Proc. Iowa Acad. Sci. 89(3): 89-98, 1982

A Survey of the Benthic Macroinvertebrates of the Upper Iowa River Basin

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The benthic macroinvertebrates of the Upper Iowa River basin in extreme northeastern Iowa were sampled in late April and mid July 1980. There were distinct population trends and differences between the April and July samples and also between the 14 mainstream and the 6 tributary stations. The benthic macroinvertebrates in and immediately downstream from Decorah indicated severe water quality degradation. The problem was limited, as the expected composition returned only a few kilometers downstream. A total of 149 taxa were collected.

INDEX DESCRIPTORS: Upper Iowa River, benthic macroinvertebrates, water quality, Decorah.

The Upper Iowa River originates near the small town of Taopi in Mower County of southeastern Minnesota. It flows approximately 125 km (80 mi) in a southeasterly direction to Decorah, Winneshiek Co., Iowa, and then angles to the east-northeast for 75 km (47 mi) where it discharges into the Mississippi River at New Albin, Allamakee Co., Iowa (see Figure 1). The Upper Iowa River drains approximately 24,330 ha (924 sq mi) of northeastern Iowa in Howard, Winneshiek, and Allamakee Counties (Larimer, 1957). Land use in the basin is predominantly agricultural, especially in the upper portion of the basin and along the flood plain near the mouth. Wooded areas are common throughout the river basin. The middle and lower reaches generally are in a deep river valley bordered by steep hillsides; near Bluffton the local relief exceeds 100 m (330 ft) along the river. The Upper Iowa River basin is thinly populated with Decorah (population 7,703) being the only major population center and wastewater discharger.

Northeastern Iowa is a region of the state bypassed by the last continental glacier which accounts for the more rugged topography of the area when compared to other sections of Iowa. Most of the Upper Iowa River basin is underlain by limestone bedrock in the Cedar Valley to Decorah formations. These layers, especially the fractured Cedar Valley, are subject to being dissolved by slightly acidic rain water. Over time an intricate network of solution chambers, underground streams, caves, springs and sink holes are formed which are collectively known as Karst topography. The Karst topography results in a fairly constant supply of groundwater being discharged into the Upper Iowa River basin through springs and seeps into the stream bed. The average stream gradient for the Upper Iowa River is approximately 1.1 m/km (5.8 ft/mi), with a maximum drop of 3.4 m/km (17.9 ft/mi) at Decorah (McMullen, 1972).

The Upper Iowa River has had relatively few major man-made alterations. The most significant alteration has been the channelization of the final 11.3 km (7 mi) stretch of river as part of a flood control project in 1958 by the U.S. Army Corps of Engineers (McMullen, 1972). Several small dams have also been erected on the river. A low head dam was constructed on the Upper Iowa River near Lime Springs in the early 1920s (pers. comm., A.M. Davis). In addition, there are 2 dams, with little impoundment capacity, located approximately 6.5 km (4 mi) and 11.3 km (7 mi) downstream from Decorah. Two other dams were built on the Upper Iowa River in Decorah. Both dams, however, were almost entirely removed during the levee construction project in Decorah by the U.S. Army Corps of Engineers in the late 1940s (pers. comm., Gaige Wunder).

The Upper Iowa River is a valuable natural resource for both scenic and recreational enjoyment and was designated by the 90th U.S. Congress as among the initial 27 rivers to be included in the National Wild and Scenic River System. The Iowa General Assembly (in 1970) also established the Iowa Scenic River System with the Upper Iowa River as the 1st designee (Geary and Morris, 1975). In addition, the State of Iowa, by action of the Iowa Water Quality Commission has made the Upper Iowa River and several of its tributaries subject to water quality standards and has also included the river in Iowa's "anti-degradation policy" (Iowa Water Quality Commission, 1978). The Upper Iowa River is a highly regarded river in Iowa for canoeing and fishing, supporting 1 of the best smallmouth bass populations in the state (Harlan and Speaker, 1969). Ground water discharges into the Upper Iowa River basin maintain summer water temperatures cool enough for trout survival in many of the tributaries and some of these streams are included in the Iowa Conservation Commission's trout stocking program.

The Upper Iowa River is 1 of Iowa's most important aquatic resources, and has been the subject of several research studies. McMullen (1972) found that the water quality of the Upper Iowa River was "superior" to that of several other Iowa rivers. The students and faculty at Luther College in Decorah collected water quality and biological data for a pair of projects in 1974. Scherpelz and Eckblad (1974) studied the impacts of feedlot runoff on the aquatic habitat of several small tributaries to the Upper Iowa River and concluded that the impacts were undiscernable from individual, small feedlots under non-runoff conditions. Eckblad (1974) inventoried the aquatic organisms of the Upper Iowa River in the vicinity of Decorah. Another study conducted by the University Hygienic Laboratory (UHL) concluded that the "overall chemical water quality of the stream was very good" (Geary and Morris, 1975). The 1975 report also examined the benthic macroinvertebrates of the Upper Iowa River and noted that "the quality of the macroinvertebrate community was high and any limitations on colonization by aquatic organisms were primarily a function of substrate availability and not a reduction in water quality". However, this report was based on limited data (11 taxa collected from 6 stations) and conclusions based on benthic macroinvertebrates were questionable. The U.S. Environmental Protection Agency (USEPA) performed a biological survey on the Upper Iowa River in 1978 and summarized that both the biology and water quality of the river were in good condition (USEPA, 1979). The USEPA investigators collected a total of 79 benthic macroinvertebrate taxa, including 26 taxa of chironomids, but from only 6 stations.

The benthic macroinvertebrates of other Iowa streams have been the subject of limited attention. Two studies by Bovbjerg, et al. (1970), and Rausch and Bovbjerg (1973) inventoried the aquatic macroinvertebrates of the Little Sioux River in western Iowa. Zimmer (1976) studied benthic macroinvertebrate drift in the Skunk River near Ames, Iowa. Another study by Hummel and Haman (1977) detailed a species list and distribution records of Odonata in the Cedar-Iowa River basin. In addition, the UHL has conducted

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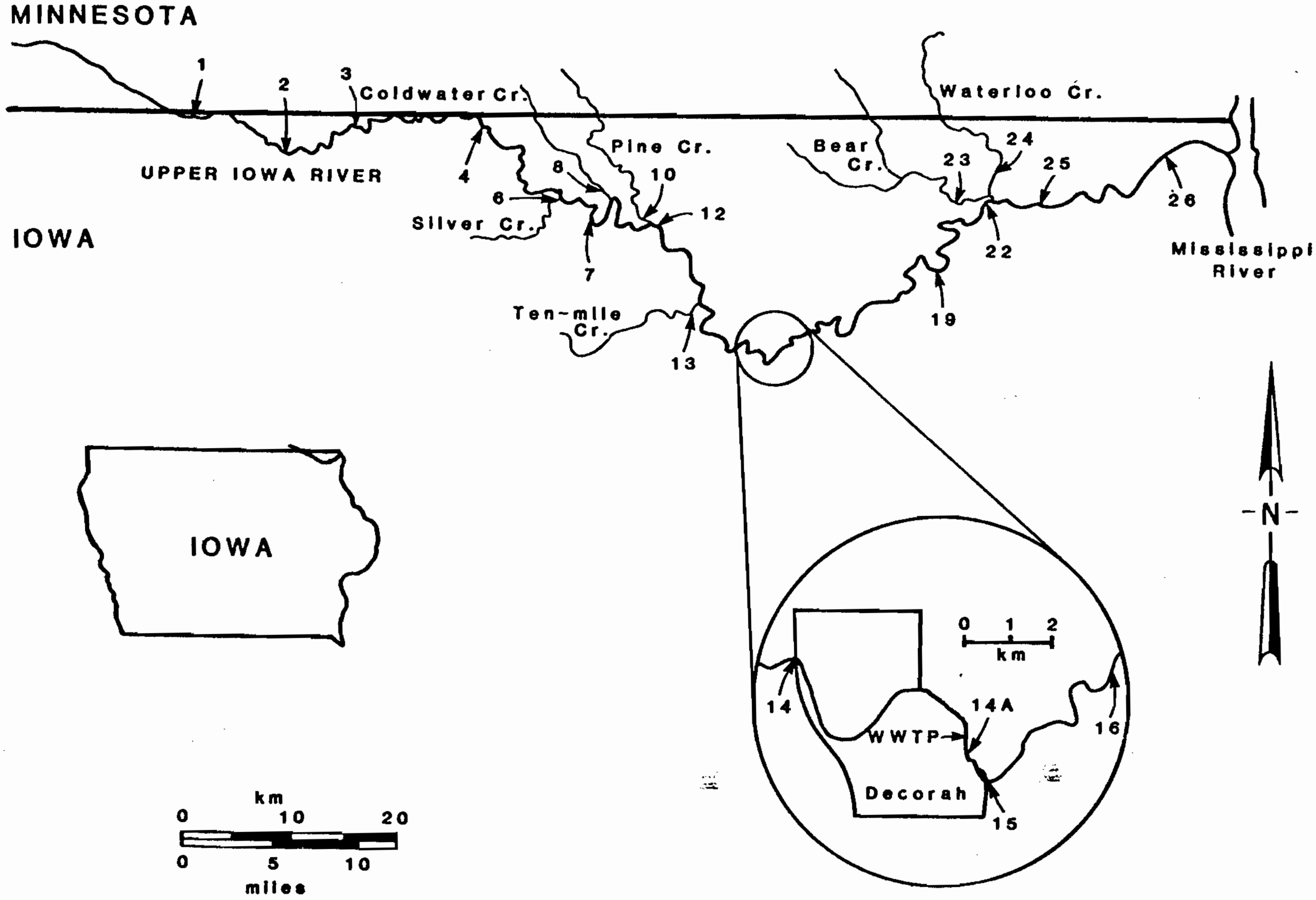

Fig. 1. Benthic Macroinvertebrate Sampling Locations in the Upper Iowa River Basin.

benthic macroinvertebrate studies as a part of water quality surveys on many Iowa streams. These include the Shellrock River (1977), the lower Cedar River (1978), Catfish Creek (1978), Maple River (1978), Bloody Run and Sny Magill Creeks (1978), Yellow River (1978), lower Des Moines River (1979), Little Turkey River (1980), Little Cedar River (1980), Crane Creek (1980), Buffalo Creek (1980), and Buck Creek (1980).

Comparisons of benthic macroinvertebrate data are difficult to make between different basins and studies. Each watershed has unique characteristics which influence the water quality and benthic macroinvertebrates. Such features include the climate, geology, land usage, and the size, number, and types of point source dischargers in a basin. Also, standard methods for the collection and identification of benthic macroinvertebrates do not exist. Collectors utilize a wide variety of methods to collect organisms, and each technique has its own sampling biases. The taxonomic level to which the benthic macroinvertebrates are identified and sources used in the identification varies among investigators. For these reasons, this paper will not attempt to compare the results found in this study to those of other benthic macroinvertebrate surveys.

During the spring and summer of 1980 the Limnology Section of the UHL conducted a detailed aquatic macroinvertebrate study in the Upper Iowa River basin. The major intentions of the survey were to document further the benthic macroinvertebrates of the Upper Iowa River basin and to establish some seasonal population shifts. A secondary purpose was to determine the effect of the metropolitan area of Decorah upon the river by examining any changes in the benthic macroinvertebrates within and downstream from Decorah.

MATERIALS AND METHODS

Benthic macroinvertebrates were collected from 14 Upper Iowa River mainstem locations and 6 tributaries during the period of 21-23 April 1980. Approximate sampling sites are shown in Figure 1. On 14-16 July 1980, a follow-up survey was conducted at the same locations, except for Silver Creek (Station 6) which was dry. Selection of the sampling locations and the numbering sequence were by the authors' preferences.

Two sampling approaches were utilized in attempting to obtain the most accurate, representative sample of the aquatic

Table 1. Percent distribution of major groups of benthic macroinvertebrates.

Station #	1	2	3	4	7	12	14	14A	15	16	19	22	25	26	x^1	6*	8	10	13	23	24	x^2	x^3
April																							
Diptera	84	22	49	27	34	31	33	34	42	54	40	59	45	39	*42*	89	88	45	73	39	72	*68*	*50*
Ephemeroptera	7	19	34	5	32	30	40	3	9	13	22	21	41	38	*23*	0	4	15	3	8	8	*6*	*18*
Trichoptera	5	16	12	66	22	30	17	52	36	30	34	17	12	18	*26*	<1	4	35	20	50	17	*21*	*25*
Other	3	43	4	2	11	9	9	11	13	3	4	3	2	6	*9*	11	4	5	4	4	3	*5*	*8*
July																							
Diptera	65	17	7	4	7	2	1	28	6	2	5	17	17	24	*14*	—	4	33	36	16	32	*24*	*17*
Ephemeroptera	35	32	15	35	54	20	44	16	67	72	32	52	37	64	41	—	21	25	4	5	3	*12*	*33*
Trichoptera	0	42	77	61	32	75	53	51	17	26	62	28	45	6	*41*	—	69	39	48	78	63	*59*	*46*
Other	0	9	1	1	7	3	2	6	10	<1	1	3	1	6	*4*	—	6	3	12	2	2	*5*	*4*

* no sample was collected from Station 6 in July
x^1 = mainstem average
x^2 = tributaries average
x^3 = basin average

macroinvertebrates present at each location. The 1st approach utilized the Surber sampler, which must be used where there is current, preferably in a riffle area of the stream. Since the samples are collected within a specific area of 0.093 sq m (m^2)-(1.0 sq ft) the Surber sampler provides a quantitative estimate of the benthic macroinvertebrates. During both the spring and summer surveys, 3 samples were taken at each sampling site. The collection location for each of the 3 samples was varied at each station to assure that different areas in the sampling location were sampled. Usually a sample was taken near each shoreline and near the middle of the stream.

Ideally the results from the Surber collections should reflect the actual benthic macroinvertebrate community at any suitable location. Unfortunately, several types of biases related to the use of the Surber can affect the results. The investigators took these biases into account and made all possible attempts to minimize them in the planning and conducting of the surveys. Each survey was performed under similar conditions, i.e. non-runoff, low-flow conditions. In addition, efforts were made to assure uniformity in all phases of the collection and identification of the benthic macroinvertebrates at each station and during each study to provide the most consistent results possible.

The 2nd sampling approach involved searching for benthic macroinvertebrates in habitats inaccessible to Surber sampling, which included hand picking benthic macroinvertebrates from natural substrates (i.e. large rocks and submerged logs). In addition, a kicknet was used to collect benthic macroinvertebrates in deep waters, in pooled areas and in vegetation at the stream edge. Neither of these methods provides quantitative results, but both add to the data base by collecting species which may not be collected by Surber sampling.

All samples were preserved in a 5% formalin solution and returned to the laboratory, where the benthic macroinvertebrates were keyed to the lowest practical taxa. Due to time and experience constraints, all chironomids and simuliids were identified no further than family. Sources used in the identification of the benthic macroinvertebrates include Bednarik and McCafferty (1979), Bergman and Hilsenhoff (1978), Brown (1972), Burks (1953), Edmunds, Jensen, and Berner (1976), Flowers and Hilsenhoff (1975), Harden and Mickel (1952), Hilsenhoff and Billmeyer (1973), Hiltunen and Klemm (1980), Klemm (1972), Lewis (1974), Morihara and McCafferty (1979), Needham and Westfall (1955), Pennak (1978), Ross (1944), Schuster and Etnier (1978), and Wiggins (1977). Samples of some of the identified macroinvertebrates were sent to authorities for verification and these are so indicated in Table 2.

RESULTS AND DISCUSSION

The mainstem Upper Iowa River sampling locations are separated from the tributary stations in Table 1 and Figures 2 and 3 for ease in data interpretation. Most of the following information, along with the raw sampling data and exact sampling locations, is also available from the University of Iowa Hygienic Laboratory as University Hygienic Laboratory report #81-32 (1981).

Spring

The benthic macroinvertebrate densities in April were low at Stations 1 and 2 (see Figure 2), probably due to poor substrate conditions. The bottom was mostly sand at Station 1, and sand and boulders at Station 2. Stations 3 and 4 showed the impact of the Lime Springs impoundment (just upstream from Station 3), with an increase in benthic macroinvertebrate densities, especially hydropsychid caddisflies. These results tend to support the conclusions of other authors (Merkley, 1978) that conditions downstream from an impoundment are similar to those downstream from a source of moderate organic pollution. While the retention time of the Lime Springs impoundment was low there was probably enough time to enable some phyto- and zooplankton production, which would form a food source for benthic macroinvertebrates downstream. In addition, the substrate at Stations 3 and 4 was more suitable for benthic macroinvertebrates than that found at the upstream stations. Station 7 had a lower density than the adjacent stations, probably due to poor substrate conditions (mostly loose gravel and sand). Station 12 had a high density of benthic macroinvertebrates almost evenly divided among mayfly, caddisfly, and dipteran larvae. The substrate at this station was excellent, with particle size ranging from fine sand to limestone slabs and velocities from 0 to 1 m/sec. The benthic macroinvertebrate density decreased within and dowstream from Decorah, with mayfly nymphs virtually absent at Stations 14A and 15. The benthic macroinvertebrates recovered by Station 16 and

Table 2. Aquatic macroinvertebrates collected from the Upper Iowa River basin, April and July 1980.

- Platyhelminthes
  - Turbellaria
    - Tricladida
      - *Dugesia* sp.
- Aschelminthes
  - Nematomorpha
    - Gordioidea
- Ectoprocta
  - Phylactolaemata
    - *Plumatella* sp.
- Annelida
  - Oligochaeta
    - Naididae
      - *Nais behningi*[a]
      - *N. bretscheri*[a]
      - *Ophidonais serpentina*[a]
      - unknown sp.
    - Tubificidae
      - *Limnodrilus claparedianus*[a]
      - *L. hoffmeisteri*[a]
      - *L. udekemianus*[a]
      - *Rhyacodrilus coccineus*[a]
      - unknown sp.
  - Hirudinea
    - Glossiphoniidae
      - *Placobdella multilineata*
      - *P. ornata*
    - Hirudidae
      - *Haemopsis marmorata*
    - Erpobdellidae
      - *Erpobdella punctata*
      - *E. triannulata*
      - unknown sp.
- Mollusca
  - Gastropoda
    - Pulmonata
      - *Ferrissia* sp.
      - *Helisoma* sp.
      - *Physa* sp.
  - Pelecypoda
    - Sphaeriidae
      - *Musculium* sp.
- Arthropoda
  - Arachnida
    - Hydracarina
  - Crustacea
    - Isopoda
      - *Asellus intermedius*
    - Amphipoda
      - *Gammarus pseudolimnaeus*
    - Decapoda
      - *Orconectes virilis*
      - *Orconectes* sp.
  - Insecta
    - Ephemeroptera
      - *Baetis brunneicolor*[b]

(Cont'd 2nd col.)

      - *B. phoebus*[b]
      - *B. vagans*[b]
      - *Baetis* sp.
      - *Baetisca bajkovi*
      - *B. laurentina*
      - *Brachycercus* sp.
      - *Caenis* sp.
      - *Callibaetis* sp.[b]
      - *Cloeon* sp.[b]
      - *Ephemerella aurivilli*[b]
      - *Ephemerella needhami*[b]
      - *Ephoron album*
      - *Heptagenia diabasia*[b]
      - *H. flavescens*[b]
      - *H. hebe*
      - H. sp. (near *juno*)[b]
      - *Isonychia* sp.
      - *Leptophlebia* sp.[b]
      - *Paraleptophlebia praepedita*
      - *Potamanthus* sp.
      - *Pseudocloeon* sp. (near *dubium*)[b]
      - P. sp. (near *punctiventris*)[b]
      - *Pseudocloeon* sp.
      - *Rithrogena* sp.[b]
      - *Stenacron minnetonka*[b]
      - *Stenonema exiguum*[b]
      - *S. femoratum*[b]
      - *S. mediopunctatum*[b]
      - *S. nepotellum*[b]
      - *S. pulchellum*[b]
      - *S. terminatum*[b]
      - *S. vicarium*[b]
      - *Stenonema* sp.
      - *Tricorythodes* sp.
    - Plecoptera
      - *Acroneuria lycorias*[b]
      - *Isoperla bilineata*[b]
      - *I. marlynia*[b]
      - *I. richardsoni*[b]
      - *Neophasganophora capitata*[b]
      - *Paragnetina media*[b]
      - *Perlinella drymo*[b]
      - *Pteronarcys* sp.
      - *Taeniopteryx parvula*
    - Odonata
      - Anisoptera
        - *Aeschna* sp. (near *sitchensis)*
        - *Boyeria vinosa*
        - *Gomphus crassus*
        - *G. spiniceps*
        - *Gomphus* sp.
        - *Ophiogomphus rupinsulensis*
      - Zygoptera
        - *Argia (apicalis* or *tibialis)*
        - *Argia* sp.
        - *Calopteryx aequabile*
        - *Hetaerina americana*
    - Megaloptera
      - *Corydalus cornutus*
      - *Sialis* sp.

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- Lepidoptera
  - *Paragyractis* sp.
- Trichoptera
  - *Brachycentrus americanus*
  - *Ceraclea maculata*
  - *Cheumatopsyche* sp.
  - *Chimarra aterrima*
  - *Glossosoma* sp.
  - *Hydropsyche cuanis*
  - *H. phalerata*[c]
  - *H. scalaris*[c]
  - *H. valanis*
  - *Hydroptila* sp. (near *ajax)*
  - *H. albicornis*
  - H. sp. (near *consimilis)*
  - H. sp. (near *hamata)*
  - *Nectopsyche candida*
  - *N. diarina*
  - *Polycentropus centralis*
  - *P. cinereus*
  - P. sp. (near *flavus)*
  - *Potamyia flava*
  - *Psychomyia flavida*
  - *Pycnopyche* sp.
  - *Symphitopsyche bifida* (gp)[c]
  - *S. morosa*[c]
  - *S. riola*[c]
  - *S. slossonae*[c]
  - *Symphitopsyche* sp.
- Hemiptera
  - Belostomatidae
    - *Belostoma* sp.
  - Corixidae
    - *Sigara* sp.
  - Gerridae
    - *Gerris* sp.
  - Veliidae
    - *Rhagovelia* sp.

- Coleoptera
  - Haliplidae
    - *Haliplus* sp.
    - *Peltodytes* sp.
  - Gyrinidae
    - *Dineutus* sp.
    - *Gyrinus* sp.

(Cont'd 2nd col.)

  - Dytiscidae
    - *Agabus* sp.
    - *Graphoderus* sp.
    - *Laccophilus* sp.
  - Hydrophilidae
    - *Berosus* sp.
    - *Helophorus* sp.
    - *Hydrochara* sp.
    - *Laccobius* sp.
    - *Paracymus* sp.
    - *Tropisternus ellipticus*
  - Dryopidae
    - *Helichus* sp.
  - Elmidae
    - *Ancyronyx variegata*[b]
    - *Dubiraphia vittata*
    - *Microcylloepus* sp. (near *pusillus)*
    - *Optioservus fastiditus*

- Diptera
  - Tipulidae
    - *Antocha* sp.
    - *Erioptera* sp.
    - *Hexatoma* sp.
    - *Limonia* sp.
    - *Tipula* sp.
  - Psychodidae
    - *Psychoda* sp.
  - Culicidae
    - *Anopheles* sp.
  - Simuliidae
  - Chironomidae
  - Ceratopogonidae
    - *Palpomyia* sp.
  - Stratiomyiidae
    - *Stratiomyia* sp.
  - Tabanidae
    - *Chrysops* sp.
  - Rhagionidae
    - *Atherix variegata*
  - Anthomyiidae
    - *Limnophora aequifrons*

their densities remained fairly constant to Station 26 near the mouth of the Upper Iowa River.

The 6 tributary stations had varying benthic macroinvertebrate densities (610/m² at Station 10 to 9,426/m² at Station 13) composed predominantly of dipteran larvae (the densities at the tributaries averaged 68%, versus 42% at the mainstem stations). The mayfly nymph densities showed a corresponding decrease at the tributary stations (6% versus 23% at the mainstem stations).

The spring collection was dominated by dipterans (see Figure 2), as half of all benthic macroinvertebrates collected were fly larvae (see Table 1). The dominant dipterans were chironomids (midge larvae). The 1978 USEPA survey found 26 types of midge larvae (USEPA, 1979). Although chironomids fit all categories of feeding behavior (Hart and Fuller, 1974), most of the larvae found in the Upper Iowa River by the USEPA were either omnivores or detritus feeders (USEPA, 1977). Thus, they may have been better able to utilize the large amounts of leaf litter trapped under the ice during winter than other benthic macroinvertebrates. Since most chironomids overwinter as larvae, they usually have higher densities in the spring than other types of aquatic insects which overwinter as eggs (Hart and Fuller, 1974). Other dipterans in this collection included simuliid larvae, a snipe fly larva (*Atherix variegata*), and a few genera of tipulid larvae.

The trichopteran larvae (the 2nd most dominant group collected)

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[a] - Verified by Dr. J. K. Hiltunen.

[b] - Verified by Dr. W. L. Hilsenhoff and Mr. B. H. Tracy.

[c] - Verified by Dr. G. A. Schuster.

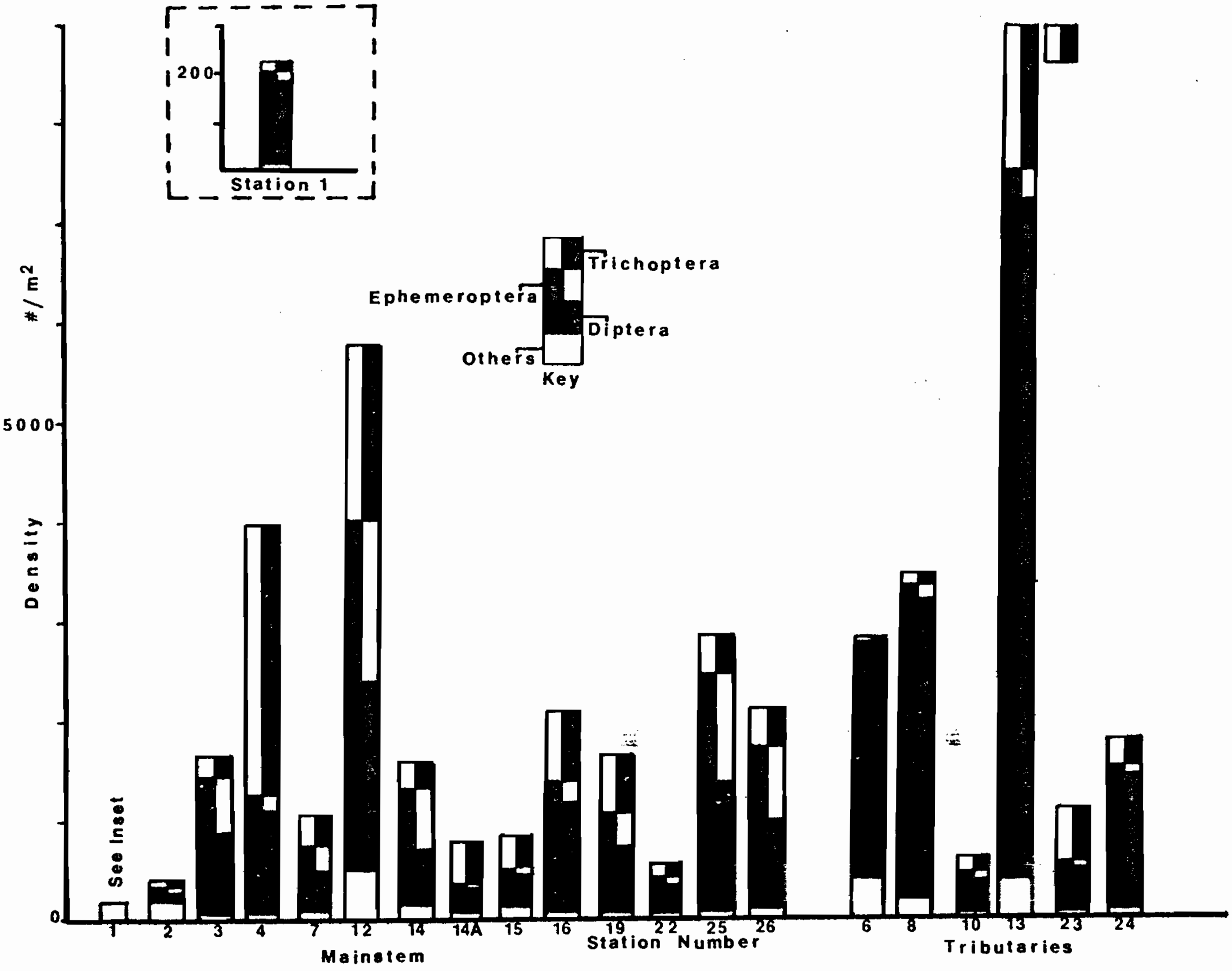

Fig. 2. Population Densities of Major Orders in the April 1980 Collections.

were almost evenly divided in abundance between *Cheumatopsyche* sp. and *Symphitopsyche bifida* (gp). Eleven other taxa were collected, primarily composed of other species of *Symphitopsyche* and *Hydropsyche*.

The mayfly nymphs were dominated by *Ephemerella needhami*, *Isonychia* sp., and *Potamanthus* sp. and 6 species of *Stenonema*. All the *Stenonema* species collected are scavenger feeders and were found at most stations throughout the basin. The principal species were *S. mediopunctatum* and *S. terminatum*. Another closely related mayfly, *Stenacron minnetonka*, was collected at 9 stations. One interesting trend noted was that several mayfly species were found only in the Upper Iowa River and not in any of its tributaries. The most notable absence from the tributaries was *E. needhami*, which had the highest density/station (166/m^2) of any nymph collected in April. Other mayfly genera not found in the tributaries were *Isonychia* sp., *Leptophlebia* sp., *Potamanthus* sp., and *Rithrogena* sp. *Leptophlebia* sp. was not collected in the Upper Iowa River in any of the Surber samples, but was found in the kicknet samples at 9 of the 14 mainstem stations. This genus has previously been collected in lakes and ponds and prefers a habitat with little or no current (USEPA, 1978).

Nine taxa of stonefly nymphs were collected in April, with *Isoperla bilineata* and *I. richardsoni* being the only species found in moderate density (Station 12 had 151 and 176 per m^2, respectively, as well as 4 other species of Plecoptera). The diversity of the stonefly fauna is somewhat surprising, since the 2 most recent Upper Iowa River biological surveys found only 1 stonefly nymph.

Other taxa commonly found in the April collection included an elmid beetle *Stenelmis crenata*, various types of oligochaetes, but especially *Limnodrilus hoffmeisteri* and *Rhyacodrilus coccineus*, an isopod *Asellus intermedius*, and a dragonfly nymph *Ophiogomphus rupinsulensis*.

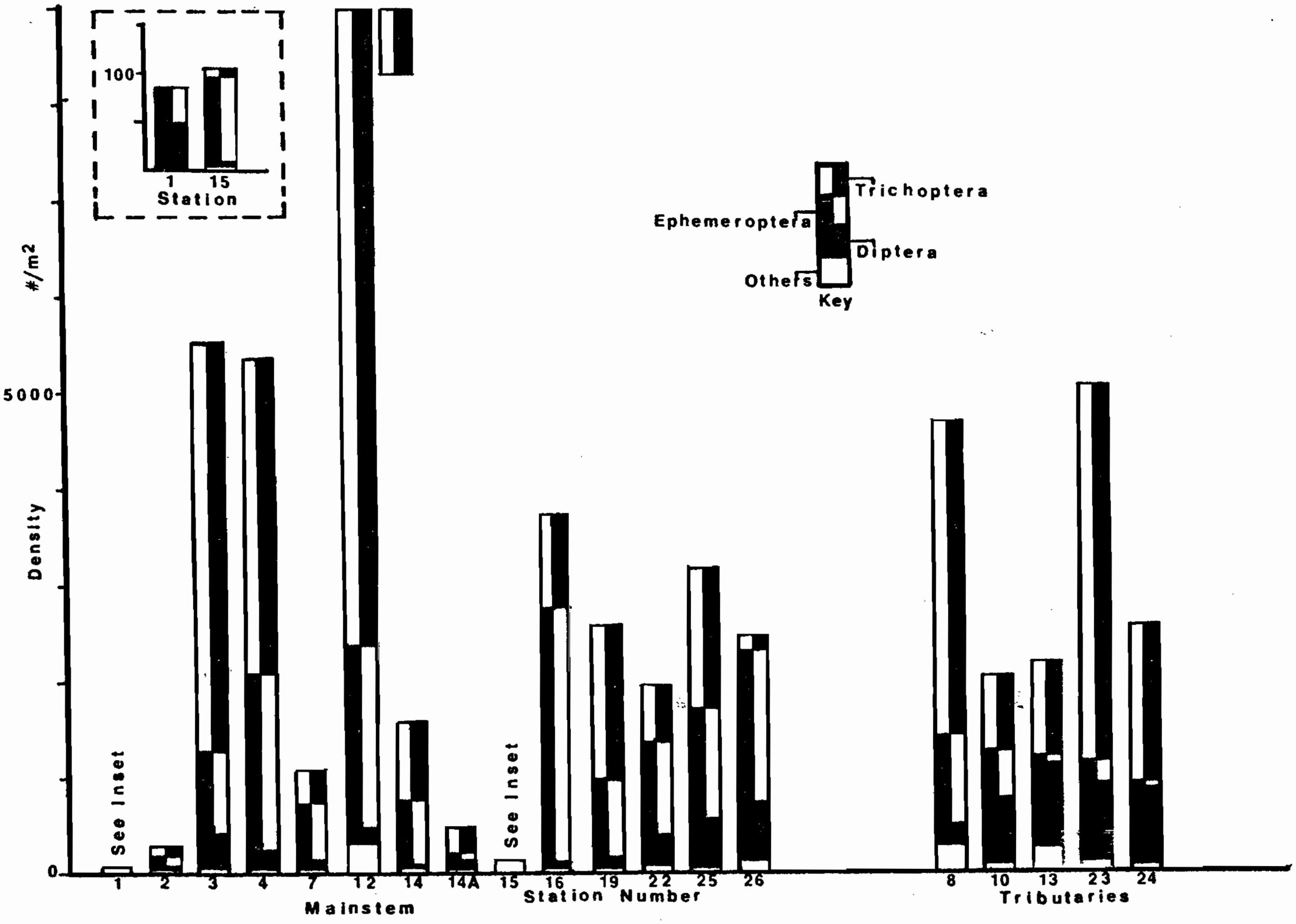

Fig. 3. Population Densities of Major Orders in the July 1980 Collections.

Summer

The benthic macroinvertebrate densities in July followed a pattern similar to that found in April (see Figure 3). Stations 1, 2, and 7 had low densities, probably due to poor substrate for benthic macroinvertebrate colonization. Stations 3 and 4 again reflected the impact of the Lime Springs impoundment. The summer phytoplankton surge in the impoundment caused an increase in benthic macroinvertebrate densities, especially in the filter feeders such as *Symphitopsyche bifida* (gp) and *Isonychia* sp., at these 2 stations. Station 12 had the highest benthic macroinvertebrate density found in this survey with 9,674 organisms/m². This spike was partially due to the excellent substrate for benthic macroinvertebrates at Station 12, which occurs at the end of a long pooled river reach. Another possible factor was the virtual absence of invertebrate predators in July. The April sample had large numbers of predaceous stonefly nymphs (approximately 340/m²). These nymphs may have exerted some pressure to limit densities of the benthic macroinvertebrates at Station 12. The stoneflies emerged between the sampling periods and the other benthic macroinvertebrates could expand without invertebrate predation. The density at Station 14 declined, with the loss of the tremendous numbers of filter feeders found upstream. Stations 14A and 15 showed a substantial decrease in densities of benthic macroinvertebrates (471 and 108/m², respectively) when compared to the average benthic macroinvertebrate density of 2,723/m² for the Upper Iowa River stations in July. These decreases may be attributed to a decline in water quality resulting from discharges in the Decorah metropolitan area (particularly the Decorah municipal wastewater treatment plant). The benthic macroinvertebrate densities had recovered by Station 16 and reflected unstressed conditions downstream to Station 26, near the mouth of the Upper Iowa River.

The benthic macroinvertebrate densities at the 5 tributary stations varied from 2,049/m² at Station 10 to 5,045/m² at Station 23. Stations 8 and 23 had elevated levels of filter feeding caddisfly larvae which dominated the densities and indicated the presence of large amounts of particulate organic matter in Coldwater and Bear Creeks, which the caddisfly larvae utilize as food. Coldwater Creek receives the input from Coldwater Spring approximately 0.8 km (0.5 mi) upstream from the sampling site. Water samples from the spring contained elevated levels of fecal coliform bacteria ranging from 900 to 65,000 bacteria/100 ml, indicative of groundwater contamination by surface sources (unpublished 1980 UHL data). This additional food source (bacteria) may have formed the basis for the increased density of caddisfly larvae at Station 8. Station 23, on Bear Creek, was just downstream from a cattle feeding operation. The cattle have access to the creek as it flows through the pastures and the increased particulate organic matter may be a result of cattle inputs to the stream. The results from Stations 8 and 23 agree with those of Scherpelz and Eckblad (1974) in that small feedlots for cattle act as sources of moderate organic enrichment. This enrichment promotes the growth of the filter feeding elements of the benthic community, but is not severe enough to cause water quality degradation.

The summer collection showed a distinct shift in dominance from the dipterans found in April to caddisfly larvae (see Table 1 and Figure 3). A total of 23 trichopteran taxa were collected from the Upper Iowa River basin in July (versus 13 taxa in April). Similar to the April collection, the major trichopteran taxa were *Cheumatopsyche* sp. and *Symphitopsyche bifida* (gp). However, their average densities increased substantially since the spring collection. The increase in trichopteran densities was most likely due to the summer increases in phytoplankton density, which forms the food source for most filter feeding caddisfly larvae. Caddisfly larvae commonly collected included *Hydropsyche scalaris*, *Symphitopsyche morosa*, *S. riola* and 3 species of *Hydroptila*. *S. riola* had an unusual distribution pattern in that it was virtually absent in the Upper Iowa River stations. Another species, *S. slossonae*, exhibited a similar trend to that of *S. riola* in that it was found primarily in the tributaries to the Upper Iowa River. *S. slossonae* always occurs in cold water situations and is likely restricted in Iowa to the "trout streams" of the northeastern corner of the state (Schuster and Etnier, 1978).

The mayfly nymph densities generally increased in the summer collection. They composed an average of 33% of the density at each station in contrast to 18% found in the spring (see Table 1). The number of taxa also increased to 29 in the summer as compared to 21 in the spring. The dominant mayfly nymphs were *Tricorythodes* sp. (especially at the downstream Upper Iowa River stations) and *Isonychia* sp. A distinct pattern was noted in the occurrences of most of the common genera from the summer collection. Although *Caenis* sp., *Cloeon* sp., *Ephoron album*, *Heptagenia* sp. (near *juno*), *Pseudocloeon* spp., and *S. terminatum* were common in the river, they were rare or totally absent at the 5 tributary stations. This uneven distribution reflects an ecological preference for larger bodies of water and slower current velocities. In fact, with the exceptions of *Baetis vagans* at Station 8 and 10 and *Isonychia* sp. at Station 10, mayfly nymphs were not abundant at any of the tributary stations.

The only other common taxa from the summer collection was the elmid beetle *Stenelmis*. Although the larvae can only be identified to genus, the adults were identified as *S. crenata* and *S. musgravei.*

A listing of the benthic macroinvertebrates found in the Upper Iowa River during the April and July surveys may be found in Table 2.

Seasonal Differences

The spring and summer collections yielded quite different organisms. Perhaps the most striking difference between the 2 collections was the number of stonefly nymphs collected in April. The 9 taxa collected in April composed the most numerous and diverse stonefly fauna collected in any Iowa basin by the UHL. The only stoneflies collected in July were 2 specimens of *Pteronarcys* sp., which was also the only stonefly numph found by the USEPA (USEPA, 1979).

The mayfly nymphs also exhibited marked differences between the April and July collections. The only mayflies common to both collections were *Isonychia* sp., *Stenonema* spp. and *Stenacron minnetonka*. The April collection had large numbers of nymphs of *Ephemerella aurivilli* and *E. needhami*, which emerged prior to the July collection. The summer collection had a much more diverse mayfly population, dominated by *Baetis* spp., *Pseudocloeon* spp., *Cloeon* sp., *Ephoron album*, and *Heptagenia* spp. with only *B. vagans* being found in April.

The caddisfly larvae seasonal differences were notable, except in the family Hydropsychidae. Although the densities of the species of *Hydropsyche*, *Symphitopsyche*, and *Cheumatopsyche* fluctuated to some extent, the distribution patterns of the spring and summer collections were similar. The summer caddisfly population was much more diverse with 23 taxa (compared to 13 found in the spring). The caddisfly larvae found only in the spring were *Polycentropus centralis* and *Hydroptila* sp. (near *hamata*). Some of the more uncommon summer caddisfly larvae were *Brachycentrus americanus*, *Ceraclea maculata*, *Chimarra aterrima*, *Glossosoma* sp., and *Nectopsyche candida.*

Another major seasonal difference occurred in the dipteran larvae, especially the midge larvae. As was previously discussed, the chironomids dominated the April collection comprising up to 84% of the total fauna at a station. The summer maximum was 65%, but many stations had less than 10% midge larvae (see Table 1).

Impact of Decorah

Four Upper Iowa River stations were sampled in and near Decorah in an effort to note any effects Decorah had upon the stream. As indicated in Figure 1, Station 14 was located just upstream from Decorah as a control station. Station 14A was approximately 100m downstream from the Decorah Wastewater Treatment Plant (WWTP). At this location, an island separates the river into east and west channels. The west channel carries the effluent from the WWTP in a plume along the western edge of this channel. Benthic macroinvertebrate sampling was conducted only in the west channel. One Surber sample was taken in the effluent plume, 1 in the edge of the plume in the middle of the channel and 1 in the eastern portion of the channel which was not affected by the effluent. Stations 15 and 16 were located roughly 1 and 5 km, respectively, downstream from the Decorah WWTP.

The results of both the spring and summer collections indicated that the Decorah area had a marked impact on the benthic macroinvertebrates of the Upper Iowa River. The extent of the impact may be noted in Figure 2 and especially Figure 3, in terms of the relative densities at the 4 stations. Upstream at Station 14, the collections yielded a benthic community that was relatively stable and unstressed. Total taxa in the April and July collections at this station were 22 and 30, respectively, with densities of nearly 1,600/m^2 during each sampling. At Station 14A, below the Decorah WWTP outfall, the total number of taxa collected (23 taxa in April and 24 taxa in July), was similar to those found at Station 14. However, a decrease in benthic macroinvertebrate densities was apparent. In April the density decreased to half (779/m^2) while in July an even greater decrease in density (471/m^2) was noted when compared to densities at Station 14. Mayflies were the major group most affected. Densities of mayflies at Station 14A were 23/m^2 in April and 77/m^2 in July, which is in sharp contrast to mayfly densities of 642 and 697/m^2 taken upstream at Station 14 in April and July, respectively. A large decrease in the caddisfly population also occurred in July, falling from 847/m^2 at Station 14 to 238/m^2 at Station 14A. In the April collection, caddisflies showed a small increase in densities from Station 14 to 14A (281-410/m^2).

The source of the overall decrease in benthic macroinvertebrate densities at Station 14A is believed to be the effluent from the Decorah WWTP. In addition, the effluent is also considered the cause for appearance of 2 undesirable aquatic organisms in the pd Stenacron

Upper Iowa River, *Psychoda* sp. (moth flies) and sewage fungus. The larvae and pupae of the more common species of *Psychoda* "usually occur in foul water, sewage, filter beds and decaying organic matter" (Pennak, 1978). During the April sampling, 29/m² and in July, 40/m² *Psychoda* sp. were collected at Station 14A. Although these densities were not great, the presence of *Psychoda* sp. in the benthic community at Station 14A was indicative of the organic input from the Decorah WWTP effluent into the river. The finding of sewage fungus at this sampling location was of a more serious nature. Sewage fungus has been described as "one of the most unsightly products of pollution" (Hynes, 1974). The main constituent of sewage fungus is not fungus, but is actually the sheath-bacterium, *Sphaerotilus* (Hynes, 1974). During the spring study, sewage fungus was present only sporadically on the substrate at Station 14A. At the time of the July study, the sewage fungus had covered the substrate in a thick, slimy growth. The sewage fungus was most common in the western portion of the west channel, in the Decorah WWTP effluent plume. The quantity of growth decreased toward the eastern portion of the channel, away from the plume. This was the only sampling location in the survey where sewage fungus was found.

At Station 15, benthic macroinvertebrate densities were low in both April and July (869/m² and 107/m², respectively) indicating that inputs from Decorah were adversely affecting the benthic macroinvertebrates for at least 1 km downstream from the Decorah WWTP. The very low density in the July collection is especially disturbing since this was the second lowest density obtained in the collections. The number and types of taxa at Station 15 in the summer were similar to those found elsewhere in the river, although, the respective densities were much lower. One factor partially responsible for the low densities was the generally poor substrate for Surber sampling encountered at Station 15. However, this substrate seemed adequate to support a greater benthic macroinvertebrate population than was obtained in the collections. Other sources which were believed to have contributed to the depressed benthic community were inputs into the Upper Iowa River from Decorah. If the effluents from Decorah were of a purely organic nature, then a benthic community that would utilize this material would be expected to be found downstream (i.e., large numbers of Chironomidae and Tubificidae). The results of this study do not indicate this type of community exists downstream from Decorah. Rather, a benthic community with a much lower than expected density was found, most notably in the July collections. One possible explanation for the observed low densities may have been the release of substances toxic to aquatic life into the Upper Iowa River from the Decorah area. There are, however, no known toxic wastes entering the river from Decorah (pers. comm., J. L. Rattenborg).

Station 16 was located about 4 km downstream from Station 15. At this station the benthic macroinvertebrates had recovered so that no adverse impacts from Decorah could be detected. Densities increased significantly at Station 16 with 2,121/m² collected in April and 3,725/m² collected in July; a 2.5 and 35 fold increase in densities when compared to densities taken at Station 15 in April and July, respectively. During the July collection, the number of taxa at Station 16 had increased to 36, compared to the 22 taxa collected from Station 15. It appeared from the data that the adverse effects of Decorah upon the water quality of the Upper Iowa River were limited to the river reach just downstream from Decorah.

The impacts from the Decorah WWTP were also noted by Eckblad (1974). Benthic macroinvertebrate samples collected upstream from the WWTP "showed a greater number of taxa, and a greater mean number per sample, than downstream samples." Mayfly nymphs collected upstream from the WWTP averaged 65.4 per sample, composed of 14 genera, compared to 27.8 per sample, composed of 10 genera collected downstream.

SUMMARY

The benthic macroinvertebrates of the Upper Iowa River basin generally reflected good water quality conditions. Exceptions occurred in and immediately downstream from the Decorah metropolitan area. The benthic macroinvertebrates collected at these stations (14A and 15) had lower densities than other Upper Iowa River stations. When coupled with the presence of such indicators of poor water quality as *Sphaerotilus* sp. and *Psychoda* sp., these factors indicate severe water quality degradation at Stations 14A and 15. Other exceptions to the good water quality conditions were reflected by the benthic macroinvertebrates collected from Ten-mile Creek (Station 13) in April, Coldwater Creek (Station 8) in July, and Bear Creek (Station 23) in July. These stations received inputs of large amounts of particulate organic matter from an unknown source(s). These inputs formed the food supply for large numbers of filter and detritus feeding benthic macroinvertebrates which were not present at other tributary stations.

The benthic macroinvertebrates in the Upper Iowa River basin differed between the April and July sampling periods. Although the densities and distributions of most caddisfly larvae were similar in April and July, the July collection had 13 taxa not found in April. The distribution and densities of almost all of the mayfly nymphs were different from April to July. Six of the 35 mayfly taxa were found only in April and 14 were found only in July. Stonefly nymphs were common in April (9 taxa) but virtually absent in July. Although dipteran larvae (especially Chironomidae) dominated the April collection, they composed only a minor part of the July collection. Most of the other insect orders (Megaloptera, Coleoptera, Lepidoptera, etc.) were more commonly found in the July sampling than in the April. The observed differences emphasize the importance of seasonal, repeated sample collections in benthic macroinvertebrate surveys.

ACKNOWLEDGEMENTS

The authors would like to thank Mr. Bret Purcell and Mr. Rick Hausler for their help in the collection and the preparation for identification of the benthic macroinvertebrates collected during this survey. A special note of thanks is to be given to Dr. J. K. Hiltunen, U.S. Fish and Wildlife Service; Dr. W. L. Hilsenhoff and Mr. B. H. Tracy, University of Wisconsin at Madison; and Dr. G. A. Schuster, Eastern Kentucky University for their verifications of specimen identifications. In addition, the authors are indebted to Dr. R. V. Bovbjerg, University of Iowa and Mr. J. O. Kennedy, University Hygienic Laboratory for their critical review of this manuscript. Finally, the authors thank the clerical staff of the University Hygienic Laboratory for their assistance in the preparation of this paper. This project was made possible through funding provided by the University Hygienic Laboratory, University of Iowa.

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