Zoogeographic affinities of the stoneflies (Plecoptera) of the Raft River Mountains, Utah

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ZOOGEOGRAPHIC AFFINITIES OF THE STONEFLIES (PLECOPTERA) OF THE RAFT RIVER MOUNTAINS, UTAH

Richard M. Houseman 1 and Richard W. Baumann 2

ABSTRACT.—We examined faunal affinities of the Raft River Mountains using stoneflies (Plecoptera) as indicators. This island-like mountain range is isolated from other major mountain ranges in the Intermountain West by low-elevation, arid regions. Thirty-seven species were recorded from collections made from 19 sites in the Raft River Mountains. Cluster analysis demonstrated the Raft River Mountain stonefly assemblage to be most similar to faunas of the Sawtooth and Wasatch mountains, and quite different from that of the Sierra Nevada. An analysis of the distribution patterns of each species, on a family-by-family basis, showed that the Raft River Mountains fauna consists mostly of species widespread in western North America. Most families were represented by at least 1 species whose distribution supports faunal affinities with regions to the north and west. Logistic regression of 6 long-distance dispersal factors against stonefly presence-absence data did not support long-distance dispersal as a viable means of colonization for the Raft River Mountains. This suggests that stonefly distribution patterns may be attributed to expansion and subsequent vicariance of suitable stonefly habitats during Pleistocene climatic oscillations.

Key words: Plecoptera, stoneflies, zoogeography, affinity, Pleistocene, Great Basin, Raft River Mountains, Utah.

Biogeographic properties of island-like mountain ranges in the Intermountain West have been a topic of much research (MacArthur and Wilson 1963, Brown 1971, Johnson 1975, Behle 1978, Harper et al. 1978, Wells 1983). These mountain islands are appealing as opportunities to study the distribution, diversity, and evolution of organisms inhabiting them. The Raft River Mountains in extreme northwestern Utah are such a mountain range, and various studies have recognized that they are distinct from nearby regions (Durrant 1952, Behle 1958, McMahon and Wiebolt 1978).

McMahon and Wiebolt (1978) used a classification system developed by Holdridge (1947) and Holdridge et al. (1971) to divide Utah into “life zones” based on mean annual temperature, mean annual precipitation, and potential evapotranspiration. According to their classification, the Raft River Mountains are an ecologically isolated island of subtropical, montane, moist forest surrounded by regions of montane steppe and desert (McMahon and Wiebolt 1978).

Durrant (1952) concluded that the Raft River Mountains have mammal faunal affinities with the Columbia Plateau. His conclusions were based on 2 unique mammal species, Tamias amoenus Allen (yellow pine chipmunk) and Citellus beldingi Hall (Belding ground squirrel), both found in the Raft River Mountains but nowhere else in Utah. In addition, the broader distributions of these species extend north and west into regions associated with the Columbia Plateau (Durrant 1952).

The damselfly, Calopteryx aequabilis Say, and rugose stag beetle, Sinodendron rugosum Mann, are insects in the Raft River Mountains with interesting faunal affinities. Calopteryx aequabilis is known to occur throughout most of Canada, the north central and northeastern United States, and in isolated pockets in the western United States, including the Columbia River drainage (Provonsha 1975). Sinodendron rugosum has an overall distribution outside Utah that includes Idaho, Washington, Oregon, California, and British Columbia (Essig 1929, Hatch 1971).

Behle (1958) lists 172 bird species and subspecies from the Raft River Mountains and concludes that the bird assemblage in the Raft River Mountains more closely resembles that of the Great Basin than the nearby Wasatch Mountains.

The most desirable organisms to use when studying patterns of faunal affinities are those...
restricted to definable habitats (Sargent et al. 1991). Stoneflies (Plecoptera) are such a model group (Nelson 1994). Many stonefly species have limited ranges, and distinctive differences occur between the stonefly faunas of the Rocky Mountains, the Coast and Cascade mountains, and the Sierra Nevada (Jewett 1959).

Stoneflies depend on a water connection, with very specific habitat requirements (Surdick and Gaufin 1978, Baumann 1979), to expand their distribution. They are greatly influenced by water temperatures (Baumann 1979), pollution levels (Surdick and Gaufin 1978), and dissolved oxygen concentrations (Gaufin et al. 1966). Rocky streambeds or rocky lakeshores often are required for nymphs to complete their development (Gaufin et al. 1966, Hynes 1976), and the riparian environment is important for adult stoneflies to survive and successfully reproduce once they emerge from the final nymphal instar.

Adult stoneflies normally fly only short distances (Marden and Kramer 1994), and many are short-winged, which further reduces flying ability. Additionally, phenology of adult emergence may have an effect on the distribution of many species. For example, species in the family Capniidae emerge only during winter through breaks in the ice (Frison 1929). Species in this family are generally more limited in their distributions than those of other families (Nebeker and Gaufin 1967) that emerge during seasons when habitats and temperatures are more conducive to dispersal.

In this study we examine species composition, faunal affinities, and long-distance dispersal potential of stoneflies in the Raft River Mountains. We compare species composition with that from 3 other regional mountain ranges to determine overall similarity between their stonefly faunas and possible modes of colonization. The Sawtooth Mountains in central Idaho, Wasatch Mountains in northern Utah, and Sierra Nevada in California are regions with which the Raft River Mountains may have affinities.

STUDY AREA

The Raft River Mountains, near the borders of Utah, Idaho, and Nevada in extreme northwestern Utah, resemble a gently sloping plateau that rises from surrounding arid basins to an elevation of 2900 m. The range has an area of approximately 990 km² and lies in an east-west orientation as part of the northern edge of the Great Basin.

Considerable differences in vegetation and precipitation exist between the north and south slopes of these mountains due to their east-west orientation (Behle 1958). Northern slope streams are unique in Utah since they flow into the Snake River drainage system. Southern drainages that once flowed into Pluvial Lake Bonneville (Stokes 1987) now drain into the Bonneville Basin.

The insular nature of this mountain range makes it excellent for testing biogeographical hypotheses. Immediately surrounding the Raft River Mountains are arid lowlands (Great Basin, Bonneville Basin, and Snake River Plain), which effectively isolate them from other mountain ranges in the region (Fig. 1). The Bonneville Basin currently isolates the Raft River Mountains from the Wasatch Mountains to the southeast, the Snake River Plain is a barrier for stonefly dispersal from the Sawtooth Mountains in central Idaho (Nebeker and Gaufin 1967), and the Great Basin isolates the Raft River Mountains from the Sierra Nevada (Nebeker and Gaufin 1967, Brown 1971, Johnson 1975). For purposes of this study, we consider these 3 mountain ranges as hypothesized source pools for stonefly dispersal to the Raft River Mountains.

METHODS

We visited most major drainages in the Raft River Mountains at least once during each season for 2 yr. We collected data during 1994-95 and also included previous collection records from 1977 to 1980.

Stonefly nymphs were collected using an aquatic kick net. Adults were collected with a beating sheet from riparian vegetation and with ultraviolet light traps near streams at night. Exuviae were also collected.

Nymphal and adult stoneflies were preserved in 70% ethyl alcohol and identified to the lowest possible taxon using current identification keys (Baumann et al. 1977, Nelson and Baumann 1987, 1989, Stewart and Stark 1988, and Stanger and Baumann 1993).

Species lists from the Sawtooth Mountains, Wasatch Mountains, and Sierra Nevada were compiled directly from the literature (Jewett...
Fig. 1. Mountain ranges considered in this study and intervening barriers for stonefly dispersal.


We investigated faunal affinities of each species collected in the Raft River Mountains by examining its distribution in North America. Each species was classified according to the region of faunal affinity it supports.

Similarities between stonefly species composition of the Raft River Mountains and the 3 hypotized source pool mountain ranges were determined with cluster analysis using NTSYSpc 1.70 (Rohlf 1992). Stonefly presence-absence data were entered into a matrix from which a distance matrix was constructed using Jaccard’s coefficient. The distance matrix, which quantifies the similarity between a pair of areas as a decimal value, was SAHN (sequential, agglomerative, hierarchical, nested) clustered using UPGMA (unweighted pairs-group method with arithmetic averaging). Single-link and complete-link methods were also employed. All clustering methods resulted in dendrograms that demonstrate similarities of faunal composition between mountain ranges.

Since SAHN will produce clusters whether or not natural groups are present in the data (Rohlf 1992), a cophenetic value matrix was computed from the dendrogram matrix to
analyze goodness of fit between the cluster dendrogram matrix and distance matrix. The cophenetic matrix was compared element by element with the original distance matrix according to a test developed by Mantel (1967). This comparison produces a product-moment correlation, which measures the degree of relationship between the distance matrix and dendrogram matrix. Values >0.90 indicate that the tree accurately represents natural groupings present in the data. Values <0.70 indicate that natural groups may not be present (Rohlf 1992).

Dispersal abilities were quantified for all stonefly species recorded from the hypothesized source pool mountain ranges. Scores for dispersal ability were based on published data for 6 factors that influence stonefly distribution and long-distance dispersal (Logan et al. 1966, Nebeker et al. 1966, Baumann et al. 1977, Surdick and Gaufin 1978, Baumann 1979, Nelson and Baumann 1987, 1989, Kondratieff and Baumann 1988, Stanger and Baumann 1993): season of emergence, length of emergence, distribution within the source mountain range, relative distance from the Raft River Mountains, environmental tolerance, and wing length (Table 1). If colonization of the Raft River Mountains by stoneflies occurred via random, long-distance dispersal, one would expect the Raft River Mountains fauna to be composed of species with high quantified dispersal ability (Coleman et al. 1982).

We used logistic regression analysis (P = 0.05) to test for correlation between high scores for these 6 factors and stonefly presence-absence data in the Raft River Mountains. Significant correlation would provide evidence for long-distance dispersal as a mode of colonization for those stonefly species found in these mountains.

**WING LENGTH.**—Because macropterous (long-winged) stoneflies are better fliers than brachypterous (short-winged), micropterous (minutely-winged), or apterous (without wings; Marden and Kramer 1994), they were assumed to be better adapted for long-distance dispersal. Both sexes were examined for wing morphology and scored according to wing length. Apterous or micropterous species of either sex were given a score of 1. Species with brachypterous members of either sex were scored 2, and species where both sexes were macropterous received a score of 3.

**ECOLOGICAL TOLERANCE.**—Species that survive in a broader range of ecological conditions were assumed to be better adapted for long-distance dispersal because a broad tolerance allows a species to survive in a greater number of post-dispersal environments. Baumann (1979) identifies 3 stonefly environments, cold lotic, warm lotic, and cold lentic, and calls them "ecological groupings.” Species that are limited to only 1 of these ecological groupings received a score of 1, species in 2 of these groupings were scored 2, and those species capable of living in all 3 ecological groupings were given a score of 3.

**SEASON OF EMERGENCE.**—Dispersal is more probable during warmer seasons (Nebeker and Gaufin 1967). Fall- or winter-emerging species received a score of 1, spring-emerging species received a score of 1, and summer-emerging species received a score of 3.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Category and score</th>
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<tbody>
<tr>
<td>Season of emergence</td>
<td>Fall or winter</td>
</tr>
<tr>
<td>Length of emergence</td>
<td>1–3 months</td>
</tr>
<tr>
<td>Ecological tolerance</td>
<td>1 grouping</td>
</tr>
<tr>
<td>Wing length</td>
<td>Apterous or micropterous</td>
</tr>
<tr>
<td>Relative distance from Raft River Mountains</td>
<td>Farthest 1/3</td>
</tr>
<tr>
<td>Distribution within source mountain range</td>
<td>1 of 3 regions</td>
</tr>
</tbody>
</table>
were scored 2, and summer-emerging species were scored 3. September through February were considered fall and winter; spring months were considered April and May; and June through August was considered summer.

**LENGTH OF EMERGENCE.**—We assumed dispersal to be more probable for species whose adults are present for longer periods of time. By using emergence and collection records, we determined how many months during the year adults are present for each source pool mountain range. Species whose adults were present up to 3 months were given a score of 1, presence during 4–5 months of the year was scored 2, and species with adults present >5 months were scored 3.

**DISTRIBUTION WITHIN HYPOTHESIZED SOURCE MOUNTAIN RANGES.**—Long-distance dispersal was assumed to be more probable for species with widespread distributions in the hypothesized source mountain ranges. To assess how widespread each species was within a source pool mountain range (Sierra Nevada, Sawtooth, Wasatch), we subdivided each mountain range along its length into 3 equally sized regions. If a species was recorded from only 1 of these regions, we scored it as 1. If a species’ distribution covered 2 adjacent regions, it was scored 2. Presence in all 3 regions was scored 3. If a species was present in the regions at opposite ends of the mountain range, we assumed it also was present in the middle and scored it 3.

**RELATIVE DISTANCE FROM THE RAFT RIVER MOUNTAINS.**—Dispersal is more likely between areas nearer to each other (MacArthur and Wilson 1963). We measured straight-line distances from the Raft River Mountains to the single nearest and most distant counties. Nearest was Cache County in the Wasatch Mountains and farthest was Kern County in the Sierra Nevada. Once the nearest and most distant counties were located, we calculated the difference in distance between them and divided it into thirds. Species whose nearest literature record was from a county in the most distant third were scored 1. If the closest record was from a county in the middle third, it was scored 2. Species from the nearest third were scored 3.

**RESULTS**

We collected 37 species in 25 genera and 8 families from the Raft River Mountains. They are listed in Table 2 by collection site and presence in each source mountain range. Of these 37 species, 5 are unique records for Utah and have distributions extending outside the state to the northwest: Malenka tina (Ricker), Taeniopteryx nivalis (Fitch), Capnia petila Jewett, Capnura intermontana Nelson and Baumann, and Doroneuria sp. In addition, a potentially undescribed species in the genus Kogotus was collected in several of the Raft River Mountain drainages.


UPGMA clustering suggested that stonefly species composition of the Raft River Mountains was most similar to the Sawtooth Mountains. Species composition is also similar to the Wasatch Mountains and different from the Sierra Nevada (Fig. 2). A matrix correlation of $r = 0.94$ demonstrated a good fit between the dendrogram data and taxonomic distance matrix. These data support previous findings by Nelson (1994), Harper et al. (1978), and Wells (1983).

Single and complete-link methods produced the same tree topology as UPGMA, and similar cluster and matrix correlation values were obtained. Single-link clustering produced similarity values of 0.431, 0.407, and 0.273 with a matrix correlation $r = 0.94$. Complete-link cluster values were 0.431, 0.375, and 0.272 with a matrix correlation value $r = 0.94$.

Clear Creek yielded the highest number of species. However, this is probably a result of the number of different times the site was sampled. The number of species per site and the number of times a site was sampled had a
correlation coefficient of 0.87. The Upper Narrows of the Raft River displayed the greatest amount of local endemism. This is the only site in the Raft River Mountains where Taeniopteryx nivalis (Fitch), Capnia vernalis Newport, Capnura intermontana Nelson and Baumann, Isoperla fulva Claassen, and Isoperla pinta Frison occur. Podmosta delicatula (Claassen), Doroneura sp., and Suallya pallidula (Banks) were collected only from Clear Creek, and Capnia petila was found only in Fisher Creek.

A distribution analysis of the 37 species based on their occurrence in either northern or southern drainages showed that 36 of 37
species (97%) were collected in northern drainages, Capnia petilia being the exception. Only 28 of 37 (76%) species were collected in southern drainages. Of the 9 species not collected from southern drainages, 5 from the Upper Narrows of the Raft River and 3 from Clear Creek (both northern drainages) were not found elsewhere in the study area. These 2 sites alone accounted for 32 of 37 (84%) total species collected in the Raft River Mountains. Differences in northern versus southern drainage diversity are almost completely explained by the uniqueness of these 2 sites.

Logistic regression analysis of the 6 factors affecting stonefly long-distance dispersal found that distance was the only factor significantly correlated with stonefly presence-absence data in the Raft River Mountains. Every species collected in the Raft River Mountains was also found in the closest distance category. Those species in the middle or farthest distances were present in the Raft River Mountains only if they were also present in the nearest distance. An additional analysis of the remaining 5 factors for only those species within the nearest distance category also demonstrated that none are significantly correlated with stonefly presence-absence in the Raft River Mountains. A long-distance dispersal model does not explain presence-absence data for the Raft River Mountains.

**DISCUSSION**

**Faunal Affinities**

Distributions of each species in the Raft River Mountains, on a family-by-family basis, showed some interesting patterns of faunal affinity not revealed by analyses of overall similarity.

**PTERONARCYIDAE.**—Pteronarcyis princeps Banks is abundant throughout the Pacific Northwest and California but rare in the Rocky Mountains (Jewett 1959, Baumann et al. 1977). Its presence in the study area supports a faunal relationship with regions to the northwest. Pteronarcella badia (Hagen) is common in the Rocky Mountains, extends into the Pacific Northwest (Baumann et al. 1977), but is absent in the Sierra Nevada.

Pteronarcyis californica Newport was absent from the Raft River Mountains, even though it is commonly found throughout the West (Baumann et al. 1977). Its absence is due probably to lack of high-quality, large rivers in the study area.

**TAENIOPTERYGIDAE.**—Taeniopteryx nivalis, commonly found in eastern North America, is rare in the West, being limited to western Canada and the Pacific Northwest (Ricker 1964, Kondratieff and Baumann 1988). Ricker (1964) attributed this distribution to a postglacial or interglacial dispersal across Canada and down the Rocky Mountains with subsequent extinction in central Canada. Taeniopteryx nivalis reaches the southernmost part of its range in the Raft River Mountains where its presence indicates a faunal relationship between these mountains and areas to the northwest.

Doddsta occidentalis (Banks) and Taenionema pallidum (Banks) were both found in the Raft River Mountains and are widely distributed in western North America (Baumann et al. 1977). They are not useful species for determining faunal affinities with any particular region.

**NEMOURIDAE.**—Malenka californica Claassen, Podmosta delicatula, Podmosta decepta (Frison), Prostota besametsa (Ricker), Zapada cinetipes (Banks), and Zapada haysi (Ricker) are all widely distributed in western North America (Baumann et al. 1977) and occur in the Raft River Mountains, giving no clear indication of faunal affinities.

The presence of Malenka tina supports faunal relationships between the Raft River Mountains and regions to the northwest (Jewett 1959).
CAPNIIDAE.—Species in this family typically have limited distributions (Nebecker and Gaufin 1967). Only 1 species, Eucaecropis brevicauda Claassen, was collected in all 3 hypothesized regions of faunal affinity.

Capnia gracilaria Claassen, Capnia verellus, and Utacapnia leonidiana (Nebecker and Gaufin) were shared by the Raft River, Sawtooth, and Wasatch mountains. Capnia gracilaria is also found in the Pacific Northwest but does not support faunal affinities with that region since its overall distribution is much more widespread.

Capnia petilla and Capnura interna montana were shared only by the Sawtooth Mountains. The presence of C. petilla in the study area represents the southernmost collection of this species in western North America. It supports a faunal relationship with northern regions of the Rocky Mountains but not with the Pacific Northwest. Capnura interna montana is limited to drainages in the northern Great Basin and tributaries of the Snake River (Nelson and Baumann 1989, Nelson 1994). It indicates faunal relationships between the Raft River Mountains and regions to the north and west.

PERLIDAE.—Eight species from this family were collected in the Raft River Mountains. Seven of these, Diura knowltoni (Frison), Isoperla fulva Claassen, Isoperla pinta Frison, Isoperla quinquepunctata (Banks), Isoperla sobria (Hagen), Megarcys signata (Hagen), and Skwala americana (Frison), are relatively widespread in western North America (Baumann et al. 1977).

An interesting species, Kogotus sp. A, with brachypterous wings was collected in the Raft River Mountains and further west in the Jarbridge Mountains of central Nevada. Two other species of Kogotus occur in western North America: Kogotus nonus (Needham and Claassen) in the Coast and Cascade ranges, and Kogotus modestus (Banks) in the Rocky Mountains (Jewett 1959). Kogotus sp. A in the Raft River Mountains may be a potential new species with distribution between K. nonus and K. modestus.

PELTOPERLIDAE.—No species in this family were collected from the Raft River or Wasatch Mountains, but it was represented by Yoroperla brevis (Banks) in the Sawtooth Mountains and Yoroperla nigrisoma (Banks) in the Sierra Nevada (Stark and Nelson 1994). The Pacific Northwest also has several peltoperlid species (Jewett 1959), and their absence in the Raft River Mountains implies a lack of strong faunal relationships with regions to the northwest.

In summary, faunal affinities of those species and families collected in the Raft River Mountains indicate the Plecoptera fauna is composed of 2 dominant groups (Table 3). The largest group (68% of 37 species) consists of species widely distributed in western North America. Species associated with regions north and west of the Raft River Mountains constitute the 2nd group and represent 22% of the Raft River Mountains fauna. Most families in the study are represented by at least 1 species from this 2nd group. Similarities revealed by cluster analysis are the result of repeated faunal relationships within each family and not the result of any single family influencing overall similarity patterns.

Colonization

The Raft River Mountains provide a good model of an island habitat; however, geologic history indicates they have not been completely
isolated from these hypothesized colonization sources in the past (Petersen et al. 1980). Climatic changes caused by Pleistocene glacial and interglacial cycles had a profound effect on biotic distributions and connectedness of habitats within the Great Basin region (Axelrod 1981, Grayson 1993). These climatic oscillations provided the mechanism for a vicariance model of stonefly colonization in the Raft River Mountains.

Pleistocene climatic changes directly affected the location of stonefly habitats in North America. Cooler climates moved south from polar regions and pushed stonefly habitats further south and into the lower elevations of the Intermountain West (Sargent et al. 1991). Increased precipitation and subsequent runoff from glaciers caused an overall expansion of pluvial environments. Stonefly habitats expanded into generalized tracks of distribution (Croizat et al. 1974). The later retreat of glaciers moved stonefly habitats northward and into higher elevations. Island-like habitats were separated by intervening lowlands and dry lakebeds. This occurred most recently within the last 10,000 yr (Stokes 1987).

During glacial intervals corridors were opened between the Raft River and other mountains to the north and west. Species in regions to the north and west were able to reach their southernmost distributions in the Raft River Mountains before vicariance isolated them. These same corridors of distribution did not exist between the Raft River Mountains and Sierra Nevada due to the presence of extremely low elevation valleys in western Nevada (Wells 1983). This explains why all species shared between the Raft River Mountains and Sierra Nevada are also present in the Rocky Mountains.

### Table 3. Stonefly species found in the Raft River Mountains listed by family and region of faunal affinity each supports.

<table>
<thead>
<tr>
<th>Family</th>
<th>Widespread</th>
<th>Northwestern</th>
<th>Other</th>
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<tbody>
<tr>
<td>Pteronarcyidae</td>
<td><em>Doddsta occidentalis</em></td>
<td><em>Taeniopteryx nivavis</em></td>
<td><em>Pteronarcyis princeps</em></td>
</tr>
<tr>
<td>Taeniopterygidae</td>
<td><em>Doddsia occidentalis</em></td>
<td><em>Taeniopteryx nivavis</em></td>
<td><em>Pteronarcyis princeps</em></td>
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<tr>
<td>Nemouridae</td>
<td><em>Malenka californica</em></td>
<td><em>Malenka tina</em></td>
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<td></td>
<td><em>Podmosta delicatula</em></td>
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<td><em>Podmosta decepta</em></td>
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<td><em>Podmosta bimametsa</em></td>
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<td></td>
<td><em>Podmosta decepta</em></td>
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<td></td>
<td><em>Zapada cinctipes</em></td>
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<td><em>Zapada hayst</em></td>
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<td>Leuctridae</td>
<td><em>Paraleuctra vershina</em></td>
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<td>Capniidae</td>
<td><em>Eucapnia breviscula</em></td>
<td><em>Capnia petula</em></td>
<td><em>Capnia vernalis</em></td>
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<td></td>
<td><em>Capnia gracilis</em></td>
<td><em>Capnara intermontana</em></td>
<td><em>Utacapnia lenmoniana</em></td>
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<tr>
<td>Perlodidae</td>
<td><em>Diura knovtami</em></td>
<td><em>Isoperla fulva</em></td>
<td><em>Kogotus sp. A</em></td>
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<td></td>
<td><em>Isoperla fulva</em></td>
<td><em>Isoperla pinta</em></td>
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<td><em>Isoperla quinquenectata</em></td>
<td><em>Isoperla sohia</em></td>
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<td></td>
<td><em>Isoperla signata</em></td>
<td><em>Megarctys signata</em></td>
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<td></td>
<td><em>Skwala americana</em></td>
<td><em>Suwallia pallidula</em></td>
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<tr>
<td>Perlidae</td>
<td><em>Hesperoperla pacifica</em></td>
<td><em>Doroneuria sp.</em></td>
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<tr>
<td>Chloroperlidae</td>
<td><em>Snoallia pallidula</em></td>
<td><em>Utaperla sopladora</em></td>
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<td><em>Snoallia lineosa</em></td>
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<td><em>Snoallia borealis</em></td>
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<td><em>Snoallia lamba</em></td>
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<td><em>Trisenka pintada</em></td>
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Climatic changes caused by Pleistocene glacial and interglacial cycles had a profound effect on biotic distributions and connectedness of habitats within the Great Basin region (Axelrod 1981, Grayson 1993). These climatic oscillations provided the mechanism for a vicariance model of stonefly colonization in the Raft River Mountains.
The vicariance argument is strengthened by repeated patterns of affinity for each of the stonefly families present in the Raft River Mountains. Similar patterns exist for mammals (Durrant 1952, Brown 1971) and plants (Billings 1978, Harper et al. 1978) in the Great Basin. Similarities in distribution patterns for different taxonomic groups are undoubtedly the result of a vicariant event splitting all biotas rather than multiple long-distance dispersal events. Stonefly distribution patterns in the southwestern United States (Stewart et al. 1974) and northern Mexico (Sargent et al. 1991) have also been attributed to vicariance events during the Pleistocene.

CONCLUSIONS

The stonefly fauna of the Raft River Mountains consists of 37 species in 25 genera and 8 families. Five are unique records for the state of Utah, and 1 is a potentially undescribed species in the genus Kogotus.

Most species collected in the Raft River Mountains are those with widespread distributions in western North America. Repeated patterns of faunal affinity for most stonefly families show strong faunal affinities with stonefly assemblages in the Rocky Mountains to the north. Of the mountain ranges examined, the Raft River Mountains stonefly fauna most closely resembles that of the Sawtooth Mountains in central Idaho.

Logistic regression analysis demonstrated that a long-distance dispersal model of stonefly colonization cannot explain patterns of presence-absence in the Raft River Mountains. Stonefly distributions in the Raft River Mountains appear to be the result of expanded stonefly distributions and subsequent vicariance caused by Pleistocene climatic oscillation.

ACKNOWLEDGMENTS

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LITERATURE CITED


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