhabiting stoneflies.

Drumming: Hitchcock (1974), Ziegler and Stewart (1977, 1985, 1988), Snellen and Stewart (1979), Szczytko and Stewart (1979), Stewart *et al.* (1982a, 1982b), Maketon and Stewart (1984, 1988), Stewart and Maketon 1991), Stewart (1997) cite a variety of references for drumming activity within the Plecoptera. Ziegler and Stewart (1977) and Snellen and Stewart (1979) described the drumming behavior of *Zealeuctra claasseni.*

Mating: Hitchcock (1974) reported that the male mounts the back of the female, placing his abdomen to her side and recurving the apex of his abdomen to position his genitalia in line with the female terminalia on the ventral surface

Drift: Most Plecoptera have a low propensity to drift (Brusven 1970; Elliot 1967a, 1967b; Stewart and Szczytko 1983) but when it occurs it is generally in pre-emergent instars, just after sunset. For *Allocapnia rickeri* (Ernst and Stewart 1985) drift was correlated to their standing stock. Ernst and Stewart (1985: Fig. 3) reported that nymphs of *Prostoia completa* drifted during February and March and that the size of the drifting nymphs was always greater than the average size of nymphs concurrently found in benthic samples. Ernst and Stewart (1985: Fig. 4) reported that a few nymphs of *A. rickeri* displayed pre-sunset drifting at the beginning of emergence.

In contrast to drifting, adults and nymphs of Plecoptera can disperse upstream (Hitchcock 1974). Both sexes fly with the wind (Elliot 1967b, Hitchcock 1974) and may disperse significant distances. Adults also have been reported to walk upstream once they reach the shoreline (Hitchcock 1974, Thomas 1966). Nymphs of *Allocapnia pygmaea* have been observed moving upstream by Hultin *et al.* (1969) and Bishop and Hynes (1969).

Economic importance: In general, adult stoneflies are of little economic importance. They have been reported as a minor pest of orchards and ornamental plants (Hitchcock 1974; Kawai 1967; Newcomer 1918, 1950; Schuh and Mote 1948).

Distribution and seasonal activity: 21 species of winter stoneflies have been reported for Illinois, although 4 species now appear to be extirpated from the state (*Allocapnia illinoensis, Nemocapnia carolina, Paracapnia angulata, Taeniopteryx parvula*). Eight of the extant winter stoneflies are restricted to the Shawnee Hills of southern Illinois (*Allocapnia forbesi, A. mystica, A. smithi, Prostoia completa, Taeniopteryx metequi, Zealeuctra claasseni, Z. fraxina, and Z. narfi*). Six species have a general distribution over much of Illinois (*Allocapnia recta, A. rickeri, A. vivipara,*

Strophopteryx fasciata, Taeniopteryx burksi, T. lita), two species are found in the northern third of the state (*Allocapnia granulata, Taeniopteryx nivalis*), and one species was found in the remnants of the eastern deciduous forest in Cole and Vermilion counties of eastern Illinois (*A. nivicola*).

METHODS

To re-evaluate the biodiversity and distribution of winter stoneflies in Illinois, attempts were made to collect adults from every county in the state. Extensive efforts were made to collect stoneflies in areas where specimens had been previously reported by Frison, Ross, and Ricker and for those species that were rare in Illinois.

Specimens were collected as they walked on bridge railings, bridge abutments, ice, and snow; by beating or sweeping low hanging brush, weedy vegetation and grass along the stream margins; by separating leaf packs and woody debris in a large tray; and by collecting specimens sitting on or under rocks or logs that projected from a stream. Specimens were preserved in 80% ethyl alcohol, identified, and entered into our database.

The entire Plecoptera collection of the Illinois Natural History survey has been recurated and the species reorganized to conform to the current nomenclature (Stark *et al.* 1986). Collection information on all stonefly species in the INHS collections has been integrated into a Filemaker Pro database, utilizing field parameters similar to those used for existing INHS databases (fishes, molluscs, crayfishes, amphipods).

Keys to the families, genera, and species of Illinois winter stoneflies are provided. For each species, their nomenclatoral history is cited, along with a diagnostic description of the male, female, and nymph (when known) and information on their biology, habitat preference, distribution, seasonal activity, and current status in Illinois. Changes in the distribution pattern of each species for the historical period 1900–1945, from 1946–1975, and from 1976–2000 are mapped (Figs. 5–7) for each species. For those species with limited distributions in Illinois (10 localities or less), specific locality information is provided. Specific locality information on Illinois stoneflies may be obtained through the Illinois Natural History Survey Web site at www.inhs.uiuc.edu/cbd.EPT/index.html.

RESULTS

Table 2 outlines the species diversity of winter stoneflies in Illinois from 1900–1945, 1946–1975, 1976–2000, and for the past century 1900–2000.

Table 3 outlines the species diversity of winter stoneflies within the Natural Divisions of Illinois for the past century 1900–2000.

Table 4 outlines the species diversity of winter stoneflies within the drainage basins of Illinois for the past century 1900–2000.

Historical changes within a species' distribution pattern in Illinois from 1900–1945, 1946–1975, and 1976–2000 are presented within each species account.

DISCUSSION

The collections of winter stoneflies in Illinois made by Frison and colleagues from 1900–1945, by Ross and his "winter stonefly club" from 1946 to 1975, and my own extensive collecting during the 1990s as well as other specimens collected by colleagues for the period 1976–2000 provide us with a unique opportunity to examine the changing patterns of species diversity and distribution within three distinct time frames, as well as to look at the total overall picture for the past 100 years.

Frison (1900–1945) collected specimens from 54 counties at an average of 2.1 species per county. Ross and his "winter stonefly club" (1946–1975) collected in 46 counties, with an average of 1.9 species per county. From 1976 to 2000, attempts were made to collect winter stoneflies from every county in the state (Fig. 5), with an average of 1.9 species per county collected. When viewed over the past 100 years, the species diversity of winter stoneflies in Illinois averaged 2.5 species per county, with winter stoneflies reported in every county but 3 (Carroll, DuPage, Ford) and with 10 counties recording five or more species. In comparison to the century picture, recent collections (1976–2000) indicate that the overall species diversity

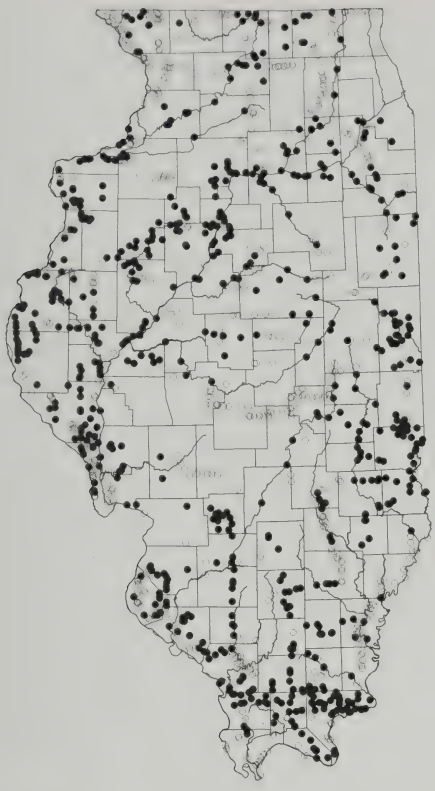

Figure 5. Recent (1976–2000) collecting sites for winter stoneflies in Illinois. Closed circles=specimens collected. Open circles=negative results.

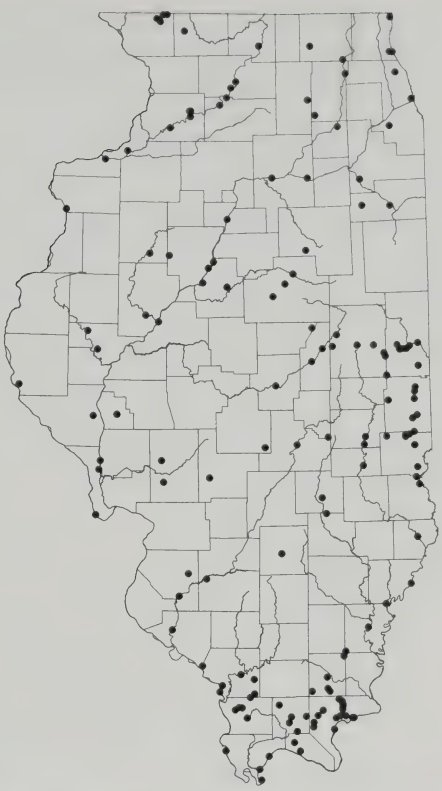

Figure 6. Collection sites for Illinois winter stoneflies 1900 through 1945.

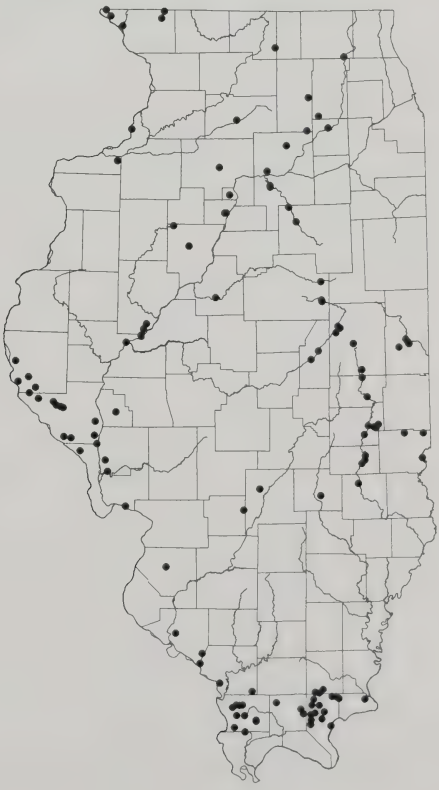

Figure 7. Collection sites for Illinois winter stoneflies during 1946–1975.

within the various counties has dwindled with winter stoneflies not found in 11 counties, and only 3 counties (Hardin, Pope, and Saline) exhibiting 5 or more species.

Over the past century (1900–2000), Pope County, with 13 species, has been the most species-rich county for winter stoneflies, although *Taeniopteryx lita* and *T. burksi* have not been collected there since the 1930s. Saline County with nine species reported, is interesting in that six of these species were collected only during the recent (1976–2000) resurvey. Clark County with eight species, has lost five of these species since 1975. Four of these species were from Rocky Branch, a favorite collecting site of Frison and Ross. Hardin County with seven species, has lost two of these species since 1946. In general, there has been a decline in species diversity per county.

Of the 21 species of winter stoneflies discovered during the past century (1900–2000), 7 species were found to be common (currently known from more than 15 localities): *Allocapnia forbesi*, restricted to the Shawnee Hills; *A. granulata*, its previous distribution reduced and now restricted to the Rock River drainage; *A. mystica*, its previous distribution reduced and now restricted to the Shawnee Hills; *A. rickeri*, abundant in the Shawnee Hills, with extensions up the eastern and western borders of Illinois; *A. vivipara* and *Taeniopteryx burksi*, widespread throughout state; *T. nivalis*, previously rare but now spreading its distribution across northern Illinois. Four species are considered uncommon (currently known from 4–15 localities): *Allocapnia recta,* scattered in eastern Illinois; *Strophopteryx fasciata*, widespread but disappearing from the state; *Taeniopteryx metequi* and *Zealeuctra claasseni*, restricted to the Shawnee Hills. Six species are considered rare (currently known from 1–3 localities): *Allocapnia nivicola*, known only from a single locality in Vermilion County; *A. smithi*, found in the eastern Shawnee Hills; *Prostoia completa*, known only from Hutchins Creek in the western Shawnee Hills; *Taeniopteryx lita*, scattered in east central Illinois; *Zealeuctra fraxina*, eastern Shawnee Hills; and *Z. narfi*, found at single localities in Saline, Union, and Vermilion counties. Four species are considered extirpated from Illinois: *Allocapnia illinoensis, Nemocapnia carolina, Paracapnia angulata*, and *Taeniopteryx parvula.*

Natural Divisions of Illinois

Schwegman (1973) outlined 14 Natural Divisions in Illinois (Fig. 2), and the species diver-

Table 2. The species diversity of winter stoneflies in Illinois by county.

Species per County	1900-2000	1900-1945	1946-1975	1976-2000
0	3			11
1	31	26	16	38
2	27	13	15	28
3	18	7	11	16
4	13	3	2	6
5	4	2	1	1
6	1	2	0	0
7	2	0	0	0
8	1	1	1	0
9	1			1
10	0			1
11	0			
12	1			
Number of counties	102	54	46	102
Species average/county	2.5	2.1	1.9	1.9

Table 3. The historical distribution (1900-2000) of winter stoneflies within the Natural Divisions of Illinois

Species/Divisions	WDD	RRHCD	NEMD	GPD	UM/IRBD	IMRSA	WFPD	MMBD	STPD	WBD	OD	LMRBD	SHD	CPD	Occurrence per Division
A. forbesi													X		1
A. granulata		X	X	X						X			X		5
A. illinoensis										X					1
A. mystica		X							X	X		X	X		5
A. nivicola				X						X					2
A. recta				X						X					2
A. rickeri	X				X		X	X	X		X	X	X		8
A. smithi													X		1
A.vivipara	X	X	X	X	X		X	X	X	X	X	X	X	X	13
N. carolina										X					1
P. angulata			X												1
P. completa													X		1
S. fasciata		X	X	X	X				X	X			X		7
T. burksi		X	X	X	X		X	X	X	X			X	X	10
T. lita									X	X			X		3
T. metequi													X		1
T. nivalis		X	X	X			X								4
T. parvula		X			X										2
Z. claasseni													X		2
Z. fraxina													X		1
Z. narfi										X			X		2
Species Richness	2	7	6	7	5	0	4	3	6	12	2	3	14	2	73

WDD(1*): Wisconsin Driftless Division. RRHD(2): Rock River Hill Country Division. NEMD(3): Northeast Morainal Division.
GPD(4): Grand Prairie Division. UM/IRBD(5): Upper Mississippi/Illinois River Bottomlands Division.
IMRSA(6): Illinois/Mississippi River Sand Areas Division. WFPD(7): Western Forest-Prairie Division.
MMBD(8): Middle Mississippi Bottomlands Division. STPD(9): Southern Till Plain Division.
WBD(10): Wabash Border Division. OD(11): Ozark Division. LMRBD(12): Lower Mississippi River Bottomlands Division.
SHD(13)*: Shawnee Hills Division. CPD(14): Coastal Plain Division.
*The number in parenthesis refers to the Natural Divisions numbered on the map in Figure 2 (Schwegman 1973).

Table 4. The distribution of winter stoneflies within the drainage basins in Illinois.

1900-2000

Species/Drainage	GAPRS	RRS	MMR T	DPRLMT	FRS	LVBBKCS	KIRS	VMRS	SPRS	LMRS	MRS	SRS	LIRABS	KRS	BMRS
A. forbesi															
A. granulata		X			X		X	X			X	X		X	
A. illinoensis															
A. mystica		X												X	X
A. nivicola			X												
A. recta															
A. rickeri	X		X						X	X				X	X
A. smithi															
A.vivipara	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
N. carolina															
P. angulata					X										
P. completa															X
S. fasciata		X	X		X	X	X	X			X	X			
T. burksi		X	X	X	X	X	X	X	X	X	X	X		X	
T. lita														X	
T. metequi															
T. nivalis		X			X		X		X						
T. parvula		X	X												
Z. claasseni															X
Z. fraxina															
Z. narfi															X
Species Richness	2	7	6	2	6	3	5	4	4	3	4	4	1	6	6

1976-2000

Species/Drainage	GAPRS	RRS	MMR T	DPRLMT	FRS	LVBBKCS	KIRS	VMRS	SPRS	LMRS	MRS	SRS	LIRABS	KRS	BMRS
A. forbesi															
A. granulata		X													
A. illinoensis															
A. mystica															X
A. nivicola															
A. recta															
A. rickeri			X							X					X
A. smithi															
A.vivipara	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
N. carolina															
P. angulata															
P. completa															X
S. fasciata							X								
T. burksi		X	X		X	X	X	X	X	X	X	X		X	
T. lita														X	
T. metequi															
T. nivalis		X			X		X		X						
T. parvula															
Z. claasseni															X
Z. fraxina															
Z. narfi															
Species Richness	1	4	3	1	3	2	4	2	3	3	2	2	1	3	5

GAPRS(1): Galena, Apple, Plum Rivers Systems. RRS(2): Rock River System.
MMRT(3): Middle Mississippi River Tributaries. DPRLMT(4): Des Plaines River & Lake Michigan Tributaries.
FRS(5): Fox River System. LVRBBKCS(6): Little Vermilion River, Big Bureau & Kickapoo Creek Systems.
KIRS(7): Kankakee-Iroquois River Systems. VMRS(8): Vermilion-Mazon River Systems.
SPRS(9): Spoon River System. LMRS(10): LaMoine River System. MRS(11): Mackinaw River System.
SRS(12): Sangamon River System. LIRT-ABS(13): Lower Illinois River Tributaries-American Bottoms Systems.
KRS(14): Kaskaskia River System. BMRS(15): Big Muddy River System.

* The numbers in parentheses ( ) refer to the drainage basins on the map in Figure 3.

Table 4 continued.

1900-2000

Species/Drainages	CRS	MBLBGPBCS	SalRS	LWRBCS	ERWRTS	VLVRS	IR	MR	OR	WR	Occurrence per Drainage
A. forbesi		X	X								2
A. granulata		X			X	X	X				11
A. illinoensis					X						1
A. mystica		X	X		X	X					7
A. nivicola						X					2
A. recta					X	X					2
A. rickeri		X	X	X							9
A. smithi		X	X								2
A.vivipara	X	X	X	X	X	X	X	X	X	X	25
N. carolina										X	1
P. angulata											1
P. completa											1
S. fasciata		X		X	X					X	12
T. burksi	X	X		X	X	X	X	X	X	X	21
T. lita		X		X	X				X		5
T. metequi		X									1
T. nivalis							X				5
T. parvula											2
Z. claasseni		X	X								3
Z. fraxina		X									1
Z. narfi		X									2
Species Richness	2	13	6	5	8	6	4	2	3	4	116

1976-2000

Species/Drainages	CRS	MBLBGPBCS	SalRS	LWRBCS	ERWRTS	VLVRS	IR	MR	OR	WR	Occurrence per Drainage
A. forbesi		X	X								2
A. granulata							X				2
A. illinoensis											0
A. mystica		X	X								3
A. nivicola						X					1
A. recta					X	X					2
A. rickeri		X	X	X							6
A. smithi		X	X								2
A.vivipara	X	X	X	X	X	X	X		X		23
N. carolina											0
P. angulata											0
P. completa											1
S. fasciata		X									2
T. burksi		X			X	X	X	X	X		17
T. lita				X	X						3
T. metequi		X									1
T. nivalis							X				5
T. parvula											0
Z. claasseni		X	X								3
Z. fraxina		X									1
Z. narfi		X									1
Species Richness	1	11	6	3	4	4	4	1	2	0	75

CRS(16): Cache River System. MBLBGPBCS(17): Massac, Bay, Lusk, Big Grand Pierre, Big Creek Systems.
SalRS(18): Saline River System. LWRBCS(19): Little Wabash River-Bonpas Creek Systems.
ER-WRTS(20): Embarras River-Wabash River Tributaries. VLVRS(21): Vermilion-Little Vermilion River Systems.
IR(22): Illinois River System.MR(23): Mississippi River System. OR(24): Ohio River System.
WB(25): Wabash River System

* The numbers in parentheses ( ) refer to the drainage basins on the map in Figure 3.

sity of winter stoneflies within these divisions over the past 100 years (Table 3) has undergone a significant decline. Winter stoneflies have been collected in 13 of these divisions with only the Illinois/Mississippi River Sand Areas lacking winter stoneflies.

In the last century (1900–2000), winter stoneflies had been reported on 73 occasions in the natural divisions of Illinois with an average of 5.2 species per division. Fourteen species and 12 species were reported, respectively, from the Shawnee Hills and Wabash Border Divisions. The remaining natural divisions recorded 0–8 species at an average of 3.4 species per division.

Early on, Frison and his colleagues (1900–1945) recorded winter stoneflies on 58 occasions within the natural divisions with an average of 4.1 species per division. Twelve species were recorded from the Shawnee Hills Division and 10 species within the Wabash Border. The remaining 12 divisions recorded 0–6 species. From 1946 to 1975, winter stoneflies were recorded on only 40 occasions within the natural divisions with an average of 2.9 species per division, with only 8 species found within the Shawnee Hills Division and 6 species within the Wabash Border Division. The remaining 12 divisions recorded 0–5 species.

During the recent resurvey (1976–2000), winter stoneflies were recorded on 52 occasions in the natural divisions with an average of 3 species per division. The Shawnee Hills Division (11 species) was still the most species- rich area although *Allocapnia granulata,* and *Taeniopteryx lita* have disappeared from this division. Six species—*Allocapnia illinoensis, A. granulata, A. mystica, Nemocapnia carolina, Strophopteryx fasciata,* and *Zealeuctra claasseni*—have disappeared from the Wabash Border Division, although *Allocapnia nivicola* and *Zealeuctra narfi* have been added to this area recently. This division displayed the greatest loss of winter stoneflies. The remaining 12 divisions recorded 0–5 species with the Western Forest-Prairie and Ozark divisions reporting an increase in species richness. Overall, the species diversity of winter stoneflies within the Natural Divisions of Illinois has declined by an average of over two species per division. This decline appears to be a pattern over the entire state with the exception of the Western Forest Prairie and the Ozark divisions.

Allocapnia vivipara (collected in 13 divisions) and *Taeniopteryx burksi* (collected in 10 divisions) displayed the greatest geographic range as measured by natural divisions. *Allocapnia forbesi, A. illinoensis, A. smithi, Nemocapnia carolina, Paracapnia angulata, Prostoia completa, Taeniopteryx metequi, T. parvula,* and *Zealeuctra fraxina* were restricted to one natural division.

River Drainages

Page *et al.* (1992) outlined the 25 river drainages within Illinois (Fig. 3) and the following summary evaluates the occurrence of winter stoneflies within these basins (Table 4) over the past century. The number in parentheses following the name of each drainage refers to Figure 3.

Galena, Apple, and Plum River systems (1)

These rivers and their tributaries lie within the Wisconsin Driftless Area of Illinois and drain 2,214 sq. km (855 sq. mi.) (Page *et al.* 1992). Streams in this area are highly variable in their substrates, ranging from gravel and silt to cobble and bedrock. Row crops and pasture form the major land use and silt run-off and barnyard pollution appear to be the major pollutants of the streams (Page *et al.* 1992).

Smith (1971) rated the Apple River as good, with an excellent rating in the upper reaches. The Galena River was rated as good and the Plum River as fair. The Illinois Water Quality Report (IEPA 1996) rated most of the Apple and Galena Rivers as *Full Support* and 14 km of the Galena River, Coon Creek, Lilly Branch, Wolf Creek and the South Fork Apple River as *Partial Support/Minor Impairment.* The Illinois Water Quality Report (IEPA 1990) rated the Plum River and its tributary Carroll Creek as *Partial Support/Minor Impairment.* Phosphorus released in municipal wastewater discharges and agricultural runoff led to the lower ratings. Although this area is one of the most attractive areas of Illinois, there are no "A" streams in this region (Hite and Bertrand 1989, Page *et al.* 1992). The rivers and tributaries in this area were rated from "B" to "C."

Only two species of winter stoneflies have been collected from this area. *Allocapnia rickeri* was collected prior to 1946 in the Apple River drainage in and around Apple River State Park. Although several recent trips were made to this

area, this species was not collected. Much of the natural areas around the Apple River and it tributaries have been cleared for pastureland. Here, the trees and vegetation have been removed up to the stream edge. *Allocapnia vivipara* has been collected at several localities within Jo Daviess County, but no winter stoneflies have been collected in Carroll County through which much of the Plum River and its tributaries run. The absence of winter stoneflies from Carroll County is somewhat perplexing, as the county is not heavily impacted by agriculture and numerous pristine gravel streams run off the limestone bluffs along its western border.

Rock River System (Rock, Pecatonica, Kishwaukee, and Green River drainages) (2)
The Rock River (Page *et al.* 1992) drains an area of 13,838 sq. km and runs from the Wisconsin border north of Rockford to the Mississippi River at Rock Island. The river is predominately a gravel-bottomed stream interspersed with sand, rubble, and silt. The creation of channel dams has significantly altered the current and depth of this river. Channelization has been extensive in the southern and eastern areas of this basin. The principal land use is row crops and pasture leading to extensive siltation. This river has also had a history of domestic and industrial pollution, especially below Rockford and Sterling. Phosphorus, siltation, and channel modifications have adversely affected this river and its tributaries (IEPA 1996).

The Pecatonica River (Page *et al.* 1992) drains an area of 2,085 sq. km with the primary stream substrate being sand and silt. Phosphorus, siltation, and municipal wastewater discharges have impacted this river and its tributaries (IEPA 1996).

The Kishwaukee River (Page *et al.* 1992) drains an area of 3,173 sq. km and is separated into a North and South Branch. The upper reaches of the North Branch have a substrate of gravel, which changes to silt and sand downstream. The South Branch consists primarily of rocks with a mixture of gravel and sand. Phosphorus, organic enrichment, agricultural runoff, and municipal wastewater discharges have impacted this river and its tributaries (IEPA 1996).

The Green River and its tributaries (Page *et al.* 1992) drain an area of 2,930 sq. km over a lake plain of sand and gravel outwash from the Wisconsinan Glacier. Most of this river has been channelized. Siltation, agricultural runoff, channelization, and animal, domestic, and industrial wastes have vastly altered this stream (IEPA 1996).

Smith (1971) rated the Rock River as good to excellent, except where it ran through extensive urban or industrial areas. Hite and Bertrand (1989) and Page *et al.* (1992) rated the Kishwaukee River, upstream from South Branch, Piscasaw Creek, upstream from West Branch, and the entire Rush Creek as "A" streams along with the Sugar River, and upstream from Otter Creek in the Pecatonica River drainage.

Over the past century (1900–2000), seven species, *Allocapnia granulata, A. mystica, A. vivipara, Strophopteryx fasciata, Taeniopteryx burksi, T. nivalis,* and *T. parvula,* have been collected from this drainage area. *Allocapnia mystica, S. fasciata,* and *T. parvula* have not been collected here since the 1930s. *Allocapnia vivipara,* although it is the most common species of winter stonefly in Illinois, has not been collected often within the Rock, Pecatonica, and Green River drainages and is still scarce within these drainages. *Allocapnia granulata* is well established along the Rock River and its tributaries, as well as on the Green River and the Kishwaukee. *Taeniopteryx burksi* is the most widespread winter stonefly in this area, being found all along the Rock River, with populations still present on the Green River, the Pecatonica, and the Kishwaukee. *Taeniopteryx nivalis* is a northern species of *Taeniopteryx* that was first collected in Illinois along the Fox River and it tributaries in the 1960s. During the recent resurvey (1976–2000), it was collected widely along the upper Rock River, the Green River, the Pecatonica, and the Kishwaukee River.

Middle Mississippi River tributaries (Edwards River, Henderson Creek, Bear Creek, Sny Creek, Bay Creek) (3)
This area (Page *et al.* 1992) drains numerous small streams along the eastern Mississippi and western Illinois River bottomlands, which are primarily covered by the Middle Mississippi Border (Schwegman 1973). This is an area of mixed forest and upland prairie, although row crops and pasture are the primary land uses.

Agricultural siltation, herbicides, fertilizers, and livestock sewage contributes much of the pollution to the streams of this area.

The Edwards River (Page *et al.* 1992) drains an area of 1,129 sq. km, although it has been channelized for much of its length. The stream substrate is principally sand and silt.

Henderson Creek (Page *et al.* 1992) and its tributaries drain an area of 1,572 sq. km with a bottom substrate of silt and sand with scattered gravel riffles. The lower extremities of this creek have been channelized.

Bear Creek and its tributaries (Page *et al.* 1992) drain an area of 2,595 sq. km with a bottom substrate of sand and gravel. The lower extremities of this creek have been channelized as well as various tributaries.

Sny Creek and its tributaries (Page *et al.* 1992) originally drained an area of 1,961 sq. km, but now after diversion drain 787 sq. km, with a bottom substrate of sand and gravel.

Bay Creek (Page *et al.* 1992) drains an area of 456 sq. km with a bottom substrate of sand and gravel. The lower extremities of this creek are confined within a levee for 24 km before entering the Mississippi River.

Smith (1971) categorized the streams of this area as poor to fair, with agricultural pollution, siltation, and desiccation from drought as the major environmental problems in this area. The Illinois Water Quality Report (IEPA 1996) rated half of the Edwards River, much of Henderson River and Bear Creek as *Full Support,* with the upper portion of Cedar Creek and Middle Henderson Creek as *Partial Support/Moderate Impairment* and Bay Creek, half of the Edwards River and 126.5 stream km of Bear Creek as *Partial Support/Minor Impairment. Nonsupport* was limited to 2.1 km of Cedar Creek due to organic enrichment and elevated levels of ammonia. Hite and Bertrand (1989) and Page *et al.* (1992) listed no "A" streams in this area, with some streams in this area listed as "D" streams (streams with limited aquatic resource).

Over the last century (1900–2000), four species of winter stoneflies, *Allocapnia rickeri, A. vivipara, Strophopteryx fasciata,* and *Taeniopteryx burksi* have been collected in the various streams of this drainage area. *Allocapnia rickeri* is rare in this area and recently has been collected at a single site in each of Calhoun and Pike counties. *Strophopteryx fasciata* has not been collected in these streams since the 1920s. Currently, *A. vivipara* is widespread throughout this area. *Taeniopteryx burksi* was collected at two sites in Calhoun County during the 1920s but recently (1976–2000) has been collected at several sites in each of Calhoun and Pike counties, as well as being widespread within the Edwards River and Henderson Creek drainages.

Des Plaines River and Lake Michigan tributaries (Des Plaines, DuPage rivers) (4)

This area (Page *et al.* 1992) encompasses principally Lake, Cook, DuPage, and Will counties and drains an area of 3,188 sq. km, which falls within the Northeastern Morainal and Grand Prairie Natural Divisions (Schwegman 1973). Over the past 40 years, urbanization and industrial use have heavily impacted it. Eutrophication from treated and untreated sewage is a major pollution problem for streams in this drainage.

The Des Plaines River historically contained large areas of rapids, riffles, and rocky shallows, although today little remains of what was considered a dangerous river (Vierling 1977). The river bottom is bedrock covered with sand and gravel (Page *et al.* 1992) although the sand and gravel is often imbedded with organic muck. Considerable dredging and channelization has altered this stream, in addition to the construction of two major lock and dam structures. This stream has been heavily impacted by pollution.

The DuPage River (Page *et al.* 1992) has two major branches with the West Branch having numerous riffles and gravel flats, and the East Branch having a substrate of silt and muck. The DuPage River proper contains numerous riffles and small rapids. Forty-one km of this stream have been channelized and several small dams impound its flow.

Smith (1971) rated the Des Plaines River as poor with domestic and industrial sewage being the major pollution problem. The Illinois Water Quality Report (IEPA 1996) rated 80% of the Des Plaines River as *Partial Support/Minor Impairment* and 17% as *Partial Support/Moderate Impairment* with nearly 90% of the DuPage River rated as *Full Support.* Hite and Bertrand (1989) and Page *et al.* (1992) rated Manhattan Creek as an "A" stream.

Over the past century (1900–2000), only *Allocapnia vivipara* and *Taeniopteryx burksi* have been collected in this drainage. *Allocapnia vivipara* can still be collected in northern Will County, but *Taeniopteryx burksi* has not been collected in this drainage since the 1920s.

Fox River system (5)

The Fox River and its tributaries (Page *et al.* 1992) drain an area of 4,455 sq. km and fall within the Northeastern Morainal and Grand Prairie Natural Divisions (Schwegman 1973). The upper portion of this drainage contains numerous natural lakes, while the lower portion of the Fox River and its tributaries have a bottom substrate of gravel, cobble, and sand.

Smith (1971) rated the Fox River as good to excellent with domestic and industrial pollution its dominant pollution problems. The Illinois Water Quality Report (IEPA 1996) rated 80.4% of the Fox River drainage as *Full Support* with 15.6 % as *Partial Support/Minor Impairment.* Hite and Bertrand (1989) and Page *et al.* (1992) rated Buck Creek as the only "A" stream in this drainage.

Over the past century (1900–2000), six species of winter stoneflies, *Allocapnia granulata, A. vivipara, Paracapnia angulata, Strophopteryx fasciata, Taeniopteryx burksi,* and *T. nivalis* have been collected within this drainage. *Paracapnia angulata* and *Strophopteryx fasciata* have not been collected here since the 1920s. *Paracapnia angulata* was restricted in Illinois to several seep springs in the Elgin Botanical Garden (now Trout Park) and was not collected recently although several specific trips were made to this site in search of this species. *Allocapnia granulata* has not been collected within this drainage since the 1960s. *Allocapnia vivipara* and *Taeniopteryx burksi* are still found abundantly within this drainage. *Taeniopteryx nivalis* began being collected within this drainage in the 1960s and recently (1976–2000) has expanded its range throughout this drainage.

Little Vermilion River, Big Bureau and Kickapoo Creek systems (6)

The Little Vermilion River, Big Bureau Creek, Kickapoo Creek, and their tributaries are located in north-central Illinois on the west side of the Illinois River (Page *et al.* 1992) and fall within the Grand Prairie, Upper Mississippi River and Illinois Bottomlands, and Western Forest-Prairie Natural Divisions (Schwegman 1973). Row crops and pasture are the principal land use within this drainage.

The Little Vermilion River (Page *et al.* 1992) drains an area of 326 sq. km with a bottom substrate of sand and gravel. Smith (1971) rated this drainage as fair. The Illinois Water Quality Report (IEPA 1990) rated this drainage as *Partial Support/Moderate Impairment.*

Big Bureau Creek (Page *et al.* 1992) drains an area of 1,259 sq. km with a bottom substrate of sand and gravel. Smith (1971) rated this drainage as good to excellent. The Illinois Water Quality Report (IEPA 1996) rated 76.2% of this drainage as *Full Support* and 23.6% as *Partial Support/Minor Impairment.*

Kickapoo Creek (Page *et al.* 1992) drains an area of 793 sq. km, principally in Peoria County. Much of this area is utilized for row crops, which has created a problem with siltation. Local discharge of domestic sewage is also a pollution problem. Smith (1971) rated this drainage as good. The Illinois Water Quality Report (IEPA 1990) rated this drainage as *Partial Support/ Minor Impairment.*

Smith (1971) rated Big Bureau Creek as good to excellent, Kickapoo Creek as good, and the Little Vermilion River as fair. Hite and Bertrand (1989) and Page *et al.* (1992) rated no streams in this system as "A."

Over the past century (1900–2000), four species of winter stoneflies, *Allocapnia granulata, A. vivipara, Strophopteryx fasciata,* and *Taeniopteryx burksi* have been collected within this drainage. Both *Allocapnia granulata* and *Strophopteryx fasciata* were collected in this system at single localities during the 1960s but were not collected recently (1976–2000). *Allocapnia vivipara* and *Taeniopteryx burksi* were collected at scattered localities by both Frison (1900–1945) and Ross (1946–1975) but after the recent resurvey (1976–2000) are considered widespread through these drainages.

Kankakee and Iroquois River systems (7)

The Kankakee River System (Page *et al.* 1992) drains an area of 5,618 sq. km principally in the Grand Prairie Natural Division (Schwegman 1973).

The Kankakee River flows through the flat terrain on an old glacial lake (Page *et al.* 1992) over a substrate of bedrock covered with a thin layer of sand and gravel upstream of Kankakee. Downstream from Kankakee the river runs through silted pools and long stretches of bedrock.

The Iroquois River (Page *et al.* 1992) drains an area of 3,212 sq. km, principally in Iroquois County, with primarily a silt substrate.

Smith (1971) rated the Kankakee and Iroquois rivers as excellent. The Illinois Water Quality Report (IEPA 1996) rated 89.3 % of this drainage as *Full Support* and 2.8% as *Full Support/Threatened.* Hite and Bertrand (1989) rated no streams in this system as "A."

Over the past century (1900–2000), five species of winter stoneflies, *Allocapnia granulata, A. vivipara, Strophopteryx fasciata, Taeniopteryx burksi,* and *T. nivalis* have been collected within this drainage area. No winter stoneflies were collected in this drainage basin by Ross and his colleagues (1946–1975). *Allocapnia granulata* has not been collected here since the 1920s. Recently (1976–2000), *Taeniopteryx nivalis* has moved into this area and has been collected in both the Kankakee and Iroquois River drainages. *Strophopteryx fasciata* is somewhat rare in this system but is still present at two localities along the Iroquois River. Both *Allocapnia vivipara and Taeniopteryx burksi* are widespread throughout this area.

Vermilion and Mazon River systems (8)

The Vermilion and Mazon rivers (Page *et al.* 1992) drain an area of 5,180 sq. km in central Illinois south of the Illinois River, predominately in the Grand Prairie Natural Division (Schwegman 1973). Row crops are the dominant land use and siltation and agricultural runoff are the major pollution problems.

The Vermilion River (Page *et al.* 1992) drains an area of 3,447 sq. km. Upstream of Streator, the substrate is sand, silt, and gravel. Downstream of Streator, the substrate becomes gravel and cobble. Smith (1971) rated this river as fair with domestic and agricultural pollution a problem. The Illinois Water Quality Report (IEPA 1996) rated 85.4 % of this drainage as *Full Support* and 14.6% as *Partial Support/Minor Impairment.*

The Mazon River (Page *et al.* 1992) drains an area of 1,419 sq. km with a bottom substrate of gravel and rock. Smith (1971) rated this river as good. The Illinois Water Quality Report (IEPA 1996) rated this drainage as *Full Support.* Hite and Bertrand (1989) rated no "A" streams in this area.

Over the past century (1900–2000), four species of winter stoneflies, *Allocapnia granulata, A. vivipara, Strophopteryx fasciata,* and *Taeniopteryx burksi,* have been collected in this area. *Strophopteryx fasciata* has not been collected here since the 1920s, and *Allocapnia granulata* has not been taken here since the 1960s. Most recently (1976–2000), only the two commonest species of winter stoneflies in Illinois, *Allocapnia vivipara* and *Taeniopteryx burksi,* have been collected in this drainage system.

Spoon River system (9)

The Spoon River (Page *et al.* 1992) drains an area of 4,804 sq. km on the west side of the Illinois River, predominately in the Western Forest-Prairie Division with the upper reaches in the Grand Prairie Natural Division (Schwegman 1973). This drainage system flows through flat prairie land that is now dominated by row crops and has a bottom substrate of gravel and sand. The major pollution problems are siltation, pesticides, stripmine and industrial waste, and domestic and animal waste. Smith (1971) rated this drainage area as fair, with excessive siltation and agricultural pollution as problems. The Illinois Water Quality Report (IEPA 1996) rated portions of the Spoon River and most of the tributaries as *Full Support* and some portions of the Spoon River and Big Creek as *Partial Support/ Minor Impairment.* Hite and Bertrand (1989) and Page *et al.* (1992) rated no "A" streams in this area.

Over the past century (1900–2000), four species of winter stoneflies, *Allocapnia vivipara, Strophopteryx fasciata, Taeniopteryx burksi,* and *T. nivalis*, have been collected within this drainage. *Strophopteryx fasciata* has not been collected here since the 1920s and *T. nivalis,* a winter stonefly that is expanding its distribution in northern Illinois, has recently (1976–2000) been collected here at a single site. *Allocapnia vivipara* and *Taeniopteryx burksi* are both widespread within this drainage.

LaMoine River system (10)

The LaMoine River drainage (Page *et al.* 1992) consists primarily of the LaMoine River and McKee Creek. This system encompasses an area of 3,497 sq. km principally in the Western Forest-Prairie Natural Division (Schwegman 1973), with bottom substrates principally of sand with some gravel.

Smith (1971) rated the LaMoine River as fair with siltation and agricultural pollution affecting the quality of the LaMoine River and its tributaries. The Illinois Water Quality Report (IEPA 1996) rated 79.2% of this drainage as *Full Support* and 20% as *Partial Support/Minor Impairment.* An 11-km stretch of the South Branch of the LaMoine River was rated as *Partial Support/ Moderate Impairment.* Hite and Bertrand (1989) and Page *et al.* (1992) rated the LaMoine River from Flour Creek to Cedar Creek as an "A" stream.

Over the past century (1900–2000), three species of winter stoneflies, *Allocapnia rickeri, A. vivipara,* and *Taeniopteryx burksi* have been collected in this system. *Allocapnia vivipara* has been recorded from this drainage since the 1920s. Recently (1976–2000), *Taeniopteryx burksi* has been collected at several localities and *A. rickeri* at one site along the LaMoine River. This is one of the few instances when the overall species diversity has increased within a drainage system.

Mackinaw River system (11)

The Mackinaw River (Page *et al.* 1992) and its three main tributaries, Panther, Walnut, and Money creeks, drain an area of 2,942 sq. km primarily in the Grand Prairie Natural Division (Schwegman 1973) of central Illinois. The bottom substrate of these streams is sand and gravel with scattered silt and cobble. The Mackinaw River has no dams on it, but the upper 17.7 km have been channelized. Ninety percent of the drainage area has been converted to row crops, and siltation and agricultural pollution are the major environmental problems.

Smith (1971) rated this drainage as good to excellent and the Illinois Water Quality Report (IEPA 1996) rated this drainage as *Full Support.* Hite and Bertrand (1989) and Page *et al.* (1992) rated several tributaries and parts of the Mackinaw River as "A" streams. As a percentage of the total drainage area, the Mackinaw River system has the highest number of "A" streams in Illinois.

Over the past century (1900–2000), four species of winter stoneflies, *Allocapnia granulata, A. vivipara, Strophopteryx fasciata,* and *Taeniopteryx burksi,* have been collected within this system. *Strophopteryx fasciata* has not been collected here since the 1920s and *Allocapnia granulata* has not been reported here since the 1960s. *Allocapnia vivipara* and *Taeniopteryx burksi* are still well established within this system.

Sangamon River system (12)

The Sangamon River system (Page *et al.* 1992) drains an area of 14,035 sq. km primarily in the Grand Prairie Natural Division (Schwegman 1973) of central Illinois. The topography of the basin is rolling with flat valleys along the rivers. Five major impoundments impede the flow of this stream. Two areas, between Decatur and Springfield and between Petersburg and Beardstown, have been channelized. Row crops cover much of the topography and coal mining occurs within the southern half of this basin. Siltation, agricultural pesticides and fertilizer, domestic sewage, and acid mine waste are the dominant pollutants of the streams. The bottom substrate of the streams is sand, with gravel, silt, and cobble.

Smith (1971) rated the Sangamon from good to fair. The Illinois Water Quality Report (IEPA 1990) rated most of this river as *Partial Support/Minor Impairment* with 6 km rated as *Partial Support/Moderate Impairment.* Hite and Bertrand (1989) and Page *et al.* (1992) rated three streams, Drummer, Goose, and Ten Mile creeks, as "A." Most tributaries were rated "B," with the main stream of the Sangamon as "C." A small segment of the upper Sangamon was rate "D."

Over the past century (1900–2000), four species of winter stoneflies, *Allocapnia granulata, A. vivipara, Strophopteryx fasciata,* and *Taeniopteryx burksi,* have been collected within this system. *Strophopteryx fasciata* has not been collected here since the 1920s and *Allocapnia granulata* has not been reported here since the 1960s. *Allocapnia vivipara* and *Taeniopteryx burksi* are still well established within this system.

Lower Illinois River tributaries and American Bottoms (13)

The American Bottoms and the tributaries of the lower Illinois River (Page *et al.* 1992) drain an area of approximately 5,856 sq. km, primarily in the Western Forest-Prairie, Lower Mississippi River Bottomlands, and the Ozark Natural Division (Schwegman 1973) in southwestern Illinois. The topography is rolling uplands and bottomlands along the Illinois and Mississippi rivers. Row crops form the major land use, with urban and industrial development prevalent in the southern bottomland around East St. Louis. Siltation, pesticides, and fertilizers from the uplands and domestic and industrial waste in the lowlands form the major pollution problems to streams in this system. Sand forms the predominate bottom substrate with some gravel and cobble with considerable silt in the lower reaches.

Smith (1971) and Page *et al.* (1992) rated several streams in this area as variable, with Wood River and Cahokia Creek as poor. The Illinois Water Quality Report (IEPA 1990) rated the upper reaches of Cahokia Creek, Sandy Creek, and part of Macoupin Creek as *Full Support* with most streams rated as *Partial Support/Minor Use*. The lower 4.8 km of Wood River were rated as *Non Support*. Hite and Bertrand (1989) and Page *et al.* (1992) rated streams in this region as "B" and "C." Siltation, pesticides and fertilizers from agricultural practices, as well as pollution from coalmines and oil fields affect the quality of streams in this area.

Over the past century (1900–2000), only *Allocapnia vivipara* has been reported from this area and it has been consistently collected in this drainage since the 1920s.

Kaskaskia River system (14)

The Kaskaskia River drainage (Page *et al.* 1992) extends from Champaign County in east-central Illinois to the Mississippi River and drains an area of 15,022 sq. km within the Grand Prairie, Southern Till Plain, and Ozark Natural Divisions (Schwegman 1973). Sand and gravel is the primary substrate for most streams with some silt. Shelbyville and Carlyle Reservoirs form two major impoundments on this stream and the lower reaches have been channelized. Row crops form the major land use but coal underlies much of this basin and several oilfields are active. Siltation, pesticides and fertilizers from agricultural practices, as well as pollution from coalmines and oil fields affect the quality of streams in this area.

Smith (1971) rated the Kaskaskia River as variable and the Illinois Water Quality Report (IEPA 1996) rated 2,407 km as *Full Support*, 96 stream km as *Full Support/Threatened,* 1,841 stream km as *Partial Support/Minor Impairment*, and 397 stream km as *Partial Support/Minor Impairment.* Hite and Bertrand (1989) and Page *et al.* (1992) rated parts of Ramsey Creek and the West Okaw River as "A." The majority of the basin was rated as "B" with the lower reaches rated as "C" or "D."

Over the past century (1900–2000), six species, *Allocapnia granulata, A. mystica, A. rickeri, A. vivipara, Taeniopteryx burksi,* and *T. lita,* have been reported from this system. *Allocapnia granulata, A. mystica, and A. rickeri* have not been collected in this drainage since the 1960s. *Taeniopteryx lita* has always been rare in this drainage, and recent collecting (1976–2000) found it at only one locality. *Allocapnia vivipara* and *Taeniopteryx burksi* have always been widespread over this system.

Big Muddy system (15)

The Big Muddy system (Page *et al.* 1992) drains 6,112 sq. km in southern Illinois within the Southern Till Plain, Shawnee Hills, and Lower Mississippi River Bottomlands Natural Divisions (Schwegman 1973). Half of this drainage area supports row crops and coal underlies the southwestern part of this basin. The bottom substrate of most streams is clay and three impoundments Rend, Crab Orchard, and Kinkaid reservoirs impede the flow of this system. Siltation, pesticides and fertilizers from agricultural practices, as well as pollution from coalmines and oil fields affect the quality of streams in this area.

Smith (1971) rated the lower reaches as good and the upper reaches above Murphysboro as very poor. The Illinois Water Quality Report (IEPA 1996) rated 15.3% of this drainage as *Full Support, 81%* as *Partial Support/Minor Impairment,* and *3.6%* as *Partial Support/Minor Impairment.* Hite and Hebrand (1989) and Page *et al.* (1992) rated Miller creek as an "A" stream, but the remainder of the system varied from "B" to "D."

Over the past century (1900–2000), six species, *Allocapnia mystica, A. rickeri, A. vivipara, Prostoia completa, Zealeuctra claasseni,* and *Z. narfi,* have been collected within this system. *Zealeuctra narfi* has not been collected here since the 1920s, but *Z. claaseni* was recently (1976–2000) collected in a tributary of the Big Muddy River. *Prostoia completa* is a rare species in Illinois, collected at a single site by Frison (1900–1945) from Hutchins Creek and has been recollected there recently (1976–2000). *Allocapnia mystica, A. rickeri,* and *A. vivipara* are still well established within this system. For some unknown reason, no species of *Taeniopteryx* have been collected within this drainage basin.

Cache River system (16)

The Cache River system (Page *et al.* 1992) drains an area of 2,717 sq. km in southern Illinois primarily within the Coastal Plain Natural Division (Schwegman 1973), with a small portion of its upper reaches extending into the Ozark and Shawnee Hills divisions. The upper reaches drain through rolling hills and the stream substrate is primarily gravel riffles, but once out of the Shawnee Hills, the basin is low-lying, and has been severely impacted by dredging and channelization with the substrate becoming silt. Row crops and the Shawnee National Forest cover most of this basin, and siltation, pesticides, and fertilizers from agricultural practices affect the quality of streams in the lower reaches.

Smith (1971) rated the Cache River as good, and the Illinois Water Quality Report (IEPA 1990) rated this drainage as *Partial Support/ Minor Impairment,* with Lick Creek rated as *Full Support.* Hite and Bertrand (1989) and Page *et al.* (1992) rated the streams within this basin as "C" (moderate aquatic resource).

Over the past century (1900–2000), three species, *Allocapnia mystica, A. rickeri,* and *A. vivipara,* have been collected from this drainage. *Allocapnia mystica* and *A. rickeri* have not been collected in this drainage since the 1960s. *Allocapnia vivipara* has remained well established within this system.

Massac, Bay, Lusk, Big Grand Pierre, and Big Creek systems (17)

These systems of streams (Page *et al.* 1992) drain a small area of 1,331 sq. km, principally in the Shawnee Hills Natural Division (Schwegman 1973) with Massac Creek and Mud Creek falling within the Coastal Plain Division. The topography here is primarily rolling hills in the Shawnee Hills and flat lowland in eastern Massac County. The Shawnee National Forest covers much of this area, with row crops being cultivated in the lowlands. Stream substrates are primarily gravel with patches of bedrock, cobble, and some sand. Streams in the lowlands have bottom substrates of silt. Occasional siltation is a problem in the upper reaches but heavier siltation, pesticides, and fertilizers from agricultural practices affect the quality of lowland streams in eastern Massac County.

Smith (1971) rated Big Creek and Lusk Creek as outstanding streams in this area, with the majority of streams being rated as excellent, with only the lowland streams in eastern Massac County being rated as good. The Illinois Water Quality Report (IEPA 1990, 1996) rated the streams in the Shawnee Hills area as *Full Support* with Massac and Mud Creeks being considered *Partial Support/Minor Impairment.* Hite and Bertrand (1989) and Page *et al.* (1992) rated upper Lusk and Big Creeks as "A" streams with the remaining streams in Hardin and Pope counties as "B" except for their lowest extremities.

Over the past century (1900–2000), 13 species of winter stoneflies, *Allocapnia forbesi, A. granulata, A. mystica, A. rickeri, A. smithi, A. vivipara, Strophopteryx fasciata, Taeniopteryx burksi, T. lita, T. metequi, Zealeuctra claasseni, Z. fraxina,* and *Z. narfi,* have been collected from this region. Only *Allocapnia granulata* and *Taeniopteryx lita* have not been collected here since the 1920s. All of the other species are still well established within this region.

Saline River system (18)

The Saline River System (Page *et al.* 1992) drains an area of 3,048 sq. km primarily within the Southern Till Plain and the Wabash Border Natural Divisions (Schwegman 1973) of southeastern Illinois, with a small amount of the Saline River and the South Fork of the Saline River extending into the Shawnee Hills Division. Much of this basin is flat with the bottom substrate of the slow moving streams being covered with silt. Row crops form the dominant land

use, but coal mining and oil wells are present. Siltation, pesticides, and fertilizers from agricultural practices as well as leaching of acid water from abandoned coal mines, strip mine waste, and leakage of brine from oil wells affect the quality of streams in this basin (Allen and Wayne 1973, Page *et al.* 1992).

Smith (1971) rated the Saline River as poor and the Illinois Water Quality Report (IEPA 1996) rated a 28-km reach of Bear Creek in the North Fork and Sugar Creek (except for the lowermost 46.8 km) in the South Fork as *Full Support;* the North Fork, Middle Fork, and the lower 2.3 km of the Saline River as *Partial Support/ Minor Impairment;* a 22.4-km reach of the Saline River below the confluence of the North and South Forks as *Partial Support/Moderate Impairment*; and 3.4 km of the South Fork and 6.8 km of Sugar Creek as *Nonsupport.* Hite and Bertrand (1989) and Page *et al.* (1992) rated no "A" streams within this drainage, with the streams varying in characterization from "B" (highly valued aquatic resource) to "D" (limited aquatic resource).

Over the past century (1900–2000), six species of winter stoneflies, *Allocapnia forbesi, A. mystica, A. rickeri, A. smithi, A. vivipara,* and *Zealeuctra claasseni,* have been collected from this area. *Allocapnia rickeri* and *A. smithi* were not collected by Frison (1900–1945) or Ross (1946–1975) from this drainage, and for some unknown reason species of *Taeniopteryx* have not been collected in this drainage. Still, overall there has been a increase in the diversity of species collected within this system.

Little Wabash River and Bonpas Creek systems (19)

This drainage system (Page *et al.* 1992) encompasses an area of 8,936 sq. km primarily in the Southern Till Plain and Wabash Border Natural Divisions (Schwegman 1973) of southeastern Illinois. This area is characterized by broad flat uplands and U-shaped valleys with the substrate of the streams consisting of silt and sand. Land use is primarily row crops, with all of the area underlain by coal (Barker *et al.* 1967), in addition to one-third of the oil produced in Illinois coming from this area (Page *et al.* 1992). Siltation, pesticides, fertilizers from agricultural practices, and oil field pollution affect the quality of streams in this basin.

Smith (1971) rated the lower reaches of the Little Wabash River as poor and the upper reaches as good. He rated Bonpas Creek as fair. The Illinois Water Quality Report (IEPA 1990) has generally rated the Little Wabash River as *Partial Support/Minor Impairment.* Hite and Bertrand (1989) and Page *et al.* (1992) rated the streams in this system as "B" (highly valued aquatic resource) and "C" (moderate aquatic resource).

Over the past century (1900–2000), five species of winter stoneflies, *Allocapnia rickeri, A. vivipara, Strophopteryx fasciata, Taeniopteryx burksi,* and *T. lita,* have been collected in this system. *Allocapnia rickeri* and *Taeniopteryx lita* were not collected by either Frison (1900–1945) or Ross (1946–1975) in this system, but recently (1976–2000), each species has been collected at single localities. *Taeniopteryx burksi* has not been collected here since the 1920s and *Strophopteryx fasciata* not since the 1960s. Only *Allocapnia vivipara* is well established in this basin.

Embarras River and Wabash River tributaries (20)

The Embarras River and Wabash River tributaries (Page *et al.* 1992) encompass an area of 7,646 sq. km in southeastern Illinois within the Grand Prairie, Southern Till Plain, and Wabash Border Natural Divisions (Schwegman 1973). This basin has a topography of rolling hills and low flat land in the Wabash bottoms. The substrate of streams is gravel and sand in the upper reaches and silt in the lowlands. Row crops are the principal land use, with scattered oil fields. Siltation, pesticides, fertilizers from agricultural practices, and oil field pollution affect the quality of streams in this basin.

Smith (1971) rated the Embarras River as variable, with the middle reaches of the Embarras designated as one of Illinois' outstanding streams (Evers and Page 1977, Smith 1971). The Illinois Water Quality Report (IEPA 1996) rated 51.9% of the Embarras River as *Full Support,* 43.3% was rated as *Partial Support/Minor Impairment*, and *4.8%* was rated as *Full Support/ Threatened.* Hite and Bertrand (1989) and Page *et al.* (1992) rated Riley Creek as an "A" stream. Most of this basin was rated "B" with the lower reaches rated "C."

Over the past century (1900–2000), eight species of winter stoneflies, *Allocapnia granulata, A. illinoensis, A. mystica, A. recta, A. vivipara, Strophopteryx fasciata, Taeniopteryx burksi,* and *T. lita,* have been collected within this basin. *Allocapnia mystica* has not been collected here since the 1920s and *A. granulata, A. illinoensis,* and *S. fasciata* have not been collected here since the 1960s. *Taeniopteryx lita* was not collected in this drainage by either Frison (1900–1945) or Ross (1946–1975), but recently (1976–2000) was collected at a single locality. *Allocapnia recta* has been uncommon in this drainage basin but still can be found at two localities. *Allocapnia vivipara* and *Taeniopteryx burksi* remain widespread throughout this system.

Vermilion and Little Vermilion River systems (21)

The Vermilion and Little Vermilion systems (Page *et al.* 1992) drain an area of 4,268 sq. km in east-central Illinois within the Grand Prairie and Wabash Border Natural Divisions (Schwegman 1973). Much of the topography here is gently rolling with stream substrates being sand and gravel with some cobble and silt. Row crops are the major land use but much of this area is also underlain by coal. Siltation, pesticides and fertilizers from agricultural practices, and domestic sewage affect the quality of streams in this basin.

Smith (1971) rated the streams in this basin as variable, with the Middle Fork of the Vermilion River as one of the outstanding streams in the state. The Illinois Water Quality Report (IEPA 1996) rated all of the Vermilion River and Little Vermilion River as *Full Support.* Hite and Bertrand (1989) and Page *et al.* (1992) rated Jordan Creek, Spoon River, and the Middle Fork from Knights Branch to its mouth as "A." The remainder of the basin was rated "B" with the Little Vermilion River not being rated.

Over the past century (1900–2000), six species of winter stoneflies, *Allocapnia granulata, A. mystica, A. nivicola, A. recta, A. vivipara,* and *Taeniopteryx burksi,* have been collected in this system. *Allocapnia mystica* has not been collected since the 1920s, and *A. granulata* has not been collected since the 1960s. *Allocapnia nivicola* is rare in Illinois and a single new locality was found at Forest Glen Forest Preserve. *Allocapnia recta, A. vivipara,* and *Taeniopteryx burksi* remained well established within this drainage basin.

Illinois River (22)

The Illinois River proper (Page *et al.* 1992) extends 439 km from the confluences of the Kankakee and Des Plaines rivers to the Mississippi. Much of it length has undergone human disturbances from the dumping of untreated sewage and industrial waste to the development of six dams. Much of the original flow of this river has now been impeded and the substrate is primarily sand and silt. Row crops are the major land use along this river and siltation, pesticides, and fertilizers from agricultural practices severely affect the quality of this stream.

The Illinois Water Quality Report (IEPA 1996) rated all of the mainstem of the Illinois River as *Full Support/Minor Impairment.*

Over the past century (1900–2000), four species of winter stoneflies, *Allocapnia granulata, A. vivipara, Taeniopteryx burksi,* and *T. nivalis* have been collected from this river. Recently (1976–2000), *Allocapnia granulata* and *Taeniopteryx nivalis* each have been collected at one locality along the river. *Allocapnia vivipara* and *Taeniopteryx burksi* remain well established in the Illinois River.

Mississippi River (23)

The Mississippi River proper (Page *et al.* 1992) forms a 1,094-km border along the western side of Illinois. Because of the need for navigation in this river, much of it original character has been altered. Twenty-six locks and dams from Minneapolis, Minnesota, to Alton, Illinois, have seriously impounded the flow of this river. The substrate is principally sand. Siltation has been a major form of pollution as well as domestic and industrial pollution and run off of agricultural pesticides and fertilizers into the streams that feed this river.

The Illinois Water Quality Report (IEPA 1990) rated the Mississippi River from East Dubuque to Quincy as *Full Support*, from Quincy to the mouth of Chain of Rocks Canal as *Partial Support/Minor Impairment*, from there to the Meramec River as *Non Support*, and from the Meramec River to the Ohio River as *Partial Support/Moderate Impairment.*

Over the past century (1900–2000), two species, *Allocapnia vivipara* and *Taeniopteryx burksi,* have been collected along this river. No winter stoneflies were collected by Frison (1900–1945) or Ross (1946–1975) from the Mississippi River. Both records were made during recent collecting (1976–2000). Attempts to collect winter stoneflies along this river were made from several of the bridges that cross the river, but little collecting along the shoreline proper was conducted.

Ohio River (24)

The Ohio River proper (Page *et al.* 1992) extends from its confluence with the Wabash River across the southern tip of Illinois to the Mississippi River. Its flow has been impeded over it entire length by 20 locks and dams, creating a substrate of silt.

Over the past century (1900–2000), four species, *Allocapnia vivipara, Strophopteryx fasciata, Taeniopteryx burksi,* and *T. lita,* have been collected along this river in Illinois. *Strophopteryx fasciata,* and *T. lita* have not been collected from the river since the 1920s, but *A. vivipara* and *T. burksi* are still established.

Wabash River (25)

The Wabash River proper (Page *et al.* 1992) runs for 319 km along the southeast border of Illinois. The substrate is sand, gravel, and rock with pools and riffles. No locks or dams impede the flow of this river.

The Illinois Water Quality Report (IEPA 1996) rated the Wabash River from Terre Haute, Indiana, to the Ohio River as *Partial Support/ Minor Impairment.* Industrial, municipal, and agricultural pollution impinges upon the quality of this river.

Over the past century (1900–2000), four species of winter stoneflies, *Allocapnia vivipara, Nemocapnia carolina, Strophopteryx fasciata,* and *Taeniopteryx burksi,* have been collected from the Illinois portion of this river. *Nemocapnia carolina* has not been collected along the Illinois portion of the river since the 1920s, and *Allocapnia vivipara, Strophopteryx fasciata*, and *Taeniopteryx burksi* have not been collected along here since the 1960s. Although numerous trips were made recently (1976–2000) to collect winter stoneflies along the Wabash River, not a single specimen was collected. This is a rather strange situation as easy access to the shoreline of the river is available at several sites.

Over the past 100 years, the species richness of winter stoneflies within the 25 drainage basins of Illinois ranged from 1 in the lower Illinois River-American Bottoms to 13 within the Massac, Bay, Lusk, Big Grand Pierre, and Big Creek System. Following the recent resurvey (1976–2000), the species richness ranged from 0 in the Wabash River (where 4 species had been collected previously) to 11 within the Massac, Bay, Lusk, Big Grand Pierre, and Big Creek System. Twenty-two of the 25 drainage basins displayed a reduction in species richness. Four species (*Allocapnia illinoensis, Nemocapnia carolina, Paracapnia angulata,* and *Taeniopteryx parvula)* are considered extirpated from the state and eight other species displayed a reduction in the diversity of drainage basins in which they had previously been collected. *Strophopteryx fasciata* and *Allocapnia granulata* which historically had been collected in 12 and 11 drainage basins respectively, had their distributions reduced to 2 drainage basins.

SUMMARY

Over the past century (1900–2000), the species diversity of winter stoneflies averaged 2.5 species per county with species reported from every county but 3 (Carroll, DuPage, Ford) and with 10 counties recording 5 or more species. Pope County (14 species) reported the greatest species diversity of winter stoneflies.

Frison (1900–1945), collected in 54 counties finding an average of 2.1 species per county. Ross and his "winter stonefly club" (1946–1975) collected in 46 counties, reporting an average of 1.9 species per county.

During the recent resurvey of the state (1976–2000), attempts were made to collect winter stoneflies from every county, with an average of 1.9 species per county collected. Compared to the overall picture of winter stoneflies in Illinois (1900–2000), species diversity within the various counties has dwindled and now winter stoneflies are not found in 11 counties, and only 3 counties (Hardin, Pope, and Saline) exhibited 5 or more species. *Allocapnia granulata* and *Taeniopteryx lita* have disappeared from species-rich Pope

County. Saline County with nine species, is interesting in that six of these species were only collected recently. Clark County with eight species, has lost five species since 1975; four of these species were from Rocky Branch, a favorite collecting site of Frison and Ross. Hardin County with seven species, has lost two species since 1946. Seven species were found to be common (currently known from more than 15 localities): *Allocapnia forbesi*, restricted to the Shawnee Hills; *A. granulata*, its previous distribution reduced and now restricted to the Rock River drainage; *A. mystica*, its previous distribution reduced and now restricted to the Shawnee Hills; *A. rickeri*, abundant in the Shawnee Hills, with extensions up the eastern and western borders of Illinois; *A. vivipara* and *Taeniopteryx burksi*, widespread throughout state; *T. nivalis*, previously rare but now spreading its distribution across northern Illinois. Four species are considered uncommon (currently known from 4–15 localities): *Allocapnia recta,* scattered in eastern Illinois; *Strophopteryx fasciata*, widespread but disappearing from the state; *Taeniopteryx metequi* and *Zealeuctra claasseni*, restricted to the Shawnee Hills. Six species are considered rare (currently known from 1–3 localities): *Allocapnia nivicola*, known only from a single locality in Vermilion County; *A. smithi*, found in the eastern Shawnee Hills; *Prostoia completa*, known only from Hutchins Creek in the western Shawnee Hills; *Taeniopteryx lita*, scattered in east central Illinois; *Zealeuctra fraxina*, eastern Shawnee Hills; and *Z. narfi*, found at single localities in Saline, Union, and Vermilion counties. Four species are considered extirpated from Illinois: *Allocapnia illinoensis, Nemocapnia carolina, Paracapnia angulata*, and *Taeniopteryx parvula.*

Over the past century (1900–2000), the various species of winter stoneflies had been reported on 73 occasions within the 14 Natural Divisions of Illinois on an average of 5.2 species per division. The remaining natural divisions recorded 0–8 species. Only the Illinois/Mississippi River Sand Areas Division lacked winter stoneflies. The Shawnee Hills (14 species) and Wabash Border (12 species) divisions were the most speciose. *Allocapnia vivipara* (13 divisions) and *Taeniopteryx burksi* (10 divisions) displayed the greatest diversity. *Allocapnia forbesi, A. illinoensis, A. smithi, Nemocapnia carolina, Paracapnia angulata, Prostoia completa, Taeniopteryx metequi, T. parvula,* and *Zealeuctra fraxina* were restricted to one natural division.

From 1900–1945, they were collected on 58 occasions at an average of 4.1 species per division. Twelve and 10 species were recorded, respectively, from the Shawnee Hills and Wabash Border divisions, with the remaining 12 divisions recording 0–6 species.

From 1946–1975, they were recorded on 40 occasions at an average of 2.9 species per division. Eight and six species were found, respectively, within the Shawnee Hills and Wabash Border divisions with the remaining 12 Divisions recording 0-4 species.

During the recent resurvey (1976–2000), winter stoneflies were recorded on 52 occasions at an average of 3 species per division. Overall, the species diversity within the Natural Division of Illinois has declined by an average of over two species per Division. The Shawnee Hills Division (11 species) was still the most species-rich area although *Allocapnia granulata*, and *Taeniopteryx lita* have disappeared from this division. Six species *Allocapnia illinoensis, A. granulata, A. mystica, Nemocapnia carolina, Strophopteryx fasciata,* and *Zealeuctra claasseni* have disappeared from the Wabash Border Division, although *Allocapnia nivicola* and *Zealeuctra narfi* have been added to this area recently. This division displayed the greatest loss of winter stoneflies. The remaining 12 divisions recorded 0–5 species with the Western Forest-Prairie and Ozark Divisions reporting an increase in species richness.

Over the past 100 years the species richness of winter stoneflies within the 25 drainage basins of Illinois ranged from 1 in the lower Illinois River-American Bottoms to 13 within the Massac, Bay, Lusk, Big Grand Pierre, and Big Creek System. Following the recent resurvey (1976–2000), the species richness ranged from 0 in the Wabash River (where 4 species had been collected previously) to 11 within the Massac, Bay, Lusk, Big Grand Pierre, and Big Creek System. The absence of winter stoneflies from the Wabash River is a strange situation because this river is considered to have good water quality. Several attempts were made to collect adults during the 1990s along the river's banks and on

bridges spanning it, however no adults were found. *Strophopteryx fasciata* and *Allocapnia granulata* which historically had been collected in 12 and 11 drainage basins respectively, had their distributions reduced to 2 drainage basins.

KEYS

Twenty-one species of winter stoneflies have been reported for Illinois. Keys to the various families, genera, and species are given. Within each species I have tried to pull together all of the pertinent related information; the nomenclatoral changes; the diagnostic characteristics of the males, females, and nymphs (when possible); information of their biology, habitat preference, distribution, and seasonal activity; and the current status of each species based on the recent resurvey of the state (1976–2000). Maps outlining their distribution patterns within Illinois for the Frison period (1900–1945), Ross period (1946–1975) and the recent resurvey of the state (1976-2000) are provided. When distribution records are limited, no distribution map is provided, rather the individual locality data are given.

Key to Families of Illinois Winter Stoneflies

Adults (from Poulton and Stewart 1991, Stewart and Harper 1996, Stark and Nelson 2000)

1. First and second tarsal segments subequal in length (as in Fig. 8.....Taeniopterygidae

   First tarsal segment much longer than second (as in Fig. 9).....2

2. Cerci multisegmented; forewing vein A_2 simple, unforked (Fig 12), intercubital crossveins few, usually 1-2.....Capniidae

   Cerci one-segmented; forewing vein A_2 forked (Fig. 13), intercubital crossveins numerous, usually 5 or more.....3

3. Wings lying flat over back; costal space with crossvein just beyond cord, forming X-pattern with adjoining veins (Fig.13).....Nemouridae

   Wings rolled, covering dorsum and sides of abdomen; costal space with no crossveins beyond cord.....Leuctridae

Nymphs (from Stewart and Stark 1988, Poulton and Stewart 1991)

1. First and second tarsal segments subequal in length (Fig. 8); coxae with single, telescoping gills or abdomen with large triangular ventroapical plate.....Taeniopterygidae

   Second tarsal segment wedge-shaped, shorter than first (Fig. 9); coxal gills and apical abdominal plates absent 2

2. Metathoracic wingpads strongly diverging from body axis (as in Fig. 17); cervical gills sometimes present; body short and robust; extended hindlegs reaching approximately to apex of abdomen .....Nemouridae (only *Prostoia completa*)

   Metathoracic wingpads essentially parallel to body axis (Fig. 16); cervical gills absent; body slender and elongate; extended hindlegs reaching far short of apex of abdomen.....3

3. Abdominal terga widest posteriorly (Figs. 18 and 19), with posterior setal fringe; membranous pleural fold on abdominal sterna 1–9; metathoracic wingpads about as wide as long, reduced or absent .....Capniidae

   Abdominal terga essentially parallel-sided, often without posterior fringe; membranous pleural fold not extending beyond sternum 7; metathoracic wingpads usually longer than wide .....Leuctridae

Capniidae

This family contains 10 North American genera and 152 species (Bill Stark 2001 http://www.mc.edu/campus/users/stark).

Adult capniids (Harper 1984, Stewart and Harper 1996, Stark and Nelson 2000) are characterized by having the glossae and paraglossae subequal in length and size (Fig. 15); the absence of gill remnant on the sides of the thorax; the wings at rest folded flat over the back and the forewing with only 1–2 median crossveins and one cubital crossvein; vein A_2 of forewing simple and unforked (Fig. 12); few intercubital crossveins; the first tarsal segment long, much longer than second (as in Fig. 9); the cerci multisegmented; and females with small subgenital plates. Hanson (1946) discussed the adult taxonomy of the Capniidae and gives a comparison of the morphology of the various genera within the Capniidae.

Nymphs (Harper and Hynes 1971a, Harper 1984, Stewart and Harper 1996) are small and dark with the glossae and paraglossae subequal in length (Fig. 15); thoracic sterna not overlapping posteriorly; the first tarsal segment long, much longer than second (Fig. 9); abdominal segments 1–2 lacking ventral gill tufts; abdominal terga and sterna on segments 1–9 separated by membranous pleural fold; abdominal terga widest posteriorly, with posterior fringe of setae (Fig. 18, 19). Nymphs of the Capniidae remain the most poorly known of all North American families (Stewart and Stark 1988) although Harper and Hynes (1971a) produced a key to various capniid species.

Biology: Capniids are principally sprawler-clingers in lotic situations where they feed as shredder-detritivores (Hynes 2000, Stewart and Harper 1996).

Key to Adults of Illinois Capniidae

(Harper 1984, Poulton and Stewart 1991, Stewart and Harper 1996)

1. Wings absent.....*Allocapnia*

   Wings present.....2

2. Cerci with less than 11 segments.....*Nemocapnia carolina*

   Cerci with more than 11 segments.....3

3. Anal lobe of hindwing enlarged, subequal in size to rest of wing (Fig. 20).....*Allocapnia*

   Anal lobe noticeably smaller than rest of wing (Fig. 21).....*Paracapnia angulata*

Key to Mature Nymphs of Illinois Capniidae

(Harper and Hynes 1971a, Harper 1984, Poulton and Stewart 1991, Stewart and Stark 1988)

1. Basal or apical cercal segments or both with multiple, long, fine hairs forming a prominent vertical fringe (Fig. 11).....*Nemocapnia carolina*

   Long cercal hairs restricted to apical segmental whorls, no prominent vertical fringe (Fig. 10).....2

2. Body and appendages densely clothed with long, stout bristles (Fig. 19), some abdominal bristles one-half or more as long as their segment.....*Paracapnia angulata*

   Bristles on body and appendage few or short (Fig. 18); abdominal hairs or bristles less than one-third length of segment .....*Allocapnia*

Allocapnia Claassen

Allocapnia Claassen (1928:667, 1931:111): Hanson (1946:211, 231), Harper (1984:105), Harper and Hynes (1971a:924), Illies (1966:122), Poulton and Stewart (1991:16), Stewart and Harper (1996:228, 246), Stewart and Stark (1988:98), Zwick (1973:360). New name for *Capnella*. Genotype: *Allocapnia granulata* (Claassen).

Capnella Claassen (1924:43). Name preoccupied.

Capnellula Strand (1935:304). New name for *Capnella* Claassen.

This genus contain 43 North American species (Bill Stark 2001 http://www.mc.edu/campus/users/stark).

Adults (Hanson 1946, Stewart and Harper 1996) of *Allocapnia* are characterized by having R_1 straight beyond origin of Rs; anal lobe of hindwing subequal in size to remainder of wing (Fig. 20), wings occasionally absent (*A. vivipara* males); cerci with more than 11 segments. Color dark brown. Length about 5 mm in males, 6 mm in females. Wings slightly smoky with brown veins; female wings extend beyond apex of abdomen; male wings highly variable within and among species. Hanson (1946:211) discussed the comparative morphology of the *Allocapnia* relative to other genera of capniids. Nymphs (Stewart and Harper 1996) of *Allocapnia* are characterized by having few bristles on body and appendages; wingpads brachypterous in males (absent in *A. vivipara*) and variable in females; the medial margin of the hindwing pad unnotched or notched close to apex; abdominal terga with posterior fringe of short setae, and scattered intercalary setae (Fig. 18); long hairs on cerci restricted to apical segmental whorls (as in Fig. 10).

Key to Males

(from Ross and Ricker 1971)

1. Wings vestigial (Fig. 4A); dorsal process on tergite 8 with low, sharp profile (Fig. 47) .....*vivipara*

   Wings about half as long as abdomen or greater.....2

2. Apical segment of upper limb of epiproct long, flat to tip, very thin and regular in profile, with short dorsal retrorse spines (Fig. 39) .....*recta*

   Apical segment of upper limb of epiproct either short, narrow, or tip expanded.....3

3. Dorsal process of tergite 8 forming pair of oblique rugose areas, their dorsal aspect U- or V-shaped (Fig. 27) ..... *granulata*

   Dorsal process forming a transverse bar or oval having 2 or 3 projecting apical points or lobes (Figs. 24, 31, 34, 37, 42, 45) 4

4. Tergite 7 with sclerotized process as large as sclerotized portion of tergite 8 (Figs. 24 and 31) 5

   Tergite 7 lacking sclerotized process or with small sclerotized ridge (Figs. 34, 37, 42, 45) 6

5. Sclerotized projection of tergite 8 triangular in lateral view, apex pointed posteriorly (Fig. 31)..... *illinoensis*

   Sclerotized projection of tergite 8 quadrate in lateral view, apex angulate (Fig. 24)..... forbesi

6. Dorsal process of tergite 8 with mesal point at least half height of lateral lobe (Fig. 45) 7

   Dorsal process of tergite 8 with only two apical lobes (Figs. 34 and 42) 8

7. Dorsal process of tergite 8 as high as wide, without a posterodorsal projecting corner; lower limb of epiproct wider and extending laterally considerably beyond upper limb, lateral margins often angulate (Fig. 37)..... *nivicola*

   Dorsal process wider, posterodorsal corner markedly projecting; lower limb of epiproct extending only slightly beyond sides of upper limb (Fig. 45)..... *smithi*

8. Apical segment of upper limb of epiproct ovoid, less than one-half length of base (Fig. 42)..... *rickeri*

   Apical segment more slender and more than one-half length of base (Fig. 34) ..... *mystica*

Key to Females

(from Ross and Ricker 1971)

1. Tergite 8 with sclerotization covering more that half of tergite (as in Fig. 22) 2

   Tergite 8 with mesal area membranous (as in Fig. 23) over length of tergite..... 3

2. Sternites 7 and 8 fused, mesal area forming solid transverse area, intersegmental suture obliterated (Fig. 48) ..... *vivipara*

   Sternites 7 and 8 with distinct intersegmental suture (Fig. 25) ..... *forbesi*

3. Sternites 7 and 8 solidly fused medially (Figs. 32, 38, 43, 46)..... 4

   Sternites 7 and 8 completely separated by membranous strip (Figs. 28, 35, 40)..... 7

4. Sternites 7 and 8 with medial suture not evident (Fig. 43) ..... *rickeri*

   Sternites 7 and 8 with medial suture indicated by a dark line (Figs. 32, 38, 46) 5

5. Apex of sternite 8 with wide sagittate medial portion contrasting sharply with less sclerotized remainder of mesal area (Fig. 32).....*illinoensis*

   Apex of sternite 8 with mesal area not contrasting noticeably with more basal area of sclerite 6

6. Sternite 8 with apical flap moderately wide; lateral humps of sternite chiefly membranous; the combination of the two producing an hourglass-shaped mesal dark area (Fig. 46) .....*smithi*

   Sternite 8 with apical flap narrower; lateral humps more extensively sclerotized (Fig. 38) .....*nivicola*

7. Sternite 8 with apicomedial area differentiated into a sagittate or emarginate fluted area set off laterally by pale membranous areas (Fig. 28) .....*granulata*

   Sternite 8 with apicomedial area not markedly differentiated from lateral areas (Figs. 35, 40) 8

8. Sternite 8 with apical margin concave (Fig. 40) ..... *recta*

   Sternite 8 with apical margin convex (Fig. 35) ..... *mystica*

Key to Mature Nymphs
(from Harper and Hynes 1971a)

1. Abdominal tergites with erect hairs throughout (Harper and Hynes 1971a: Fig. 64) ..... *illinoensis*

   Abdominal tergites with erect hairs not evenly distributed, more abundant near posterior margin and sometimes at midlength of tergites (Harper and Hynes 1971a: Figs. 59–63) 2

2. Abdominal tergites, in addition to prostrate clothing hairs, bearing only a terminal row of erect hairs (lateral view) (Harper and Hynes 1971a: Fig. 60) 3

   Abdominal tergites, in addition to prostrate clothing hairs, bearing terminal and intermediate rows of erect hairs (lateral view) (Harper and Hynes 1971a: Figs. 61–63) 4

3. Terminal abdominal tergites with intermediate erect hairs only on lateral margins; supra-anal lobe of male long; abdominal tergites, in addition to prostrate clothing hairs, bearing only a terminal row of erect hairs (lateral view) (Harper and Hynes 1971a: as in Fig. 59) ....*nivicola*

   Terminal abdominal tergites with intermediate erect hairs on lateral third of tergite; supra-anal lobe of male short (Harper and Hynes 1971a: Fig. 60) .....*recta*

4. Abdominal tergites with erect bristles on margin long, about half as long as mid-dorsal tergite length; intermediate bristles few (Harper and Hynes 1971a: Fig. 61); nymphs of moderate size (6–8 mm) ..... *rickeri*

   Abdominal tergites with erect bristles on margin short, about one-third as long as mid-dorsal tergite length; intermediate bristles numerous (Harper and Hynes 1971a: Figs. 62-63); nymphs of large size (8–10 mm) 5

5. Head and pronotum hairy (lateral view); male without wing pads; supra-anal lobe of male twice as long as abdominal segment 10 (Harper and Hynes 1971a: Fig. 63) ..... *vivipara*

   Head and pronotum with fewer hairs (lateral view); male with short wing pads; supra-anal lobe of male short, about as long as abdominal segment 10 (Harper and Hynes 1971a: Fig. 62) ..... *granulata*

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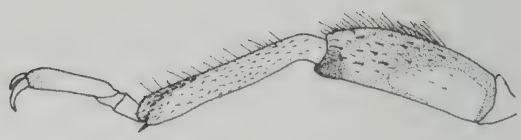

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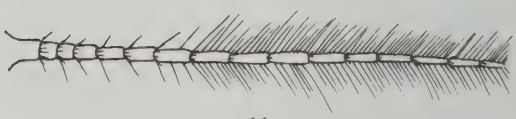

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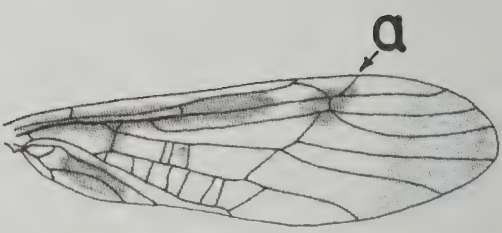

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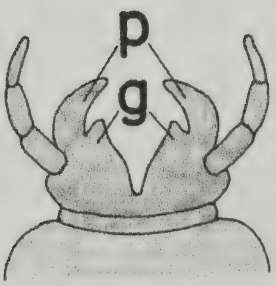

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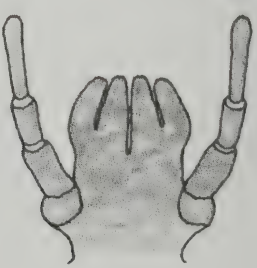

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Figures 8–15. 8. Nymphal leg, *Taeniopteryx burksi*. 9. Nymphal leg, *Prostoia completa*.10. Nymphal cerci, *Paracapnia angulata*. 11. Nymphal cerci, *Nemocapnia carolina*. 12. Forewing, *Nemocapnia carolina*. 13. Forewing, *Prostoia completa*. 14. Nymphal labial palps.15. Nymphal labial palps. a=costal space crossvein, g=glossae, p=paraglossae. (Fig. 8–15 from Poulton & Stewart 1991).

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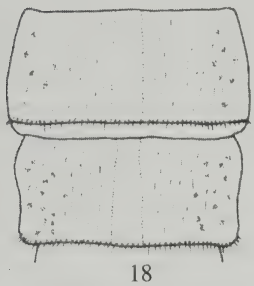

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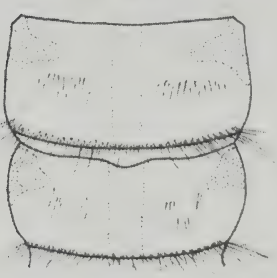

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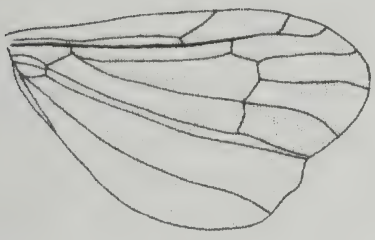

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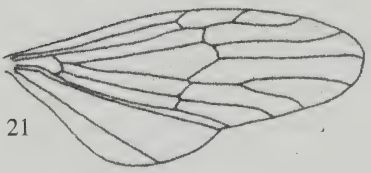

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Figures 16–23. 16. Nymphal wingpads, *Allocapnia granulata.* 17. Nymphal wingpads, *Taeniopteryx burksi.* 18. Nymphal abdominal terga, *Allocapnia granulata.* 19. Nymphal abdominal terga, *Paracapnia angulata.* 20. Hindwing, *Allocapnia granulata.* 21. Hindwing, *Paracapnia angulata.* 22. Female terminalia, *Allocapnia tennessa.* 23. Female terminalia, *Allocapnia brooksi.* (Figs. 16–21 from Poulton & Stewart 1991; 22–23 from Ross & Ricker 1971).

Allocapnia forbesi Frison

Allocapnia forbesi Frison (1929:397): Claassen (1940:89), Harris and Webb (1995:342); Hitchcock (1974:50), Illies (1966:123), Poulton and Stewart (1991:17), Ross and Ricker (1971:35), Zwick (1973:362). Type locality: Illinois, Herod, tributary North Branch, Hicks Creek.

Allocapnia forbesi cornuta Frison (1935:363): Claassen (1940:89), Harris and Webb (1995:342), Illies (1966:123), Ross and Ricker (1971:35). Type locality: Illinois, Pope County, Dixon Springs, Hills Branch Creek.

Adult: (Ross and Ricker 1971). **Male** (Fig. 24 A–D): Wings highly variable, ranging from reduced vestiges to reaching abdominal tergites 5 or 6. Tergite 6 occasionally with dorsal process similar to that on tergite 7. Tergite 7 with dorsal process on posterior half of segment, conical, distinctly raised in lateral view; conical in posterior view. Tergite 8 with dorsal process distinctly raised, quadrate, apex truncate; emarginate medially producing two short, well-separated, rounded lobes in posterior view. Upper limb of epiproct elongate, apical segment short, distinctly shorter than basal half; lower limb with apical segment narrow, fingerlike. **Female** (Fig. 25): Wings varying from vestigial to reaching apex of abdomen. Tergite 8 generally sclerotized, occasionally with narrow, medial, membranous area. Sternite 7 more sclerotized than sternite 6, distinctly separated from sternite 8, posterior margin produced into broadly rounded lobe. Sternite 8 with distinct lateral lobes, medial area wedge-shaped, rounded posteriorly.

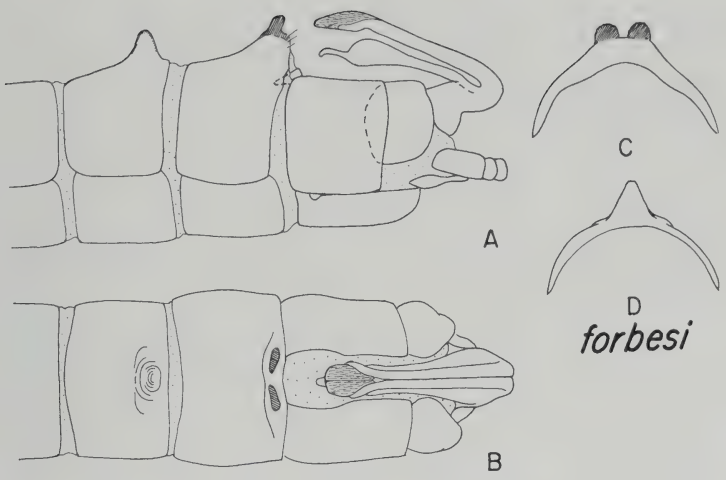
Nymph: unknown.

Biology: Hitchcock (1974) reported that Frison (1929) found the adults feeding on algae from stones and posts. This reference is in error. Frison (1929:360) did report observing several species of winter stoneflies feeding "...upon blue-green algae growing on tree trunks, stones, old logs, etc...." but *Allocapnia forbesi* was not one of the species.

Habitat: Ross and Ricker (1971) reported *A. forbesi* from clear, cool, rocky, spring-fed streams that had a tendency to become dry during the summer. Surdick and Gaufin (1978) reported *A. forbesi* as being oligothermal, eulichtophilous, and found in rivers or permanent and intermittent streams. Adults collected from 1976–2000 were taken on the railings and abutments of bridges, on and under moderate sized rocks, and from leaf packs collected near the water surface. Adults were collected near small streams with a slow to moderate flow, 30 cm–1 m deep and 60 cm–7 m wide with a substrate of gravel, sand, cobblestone and bedrock. At two localities they were collected from streams with moderate flow, 35 m wide, 30 cm–1 m deep, with a substrate dominated by gravel.

Distribution and Seasonal Activity: *Allocapnia forbesi* ranges from western Virginia to Illinois (Ross and Ricker 1971, Fig. 98; Stark *et al.* 1986). In Illinois, adults were collected from 30 November to 24 March. Figure 26 displays the distribution of *Allocapnia forbesi* from 1900–1945, 1946–1975, and 1976–2000.

Current Status: In Illinois, *Allocapnia forbesi* is an uncommon species that historically (1900–2000) was collected across the Shawnee Hills Natural Division of southern Illinois. Recent collections (1976–2000) indicate that *A. forbesi* is now restricted to the eastern Shawnee Hills in the Bay, Lusk, Big Grand Pierre, Big Creeks drainage system and the Saline River drainage system (Table 4).



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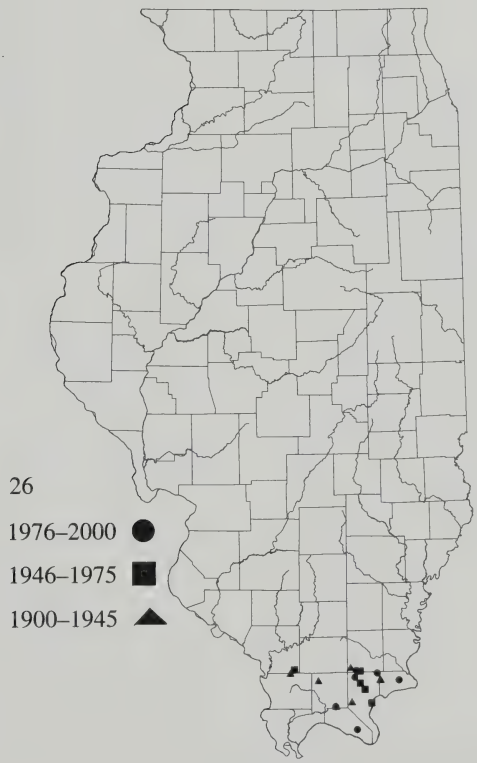


Figures 24–26. *Allocapbnia forbesi.* 24. Male terminalia, A=lateral view, B=dorsal view, C=posterior view of tergite 8, D=posterior view of tergite 7. 25. Female terminalia, 26. Distribution in Illinois. (Figs. 24–25 from Ross & Ricker 1971).

Allocapnia granulata (Claassen)

Allocapnia granulata (Claassen): Claassen (1931:114, 1940:89), Finni and Chandler (1977:243), Frison (1929:394, 1935:364); Hanson (1946:211); Harper and Hynes (1971a); Harris and Webb (1995:342); Illies (1966:123), Poulton and Stewart (1991:17), Ross and Ricker (1971:28), Zwick (1973:362). Type locality: Johnstown, New York.

Capnella granulata Claassen (1924:44): Illies (1966:123), Needham and Claassen (1925:272).

Adult: (Ross and Ricker 1971). **Male** (Fig. 27 A–C): Wings vary from extremely short to moderately long, reaching tergite 7. Hindwing (Harper 1984, Fig. 13.168; Poulton and Stewart 1991, Fig. 13; Stewart and Harper 1996, Fig. 14.172). Tergite 6 without dorsal process. Tergite 7 with slightly raised, nonsclerotized bulge on posterior half. Tergite 8 with dorsal process distinctly raised, sloping posteriorly from base, apex rounded with V-shaped medial emargination and small lateral tubercle bearing a few hairs in posterior view. Upper limb of epiproct with apical segment subtriangular, equal in length to basal segment, apical segment bulbous, wider apically than basal half in dorsal view; lower limb narrow, elongate, apex rounded, often with short, blunt projection. Other figures: Frison (1929, Fig. 51 male habitus; 1935, Fig. 227 male terminalia), Needham and Claassen (1925, pl. 47, Fig. 3 male wings, 5 female wings, pl. 50, Figs. 6 and 6a male terminalia, 7 female terminalia), Harper and Hynes (1971a, Fig.12 terminalia), Stewart and Harper (1996, Fig. 14.172 hindwing). **Female** (Fig. 28), Tergite 8 membranous dorsally. Sternite 7 separated from sternite 8. Sternite 8 more heavily sclerotized than sternite 7, posterior margin triangular medially, although this area varies considerably. Other figures: Frison (1929, Fig. 12 female habitus; Figs. 44–45 female habitus; Fig. 71, female abdominal sterna 7–8; 1935, Fig. 220 female abdominal sterna 7-8; Figs. 294–295, female habitus); Harper and Hynes (1971a, Fig. 33 subgenital plate); Needham and Claassen (1925, pl. 47, Fig. 5 female wings, pl. 50, Fig. 7 female terminalia).

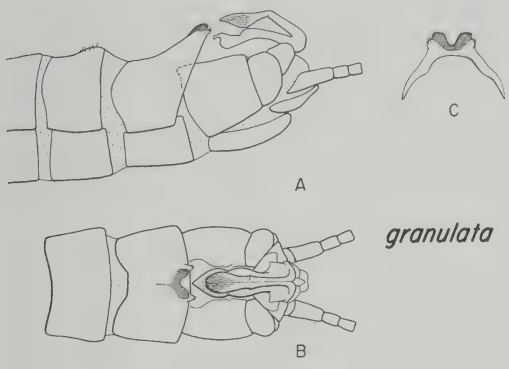
Nymph (Fig. 29) (Harper and Hynes 1971a): Length 7–9 mm. Medium to dark yellowish brown. Head and pronotum with sparse pubescence, pronotum fringe very conspicuous; tergites with well-developed intermedial and terminal bristles, about one-third as long as mid-dorsal length of tergite (Harper and Hynes 1971a, Fig. 62, male setal pattern). Other descriptions of the nymphs are found in Claassen (1931:114); Frison (1929:395, Fig. 35, female habitus; Fig. 40 female terminalia; 1935, Fig. 289, female terminalia); Harden and Mickel (1952:29, plate III, Fig. 1 habitus, pl. IX, Fig. 1 maxilla, Fig. 2 mandible); Harper (1984, Fig. 13.12, abdominal ventrum; Fig. 13.37, male wing pads), and Stewart and Harper (1996, Fig. 14.11, abdominal venter; Fig. 14.12, abdominal terminalia; Fig. 14.37, male wing pads).

Biology: Harper and Hynes (1970:925) determined *Allocapnia granulata* to have a univoltine life cycle with eggs deposited in May. Nymphs hatched within a month and underwent a diapause during the summer, with development proceeding rapidly through the fall and winter. Finni and Chandler (1977) reported five post-diapausal instars for *A. granulata.*

Habitat: Ross and Ricker (1971) reported *Allocapnia granulata* from larger, slower, and more turbid streams but also collected this species from smaller tributaries of large rivers. Surdick and Gaufin (1978) reported *A. granulata* as being a herbivore or scavenger that was alkaliphilous, mesotrophic, saprophobic, eu- and mesoxyphilous, meso-, meta-, and oligothermal, eu- and mesolichtophilous, rheophilous and rheobiontic, epilithic and epiphytic, and found in rivers or permanent and intermittent streams. Gaufin (1958) reported *A. granulata* to be intolerant of pollution, preferring water with high levels of dissolved oxygen (70–115% saturation). Poulton and Stewart (1991) reported *A. granulata* being collected up to 1 km away from moving water. Adults from 1976–2000 in Illinois, were collected on the railings and abutments of bridges and from leaf packs collected near the water surface. They were collected from small- to moderate-sized streams, 6–25 m wide, 1–2 m deep with a gravel and sand substrate, although collections from the Leaf River were from a stream that has a bottom substrate of 70% sand and 30% silt. *Allocapnia granulata* was also collected from two localities on the Rock River, a deep river, over a quarter of a km wide, with a substrate of sand and silt.

Distribution and Seasonal Activity: *Allocapnia granulata* is widely distributed in eastern North America from Alabama to Quebec west to Minnesota and Texas (Ross and Ricker 1971, Fig. 96, Stark *et al.* 1986). In Illinois, adults were collected from 19 January to 3 April, with a single collection made on 3 December. Figure 30 displays the distribution of *A. granulata* from 1900–1945, 1946–1975, and 1976–2000.

Current Status: *Allocapnia granulata* is considered an environmentally tolerant species and for many years in Illinois it ranged from Hardin County in southern Illinois to the Wisconsin border in 5 of the Natural Divisions of Illinois (Table 3) and 11 of the drainage systems (Table 4). Over the past 25 years, its distribution pattern has been reduced to 3 natural divisions (Table 3) and the Rock River Hill Country drainage system, with a single disjunct collection found at Morris, on the Illinois River (Table 4). Although broadly distributed within the Rock River Hill Country drainage, *A. granulata* appears to be disappearing from the remainder of the state.



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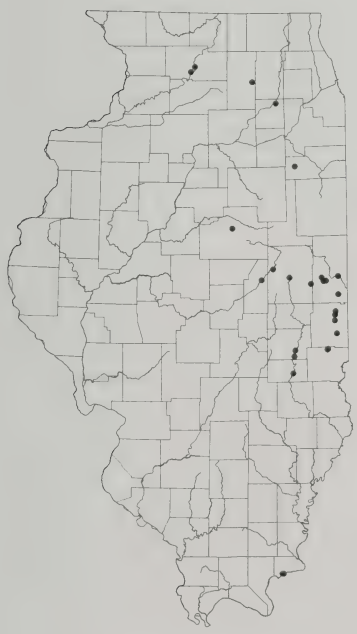
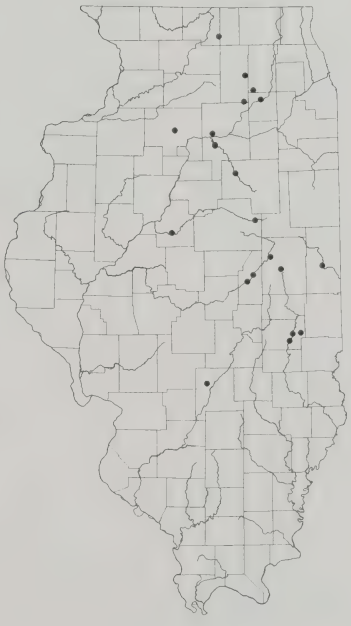


30A. 1900–1945



30B. 1946–1975

30C. 1976–2000

Figures 27–30. *Allocapnia granulata.* 27. Male terminalia, A=lateral view, B=dorsal view, C=posterior view of tergite 8. 28. Female terminalia, 29. Nymph. 30. Distribution in Illinois. (Figs. 27–28 from Ross & Ricker 1971; 29 Stewart & Stark 1988).

Allocapnia illinoensis Frison

Allocapnia illinoensis Frison (1935:365): Claassen (1940:89), Harris and Webb (1995:342); Hanson (1946:238), Harper and Hynes (1971a:924, 934), Illies (1966:123), Ross and Ricker (1971:33), Zwick (1973:363). Type locality: Illinois, Clark County, Dolson (Clarksville), on fence post near Rocky Branch.

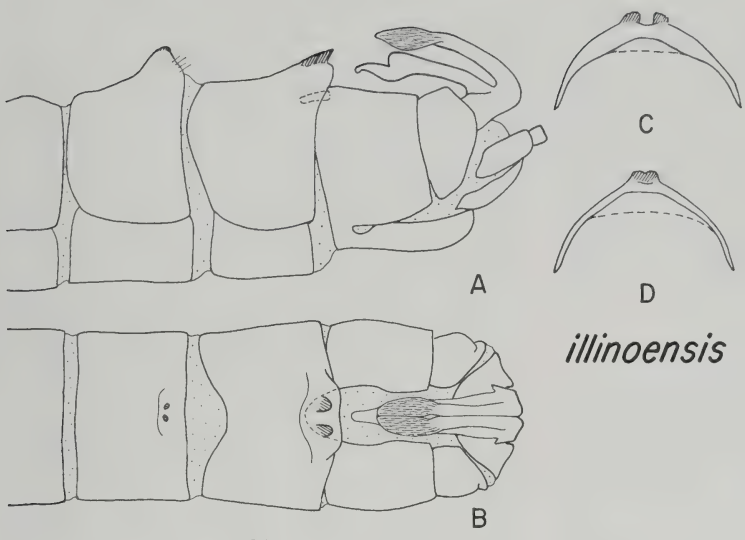
Adult: (Ross and Ricker 1971). **Male** (Fig. 31 A–D): Wings reaching abdominal tergites 6 or 7. Tergite 6 without dorsal process. Tergite 7 with dorsal process on posterior half moderately produced into a conical tubercle; with slight medial emargination in posterior view. Tergite 8 with dorsal process not very high, sloping noticeably posteriorly, with distinct, widely separated medial emargination in posterior view. Upper limb of epiproct with apical segment short, spatulate, distinctly shorter than basal segment; lower limb with apical segment shallow. Other figures: Frison (1935: Fig. 212 male genitalia), Harper and Hynes (1971a, Fig. 17, terminalia. **Female** (Fig. 32): Tergite 7 with posterior margin slightly arcuate, joined to tergite 8 on meson by faint sclerotized area. Tergite 8 slightly more sclerotized than tergite 7, lateral lobes distinct, posterior margin produced into wide sagittate process, dark along posterior extremities and rapidly becoming less sclerotized anteriorly. Other figures: Frison (1935, Fig. 225, female genitalia), Harper and Hynes (1971a, Fig. 34, subgenital plate).

Nymph (Harper and Hynes 1971a)**:** Length 8–10 mm. Yellowish brown with venter and appendages paler. Body covered with short, dense pubescence, with a few bristles that are markedly longer than the others. Tergites covered with erect bristles in addition to prostrate clothing bristles (Harper and Hynes 1971a, Fig. 64).

Habitat: Ross and Ricker (1971) reported *Allocapnia illinoensis* from clear, rocky, spring-fed streams. Surdick and Gaufin (1978) reported *A. illinoensis* as being neutral, eury- and oligothermal, eulichtophilous, and found in streams.

Distribution and Seasonal Activity: *Allocapnia illinoensis* ranges from New York to Quebec west to Minnesota and Illinois (Ross and Ricker 1971, Fig. 96; Stark *et al.* 1986). In Illinois adults were collected from 5 January to 23 March. Figure 33 displays the distribution of *A. illinoensis* from 1900–1945. This species was collected only once from 1946–1975 (Clark County, Rocky Branch, 4.2 km NE Dolson (Clarksville)).

Current Status. *Allocapnia illinoensis* has always been rare in Illinois, being restricted to the Wabash Border Natural Division and the Wabash tributaries drainage. Ross *et al.* (1967) and Ross and Ricker (1971) discussed the postglacial dispersal of *A. illinoensis* from the Cumberland Plateau into the northeastern United States and southern Canada. Prior to 1946, Frison collected 12 males and 1 female at 3 sites on Rocky Branch and the East Fork of Big Creek west of Oliver. From 1946–1975, only 22 specimens (1male 1958, 21 females 1965) were collected from Rocky Branch. Since 1965, no specimens of *A. illinoensis* were collected in Clark County although extensive collecting (Fig. 5) has been done on several occasions. Historically (1900–2000), four winter stoneflies were collected at Rocky Branch. Frison recorded *A. granulata, A. illinoensis, A. recta,* and *A. vivipara*; Ross and Ricker recorded only *A. illinoensis*; and currently only *A. vivipara* has been collected from this locality. Rocky Branch is currently protected as an Illinois Nature Preserve yet three species of winter stoneflies have disappeared from this locality, with *A. illinoensis* appearing to be extirpated from Illinois.



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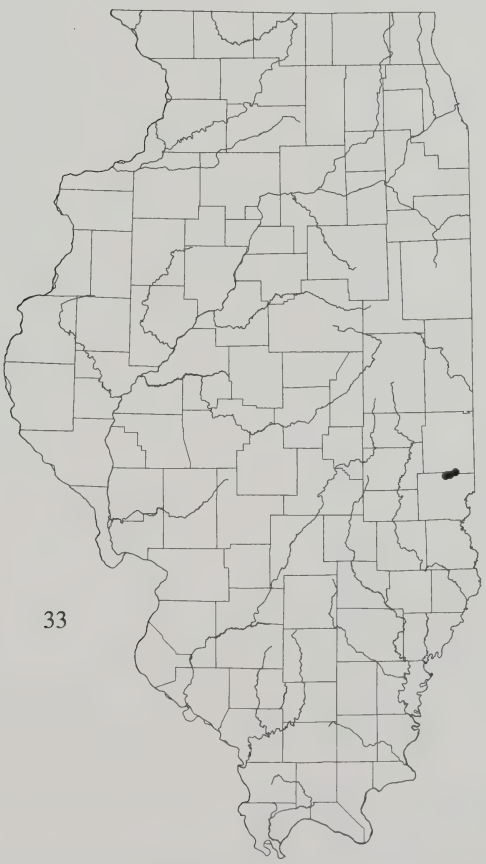

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Figures 31–33. *Allocapnia illinoensis*. 31. Male terminalia. A=lateral view, B=dorsal view, C=posterior view of tergite 8, D=posterior view of tergite 7. 32. Female terminalia. 33. Distribution in Illinois. (Figs. 31–32 from Ross & Ricker 1971).

Allocapnia mystica Frison

Allocapnia mystica Frison (1929:399): Claassen (1931:116, 1940:89), Illies (1966:125), Harris and Webb (1995:342), Hitchcock (1974:57), Poulton and Stewart (1991:18), Ross and Ricker (1971:31), Zwick (1973:365). Type locality: Illinois, Vermilion County, Oakwood, a small tributary of the Salt Fork of Vermilion River.

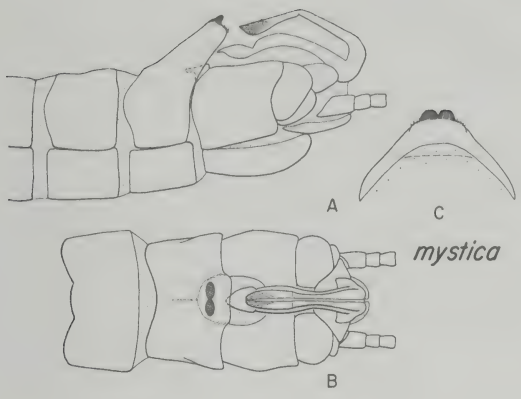
Adult: (Ross and Ricker 1971). **Male** (Fig. 34 A–C): Wings reaching abdominal tergites 5 or 6. Tergite 6 and 7 without dorsal process. Tergite 8 with dorsal process large, sloping posteriorly and ending in small apical point, truncate apically with small medial emargination in posterior view. Upper limb of epiproct elongate, apical segment shorter than basal segment; lower limb with apical segment short, with flat apical point. Other figures: Frison 1929, Figs. 57, 67, 72; 1935, Figs. 175, 177, 219, 229, 287). **Female** (Fig. 35): Tergite 8 membranous dorsally. Sternite 7 separated from sternite 8. Sternite 8 more heavily sclerotized than sternite 7, posterior margin produced medially into a highly polished bulge.

Nymph: The male and female nymphs were described by Frison (1929:402–403) and redescribed by Claassen (1931:116).

Habitat: Ross and Ricker (1971) reported *Allocapnia mystica* from cool, rapid, clear, gravel or rocky streams, usually spring-fed and small. Surdick and Gaufin (1978) reported *A. mystica* as being a herbivore or scavenger that was oligothermal, rheobiontic, epilithic, and found in streams. From 1976–2000, adults of *A. mystica* were collected from bridge railings and abutments, in leaf pack near the water surface, and from tree trunks. It has been collected from small moderately flowing streams 1–7 m wide, 30 cm–1 m deep, with a substrate of gravel, sand, cobblestone, and bedrock. It has also been collected from moderate sized streams, 35 m wide, 30 cm–1 m deep with a bottom substrate of gravel.

Distribution and Seasonal Activity: *Allocapnia mystica* ranges from Georgia and Virginia west to Missouri and Arkansas (Ross and Ricker 1971: Fig. 96, Stark *et al.* 1986). In Illinois, adults were collected from 18 September to 16 March. Figure 36 displays the distribution of *A. mystica* from 1900–1945, 1946–1975, and 1976–2000.

Current Status. Prior to 1946, *Allocapnia mystica* had been collected across the Shawnee Hills Natural Division of southern Illinois, the Wabash Border Division, and the Rock River Hill Country Division (Table 3). From 1946–1975 it was still well established in the Shawnee Hill Natural Division, with a single record from the Southern Till Plain Division. Current records indicate that this species is still well established across the Shawnee Hills Natural Division, but has disappeared from the northern three-fourths of the state. Historically (1900–2000), *A. mystica* was collected from seven drainage systems (Table 4), but now is only found in the Big Muddy, the Bay, Lusk, Big Grand Pierre, Big Creek, and the Saline River drainage systems.



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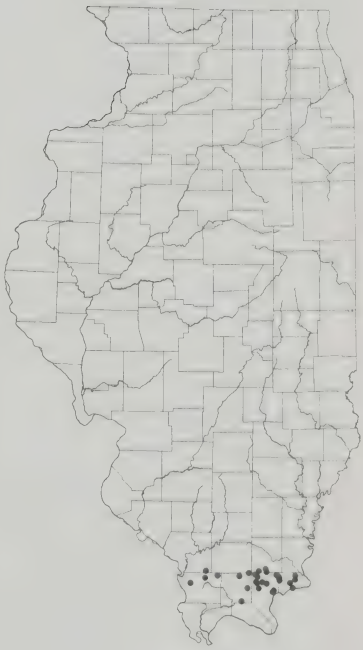
36A.1900–1945

36B. 1946–1975



36C. 1976–2000

Figures 34–36. *Allocapnia mystica*, 34. Male terminalia. A=lateral view, B=dorsal view, C=posterior view of tergite 8. 35. Female terminalia. 36. Distribution in Illinois. (Figs. 35–36 from Ross & Ricker 1971).

Allocapnia nivicola (Fitch)

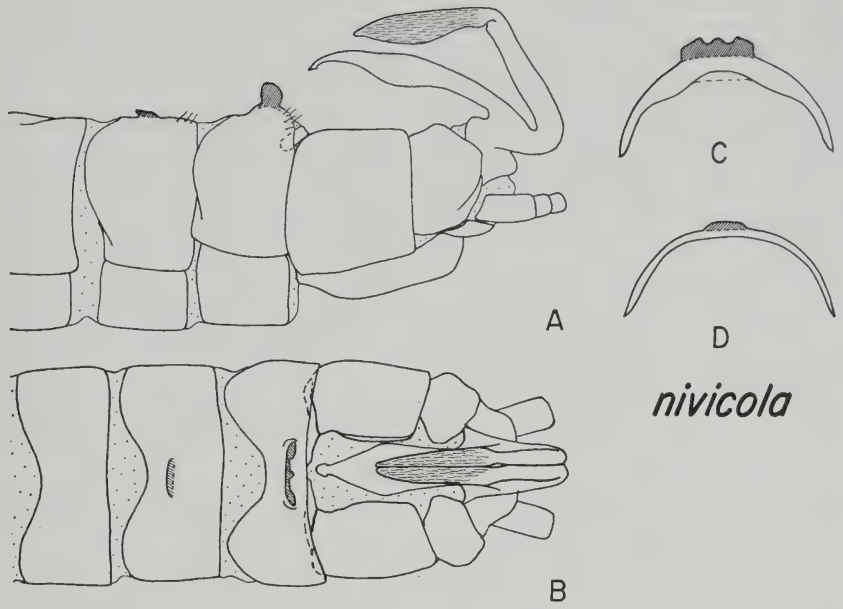
Allocapnia nivicola (Fitch): Hanson (1942:83), Harper and Hynes (1971a:925, 935), Illies (1966:125), Harris and Webb (1995:342), Hitchcock (1974:58), Ricker (1952:164), Ross and Ricker (1971:49), Zwick (1973:365). Type locality: New York.
Perla nivicola Fitch (1847:278): Illies (1966:125).

Adult: (Ross and Ricker 1971). **Male** (Fig. 37 A–D): Tergite 6 without dorsal process. Tergite 7 with low medial dorsal process only slightly raised above tergite, truncate apically; broad, shallow truncate apically in posterior view. Tergite 8 with dorsal process higher than long, directed vertically with three apical teeth, mesal tooth usually slightly lower than lateral ones in posterior view. Upper limb of epiproct with apical segment triangular in dorsal view, tapered apically, shorter than basal segment; lower limb in dorsal view much wider than upper limb. Other figures: Hanson (1942, Fig. 2, male terminalia; Fig. 4 female terminalia), Harper and Hynes (1971a, Fig. 16). **Female** (Fig. 38): Tergite 8 membranous dorsally. Sternite 7 lightly sclerotized, separated from sternite 8. Sternite 8 with posterior margin concave with narrow, medial, truncate flap. Other figures: Hanson (1942, Fig. 4, female terminalia), Harper and Hynes (1971a, Fig. 39).
Nymph (Harper and Hynes 1971a:935) found the nymphs of *A. nivicola* to be similar to *A. pygmaea* in the abdominal setal bristles (Harper and Hynes 1971a, Fig. 59), each species being separated by the setal pattern on the outer surface of the galea. Length 6–7.5 mm. The tuft of setae on the outer surface of the galea is poorly developed in *A. nivicola* (rarely more the 10 setae) (Harper and Hynes 1971a, Fig. 45). Nymphs move from the gravel (where they were recruited) to leaf habitats for active growth (Mackay 1969, Stewart and Stark 1988).
Habitat: Ross and Ricker (1971) reported collecting *Allocapnia nivicola* from small stony brooks. Surdick and Gaufin (1978) reported *A. nivicola* as being neutral or alkaliphilous, saprophobic, euoxyphilous, eury-, meso-, meta-, and oligothermal, epiphytic, and found in streams. Gaufin (1958) reported *A. nivicola* to be intolerant of pollution, preferring water with high levels of dissolved oxygen (70–115% saturation). From 1976–2000, adults of *A. nivicola* in Illinois were collected only from a small slow-flowing stream, 30 cm-1 m wide, 15 cm deep, with a gravel and sand substrate. Adults were collected on and under moderate size stones, from leaf packs, and from woody debris.
Distribution and Seasonal Activity: *Allocapnia nivicola* ranges from northern Alabama to Nova Scotia west to eastern Illinois (Ross and Ricker 1971: Fig. 96, Stark *et al.* 1986). In Illinois, adults were collected from 28 January to 25 February.

Illinois Record: 1900–1945.
Coles County: Fox Ridge State Park.

1976–2000.
Vermilion County: Forest Glen Forest Preserve, 8.5 km SE Westville.

Current Status. *Allocapnia nivicola* is a rare species in Illinois originally found at a single locality in the Grand Prairie Natural Division and currently known from a single locality in the Wabash Border Natural Division (Table 3). Frison collected three males in a small, shallow creek in Fox Ridge State Park in conjunction with *A. granulata, A. recta,* and *A. vivipara*. No specimens were collected there during 1946–1975, although a collecting trip to this park had been made in the winter of 1964. During 1993–1995, five collecting trips were made to this park with only *A. recta* and *A. vivipara* being collected. In 1993 and 1995, a population was collected in Forest Glen Forest Preserve in Vermilion County in the Vermilion-Little Vermilion River drainage system. Efforts were made to collect winter stoneflies from this type of habitat in other seep areas of Vermilion County with no success.



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Figures 37–38. *Allocapnia nivicola*. 37. Male terminalia. A=lateral view, B=dorsal view, C=posterior view of tergite 8, D=posterior view of tergite 7. 38. Female terminalia. (Figs. 37–38 from Ross & Ricker 1971).

Allocapnia recta (Claassen)

Allocapnia recta (Claassen): Claassen (1931:113, 1940:90), Frison (1929:395), Harper and Hynes (1971a: 925, 936), Harris and Webb (1995:342), Hanson (1946:238), Illies (1966:127), Ross and Ricker (1971:23), Zwick (1973:367). Type locality: Ithaca, New York.

Capnella recta Claassen (1924:44): Illies (1966:127).

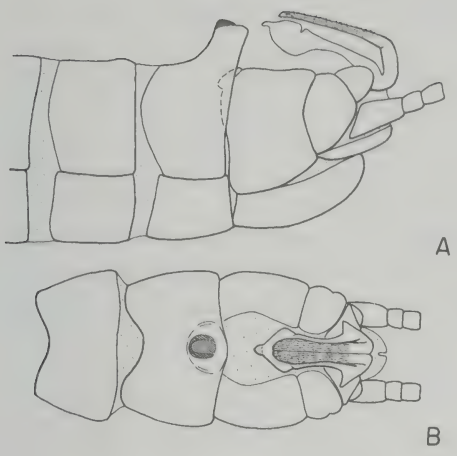
Adult: (Ross and Ricker 1971). **Male** (Fig. 39 A–C): Tergite 6 and 7 lack a dorsal process. Tergite 8 with dorsal process quadrate, apical margin highly variable, in posterior view broad basally with narrow, quadrate, apical process, apex truncate. Upper limb of epiproct flat, elongate, apical segment distinctly longer than basal segment, apical segment clavate in dorsal view; lower limb bulbous apically, wider apically than apical segment of upper limb in dorsal view. Other figures: Frison (1935, Fig. 221, terminalia); Hanson (1946, Fig. 60); Harper and Hynes (1971a, Fig. 13); Needham and Claassen (1925, pl. 50, Fig. 8, terminalia); Kondratieff and Kirchner (2000, Figs. 21–26, male terminalia). **Female** (Fig. 40): Tergite 8 membranous dorsally. Sternite 7 distinctly separated from sternite 8. Sternite 8 markedly darker than sternite 7, posterior margin concave. Other figures: Harper and Hynes (1971a, Fig. 35); Needham and Claassen (1925, pl. 50, Fig. 9, terminalia); Frison (1935, Fig. 213, sternites 7 and 8).

Nymph (Harper and Hynes 1971a:936): Length 6–7.5 mm. Light yellowish brown. Femora covered with short bristles, anterior bristles equal in length to posterior bristles. Abdomen with prostrate clothing bristles and erect bristles on posterior margin (about one-third as long as middorsal length), intermediate erect setae on lateral third of caudal 4–5 tergites, not on middle of tergite (Harper and Hynes 1971a, Fig. 60). Other figures: Frison (1929:396, Fig. 36, female habitus; Fig. 37, male habitus; Fig. 39, female habitus; Fig. 55, female habitus; 1935:367, Fig. 290, female abdomen; Fig. 291 male habitus), and Claassen (1931:113).

Habitat: Ross and Ricker (1971) reported *A. recta* from fairly rapid, clear, cool streams with gravel or rocky bottoms and very common in small spring-fed brooks. Harper and Hynes (1971a) found *A. recta* in small spring-fed streams that did not freeze. Surdick and Gaufin (1978) reported *A. recta* as being a herbivore or scavenger that was alkaliphilous, saprophobic, epiphytic, and found in permanent and intermittent streams. Gaufin (1958) reported *A. recta* to be intolerant of pollution, preferring water with high levels of dissolved oxygen (70–115% saturation). From 1976–2000, adults of *A. recta* in Illinois, were collected from bridge railings and abutments, on and under cobblestones, and in leaf packs from small, slow- to moderate- flowing streams, 1–15 m wide, less than 30 cm–1 m deep, with a gravel, sand, and cobblestone substrate.

Distribution and Seasonal Activity: *Allocapnia recta* ranges from Alabama to Nova Scotia west to Illinois (Ross and Ricker 1971: Fig. 90, Stark *et al.* 1986). In Illinois, adults were collected from 17 November to 25 March. Figure 41 displays the distribution of *Allocapnia recta* from 1900–1945, 1946–1975, and 1976–2000.

Current Status. Prior to 1946, *Allocapnia recta* had been collected abundantly in Clark, Coles, and Vermilion counties in the Grand Prairie and Wabash Border Natural Divisions of eastern Illinois (Table 3). Only one collection of this species was obtained during 1946–1975. From 1976–2000, abundant populations were collected in Coles and Vermilion counties (Fig. 41). Eastern Illinois appears to be the western tip of its distribution, but it is still well established in the Embarras River-Wabash Tributaries drainage system and the Vermilion-Little Vermilion River drainage systems (Table 4).



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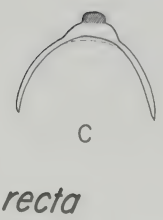

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41A. 1900–1945

41B. 1946–1975

41C. 1976–2000

Figures 39–41. *Allocapnia recta*. 39. Male terminalia. A=lateral view, B=dorsal view, C=posterior view of tergite 8. 40. Female terminalia. 41. Distribution in Illinois. (Figs. 39–40 from Ross & Ricker 1971).

Allocapnia rickeri Frison

Allocapnia rickeri Frison (1942:269): Hanson (1946:238), Harper and Hynes (1971a: 925, 936), Harris and Webb (1995:342), Illies (1966:127), Poulton and Stewart (1991:20), Ricker (1945:227), Zwick (1973:365). Type locality: Illinois, Pope County, Golconda, and Big Grand Pierre Creek.

Allocapnia pygmaea (Burmeister 1839:874): Frison (1929:396, 1935:367). Misidentification.

Adult: (Ross and Ricker 1971). **Male** (Fig. 42 A–C): Wings reaching tergites 4 or 5. Tergites 6 and 7 lacking dorsal process. Tergite 8 with dorsal process raised vertically above tergite, apex tapered posteriorly, in posterior view apex truncate with wide medial emargination. Upper limb of epiproct with apical segment bulbous, distinctly shorter than basal segment; lower limb narrow, tapered apically. Other figures: Frison (1942: Fig. 36), Harper and Hynes (1971a: Fig. 14), Stark and Nelson (2000: Fig. 2.1, triocellate head; Fig 2.8, mouthparts). **Female** (Fig. 43): Tergite 8 membranous dorsally. Sternites 7 and 8 broadly fused over three-fourths of width. Sternite 8 with lateral lobes usually lighter than mesal portion, posterior margin truncate. Other figures: Harper and Hynes (1971a: Fig. 37).

Nymph (Harper and Hynes 1971:936): Length 6–7.5 mm. Light to medium yellowish brown. Pronotum with well-developed anterior and posterior fringe; few setae on disc and not much shorter than on fringe. Abdomen covered with short prostrate setae, a few long erect bristles on posterior margin (about half as long as mid-dorsal length), a few erect intermediate setae on middle of each segment (three-fourths length of segment) (Harper and Hynes 1971a, Fig. 61).

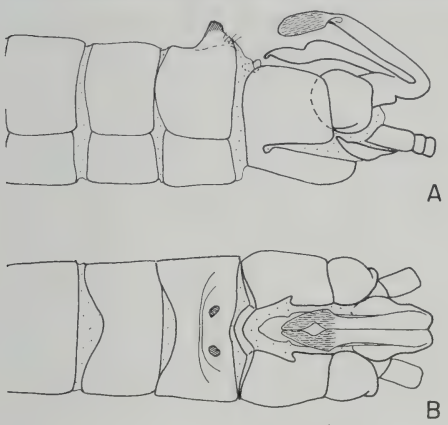
Biology: *Allocapnia rickeri* has a univoltine fast cycle of development with a nine-month diapause in Oklahoma (Ernst and Stewart 1985, Stewart and Stark 1988) and a univoltine slow cycle of development in southern Canada (Harper 1973, Ernst and Stewart 1985). Krueger and Cook (1981) noted a longer developmental time in Minnesota with small nymphs appearing in July, growing rapidly until December, slowing growth in December–January, then resuming growth until a March-April emergence. A few nymphs of *A. rickeri* displayed pre-sunset drifting at the beginning of emergence (Ernst and Stewart 1985, Fig. 4) and drift was related to their standing stock (Krueger and Cook 1981). Krueger and Waters (1983) and Jop and Stewart (1987) give annual production rates of this herbivore-detritivore.

Habitat: Ross and Ricker (1971) reported *Allocapnia rickeri* from clear cool rocky or gravelly streams. Surdick and Gaufin (1978) reported *A. rickeri* as being neutral or alkaliphilous, euphilous, eury-, meta-, and oligothermal, eulichtophilous, rheobiontic, and found in streams. From 1976–2000, adults of *A. rickeri* were collected in Illinois on bridge railings and abutments, on and under cobblestones, in leaf packs, generally from small, slow-moving streams, 1–10 m wide, less than 30 cm–1 m deep, with a gravel substrate. At one locality, it was collected abundantly from a channelized creek (Max Creek) with a clay/silt substrate.

Distribution and Seasonal Activity: *Allocapnia rickeri* is widespread, ranging from Alabama to New York west to Minnesota and Oklahoma (Stark *et al.* 1986). Ross and Ricker (1971) and Stewart and Stark (1988) did not list this species from Illinois, although the type locality is Big Grand Pierre Creek, Golconda, Illinois. In Illinois, adults were collected from 1 January to 22 June. Figure 44 displays the distribution of *A. rickeri* from 1900–1945, 1946–1975, and 1976–2000.

Current Status. *Allocapnia rickeri* was described by Frison (1942) from Big Grand Pierre Creek, Pope County, Illinois. Ross and Ricker (1971) neglected to list Illinois in their distribution of this species (p. 41), although their map (p. 102) correctly indicates its Illinois distribution. Consequently, subsequent authors have omitted this species from the Illinois fauna. *Allocapnia rickeri* remains an abundant member of the winter stoneflies of Illinois. Frison reported it abundantly from across the Shawnee Hills, with a disjunct record from Jo Daviess County. Ross and Ricker (1971) reported numerous records from across the Shawnee Hills, with additional records from Calhoun, Fayette, Fulton, and Pike counties in central and western Illinois. From 1976–2000, *A. rickeri* was one of the most abundant species in the Shawnee Hills with a continuing distribution up the west

side of Illinois into Calhoun, Pike, and Schuyler counties. Two populations were also found in eastern Illinois in Vermilion and Wayne counties. On two separate occasions, efforts were made to collect this species in northeastern Jo Daviess County near Warren and Apple River Canyon State Park with no success. Much of this area has been transformed into pastureland with trees being removed up to the edges of the streams. Historically (1900–2000), this species was collected from within eight Natural Divisions of Illinois (Table 3) and nine drainage basins (Table 4). Recent records (1976–2000) indicate that the distribution of this species has been reduced to five natural divisions (Table 3) and six drainage basins (Table 4) yet this species is well established in Illinois.



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44A. 1900–1945 44B. 1946–1975 44C. 1976–2000

Figures 42–44. *Allocapnia rickeri*. 42. Male terminalia. A=lateral view, B=dorsal view, C=posterior view of tergite 8. 43. Female terminalia. 44. Distribution in Illinois. (Figs. 42–43 from Ross & Ricker 1971).

Allocapnia smithi Ross and Ricker

Allocapnia smithi Ross and Ricker (1971:48): Harris and Webb (1995:342), Hitchcock (1974:64), Poulton and Stewart (1991:20), Zwick (1973:368). Type locality: Kentucky, Butler County, 5.5 km west of South Hill.

Adult: (Ross and Ricker 1971). **Male** (Fig. 45 A–D): Wings long, reaching tergite 7. Tergite 6 lacking dorsal process. Tergite 7 with dorsal process slightly raised above tergite, apex truncate, in posterior view apex truncate, broad. Tergite 8 with dorsal process raised vertically above tergite, quadrate, apical margin angulate; in posterior view dorsal process with three points, mesal one slightly higher than laterals. Upper arm of epiproct with apical segment subequal to basal segment, in dorsal view apical segment narrow, slightly tapered apically; lower limb in lateral view narrow, slightly swollen medially, tapered apically and recurved ventrally, in dorsal view about as wide as upper limb. **Female** (Fig. 46): Wings reaching to or beyond apex of abdomen. Tergite 8 membranous dorsally. Sternites 7 and 8 fused for most of their width, line of fusion indicated by sharp crease. Sternite 8 with lateral areas semi-membranous; posterior margin produced into wide, sclerotized reflexible flap.

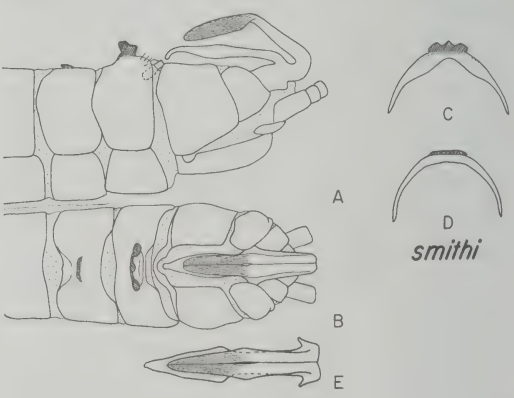
Habitat: Ross and Ricker (1971) reported *Allocapnia smithi* from small spring fed creeks. From 1976–2000, adults of *A. smithi* in Illinois, were collected from leaf packs in small slow flowing streams, 5–7 m wide, 30 cm–1 m deep, with a gravel, cobblestone, and sand substrate.

Distribution and Seasonal Activity: *Allocapnia smithi* is a southern species ranging from northern Alabama to western Kentucky, southern Illinois, and southern Ohio (Ross and Ricker 1971, Fig. 198; Stark *et al.* 1986). In Illinois, adults were collected from 20 January to 5 March.

Illinois Record 1946–1975.
Pope County: Lusk Creek, 5 km SE Eddyville.

1976–2000.
Pope County: East Fork, Little Lusk Creek, 7.4 km SW Herod. **Saline County**: tributary Battle Ford Creek, 3.7 km NE Delwood.

Current Status. *Allocapnia smithi* is rare in Illinois, even with the extensive collecting that has been done recently across the Shawnee Hills (Fig. 5). It is restricted to the Shawnee Hills Natural Division (Table 3) and the Lusk Creek and Saline River drainages (Table 4). Ross and Ricker (1971) reported *A. smithi* from Lusk Creek, southeast of Eddyville, Pope County. Recent collections have added an additional locality in both Pope and Saline counties, but it was not collected at Lusk Creek, which is a favored collecting site in the Shawnee Hills.



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Figures. 45–46. *Allocapnia smithi*. 45. Male terminalia. A=lateral view, B=dorsal view, C=posterior view of tergite 8, D=posterior view of tergite 7. 46. Female terminalia. (Figs. 45–46 from Ross & Ricker, 1971).

Allocapnia vivipara (Claassen)

Allocapnia vivipara (Claassen): Claassen (1931:114, 1940:90), Frison (1929:392, 1935:370, 1942:265), Gaufin (1958), Hanson (1946:238), Harper and Hynes (1971a:925, 937), Harris and Webb (1995:342), Hitchcock (1974:65), Harden and Mickel (1952:32), Illies (1966:128), Poulton and Stewart (1991:20), Ross (1962:105), Ross and Ricker (1971:21), Zwick (1973:369). Type locality: Lake Forest, Illinois.

Capnella vivipara Claassen (1924:46): Illies (1966:128).

Capnia minima Walsh (1862) from Rock Island probably is *A. vivipara* (Frison 1935, Ross and Ricker 1971).

Adult: (Ross and Ricker 1971). **Male** (Fig. 47 A–D): Wings apterous. Tergite 6 lacking dorsal process. Tergite 7 slightly raised posteriorly. Tergite 8 with dorsal process moderately raised above tergite, apical margin slanted anteriorly, broad, rounded in posterior view. Upper limb of epiproct elongate, apical segment bulbous, distinctly shorter than basal segment, triangular, tapered apically in dorsal view; lower limb with apical half bulbous with apical steplike projection in lateral view, lower limb wider than apical segment of upper limb in dorsal view. Other figures: Frison (1929, Fig. 49, habitus; 1935, Fig. 228, terminalia, Fig. 293, habitus); Hanson (1946, Fig. 38a, metatergum); Harper and Hynes (1971a, Fig. 10); Needham and Claassen (1925, pl. 6 Fig. 9, egg, pl. 50 Figs. 4–5, terminalia). **Female** (Fig. 48): Wing length variable (Ross 1962, Fig. 44), reaching from tergite 1 to apex of abdomen. Tergite 7 often with much of tergite sclerotized. Tergite 8 sclerotized completely. Sternites 7 and 8 with broad, medial, cone-shaped fusion. Sternite 8 with inconspicuous lateral bulges, posterior margin truncate. Other figures: Frison (1929, Fig. 46 habitus, Figs. 52–53 habitus, Fig. 74, sterna 7-8; 1935, Fig. 218, sterna 7-8, Fig. 292 habitus); Harper and Hynes (1971a, Fig. 36); Needham and Claassen (1925, pl. 50, Fig. 5 terminalia). **Egg.** Needham and Claassen (1925, pl. 6, Fig. 9).

Nymph (Harper and Hynes 1971a: 937): Length 7–10 mm. Setation pattern almost identical to that of *A. granulata* (Harper and Hynes 1971a, Figs. 62 and 63). Mature male nymphs lack wingpads. Other figures: Frison (1929:395, Fig. 15 male labium, 19 male maxilla, 23 male mandibles, 27 male hind leg, 33 male habitus, 34 female habitus; 1935:370, Fig. 57 female mandibles, 87 female maxilla, 117 female labium, 144 female mentum and submentum, 257 male hind leg, 297 male habitus, 298 female habitus), and Claassen (1931:114). Harper and Hynes (1970:925, Fig. 1) illustrated the diapausing nymph.

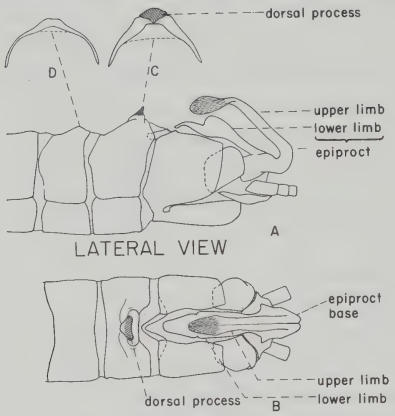
Biology: *Allocapnia vivipara* has a univoltine life cycle (Harper and Hynes 1970) with eggs deposited in May, hatching within a month, undergoing a diapause during summer (Coleman and Hynes 1970, Harper and Hynes 1970, Pugsley and Hynes 1985), and developing rapidly through the fall and winter.

Habitat: Frison (1929) reported *Allocapnia vivipara* from small and medium streams in Illinois, and it has been reported from small streams in Minnesota (Harden and Mickel 1952:32). Ross and Ricker (1971) found *A. vivipara* in streams of various sizes and abundant in streams heavily loaded with organic materials, as it is especially tolerant of barnyard pollution. Gaufin (1958) reported *A. vivipara* to be intolerant of pollution, preferring water with high levels of dissolved oxygen (70–115% saturation). Surdick and Gaufin (1978) reported *A. vivipara* as being a herbivore or scavenger that was neutral or alkaliphilous, saproxenous or saprophobic, euoxyphilous, eury-, meso-, meta-, and oligothermal, rheophilous and rheobiontic, epilithic and epiphytic, and found in rivers or permanent and intermittent streams. From 1976–2000, adults of *A. vivipara* were the most commonly collected winter stonefly in Illinois. Adults were collected from bridge railings and abutments, on and under cobblestone and cement blocks, in leaf packs and woody vegetation, and as they walked across snow and ice. This species displayed a wide diversity in habitat selection, being collected from small slow flowing streams, 1–10 m wide, less than1–3 m deep, with a gravel, sand, and cobblestone substrate. In the central part of the state, *A. vivipara* was collected predominately from clay/silt or sand bottom streams. It was also collected from large streams over 35 m wide and greater than 2 m deep with clay/silt and sandy substrates to big rivers over

a quarter of a kilometer wide with clay/silt and sandy bottoms.

Distribution and Seasonal Activity: *Allocapnia vivipara* is widely distributed from Virginia to southern Quebec west to eastern Wisconsin, eastern Kansas and northeastern Oklahoma (Ross and Ricker 1971, Fig. 88; Stark *et al.* 1986), with a single locality from northeastern Arkansas (Poulton and Stewart 1991). In Illinois, adults were collected from 10 December to 30 April. Figure 49 displays the distribution of *A. vivipara* from 1900–1945, 1946–1975, and 1976–2000.

Current Status. *Allocapnia vivipara* is the most widespread and commonest species of winter stonefly in Illinois. It also is the most environmentally tolerant species; being collected from pristine streams to those heavily impacted with livestock waste. During the resurvey of Illinois, it was collected in all natural divisions, except the Illinois/Mississippi River Sand Areas (Table 3). Historically (1900–2000), it has been collected from all drainage basins within the state (Table 4). Recently (1976–2000), it was collected in all drainage basins except the Mississippi River and Wabash Rivers proper (Table 4).



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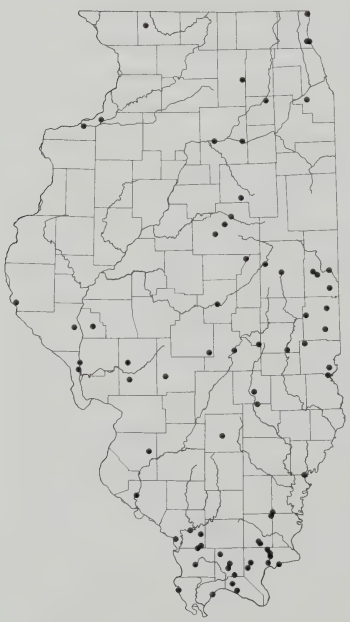
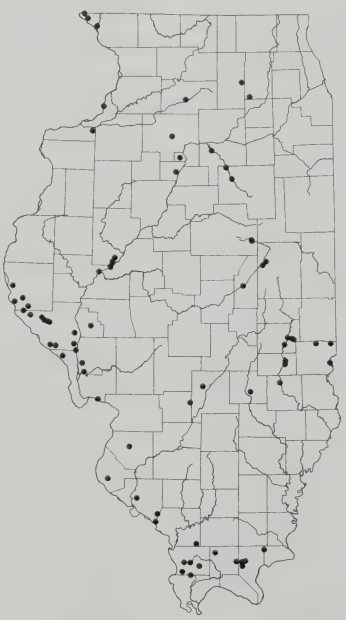
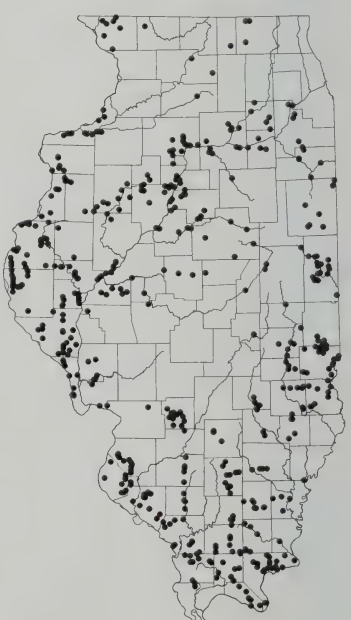


49A. 1900–1945



49B. 1946–1975



49C. 1976–2000

Figures 47–49. *Allocapnia vivipara.* 47. Male terminalia. A=lateral view, B=dorsal view. 48. Female terminalia. 49. Distribution in Illinois. (Figs. 47–48 from Ross & Ricker 1971).

Nemocapnia Banks

Nemocapnia Banks (1938:74): Claassen (1940:96), Frison (1942:262), Hanson (1946:223, 236), Harper and Hynes (1971a:938), Harper (1984), Hitchcock (1974:70), Illies (1966:160), Stewart and Harper (1996). Genotype *Nemocapnia carolina* Banks.

This genus contain only one North American species (Bill Stark 2001 http://www.mc.edu/campus/users/stark).

Nemocapnia (Hanson 1946, Hitchcock 1974) is separated from other capniid genera by having the presternum united to the basisternum on each thoracic sternite; its mesothoracic postfurcasternum is large and united to the spinasternum and furcasternum (Hitchcock 1974, Fig. 13); vein A_1 of forewing is slightly bent just beyond the origin (Fig. 50) and there is no costal crossvein beyond Sc in the forewing. The epiproct is bluntly pointed, with no lower limb separate this genus from *Allocapnia* (Poulton and Stewart 1991). Hanson (1946:236) also defined this genus and discussed the comparative morphology of *Nemocapnia* within the Capniidae. There is only one Nearctic species.

Nemocapnia carolina Banks

Nemocapnia carolina Banks (1938:74): Claassen (1940:96), Frison (1942:262), Harper and Hynes (1971a:926, 939), Harris and Webb (1995:342), Illies (1966:160), Poulton and Stewart (1991:21), Ricker (1945:227), Stark and Gaufin (1979:428). Type locality: Morgantown, North Carolina.

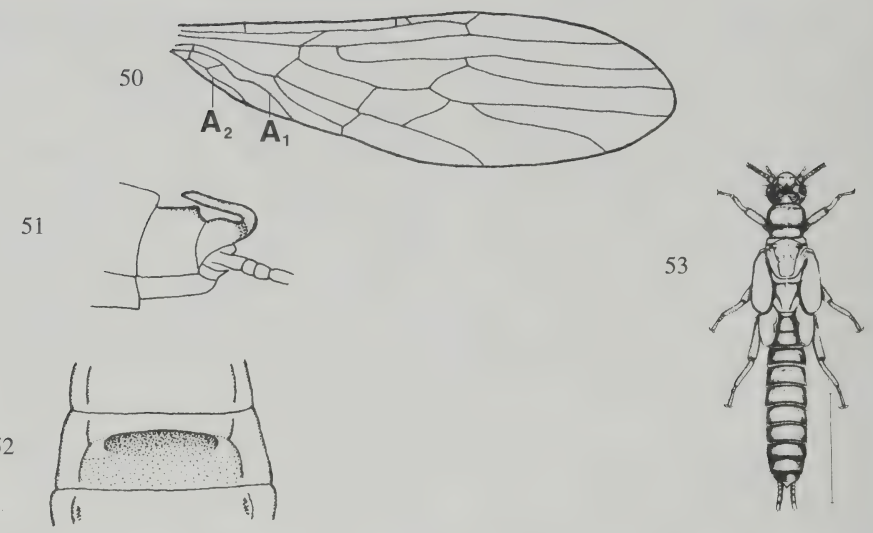
Adult: (Poulton and Stewart 1991). **Male** (Figs. 50 and 51): Length 7 mm. Forewing (Harper 1984, Fig. 13.162; Poulton and Stewart 1991, Fig. 15; Stewart and Harper 1996, Fig. 14.166). Epiproct unipartite, sternite 9 lacking ventral lobe (vesicle) Frison (1942, Fig. 28, terminalia), Harper and Hynes (1971a, Fig. 9, terminalia), Hitchcock (1974, Fig. 68 terminalia), Stark and Gaufin (1979, Figs. 61–62, terminalia), Stewart and Stark (1988, Fig. 7.14 F–H), Poulton and Stewart (1991, Fig. 55, terminalia). **Female** (Fig. 52): Subgenital plate slightly rounded, but set before the hind margin of the sternite (Hitchcock 1974), Frison (1942, Fig. 30), Hanson (1946, Fig. 51), Stark and Gaufin (1979, Fig. 63), Poulton and Stewart (1991, Fig. 54).

Nymph (Fig. 53) (Harper and Hynes 1971a: 939, Stewart and Stark 1988:122). *Nemocapnia* differs from *Isocapnia* in having the fringe less dense, the enclosure of the anterior mesosternal Y ridge is narrowly rectangular, and the body has fewer erect setae. Length 6–7 mm. Yellowish brown. Most of body with well-developed prostrate clothing hairs, no erect setae (Harper and Hynes 1971a, Fig. 52). Antennae short, about one-half length of body; mandibles without patches of hairs near ventral socket; legs very short, usually with fringe of setae on tibiae and tarsi. Abdomen with prostrate clothing setae, no erect setae (Harper and Hynes 1971a: Fig. 52). Cerci short, about 15 segments, apical segments with vertical fringe of long setae which are absent of the basal 5 or 6 segments (Fig. 11). Other figures: Frison (1942, Fig. 29 mandibles, maxilla, labium, Fig. 31, habitus); Harper and Hynes (1971a, Fig. 52, abdominal setation); Harper (1984, Fig. 13.33, cercus); Poulton and Stewart (1991, Fig. 49, cercus); Stewart and Stark 1988:122, Fig. 7.13, habitus, Fig. 7.14, A head-pronotum, B mandible, C lacinia, D front leg, E mesosternum, F–H male terminalia lateral, dorsal ventral, I female terminalia, J cercus), Stewart and Harper (1996, Fig. 14.33, cercus).

Distribution and Seasonal Activity: *Nemocapnia carolina* ranges from Florida to Quebec, west to Illinois and Arkansas (Stark *et al.* 1986). In Illinois, adults were collected 8 March.

Illinois Records 1900–1945.
White County: Wabash River, Grayville.

Current Status: *Nemocapnia carolina* has been collected only once in Illinois in 1928 from the Wabash River at Grayville. Several attempts were made to collect this species at Grayville and other localities along the Wabash River but were unsuccessful. This species must be considered as extirpated from the state.



Figures 50–53. *Nemocapnia carolina*. 50. Forewing. 51. Male terminalia. 52. Female terminalia. 53. Nymph. (Figs. 50–52 from Poulton & Stewart 1991; 53 Stewart & Stark 1988).

Paracapnia Hanson

Paracapnia Hanson (1946:225, 236): Hanson (1961:25), Harper (1984:117), Illies (1966:161), Stewart and Harper (1996:228, 246, 264), Zwick (1973:389).

This genus contains five North American species (Bill Stark 2001 http://www.mc.edu/campus/users/stark).

Paracapnia (Hanson 1946, Hitchcock 1974, Stewart and Harper 1996) is separated from other capniid genera by having the mesothoracic postfurcasternal plate united with the furcasterna and the spinasternus; the mesofurcasternum and metafurcasternum transverse and almost rectangular; forewing with 0–3 costal crossveins; R_1 of forewing slightly curved cephalad then more broadly curved distad beyond origin of Rs; and the apical portion of Cu_1 of the hindwing generally missing; anal lobe of hindwing smaller than remainder of wing; cerci with more than 11 segments.

Hanson (1946:236) discusses the comparative morphology of *Paracapnia* within the Capniidae.

Paracapnia angulata is separated from *P. opis* (Newman) in the shape of the male epiproct (Hanson 1961).

Paracapnia angulata Hanson

Paracapnia angulata Hanson (1961:29): Harper and Hynes (1971a:926, 939), Harris and Webb (1995:342), Hitchcock (1974:69), Illies (1966:161), Poulton and Stewart (1991:21), Zwick (1973:389). Type locality: Pelham, Massachussetts.

Capnia opis (Newman): Frison (1942:264, in part), Ricker (1938:134, in part).

Capnia vernalis Needham and Claassen (1925:356) (male and female figures questionable): Frison (1942:264), Hanson (1961:29).

Adult (Hanson 1961): Male (Figs. 54–55): Epiproct thick, broadened once then tapered to apex. Other figures: Frison (1942, Fig. 32, terminalia, as *P. opis*); Hanson (1946, Fig. 52, as *P. opis*); Hanson (1961, Fig. 1-4 epiproct), Harper and Hynes (1971a: Fig. 2 terminalia), Hitchcock (1974, Fig. 65, epiproct); Poulton and Stewart (1991, Figs. 51–52, terminalia). **Female** (Fig. 56): indistinguishable from *P. opis*. Other figures: Frison (1942, Fig. 32, terminalia, as *P. opis*); Poulton and Stewart (1991, Fig. 53, terminalia).

Nymph (Figs. 10, 19, 57) (Harper and Hynes 1971a:939): Length 6–8 mm. Reddish brown with distinct purplish markings on head; appendages and wingpads yellowish. Body generally hairy. Head with long setae, especially on antero-

lateral margins of frons and near compound eyes. Antennae long, about three-fourths the length of body. Pronotum with numerous long setae (Harper and Hynes 1971a, Fig. 56); meso- and metanota with tufts of long bristles on anterior angles. Wingpads bordered with long bristles. Outer margins of legs with long bristles; bristles on inner surface of tibiae short, half as long as width of tibia; middle and distal segments of cerci with long intermediate bristles at ventral base of segment. Abdomen with clothing setae yellow, many erect purplish setae on margins of tergites. Cerci about as long as abdomen, each segment with whorl of short bristles. Other figures: Harper (1984, Fig. 13.34, abdominal terga); Stewart and Harper (1996, Fig. 14.34, abdominal terga); Stewart and Stark (1988, Fig. 7.15, habitus, Fig. 7.16 A–J, A head-pronotum, B mandible, C lacinia, D front leg, E mesosternum, F–H male terminalia lateral, dorsal, ventral, I female terminalia, J-L cercus, basal, middle, and apical sections).

First instar nymph: Harper (1979, Fig. 8, first-instar habitus).

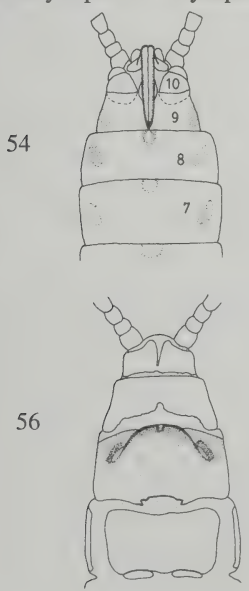
Biology: In Illinois, adults emerged over a short period in March. Eggs presumably hatch within a few weeks (Harper and Hynes 1972) and the nymphs grow rapidly throughout the summer and autumn. The last instar occurring sometime in December with a slowing of growth until emergence in early April. No nymphal diapause has been observed (Harper and Hynes 1970, 1972). Surdick and Gaufin (1978) reported *Paracapnia angulata* as being neutral or alkaliphilous, eurymeta- and oligothermal, and found in streams.

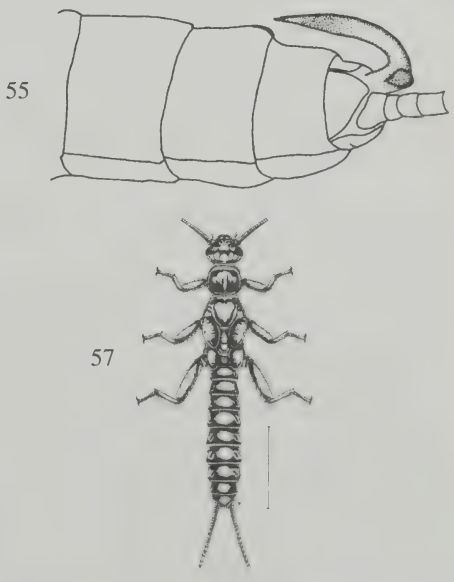
Habitat: In Illinois, *Paracapnia angulata* has been collected from small, spring-fed streams, 30–60 cm wide and less than 30 cm deep with a gravel and sand substrate.

Distribution and Seasonal Activity: *Paracapnia angulata* ranges from North Carolina to Maine west to Washington and Oregon (Stark *et al.* 1986, Stewart and Stark 1988). In Illinois, adults were collected from 7–20 March.

Illinois Records 1900–1945.
Kane County: Elgin, Trout Park (Elgin Botanical Garden).

Current Status: *Paracapnia angulata* in Illinois has been collected on two separate dates from an area of springs and spring-fed streams in Trout Park (Elgin Botanical Garden) in 1940. These springs and shallow streams support a rich variety of aquatic organisms, with several species of caddisflies and one species of mayfly found nowhere else in the state (Ross 1944). Several attempts were made to collect *P. angulata* during the past five years but with no success. At this time, this species must be considered as extirpated from the state.





Figures 54–57. *Paracapnia angulata*. 54–55. Male terminalia. 56. Female terminalia. 57. Nymph. (Figs. 54–56 from Poulton & Stewart 1991; 57 Stewart & Stark 1988).

Leuctridae

This family contains 9 North American genera and 55 species (Bill Stark 2001 http://www.mc.edu/campus/users/stark).

Adults (Stewart and Harper 1996, Stark and Nelson 2000) have the glossae and paraglossae subequal in length and size, set at same level on labium, apical segment elongate, but not much larger than preceding segment; the thorax lacking gill remnants; first tarsal segment much longer than second; wings at rest rolled over the back and sides of the abdomen, giving leuctrids a cylindrical, stick-like appearance; no crossvein in the costal space beyond the cord; vein A_2 in forewing forked; intercubital crossveins numerous, usually five or more; cerci one-segmented.

Nymphs (Stewart and Harper 1996) have the glossae and paraglossae subequal in length and size; lack cervical gills; have the extended hindlegs reaching far short of the abdominal apex; first tarsal segment longer than second; the hindwing pads usually longer than wide; abdominal terga 1–2 or 1–3 lacking gill tufts; at most abdominal segments 1–7 separated by a membranous pleural fold; a posterior fringe of setae on abdominal terga (lacking in *Zealeuctra*).

Biology: Leuctrids are principally sprawler-clingers in lotic situations where they feed as shredder-detritivores (Stewart and Harper 1996).

Zealeuctra Ricker

Zealeuctra Ricker (1952:173): Harper (1984:116), Illies (1966:120), Stewart and Harper (1996: 218-219, 228, 249, 263), Zwick (1973:412). Type species *Leuctra claasseni* (Frison 1929).

This genus contains eight North American species (Bill Stark 2001 http://www.mc.edu/campus/users/stark).

Adults (Poulton and Stewart 1991, Stewart and Harper 1996) have the glossae and paraglossae subequal in length and size (Fig. 15); gill remnants absent on sides of thorax and abdominal segments 1–2; at rest, wings rolled, covering both back and sides of abdomen; A_2 of forewing forked (as in Fig. 13); intercubital crossveins numerous; crossveins absent beyond cord in costal space; first tarsal segment longer than second (as in Fig. 9); cerci one-segmented (Fig. 58C).

Nymphs (Poulton and Stewart 1991, Stewart and Harper 1996, Stewart and Stark 1988) have the wing pads nearly parallel to axis of body (as in Fig. 16); abdominal segments cylindrical, segments 1–6 separated by a pleural fold, posterior margin of terga without setal fringe (Fig. 60).

Key to adults of Illinois *Zealeuctra*
(Hitchcock 1974, Ricker and Ross 1969)

1. Male epiproct with secondary cusp near tip of main cusp (Fig. 62B); female sternite 7 with hind margin emarginate medially to contain median lobe (Fig. 63).....*fraxina*

   Male epiproct ending in simple tapered cusp (Figs. 58B and 64B); female sternite 7 with hind margin truncate (Figs. 59 and 65).....2

2. Male tergite 9 with medial margin of central depression minutely and irregularly serrated anteriorly (Fig. 58A); base of epiproct rounded, as long as wide (Fig. 58B); female sternite 7 with median lobe thick, white, as broad as long (Fig. 59); sternite 7 with posterior marginal hairs numerous, long .....*claasseni*

   Male tergite 9 with medial margin of central depression smooth except for rounded terminal and subterminal projections (Fig. 64A); base of epiproct half as long as wide (Fig. 64B); female sternite 7 with median lobe brown, about twice as broad as long (Fig. 65); sternite 7 with posterior marginal hairs few, short.....*narfi*

Of the three species of Illinois *Zealeuctra,* only the nymphs of *Z. claasseni* are known.

Zealeuctra claasseni (Frison)

Zealeuctra claasseni (Frison): Harris and Webb (1995:342); Hitchcock (1974:87), Illies (1966:120), Poulton and Stewart (1991:23), Ricker and Ross (1969), Snellen and Stewart (1979:65), Stewart *et al.* (1974), Ziegler and Stewart (1977), Zwick (1973:41). The type locality was given as Bushy Fork, Herod, Illinois. On the 1916 Equality Quadrangle topographic map this fork is listed as Brushy Fork and on current topographic maps is cited as Pinhook Creek.

Leuctra classeni Frison (1929:404, in part): Claassen (1931:100, 1940:77), Frison (1935:354), Ricker (1945:227), Zwick (1973:412).

Leuctra (*Paraleuctra*) *claasseni* Frison: (Frison 1942:256).

Leuctra (*Zealeuctra*) *claasseni*: Jewett (1956:168), Ricker (1952:173).

Paraleuctra claasseni (Frison): Hanson (1941:58).

Adult: (Hitchcock 1974, Poulton and Stewart 1991, Ricker and Ross 1969). Length 8–10 mm. **Male** (Fig. 58): Lateral margins of medial depression strongly convergent anteriorly, almost V-shaped (Fig. 58A), terminating posteriorly in a sharp medially directed point and smaller subterminal projection. Epiproct with single sharp tooth on broadly rounded base (Fig. 58B). Cerci with rounded hump on upper side (Fig. 58C). Other figures: Frison (1929, Figs. 68 and 69, terminalia; 1935, Figs. 178, 194, 230, 285; 1942, Fig. 18). **Female** (Fig. 59): Sternite 7 with numerous long hairs, especially near hind margin; posterior margin straight; median lobe white, about as broad as long. Sternite 8 with anterior pair of sclerotized knobs bearing long hairs, and lying on either side of the median lobe of sternite 7.

Nymph: (Fig. 60). Frison (1929, Fig. 16, labium; Fig. 20, maxillae; Fig. 24 mandibles; Fig. 28, legs; Fig. 38, male nymph; 1935, Figs. 59, 88, 118, 153, 258, 283, 284) and Claassen (1931:100) have described the nymph. In 1935, Frison described anal gills on the nymph but Hitchcock (1974:8) concluded that these were probably fungal growths. Other figures: Harper (1984, Figs. 13.13 and 13.48, abdominal ventrum; Fig. 13.49, male abdominal dorsum); Stewart and Stark (1988, Fig. 8.14 a–l, a head-pronotum, b mandible, c lacinia, d front leg, e mesosternum, f–h male terminalia lateral dorsal ventral, i female terminalia, j–l basal, middle, and apical sections of cercus) and Stewart and Harper (1996, Fig. 14.13, abdominal venter; Fig. 14.48, abdominal venter; fig. 14.49, abdominal dorsum).

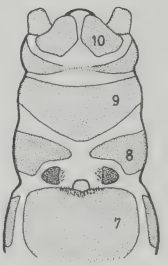
The first instars (Snellen and Stewart 1979, Fig. 9 and Fig. 11 A mandible, B maxilla, C hind leg) are consistent in being unpigmented, without ocelli, and having antenna:cercal segment formulae of 8-11:3-5; compound eyes with 2–4 ommatidia; gills absent, reduced, or represented only by knobs or stubs, generally few hairs compared with later instars; and three tarsal segments, the first two short and together subequal to the longer third.

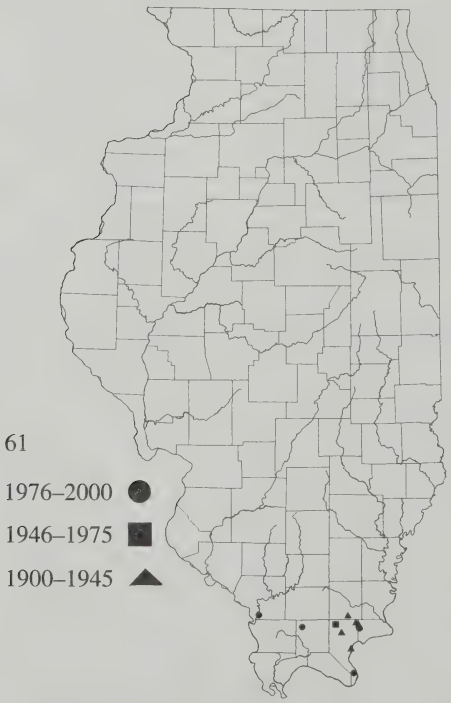
Biology: Snellen and Stewart (1979) found *Zealeluctra claasseni* to have a flexible life cycle. Both diapausing and nondiapausing eggs are produced with extended periods of egg diapause in dry years and a very fast nymphal growth. Adults displayed a peak in emergence when the daily water temperature was about 12°C. Emergence was diurnal and teneral adults and mating pairs were found from dawn to late evening. Ziegler and Stewart (1977) described the drumming of the male to be a multi-beat signal with more than 20 beats per signal and an interbeat interval that shortened as the signal progressed. Snellen and Stewart (1979) also reported on the drumming behavior. Laboratory reared nymphs fed on detritus and algae (Snellen and Stewart 1979) and Frison (1929) found decaying vegetation in the gut of one nymph.

Habitat: *Zealeuctra claasseni* emerges early in the spring (Frison 1935) and can be found even in streams that dry up in midsummer (Ricker 1952) or in intermittent limestone-base streams (Stewart and Stark 1988). Surdick and Gaufin (1978) reported *Z. claasseni* as being a herbivore, alkaliphilous, saprophobic, euoxyphilous, meso- and metathermal, rheobiontic, epilithic and epiphytic, and found in permanent and intermittent streams. From 1976–2000, *Z. claasseni* was collected from bridge railings and leaf packs near small, permanently flowing streams, 1–2 m wide, less than 60 cm deep, with a gravel, sand, and cobble substrate.

Distribution and Seasonal Activity: *Zealeuctra claasseni* ranges from West Virginia to Oklahoma and eastern Texas, with isolated populations in the Wichita and Arbuckle mountains of southwestern and south-central Oklahoma (Stewart *et al.* 1974, Stark *et al.* 1986). In Illinois, adults were collected from 27 February to 1 May. Figure 61 displays the distribution of *Z. claasseni* from 1900–1945, 1946–1975, and 1976–2000.

Current Status: *Zealeuctra claasseni* is uncommon in Illinois but it remains established across the Shawnee Hills. Historically (1900–2000), it was collected in the Shawnee Hills and Southern Till Plain Natural Divisions of Illinois (Table 3) and four river drainages in the Shawnee Hills (Table 4). Recently (1976–2000), it was collected only in the Shawnee Hills Division (Table 3).





Figures 58–61. *Zealeuctra claasseni*. 58. Male terminalia (A). B=epiproct, C=cercus. 59. Female terminalia. 60. Nymph. 61. Distribution in Illinois. (Figs. 58–59 from Poulton & Stewart 1991; 60 Stewart & Stark 1988).

Zealeuctra fraxina Ricker and Ross

Zealeuctra fraxina Ricker and Ross (1969:1117): Harris and Webb (1995:342), Poulton and Stewart (1991:23), Zwick (1973:413). Type locality Hardinsburg, Breckenridge County, Kentucky.

Leuctra claasseni Frison (1929, in part, Fig. 68 and 69 are of the female paratype of *Zealuctra fraxina.*

Leuctra claasseni Frison (1935, in part, Fig. 194 and 230 are *Zealuctra fraxina.*

Adult: (Hitchcock 1974, Poulton and Stewart 1991, Ricker and Ross 1969). Length 8–10 mm. **Male:** Tergite 9 with medial depression U-shaped, lateral margins heavily sclerotized (Fig. 62A), terminating posteriorly in a sharp medially directed point and smaller subterminal projection. Epiproct with secondary subapical cusp (Fig. 62B). Cerci with a blunt, fingerlike, lateral terminal lobe and a dorsal lobe near middle of cercum (as in Fig. 64C). **Female** (Fig. 63): Sternite 7 with median portion well sclerotized and with numerous hairs; posterior margin strongly notched medially; median lobe white.

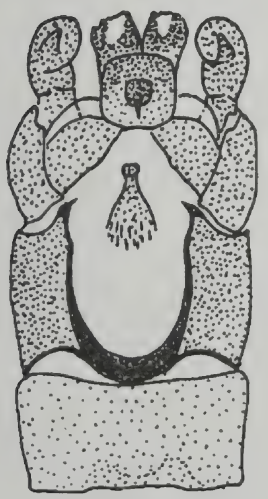
Habitat: Adults of *Zealeuctra fraxina* were collected from leaf packs along a small, slow flowing stream, 3 m wide, 30 cm deep, with a cobble, gravel, and sand substrate.

Distribution and Seasonal Activity: *Zealeuctra fraxina* ranges from Tennessee to West Virginia, west to southern Illinois (Stewart *et al.* 1974, Stark *et al.* 1986). In Illinois, adults were collected from 20 January to 6 March.

Illinois Records. 1900–1945. Pope County: Gibbons Creek, Herod.

1976–2000. Pope County: tributary Hart Creek, 2.5 km SW Herod. **Saline County**: tributary Battle Ford Creek, 3.7 km NE Delwood.

Current Status: *Zealeuctra fraxina* is rare in Illinois but is still established at two sites in the eastern Shawnee Hills. Historically (1900–2000), it has been collected only in the Shawnee Hills Natural Division (Table 3). Prior to 1946, it had been collected only in the Big Grand Pierre Creek drainage (Table 4), but recently (1975–2000) it was also collected in the Saline River Drainage (Table 4).



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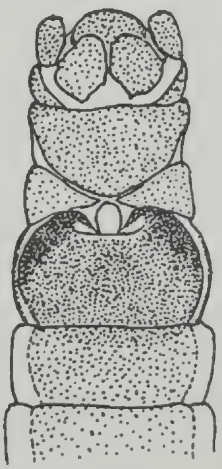

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Figures 62–63. *Zealeuctra fraxina.* 62. Male terminalia (A), B=epiproct. 63. Female terminalia. (Figs. 62–63 from Ricker & Ross 1969).

Zealeuctra narfi Ricker and Ricker

Zealeuctra *narfi* Ricker and Ross (1969:1118): Harris and Webb (1995:342), Hitchcock (1974:89), Poulton and Stewart (1991:24), Zwick (1973:413). Type locality Otter Creek, Sauk County, Wisconsin.

Leuctra claasseni Frison (1929, in part) the female specimen from Fountain Bluff, Illinois is *Z. narfi.*

Adults: (Hitchcock 1974, Poulton and Stewart 1991, Ricker and Ross 1969). Length 6.0–7.5 mm. **Male:** Tergite 9 with lateral margins of medial depression terminating in a rounded point and rounded subterminal tooth (Fig. 64A). Epiproct with single tooth on a subrectangular base that is wider than long (Fig. 64B). Cerci with a blunt, fingerlike, lateral terminal lobe and a dorsal lobe near middle of cercum (Fig. 64C). **Female** (Fig. 65): Sternite 7 with scattered short hairs, not forming a tuft posteromedially, posterior margin straight, median lobe brown, about twice as wide as long.

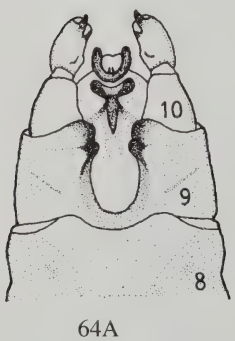
Habitat: Surdick and Gaufin (1978) reported *Zealeuctra narfi* as being neutral with regards to pH, eury- and oligothermal, eu- and mesolichtophilous, and rheophilous. In Illinois, adults of *Z. narfi* were collected from leaf packs along a small, slow flowing stream, 3 m wide, 30 cm deep, with a cobble, gravel, and sand substrate.

Distribution and Seasonal Activity: *Zealeuctra narfi* ranges from Oklahoma to Wisconsin (Stark *et al.* 1986). In Illinois, adults were collected from 6 February to 5 May.

Illinois Records 1900–1945.
Jackson County: Fountain Bluff.

1976–2000. Saline County: tributary Battle Ford Creek, 3.7 km NE Delwood. **Union County**: Alto Pass, Cave Spring Cave. **Vermilion County**: Kickapoo State Park.

Current Status: *Zealeuctra narfi* was originally known only from Fountain Bluff, Jackson County, Illinois. Several attempts were made to collect this species at Fountain Bluff with no success. From 1976–2000, specimens were collected at three new localities in Saline, Union, and Vermilion counties in eastern Illinois. Although rare in Illinois, this species is still established. Prior to 1946, this species was known only from the Shawnee Hills Natural Division and within the Big Muddy Drainage System. Recently (1975–2000), it has been collected within the Shawnee Hills and Wabash Border Natural Divisions and the Big Muddy, Saline, and Vermilion River drainage basins (Table 4).



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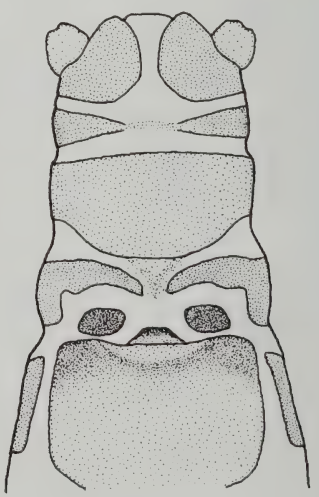
64C



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Figures 64–65. *Zealeuctra narfi.* 64. Male terminalia (A), B=epiproct, C=cercus. 65. Female terminalia. (Figs. 64–65 from Poulton & Stewart 1991).

Nemouridae

This family contains 12 North American genera and 71 species (Bill Stark 2001 http://www.mc.edu/campus/users/stark).

Adults (Poulton and Stewart 1991:28, Stewart and Harper 1996:239, Stark and Nelson 2000) have the glossae and paraglossae subequal in length and size; apical segment of labial palpus circular, larger than penultimate segment; gill remnants lacking on sides of thorax; at rest, wings folded flat over dorsum; an extra crossvein in the costal space beyond the cord of the forewing (Fig. 13); first tarsal segment longer than second (as in Fig. 9); and cerci one-segmented (Fig. 66); female subgenital plate usually small. Nymphs have divergent wing pads similar to Taeniopterygidae. Only one species *Prostoia completa* is considered a winter stonefly in Illinois.

Biology: Nemourids are principally sprawler-clingers in lotic situations where they feed as shredder-facultative detritivores or collector-gatherers (Stewart and Harper 1996).

Prostoia Ricker

Prostoia (Ricker): Harper (1984:116), Illies (1966:220), Poulton and Stewart (1991:29), Stewart and Harper (1996:29). Type species *Prostoia completa* (Walker), Zwick (1973:345).

Nemoura (*Prostoia*) Ricker (1952:47): Illies (1966:220).

This genus contains four North American species (Bill Stark 2001 http://www.mc.edu/campus/users/stark).

Adults (Harper 1984, Stewart and Harper 1996) have gill remnants absent on the submentum or cervix; forewing with terminal crossvein joining R (Fig. 13), veins A_1 and A_2 separate; male sternum 9 with vesicle, epiproct long and simple, cerci membranous; female wings distinctly banded, sternum 8 unsclerotized except at margin, and not extending over sternum 9.

Nymphs (Harper 1984, Stewart and Stark 1988) have the submentum and cervix lacking gills; width of the pronotum usually subequal to distance between eyes, with rounded corners, without a lateral notch and with tiny inconspicuous bristles; fore tibial fringe of outer hairs complete, without distinct rows of robust bristles; tibia with short, stout bristles along outer margins (Fig. 9); middle and apical cercal segments with dorsal or ventral intersegmental hairs or both.

Biology: Nymphs of *Prostoia* are herbivore-detritivores (Krueger and Waters 1983) or shredder-detritivores (Stewart and Harper 1996).

Prostoia completa (Walker)

Prostoia completa (Walker): Illies (1966:221), Poulton and Stewart (1991:29), Zwick (1973:346). Type locality Nova Scotia, Canada.

Nemoura (*Prostoia*) *completa* (Walker): Poulton and Stewart (1991:29), Ricker (1952:49)

Nemoura completa Walker (1852:191): Claassen (1940:53), Harden and Mickel (1952:16), Poulton and Stewart (1991:29), Zwick (1973:346).

Nemoura glabra Claassen (1923:281): Illies (1966:221). Type locality Nova Scotia, Canada.

Adult: (Poulton and Stewart 1991). **Male** (Fig. 66): Epiproct widened with a short basal process. Other figures: Needham and Claassen (1925: pl. 34, Figs. 1–4), Ricker (1952, Fig 23, epiproct). **Female** (Fig. 67): Posterior margin of sternite 8 not extending over sternite 9.

Nymph: (Fig. 68). Harden and Mickel (1952, pl. 1, Fig. 2, pl. 8, Figs. 1–2). First instar nymph: Harper (1979, Fig. 4, first instar habitus).

Biology: In Oklahoma, Ernst and Stewart (1985) reported *Prostoia completa* to have a univoltine fast life cycle with a probable egg diapause of 6–7 months during spring and summer. Harper (1973) reported a four-month diapause for eggs from southern Ontario reared in the laboratory. Ernst and Stewart (1985, Fig. 3) reported nymphs during February and March and that the size of the drifting nymphs was always greater than the average size of nymphs concurrently found in benthic samples. Bishop and Hynes (1969) reported on the upstream migration of *P. completa* (as *Nemoura*) in the Speed River, Ontario.

Habitat: Surdick and Gaufin (1978) reported *Prostoia completa* as being alkaliphilous, eury-,

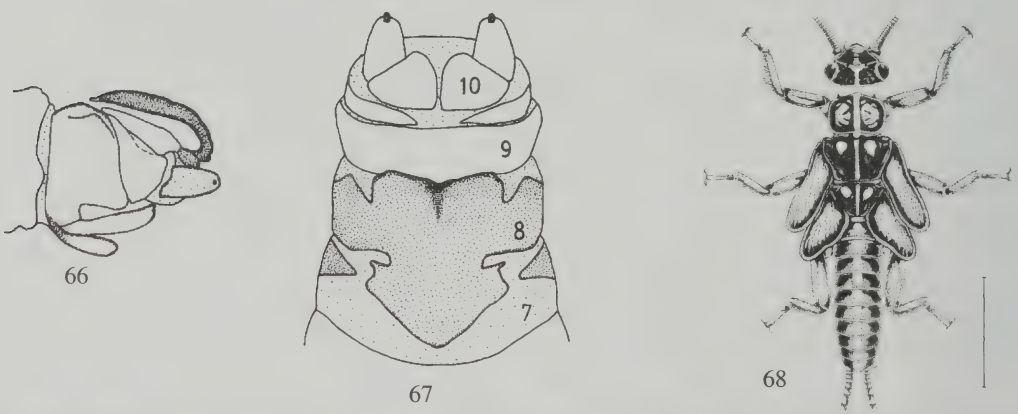
meso-, and oligothermal, and found in rivers and streams. Stewart and Poulton (1991) collected *P. completa* from permanently flowing streams. From 1976–2000, adults of *P. completa* were collected from leaf packs along a permanent, moderately flowing stream, 3–4 m wide, less than 30 cm deep with a gravel and sand substrate.

Distribution and Seasonal Activity: *Prostoia completa* ranges from Alabama to Quebec west to Minnesota and Oklahoma (Stark *et al.* 1986, Stewart and Stark 1988). In Illinois, adults were collected from 13 March to 19 April.

Illinois Records 1946–1975.
Union County: Hutchins Creek.

1976–2000. Union County:
Hutchins Creek, 5.4 km E Wolf Lake.

Current Status. *Prostoia completa* is rare in Illinois, having been collected at only one site in the Big Muddy Drainage System in the Shawnee Hills Natural Division. It still can be collected at that site.



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Figures 66–68. *Prostoia completa*. 66. Male terminalia. 67. Female terminalia. 68. Nymph. (Figs. 66–67 from Poulton & Stewart 1991; 68 Stewart & Stark 1988).

Taeniopterygidae

This family contains 6 North American genera and 34 species (Bill Stark 2001 http://www.mc.edu/campus/users/stark).

Adults (Harper 1984, Poulton and Stewart 1991, Stewart and Harper 1996, Stark and Nelson 2000) have the glossae and paraglossae subequal in length and size (as in Fig. 15); cervical gill remnants lacking; the first tarsal segment long, although subequal in length to the second (Fig. 8); cerci multisegmented or one-segmented.

Nymphs (Harper 1984, Poulton and Stewart 1991, Stewart and Harper 1996) have the glossa and paraglossae subequal in length (as in Fig. 15); wing pads strongly divergent from the body axis (Fig. 17); tarsal segments 1 and 2 subequal in length (Fig. 8), and ventral gill tufts absent on abdominal segments 1 and 2.

Biology: Taeniopterygids are principally sprawler-clingers in lotic situations where they feed as shredder-detritivores or facultative collector-gatherers (Krueger and Waters 1983, Stewart and Harper 1996).

Key to Genera of Taeniopterygidae in Illinois (Stewart 2000).

1. Gill scar present, appearing as a membranous circle in coxa; sternum 9 extended little, if any, distad to tergite 10 in males, and not reaching base of subanal lobes in females ..... *Taeniopteryx*

   Gill scar absent on coxa; sternum 9 extended distinctly distad to tergite 10 in males, and distad to base of subanal lobes in females..... *Strophopteryx*

Strophopteryx Frison

Strophopteryx Frison (1929:374): Claassen (1940:41), Harper (1984:205), Illies (1966:67), Stewart (2000:59), Stewart and Harper (1996: 224,242), Zwick (1973:315). Type species *Strophoteryx* (*Semblis*) *fasciata* (Burmeister).

Taeniopteryx (Rhabdiopteryx) Banks (1907:14); Illies (1966:67).

This genus contains 5 North American species (Bill Stark 2001, http://www.mc.edu/campus/users/stark).

Adults (Harper 1984, Ricker and Ross 1975, Stewart and Harper 1996) have 1 or 2 costal crossveins; Rs with two branches, Cu_1 with 2–3 branches; coxa lacking a gill scar; posterior margin of the male sternum 9 symmetrical, elevated medially, corners low; apex of the epiproct symmetrical with one prong; female sternum 9 subtriangular, tapered posteriorly (Fig. 71).

Nymphs (Harper 1984, Stewart and Harper 1996) have the coxae without gills; tibiae with dorsal and ventral hair fringe (*Strophopteryx fasciata*) or only a dorsal hair fringe; some basal cercal segments or entire cercus with dorsal hair fringe.

Biology: Nymphs have a univoltine life cycle and within the functional feeding groups they are scrappers (Krueger and Waters 1983). Frison (1929) reported that the nymphs of Taeniopterygidae fed on decaying leaves and seven species of diatoms. Brinck (1949), Hynes (1941), and Richardson and Gaufin (1971) reported taeniopterygids feeding primarily on detritus, with appreciable amounts of plant material, diatoms, and algae.

Strophopteryx fasciata (Burmeister)

Strophopteryx fasciata (Burmeister): Claassen (1940:41), Frison (1929:384, 1935:347), Funk and Sweeney (1990), Harper and Hynes (1971b:1942), Harris and Webb (1995:342), Illies (1966:67), Poulton and Stewart (1991:27), Stewart (2000:61), Ricker and Ross (1975:143), Zwick (1973:315). Type locality: Pennsylvania.

Semblis fasciata Burmeister (1839:875): Illies (1966:67), Ricker and Ross (1975:143).

Brachyptera fasciata (Burmeister): Frison (1942:250), Harper and Hynes (1972:302), Harden and Mickel (1952:14), Hitchcock (1974:127).

Brachyptera (*Strophopteryx*) *fasciata* (Burmeister): Harper and Hynes (1971b:942), Hitchcock (1974:127).

Nemoura fasciata (Burmeister): Pictet (1841:359).

Rhabdiopteryx fasciata (Burmeister): Banks (1907:14), Illies (1966:67).

Taeniopteryx (*Strophopteryx*) *fasciata* (Burmeister): Frison (1942:250), Ricker (1945:226).

Taeniopteryx fasciata (Burmeister): Claassen (1931:106), Hagen (1861:34), Needham and Claassen (1925:243).

Taeniopteryx frigida Hagen (1861:35): Illies (1966:67).

Adults: (Hitchcock 1974, Poulton and Stewart 1991:26). Length 10–15 mm. **Male** (Figs. 69 and 70): Tergite 9 with two conspicuous posterior setose lobes extending posteriorly. Sternite 9 broad, elliptical anteriorly, posterior half narrowed, recurved, bifurcated apically. Epiproct connected to tergite 10 by three sclerotized bands. Other figures: Frison (1935, Figs. 199 226 280, terminalia; 1942, Figs. 9 and 10, terminalia); Needham and Claassen (1925, pl. 33, Fig. 2, pl. 45 Figs. 3 and 4, pl. 46, Fig. 2); Harper (1984, Fig. 13.127, terminalia); Stewart and Harper (1996, Fig. 14.130 terminalia); Stark and Nelson (2000, Figs. 2.28 and 2.29 epiproct); Stewart (2000, Figs. 5.43–5.46, terminalia). **Female** (Fig. 71): Subgenital plate with narrow tonguelike extension, tapered posteriorly, truncate apex. Other figures: Frison (1929, Fig. 30, coxae; 1935, Fig. 2b, coxae, Fig. 172 forewing, Fig. 280 terminalia); Stewart (2000, Fig. 5.47, genitalia).

Nymph: (Fig. 72) (Harper and Hynes 1971b:942, Fig. 1, Poulton and Stewart 1991:27, Stewart and Stark 1988:207). Mature nymphs 8–9 mm. Overall color yellow with distinctive dark patterns on head and thorax; antenna subequal in length to body length; yellow with basal three segments dark, mouthparts yellow, labrum with indistinct median marking. Wings pads with dark markings. Legs yellow, femora becoming darker distally but with terminal yel-

low band, tibiae with proximal dark band and often a longitudinal median line; legs with dorsal and ventral fringe of long hairs. Abdomen yellow, basal half and posterior margin of tergites dark; sternites 1–7 unsclerotized; dorsum of tergites with short bristles, posterior margin with row of short bristles and a few long hairs; cerci longer than body, yellow with light apical band, each segment with terminal whorl of short apical bristles. Other figures: Claassen (1931:106, pl. 29 Fig. 215 male terminalia, 216 female terminalia), Frison (1929, Fig. 11, female exuvium, Fig. 14, male labium, Fig. 18, male maxillae, Fig. 22, male mandibles, Fig. 26, male hind leg, Fig. 31, female habitus, Fig. 42, female nymph, Fig. 43, male and female nymphs); Frison (1935, Fig. 56, female mandible, Fig. 86, female maxillae, Fig. 116, female labium, Fig. 148, female mentum and submentum, Fig. 255, male hind leg, Fig. 278, female habitus, Fig. 279, female terminalia); Harper (1984, Fig. 13.4c); Stewart and Harper (1996, Fig. 14.4d, habitus); Stewart and Stark (1988, Fig. 10.7, habitus, Fig. 10.8 a–h, a lacinia, b mandible, c front leg, d, mesosternum, e, f, g, male terminalia, lateral, dorsal, ventral, h, female terminalia).

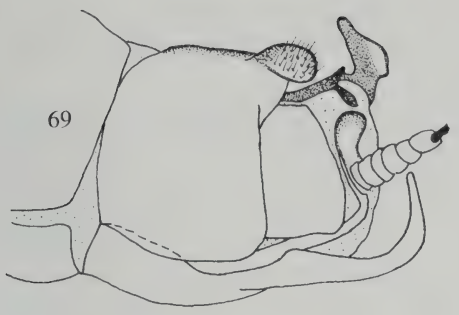
First instar nymph: Harper (1979, Fig. 2, habitus); Stewart and Harper (1996, Fig. 14.4c, habitus). Harper and Hynes (1970, Fig. 2) described the diapausing nymph.

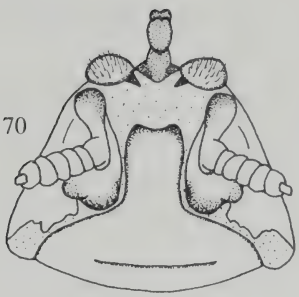
Biology: *Strophoteryx fasciata* has a fast univoltine life cycle, a nymphal diapause (Frison 1929, 1935; Harper and Hynes 1970, 1972) beginning in the fourth instar (Harper and Hynes 1970, Puglsley and Hynes 1985) and a peak emergence during the last half of March and the first half of April (Frison 1929, 1935). Eggs develop directly following oviposition and nymphs in the laboratory underwent diapause in their fourth instar (Harper and Hynes 1972). The nymphs prefer the gravel areas of the stream and are herbivorous, feeding on leaf fragments and diatoms (Frison 1929, 1935). Frison (1929) reported the adults feeding on the blossoms of elm trees.

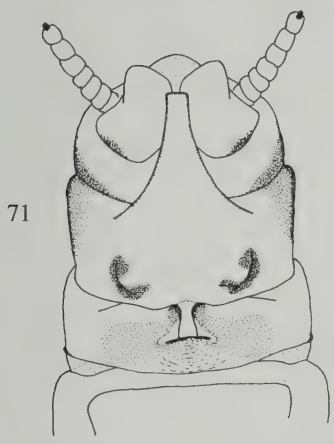
Habitat: Surdick and Gaufin (1978) reported *Strophopteryx fasciata* as being a herbivore that was neutral or alkaliphilous, saprophobic, euoxyphilous, eury-, meso-, and metathermal, eulichtophilous, rheophilous and rheobiontic, epilithic, and found in rivers and streams. Harper and Hynes (1971b) reported *S. fasciata* from large streams and rivers and in 1972 they reported it to be a warm river species. Poulton and Stewart (1991) reported *S. fasciata* from permanently flowing streams in mountainous regions. From 1976–2000, *S. fasciata* in Illinois has been collected from leaf packs along broad, moderate flowing streams 35 m wide and 30 cm–1 m deep with a gravel substrate.

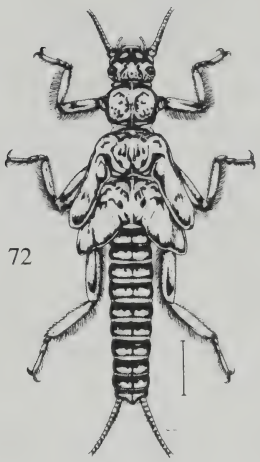
Distribution and Activity: *Strophopteryx fasciata* ranges from Alabama to Quebec, west to Manitoba and Oklahoma (Stark *et al.* 1986, Stewart and Stark 1988). In Illinois, adults were collected from 23 November to 23 April. Figure 73 displays the distribution of *S. fasciata* from 1900–1945, 1946–1975, and 1976–2000.

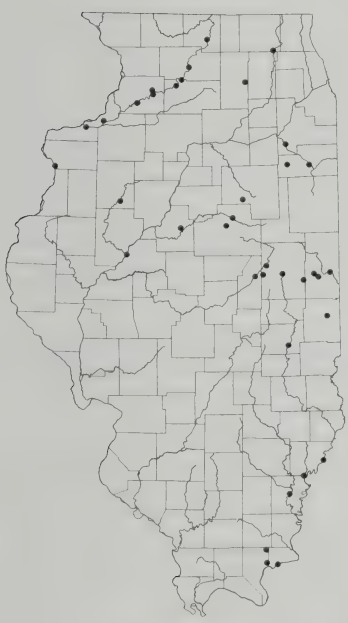
Current Status: Through 1945, *Strophopteryx fasciata* was recorded from 39 localities throughout Illinois. It was collected at five localities from 1946–1975 and four localities from 1976–2000. The distribution of this species has been severely reduced in the state, currently being found only in the Kankakee River in northern Illinois and Lusk Creek in the Shawnee Hills.











73A. 1900–1945

73B. 1946–1975

73C. 1976–2000

Figures 69–73. *Strophopteryx fasciata*. 69. Male terminalia, lateral view. 70. Male terminalia, dorsal view. 71. Female terminalia. 72. Nymph. 73. Distribution in Illinois. (Figs. 69–71 from Poulton & Stewart 1991; 72 Stewart & Stark 1988).

Taeniopteryx Pictet

Taeniopteryx 1963: Official list of generic names in Zoology. Opinion Number 652, ICZN: Harper (1984:205), Stewart (2000:63), Stewart and Harper (1996: 219, 242, 262), Zwick (1973:304).

Nemoura (*Taeniopteryx*) Pictet (1841:345): Banks (1907:14), Illies (1966:71), Needham and Claassen (1925:236). Type species: *Phryganea nebulosa* Linnaeus.

Neophopteryx Klapálek (1902:179): Illies (1966:71). (Preoccupied). Type species: *Phryganea nebulosa* Linnaeus.

Nephelopteryx Klapálek (1903:42). (new name for *Neophopteryx*): Illies (1966:71).

This genus contains 11 North American species (Bill Stark 2001 http://www.mc.edu/campus/users/stark).

Adults (Harper 1984, Stewart and Harper 1996) of *Taeniopteryx* are characterized by having the glossae and paraglossae subequal in length (as in Fig. 15); gill remnants lacking from sides of the thorax; and the first tarsal segment subequal in length to the second (as in Fig. 8).

Nymphs (Harper 1984, Stewart and Harper 1996) of *Taeniopteryx* have the glossae and paraglossae subequal in length (Fig. 15); thoracic sterna not overlapping on succeeding sterna; wing pads divergent posteriorly (Fig. 17); coxae with unmodified gills; gills absent on abdominal segments 1–2; first and second tarsal segments equal in length (Fig. 8); cerci with complete vertical fringe.

Key to Adults of Illinois *Taeniopteryx*
(Ricker and Ross 1968)

Males

1. Sternite 9 with ventral lobe (vesicle) (Fig. 76).....2

   Sternite 9 lacking ventral lobe.....3

2. Sternite 9 with hairs on posterior margin pointing ventrally and anteriorly, usually much shorter than more anterior hairs and with ventral lobe 2–3 times longer than wide; extruded aedeagus lacking brown band between lateral lobes .....*nivalis*

   Sternite 9 with hairs on posterior margin directed posteriorly, much longer than anterior hairs and with ventral lobe 3–5 times longer than wide (Fig. 76); extruded aedeagus with brown band between lateral lobes (Fig. 74).....*burksi*

3 Apical half of subanal lobes broad, flat, apical margin broadly rounded (Fig. 80) .....*lita*

   Apical half of subanal lobes reduced, clavate (Figs. 84, 91).....4

4. Apex of subanal lobes bent outward, subacute (Fig. 91) .....*parvula*

   Apex of subanal lobes straight, somewhat swollen, narrowly rounded at apex (Fig. 84)..... .....*metequi*

Females

1. Sternite 8 with posterior emargination deep, broadly U-shaped, heavily sclerotized laterally (Fig. 81) .....*lita*

   Sternite 8 with posterior emargination shallow, V-shaped, normally sclerotized (Figs. 77, 85, 89, 92).....2

2. Sternite 8 with medial half lightly sclerotized, pale, contrasting strongly with central plate and narrow dark margin of emargination (Fig. 92).....*parvula*

Sternite 8 with medial half normally sclerotized, occasionally with pale anterior area near median (Figs. 77, 85, 89).....3

3. Sternite 8 with margins of posterior emargination meeting anteriorly at obtuse angle (Fig. 77).....*burksi*

Sternite 8 with margins of posterior emargination meeting anteriorly at acute angle (Figs. 85, 89), usually strongly sclerotized near hind margin.....*metequi*, *nivalis*

Nymphs: (Poulton and Stewart 1991).

1. Median dorsal stripe absent or incomplete (Fig. 93).....2

Median dorsal stripe complete (Figs. 78, 82, 86).....3

2. Median dorsal stripe complete on abdomen (Fig. 82); thorax and pronotum concolorous or with pale markings; area adjacent to eyes concolorous with remainder of head .....*lita* (in part)

Median dorsal stripe incomplete throughout its length, weak or absent on abdomen (Fig. 93); area adjacent to eyes paler than remainder of head.....*parvula*

3. Median dorsal stripe with dark pigmented border, either throughout its length or on thorax only (Figs. 78, 86).....4

Median dorsal stripe with pigmented border of median dorsal stripe as dark as rest of nymph (Fig. 82).....5

4. Pale area between eyes wider than pronotal portion of median dorsal stripe (Fig. 86); pale ring around eyes broad.....*metequi* (in part)

Pale area between eyes and pronotal portion of median dorsal stripe of equal width (Fig. 78); pale ring around eyes narrow or absent.....*burksi*

5. Median dorsal stripe on head portion wider than pronotal portion (Fig. 86); pale ring around eyes broad.....*metequi* (in part)

Median dorsal stripe on head portion the same width or narrower than pronotal portion (Fig. 82); pale ring around eyes narrow or absent.....*lita* (in part)

Taeniopteryx burksi Ricker and Ross

Taeniopteryx burksi Ricker and Ross (1968:1425): Fullington and Stewart (1980:244), Stark and Gaufin (1979:424), Funk and Sweeney (1990), Harper and Magnin (1969:487), Harris and Webb (1995:342), Hitchcock (1974:117), Poulton and Stewart (1991:27), Stewart (2000:63), Zwick (1973:305). Type locality: Illinois, Champaign County, Urbana.

Taeniopteryx nivalis Needham and Claassen (1925:240, in part): Claassen 1931:104, Frison (1929:378, 1935:341). Illinois records are *T. burksi* (Ricker and Ross 1968).

Taeniopteryx maura Frison (1942:248, in part): Ricker (1945:226, in part).

Adults: (Poulton and Stewart 1991:27, Ricker and Ross 1968:1425). **Male** (Figs. 74–76): Hind femora generally lacking lateral spur, when present, its height less than half width of femur. Sternite 9 with ventral lobe (vesicle) 3–5 times as long as wide, shape variable. Extruded aedeagus in posterior view with medial transverse brown band. Subanal lobe narrow tapered posteriorly. Cerci lobate rounded posteriorly. Other figures: Frison (1929 as *T. nivalis*, Fig. 13 1935 as *T. nivalis*, Figs. 195, 231 terminalia); Stark and Gaufin (1979, Fig. 53, terminalia); Stewart (2000, Figs. 5.60–5.65, terminalia and male femur). **Female** (Fig. 77): Subgenital plate lacking marginal sclerotized band. Other figures: Frison (1935, Fig. 2a, coxae); Frison (1935, as *T. nivalis*, Fig. 216, sternites 7 and 8, Figs. 256 and 276); Stark and Gaufin (1979, Fig. 55, sternum 8); Stewart (2000, Fig. 5.66, genitalia). **Nymph** (Fig. 78): Fullington and Stewart 1980:244, Poulton and Stewart (1991:27) pale area between eyes wider than pronotal portion of median dorsal stripe; pale ring around eyes narrow or absent; median dorsal stripe complete, pigmentation darkest along border throughout its length. Other figures: Frison (1929, as *T. nivalis,* Fig. 13 male labium, Fig. 17 male maxillae, Fig. 21 male mandibles, Fig. 25 male hind leg, Figs. 32 and 41 male nymph, Figs. 58, 60, and 62 apical abdominal segments of male, Figs. 59 and 61, apical abdominal segments of female; 1935, as *T. nivalis*, Fig. 55, female mandibles, Fig. 85, female maxillae, Fig. 115, female labium, Fig. 156, female mentum and submentum, Fig. 256 hind leg, 276 habitus) and Harper and Hynes (1971b:943, Fig. 2). Kapoor (1983, 1985) utilized electron microscopy to examine the cuticular structures of the body surfaces.

First instar nymph: Harper (1979, Fig. 1 habitus).

Biology: Harper and Hynes (1972) reported *Taeniopteryx burksi* and *T. nivalis* emerging roughly at the same time from a stream without the temporal segregation mentioned by Ricker (1964). The female oviposites directly into the water by alighting and releasing her eggs on the surface (Hitchcock 1974). The life cycle is univoltine (Coleman and Hynes 1970, Fig. 2; Harper and Hynes 1970; Harper and Magnin 1969). The eggs hatch within a month and the nymphs undergo diapause in the 5th to 7th instar (Harper and Hynes 1970, 1972; Pugsley and Hynes 1985). In addition to the accumulation of fat globules, the nymph loses all of its bristles, the cerci are cast off, the head and antennae are reflected under the thorax, and the legs are folded. Appendages become weakly sclerotized.

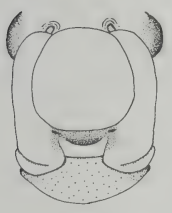
Adults feed on the blue-green alga *Protococcus* sp. that grows on trees (Hitchcock 1974) and nymphs feed on decaying leaves and diatoms (Hitchcock 1974). Frison (1929) listed 13 species of diatoms on which the nymphs fed and reported that under laboratory rearing conditions nymphs will cannibalize other nymphs.

Habitat: Surdick and Gaufin (1978) reported *Taeniopteryx burksi* as being a predator, herbivore, or scavenger that was alkaliphilous, saproxenous, euoxyphilous, meso-, meta-, and oligothermal, polylichtophilous, rheophilous, epiphytic, and found in rivers or streams. Nymphs inhabit organic debris and leaf packs (Poulton and Stewart 1991) in medium to large permanent or intermittent streams. From 1976–2000, adults of *T. burksi* in Illinois were collected from bridge railings and abutments; buildings, rip rap, and trees along streams; crawling on the ice; and swept from woody vegetation. They were collected from small, slow flowing streams, 1–2 m wide, less than 1–2 m deep with a substrate of gravel, sand, and cobble; moderate sized streams, 15–33 m wide, more than 2 m deep, with gravel and sand substrates; and large rivers (Illinois, Kankakee, Rock, and Mississippi riv-

ers) which are over a quarter of a kilometer wide and more than 10 m deep with a substrate of sand and silt.

Distribution and Seasonal Activity: *Taeniopteryx burksi* is widely distributed from Florida to Quebec west to Minnesota and Texas (Stark *et al.* 1986, Stewart and Stark 1988, Stewart 2000). In Illinois, adults were collected from 11 October to 15 June. Figure 79 displays the distribution of *Taeniopteryx burksi* from 1900–1945, 1946–1975, and 1976–2000.

Current Status: *Taeniopteryx burksi* has been and still is common and widespread in Illinois. It is primarily a big river species and historically (1900–2000) has been collected in 10 natural divisions (Table 3) and 20 drainage basins (Table 4) in Illinois. Recent collecting (1976–2000) did not obtain *T. burksi* in the DuPage and Little Wabash River drainages and Wabash River proper.



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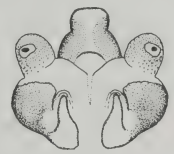

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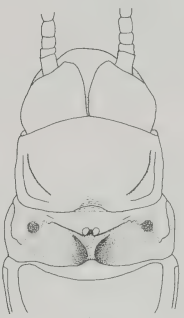

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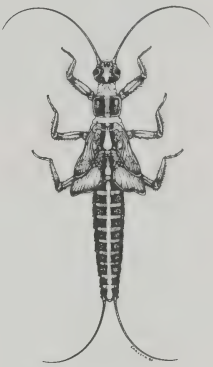

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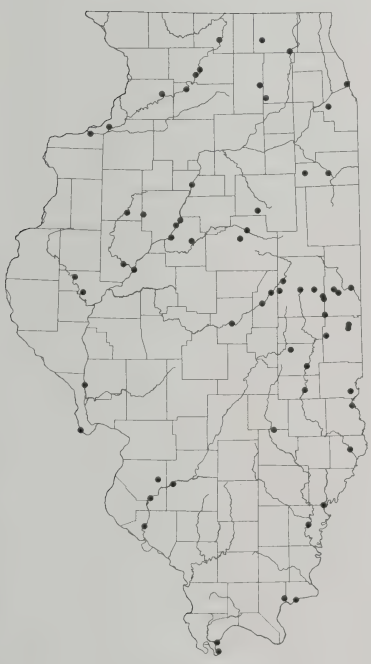
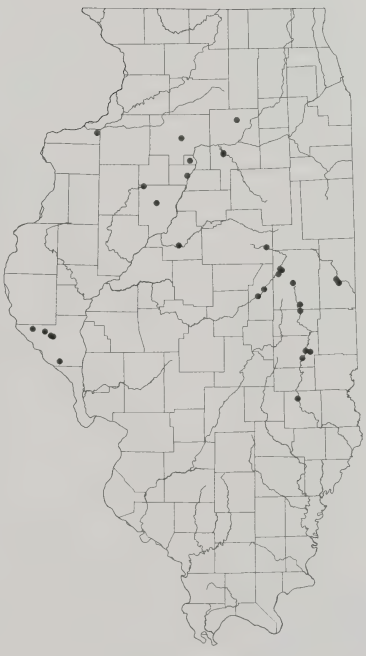
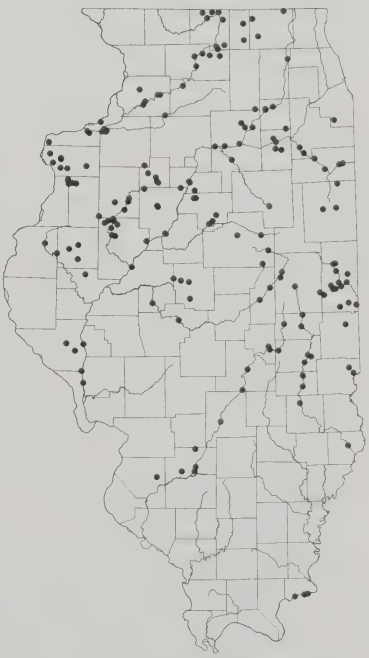


79A. 1900–1945



79B. 1946–1975



79C. 1976–2000

Figures 74–79. *Taeniopteryx burksi.* 74. Male terminalia, caudal view. 75. Male terminalia, dorsal view. 76. Ventral lobe, variation. 77. Female terminalia. 78. Nymph. 79. Distribution in Illinois. (Figs. 74–76 from Poulton & Stewart 1991; 78 Stewart & Stark 1988).

Taeniopteryx lita Frison

Taeniopteryx lita Frison (1942:249): Fullington and Stewart (1980:246), Stark and Gaufin (1979:425), Harris and Webb (1995:342), Hitchcock (1974:118), Illies (1966:73), Poulton and Stewart (1991:27), Stewart (2000:63), Zwick (1973:306). Type locality: Elizabethtown, Illinois.

Taeniopteryx parvula Frison (1929:383, in part; 1935:345, in part). Specimens from Elizabethtown and Grayville, Illinois are *T. lita* (Ricker and Ross 1968:1426).

Taeniopteryx lita Frison (1942:249, Fig. 8): Harris and Webb (1995:342); Hitchcock (1974:118).

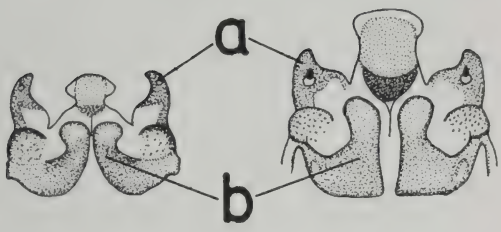
Adult: (Ricker and Ross 1968). Length 10 mm. **Male** (Fig. 80): Sternite 9 lacking ventral lobe. Paraprocts broadened and lobate distally. Cerci shorter and thicker than in *T. lonicera*. Sternite 9 with distal part swollen, light in color, bearing long hairs. Other figures: Frison (1942, Fig. 8); Stark and Gaufin (1979, Fig. 54, terminalia); Stewart (2000, Figs. 5.67–5.73, genitalia). **Female** (Fig. 81). Median notch of subgenital plate bordered by wide U-shaped sclerotized band. Other figures: Stark and Gaufin (1979, Fig. 56, sternum 8); Stewart (2000, Figs. 5.74 and 5.75, genitalia).

Nymph (Fig. 82): (Fullington and Stewart 1980:246, Poulton and Stewart 1991). Characteristics of nymph are variable; area adjacent to eye concolorous with remainder of head or with narrow pale ring around eyes; head occasionally with pale rectangular area between eyes limited to area between lateral ocelli; median dorsal stripe continuous or incomplete; thorax and pronotum concolorous or with pale markings.

Habitat: Surdick and Gaufin (1978) reported *Taeniopteryx lita* as being polylichtophilous, rheophilous, and found in streams. Poulson and Stewart (1991) reported *T. lita* from large, slow moving streams surrounded by bottomland hardwoods. From 1976–2000, adults were collected in Illinois on bridge railings and abutments over small moderate flowing streams 4 m wide and less than 60 cm deep with a gravel and sand substrate to moderate sized, slow-flowing rivers, 60–100 m wide and more than 2 m deep with a sand and silt substrates.

Distribution and Seasonal Activity: *Taeniopteryx lita* is a southern species ranging from North Carolina to Arkansas, and north into southern Illinois (Stark *et al.* 1986, Stewart and Stark 1988, Stewart 2000). In Illinois, adults were collected from 3 February to 17 March. Figure 83 displays the distribution of *Taeniopteryx lita* from 1900–1945, and 1976–2000.

Current Status: Prior to 1946, *Taeniopteryx lita* was known from only four scattered localities of southern Illinois in the Shawnee Hills, Southern Till Plain, and the Wabash Border Natural Divisions (Table 3) and the Kaskkaskia, Big Creek, and Wabash River proper drainage basins (Table 4). More recently, 1976–2000, it was not collected at any of the original sites, but at three scattered localities in the Southern Till and Wabash Border Natural Division (Table 3) and the Kaskaskia and Little Wabash River drainages and the Wabash tributaries drainage (Table 4). Although now considered rare in Illinois, it still must be considered established.



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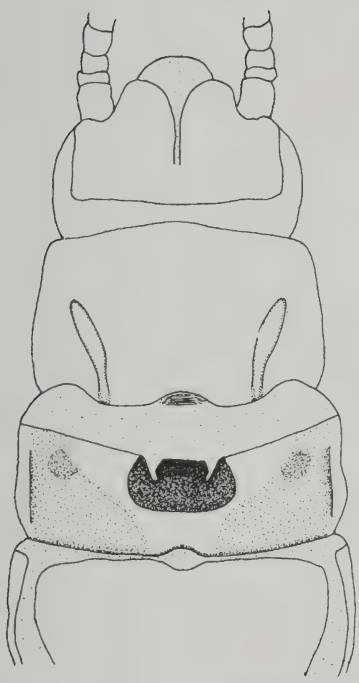

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Figures 80–83. *Taeniopteryx lita.* 80. Male terminalia. a=cercus, b=subanal lobe. 81. Female terminalia. 82. Nymph. 83. Distribution in Illinois. (Figs. 80–82 from Poulton & Stewart 1991).

Taeniopteryx metequi Ricker and Ross

Taeniopteryx metequi Ricker and Ross (1968:1431): Fullington and Stewart (1980:252), Harper and Hynes (1971b:944), Harris and Webb (1995:342), Hitchcock (1974:120), Poulton and Stewart (1991:28), Stewart (2000:65), Zwick (1973:306). Type locality Hayes Creek, Glendale, Illinois.

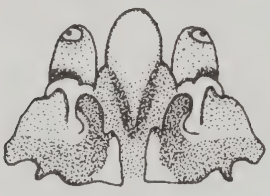
Adult: (Poulton and Stewart 1991, Ricker and Ross 1968). Length 5.5–11.5 mm. **Male** (Fig. 84): Sternite 9 lacking ventral lobe (vesicle); apical half of subanal lobe clavate; cerci globular. Other figures: Stark and Nelson (2000: Fig. 2.14, tarsal segments), Stewart (2000, Figs. 5.92–5.95, genitalia). **Female** (Fig. 85). Median notch of subgenital plate U-shaped, with wide median flap, truncate apically. Other figures: Stewart (2000, Fig. 5.96, genitalia).

Nymph (Fig. 86): (Fullington and Stewart 1980:252, Harper and Hynes 1971b:944), Poulton and Stewart 1991:28). Length of mature nymph 7–11 mm. Characteristics of nymph variable. Pale area between eyes wider than pronotal portion of median dorsal stripe; eyes with broad pale ring; color medium brown with yellow median dorsal stripe continuous, or with pigmented border dark on thorax only, head portion of median dorsal stripe occasional wider than pronotal portion.

Habitat. From 1976–2000, adults of *Taeniopteryx metequi* in Illinois were collected from leaf packs along large, moderately flowing streams, 33 m wide and 30 cm–1 m deep with a gravel substrate.

Distribution and Seasonal Activity: *Taeniopteryx metequi* ranges from North Carolina to Ontario west to Kansas (Stark *et al.* 1986, Stewart and Stark 1988, Stewart 2000). In Illinois, adults were collected from 22 January to 11 March. Figure 87 displays the distribution of *Taeniopteryx metequi* from 1946–1975, and 1976–2000.

Current Status: Prior to 1946, *Taeniopteryx metequi* was rare in Illinois, known from one locality in the Shawnee Hills Natural Division (Table 3) and the Lusk Creek Drainage (Table 4). From 1946–1975, it was recorded from six localities and at five localities from 1976–2000 in the Lusk Creek and Saline River drainages (Table 4). It is now considered uncommon in Illinois, but well established.



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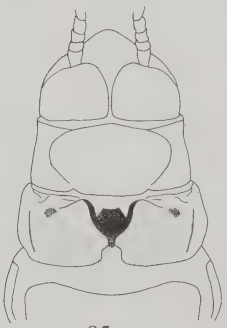

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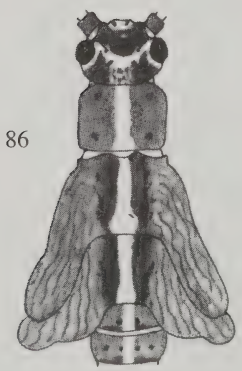

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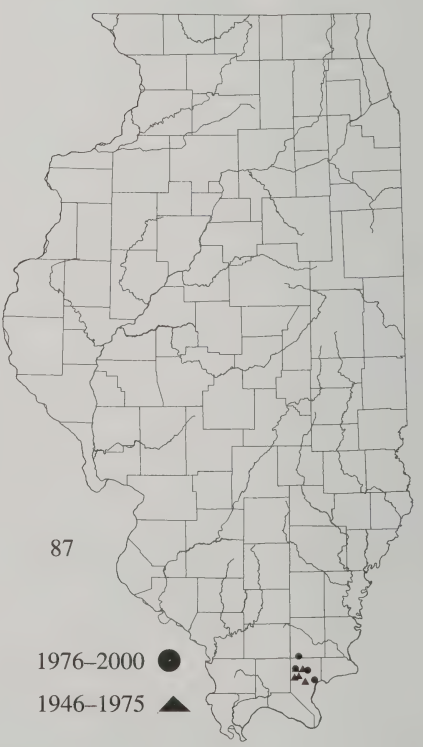


Figures 84–87. *Taeniopteryx metequi*. 84. Male terminalia. 85. Female terminalia. 86. Nymph. 87. Distribution in Illinois. (Figs. 84–86 from Poulton & Stewart 1991).

Taeniopteryx nivalis (Fitch)

Taeniopteryx nivalis (Fitch): Claassen (1931:103, 1940:45), Fullington and Stewart (1980:253), Funk and Sweeney (1990), Needham and Claassen (1925:240, in part), Ricker and Ross (1968:1434), Stewart (2000:66), Zwick (1973:307). Type locality New York.

Nemoura nivalis Fitch (1847:279): Ricker and Ross (1968:1434).

Taeniopteryx maura (Pictet): Frison (1942:248, in part), Harden and Mickel (1952:12, in part, most of these records pertain to *nivalis*, but a few may be *burksi* (Ricker and Ross 1968:1434), Harris and Webb (1995:342), Hitchcock (1974:121), Jewett (1959:55, 1960:151), Ricker (1945:226, in part, includes part of the specimens from Warsaw, Indiana).

Taeniopteryx sp. cf. *maura*: Ricker (1944:176).

Adult: (Ricker and Ross 1968:1434, Needham and Claassen 1925:240, Stewart 2000:65). Length 11–17 mm. **Male** (Fig. 88): Ventral lobe (vesicle) 2–3 times longer than wide; apical half of subanal lobes broad, tapered to a straight subacute apex; hairs on hind margin of sternite 9 reflexed ventrally and anteriorly usually much shorter than the more anterior hairs; extruded aedeagus lacking brown sclerotized band between lateral lobes. Other figures: Stewart (2000, Figs. 5.103–5.106, genitalia). **Female** (Fig. 89): Median area of sternite 8 V-shaped with strongly sclerotized shoulder near posterior margin. Other figures: Stewart (2000, Fig. 5.107, genitalia).

Nymph: (Fullington and Stewart 1980:253, Kondratieff and Baumann 1988:382). Total length of mature nymph 10–14 mm. Medium to dark brown in color, occasionally with reddish tinge, venter light brown; median dorsal stripe variable, present in description by Claassen (1931: Fig. 210) or represented by interrupted dashes which never extend onto head capsule (Harper and Hynes 1971b: Fig. 4). Head brown dorsally with yellow spots around ocelli, yellow rings around compound eyes, and a yellow margin on frons; antenna yellow, basal 4–5 segments dark. Pronotum brown with two yellow lateral bands; median dorsal stripe most often present as a thin line and a large spot at each margin. Wing pads yellow to light-brown. Femora dark with apical yellow ring; tibiae brown. Abdomen with a median dorsal stripe or a series of light dots on posterior of each segment; when median dorsal stripe present, dark border absent; abdominal tergites with short, thick bristles; cerci yellow, proximal fifth dark, length longer than abdomen with vertical fringe of hairs. Other figures: Claassen (1931, Fig. 135, labrum; Figs. 136 and 138, mandibles; Fig. 137, front leg; Fig. 139, labium; Fig. 140, maxillary palpus; Figs. 210 and 229, habitus) and Harper and Hynes (1971b, Fig. 4, male nymph; Fig. 8, male terminalia).

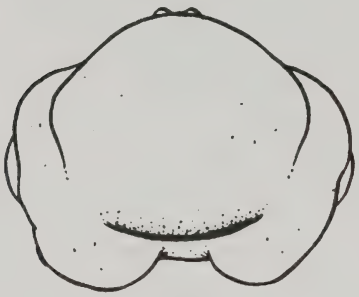
Biology: Harper and Hynes (1970) reported that the eggs hatch soon after deposition but the nymphs enter a diapause stage during the summer (Pugsley and Hynes 1985). Rapid larval growth occurs from October through March (Coleman and Hynes 1970) with nymphs reaching an average size of 12 mm before emergence.

Habitat. Surdick and Gaufin (1978) reported *Taeniopteryx nivalis* as being a predator, omnivore, herbivore, or scavenger that was neutral or alkaliphilous, saprophobic, euoxyphilous, eury-, meso-, meta-, and oligothermal, eu- and mesolichtophilous, rheophilous, and found in rivers or streams. From 1976–2000, adults of *T. nivalis* in Illinois were collected on bridge railings and abutments and swept from woody vegetation along small, slow to moderate flowing streams, 3–6 m in width and less than 30 cm–1 m deep with gravel and sand substrates to moderate sized (10–15 m wide) and large rivers (over a quarter of a kilometer wide) with sand or silt substrates.

Distribution and Seasonal Activity: *Taeniopteryx nivalis* is a widespread species extending from New York to Newfoundland west to Minnesota in the east and from California to Idaho and Alberta in the west (Stark *et al.* 1986, Stewart and Stark 1988, Stewart 2000). In Illinois, adults were collected from 7 March to 28 March. Figure 90 displays the distribution of *T. nivalis* from 1946–1975, and 1976–2000.

Current Status: Ricker and Ross (1968) reported that none of the specimens of *Taeniopteryx nivalis* listed in Frison (1929, 1935) are this species, but are specimens of *T. burksi*. They cited only three localities for *T. nivalis* (Fig. 90) in the Grand Prairie Natural Division and the Fox River drainage. *Taeniopteryx nivalis* is

a northern species, and from 1976–2000 adults were collected at 32 localities in northern Illinois (Fig. 90). This species has become common and well established in northern Illinois and appears to be broadening its distribution throughout the state. It is now found within the Rock River Hill Country, Grand Prairie, Northeast Morainal, and Western Forest-Prairie Natural Divisions (Table 3) and within the Rock, Fox, Kaskaskia, and Spoon rivers and the Illinois River proper drainages (Table 4).



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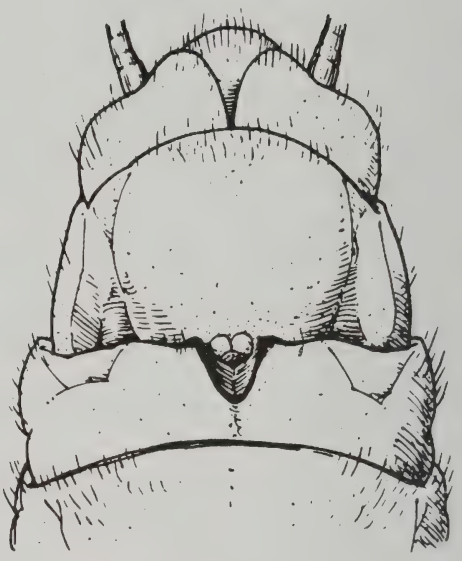

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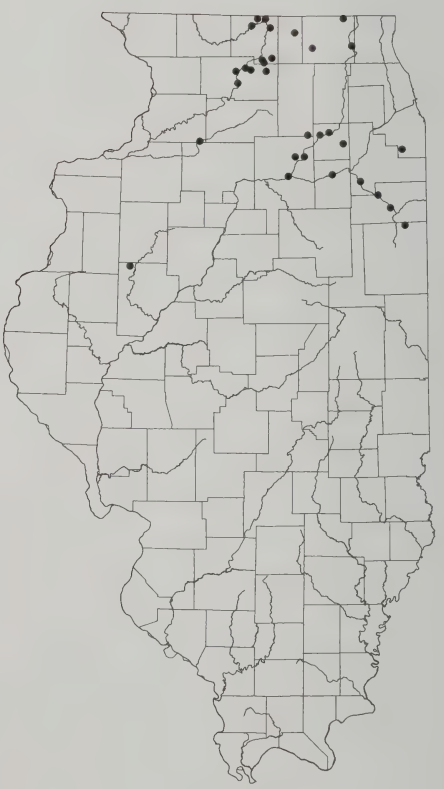
90A. 1946–1975



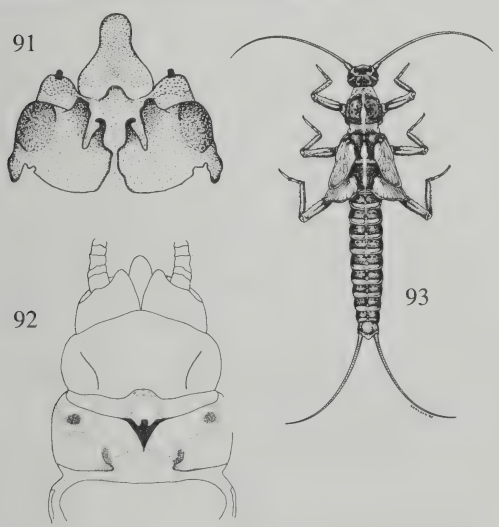
90B. 1976–2000

Figures 88–90. *Taeniopteryx nivalis*. 88. Male aedeagus, extruded, caudal view. 89. Female terminalia. 90. Distribution in Illinois. (Figs. 88–89 from Kondratieff & Baumann 1988).

Taeniopteryx parvula Banks

Taeniopteryx parvula Banks (1918:7): Claassen (1931:105, 1940:46), Frison (1929:383, 1935:345, 1942:249), Fullington and Stewart (1980:254), Funk and Sweeney (1990), Harden and Mickel (1952:13), Harris and Webb (1995:342), Hitchcock (1974:122), Illies (1966:75), Needham and Claassen (1925:241), Poulton and Stewart (1991:28), Stewart (2000:66), Zwick (1973:307). Specimens (Frison 1929, 1935) from Elizabethtown and Grayville, Illinois, are *T. lita* (Ricker and Ross 1968:1426). Type locality: Peach Grove Hill, Virginia.

Adult: (Ricker and Ross 1968). Length 9–14 mm. **Male** (Fig. 91): Ventral lobe (vesicle) absent; subanal lobes with posterior half reduced with subacute, hooked-shaped projection projecting laterally; cerci globular. Other figures: Frison (1935, Figs. 190 and 223, terminalia; 1942, Fig. 7, terminalia); Needham and Claassen (1925, pl. 44, Figs. 1 and 2, terminalia); Stewart (2000, Figs. 5.108–5.112, genitalia). **Female** (Fig. 92): Sternite 8 very lightly sclerotized, in contrast to the dark color of the V-shaped notch. Other figures: Frison (1929, Fig. 77, sternites 7 and 8; 1935, Fig. 214, sternites 7 and 8); Needham and Claassen (1925, pl. 46, Fig. 9, terminalia); Stewart (2000, Fig. 5.113, genitalia).



Figures 91–94. *Taeniopteryx parvula*. 91. Male terminalia. 92. Female terminalia. 93. Nymph. 94. Distribution in Illinois. (Figs. 91–92 from Poulton & Stewart 1991; 93 Stewart & Stark 1988).

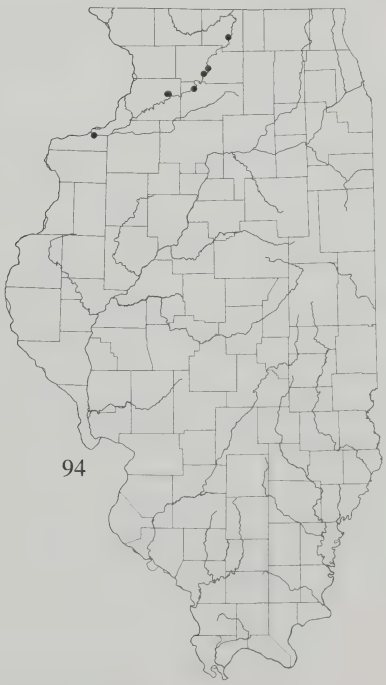
Nymph (Fig. 93): (Fullington and Stewart 1980:254, Poulton and Stewart 1991). Median dorsal stripe incomplete; area adjacent to eyes paler than remainder of head. Claassen (1931:105) also described the nymph. Other figures: Frison (1935, Fig. 277, habitus).

Biology: Frison (1929) reported that adults feed on algae on tree trunks.

Habitat: Surdick and Gaufin (1978) reported *Taeniopteryx parvula* as being a herbivore or scavenger that was rheophilous, epiphytic, and found in rivers and streams. In Illinois, adults were collected principally along the Rock River, which is over a quarter of a kilometer wide with a bottom substrate of sand with silt.

Distribution and Seasonal Activity: *Taeniopteryx parvula* ranges from Georgia north to Nova Scotia, west to Manitoba and Arkansas (Stark *et al.* 1986, Stewart and Stark 1988, Stewart 2000). In Illinois, adults were collected from 7 March to 23 April. Figure 94 displays the distribution of *T. parvula* from 1900–1945.

Current Status: Ricker and Ross (1968) confirmed *Taeniopteryx parvula* in Illinois. Illies (1966), referencing Frison (1942) also listed it in Illinois. Stark *et al.* (1986) did not list it for Illinois. Frison reported this species from the Rock River drainage in northern Illinois. Since 1928, it has not been collected in Illinois and is now considered extirpated from the state.



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