

COMPARISON OF THE PLANKTONIC DIATOM COMMUNITY AND NET DIATOM  
COMMUNITY OF *NEURECLIPSIS CREPUSCULARIS*

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*Abstract.* The caddisfly *Neureclipsis crepuscularis* (Polycentropodidae) filters the water column downstream of lake effluents. Although they are predaceous, algal communities commonly thrive on their nets. I analyzed the diatom communities in these nets on two branches of a river in northern Michigan, USA. The net community was compared to the local plankton community, and at least one taxon per site was significantly different ( $n=2$ ,  $p<0.05$ ), and the abundance of many other taxa was noticeably different. Shannon-Weiner species diversity indices supported the observed differences in taxa, and also gave an overall analysis of difference between the two study sites. The results do show a difference in diatom community composition, but we can only speculate about the mechanism of the difference. Behavioral considerations (i.e. gardening) are a possibility, but the difference can also be explained in terms of diatom morphology, net mesh size, and the ecology of the specific diatom flora. A lack of statistical power limited the thoroughness of the study, as most of the data indicated that more differences in taxa could exist. *Neureclipsis crepuscularis* nets have the potential to be important in lotic diatom community assessments and as bioindicators, and this unique phenomenon deserves further study.

## Introduction

Macroinvertebrates are among the most ubiquitous fauna in stream communities. Their role as a fundamental link in stream food webs between organic matter resources and fishes, along with their astonishing diversity, has made their study an integral part of stream ecology (Hynes 1970, Allen 1995, Hauer and Resh 1996). Among macroinvertebrate taxa, the caddisflies (Trichoptera) are one of the most diverse insect orders in freshwater environments, and have a worldwide distribution apart from Antarctica (Giller and Malmqvist 1998). The family Polycentropodidae constructs silken capture nets in a variety of designs to filter food from the water column (Allan 1995). A prominent genus of this family is *Neureclipsis*, who constructs trumpet-shaped nets in slower lake-outlet streams in holarctic regions (Richardson 1984). Gut analyses and a variety of prey-selection experiments have revealed that they are mainly predaceous, feeding on planktonic crustaceans, insects, and miniscule amounts of algae and coarse detritus (Richardson 1984, Petersen et al. 1984). However, the feeding method (filtering the water column) and behavior of *Neureclipsis* spp. displays relatively unspecialized food selection, and is considered a generalist predator (Petersen et al. 1984). Among other constraints (e.g. flow velocity, substrate), the availability and abundance of prey is perhaps the most important factor governing the distribution of *Neureclipsis* spp. to lake outlets (Otto 1984, Richardson 1984, Petersen et al. 1984).

In addition to silk and detritus, algae are a main component of *Neureclipsis* nets. Stream algae are mostly on the benthos, comprising a large component of periphyton. The vast majority of lotic algae are diatoms, as they dominate riffles in eutrophic streams and virtually all microhabitats in oligotrophic streams (Biggs 1996). Although benthic algae are considered to be the main energy source for higher trophic levels in unshaded temperate streams (Biggs 1996),

algae in the water column may be important in reaches close to lake outlets. The ultimate source of algae in *Neureclipsis* spp. nets is therefore worthy of investigation. *Neureclipsis* spp. could passively let algae build up in its net, or there could be a difference in the net algal community compared to the algae in the water column. I hypothesize that the diatom community composition in *Neureclipsis* nets will differ from the ambient planktonic diatom community. Specifically, between two sites: (a) the diatom community will differ between the nets and plankton within each respective site; (b) the planktonic diatom community will differ between the two sites; and (c) the net algal community will differ between the two sites.

### Methods

The study took place *in situ* on the East and Main Branches of the Maple River in Emmet County, Michigan, USA. The East Branch drains Douglas Lake, a meso-to-oligotrophic temperate lake. Lake Kathleen is a reservoir that forms from the confluence of the East and West Branches of the Maple River. The epilimnion of Lake Kathleen drains over a dam to form the Main Branch of the Maple River, which meanders its way to Burt Lake.

One site was sampled on the East Branch, and one on the Main Branch. *Neureclipsis* spp. distribution is limited, but when they are found it is in relatively high densities. Consequently, samples were taken within the same microhabitat (< 1m apart) to assure habitat homogeneity; and between the two sites, physical parameters were kept as similar as possible. Nets were collected at each site into Whirl Packs<sup>®</sup> by removing the entire portion of substratum on which the net was attached (a macrophyte in this case). Plankton was collected with a number 20 plankton net directly upstream of the nets (< 3m upstream). N=2 for nets and plankton at each site, respectively.

Samples were immediately taken to the lab for processing. The caddisfly was removed from the net and preserved in 70% ethanol. Each net was homogenized and 75 ml was set aside for diatom analysis. The nets were chemically oxidized of all organic material, and permanent diatom mounts were made following the procedure outlined by Van Der Werff (1955).

The relative abundance of diatom taxa was determined by counting 300 diatom individuals per replicate on a light microscope under oil immersion (1000x). Counting was done in random transects by moving only along the x-axis of the stage. Each individual was identified to species when possible.

Statistical analysis was conducted using Analysis of Variance (ANOVA) to find significant differences between taxa per site. Additionally, Shannon-Weiner species diversity indices were calculated for each site to compare species diversity between sites.

## Results

In each net, the caddisfly was removed and identified as *Neureclipsis crepuscularis*.

Figure 1 clearly shows that several taxa (*Fragilaria capucina*, *Melosira sp. A*, *Navicula cryptotenella*, and *Navicula sp. K*) are more abundant in the plankton of the East Maple River than in the nets of *N. crepuscularis*. Conversely, *Navicula trivialis*, *Navicula capitata*, *Navicula gastrum*, and *Martyana sp. A* are all more abundant in *N. crepuscularis* nets than in the plankton. However, only one taxon, *Fragilaria capucina*, was significantly different between the two sites ( $p < 0.05$ ).

The relative abundance of certain taxa in the Maple River plankton and the net of *N. crepuscularis* in the Maple River are shown in Figure 2. *Fragilaria sp. A*, and *Achnanthydium minutissima* were more abundant in the plankton than in the nets; meanwhile, *Navicula*

*menisculus*, *Cocconeis placentula*, *Diatoma sp. C*, and *Meridion circulare* were all more abundant in the nets than in the plankton. Of these taxa, only *Fragilaria sp. A* was significantly different between the two sites ( $p < 0.05$ ).

Figure 3 compares the relative abundances of certain planktonic taxa between the East and main branches of the Maple River. *Fragilaria sp. A*, *Aulacoseira sp. A*, *Navicula menisculus*, *Navicula porifera var. opportuna*, and *Diatoma sp. D* were all more abundant in the plankton of the Main Branch of the Maple River. *Cocconeis pediculus*, *Cocconeis placentula*, *Melosira sp. A*, and *Cyclotella cemensis* were all more abundant in the plankton of the East Maple River than in the Main Branch of the Maple River. Of these taxa, *Fragilaria sp. A* and *Aulacoseira sp. A* were significantly more abundant in the Main Branch ( $p < 0.05$  for each), and *Cocconeis pediculus* and *Cocconeis placentula* were significantly more abundant on the East Branch ( $p < 0.05$  for each).

The relative abundance of taxa in *N. crepuscularis* nets is compared between the East and Main Branches of the Maple River in Figure 4. *Fragilaria sp. A*, *Aulacoseira sp. A*, *Navicula menisculus*, *Diatoma sp. D*, and *Melosira sp. A* were noticeably more abundant on the Main Branch than on the East Branch. *Cocconeis pediculus*, *Cocconeis placentula*, *Cyclotella cemensis*, and *Navicula trivialis* were each noticeably more abundant on the East Branch than on the Main Branch. *Fragilaria sp. A* and *Aulacoseira sp. A* were both significantly more abundant on the Main Branch ( $p < 0.05$  for each), and *Cocconeis pediculus* and *Cocconeis placentula* were significantly more abundant on the East Branch ( $p < 0.05$  for each).

Figure 5 displays the Shannon-Weiner species diversity indices at the four sites of interest. The specific values of each index are tabulated in Table 1. This table compares the index values according to the questions of interest. The first comparison shows that the plankton

in the East Maple River is slightly more diverse than the diatom community in *N. crepuscularis* nets. The data shows that the diatom community in *N. crepuscularis* nets in the Maple River is more diverse than the community in the plankton. This table also shows that *N. crepuscularis* nets in the Maple River are more diverse than those in the East Maple River. Further, the plankton in the Maple River is more diverse than the plankton in the East Maple River.

The percent of community composition for the five most abundant taxa is displayed in Figure 6. The change in relative composition between each site is clearly seen in this chart, with these taxa generally decreasing in percent composition from the E. Maple River net, to the E. Maple River plankton. A large decrease occurs in the Maple River nets, but it then slightly increases in the Maple River plankton.

### Discussion

On the E. Maple River, the significant difference in abundance of *Fragilaria capucina* (Fig.1) shows that there is some difference in the diatom community between the net and plankton. Even so, it is possible that the rest of the taxa could be statistically significant if more replicates were performed. With such a low degree of freedom ( $n=2$ ,  $df=1$ ), statistical power was lacking.

When comparing the Shannon-Weiner species diversity indices, the slight difference could also result from weak statistical power. The ecology of this diatom species should be considered in the context of this investigation as well. *F. capucina* is found mainly in eutrophic, lentic habitats, where it is mainly a part of the periphyton or tychoplankton communities (Lowe 1974, Jorgensen 1952). With these descriptors, this taxon seems out of place in the E. Maple River. Even if we consider Douglas Lake, the source of the E. Maple River, we find a meso-to-

oligotrophic lake, which should not have a eutrophic species such as *F. capucina*. However, we cannot rule-out its presence in Douglas Lake since sampling was not conducted in the lake for this investigation, which in this case would be most useful. Alternatively, a nutrient input (e.g. septic effluent) into the E. Maple River could explain the presence of this eutrophic species within the actual river. Further investigation into the range and source of *F. capucina* would help to better explain its ecology.

Only *Fragilaria sp. A* was statistically different when comparing taxa in the nets and plankton of the Maple River (Fig.2). This positively supports the hypothesis that a difference in community composition occurs between *N. crepuscularis* nets and the ambient plankton; in this case, *Fragilaria sp. A* is more prevalent in the Maple River plankton than in the nets of *N. crepuscularis*. Although only one taxon is significantly different, Figure 2 does show noticeable differences between other taxa in this comparison. These differences should not be ignored; and, again, insufficient statistical power could limit our analysis. However, a sizable disparity exists between the Shannon-Weiner species diversity values for these sites, which is a powerful indicator of the difference. Further, the presence of *Fragilaria sp. A* itself should be considered. This genus is predominantly lentic (Kingston 2003), and its presence in a lotic environment could be explained in a number of ways. *Fragilaria sp. A* could be present in Lake Kathleen, and it therefore could make its way downstream into the Maple River as the epilimnion of Lake Kathleen forms the main branch. Alternatively, *Fragilaria sp. A* could exploit any pseudo-lentic microhabitat in the Maple River, such as a large pool on the river margin.

Comparing plankton and net diatom communities between sites can help in understanding whether or not *N. crepuscularis* nets have different algal communities. If differences exist between the plankton communities at each site, we would expect the nets to

mirror that difference. In Figure 3, it is clear that *Fragilaria sp. A* and *Aulacoseira sp. A* were significantly more abundant in the Maple River than in the E. Maple River; and *Cocconeis placentula* and *Cocconeis pediculus* were significantly more abundant in the E. Maple River than in the Maple River. This means that the plankton communities of the E. Maple River and Maple River are fairly different. If the net communities between the East and main branches also differ in the same respect, then we can assume that *N. crepuscularis* is utilizing only the specific taxa present at each site. The data supports this idea. The same taxa, *Fragilaria sp. A*, *Aulacoseira sp. A*, *Cocconeis placentula*, and *Cocconeis pediculus* are more abundant in the nets at their respective sites (Fig. 4). This suggests that *N. crepuscularis* does not collect the same exact taxa regardless of its location and the ambient plankton community. Rather, it collects certain taxa in different abundances based on the local plankton community composition.

A number of phenomena could explain the observed differences in diatom community composition between the nets and plankton at each site. The behavior of *N. crepuscularis* could cause the difference. For example, the net could be mended to remove *F. capucina* or *Fragilaria sp. A*. Net dimensions are closely correlated with flow velocity (Petersen et al. 1984, Keilty 1980), so any diatom that unfavorably enlarges the net could be removed by *N. crepuscularis*. Feeding behavior could be the possible mechanism as well. *N. crepuscularis* could "garden" the net with a diatom community to lure prey into its net. However, simpler explanations exist for the different diatom community. The mesh size of the net could limit diatoms of certain morphologies from passing through it. However, noticeable size and morphological differences of diatoms between the nets and plankton were not conspicuously observed (TB, personal observation). Another suggested explanation revolves around habitat preferences of the significantly different diatoms. *Fragilaria capucina* is planktonic, and therefore would be rare



on attached substrata. Nets of *N. crepuscularis* are, categorically, substrata, and therefore diatoms with preferences for substrata should adhere to them. However, since *Fragilaria sp. A* was not identified to species, we cannot comment on its substratum preference (or lack thereof). Identifying this diatom to species would be immensely helpful in suggesting a possible mechanism in this investigation.

The results of this experiment broadly confirm the hypotheses, since the diatom flora differed between (1) the nets and plankton for the two sites, (2) the plankton between the two sites, and (3) the nets between the two sites. Although the statistical power was limited, the differences found do agree with previous studies. Foged (1952) first described the diatom community of *Neureclipsis bimaculata* nets in Sweden, and subsequently found that *Neureclipsis* spp. nets are good indicators of the stream diatom community. In fact, these nets seemed to provide the most representative sample of diatom fauna than any other single sampling site in streams (Foged 1952). Thus, *Neureclipsis* spp. nets are important in evaluating overall stream diatom community structure, diversity, and health; their potential use as a bioindicator should also be considered. The different diatom community structure in the nets of *Neureclipsis crepuscularis* poses an interesting ecological question, and has the potential as an important environmental assessment tool. Further investigation into this phenomenon should be done to reveal the mechanism underlying the different diatom community structure in the nets of this caddisfly.

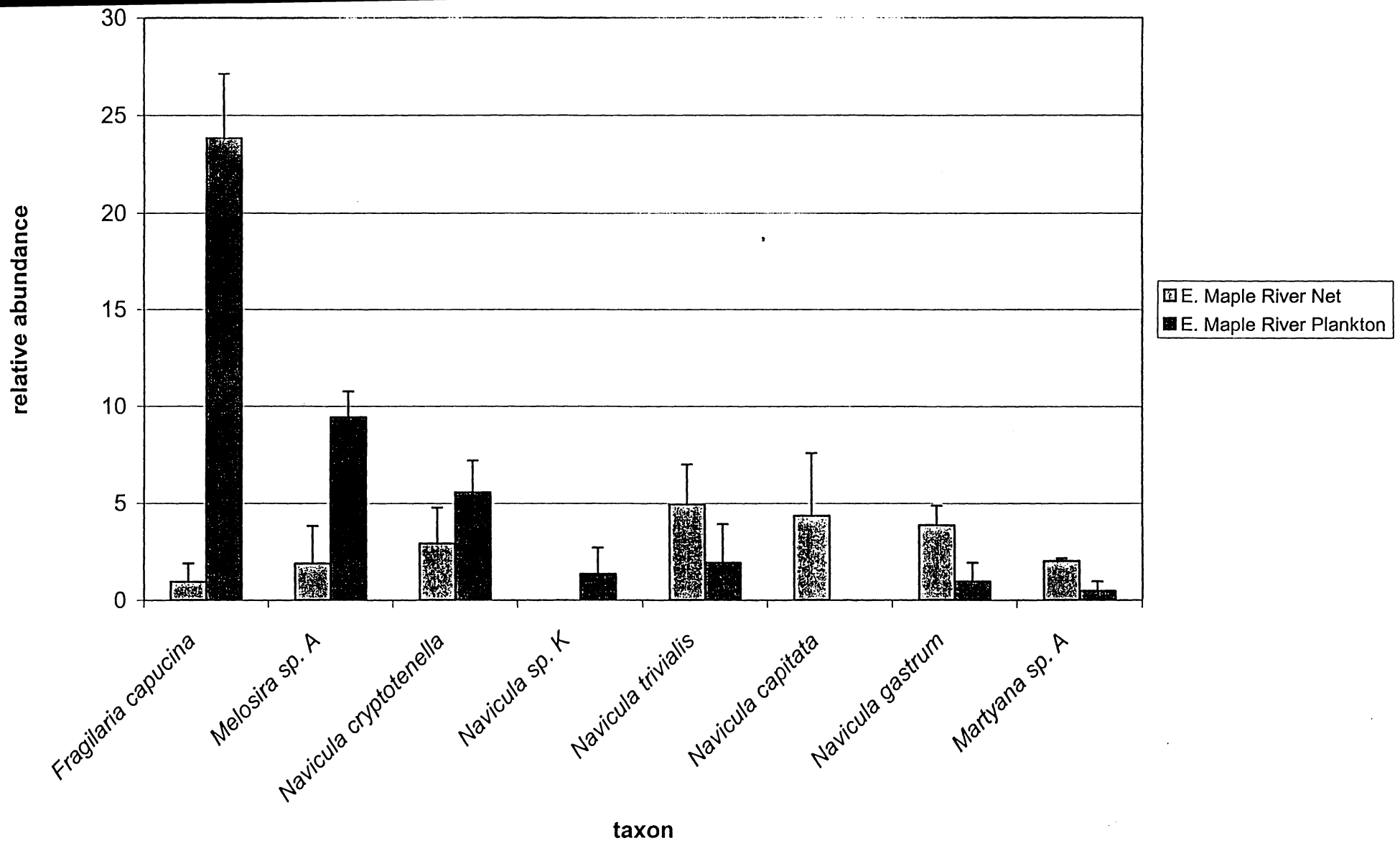


Fig.1. Relative abundances of taxa between *N. crepuscularis* nets and plankton on the East Maple River. *Fragilaria capucina* is statistically significant ( $p < 0.05$ ).

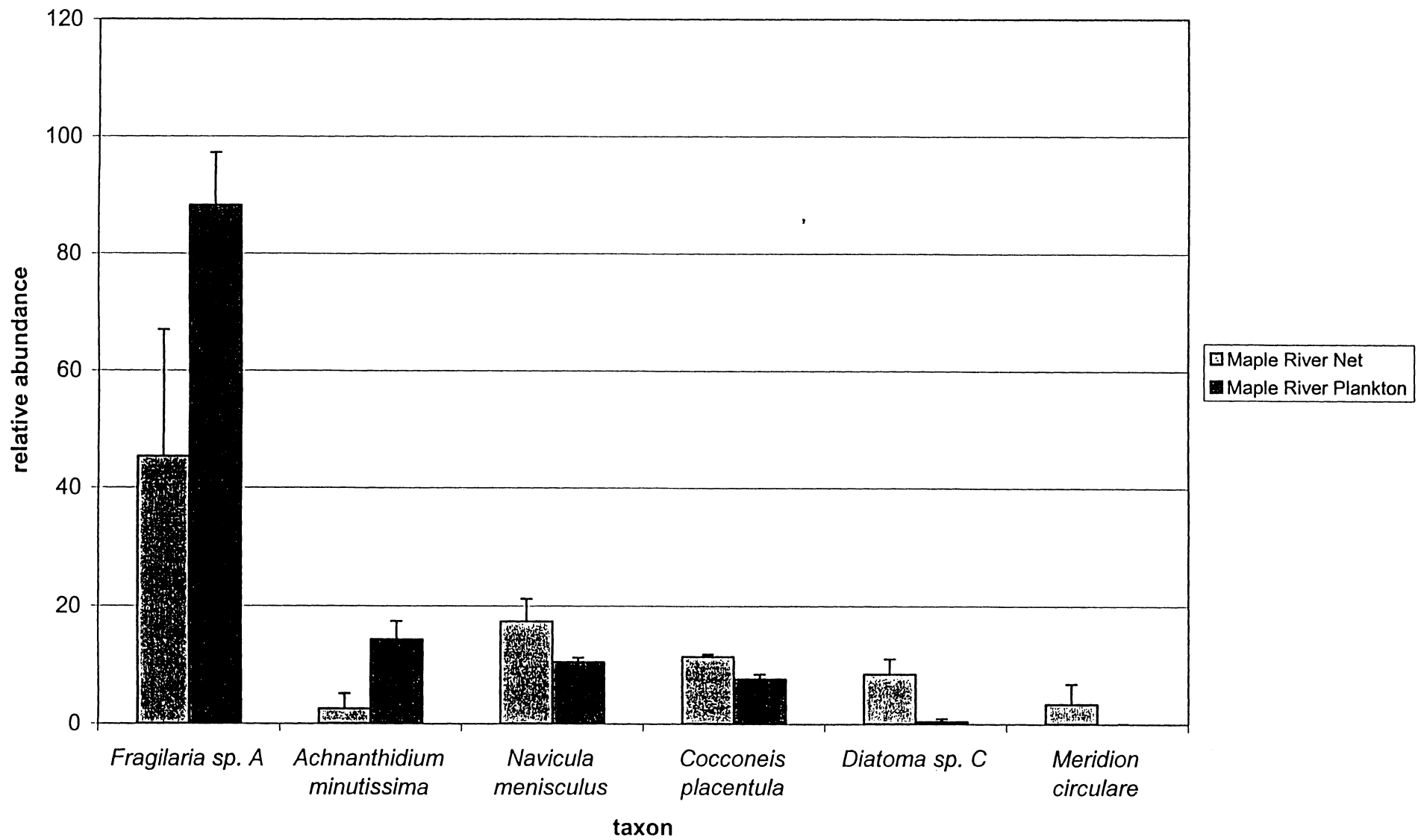


Fig. 2. Relative abundances of taxa between *N. crepuscularis* nets and plankton on the Maple River. *Fragilaria sp. A* is statistically significant ( $p < 0.05$ ).

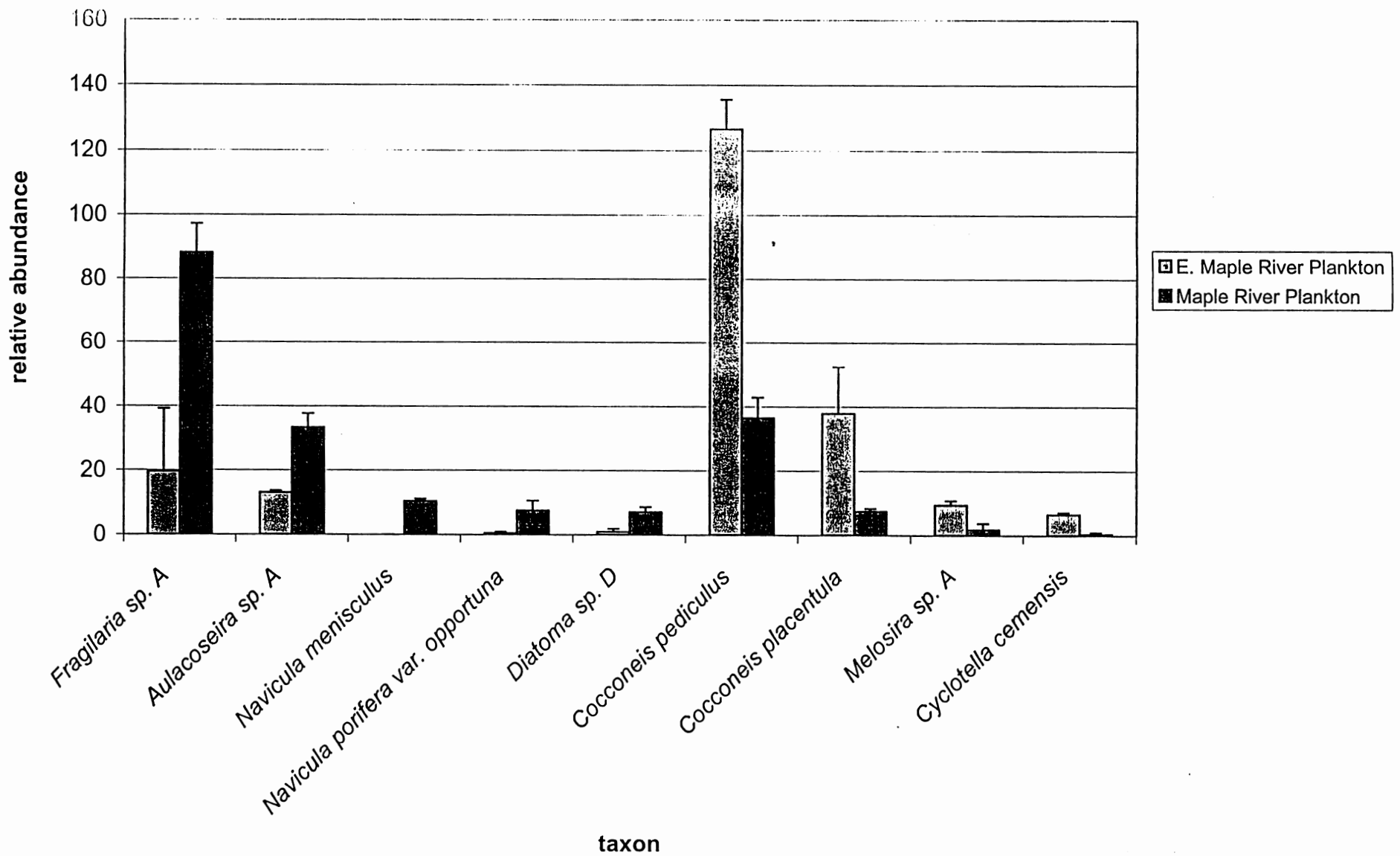


Fig. 3. Relative abundances of taxa between the plankton of the East Maple River and Maple River. *Fragilaria sp. A*, *Aulacoseira sp. A*, *Cocconeis pediculus*, and *Cocconeis placentula* are statistically significant ( $p < 0.05$ ).

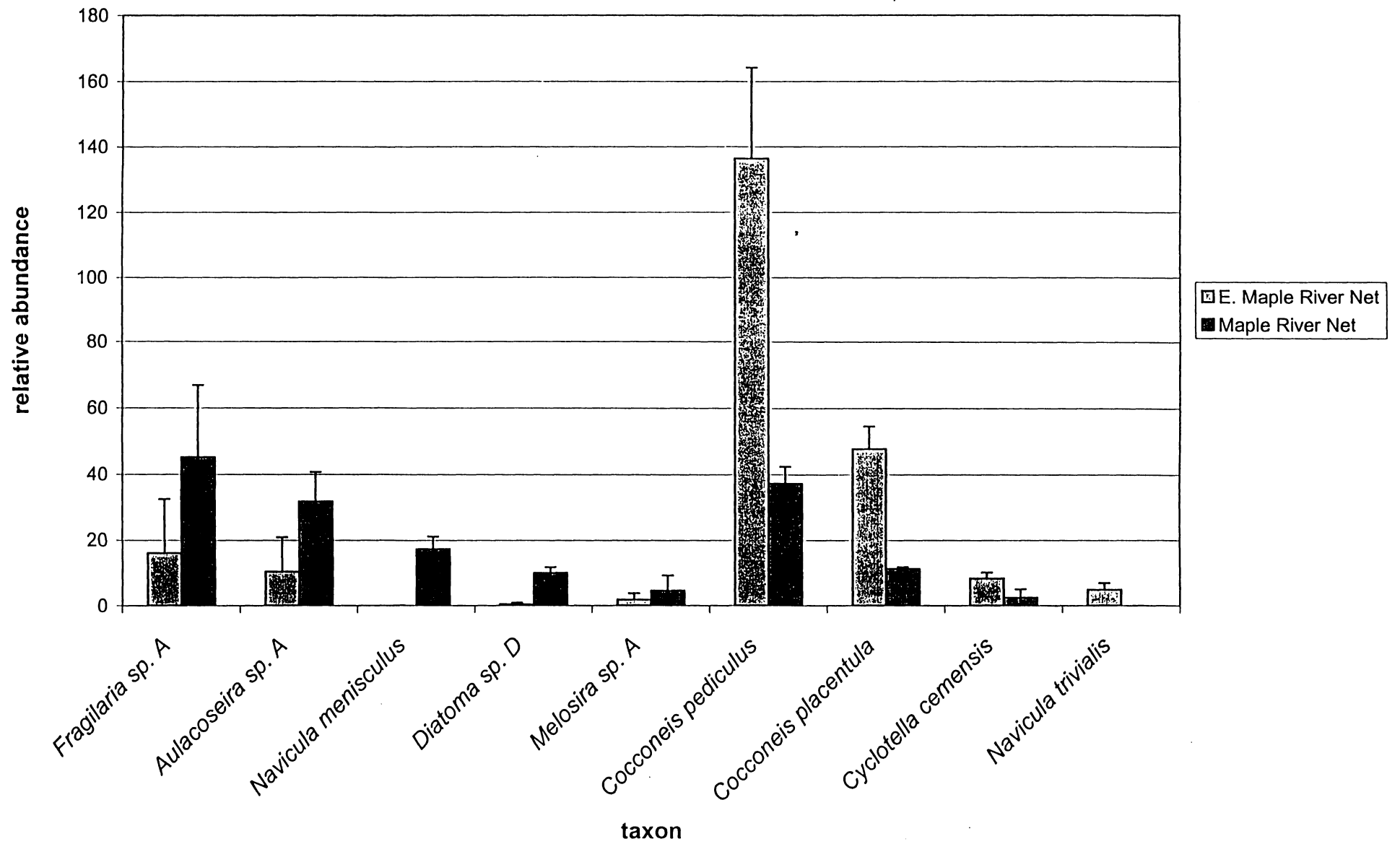


Fig. 4. Relative abundances of taxa between *N. crepuscularis* nets on the East Maple River and Maple River. *Fragilaria sp. A*, *Aulacoseira sp. A*, *Cocconeis pediculus*, and *Cocconeis placentula* are statistically significant ( $p < 0.05$ ).

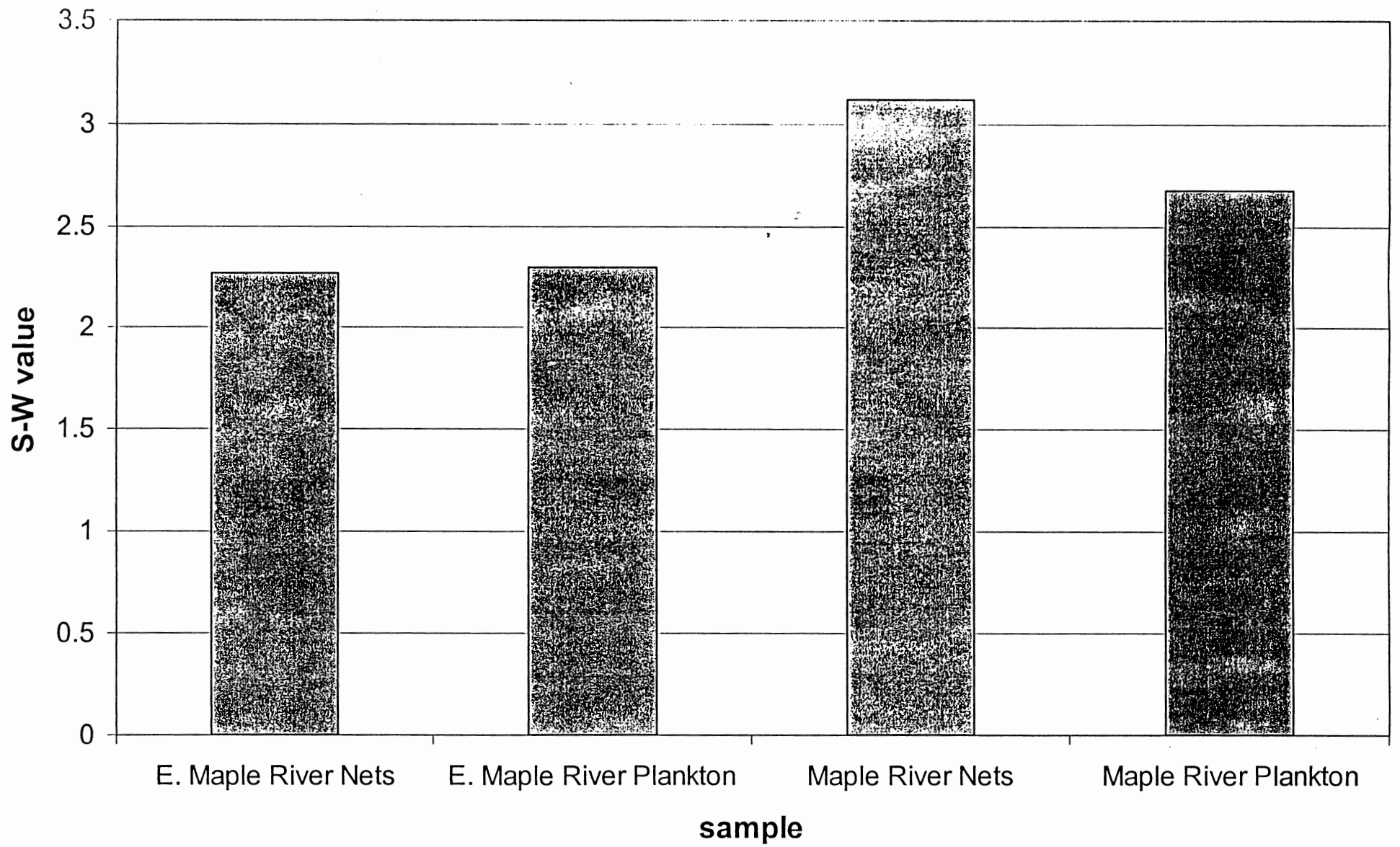


Fig. 5. Shannon-Weiner species diversity indices for each site (n=2).

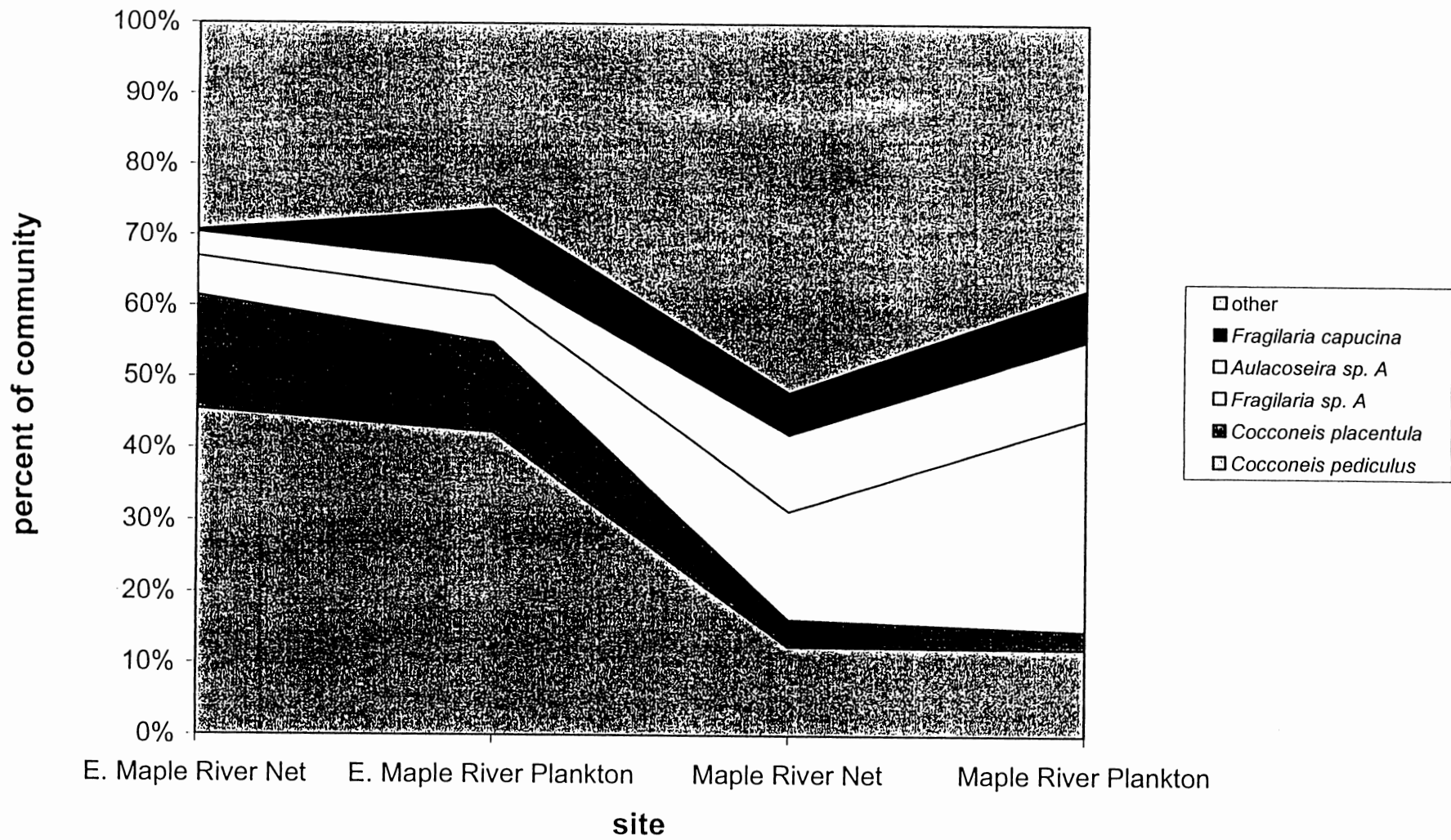


Fig. 6. The change in percent community composition of five abundant taxa between each site (n=2).

Table 1. Comparison of Shannon-Weiner species diversity indices for tested hypotheses.

S-W Value	E. Maple River Nets 2.2703608	<	E. Maple River Plankton 2.2965437
S-W Value	Maple River Nets 3.1204409	>	Maple River Plankton 2.6762941
S-W Value	E. Maple River Nets 2.2703608	<	Maple River Nets 3.1204409
S-W Value	E. Maple River Plankton 2.2965437	<	Maple River Plankton 2.6762941



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