EPHEMEROPTERA, PLECOPTERA, and ODONATA[1]

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Abstract

The current and prospective systematic and faunistic status of Ephemeroptera, Plecoptera, and Odonata of North America north of Mexico is evaluated. There are 19 families, 81 genera, and 614 species of Ephemeroptera; 9 families, 100 genera, and 578 species of Plecoptera; and 11 families, 91 genera, and 415 species of Odonata. Adults are relatively well known, but many species remain to be described in the larval stage, which is critical to systematics and freshwater studies. Numbers of species known as adults and/or larvae in each genus are tabulated. Discoveries of new species of Ephemeroptera and Plecoptera, and possibly Odonata, are expected. Species keys are needed, especially for larvae. Revisions are needed in Ephemeroptera and Plecoptera, but research emphasis has shifted in Odonata. Many rare Ephemeroptera and Plecoptera are found in large rivers and spring seeps, respectively. Odonata at risk are mostly from southeastern streams. Such habitats warrant special consideration. Collections and other data sources are noted.

Ephemeroptera

The North American mayfly fauna appears rich compared to other regions. Of the 19 families listed by McCafferty & Edmunds (1979), 17 occur in the Nearctic, one of which (Baetiscidae) is endemic. The 614 species in North America north of Mexico represent about 27% of the 2,250 species recorded for the world. It is difficult to make world comparisons because the Neotropical, Afrotropical, and Oriental realms remain poorly known, and a world catalogue of extant Ephemeroptera has not been compiled. *Cloeon cognatum* is the only known adventive in North America.

Families, genera, and numbers of species are given in Table 1. Known genera in the region have increased from 60 to 81 since 1976. On the other hand, species have decreased from the 622 species listed by Edmunds et al. (1976). Although new species have been described, more species were synonymized, mainly due to findings by Bednarik & McCafferty (1979), Morihara & McCafferty (1979a), and Kondratieff & Voshell (1984). New species, however, are expected in Caenidae, Ephemerellidae, Tricorythidae, and Baetidae. Funk et al. (1988) showed that new cryptic species of Ephemerellidae are suggested by electrophoresis, and McCafferty (1985a) indicated that winter collections of larvae should yield unknown species.

Numbers of species known as adults and/or larvae for each genus (McCafferty, unpublished) appear in Table 1. There are 555 species known as adults and 461 as larvae. When

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Table 1. Alphabetical list of families and genera of extant Ephemeroptera known from North America north of Mexico. Numbers of currently valid nominal species in the area, and numbers of those species known as adults and larvae, are indicated respectively after each genus.

SCHISTONOTE MAYFLIES

Family Ametropodidae

Ametropus 3,3,3

Family Baetidae

Acentrella 5,5,4
Acerpenna 2,2,2
Apobaetis 2,2,1
Baetis 33,32,12
Baetodes 2,2,2
Barbaetis 1,0,1
Callibaetis 22,22,10
Centroptilum 24,24,10
Cloeodes 2,0,2
Cloeon 11,11,7
Dactylobaetis 6,2,6
Diphetor 2,2,1
Fallceon 1,1,1
Heterocloeon 4,3,4
Neocloeon 1,1,1
Paracloeodes 2,2,2
Pseudocloeon 17,17,11

Family Behningiidae

Dolania 1,1,1

Family Ephemeridae

Ephemera 7,7,4
Hexagenia 4,4,4
Litobrancha 1,1,1

Family Heptageniidae

Acanthomola 1,0,1
Anepeorus 2,2,1
Arthroplea 1,1,1
Cinygma 3,3,2
Cinygmula 11,11,6
Heptagenia 13,13,8
Iron 17,17,13
Ironodes 6,6,4
Ironopsis 2,2,1
Leucrocuta 10,10,8
Macdunnoa 3,3,2
Nixe 13,13,7
Pseudiron 1,1,1
Raptoheptagenia 1,1,1
Rhithrogena 22,20,16
Stenacron 6,6,6
Stenonema 16,15,16

Family Leptophlebiidae

Choroterpes 12,9,8
Farrodes 1,1,1
Habrophlebia 1,1,1
Habrophlebioides 4,4,3
Leptophlebia 10,10,10
Paraleptophlebia 35,35,26
Thraulodes 5,4,5
Traverella 4,2,4

Family Metretopodidae

Metretopus 1,1,1
Siphloplecton 7,7,5

Family Oligoneuriidae

Homoeoneuria 4,3,4
Isonychia 17,17,15
Lachlania 3,3,2

Family Palingeniidae

Pentagenia 2,2,1

Family Polymitarcyidae

Campsurus 1,1,1
Ephoron 2,2,2
Tortopus 3,3,1

Family Potamanthidae

Potamanthus 8,8,6

Family Siphlonuridae

Acanthametropus 1,0,1
Ameletus 33,33,22
Analetris 1,1,1
Edmundsius 1,1,1
Parameletus 4,4,3
Siphlonisca 1,1,1
Siphlonurus 19,19,13

PANNOTE MAYFLIES

Family Baetiscidae

Baetisca 12,10,12

Family Caenidae

Amercaenis 1,1,1
Brachycercus 12,9,12
Caenis 13,13,2
Cercobrachys 2,1,2

Family Ephemerellidae

Attenella 4,2,4
Caudatella 5,3,4
Caurinella 1,0,1
Dannella 3,2,3
Drunella 15,13,15
Ephemerella 31,23,28
Eurylophella 11,10,11
Serratella 14,10,14
Timpanoga 1,1,1

Family Neoephemeridae

Neoephemera 4,4,4

Family Tricorythidae

Leptohyphes 10,2,10
Tricorythodes 14,11,11

Needham et al. (1935) published the first book on North American mayflies, only about half of the then 507 species were known as larvae. In the 1960s it was recognized that larvae were systematically important and also critical for assessing stream pollution. There is now a concerted effort to rear and associate larvae, and also some tendency to describe new species as larvae only. Tricorythidae provides the best example of larva-emphasized taxonomy. Approximately 22% of the North American species are known in the egg stage.

Adult species characters are usually associated with males. Some species remain known from the female only and are therefore tenuous; however, certain Baetidae and Siphlonuridae are parthenogenetic. Characteristics do not generally vary between the sexes of larvae; however, sexual dimorphism is prevalent in larvae of many pannote mayflies, especially Tricorythidae. The propensity for many species to have ecophenotypes, which vary with thermal aquatic regimes and timing of developmental cohorts, was shown by McCafferty & Periera (1984) and Kondratieff & Voshell (1984). Ecophenotypic variation is an important consideration because it affects structural characters sometimes used for species. The need or effectiveness of electrophoretic applications has yet to be fully explored.

The status of North American systematics prior to 1976 can be found in Edmunds et al. (1976). Present needs and a short review of work since then are given here. In **Baetidae**, genera have been revised by Morihara & McCafferty (1979a,b), Waltz & McCafferty (1987a), and G. R. Check (unpublished), and rearings, such as those conducted by R. G. Lowen, are necessary for revisionary progress. Many species require recombination (Waltz & McCafferty 1987b), and many are expected to fall into synonymy. In **Heptageniidae**, the importance of accurate correlation of stages and application of names to larvae was recently exemplified by Whiting & Lehmkuhl (1987a) and McCafferty & Provonsha (1988). Bednarik & McCafferty (1979) dealt with species concepts, and Flowers (1980) revised certain generic concepts. Acquisition and study of Asian Heptageniidae are needed to resolve North American systematics. In **Leptophlebiidae** and **Siphlonuridae**, revisions are required for most large genera. Revisions were recently published by Kondratieff & Voshell (1984) in **Oligoneuriidae**, Pescador & Berner (1981) in **Baetiscidae**, and Soldan (1986) in **Caenidae**. A revision of *Caenis* is expected soon and will result in several synonyms (Provonsha, unpublished). In **Ephemerellidae**, McCafferty (1977) showed the cladistic relationships of several genera, and Allen (1980) raised subgenera to generic rank. Larvae of **Tricorythidae** were studied by Allen (1978). Works affecting small numbers of species in various families have included Allen & Edmunds (1976), Berner (1978), McCafferty (1978), Lehmkuhl (1979), Morihara & McCafferty (1979c), Pescador & Peters (1980), Flowers (1982), McCafferty & Provonsha (1985), Pescador (1985), Provonsha & McCafferty (1985), Waltz et al. (1985), Soldan (1986), Allen & Murvosh (1987), Waltz & McCafferty (1987b,c), and Whiting & Lehmkuhl (1987b).

Although species keys exist for a few states and provinces, adequate keys for the entire region do not exist except for *Stenonema* (Bednarik & McCafferty 1979), *Baetisca* (Pescador & Berner 1981), *Isonychia* (Kondratieff & Voshell 1984), and *Brachycercus* (Soldan 1986). A key to all species is sorely needed but awaits additional larval descriptions and revisions. Interim keys to large subregions would, however, be valuable. Various faunal accounts exist. Some are relatively complete, such as for Florida (Berner & Pescador 1988), Wisconsin (Hilsenhoff 1981), and Saskatchewan (Lehmkuhl 1976). Several are out-of-date, such as for Illinois (Burks 1953) and California (Day 1956); and many are incomplete, such as for Alaska (McCafferty 1985b), northern Canada (Harper & Harper 1981), and Arkansas (McCafferty & Provonsha 1978). Texas, Nebraska, and other plains areas have been relatively neglected by collectors. Although mayflies of western Canada and northwestern U.S. south to Arizona have been studied, much of the data remain unpublished in theses. The mayflies of New Mexico are currently being studied by G. Z. Jacobi and W. P. McCafferty.

Large rivers are of special concern because many possess a unique fauna, and the habitats they provide are susceptible to impoundment, dredging, and other river alterations. The fauna of the Green River (Edmunds & Musser 1960) has been significantly altered or eliminated by the effects of Flaming Gorge Reservoir (G. F. Edmunds, Jr., personal communication). The Saskatchewan River has yielded many recent finds of new and unusual but often difficult-to-collect mayflies (Lehmkuhl 1976, 1979; Whiting & Lehmkuhl 1987a,b). Researchers are pessimistic about the future collection there of unknown stages and biological data because of imminent danger to habitats (Whiting & Lehmkuhl 1987b). The discovery that many of the faunal elements of deep-water habitats of the Saskatchewan River are also isolated in deep regions of the White River of Indiana (e.g., McCafferty & Provonsha 1988) illustrates the widely disjunct nature of these threatened forms.

About 7% of the North American species are known from single collections. Since there are many alternative explanations for such species that have yet to be sorted out, an assessment of "rare and endangered" species is now not possible. *Pentagenia robusta* McDunnough, however, has most probably become extinct. It was previously known from the Ohio River at Cincinnati. Locations of potentially very rare mayfly species include Baffin Island; Blue Lake, B.C.; Lake Lagunitas and Silver Canyon, CA; Swamp Creek, GA; Goshen Swamp and Bald Creek, NC; Murray Creek, OK; Geronimo Creek, Rio Frio, and Guadalupe River, TX; Green River, UT; and Columbia River, WA.

Systematic data, other than species descriptions and new records, have been contributed by 9 researchers in the 1980s. Of these, 6 have been involved in revisions of Nearctic taxa. The most active programs for systematic training are at Purdue University and Florida A & M University. The largest collections of Nearctic mayflies are at Purdue University, the University of Utah, and the Florida State Collection of Arthropods (Tallahassee and Gainesville). The California Academy of Sciences, Illinois Natural History Survey, and Cornell University also house important collections. A computerized data bank of nomenclatural, descriptive, and distributional information is being established at Purdue University. A comprehensive bibliography of Ephemeroptera appeared in "Eatonia" from 1954 to 1980. A limited bibliography is now published annually by the North American Benthological Society.

Plecoptera

Currently 578 species of Plecoptera in 100 genera and 9 families (Table 2) are recognized for North America north of Mexico. They represent about 27% of the known world fauna, but this percentage should decline as Oriental and Neotropical faunas become better known. Only the Oriental realm, with 662 species, exceeds the Nearctic in numbers. There are no endemic families in the Nearctic, but over half the genera are endemic. Illies (1966), Zwick (1973), and Stark et al. (1986) have provided catalogue information for world species. The North American stoneflies show relatively strong biogeographic affinities with the Palearctic and Oriental realms. We estimate that another 50 North American species await description, primarily in the genera *Isoperla, Perlesta, Capnia*, and *Leuctra*. California has recently been, and is anticipated to continue to be, the site of major discoveries at both the generic and species level.

Unlike the mayflies, all species of stoneflies are known in the adult stage. Nearly all species are known from both sexes (3% from one sex). Some 45% of North American species are known as larvae (nymphs) (Stewart & Stark 1988), although not necessarily formally described. Considerable effort should be placed on rearing, associating, and describing larvae. Placing larvae within a natural generic classification will be aided by the new work of Stewart & Stark (1988). Larval keys should soon be available for *Acroneuria, Neoperla, Isogenoides*, and *Isoperla*. The eggs of 205 species are known, mostly from the Systellognatha.

Table 2. Alphabetical list of families and genera of extant Plecoptera known from North America north of Mexico. Numbers of currently valid nominal species in the area, and numbers known as larvae, are indicated respectively after each genus.

EUHOLOGNATHAN STONEFLIES

Family Capniidae

Allocapnia 41,10
Bolshecapnia 6,1
Capnia 55,4
Capnura 7,1
Eucapnopsis 1,1
Isocapnia 11,6
Mesocapnia 13,2
Nemocapnia 1,1
Paracapnia 3,2
Utacapnia 10,3

Family Leuctridae

Despaxia 1,1
Leuctra 25,8
Megaleuctra 6,1
Moselia 1,1
Paraleuctra 9,2
Perlomyia 2,2
Zealeuctra 8,1

Family Nemouridae

Amphinemura 10,5
Lednia 1,1
Malenka 11,3
Nemoura 5,2
Ostrocerca 6,2
Paranemoura 1,1
Podmosta 5,3
Prostoia 4,3
Shipsa 1,1
Soyedina 7,2
Visoka 1,1
Zapada 9,5

Family Taeniopterygidae

Bolotoperla 1,1
Doddsia 1,1
Oemopteryx 4,3
Strophopteryx 7,2
Taenionema 8,3
Taeniopteryx 12,11

SYSTELLOGNATHAN STONEFLIES

Family Chloroperlidae

Alloperla 29,4
Bisancora 2,1
Chloroperla 1,0
Haploperla 4,2
Kathroperla 2,1
Neaviperla 1,1
Paraperla 2,1
Plumiperla 2,1
Rasvena 1,1
Suwallia 5,2
Sweltsa 21,4
Triznaka 2,2
Utaperla 2,2

Family Peltoperlidae

Peltoperla 2,1
Sierraperla 1,1
Soliperla 6,4
Tallaperla 6,1
Viehoperla 1,1
Yoraperla 2,2

Family Perlidae

Acroneuria 12,9
Agnetina 3,3
Anacroneuria 2,1
Attaneuria 1,1
Beloneuria 3,2
Calineuria 1,1
Claassenia 1,1
Doroneuria 2,2
Eccoptura 1,1
Hansonoperla 1,1
Hesperoperla 2,2
Neoperla 13,1
Paragnetina 5,4
Perlesta 2,2
Perlinella 3,3

Family Perlodidae

Arcynopteryx 1,1
Baumannella 1,1
Calliperla 1,1
Cascadoperla 1,1
Chernokrilus 3,1
Clioperla 1,1
Cosumnoperla 1,1
Cultus 6,3
Diploperla 4,3
Diura 3,3
Frisonia 1,1
Helopicus 4,3
Hydroperla 3,3
Isogenoides 9,8
Isoperla 57,38
Kogotus 2,2
Malirekus 2,2
Megarcys 5,1
Oconoperla 1,1
Oroperla 1,1
Osobenus 1,1
Perlinoides 1,1
Pictetiella 1,1
Remenus 1,1
Rickera 1,1
Salmoperla 1,1
Setvena 3,3
Skwala 2,2
Yugus 2,2

Family Pteronarcyidae

Pteronarcella 2,2
Pteronarcys 8, 8

Careful descriptions or redescriptions of genitalia of most species are needed to document ultrastructure. Nelson & Baumann (1987), Stark and Szczytko (1988), and Stark (1989) demonstrated their value in the Capniidae, Perlodidae, and Perlidae. Keys to species are critically needed for far western U.S. and Canada as well as eastern North America. Works by Jewett (1959, 1960) for the West and Hitchcock (1974) for the East are considerably out-of-date. Adults and known larvae of Rocky Mountain species are usually identifiable with the keys of Baumann et al. (1977).

An overview of the status and need of revisionary work on the 9 North American families follows: 1) **Capniidae**--C. R. Nelson is conducting research and beginning to examine world genera as an approach to revising polyphyletic genera; 2) **Leuctridae**--Genera are relatively well known, but a new genus is thought to occur in California, and certain species revisions are needed; 3) **Nemouridae**--Genera are well known (Baumann 1975), but species revisions are required for some, which are being studied by R. W. Baumann; 4) **Taeniopterygidae**--Ricker & Ross (1968, 1975) established the foundation for understanding this group; revisions are being carried out by J. A. Stanger & R. W. Baumann, and extensive stage correlations are being conducted by K. W. Stewart & J. A. Stanger on western species and by R. F. Kirchner on eastern species; some unpublished electrophoretic work has also been conducted by D. H. Funk; 5) **Chloroperlidae**--A family revision was recently completed by Surdick (1985), and species-level revisions are now needed for larger genera; 6) **Peltoperlidae**--Stark & Stewart (1981) reviewed the Nearctic genera, and Stark (1983a,b) and Stark & Kondratieff (1987) have revised larger genera; 7) **Perlidae**--Stark & Gaufin (1976) reviewed Nearctic genera. The greatest problems remain in the genus *Perlesta*. Stark (unpublished) has reviewed the types, and B. C. Poulton and K. W. Stewart are working on the Ozark-Ouachita species; 8) **Perlodidae**--Stewart & Stark (1984) described known larvae, and Stark & Szczytko (1984) used egg morphology to revise tribal classification; certain western species were revised by Szczytko & Stewart (1979), and Szczytko is now revising eastern species; new genera continue to be discovered in isolated areas of California; 9) **Pteronarcyidae**--Stark & Szczytko (1982) have studied the eggs, and Nelson (1988) has presented a species phylogeny; revised keys to adults and larvae are needed.

With respect to special stonefly habitat considerations, spring seeps are probably the most critical because they have been historically overlooked by many collectors. As a result, they contain a high percentage of species that are not well known or that could be considered rare. Also, the relatively small insulated habitats provided by spring seeps and their usual patchy geographic distribution provide an ideal situation for studying geographic speciation and adaptive radiation in certain groups of stoneflies (e.g., Ross & Ricker 1971). Several genera have been named from spring seeps in recent years, and several other "rare" genera are also found in this habitat. Unfortunately, spring seeps are often aesthetically pleasing, and thus are frequently enclosed by parks or private property where water use can be incompatible with stonefly survival.

The bulk of systematic research on North American stoneflies in the past 15 years has been carried out by 8 researchers in scattered localities. North Texas State University and Brigham Young University currently have the most active programs in Plecoptera systematics for Ph.D. students. Large collections are housed at these institutions, the United States National Museum of Natural History, the California Academy of Sciences, and the Illinois Natural History Survey. A computer file of North American species and distributions is maintained by B. P. Stark, S. W. Szczytko, and R. W. Baumann. Annual bibliographies are compiled by these workers and published by the North American Benthological Society. In addition, "Perla" is a regular international newsletter of Plecoptera.

Odonata

Of the 3 orders of aquatic insects treated here, the Odonata is by far the best known taxonomically both in North America and elsewhere in the world. Both professional entomologists and amateur collectors have long had an interest in these large and colorful insects. In recent years most contributions to the North American fauna have been new regional records. Much of the current research on the group is in the fields of population dynamics, behavior, and predator-prey relationships.

Currently 415 species of Odonata in 91 genera and 11 families (Table 3) are recognized for North America north of Mexico. An additional 14 families (Fraser 1957) are not represented, and no families are endemic to North America. The region contains a mere 8% of the world fauna based on a world number of 4,875 species contained in the lists of Davies & Tobin (1984, 1985). As numbers from other temperate areas are even lower, and as Davies & Tobin (1984, 1985) listed some 1,400 species for the Neotropical realm and 850 for the Afrotropical realm, it is clear that the group is primarily tropical and semitropical. A comprehensive catalogue of world Odonata was begun by the late B. E. Montgomery, but although needed, there are no prospects for its completion. Within the past 10 years, 9 new species have been described in the region. A few species may remain to be discovered in North America, mainly because certain species known from the Antilles and northern Mexico may eventually be found in the southern U.S. *Crocothemis servilia* has been introduced from Asia into Florida (Daigle 1984).

Unlike the mayflies, but similar to the stoneflies, the dragonflies and damselflies of North America are all known as adults. Of the 415 species, about 85% are currently known as larvae (Table 3) (Provonsha, unpublished). Over half the species of Odonata still unknown as larvae are from the southwestern U.S. and another 29% are from the southeastern U.S.. The high number from the southwestern U.S. is attributable to relatively less collecting effort there and the fact that species densities are low and habitats sparse and patchy (e.g., Provonsha & McCafferty 1973). Although the southeastern U.S. has been intensively collected, the rarity of many species there accounts for that region's large number of unknown larvae. Sexual dimorphism is highly developed in many Odonata, particularly in coloration. Therefore, it is significant that both sexes have been described for virtually all North American species. Relatively few species are known as eggs (Hinton 1981), and, except for Gomphidae (Stark, unpublished), egg structure appears to have limited taxonomic value.

Walker (1953, 1958), Walker & Corbet (1975), and Needham & Westfall (1955) continue to be the primary general manuals for Odonata in North America, leaving only the Zygoptera of the lower 48 states not generally treated. Needham & Westfall's (1955) manual on Anisoptera is out-of-print and in need of revision. Checklists and faunal accounts of Odonata, however, exist for at least 39 states and provinces. References to most of these can be found in Westfall (1984). A recent key to North American genera was also given by Westfall (1984). Species keys to adults may be found in the general manuals mentioned above or in many of the regional works listed by Westfall (1984). The excellent work on Texas Zygoptera by Johnson (1972) is typical of many works, in that adults are considered in detail and keyed, but the larvae are not treated. For many groups, identification of larvae to species is impossible, or difficult even for specialists. Not only do many larvae remain undescribed, but knowledge of many that have been described is inadequate for identification purposes. Another problem is that many characteristics change with the instar, and most existing keys are consistently reliable only for the last instar. Also, certain variability, e.g., of zygopteran caudal lamellae, is influenced by environmental conditions. Garrison's (1981, 1984) species characterization of *Ischnura* and *Enallagma* larvae, however, demonstrated that keys to difficult larvae are possible.

Table 3. Alphabetical list of families and genera of extant Odonata known from North America north of Mexico. Numbers of currently valid nominal species in the area, and numbers of those known as larvae, are indicated respectively after each genus.

ANISOPTERA

Family Aeshnidae

Aeshna 19,17
Anax 4,4
Basiaeschna 1,1
Boyeria 2,2
Coryphaeschna 4,3
Epiaeschna 1,1
Gomphaeschna 2,2
Gynacantha 1,1
Nasiaeschna 1,1
Oplonaeschna 1,1
Triacanthagyna 1,1

Family Cordulegastridae

Cordulegaster 5,5
Taeniogaster 1,1
Zoraena 2,1

Family Corduliidae

Cordulia 1,1
Dorocordulia 2,2
Epicordulia 2,2
Helocordulia 2,2
Neurocordulia 6,6
Somatochlora 26,20
Tetragoneuria 10,8
Williamsonia 2,2

Family Gomphidae

Aphylla 3,3
Arigomphus 7,7
Dromogomphus 3,3
Erpetogomphus 5,3
Gomphurus 14,13
Gomphus 17,13
Hagenius 1,1
Hylogomphus 7,7
Lanthus 2,2
Octogomphus 1,1
Ophiogomphus17,16
Phyllogomphoides 2,2
Progomphus 4,3
Stylogomphus 1,1
Stylurus 11,10

Family Libellulidae

Belonia 2,2
Brachymesia 3,2
Brechmorhoga 1,1
Cannaphila 1,0
Celithemis 8,8
Crocothemis 1,1
Dythemis 3,3
Erythemis 3,3
Erythrodiplax 4,4
Idiataphe 1,1
Landona 3,2
Lepthemis 1,1
Leucorrhinia 7,6
Libellula 16,15
Macrodiplax 1,1
Macrothemis 2,1
Miathyria 1,1
Micrathyria 2,2
Nannothemis 1,1
Orthemis 1,1
Pachydiplax 1,1
Paltothemis 1,1
Pantala 2,2
Perithemis 2,1
Plathemis 2,2
Pseudoleon 1,1
Sympetrum 13,13
Tauriphila 1,1
Tramea 7,4

Family Macromiidae

Didymops 2,2
Macromia 10,6

Family Petaluridae

Tachopteryx 1,1
Tanypteryx 1,1

ZYGOPTERA

Family Calopterygidae

Calopteryx 5,5
Hetaerina 3,3

Family Coenagrionidae

Acanthagrion 1,1
Amphiagrion 2,2
Anomalagrion 1,1
Apanisagrion 1,1
Argia 24,13
Argiallagma 1,1
Chromagrion 1,1
Coenagrion 3,3
Enallagma 35,26
Hesperagrion 1,1
Ischnura 13,11
Nehalennia 3,3
Neoerythromma 1,1
Telebasis 2,2
Zoniagrion 1,1

Family Lestidae

Archilestes 2,2
Lestes 16,11

Family Protoneuridae

Neoneura 1,1
Protoneura 1,1

Major revisionary results published within the past 10 years and involving North American Odonata are found mainly in Carle's (1986) monograph on the Gomphidae. Publications of Westfall & Tennessen (1979) on *Dromogomphus*, Carle (1983) on Cordulegastridae, and Dunkle (1985) on *Libellula* have dealt with minor revisionary problems. Data have been amassed on the damselfly genus *Argia* (L. Gloyd, unpublished), but need to be published. Otherwise, few revisions are being conducted. It appears that most future research will continue to be in the areas of faunistics, ecology, and behavior. Nevertheless, we reiterate that descriptions and keys are greatly needed for Zygoptera larvae.

Because Odonata are relatively much better known than the Ephemeroptera or Plecoptera, more definitive kinds of statements regarding rare and endangered species are possible. Carle (1979) listed Anisoptera at risk in Virginia, Dunkle & Westfall (1982) discussed rare and threatened Odonata in Florida, and Bick (1983) proposed "red data book" categories for all species at risk. Table 4, modified from Bick (1983), categorizes 30 species that are at various levels of risk or perhaps extinct. Most occur in the southeastern U.S., and more than three fourths are associated with flowing water habitats. The loss of clear, high quality, unobstructed streams (e.g., by impoundments) appears to be the greatest threat. The second most important threat is industrial pollution to both flowing and still-water habitats. *Ophiogomphus edmundo* Needham was described from North Carolina, and no specimens have been taken since 1892. It was suspected by Bick (1983) and Daigle (1988) to be extinct. *Somatochlora hineana* Williamson is known from 29 specimens taken from bog habitats of northern Indiana and Ohio. These areas are now industrialized, and in spite of intense collecting, no specimens have been reported since 1957 (Price 1958). Odonata specialists agree that this species is probably now extinct.

Large collections of North American Odonata are located at most major museums in the U.S. and Canada. The bulk of the B. E. Montgomery collection was recently donated to the USNM. The largest collections associated with universities are at the University of Michigan and the Museum of Comparative Zoology, Harvard University. An annual bibliography is compiled by V. M. Lawrence and published by the North American Benthological Society. "Selysia" is a regular international newsletter for Odonata workers.

Table 4. Status and state and provincial distribution of species of Odonata at risk in North America north of Mexico (modified from Bick 1983).

Status	Distribution
PROBABLY EXTINCT	
Ophiogomphus edmundo	NC TN(?)
Somatochlora hineana	IN OH
ENDANGERED	
Ischnura gemina	CA
Cordulegaster sayi	FL GA
VULNERABLE	
Enallagma recurvatum	MA NJ NY
Ophiogomphus anomalus	Que. Ont. ME NY WI
Ophiogomphus howei	KY MA NC NY PA TN VA
Stylurus potulentus	FL MS
Williamsonia lintneri	MA NH NJ NY RI
RARE	
Neoneura aaroni	TX
Gomphurus consanguis	AL GA TN VA
Gomphurus lynnae	WA
Gomphurus ozarkensis	AR OK
Gomphurus septima	AL NC
Gomphus diminutus	FL NC SC TN
Gomphus hodgesi	AL FL LA MS
Hylogomphus geminatus	AL FL GA
Hylogomphus parvidens	AL GA MD NC VA
Ophiogomphus acuminatus	TN
Ophiogomphus arizonicus	AZ NM
Ophiogomphus incurvatus	AL GA MD NC SC TN VA WV
Progomphus bellei	AL FL NC
Stylurus townesi	AL FL MS NC SC
Aeshna persephone	AZ
Macromia margarita	GA NC SC VA
Somatochlora brevicincta	Que.
Somatochlora calverti	FL SC
Somatochlora incurvata	N.S. Ont. ME MI PA
Somatochlora margarita	TX
Somatochlora ozarkensis	AR KS MO OK

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