

BIOGEOGRAPHIC AFFINITIES OF THE EPHEMEROPTERA OF THE BLACK HILLS, SOUTH DAKOTA^{1, 2}

W. P. McCafferty³

ABSTRACT: Records of mayfly species in South Dakota are few in number. Most records are from the Black Hills region of southwestern South Dakota. Twelve new species records (genera *Caenis*, *Callibaetis*, *Dactylobaetis*, *Epeorus*, *Nixe*, *Paraleptophlebia*, *Siphonurus*, *Tricorythodes*) are also based on collections from the Black Hills. The diversity of the mayfly fauna in the Black Hills is relatively low, with only 19 species in seven families known. The species mix consists of some widespread North American species, but also western continental species and eastern continental species whose respective easternmost and westernmost range limits meet in the Black Hills. The somewhat insular nature of this small montane region may explain low numbers of species, and its proximity to the main body of Rocky Mountains may explain the presence of its western component. Eastern species represented are primarily northeastern North American species with disjunct, probably relict, populations now isolated in the lower Appalachian Mountains, the Ozark-Ouachita Mountains, and the Black Hills.

Very few published records of Ephemeroptera species in South Dakota have been established. Species previously reported from the Black Hills region of southwest South Dakota are included in Table 1. The Black Hills region referred to herein includes Custer, Fall River, Lawrence, and Pennington Counties (Fig. 1). The previous records were given by Morihara and McCafferty (1979) for the Baetidae, and by Allen and Edmunds (1965) for *Ephemerella inermis*. Examination of additional materials of all of these previously reported species has substantiated their presence.

Even fewer records have been established for areas of South Dakota outside of the Black Hills region. In recent revisions, Bednarik and McCafferty (1979) recorded *Stenonema mediopunctatum arwini* from the Yellowbank River in extreme northeastern South Dakota, and Kondratieff and Voshell (1984) recorded *Isonychia rufa* from Sioux Falls in the southeast corner of the state. There are new state records of mayflies based on species I have examined from eastern South Dakota, but these will be published as part of revisionary studies now in progress.

Two primary factors have prompted the present report. First, it has become increasingly important to survey the North American fauna with respect to documenting biodiversity. Second, the Black Hills region is important biogeographically since, as will be discussed below, it con-

¹Received April 20, 1990. Accepted May 22, 1990.

²Published as Purdue Experiment Station Journal No. 12466.

³Department of Entomology, Purdue University, West Lafayette, IN 47907.

tains one of the most unusual mixes of mayfly faunal elements found in North America.

All species records for the Black Hills region reported by Morihara and McCafferty (1979) and all but one reported here for the first time (Table 1) have been based on collections made by me and by A. V. Provonsha and B. L. Heath in June, 1975 (Sites 2-17 in Table 2 and Fig. 1). Site 1 (Table 2 and Fig. 1) was collected in November, 1977, by an unknown collector. All larvae upon which data in Table 1 are based are deposited in the Purdue Entomological Research Collection, West Lafayette, Indiana.

In addition to a list of species taken in the Black Hills region, Table 1 indicates numbered collection sites where each species was found. These sites are plotted on a map of the region (Fig. 1) and are detailed in Table 2. Also included in Table 1 is an indication of the general North American distribution of each of the Black Hills species.

A rather striking pattern of biogeographic affinity is found for a large proportion of Black Hills species. Black Hills records represent the extreme range margin for 13 of the 19 species listed. Ten of the species are western continental or eastern continental species whose respective easternmost or westernmost fringes of their ranges apparently include the Black Hills. For the three other species, the Black Hills distribution is apparently along their northern or northeastern range margin.

Among the Baetidae, the species listed as widespread are generally distributed with a broad east-west transcontinental pattern. In the case of *Callibaetis fluctuans* and *Dipheter hageni*, these transcontinental patterns are somewhat restricted north and south, with either a mid-latitude or more northern pattern, respectively. *Fallceon quillerei* is widespread but only as far east as Illinois (Burks 1953, as *B. cleptis*) and Louisiana (Lager 1985) and is mainly southwestern and south-central in distribution. *Fallceon quillerei* may actually represent a complex of more than one species, but requires further systematic study (Waltz and McCafferty 1987a). In the case of *Callibaetis pictus*, although the range is signified as western in Table 1, it also extends into some south-central states as far east as Texas. Those species listed as eastern generally have midwestern as well as more eastern distributions.

Baetis brunneicolor, *B. flavisriga*, and *B. intercalaris* are eastern species whose westernmost distribution limits are represented by disjunct populations in the Black Hills. *Acentrella insignificans* and *Dactylobaetis cepheus* are western species whose easternmost limits appear to be in the Black Hills. With respect to *D. cepheus*, this may have been the species that Lehmkuhl (1976) reported as *Dactylobaetis* sp. from Saskatchewan. Whereas biogeographic affinities of *Dactylobaetis* are Neotropical

(Traver and Edmunds 1968), those of *Acentrella* are Holarctic (Waltz and McCafferty 1987b). The Black Hills are along the northern fringe of the known ranges of *Callibaetis fluctuans* and *C. pictus*. *Fallceon quilleri* has been reported from Saskatchewan (Lehmkuhl 1976), but the Black Hills distribution may be disjunct and along its northeastern range margin. Eventually, the *Callibaetis* species probably will be found in Saskatchewan.

The Heptageniidae is the only other family with more than one species listed for the region. *Epeorus grandis* and *Nixe criddlei* are western species whose eastern limits are apparently the Black Hills. Records of the latter species from Fort Collins, Colorado (Traver 1935) are nearly as far east.

Of the remaining species, *Caenis amica* is widespread and ubiquitous (Provonsha 1990), and *Tricorythodes minutus* is also widespread except for its absence from the Southeast (Berner 1977). *Siphonurus columbianus* and *Ephemerella inermis* are western species whose eastern limits are apparently the Black Hills, although *E. inermis* is reported from Saskatchewan (Lehmkuhl 1976), and I have seen *S. columbianus* from north-central Colorado. Hilsenhoff (1987) reported that either *E. inermis* or a sibling of it occurs in Wisconsin. I would not expect this species in Wisconsin, given its absence in places such as Manitoba and Minnesota (Flannagan and Flannagan 1982, Lager *et al.* 1982), but I have not studied the Wisconsin material. *Paraleptophlebia mollis* is a mainly northeastern species whose previous westernmost known distribution included Manitoba and Minnesota (Flannagan and Flannagan 1982, Lager *et al.* 1982).

In conclusion, there are at least three aspects of the Black Hills mayfly fauna that are noteworthy. First, the diversity of species is relatively small. This perhaps could be explained by the fact that the region is a somewhat insular montane area. Its isolation from other montane areas may be an obstacle to dispersal for many mayfly species.

Second, the Black Hills represent the easternmost limits for certain western species. The montane nature of the region would perhaps explain the presence of such species that have populations located proximally in the main body of the Rocky Mountains and that are relatively good dispersers.

Third, and what might appear to be the most difficult to explain, four eastern species have westernmost limits in the Black Hills. *Baetis brunneicolor* and *B. flavistriga* are, however, mainly northeastern and upper midwestern in distribution (Moriyama and McCafferty 1979) as is the *Paraleptophlebia mollis* (Traver 1935). Although mainly lowland species in their primary range, their range extensions outside of this area are dis-

unct in montane areas: Unzicker and Carlson (1982) reported *B. brunneicolor* from North Carolina; Peters and Warren (1966) reported *B. flavistriga* (as *B. levitans*) from the Ozark Mountains of Arkansas, and Berner (1977) reported this same species from Tennessee and North Carolina; and Traver (1937) confirmed *P. mollis* from North Carolina, and McCafferty and Provonsha (1978) found it in the Ouachita Mountains of Arkansas. This type of pattern in North America probably indicates a relict distribution, where certain cold-water species have become restricted to northeastern regions and isolated in certain disjunct montane areas outside the Northeast as a result of glacial events during the Pleistocene.

Although the distribution of *Baetis intercalaris* is similar to the three other eastern, Black Hills species, this species is found in more diverse lowland and upland locations in the East, including areas such as Florida and Alabama (Moriyama and McCafferty 1979). The western disjunction in this instance is therefore more difficult to interpret. The species does occur in the lower Appalachians and the Ozarks (Moriyama and McCafferty 1979), but these are not disjunctions. Perhaps the species has been a better post-glacial disperser, and since it appears more ubiquitous, perhaps will be found in lowland areas adjacent to, and east of, the Black Hills. This apparent anomaly, however, may not actually exist if it is an artifact of our inexact taxonomy. *Baetis flavistriga* and *B. intercalaris* are closely related and morphologically cryptic as larvae, being separable only by color pattern (Moriyama and McCafferty 1979). Therefore, it is possible that what we have determined to be *B. intercalaris* in the Black Hills is a color variation of *B. flavistriga* that resembles *B. intercalaris* in other areas. *Baetis ochris* is another closely related and similar species that may be involved.

ACKNOWLEDGMENTS

I thank A. V. Provonsha, Purdue University, and B. L. Heath, Lafayette, IN, for their participation in the collecting phase of this research, R. D. Waltz, Indiana Division of Entomology and Plant Pathology, Indianapolis, for his aid in identifying certain specimens, and D. W. Bloodgood, Purdue University, for preparation of the regional map.

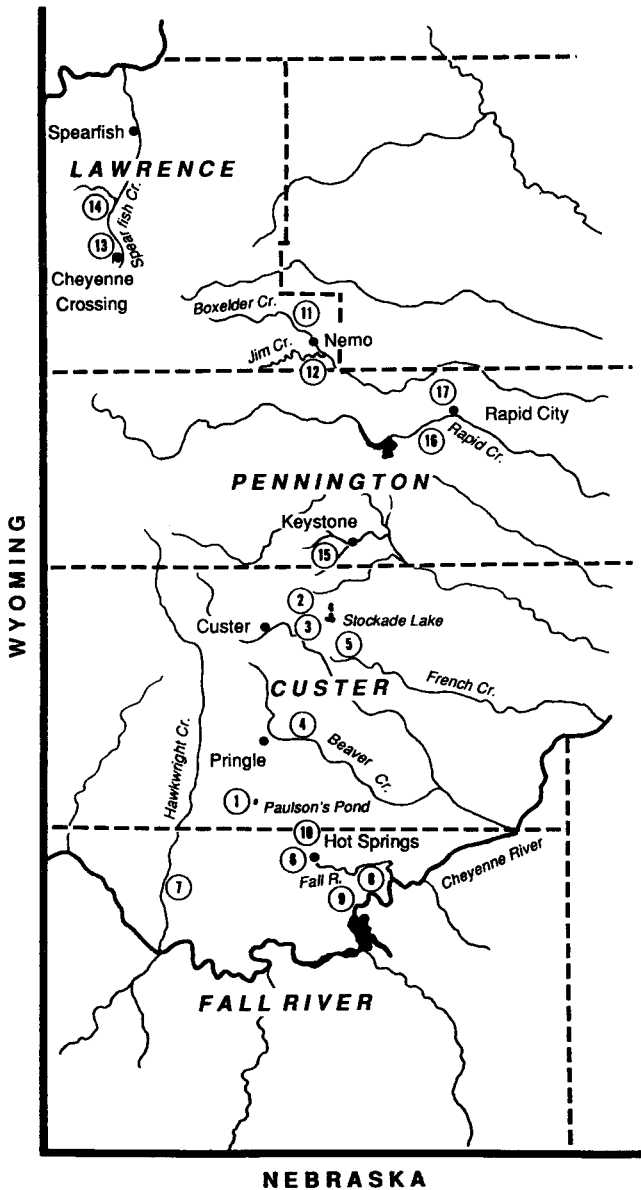


Fig. 1. Black Hills region of southwest South Dakota, with plotted mayfly collection sites.

Table 1. Distribution of the Ephemeroptera species of the Black Hills region of South Dakota. Asterisked species are newly reported for South Dakota. Numbers refer to sites plotted in Fig. 1. and detailed in Table 2.

SPECIES	SITES	N.A. DISTRIBUTION
Baetidae		
<i>Acentrella insignificans</i>	6	west
<i>Baetis brunneicolor</i>	5, 15	east
<i>Baetis flavistriga</i>	5, 11, 15, 16, 17	east
* <i>Baetis intercalaris</i>	11, 16, 17	east
<i>Baetis tricaudatus</i>	6, 11, 12, 13, 14, 16	wide
* <i>Callibaetis ferrugineus</i>	2	wide
* <i>Callibaetis fluctuans</i>	10	wide
* <i>Callibaetis pallidus</i>	1	wide
* <i>Callibaetis pictus</i>	3, 7	west
* <i>Dactylobaetis cepheus</i>	6	west
<i>Diphetero hageni</i>	12, 16	wide
<i>Fallceon quilleri</i>	6, 8	wide
Caenidae		
* <i>Caenis amica</i>	17	wide
Ephemerellidae		
<i>Ephemerella inermis</i>	4, 11, 12, 16	west
Heptageniidae		
* <i>Epeorus grandis</i>	13, 14, 15, 16	west
* <i>Nixe criddlei</i>	5	west
Leptophlebiidae		
* <i>Paraleptophlebia mollis</i>	11, 12, 15, 16	east
Siphonuridae		
* <i>Siphonurus columbianus</i>	15	west
Tricorythidae		
* <i>Tricorythodes minutus</i>	5, 8, 9, 11, 15	wide

Table 2. Details of Black Hills mayfly collection sites.

1. Custer Co, Paulson's Pond, 8 mi SW Pringle.
2. Custer Co, Bismark Lake Campground.
3. Custer Co, Stockade Lake at US 16A.
4. Custer Co, Beaver Cr 1 mi E Rifle Pit Historical Site.
5. Custer Co, French Cr at Hazelrodt Picnic Grounds.
6. Fall River Co, Hot Brook at Chataqua Park, Hot Springs.
7. Fall River Co, Hawkwright Cr at Red Canyon.
8. Fall River Co, Fall R at US 385 nr confluence of Cheyenne R.
9. Fall River Co, Cheyenne R at US 385.
10. Fall River Co, Fall Creek Reservoir 2 mi N Hot Springs.
11. Lawrence Co, Boxelder Cr at Boxelder Forks Campground 1 mi W Nemo.
12. Lawrence Co, Jim Cr 3 mi S Nemo.
13. Lawrence Co, Spearfish Cr 1 mi N Cheyenne Crossing at US 14A.
14. Lawrence Co, Iron Cr at US 14A 12 mi S Spearfish.
15. Pennington Co, Grizzly Bear Cr at Keystone.
16. Pennington Co, Rapid Cr at mouth of Dark Canyon.
17. Pennington Co, Rapid City at light.

LITERATURE CITED

- Allen, R. K. and G. F. Edmunds, Jr. 1965. A revision of the genus *Ephemerella* (Ephemeroptera: Ephemerellidae) VIII. the subgenus *Ephemerella* in North America. Misc. Publ. Entomol. Soc. Am. 4: 243-282.
- Bednarik, A. F. and W. P. McCafferty. 1979. Biosystematic revision of the genus *Stenonema* (Ephemeroptera: Heptageniidae). Canad. Bull. Fish. Aq. Sci. 201: 1-73.
- Berner, L. 1977. Distributional patterns of southeastern mayflies (Ephemeroptera). Bull. Fla. St. Mus., Biol. Sci. 22: 1-55.
- Burks, B. D. 1953. The mayflies, or Ephemeroptera, of Illinois. Bull. Ill. Nat. Hist. Surv. 26: 1-216.
- Flannagan, P. M. and J. F. Flannagan. 1982. Present distribution and post-glacial origin of the Ephemeroptera, Plecoptera, and Trichoptera of Manitoba. Man. Dept. Nat. Res., Fish. Tech. Rep. 82-1: 1-79.
- Hilsenhoff, W. L. 1987. An improved biotic index of organic stream pollution. Great Lakes Entomol. 20: 31-39.
- Kondratieff, B. C. and J. R. Voshell, Jr. 1984. The North and Central American species of *Isonychia* (Ephemeroptera: Oligoneuriidae). Trans. Am. Entomol. Soc. 110: 129-244.
- Lager, T. M. 1985. Range extensions and ecological data for southern United States Ephemeroptera. Proc. Entomol. Soc. Wash. 87: 255-256.
- Lager, T. M., M. D. Johnson and W. P. McCafferty. 1982. The mayflies of northeastern Minnesota (Ephemeroptera). Proc. Entomol. Soc. Wash. 84: 729-741.
- Lehmkuhl, D. M. 1976. Mayflies. Blue Jay. 34: 70-81.
- McCafferty, W. P. and A. V. Provonsha. 1978. The Ephemeroptera of mountainous Arkansas. J. Kans. Entomol. Soc. 51: 360-379.
- Morihara, D. K. and W. P. McCafferty. 1979. The *Baetis* larvae of North America (Ephemeroptera: Baetidae). Trans. Am. Entomol. Soc. 105: 139-221.
- Peters, W. L. and L. O. Warren. 1966. Seasonal distribution of adult Ephemeroptera in northwestern Arkansas. J. Kans. Entomol. Soc. 39: 396-401.
- Provonsha, A. V. 1990. A revision of the genus *Caenis* in North America (Ephemeroptera: Caenidae). Trans. Am. Entomol. Soc. in press.
- Traver, J. R. 1935. Systematic. pp. 237-739. In *The biology of mayflies*, by J. G. Needham, J. R. Traver and Y-C. Hsu. Comstock Publ. Co., Ithaca, N. Y.
- Traver, J. R. 1937. Notes on the mayflies of the southeastern states (Ephemeroptera). J. Elisha Mitchell Sci. Soc. 53: 27-86.
- Traver, J. R. and G. F. Edmunds, Jr. 1968. A revision of the Baetidae with spatulate-clawed nymphs (Ephemeroptera). Pac. Ins. 10: 629-677.
- Unzicker, J. D. and P. H. Carlson. 1982. Ephemeroptera. pp. 3.1-3.97. In A. R. Brigham, W. U. Brigham and A. Gnilka (eds.), *Aquatic insects and oligochaetes of North and South Carolina*. Midwest Aq. Enterprises, Mahomet, Ill.
- Waltz, R. D. and W. P. McCafferty. 1987a. New genera of Baetidae for some Nearctic species previously included in *Baetis* Leach (Ephemeroptera). Ann. Entomol. Soc. Am. 80: 667-670.
- Waltz, R. D. and W. P. McCafferty. 1987b. Systematics of *Pseudocloeon*, *Acentrella*, *Baetiella*, and *Liebebiella*, new genus (Ephemeroptera: Baetidae). J. New York Entomol. Soc. 95: 557-568.