Qualitative and quantitative benthic macroinvertebrate samplers in Cerrado streams: a comparative approach.

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ABSTRACT: Qualitative and quantitative benthic macroinvertebrate samplers in Cerrado streams: a comparative approach. Biomonitoring rapid protocols with qualitative samplers, often large-meshed, are widely used in benthic macroinvertebrates sampling, reducing time, costs and effort. In this work, we compared the efficiency of qualitative and quantitative samplers. The results show that large-meshed qualitative samplers are less efficient in detecting some taxa. Despite their advantages in finding rare species and getting quick results, those samplers should be used cautiously by researchers working with biomonitoring, taxonomic assessment or in defining priority areas for conservation.
Key-words: Surber; hand net; benthos.

RESUMO: Amostradores qualitativos e quantitativos de macroinvertebrados bentônicos em córregos do Cerrado: uma abordagem comparativa. Protocolos de biomonitoramento rápido utilizando amostradores qualitativos, muitas vezes de malha larga, são cada vez mais utilizados com intuito de amostrar macroinvertebrados bentônicos, reduzindo tempo, custo e esforço. Neste trabalho foi comparada a eficiência de amostradores qualitativos e quantitativos. Os resultados demonstraram que amostradores qualitativos de malha larga são menos eficientes para detecção de certos taxa. Apesar de apresentarem vantagens como rapidez de resultados e detecção de espécies raras, a escolha destes amostradores por pesquisadores em trabalhos de biomonitoramento, definição de áreas prioritárias para a conservação ou levantamento taxonômico deve ser feita com cautela.
Palavras-chave: Surber, rede de mão, bentos.

Introduction

Rapid assessment protocols, aimed at higher cost-benefit tradeoff between number of samples and sampling effort, are currently widely used in aquatic macroinvertebrate studies (Buss et al., 2003). Among the several characteristics of these protocols that reduce the time and effort spent are: the smaller number of replicates and sampled habitats; the usage of qualitative samplers, reducing sampling time; and the identification of sampled specimens only to family level (Resh & Jackson, 1993).

Qualitatively sampling benthic macroinvertebrate communities is actually a rather easy task, given the well developed methodology and the typically simple-to-use equipment (Hellawell, 1986), which often include large-meshed nets, since those apparently are not a problem (Resh & Jackson, 1993). These sampling techniques are frequently used in projects searching for priority conservational areas (AQUARAP), as in biomonitoring protocols (Barbour et al., 1999).

Benthic macroinvertebrates are extensively used in water quality biomonitoring studies (Junqueira et al., 2000), a preference due to some characteristics: sedentary nature; long life cycles; and the high sensitivity to different levels of pollution, which provides a broad variety of responses to environmental contamination (Hellawell, 1986; Rosenberg & Resh, 1993).

Several stream water quality metrics are currently used, such as: richness measures (e.g., total richness and EPT richness – Ephemeroptera, Plecoptera and Trichoptera), enumerations (e.g., number of specimens of a given Order), diversity measures (e.g., Shannon-Wiener), similarity indices (e.g., Sorensen index), biotic indices (e.g., BMWP, BMWP/ASPT) and functional measure indices (e.g., proportion between shredders and scrapers-collectors) (Resh & Jackson, 1993).

In this work we compared the results of sampling benthic macroinvertebrates with Surber sampler (quantitative) and hand-net (qualitative). We considered as a null hypothesis that both samplers are equally efficient in estimating taxa richness and water quality.

Methodology

Study area

This work was carried out in two sites at streams from the Rio das Almas' watershed, in Pirenópolis, GO (15° 51´ S e 48° 57´W), in October 2003 (during the transition between the dry and wet season). This river, one of the major affluents of Tocantins River, runs through Serra dos Pireneus, in the Brazilian Cerrado region. The area contains several streams descending steep slopes with stony and sandy beds. The climate, Aw following Köppen's classification, is characterized by a wet season during summer (December to February), and a dry season (May to September) (Nimer, 1989).

Data collection

We established two sampling sites, one of them of 4th order, at Rio das Almas, and the other in one of its affluents, Córrego do Inferno (3rd order). At each site, six points set in riffles areas roughly 500 meters apart from each other were selected, and the two samplers (Surber and hand-net) were used in each of them.

At each point, three sub-samples of a 0.225 mm meshed Surber (with a 0.1 m² area) were taken, totalizing a 0.3 m² area. Samples were stored in plastic flasks with 5% formalin. This material was later sorted in the laboratory, with stereomicroscope Olympus CZ 4045.

Two different techniques were performed in each point when using the hand net (a 18 cm diameter net, approximately 1mm meshed). In the first one (called here Net 15), 15 uninterrupted minutes were used for both collecting and separating the specimens from the substratum. In the second one (Net 05), on the other hand, the bottom was revolved during five intervals of one minute, and the collected organisms were separated after each interval. All organisms were stored in jars filled with 80% alcohol.

All specimens were identified in the laboratory, down to the lower taxonomic level possible: genera for Ephemeroptera (Fernandez & Dominguez, 2001), Plecoptera (Froehlich, 1984) and Trichoptera (Oliveira, 1990; Wiggins, 1977), family for all other insect Orders (Carvalho & Calil, 2000; Fernandez & Dominguez, 2001; Merritt & Cummins, 1986), and higher levels for the other invertebrates.

Data analysis

In order to compare the samplers, we utilized the following measures: total richness, EPT richness, BMWP index with modifications as shown in Junqueira et al. (2000), BMWP index corrected by ASPT; these metrics are thought to be the best biomonitoring metrics for tropical areas (Thorne & Williams, 1997), along with Sorensen's similarity index, that allowed us to compare the composition of the samples.

Two presence/absence matrices of the collected taxa were constructed: the first one comprised all organisms found, whereas the second contained only the EPT taxa. The richness values from both matrices were utilized in paired t tests (Zar, 1999), comparing the quantitative sampler with the two techniques from the qualitative ones.

Paired t tests were also performed with the purpose of comparing the biotic indices BMWP and BMWP/ASPT between methodologies in each point. In order to compare sampled

species composition, Sorensen's similarity indexes were determined between the methodologies in each point and between Surber's samples from adjacent points. T tests were performed with these similarity indices in an attempt to detect if the similarity between Surber samplers, even in adjacent points, was higher than the similarity of techniques used in the same point.

Results

A total of 4,220 organisms belonging to 10 insect Orders and 38 Families were collected (Tab. I). There were also specimens from the Classes: Hydracarina, Bivalvia, Oligochaeta and Turbellaria. Even though some of the taxa collected is not typically benthic (Gyrinidae, Collembola, Gerridae and Vellidae), all taxa sampled were used in the analysis, since they were detected by the samplers.

Table I: Taxa found for all techniques applied in the macroinvertebrates survey in streams from Rio das Almas basin, Pirenópolis–GO

Class	Family	Surber	Net 05	Net 15
Coleoptera	Elmidae	697	259	141
	Gyrinidae	0	4	1
	Hydrophilidae	61	2	0
	Coleoptera fam 1	12	0	0
	Coleoptera fam 2	0	1	0
	Psephenidae	8	0	0
Collembola	Collembola fam 1	1	0	1
Diptera	Ceratopogonidae	43	5	3
	Chironomidae	549	20	37
	Culicidae	2	0	0
	Empididae	4	0	1
	Psychodidae	1	0	0
	Simulidae	34	6	6
	Tipulidae	20	8	5
Ephemeroptera	Baetidae	210	8	6
	Leptohyphidae	241	17	25
	Leptohyphlebiidae	366	61	75
Heteroptera	Belostomatidae	3	5	4
	Gerridae	1	0	0
	Naucoridae	12	5	2
	Veliidae	21	0	0
Lepdoptera	Lepidoptera fam 1	2	2	0
Megaloptera	Corydalidae	16	15	10
Odonata	Calopterygidae	0	0	1
	Coenagrionidae	16	1	3
	Gomphidae	4	1	1
	Libellulidae	8	5	0
Plecoptera	Perlidae	154	126	95
Trichoptera	Calamoceratidae	3	1	4
	Glossosomatidae	53	0	7
	Helicopsydae	4	0	2
	Hydrobiosidae	10	0	3
	Hydropsychidae	33	148	71
	Hydroptilidae	73	1	1
	Leptoceridae	9	0	4
	Odontoceridae	24	9	2
	Philopotamidae	14	23	13
	Polycentropodidae	8	0	1
Hydracarina		1	0	0
Bivalvia		2	0	0
Oligochaeta		177	13	21
Turbellaria		14	11	6

With the exception of the comparison of BMWP/ASPT index between Surber samples and Net 15 samples, all t tests performed accused significant results (Tab. II). Fig. 1 show means along with standard deviations from all samplers at each metric.

Table II: Results from all t tests performed (p= probability; DF= Degrees of freedom; RA= Rio das almas; CI= Córrego do Inferno; S= Surber; N 05= Net 05; N 15= Net 15; S-R 05= Sorensen index between Surber and Net 05 from the same point; S-R 15= Sorensen index between Surber e Net 15 from the same point; S-S= Sorensen index between Surber from adjacent points).

Metric	Samples	Compared methodology	p	DF	T value
General Richness	Dependent	S x N 05	‹ 0.001	11	6.01304
General Richness	Dependent	S x N 15	‹ 0.001	11	10.66997
EPT Richness	Dependent	S x N 05	0.001	11	4.43922
EPT Richness	Dependent	S x N 15	‹ 0.001	11	8.25832
BMWP	Dependent	S x N 05	0.001	11	4.40193
BMWP/ASPT	Dependent	S x N 05	0.044	11	-2.27051
BMWP	Dependent	S x N 15	‹ 0.001	11	8.7897
BMWP/ASPT	Dependent	S x N 15	0.849	11	-0.19518
Sorensen RA	Independent	S-N 05 x S-S	0.001	9	-4.50614
Sorensen CI	Independent	S-N 05 x S-S	0.038	9	-2.43711
Sorensen RA	Independent	S-N 15 x S-S	0.005	9	-3.64599
Sorensen CI	Independent	S-N 15 x S-S	0.001	9	-4.00219

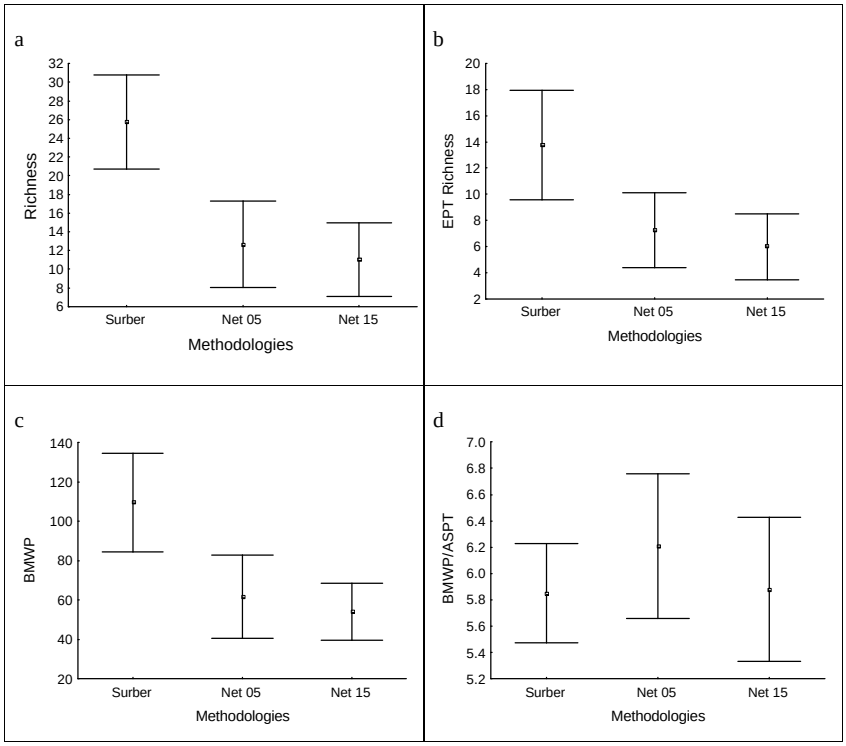

Figure 1: Means and standard deviations of all metrics applied in the comparison of benthic macroinvertebrates sampling techniques in streams of Rio das Almas basin, Pirenópolis–GO. a) Total Richness; b) EPT Richness; c) BMWP biotic index; d) BMWP/ASPT biotic index.

The results from general and EPT richness suggest that both qualitative techniques (Net 05 and Net 15) are not able to characterize the benthic community with the precision of the Surber sampler.

The BMWP biotic index computed showed low values for both qualitative techniques as well. On the other hand, BMWP/ASPT index pointed out larger values for Net 05, and equal values for Net 15 and Surber. This index is achieved by dividing the BMWP value from a given point by the total number of taxa found.

The results also showed us that the similarity between Surber samples from adjacent points is larger than the similarity between Surber samples and the two Net samples from the same point, in both study sites.

Discussion

A study performed by Carter & Resh (2001) showed that 64.4 % of the sampling techniques used by North American benthic macroinvertebrate researchers are qualitative. Besides, 59.3 % of them employ nets with mesh larger than 0.5 mm, and 17.3 % employ meshes larger than 0.8 mm. Even though its widely usage, the knowledge of these techniques' efficiency is still incipient, since there are few works aiming the comparison of different techniques.

The low values found for general and EPT richness with the qualitative techniques point toward a possible difficulty of this kind of methodology on detecting certain taxa, such as Hydroptilidae and Glossosomatidae, and this is probably due to the mesh size used. Moreover, BMWP indices for those techniques were also small, what is probably related to the small richness sampled, since the index is the sum of pre-established values of intolerance for each taxon, and is affected by the richness (Rosemberg & Resh, 1993). These results could lead to a misinterpretation of the water quality when those techniques are followed. Nevertheless, BMWP/ASPT index values from Net 05 could be overestimated if more taxa of high intolerance values (following BMWP) are more frequently collected than lower valued taxa.

The higher similarity found between Surber samplers in adjacent points when compared to the similarity of different techniques employed in the same point is most likely due to the higher ability of those samplers to characterize the community. This ability probably is an effect of the larger number of taxa collected, thus homogenizing samples from the same community.

Resh & Jackson (1993) claim that the usage of large-meshed qualitative samplers is no reason for concern, given that absolute densities are not generally used in biomonitoring researches. Additionally, they state that its use prevent us from the daunting task of identification of very small sized specimens, often collected when a quantitative sampler is applied. Unfortunately, we are not able to corroborate these authors optimism, since our results show that large-meshed qualitative samplers probably underestimate the richness and composition of a given community.

Therefore, taxonomic inventories, biomonitoring and works on conservation priorities should all avoid the use of large-meshed qualitative samplers. Also, small-meshed methods seem to be suitable to detect rare taxa (Metcalfe-Smith et al., 2000). However, detailed studies should be done to find out the efficiency of smaller-meshed nets, since these samplers dramatically decrease the time spent in the sorting, identification and quantification (Buss et al., 2003), thus also reducing the costs. This reducing also was clearly observed in our work.

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