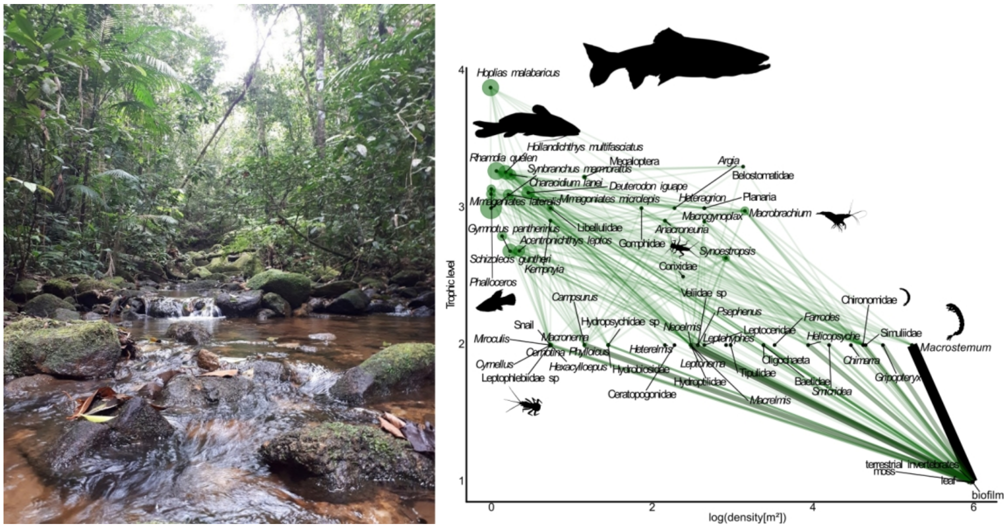
Untangling the complex food webs of tropical rainforest streams

Journal:	*Journal of Animal Ecology*
Manuscript ID	Draft
Manuscript Type:	Research Article
Key-words:	Food Webs, Metabolic Theory, Macroinvertebrates, Stable Isotopes, Stability



The meta food web of a tropical stream watershed. The width of links in the food web depicts the amount of energy fluxing from resources to consumers in a steady-state system. This system is bioenergetically stable considering a Lotka-Volterra system of equations. Simulations of individual species removal do not destabilise the food web.

1110x578mm (38 x 38 DPI)

UNTANGLING THE COMPLEX FOOD WEBS OF TROPICAL RAINFOREST STREAMS

ABSTRACT

1. Food webs depict the tangled web of trophic interactions associated with the functioning of an ecosystem. Understanding the mechanisms providing stability to these food webs is therefore vital for conservation efforts and management of natural systems.

2. Here, we first characterised a tropical stream meta food web and five individual food webs using a Bayesian Hierarchical approach unifying three sources of information (gut content analysis, literature compilation, stable isotope data). With data on population-level biomass and individually measured body mass, we applied a bioenergetic model and assessed food web stability using a Lotka-Volterra system of equations. We then assessed the resilience of the system to individual species extinctions using simulations and investigated the network patterns associated with systems with higher stability.

3. The model resulted in a stable meta food web with 307 links among the 61 components. At the regional scale, 70% of total energy flow occurred through a set of ten taxa with large variation in body masses. The remaining 30% of total energy flow relied on 48 different taxa, supporting a significant dependency on a diverse community. The meta food web was stable against individual species extinctions, with a higher resilience in food webs harbouring omnivorous fish species able to connect multiple food web compartments via weak, non-specialized interactions. Moreover, these fish species contributed largely to the spatial variation among individual food webs, suggesting that these species

could operate as mobile predators connecting different streams and stabilising variability at the regional scale.

4. Our results outline two key mechanisms of food web stability operating in tropical streams: (i) the diversity of species and body masses buffering against random and size-dependent disturbances (ii) high regional diversity and weak omnivorous interactions of predators buffering against local stochastic variation in species composition. These mechanisms rely on high local and regional biodiversity in tropical streams, which is known to be strongly affected by human impacts. Therefore, an urgent challenge is to understand how the ongoing systematic loss of diversity jeopardises the stability of stream food webs in human-impacted landscapes.

Key words: Food Webs, Metabolic Theory, Stability, Macroinvertebrates, Stable Isotopes.

RESUMO

1. As teias alimentares representam um emaranhado de interações tróficas associadas ao funcionamento de um ecossistema. Compreender os mecanismos que proporcionam estabilidade a estas teias alimentares é, portanto, vital para os esforços de conservação e gestão dos sistemas naturais.

2. Aqui, primeiro caracterizamos uma meta teia alimentar de riachos tropicais e cinco teias alimentares individuais usando uma abordagem hierárquica Bayesiana unificando três fontes de informação (análise de conteúdo

estomacal, compilação de literatura, dados de isótopos estáveis). Com dados sobre biomassa em nível populacional e massa corporal medida individualmente, aplicamos um modelo bioenergético e avaliamos a estabilidade da cadeia alimentar usando um sistema de equações Lotka-Volterra. Em seguida, avaliamos a resiliência do sistema às extinções de espécies individuais usando simulações e investigamos os padrões de rede associados a sistemas com maior estabilidade.

3. O modelo resultou em uma meta teia alimentar estável com 307 ligações entre os 61 componentes. Na escala regional, 70% do fluxo total de energia ocorreu através de um conjunto de dez taxa com grande variação nas massas corporais. Os restantes 30% do fluxo total de energia dependiam de 47 taxa diferentes, apoiando uma dependência significativa de uma comunidade diversificada. A meta teia alimentar foi estável contra extinções de espécies individuais, com uma maior resiliência em teias alimentares que abrigam espécies de peixes onívoros capazes de conectar múltiplos compartimentos da teia alimentar através de interações fracas e não especializadas. Além disso, estas espécies de peixes contribuíram amplamente para a variação espacial entre as cadeias alimentares individuais, sugerindo que estas espécies poderiam operar como predadores móveis conectando diferentes riachos e estabilizando a variabilidade à escala regional.

4. Nossos resultados descrevem dois mecanismos principais de estabilidade da cadeia alimentar operando em riachos tropicais: (i) a diversidade de espécies e massas corporais que protegem contra distúrbios aleatórios e dependentes do

tamanho (ii) alta diversidade regional e fracas interações onívoras de predadores que protegem contra a variação estocástica local na composição de espécies. Estes mecanismos dependem de uma elevada biodiversidade local e regional em riachos tropicais, que são conhecidos por serem fortemente afetados pelos impactos humanos. Portanto, um desafio urgente é compreender como a contínua perda sistemática de diversidade põe em risco a estabilidade das teias alimentares em paisagens impactadas pelo homem.

Palavras-chave: Teias alimentares, Teoria Metabólica, Estabilidade, Macroinvertebrados, Isótopos Estáveis.

INTRODUCTION

Food webs depict the tangled web of trophic interactions associated with the transfer of energy within an ecosystem. These ecological networks offer mechanistic insights into energy flow, nutrient cycling, and population dynamics, highlighting critical links that influence the stability and resilience of natural ecosystems. Consequently, food webs provide a vital tool for conservation efforts and ecosystem management, allowing better-informed decisions about how to protect and preserve the functioning of natural systems (Giakoumi et al., 2015). Therefore, understanding the mechanisms that govern food web stability with precision and detail is pivotal to improve our understanding of ecosystem functioning in the face of the current environmental crisis (Yodzis, 1981; Ives & Carpenter, 2007).

Despite decades of research on food web stability, the topic is still highly debated, especially concerning whether higher biodiversity confers higher resilience to disturbance (Hatton et al., 2024; McCann, 2000). While classic theories emphasise the destabilising role of diversity given a higher connectance among multiple nodes increasing chances of cascade extinctions (May, 1973), contemporary theory suggests a stabilising role of diversity when this is associated with weak interactions among predators and multiple prey, creating negative covariance between different resources buffering the system against extinctions (McCann, 2000). Despite the large and growing body of theoretical studies on these ideas, empirical evaluations are still lagging behind, as appropriate and detailed data for rigorously testing these theoretical advances are not widely available (Ives & Carpenter, 2007).

Describing food webs in streams and rivers is particularly challenging due to the inherent complexity and dynamics of these ecosystems (Winemiller, 1990). The continuous flow of water combined with the spatio-temporal heterogeneity of resources create a constantly changing environment, making it difficult to capture the food web in full detail. Tropical streams particularly pose a challenge as they are highly diverse and knowledge of trophic interactions is rare for many taxonomic groups (Motta & Uieda, 2005; Reboredo Segovia et al., 2020), resulting in few isolated food web descriptions (Ceneviva-Bastos et al., 2012; Motta & Uieda, 2005) that we know little about their stability in the face of disturbance. Among these understudied ecosystems, streams of Brazilian Atlantic Rainforest are highly threatened by human land-use intensification and the substitution of forests for pasture and monoculture plantations (Siqueira et al., 2015). Since these ecosystems provide a myriad of services to human society, from fresh water and recreation to nutrient cycling (Meyer, 1997; Palmer et al., 2014), understanding the stability of their food webs in well-preserved regions is the first step in predicting their response to human impacts (Collyer et al., 2023).

Importantly, tropical stream ecosystems are likely to differ in their structure and functioning compared to their better-studied temperate counterparts (Saito, Perkins, et al., 2021). In terms of food webs, warmer tropical streams should be composed of species with fast life cycles, accelerated biomass turnover, and lower local densities (Saito, Stoppa, et al., 2021), resulting in highly variable composition (Siqueira et al., 2020) and species interactions (Saito, Perkins, et al., 2021). A recent study hypothesised that such highly dynamic food webs, embedded in a high regional diversity, should be stable due to the weak interaction effects among multiple interacting species (Collyer et al., 2023), where the functioning of a diverse, generalist community would be buffered against disturbances by interchanges of trophic interactions (Kratina et al., 2012; Rooney & McCann, 2012). In that case, we should expect pristine tropical stream food webs to depict two patterns. First, local food webs should be composed of predator-prey interactions that deviate from optimal predator-prey mass ratios (Collyer et al., 2023; Kratina et al., 2012). Aquatic food webs are commonly size-structured, meaning that predators are consistently and systematically larger than their prey, and yet, under warmer tropical conditions, we should have a higher prevalence of omnivory because high energetic demands can force organisms to feed up and down the food web (González-Bergonzoni et al., 2012). Therefore, we hypothesise that pristine food webs will be composed of weakly size-structured interactions, with predators feeding on both large and small prey due to their high metabolic requirement. Second, these tropical food webs should also be characterised by high local diversity, buffering predators from extinctions due to the possibility of prey switching and stabilising dynamics between resources. Since these tropical communities are prone to random variations in composition (Siqueira et al., 2020), a high diversity of possible interactions should enhance the stability of these systems, as redundant predators and prey can buffer the system against the loss of energetic channels.

In addition, local food webs are always exchanging energy and matter within a regional meta food web (Winemiller, 1990). As such, the realisation of potential trophic interactions is constrained by the dispersal processes of predators and prey (Rooney & McCann, 2012; Winemiller, 1990). Similar to the role of predators dampening variation at the bottom of food webs (Rooney & McCann, 2012), mobile predators coupling sub-food webs can stabilise metacommunities by buffering variability among communities (Rooney et al., 2008; Siqueira et al., 2024). This should increase spatial asynchrony among communities entailing high food web dissimilarity in space, mostly due to changes in predator frequency. Considering the expected high local dynamism of Atlantic Forest stream communities due to faster metabolism, we hypothesise a high dissimilarity of local food webs in space, being stabilised by predator coupling at the regional scale (Rooney et al., 2008).

Despite the dozens of methods developed to characterise food webs in nature, the use of individual methods to estimate trophic interactions commonly results in incomplete or simplified characterizations (Layman et al., 2012). Fortunately, the combination of recent theoretical and methodological advances gives us new tools to describe patterns of energy fluxes at the population level with high precision. First, a new method unifying multiple sources of information within a singular analytical Bayesian framework provides an excellent opportunity to untangle undescribed food webs, while overcoming problems of individual sources of information (Hernvann et al., 2022). This method integrates information taken from the literature, from direct observations and extracted from stable isotope analyses to infer the most likely diet proportion of each consumer and the likelihood of these interactions. Second, advances in metabolic scaling theory allow us to infer the energy requirements of populations based on their individual body masses and their total population sizes (Brown et al., 2004). Together with information about diet proportions, we can now estimate the required energy potentially flowing from prey to predators, quantifying the food web in a general ecological currency (Gauzens et al., 2019).

Leveraging a suite of advances in food web ecology, we evaluate how stable the pristine ecosystems of the Brazilian Atlantic Rainforest should be in face of disturbances. We first characterise a well-resolved meta food web of streams from Atlantic Forest through the integration of node properties (body mass and abundance) and various sources of feeding link information. Second, we applied recent methods for calculating the stability of the food web to disturbances within an energetic framework (Gauzens et al., 2019; Moore & de Ruiter, 2012). We hypothesised that 1) due to the elevated metabolic demands in warm conditions, invertebrates and fish assemblages would be weakly size-structured, characterised by predators feeding at multiple trophic levels, with with a weak association between individual body mass and trophic level within invertebrate and fish assemblages, as well as across the whole food web. 2) Given the high species diversity in tropical streams, we anticipated that energy flow within the food webs would involve a multitude of links. Predators would engage in a range of non-specialized interactions with prey resulting in bioenergetically stable food webs (Kratina et al., 2012). 3) The simulated removal of individual taxa from a complex tropical food web would not significantly disrupt its stability, as it would not heavily rely on key strong interactions. 4) Finally, we expected that the spatial variation in the composition of local food webs would be associated with compositional changes in large predators, indicating that mobile predators enhance spatial asynchrony among communities entailing regionally stable meta food webs (Siqueira et al., 2024).

METHODS

We sampled food web components (basal resources, invertebrate and vertebrate consumers) in relatively pristine streams in Southeast Brazil. We then applied a Bayesian framework to describe a regional meta food web and five individual food webs integrating data from gut contents analysis, published studies and stable isotope analysis of consumers and resources (Hernvann et al., 2022). Finally, we applied an energetic model using body masses, energy efficiencies estimates and the network topology to describe the amount of energy fluxes and the food web stability (Gauzens et al., 2019).

Field and laboratory protocols

We sampled five (2nd to 3rd orders) stream stretches within the Cananeia catchment (state of São Paulo, Brazil) to collect high-resolution community data for food web reconstruction. We sampled three streams (S1, S6 & S8) which were less than 3 km apart, and in one stream (S8) we sampled three different stretches along an altitudinal gradient (with 24, 45 and 88 metres of altitude). The vegetation at the studied sites is predominantly formed by Ombrophilous Dense Atlantic Forest, mostly well-preserved stretches and few sections of secondary forest (Schaeffer-Novelli et al., 1990). The climate is humid subtropical (Alvares et al., 2013), with mean annual rainfall above 2,200 mm (Schaeffer-Novelli et al., 1990). There are two main seasons: summers (November - April) have mean air temperature of approximately 27° C, whereas mild winters (May - October) have a mean temperature of approximately 22° C. The five stream sites were sampled in October 2019 and had a mean water temperature of 22°C (SD=0.68), pH of 5.7 (SD=0.66) and oxidation-reduction potential (mv) of 381 (SD=111) (see Table S1).

The field protocol encompassed standard sampling techniques for surveying stream food webs. First, we performed 3-pass quantitative depletion electrofishing at each site (up to 100 m) using a Smith-Root LR-24 backpack electrofisher with the boundary of survey reaches enclosed by stop nets. We identified most captured fish to species level and measured (fork length) in the field (SISBIO ethical approval number 72482-1). We sampled macroinvertebrates (>250 µm) using 10 replicate Surber samples (30 cm X 30 cm) randomly positioned in the stream benthos. We sorted these samples live at the host laboratory using a transilluminated tray and identified them to the lowest possible taxonomic level without preparing slices (e.g. Chironomidae were identified to family level). We took measurements of individual linear dimensions (e.g. head-capsule width or body length) with a calibrated ocular micrometre allowing individual dry mass to be calculated from published regression equations (Collyer et al., 2023). We sacrificed a subsample of all captured fish (n = 142) and fixed them in 99,3% Isopropyl alcohol for subsequent gut content analysis in the laboratory. We extracted guts and examined under a stereomicroscope (Leica EZ4, 40x maximum magnification). We identified all diet items found (n = 502) to the lowest possible taxonomic level (28 categories).

During fieldwork we also collected material for subsequent stable isotope analysis (SIA). We obtained fish tissue from fin clips for a subset of individuals of each species caught during electrofishing surveys. We performed kick net sampling qualitatively in all microhabitats (mostly gravel and boulder riffles and some leaf litter pools) to collect macroinvertebrates which were processed whole for stable isotope analysis. We sampled basal resources from each stream by collecting allochthonous leaf packs, mosses attached to the substrate and scrapes of biofilm from stones and boulders. We froze all samples in the host laboratory in liquid nitrogen (at -80 °C) in individually labelled tubes until subsequent analysis. Back to the laboratory, we stored all samples at 60° C in an oven until total dry mass was achieved. We grinded the tissues to a fine powder. Subsequently, 1 mg +/- 0.2 mg of fish and macroinvertebrate samples, and 2.5 mg ±0.2 mg of basal resources were weighed into tin capsules (Elemental Microanalysis® 8×5mm) prior to isotopic analysis. For small invertebrate taxa that potentially weighed less than 1 mg individually (e.g. Chironomidae, Simuliidae), we pooled 6-20 individuals of similar size together to reach the minimum weight expected for each sample (Perkins et al., 2018). We analysed samples of macroinvertebrates (n=139), fishes (n=160) and basal resources (n=30) for carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotope ratios at an analytical laboratory at Queen Mary University of London, UK using a continuous flow isotope ratio mass spectrometer (SerCon Integra 2, Stable Isotope Analyser, Crewe, UK). Protein IRMS Standard (Elemental Microanalysis® OAS/Isotope 5g) encapsulated like the other samples was used as a standard and inserted in each run after every ten samples. We then applied an ANOVA comparing the $\delta^{15}N$ of basal resources (biofilm, moss and leaves) among stretches and found that they were not distinct (ANOVA, F = 0.35, P = 0.84) indicating that $\delta^{15}N$ baselines among stream sites were comparable.

Food web reconstruction

We applied the Ecodiet approach to derive a well-resolved meta food web (Hernvann et al., 2022). This Bayesian hierarchical model jointly considers three sources of information: direct observations (e.g. gut content analysis) including the potential proportion of different diet items, literature information describing putative feeding links based on interactions described in other sites, and data from stable isotope analysis, derived from a Bayesian mixing model to estimate the likelihood of the interactions and the diet proportions inferred from the two first sources of information. Here, we integrated data from the five stream sites including 329 $\delta^{15}N$ and $\delta^{13}C$ values of basal resources, macroinvertebrates and fish; 502 diet items identified from fish gut content analysis and; 226 potential feeding interactions for Neotropical stream communities derived from a literature search including bibliometric analysis of 52 references (see Supplementary Material). This hierarchical model generated the probabilities of trophic links and provided the proportions of diet items for each taxon. The key strengths of this framework included the quantification of i) the reliability of individual published datasets (i.e. different values range between 0 and 1 depending on the methods used in a published study for each interaction) and ii) the relative importance of gut vs. literature data to define the food web topology to be investigated in the mixing model. For this last comparison, a parameter was set to define how equivalent literature and gut content data are (e.g. setting the parameter value to 50 indicates that literature data are equivalent to analyses of 50 new stomach contents). In our case, all studies in the literature search were set to 1 (reliable) and the literature data were given equal weight compared to gut content data. We assessed the performance of the model using Gelman-Rubin test of MCMC convergence. Variables (links) with Rhat > 1.1 failed to converge and we removed them from the model. This method was implemented using the Ecodiet package in R (Hernvann et al., 2022).

Using the estimated food web topology and the diet proportions, we applied the fluxweb approach, which infers the amount of energy flowing through each population considering a steady-state system (Gauzens et al., 2019). This method was applied to both the meta food web and each of the five individual food webs. The approach requires the average species body mass and population density information to estimate the total biomass of each population and their energetic requirements.

The fluxweb method considers a top-down perspective where the energetic requirement of each consumer species is calculated from the mean body mass of that species, and its population density, balanced against the population biomasses of their prey. In this balanced system, gains G_i are balanced with losses L_i which are calculated as

$$L_i = X_i + \sum_j F_{ij} , \qquad \text{(eq. 1)}$$

where X_i defines species losses (e.g. metabolic costs or death rates) and F_{ij} is the flux of energy from species *i* to predator *j*. In this case, gain G_i is defined as

$$G_i = \sum_j F_{ji} e_{ij} , \qquad \text{(eq. 2)}$$

where F_{ji} defines the influx coming from other species depending on a diet proportion (estimated with Ecodiet in our study) and e_{ij} denotes the efficiency in energy uptake given the prey identity (see below). In our study, the metabolic cost X_i was defined from the allometric equations (Brown et al. 2004)

$$X_i = X_0 M_i^b , \qquad \text{(eq. 3)}$$

where X_0 and *b* are constants related to organismal physiologies and M_i is a given body mass. We defined X_0 equal to 18.18 for fishes, 17.17 for invertebrates, and *b* equal -0.29 for all organisms following Brown et al. (2004). Efficiencies were defined at prey level and set to 0.906, 0.545 and 0.158 for animals, plants and detritus, respectively (i.e. consumers feeding on animals have higher efficiencies per unit of mass consumed) (Gauzens et al., 2019). We additionally applied different values for *b* and efficiencies to understand the sensitivity of our analyses to specific input parameters. For the metabolic exponent *b*, we considered the values from a review of metabolic rates across organisms and ontogenetic development (Glazier, 2005). In this study he identified that metabolic rate exponents are commonly ⅔, ¾ and 1 (isometric scaling). Therefore, to consider such variation we also used the values of *b* considering these three different exponents. For the efficiency values, we considered the minimum and maximum values of the 95% confidence interval modelled in a systematic assessment of efficiencies and respiration in natural communities (Lang et al., 2017). In this assessment, they found that carnivores had the highest assimilation efficiency (ε0,carnivores = 0.906, CI 0.95 = 0.88-0.927), herbivores had an intermediate assimilation efficiency (ε0,herbivores = 0.545, CI 0.95 = 0.466-0.621), and detritivores had the lowest assimilation efficiency (ε0,detritivores = 0.158, CI 0.95 = 0.108-0.227).

Data analysis

Hypothesis 1: Due to the elevated metabolic demands in warm conditions, tropical food webs should be weakly size-structured, with variable size differences between predators and prey.

To test our first hypothesis and to determine the relationship between body mass and trophic position, we related $\delta^{15}N$ tissue values (a proxy for trophic position) and body mass by applying linear mixed effects models for the isotopic values of consumers. Log-transformed mean consumer body mass (mg of dry mass) was treated as a fixed effect while taxonomic identity was treated as random intercept and random slope, separately. We also ran models that included the group (fish or invertebrate) as a fixed effect with interaction with body mass to account for a potential relationship that is dependent on the organism group. We could not apply a single model with both random intercept and slope due to the large number of samples and taxa in our dataset (lack of sufficient degrees of freedom). Models with and without organism group as a fixed effect were compared based on their marginal R^2, AIC, and a Chi-Squared test.

We then determined size-density relationships regressing species' mean body mass and population density on double-log axes. These relationships depict how energy is shared among species with different body masses, providing information about species that have higher or lower densities than expected based on allometric scaling principles (White et al., 2007). We applied this method for the meta food web and each of the five individual food webs. These empirical relationships were contrasted against the theoretical allometric expectation considering a slope of -1, or Sheldon’s rule that considers that despite the scaling of -¾ of metabolic rates with increasing body sizes, there are consistent energetic losses among trophic levels (Brown et al., 2004). Therefore, a theoretical relationship with slope-1 for the best-fit model (we found the intercept considering minimum least-square criteria) was fitted together with the empirical linear model.

Hypothesis 2: Given the high species diversity in tropical streams, energy flow within food webs would be characterised by weak interactions between predators and prey resulting in bioenergetically stable food webs.

To test this hypothesis, first, we characterised the meta food web and each individual food web by calculating the number of nodes (number of taxa in each food web), number of links (number of trophic interactions), link density (mean number of links per node), connectance (the ratio between the number of links and all possible links), compartmentalization (measures the degree of connectedness of subsystems within a network, with higher values of connectance indicating more discrete subsystems), mean trophic position (mean trophic position of nodes within a food web with basal resources set to 1) and omnivory (the mean degree of variation in the trophic position of consumed resources) (Kones et al., 2009; Kratina et al., 2012; Latham, 2006; Pimm & Lawton, 1980). Indices were calculated using the package *NetIndices* in R (Kones et al., 2009).

Then, we tested the hypothesis by using the estimated energy fluxes from the fluxweb analysis and calculating the stability of food webs (stability of their Jacobian matrices) considering a Lotka-Volterra model of consumers and resources (Moore & de Ruiter, 2012). The stability of a food web can be measured using a Jacobian interaction matrix concerning the partial derivatives of the equations for each species with respect to all species in the food web near equilibrium (May, 1973; Neutel et al., 2002). A food web is therefore considered stable when the Jacobian matrix has negative real parts eigenvalues for every interaction - i.e., all consumers can be sustained based on the biomasses of their resources (see Supplementary Material from Gauzens et al. 2019).

Hypothesis 3: Local extinctions of individual taxa from a complex tropical food web would not significantly disrupt its stability, as it would not heavily rely on key strong interactions.

To test the third hypothesis, we simulated multiple species extinction scenarios to determine the consequences of individual species loss for the stability of the meta food web. Here, in each scenario we individually removed one species at a time, recalculating energy fluxes and stability using fluxweb in R (Gauzens et al., 2019). We performed this species removal procedure for all species in our meta food web. Secondary extinctions could happen in our model after species removal, if a given species has a positive eigenvalue in the new Jacobian matrix after calculating stability. In this case, the food web would be termed unstable. To understand which network aspect is associated with higher food web stability, we calculated the network indices described above (number of taxa in each food web, number of links, link density, connectance, compartmentalization, mean trophic position, and omnivory) for each simulated food web after each species extinction. With these values, we applied a Pearson correlation matrix between them with the inclusion of the maximum eigenvalue of the Jacobian matrices (the stability measure).

Hypothesis 4: Spatial dissimilarity of local food webs would be associated with changes in large predators, indicating that mobile predators enhance spatial asynchrony among communities entailing regionally stable meta food webs.

To test the last hypothesis we calculated compositional and network dissimilarity using the Bray-Curtis index (Legendre, 2014). Whereas the compositional dissimilarity is based on differences in the relative species abundances, the network dissimilarity also accounts for the presence or absence of species interactions following species addition - e.g. one species can add multiple interactions to a food web, while another species can add only one interaction. We decomposed the network beta diversity into the components of 'changes caused by the absence of predator', 'changes caused by the absence of prey', or 'changes caused by mutual absences' (Novotny, 2009). We did not calculate the components of network dissimilarity associated with rewiring and turnover, as our interactions are defined at the meta food web level, preventing our assessment of rewiring - i.e. species always interact with the same species once they are present. Beta diversity indices were calculated using the bipartite package (Dormann et al. 2008).

RESULTS

Food web components

We identified 1352 invertebrates from 54 different taxonomic groups. From this, 313 individuals were *Macrobrachium* (Paleomonidae, Decapoda) collected through both Surber sampling and electrofishing, while the others mostly included insects, with a small proportion (<1%) of Oligochaeta, Platyhelminthes and Gastropoda collected by Surber sampling (0.9 m^2 in total). The insects with the highest abundances were *Macrostemum* (Hydropsychidae, Trichoptera, n = 170), *Gripopteryx* (Gripopterygidae, Plecoptera, 118), *Simulium* (Simuliidae, Diptera, 95), Chironomidae (Diptera, 92), *Chimarra* (Philopotamidae, Trichoptera, 79), *Smicridea* (Hydropsychidae, Trichoptera, 60), *Helicopsyche* (Helichopsychidae, Trichoptera, 46), *Farrodes* (Leptophlebiidae, Ephemeroptera, 30), Baetidae (Ephemeroptera, 26) and Belostomatidae (Hemiptera, 20). We also captured 332 fish from 12 species (413,5 m² sampled). Two fish species were found across all sites: catfish *Acentronichthys leptos* Eigenmann & Eigenmann, 1889 (66), and knifefish *Gymninotus pantherinus* Steindachner, 1908 (32). Other abundant (but less widespread) fish species included the lambari *Deuterodon iguape* Eigenmann, 1907 (71) and the characids *Hollandichthys multifasciatus* Eigenmann & Norris, 1900 (61), *Characidium lanei* Travassos, 1967 (34) and *Mimagoniates microlepis* Steindachner, 1877 (34).

Relationship between trophic position and body mass

We analyzed 329 samples for stable isotopes that were categorized into 42 groups, including basal resources, macroinvertebrates and fish. Fish generally has the highest δ^{15}N values (i.e. occupied the highest trophic positions), but there was a considerable overlap with many macroinvertebrates and shrimps. The relationship between δ^{15}N and individual body masses suggested that fishes are more strongly size structured than macroinvertebrates, only partly supporting our first hypothesis (Figure 1B). Macroinvertebrates had high isotopic variability with large overlap in bi-dimensional space between species with different body masses (Figure 1C), although some taxa were clearly distinct (e.g. *Macrobrachium* and damselflies with high δ^{15}N values and grazers *Psephenus* and *Gripopteryx* with the lowest δ^{15}N values). Our mixed effects models supported this visual inspection with models with both random slopes and intercepts (species) returning associations with body sizes (estimate = 0.45, SE = 0.08, t = 5.38 and estimate = 0.39 SE = 0.08, t = 4.57, respectively) that depended on the group (fish or invertebrate) (interaction effect, estimate from model with random slope = -0.31, SE = 0.11, t = -2.86 and estimate from model with random intercept = -0.27, SE = 0.11, t = - 2.47). Overall, this means that there is a general association between trophic level and body sizes, where fishes are strongly size structured, but invertebrates are not. Considering groups as a fixed effect interacting with body size is important for the relationship as a comparison with a model without groups renders only half of the marginal R² (marginal R² = 0.64 vs. marginal R² = 0.31) and a significantly higher AIC (AIC = 788 vs. AIC = 802, Chi square = 17.33, P < 0.001). Moreover, separate models for only fish and only invertebrates return significant slopes only for fish (body mass fixed effect estimates = 0.60, SE = 0.09, t-value = 6.44, species as random slopes). The patterns in community-level isotopic composition for individual sites were largely similar to those observed for the regional meta food web (Figure S1).

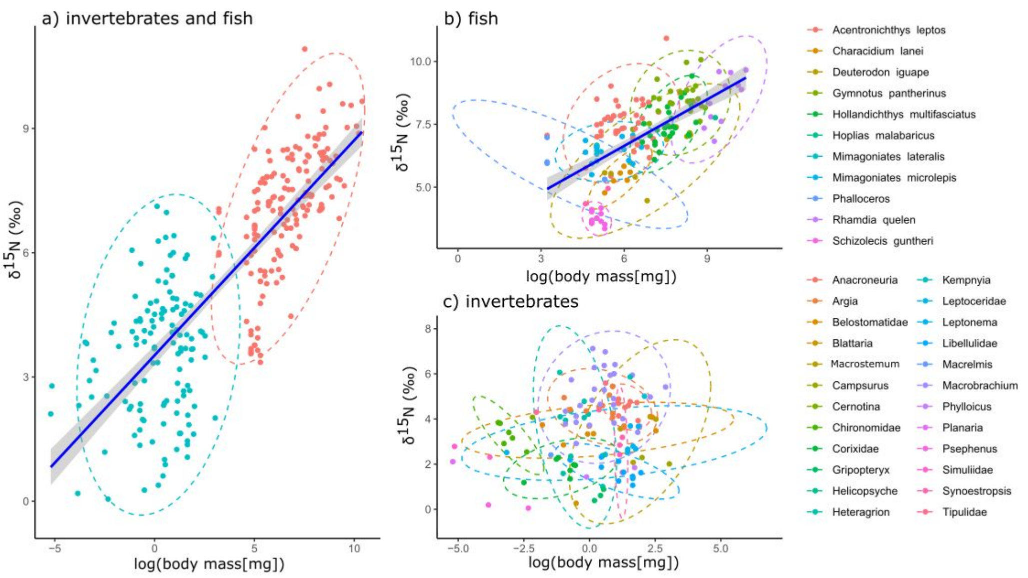


Figure 1. Isotopic composition of fish and macroinvertebrates from Atlantic Forest streams (Cananeia, Brazil). a) General association between mean body mass (mg) and $\delta^{15}N$ values (relative trophic position) of organisms (some isotopic samples encompass multiple individuals, e.g. Chironomidae). Individual associations for fish (b) and invertebrates (c). Ellipses correspond to 95% confidence level for a multivariate t-distribution. The line in the (a) panel indicates the fitted linear mixed effects model with body mass as fixed effect and species as random slope (estimate = 0.45, SE = 0.08, t = 5.38). The model in the fish panel indicates the fitted linear mixed effects model with body mass as fixed effect and species as random slope (body mass fixed effect estimates = 0.60, SE = 0.09, t-value = 6.44).

Food web construction

The EcoDiet model identified a high link probability for most of the analysed interactions with link probabilities within two groups: 14% had probabilities between 0.2 and 0.18, but all the other 86% had probabilities higher than 0.82. The diagnostics of the whole model resulted in Gelman-Rubin statistics higher than 1.1 for 54 links (~16% of the links), indicating a lack of convergence in the MCMC algorithm (Hernvann et al. 2022). The final meta food web after removing these links contained 307 links, including the likelihood of diet proportion for each consumer. The number of nodes in each site ranged between 28 and 41 while the number of interactions ranged between 73 and 171, with a positive trend between the two characteristics - more diverse sites had more links and also occurred in wider and shallower stretches of streams (e.g. S1 and S8C). Consequently, connectance was similar between stretches with a mean of 10% of all possible links actually realised (see Table S2 for other network metrics).

Energy fluxes

For the meta food web, the 10 populations with highest energetic demands were composed of six Trichoptera genera *Macrostemum*, *Leptonema*, *Synoestropsis*, *Helicopsyche*, *Cernotina* and *Phylloicus*, one Ephemeroptera (*Campsurus*), one Diptera (Chironomidae), one Plecoptera (*Gripopteryx*) and one Palaemonidae (*Macrobrachium*). In sum, these species account for 70% of total energy flux in these ecosystems. Yet, a considerable 30% of the energy flow is shared between the remaining 48 consumers, which is partially in agreement with the second hypothesis (Figure 2). The biofilm was the main basal resource that mostly contributed to food web energy flows, followed by moss and leaves (Figure S3).

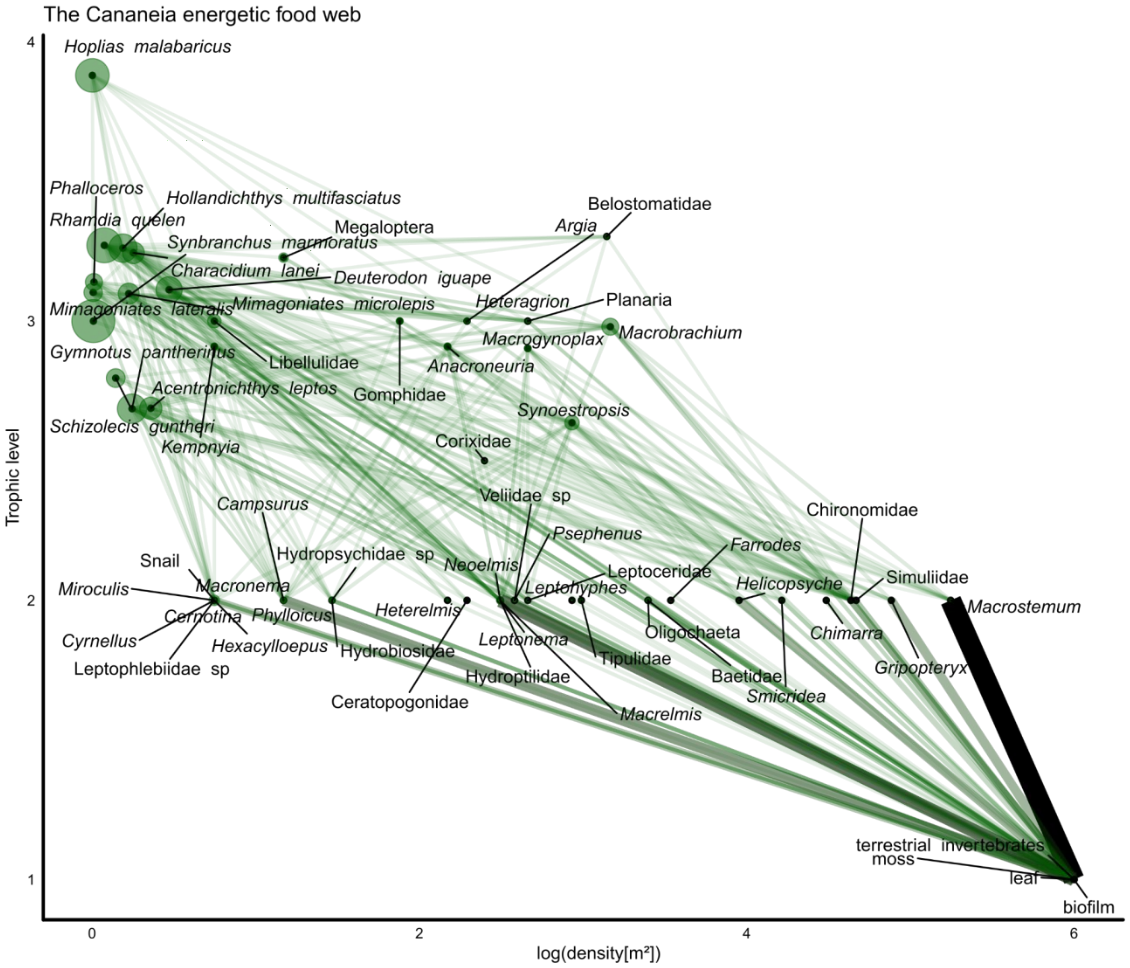


Figure 2. Regional meta food web with energy fluxes from Atlantic Forest streams (Cananeia, São Paulo, Brazil). Width of links are proportional to differences in the amount of energy flowing (J/year/m²) at the population level estimated by the *fluxweb* energetic model. Position along the y axis represents the trophic position of each taxon. Node sizes are proportional to species average body masses (mg).

Some invertebrates (e.g. *Macrostemum*, *Macrobrachium*) were disproportionately abundant (Figure 3). The relationship between body mass and population density showed that these taxa tended to be regionally more abundant than expected from their mean body masses (i.e. they were above the regression model, Figure 3), especially compared to the empirical model, but also to the theoretical expectation with slope = -1. This pattern was also evident at the local scale, but the species above the regression model varied from site to site (Figure S2). Moreover, the empirical relationship was shallower than the theoretical expectation with exponent -1.

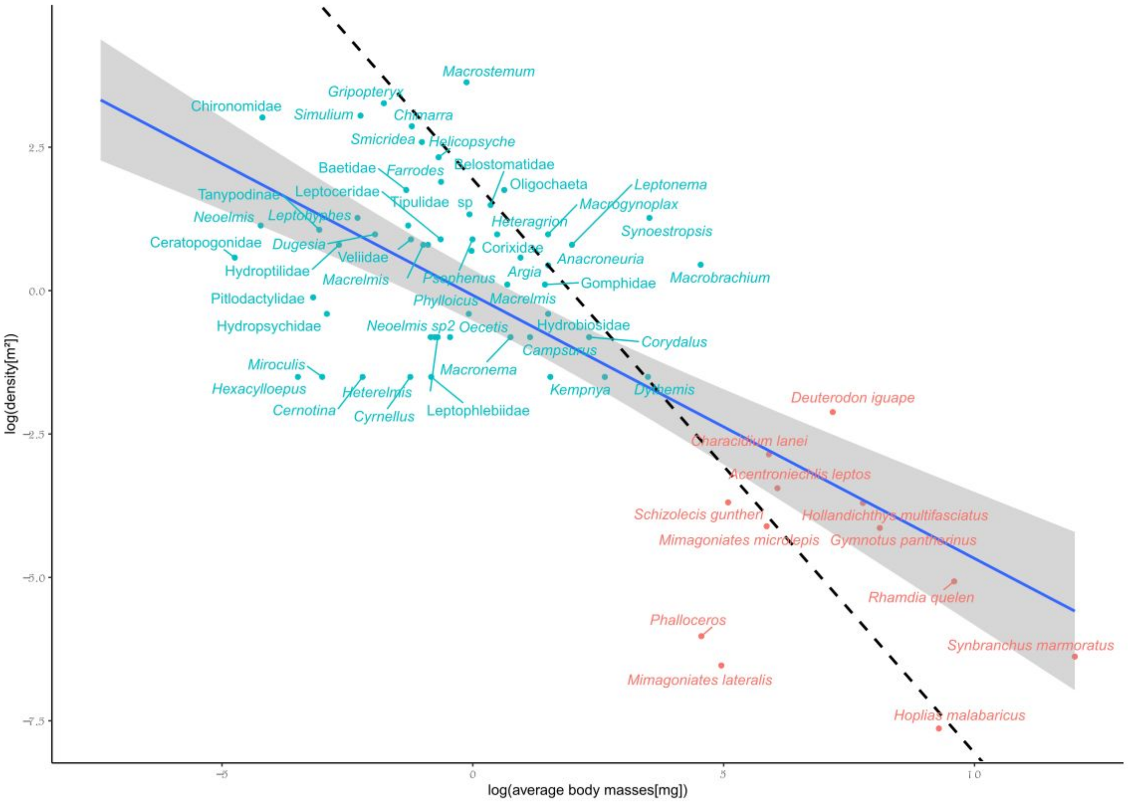


Figure 3. Species size-density relationship for Cananeia streams (density relationship for the regional meta-web). Log-transformed density of individuals in the regional species pool is regressed against log-transformed mean body masses of each taxonomic group (slope = -0.45, $R^2 = 0.48$, $P < 0.001$). Species above or below the

regression line indicate species with relatively more or less individuals than expected based upon their body size. The dashed line indicates the least-square best fit model for a slope=-1, an empirical benchmark predicted by allometric scaling theory.

For individual stream sites, some species were important contributors across all sites while some of them were only important for some specific ones (Figure 4). For instance, *Macrostemum*, Chironomidae, *Gripopteryx* and *Macrobrachium* were widespread and abundant in the regional species pool and contributed strongly to the energy flux in all five stream food webs. In contrast, *Campsurus*, *Farrodes*, *Deuterodon iguape*, *Helicopsyche*, *Macrelmis* and *Synoestropsis* were only important in one or two sites (Figure 4).

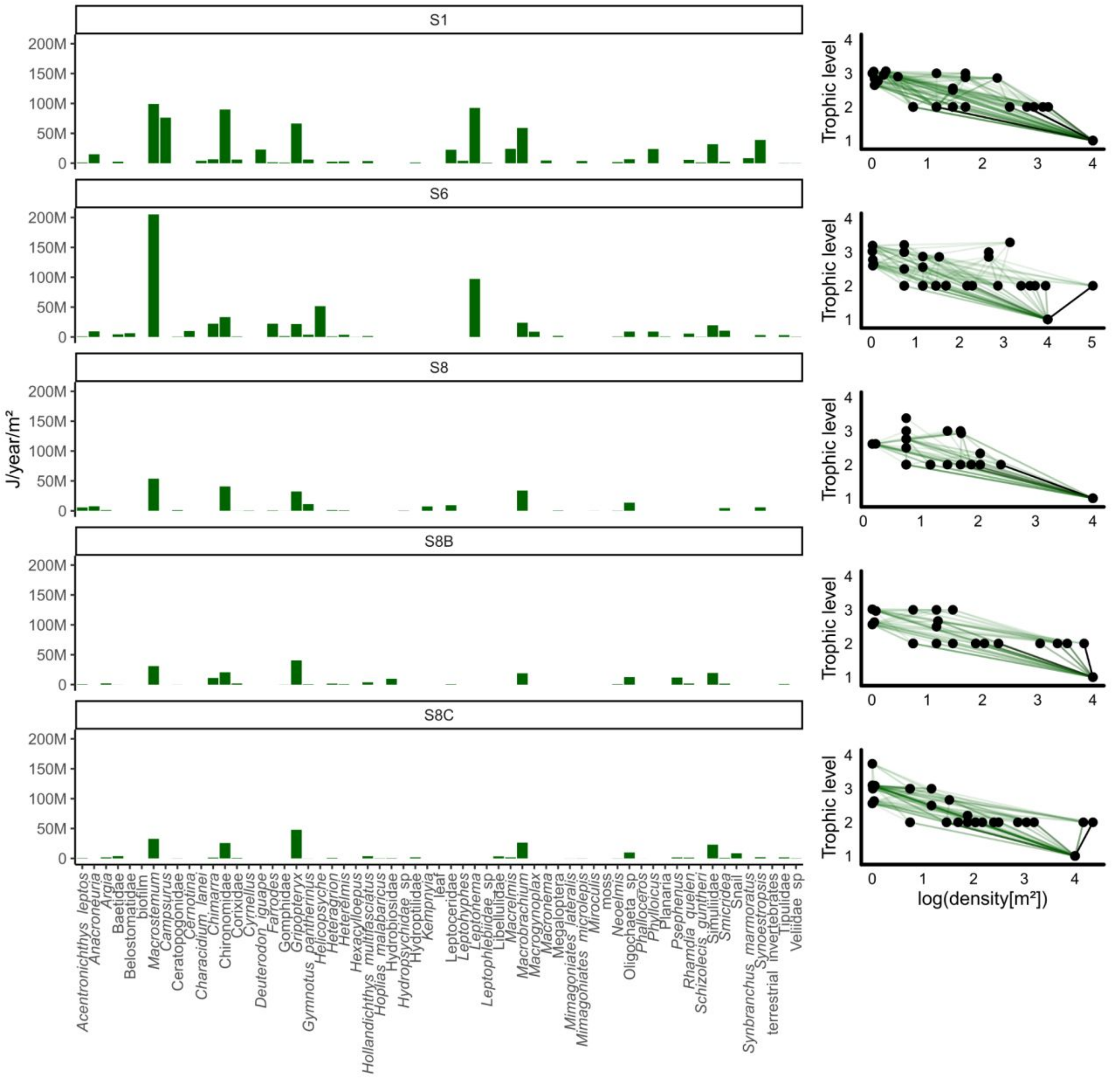


Figure 4. Energy fluxes (J/year/m²) from individual nodes and the five food webs from Atlantic Forest streams from Cananeia (São Paulo, Brazil). Position along the y axis in the individual food webs represent the trophic position of each taxon. Darker link colours represent interactions of higher energy fluxes.

Besides these differences among individual food webs, supporting our second hypothesis, all food webs and the meta food web were stable, i.e. had negative values for the maximum eigenvalue of the Lotka Volterra Jacobian matrices. This analysis considered that stream food webs are in a stable state if the real parts of eigenvalues from the Jacobian are all negative (between -4.9 and -13.5). This means that the population energy demands are consistent with the amount of energy available at lower trophic levels, meaning that there is no population too large that cannot be sustained by the amount of energy from prey. The sensitivity analyses, changing the values of *b* and efficiencies, also returned stable meta food webs in except for when *b* = 1, which is the isometric scaling where metabolic rate is constant. The results of the sensitivity analyses can be found in Supplementary Material and the results using the original values of *b* (-0.29) and mean efficiencies from Lang *et al.* (2017) are reported in following.

In agreement with our third hypothesis, the simulation extinction resulted in food webs that remained stable after the removal of individual species each at a time (maximum Jacobian eigenvalues ranging between -14.60 and -7.41). That is, after species removal, no secondary extinctions were observed (all species had negative eigenvalues after calculating stability in the resulting food webs). We found that, despite the consistent stability of the food web to species removal, and lack of secondary extinctions, there are network patterns associated with the variation in the stability values (Figure 5). Higher stability (the inverse of the maximum eigenvalue) was related to greater omnivory in the food web ($r=0.27$, $p<0.05$), lower levels of network compartmentalization ($r=-0.32$, $p<0.05$), and lower average link weights ($r= -0.40$, $p<0.05$) (Figure 5 and Figure S4). Thus, removing omnivorous species that connect different sub-webs with multiple weak interactions is detrimental to ecosystem stability. When looking into the species that have the highest impact on food web stability, we can also observe that many fish species were of high importance, especially considering how little they contribute to the total energy fluxes (e.g. the knifefish *Gymnotus pantherinus* that eats 22 different food items and the tetrafish *Deuterodon iguape* with 19 food items, Figure 5).

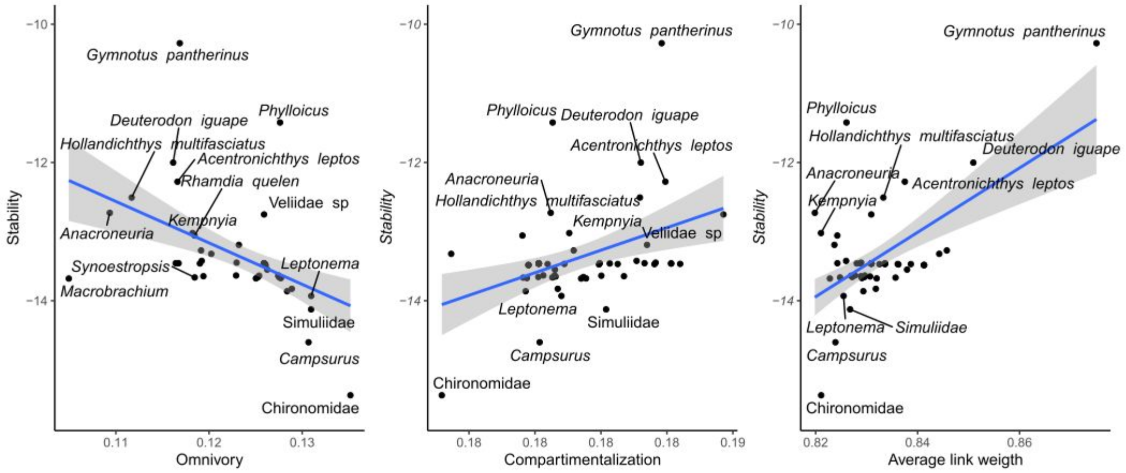


Figure 5. Associations between the stability of simulated meta food webs and network metrics. Each point in each scatterplot represents a simulated meta food web after the extinction of a given species (labelled). The stability was estimated as the maximum eigenvalue of the Jacobian matrix using a Lotka-Volterra system of equations. More negative values indicate higher system stability to disturbances. Lower stability was associated with simulations that reduced omnivory and increased compartmentalization and average link weight. The models in each plot represent linear regressions with the following results: Omnivory ($R^2 = 0.07$, $P = 0.04$), Compartmentalization ($R^2 = 0.10$, $P = 0.01$), Average link weight ($R^2 = 0.15$, $P = 0.001$).

Food web dissimilarity

As predicted by the fourth hypothesis, the dissimilarity of the network was higher than the compositional dissimilarity (Figure 6). Approximately 40% of interactions changed from one food web to another, while pure compositional dissimilarities among stream communities were approximately 25%. These compositional changes were strongly associated with the absence of predators when prey taxa were present, with a much smaller contribution of the component of prey absence and mutual absence (less than 10%, Figure 6).

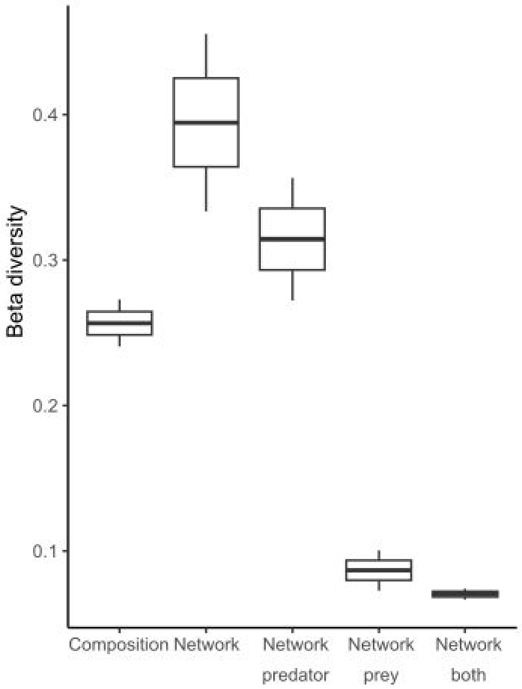


Figure 6. Compositional and network dissimilarity among local streams from the Cananeia watershed (São Paulo, Brazil) based on Bray-Curtis index. Composition = compositional beta diversity, Network = network beta diversity, Network predator = network dissimilarity caused by the absence of predator, Network prey = network dissimilarity caused by the absence of prey, Network both = network dissimilarity caused by the absence of both predators and prey.

DISCUSSION

Untangling a network of trophic interactions through integration of energetic principles has been proposed as a key new approach to understand ecosystem functioning under a comparable currency (Barnes et al., 2014). Here, we combined recently advanced methods and theories (Gauzens et al., 2019; Hernvann et al., 2022) to derive a well-resolved energetic food web from tropical rainforest and investigate the mechanisms behind its stability. By doing so, we found locally and regionally stable networks, where energy was channelized through a taxonomically diverse set of organisms, such as chironomids and stoneflies, and from small to large taxa (e.g. from chironomids to palaemonid shrimps). These food webs were stable in the face of simulated individual species extinctions with an evidenced importance of omnivorous fishes interconnecting different food web compartments at local scales and different communities at regional scales. These characteristics potentially govern food web stability at local and regional scales highlighting the roles of omnivory and alpha and beta diversity. Below, we explain these new insights for understanding the dynamics of tropical stream ecosystems and how important these mechanisms could be for anticipating the impacts of the current environmental crisis.

The relationship between organism body mass and their trophic position provides a measure of food web size structure (i.e. the extent to which larger consumers feed on small prey and whether this is at a constant ratio) (Perkins et al. 2021). Partially in contrast to our first hypothesis, there was a strong association between δ^{15}N values and body mass for fish, both within and across species, indicating that larger fish are commonly higher up the food chain. This suggests that fish predators interact within a well-defined prey size spectrum to fulfil their energetic demands, a pattern expected in simple food web compartments comprising only a limited number of functional groups (Keppeler et al., 2020). However, this pattern did not hold for invertebrates where there was no relationship, more in agreement with our second hypothesis. This lack of association indicates that invertebrate consumers feed plastically up and down the food web to meet their metabolic requirements (i.e. feeding on larger or smaller prey than expected based on their optimum predator-prey mass ratio, (Potapov et al., 2021). It has been suggested that tropical streams have a greater prevalence of omnivorous and generalist feeding than in their temperate counterparts that have proportionally more taxa from delimited trophic groups like shredders and obligatory predators (Boyero et al., 2011). This generalist feeding strategy decreases energy transfer efficiency along the food chain due to a decrease in net gains when feeding upon proportionally small or large prey (Brose et al., 2005; Stephens & Krebs, 2019). Our findings add mounting evidence that generalist macroinvertebrates at intermediate trophic positions are likely inefficient, but represent diverse conduits of energy that potentially enhance the stability of these complex systems (Collyer et al., 2023).

At the meta food web scale, 70% of the total energy flux depended on a subset of ten taxa spread over orders of magnitude in body masses (from chironomids with an average 0.2 mg per individual to large shrimps with an average of 1060 mg per individual). This may have consequences for the stability of the food web as different body masses are associated with differences in life cycles and environmental responses such as size-selective predation, size-related risks of dislodgement by hydraulic forces, and use of size-related refugia in streambeds to counter these risks (Woodward et al., 2005). Indirectly, body mass is closely related to other traits, with smaller species often exhibiting population resilience with short life cycles, rapid growth, high reproductive rates and high number of dispersal events in time (Brown et al., 2004; Saito et al., 2015). We hypothesise that having a set of invertebrates with a wide range of body masses contributing strongly to energy flow could enhance resilience to local perturbations in tropical streams. Environmental changes negatively affecting specific size classes could be compensated by organisms with different body masses, which could sustain energy flows through the food webs.

Despite the subset of macroinvertebrates that were important for energy flows in all five streams, some taxa were only important in one or two sites. This diverse set of taxa constituted approximately 30% of the total energy flow, regionally. Moreover, three key results highlight the importance of the local and regional diversity for the functioning of tropical stream food webs, where energy flows do not rely strongly on specific trophic interactions. First, we found that simulating individual extinctions did not destabilise the meta food web, nor caused any immediate secondary extinctions. However, there were associations between more stable food webs and higher prevalence of omnivory, weaker trophic interactions and lower compartmentalization. Altogether this is a direct support that omnivorous species that connect multiple compartments with weak interactions are key in sustaining stable food webs (Kratina et al., 2012). As such, we indeed found that some fish species are relatively more important for the maintenance of food web stability, which is interesting as this describes different roles a species can have in the food web. On one hand, a species can contribute highly to the total energy flux and productivity linking terrestrial and aquatic compartments through the emergence of adults, while not being strongly pivotal for the network stability (e.g. Chironomidae). On the other hand, proportionally low amounts of energy can flow through other species, but these may connect different food web compartments, allowing for higher ecosystem resilience o (e.g. omnivorous fish that connect basal resources, macroinvertebrates and other fish).

Second, local food webs were approximately 40% dissimilar among each other. A high regional diversity coupled with high spatial variation can assure that multiple species can contribute a little to the energy flow, but also that a diverse pool of potential colonisers would be able to compensate for the eventual loss of species. Indeed, we found that several size classes were regionally composed by multiple taxa that could potentially compensate for species losses. For instance, *Macrostemum* (a net-spinning caddisfly) is the main contributor to energy fluxes, that regionally have at least three other genera from the same family with fairly similar sizes co-occurring in the watershed on different densities (*Leptonema*, *Macronema*, *Smicridea*). Intriguingly, *Leptonema* and *Smicridea* were found to be the most abundant taxa in the presence of *Macrostemum* in other well preserved Atlantic Forest streams (Saito, Stoppa, et al., 2021; Siqueira et al., 2020). Tropical stream communities have been suggested to be more stochastic in terms of colonizations and demography in comparison to temperate systems due to an accelerated pace of life that leads to more dispersal events and smaller population sizes (Saito, Perkins, et al., 2021; Siqueira et al., 2020). The greater contribution of stochastic processes should render spatial and temporal variation in the relative abundance of these taxa but with potentially weak impacts for patterns of energy flow.

Third, the dissimilarity of the food webs were associated to changes in predators, rather than prey, suggesting that spatial asynchrony of mobile predators dampens variability of prey communities and stabilises food webs regionally. We found that most of the fish species sampled were only present in one or two sites out of five, while most of the smaller invertebrates were common in four to five sites. Together with the importance of omnivorous fish evidenced by our extinction simulations, we can outline a regional effect of fish beta diversity in the stability of food webs. This should happen because omnivorous fish should feed upon productive patches when resources are high and move to other patches when resources get lower, allowing recovery of resources (i.e. invertebrates) from low densities. As an example, the catfish *Rhamdia quelen*, was one of the most important taxa for food web stability and was found to move more than 300 m in two hours of observation, indicating that one individual can effectively forage across multiple stream stretches within days (Schulz &

Leuchtenberger, 2006). This spatial asynchrony in the community of larger predators within a metacommunity of small spatial extent and little environmental heterogeneity suggests that these species could operate as mobile predators connecting the different streams stabilising the meta-food web.

Despite the evidence outlining the mechanisms supporting the stability of tropical stream food webs, we describe two key limitations of our work. 1) Our study was conducted in one tropical region using five individual food webs composing one meta food web and therefore, we do not have a strong empirical gradient to test the influence of variations in species diversity, omnivory and beta diversity on stability patterns. We emphasise the need for future studies to try to disentangle such effects in studies comparing food webs across gradients using empirical data (e.g. across latitude) or experiments (mesocosm experimentations). 2) Our modelling exercise took into account the extinction of singular species and its potential effects on secondary extinctions caused by the loss of energy sources and how this could echo to destabilising the network. While accounting for realistic interactions in terms of energy flow, our simulation could not account for known mechanisms associated with secondary extinctions such as higher order interactions (Fowler, 2010) and behavioural changes with predator release (Hammerschlag et al., 2022). We emphasise how our study gives only the first steps in understanding tropical stream stability, as all these complex responses could modify real food web responses.

In summary, we found that all five tropical stream sites have energetic food webs that are stable to small perturbations. We observed two important associations: 1) diversity increases the total energy flowing up to the apex predators, 2) The presence and beta diversity of omnivorous fish stabilises local and regional food webs.

These lead us to two important mechanisms for the functioning of tropical stream food webs: (i) the diversity of body masses should buffer against size-dependent disturbances allowing high rates of productivity with higher diversity and (ii) high regional diversity and weak, non-specialized interactions buffering against local stochastic variation in species composition. These two mechanisms critically depend on the maintenance of local and regional biodiversity in tropical streams, which is known to be strongly affected by human land use intensifications from forests to monoculture plantations in different ways (Neves et al., 2023; Siqueira et al., 2015). Therefore, an urgent challenge is to understand how the systematic loss of diversity jeopardises the stability of stream food webs under human impacts and what could be the consequences for a sustainable use of resources.

References

Alvares, C. A., Stape, J. L., Sentelhas, P. C., Gonçalves, J. L. de M., Sparovek, G., & Others. (2013). Köppen's climate classification map for Brazil. *Meteorologische Zeitschrift*, *22*(6), 711–728.

Barnes, A. D., Jochum, M., Mumme, S., Haneda, N. F., Farajallah, A., Widarto, T. H., & Brose, U. (2014). Consequences of tropical land use for multitrophic biodiversity and ecosystem functioning. *Nature Communications*, *5*, 5351.

Boyero, L., Pearson, R. G., Dudgeon, D., Graça, M. A. S., Gessner, M. O., Albariño, R. J., Ferreira, V., Yule, C. M., Boulton, A. J., Arunachalam, M., Callisto, M., Chauvet, E., Ramírez, A., Chará, J., Moretti, M. S., Gonçalves, J. F., Jr, Helson, J. E., Chará-Serna, A. M., Encalada, A. C., … Pringle, C. M. (2011). Global distribution of a key trophic guild contrasts with common latitudinal diversity patterns. *Ecology*, *92*(9), 1839–1848.

Brose, U., Cushing, L., Berlow, E. L., Jonsson, T., Banasek-Richter, C., Bersier, L.-F., Blanchard, J. L., Brey, T., Carpenter, S. R., Blandenier, M.-F. C., Cohen, J. E., Dawah, H. A., Dell, T., Edwards, F., Harper-Smith, S., Jacob, U., Knapp, R. A., Ledger, M. E., Memmott, J., … Martinez, N. D. (2005). Body sizes of consumers and their resources. *Ecology*, *86*(9), 2545–2545.

Brown, J. H., Gillooly, J. F., Allen, A. P., Savage, V. M., & West, G. B. (2004). Toward a metabolic theory of ecology. *Ecology*, *85*(7), 1771–1789.

Ceneviva-Bastos, M., Casatti, L., & Uieda, V. (2012). Can seasonal differences influence food web structure on preserved habitats? Responses from two Brazilian streams. *Community Ecology*, *13*(2), 243–252.

Collyer, G., Perkins, D. M., Petsch, D. K., Siqueira, T., & Saito, V. (2023). Land-use intensification systematically alters the size structure of aquatic communities in the Neotropics. *Global Change Biology, 29*(14), 4094-4106.

Fowler, M. S. (2010). Extinction cascades and the distribution of species interactions. *Oikos* , *119*(5), 864–873.

Gauzens, B., Barnes, A., Giling, D. P., Hines, J., Jochum, M., Lefcheck, J. S., Rosenbaum, B., Wang, S., & Brose, U. (2019). fluxweb : An R package to easily estimate energy fluxes in food webs. *Methods in Ecology and Evolution*, *10*(2), 270–279.

Giakoumi, S., Halpern, B. S., Michel, L. N., Gobert, S., Sini, M., Boudouresque, C.-F., Gambi, M.-C., Katsanevakis, S., Lejeune, P., Montefalcone, M., Pergent, G., Pergent-Martini, C., Sanchez-Jerez, P., Velimirov, B., Vizzini, S., Abadie, A., Coll, M., Guidetti, P., Micheli, F., & Possingham, H. P. (2015). Towards a framework for assessment and management of cumulative human impacts on marine food webs. *Conservation Biology*, *29*(4), 1228–1234.

Glazier, D. S. (2005). Beyond the “3/4-power law”: variation in the intra- and interspecific scaling of metabolic rate in animals. *Biological Reviews*, *80*(4), 611–662.

González-Bergonzoni, I., Meerhoff, M., Davidson, T. A., Teixeira-de Mello, F., Baattrup-Pedersen, A., & Jeppesen, E. (2012). Meta-analysis Shows a Consistent and Strong Latitudinal Pattern in Fish Omnivory Across Ecosystems. *Ecosystems* , *15*(3), 492–503.

Hammerschlag, N., Fallows, C., Meÿer, M., Seakamela, S. M., Orndorff, S., Kirkman, S., Kotze, D., & Creel, S. (2022). Loss of an apex predator in the wild induces physiological and behavioural changes in prey. *Biology Letters*, *18*(1), 20210476.

Hatton, I. A., Mazzarisi, O., Altieri, A., & Smerlak, M. (2024). Diversity begets stability: Sublinear growth and competitive coexistence across ecosystems. *Science*, *383*(6688), eadg8488.

Hernvann, P.-Y., Gascuel, D., Kopp, D., Robert, M., & Rivot, E. (2022). EcoDiet: A hierarchical Bayesian model to combine stomach, biotracer, and literature data into diet matrix estimation. *Ecological Applications*, *32*(2), e2521.

Ives, A. R., & Carpenter, S. R. (2007). Stability and diversity of ecosystems. *Science*, *317*(5834), 58–62.

Keppeler, F. W., Montaña, C. G., & Winemiller, K. O. (2020). The relationship between trophic level and body size in fishes depends on functional traits. *Ecological Monographs*, *90*(4)

Kones, J. K., Soetaert, K., van Oevelen, D., & Owino, J. O. (2009). Are network indices robust indicators of food web functioning? A Monte Carlo approach. *Ecological Modelling*, *220*(3), 370–382.

Kratina, P., LeCraw, R. M., Ingram, T., & Anholt, B. R. (2012). Stability and persistence of food webs with omnivory: is there a general pattern? *Ecosphere* , *3*(6), 1–18.

Lang, B., Ehnes, R. B., Brose, U., & Rall, B. C. (2017). Temperature and consumer type dependencies of energy flows in natural communities. *Oikos* , *126*(12), 1717–1725.

Latham, L. G. (2006). Network flow analysis algorithms. *Ecological Modelling*, *192*(3), 586–600.

Layman, C. A., Araujo, M. S., Boucek, R., Hammerschlag-Peyer, C. M., Harrison, E., Jud, Z. R., Matich, P., Rosenblatt, A. E., Vaudo, J. J., Yeager, L. A., Post, D. M., & Bearhop, S. (2012). Applying stable isotopes to examine food-web structure: an overview of analytical tools. *Biological Reviews*, *87*(3), 545–562.

Legendre, P. (2014). Interpreting the replacement and richness difference components of beta diversity. *Global Ecology and Biogeography*, *23*(11), 1324–1334.

May, R. M. (1973). Qualitative stability in model ecosystems. *Ecology*, *54*(3), 638–641.

McCann, K. S. (2000). The diversity–stability debate. *Nature*, *405*(6783), 228–233.

Meyer, J. L. (1997). Stream health: Incorporating the human dimension to advance stream ecology. *Journal of the North American Benthological Society*, *16*(2), 439–447.

Moore, J. C., & de Ruiter, P. C. (2012). *Energetic Food Webs: An Analysis of Real and Model Ecosystems*. Oxford University Press.

Motta, R. L., & Uieda, V. S. (2005). Food web structure in a tropical stream ecosystem. *Austral Ecology*, *30*(1), 58–73.

Neutel, A.-M., Heesterbeek, J. A. P., & De Ruiter, P. C. (2002). Stability in real food webs: weak links in long loops. *Science*, *296*(5570), 1120–1123.

Neves, M. P., Delariva, R. L., Perkins, D. M., Fialho, C. B., & Kratina, P. (2023). Trophic plasticity of omnivorous fishes in natural and human-dominated landscapes. *Limnology and Oceanography*

Novotny, V. (2009). Beta diversity of plant–insect food webs in tropical forests: a conceptual framework. *Insect Conservation and Diversity*, *2*(1), 5–9.

Palmer, M. A., Filoso, S., & Fanelli, R. M. (2014). From ecosystems to ecosystem services: Stream restoration as ecological engineering. *Ecological Engineering*, *65*, 62–70.

Perkins, D. M., Durance, I., Edwards, F. K., Grey, J., Hildrew, A. G., Jackson, M., Jones, J. I., Lauridsen, R. B., Layer-Dobra, K., Thompson, M. S. A., & Woodward, G. (2018). Bending the rules: exploitation of allochthonous resources by a top-predator modifies size-abundance scaling in stream food webs. *Ecology Letters*, *21*(12), 1771–1780.

Pimm, S. L., & Lawton, J. H. (1980). Are food webs divided into compartments? *The Journal of Animal Ecology*, *49*(3), 879.

Potapov, A. M., Rozanova, O. L., Semenina, E. E., Leonov, V. D., Belyakova, O. I., Bogatyreva, V. Y., Degtyarev, M. I., Esaulov, A. S., Korotkevich, A. Y., Kudrin, A. A., Malysheva, E. A., Mazei, Y. A., Tsurikov, S. M., Zuev, A. G., & Tiunov, A. V. (2021). Size compartmentalization of energy channeling in terrestrial belowground food webs. *Ecology*, *102*(8), e03421.

Reboredo Segovia, A. L., Romano, D., & Armsworth, P. R. (2020). Who studies where? Boosting tropical conservation research where it is most needed. *Frontiers in*

Ecology and the Environment, *18*(3), 159–166.

Rooney, N., & McCann, K. S. (2012). Integrating food web diversity, structure and stability. *Trends in Ecology & Evolution*, *27*(1), 40–46.

Rooney, N., McCann, K. S., & Moore, J. C. (2008). A landscape theory for food web architecture. *Ecology Letters*, *11*(8), 867–881.

Saito, V. S., Perkins, D. M., & Kratina, P. (2021). A Metabolic Perspective of Stochastic Community Assembly. *Trends in Ecology & Evolution*, *36*(4), 280–283.

Saito, V. S., Soininen, J., Fonseca-Gessner, A. A., & Siqueira, T. (2015). Dispersal traits drive the phylogenetic distance decay of similarity in Neotropical stream metacommunities. *Journal of Biogeography*, *42*(11), 2101–2111.

Saito, V. S., Stoppa, N. E., Shimabukuro, E. M., Cañedo-Argüelles, M., Bonada, N., & Siqueira, T. (2021). Stochastic colonisation dynamics can be a major driver of temporal β diversity in Atlantic Forest coastal stream communities. *Freshwater Biology*, *66*(8), 1560–1570.

Schaeffer-Novelli, Y., de Souza Lima Mesquita, H., Cintrón-Molero, G., & Cintron-Molero, G. (1990). The Cananéia Lagoon Estuarine System, São Paulo, Brazil. *Estuaries*, *13*(2), 193.

Schulz, U. H., & Leuchtenberger, C. (2006). Activity patterns of South American silver catfish (*Rhamdia quelen*). *Brazilian Journal of Biology*, *66*(2A), 565–574.

Siqueira, T., Hawkins, C. P., Olden, J. D., Tonkin, J., Comte, L., Saito, V. S., Anderson, T. L., Barbosa, G. P., Bonada, N., Bonecker, C. C., Cañedo-Argüelles, M., Datry, T., Flinn, M. B., Fortuño, P., Gerrish, G. A., Haase, P., Hill, M. J., Hood, J. M., Huttunen, K.-L., … Ruhi, A. (2024). Understanding temporal variability across trophic levels and spatial scales in freshwater ecosystems. *Ecology*, *105*(2), e4219.

Siqueira, T., Lacerda, C. G.-L. T., & Saito, V. S. (2015). How does landscape modification induce biological homogenization in tropical stream metacommunities? *Biotropica*, *47*(4), 509–516.

Siqueira, T., Saito, V. S., Bini, L. M., Melo, A. S., Petsch, D. K., Landeiro, V. L., Tolonen, K. T., Jyrkänkallio-Mikkola, J., Soininen, J., & Heino, J. (2020). Community size can affect the signals of ecological drift and niche selection on biodiversity. *Ecology*, *101*(6), e03014.

Stephens, D. W., & Krebs, J. R. (2019). *Foraging Theory*. Princeton University Press.

White, E. P., Ernest, S. K. M., Kerkhoff, A. J., & Enquist, B. J. (2007). Relationships between body size and abundance in ecology. *Trends in Ecology & Evolution*, *22*(6), 323–330.

Winemiller, K. O. (1990). Spatial and Temporal Variation in Tropical Fish Trophic Networks. *Ecological Monographs*, *60*(3), 331–367.

Woodward, G., Ebenman, B., Emmerson, M., Montoya, J. M., Olesen, J. M., Valido, A., & Warren, P. H. (2005). Body size in ecological networks. *Trends in Ecology & Evolution*, *20*(7), 402–409.

Yodzis, P. (1981). The stability of real ecosystems. *Nature*, *289*(5799), 674–676.

Untangling the complex food webs of tropical rainforest streams

Supporting Information

Table S1. Physical and chemical water variables in 5 stream stretches in Cananeia (São Paulo, Brazil).

site	replicate	Temperature C°	pH	ORP mv	mS/cm	mg/L OD	% OD	TPS
S8A	1	23.06	4.79	454		14.61	174	0.023
S8A	2	22.63	5.79	430		12.3	136	0.033
S8A	3	21.34	5.09	454	0.037	14.15	165.4	0.024
S1	1	23.35	6.64	372	0.035	13.97	167.6	0.023
S1	2	23.12	6.58	392	0.034	13.06	156.1	0.022
S1	3	23.08	6.54	401	0.035	12.36	147.6	0.023
S6	1	21.65	6.3	396	0.034	14.68	171	0.022
S6	2	22.63	6.36	416	0.034	13.54	157.7	0.022
S6	3	22.59	6.27	426	0.034	15.2	176.9	0.022
S8C	1	21.72	5.71	352	0.035	14.19	165.5	0.023
S8C	2	21.65	5.62	359	0.034	13.91	162	0.022
S8C	3	21.66	5.55	355	0.035	13.27	154.6	0.022
S8B	1	21.92	5.11	459	0.024	10.59	123.9	0.016
S8B	2	21.73	5	456	0.036	13.07	152.7	0.024
S8B	3	21.68	4.91	4.58	0.036	10.89	126.9	0.024

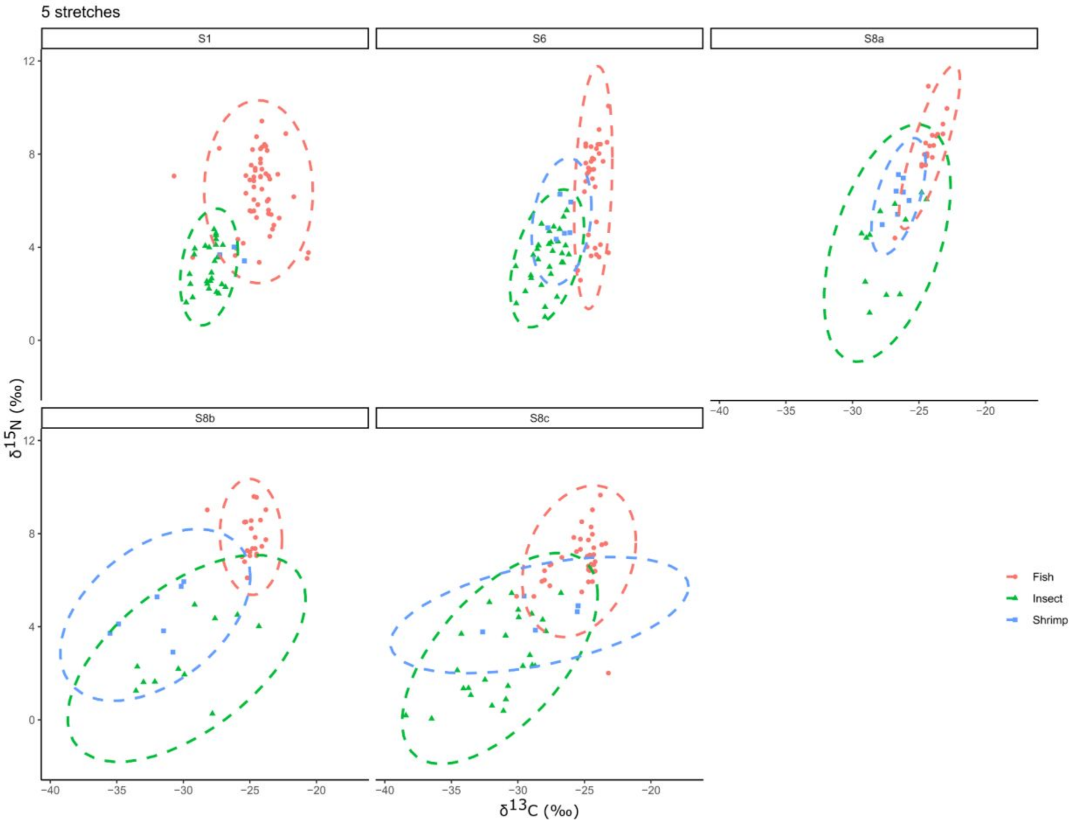


Figure S1. The isotopic signature of consumers for δ13C and δ15N for five stretches from the Cananeia watershed.

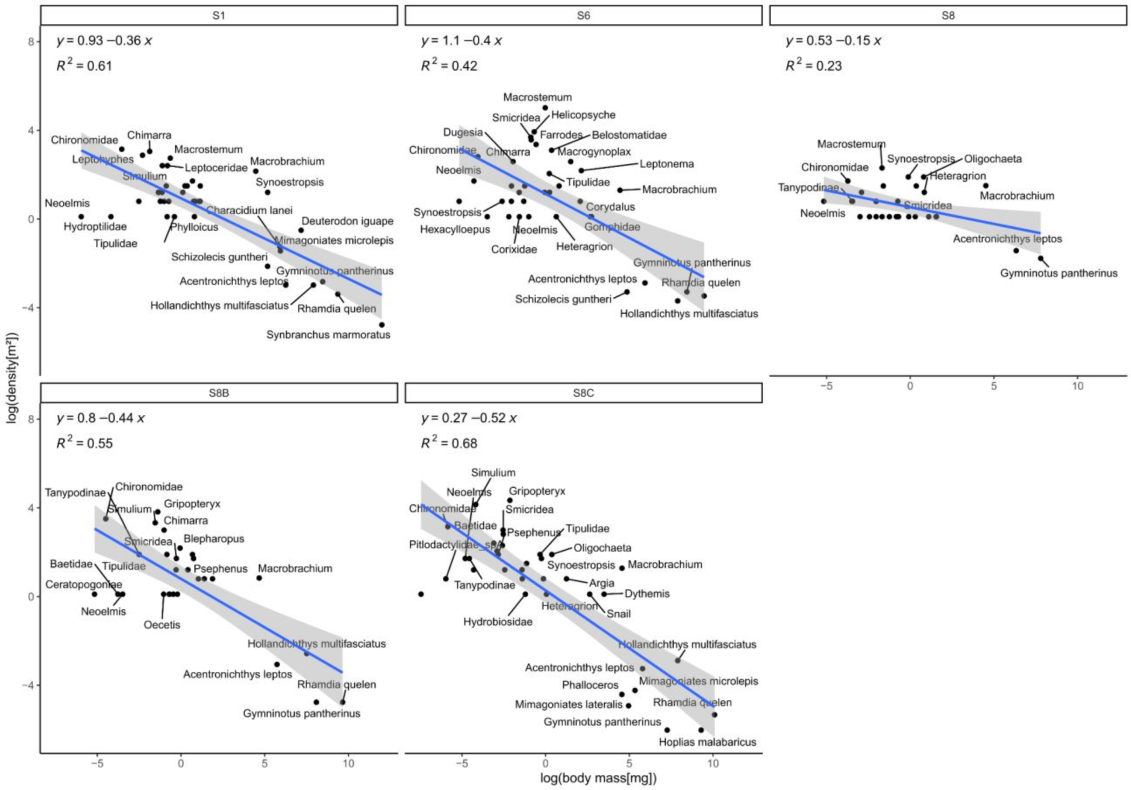


Figure S2. Local size density plot for stretches at the Cananeia watershed. Average body-masses are regressed against their summed abundances. Equations and R² are associated with linear regressions.

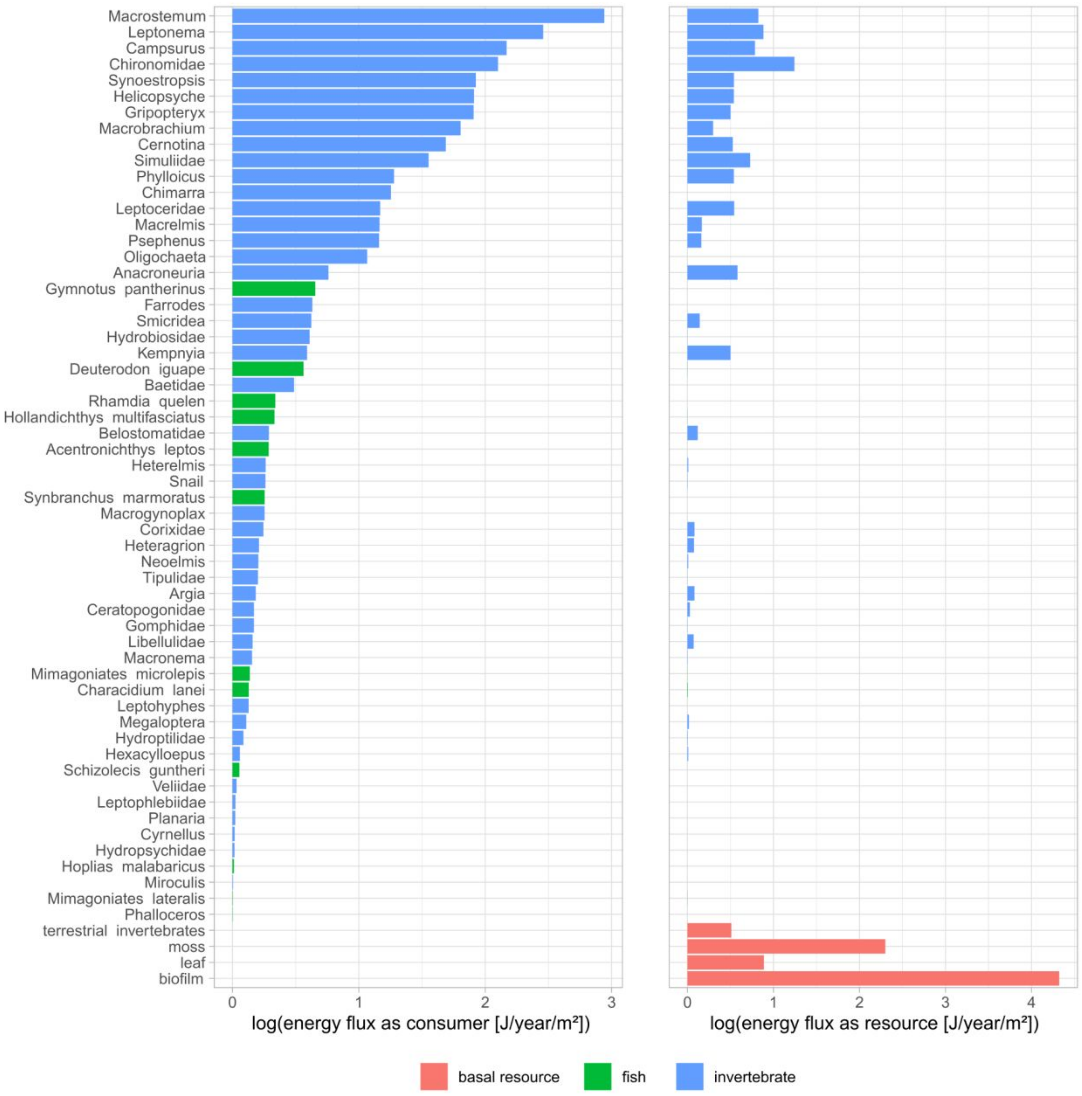


Figure S3. The proportion of energy flowing through each node in the stream meta food web from Cananeia (Brazil). Left: Energy flowing as consumers. Right: Energy flowing as resources.

Table S2. Network indices for the meta food web and individual food webs from the Cananeia watershed. See methods for the description of each index.

	Meta food web	S1	S6	S8	S8B	S8C
N nodes	65	41	38	28	28	35
N links	307	171	129	73	78	132
Link density	5,032787	4,170732	3,394737	2,607143	2,785714	3,771429
Connectance	0,08388	0,104268	0,09175	0,096561	0,103175	0,110924
Average link weight	0,836826	0,798652	0,888517	0,825698	0,798346	0,820007
Compartmentalization	0,180084	0,20211	0,186202	0,226761	0,235359	0,200116
Mean trophic level	2,35	2,21	2,24	2,17	2,11	2,24
Mean omnivory	0,12	0,11	0,11	0,10	0,09	0,15

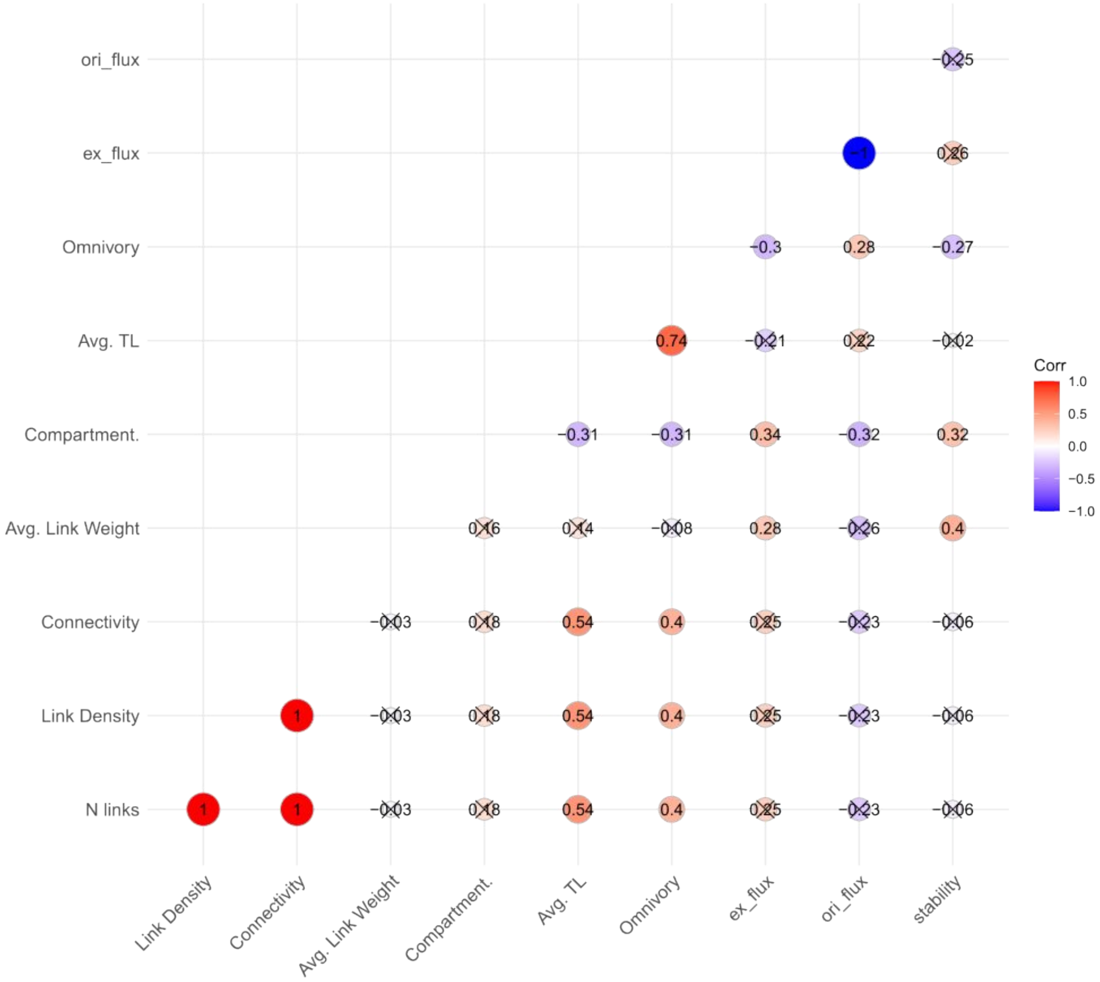


Figure S4. Correlation matrix between food web metrics and the stability of the meta food web. The stability was calculated as the maximum negative eigenvalue of the Jacobian matrix using a Lotka-Volterra approach. In this case, the more negative the value, the higher the resilience to disturbances.

Sensitivity analyses

We applied the fluxweb approach, which infers the amount of energy flowing through each population considering a steady-state system (Gauzens et al., 2019). The fluxweb method considers a top-down perspective where the energetic requirement of each consumer species is calculated from the mean body mass of that species, and its population density, balanced against the population biomasses of their prey. In this balanced system, gains G_i are balanced with losses L_i which are calculated as

$$L_i = X_i + \sum_j F_{ij} , \qquad \text{(eq. 1)}$$

where X_i defines species losses (e.g. metabolic costs or death rates) and F_{ij} is the flux of energy from species *i* to predator *j*. In this case, gain G_i is defined as

$$G_i = \sum_j F_{ji} e_{ij} , \qquad \text{(eq. 2)}$$

where F_{ji} defines the influx coming from other species depending on a diet proportion (estimated with Ecodiet in our study) and e_{ij} denotes the efficiency in energy uptake given the prey identity (see below). In our study, the metabolic cost X_i was defined from the allometric equations (Brown et al. 2004)

$$X_i = X_0 M_i^b , \qquad \text{(eq. 3)}$$

where X_0 and *b* are constants related to organismal physiologies and M_i is a given body mass. In the main text, we defined X_0 equal to 18.18 for fishes, 17.17 for invertebrates, and *b* equal -0.29 for all organisms following Brown et al. (2004). Efficiencies were defined at prey level and set to 0.906, 0.545 and 0.158

for animals, plants and detritus, respectively (i.e. consumers feeding on animals have higher efficiencies per unit of mass consumed) (Gauzens et al., 2019). Here, we present the results from sensitivity analyses applying different values for *b* and efficiencies. For the metabolic exponent *b*, we considered the values from a review of metabolic rates across organisms and ontogenetic development (Glazier, 2005). In this study, he identified that metabolic rate exponents are commonly ⅔, ¾, and 1 (isometric scaling). Therefore, to consider such variation we also used the values of *b* considering these three different exponents. For the efficiency values, we considered the minimum and maximum values of the 95% confidence interval modeled in a systematic assessment of efficiencies and respiration in natural communities (Lang et al., 2017).

We observed stable meta food webs using the confidence interval of maximum and minimum efficiency during fluxweb calculations with the maximum eigenvalue of -23.8 for the minimum efficiencies and -16.19 for the maximum efficiencies. Therefore, we had no qualitative changes in our main conclusion of observing a stable meta food web in our studied system.

We found that the meta food web was insensitive to the variation in the *b* values, with negative maximum eigenvalues of the Jacobian matrices for exponents ⅔ and ¾. When the scaling was isometric, meaning that metabolic rate is constant, the meta food web was unstable. This is because populations of larger individuals have higher energetic costs with isometric scaling and therefore demand more energy flowing through the food web in comparison to situations with allometric scaling of metabolic rates with exponents <1. This was indeed the case in our meta food web as two of the largest fish species (*Rhamdia quelen* and *Synbranchus marmoratus*) had positive eigenvalues in the stability analyses and therefore cannot be sustained in the meta food web. As the isometric metabolic rate has been extensively demonstrated for pelagic, but not benthic organisms (Glazier 2005), we have little evidence that this is the most realistic scenario to represent our system.

link.id	resource	preference	resource.li	consumer	consumer.	link.eviden	source.id
271	Acarina	medium	NA	Characidium lanei	NA	gut	38
282	Acarina	low	NA	Characidium lanei	NA	gut	39
384	Acarina	medium	NA	Mimagoniates lateralis	NA	gut	40
397	Acarina	medium	NA	Mimagoniates lateralis	NA	gut	46
417	Acarina	medium	NA	Mimagoniates microlepis	NA	gut	40
430	Acarina	medium	NA	Mimagoniates microlepis	NA	gut	46
481	Acarina	low	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	44
326	algae	low	NA	Gymninotus pantherinus (Gymnotus?)	NA	gut	40
382	algae	low	NA	Mimagoniates lateralis	NA	gut	40
415	algae	low	NA	Mimagoniates microlepis	NA	gut	40
440	algae	high	NA	Phalloceros harpagos	NA	gut	46
449	algae	low	NA	Phalloceros harpagos	NA	gut	42
459	algae	high	NA	Phalloceros harpagos	NA	gut	40
469	algae	low	NA	Phalloceros harpagos	NA	gut	34
520	algae	high	NA	Schizolecis guntheri	NA	gut	46
138	allochtonous_vegetation	low	NA	Macrobrachium_(<2cmBL)	NA	isotope_ar	18
142	allochtonous_vegetation	high	NA	Macrobrachium_(>4.5cmBL)	NA	isotope_ar	18
146	allochtonous_vegetation	low	NA	Macrobrachium_(2<4.5cmBL)	NA	isotope_ar	18
490	Amphipoda	low	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	44
1	animal_tissues	high	NA	Anacroneuria	larvae	gut	1
64	animal_tissues	medium	NA	Dythemis	larvae	isotope	14
70	animal_tissues	medium	NA	Gomphidae	larvae	gut	16
78	animal_tissues	high	NA	Heteragrion	larvae	isotope	14
95	animal_tissues	high	NA	Kempnyia	larvae	gut	1
130	animal_tissues	medium	NA	Libellulidae_spA	larvae	isotope	14
139	animal_tissues	high	NA	Macrobrachium_(<2cmBL)	NA	isotope_ar	18
143	animal_tissues	high	NA	Macrobrachium_(>4.5cmBL)	NA	isotope_ar	18
147	animal_tissues	high	NA	Macrobrachium_(2<4.5cmBL)	NA	isotope_ar	18
150	animal_tissues	high	NA	Macrogynoplax	larvae	gut	1
240	Annelida	low	NA	Acentroniechlis leptos (correct name is Acentronichthys)	NA	gut	35
283	Annelida	low	NA	Deuterodon iguape	NA	gut	35

367	Anura	low	NA	Hoplias malabaricus	NA	gut	45
241	Arachnida	low	NA	Acentroniechlis leptos (correct name is Acentronichthys)	NA	gut	35
268	Arachnida	low	NA	Characidium lanei	NA	gut	37
284	Arachnida	low	NA	Deuterodon iguape	NA	gut	35
315	Arachnida	low	NA	Deuterodon iguape	NA	gut	38
375	Arachnida	low	NA	Mimagoniates lateralis	NA	gut	35
408	Arachnida	low	NA	Mimagoniates microlepis	NA	gut	35
369	Astyanax janeiroensis	high	NA	Hoplias malabaricus	NA	gut	45
391	Baccilariophyceae	medium	NA	Mimagoniates lateralis	NA	gut	46
424	Baccilariophyceae	medium	NA	Mimagoniates microlepis	NA	gut	46
453	Baccilariophyceae	high	NA	Phalloceros harpagos	NA	gut	46
515	Baccilariophyceae	high	NA	Schizolecis guntheri	NA	gut	46
508	Bacillariophyta	high	NA	Schizolecis guntheri	NA	gut	49
187	Bacteria	high	NA	Oligochaeta_spA	NA	gut	23
339	Belostomatidae	low	NA	Hollandichthys multifasciatus	NA	gut	43
210	Bryozoa	low	NA	Synoestropsis	larvae	gut	27
288	Bryozoa	low	NA	Deuterodon iguape	NA	gut	35
13	Calamoceratidae	high	larvae	Anacroneuria	larvae	gut	3
107	Calamoceratidae	high	larvae	Kempnyia	larvae	gut	3
162	Calamoceratidae	high	larvae	Macrogynoplax	larvae	gut	3
252	Chelicerata	low	NA	Characidium lanei	NA	gut	36
6	Chironomidae	high	larvae	Anacroneuria	larvae	gut	2
14	Chironomidae	high	larvae	Anacroneuria	larvae	gut	3
26	Chironomidae	high	larvae	Anacroneuria	larvae	gut	16
30	Chironomidae	high	larvae	Argia	larvae	gut	16
52	Chironomidae	high	larvae	Corixidae	adult	trial	11
65	Chironomidae	high	larvae	Dythemis	larvae	gut	16
71	Chironomidae	high	larvae	Gomphidae	larvae	gut	16
79	Chironomidae	high	larvae	Heteragrion	larvae	gut	16
100	Chironomidae	high	larvae	Kempnyia	larvae	gut	2
108	Chironomidae	high	larvae	Kempnyia	larvae	gut	3

131	Chironomidae	high	larvae	Libellulidae_spA	larvae	gut	16
155	Chironomidae	high	larvae	Macrogynoplax	larvae	gut	2
163	Chironomidae	high	larvae	Macrogynoplax	larvae	gut	3
175	Chironomidae	high	larvae	Macrogynoplax	larvae	gut	16
211	Chironomidae	low	larvae	Synoestropsis	larvae	gut	27
231	Chironomidae	high	larvae	Acentroniechlis leptos (correct name is Acentronichthys)	NA	gut	32
278	Chironomidae	high	larvae	Characidium lanei	NA	gut	39
320	Chironomidae	medium	larvae	Deuterodon iguape	NA	gut	38
328	Chironomidae	high	larvae	Gymninotus pantherinus (Gymnotus?)	NA	gut	40
337	Chironomidae	high	larvae	Hollandichthys multifasciatus	NA	gut	43
387	Chironomidae	medium	larvae	Mimagoniates lateralis	NA	gut	40
420	Chironomidae	medium	larvae	Mimagoniates microlepis	NA	gut	40
445	Chironomidae	low	larvae	Phalloceros harpagos	NA	gut	46
473	Chironomidae	high	larvae	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	47
511	Chironomidae	low	larvae	Schizolecis guntheri	NA	gut	49
525	Chironomidae	high	larvae	Symbranchus marmoratus (Synbranchus)	NA	gut	51
392	Chlorophyceae	medium	NA	Mimagoniates lateralis	NA	gut	46
425	Chlorophyceae	medium	NA	Mimagoniates microlepis	NA	gut	46
454	Chlorophyceae	high	NA	Phalloceros harpagos	NA	gut	46
509	Chlorophyceae	high	NA	Schizolecis guntheri	NA	gut	49
516	Chlorophyceae	high	NA	Schizolecis guntheri	NA	gut	46
7	Coleoptera	high	larvae	Anacroneuria	larvae	gut	2
101	Coleoptera	high	larvae	Kempnyia	larvae	gut	2
156	Coleoptera	high	larvae	Macrogynoplax	larvae	gut	2
465	Coleoptera	low	larvae	Phalloceros harpagos	NA	gut	32
483	Coleoptera	low	larvae	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	44
494	Coleoptera	low	larvae	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	48
257	Coleoptera	low	NA	Characidium lanei	NA	gut	36
266	Coleoptera	low	NA	Characidium lanei	NA	gut	37
274	Coleoptera	high	NA	Characidium lanei	NA	gut	38
243	Collembola	low	NA	Acentroniechlis leptos (correct name is Acentronichthys)	NA	gut	35

281	Collembola	low	NA	Characidium lanei	NA	gut	39
307	Copepoda	low	NA	Deuterodon iguape	NA	gut	32
230	Crustacea	low	NA	Acentroniechlis leptos (correct name is Acentronichthys)	NA	gut	32
242	Crustacea	low	NA	Acentroniechlis leptos (correct name is Acentronichthys)	NA	gut	35
285	Crustacea	low	NA	Deuterodon iguape	NA	gut	35
323	Crustacea	high	NA	Gymninotus pantherinus (Gymnotus?)	NA	gut	33
340	Crustacea	low	NA	Hollandichthys multifasciatus	NA	gut	43
348	Crustacea	medium	NA	Hollandichthys multifasciatus	NA	gut	33
357	Crustacea	low	NA	Hollandichthys multifasciatus	NA	gut	35
359	Crustacea	high	NA	Hoplias malabaricus	NA	gut	33
361	Crustacea	high	NA	Hoplias malabaricus	NA	gut	40
363	Crustacea	high	NA	Hoplias malabaricus	NA	gut	44
376	Crustacea	medium	NA	Mimagoniates lateralis	NA	gut	35
396	Crustacea	medium	NA	Mimagoniates lateralis	NA	gut	46
409	Crustacea	medium	NA	Mimagoniates microlepis	NA	gut	35
429	Crustacea	medium	NA	Mimagoniates microlepis	NA	gut	46
477	Crustacea	high	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	44
513	Crustacea	low	NA	Schizolecis guntheri	NA	gut	49
510	Cyanophyta	low	NA	Schizolecis guntheri	NA	gut	49
517	Cyanophyta	high	NA	Schizolecis guntheri	NA	gut	46
486	Decapoda	high	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	44
495	Decapoda	high	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	48
117	detritus	low	larvae	Kempnyia	larvae	gut	4
172	detritus	low	larvae	Macrogynoplax	larvae	gut	4
2	detritus	low	NA	Anacroneuria	larvae	gut	1
23	detritus	low	NA	Anacroneuria	larvae	gut	4
34	detritus	high	NA	Baetidae	larvae	review	6
40	detritus	high	NA	Campsurus	larvae	gut	9
41	detritus	low	NA	Ceratopogoniae	larvae	gut	4
45	detritus	high	NA	Chimarra	larvae	gut	4
47	detritus	high	NA	Chironomidae	larvae	gut	9

56	detritus	high	NA	Cyrnellus	larvae	gut	12
69	detritus	high	NA	Farrodes	larvae	gut	15
74	detritus	high	NA	Gripopteryx	larvae	gut	17
76	detritus	high	NA	Helicopsyche	larvae	gut	4
82	detritus	high	NA	Heterelmis_a	larvae	gut	4
84	detritus	high	NA	Heterelmis_l	larvae	gut	4
86	detritus	high	NA	Hexacylloepus_l	larvae	gut	4
88	detritus	low	NA	Hydrobiosidae	larvae	gut	4
91	detritus	high	NA	Hydropsychidae_spA	larvae	gut	4
96	detritus	low	NA	Kempnyia	larvae	gut	1
120	detritus	high	NA	Leptoceridae	larvae	gut	4
123	detritus	high	NA	Leptohyphes	larvae	gut	4
125	detritus	high	NA	Leptonema	larvae	gut	4
128	detritus	high	NA	Leptophlebiidae_spA	larvae	gut	15
134	detritus	high	NA	Macrelmis_a	adult	gut	4
136	detritus	high	NA	Macrelmis_l	larvae	gut	4
140	detritus	high	NA	Macrobrachium_(<2cmBL)	NA	isotope_ar	18
144	detritus	high	NA	Macrobrachium_(>4.5cmBL)	NA	isotope_ar	18
148	detritus	high	NA	Macrobrachium_(2<4.5cmBL)	NA	isotope_ar	18
151	detritus	low	NA	Macrogynoplax	larvae	gut	1
178	detritus	low	NA	Macronema	larvae	gut	20
180	detritus	high	NA	Miroculis	larvae	gut	21
182	detritus	high	NA	Neoelmis_a	adult	gut	4
184	detritus	high	NA	Neoelmis_l	larvae	gut	4
188	detritus	low	NA	Oligochaeta_spA	NA	gut	23
189	detritus	high	NA	Phylloicus	larvae	gut	24
193	detritus	high	NA	Psephenus	larvae	gut	4
198	detritus	high	NA	Smicridea	larvae	gut	4
202	detritus	high	NA	Smicridea	larvae	gut	26
220	detritus	high	NA	Tanypodinae	larvae	gut	28
287	Detritus	high	NA	Deuterodon iguape	NA	gut	35

296	Detritus	low	NA	Deuterodon iguape	NA	gut	34
299	Detritus	low	NA	Deuterodon iguape	NA	gut	33
305	Detritus	low	NA	Deuterodon iguape	NA	gut	32
321	Detritus	high	NA	Deuterodon iguape	NA	gut	38
324	Detritus	high	NA	Gymninotus pantherinus (Gymnotus?)	NA	gut	33
344	Detritus	high	NA	Hollandichthys multifasciatus	NA	gut	32
351	Detritus	low	NA	Hollandichthys multifasciatus	NA	gut	33
438	Detritus	high	NA	Phalloceros harpagos	NA	gut	46
452	Detritus	high	NA	Phalloceros harpagos	NA	gut	42
467	Detritus	high	NA	Phalloceros harpagos	NA	gut	32
470	Detritus	high	NA	Phalloceros harpagos	NA	gut	34
471	Detritus	high	NA	Phalloceros harpagos	NA	gut	35
476	Detritus	low	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	47
491	Detritus	low	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	44
195	diatoms	high	NA	Simulium	larvae	gut	25
203	diatoms	high	NA	Smicridea	larvae	gut	26
212	diatoms	medium	NA	Synoestropsis	larvae	gut	27
221	diatoms	medium	NA	Tanypodinae	larvae	gut	28
301	Diatoms	high	NA	Deuterodon iguape	NA	gut	32
311	Diatoms	high	NA	Deuterodon iguape	NA	gut	38
461	Diatoms	high	NA	Phalloceros harpagos	NA	gut	32
286	Diplopoda	low	NA	Deuterodon iguape	NA	gut	35
260	Diptera	high	larvae	Characidium lanei	NA	gut	36
267	Diptera	high	larvae	Characidium lanei	NA	gut	37
276	Diptera	high	larvae	Characidium lanei	NA	gut	38
497	Diptera	low	larvae	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	48
444	Dytiscidae	low	larvae	Phalloceros harpagos	NA	gut	46
400	eggs	low	NA	Mimagoniates lateralis	NA	gut	46
433	eggs	low	NA	Mimagoniates microlepis	NA	gut	46
503	eggs	low	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	48
8	Ephemeroptera	high	larvae	Anacroneuria	larvae	gut	2

27	Ephemeroptera	high	larvae	Anacroneuria	larvae	gut	16
31	Ephemeroptera	high	larvae	Argia	larvae	gut	16
66	Ephemeroptera	high	larvae	Dythemis	larvae	gut	16
72	Ephemeroptera	high	larvae	Gomphidae	larvae	gut	16
80	Ephemeroptera	high	larvae	Heteragrion	larvae	gut	16
102	Ephemeroptera	high	larvae	Kempnyia	larvae	gut	2
132	Ephemeroptera	high	larvae	Libellulidae_spA	larvae	gut	16
157	Ephemeroptera	high	larvae	Macrogynoplax	larvae	gut	2
176	Ephemeroptera	high	larvae	Macrogynoplax	larvae	gut	16
213	Ephemeroptera	low	larvae	Synoestropsis	larvae	gut	27
253	Ephemeroptera	high	larvae	Characidium lanei	NA	gut	36
272	Ephemeroptera	high	larvae	Characidium lanei	NA	gut	38
279	Ephemeroptera	high	larvae	Characidium lanei	NA	gut	39
316	Ephemeroptera	medium	larvae	Deuterodon iguape	NA	gut	38
327	Ephemeroptera	high	larvae	Gymninotus pantherinus (Gymnotus?)	NA	gut	40
385	Ephemeroptera	medium	larvae	Mimagoniates lateralis	NA	gut	40
401	Ephemeroptera	high	larvae	Mimagoniates lateralis	NA	gut	45
418	Ephemeroptera	medium	larvae	Mimagoniates microlepis	NA	gut	40
434	Ephemeroptera	high	larvae	Mimagoniates microlepis	NA	gut	45
441	Ephemeroptera	low	larvae	Phalloceros harpagos	NA	gut	46
488	Ephemeroptera	low	larvae	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	44
496	Ephemeroptera	low	larvae	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	48
121	filamentous_algae	low	NA	Leptoceridae	larvae	gut	4
204	filamentous_algae	high	NA	Smicridea	larvae	gut	26
302	filamentous_algae	high	NA	Deuterodon iguape	NA	gut	32
312	filamentous_algae	high	NA	Deuterodon iguape	NA	gut	38
393	filamentous_algae	low	NA	Mimagoniates lateralis	NA	gut	46
426	filamentous_algae	low	NA	Mimagoniates microlepis	NA	gut	46
456	filamentous_algae	high	NA	Phalloceros harpagos	NA	gut	46
462	filamentous_algae	high	NA	Phalloceros harpagos	NA	gut	32
492	filamentous_algae	low	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	48

519	filamentous_algae	high	NA	Schizolecis guntheri	NA	gut	46
35	fish	low	NA	Belostomatidae	adult	trial	7
234	fish	low	NA	Acentroniechlis leptos (correct name is Acentronichthys)	NA	gut	32
308	fish	low	NA	Deuterodon iguape	NA	gut	32
333	fish	low	NA	Gymninotus pantherinus (Gymnotus?)	NA	gut	41
360	fish	low	NA	Hoplias malabaricus	NA	gut	33
362	fish	medium	NA	Hoplias malabaricus	NA	gut	40
364	fish	high	NA	Hoplias malabaricus	NA	gut	44
448	fish	low	NA	Phalloceros harpagos	NA	gut	46
472	fish	low	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	47
478	fish	high	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	44
489	fish	low	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	44
504	fish	high	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	48
526	fish	high	NA	Symbranchus marmoratus (Synbranchus)	NA	gut	52
529	fish	low	NA	Symbranchus marmoratus (Synbranchus)	NA	gut	34
350	fruits_seeds	high	NA	Hollandichthys multifasciatus	NA	gut	33
205	fungi	low	NA	Smicridea	larvae	gut	26
36	Gastropoda	high	NA	Belostomatidae	adult	trial	7
60	Gastropoda	low	NA	Dugesia	NA	trial	13
484	Gastropoda	low	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	44
370	Geophagus brasiliensis	high	NA	Hoplias malabaricus	NA	gut	45
15	Glossomatidae	high	larvae	Anacroneuria	larvae	gut	3
109	Glossomatidae	high	larvae	Kempnyia	larvae	gut	3
164	Glossomatidae	high	larvae	Macrogynoplax	larvae	gut	3
256	Hemiptera	low	NA	Characidium lanei	NA	gut	36
265	Hemiptera	low	NA	Characidium lanei	NA	gut	37
318	Hemiptera	medium	NA	Deuterodon iguape	NA	gut	38
485	Hemiptera	low	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	44
498	Hemiptera	low	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	48
16	Hydrobiosidae	high	larvae	Anacroneuria	larvae	gut	3
110	Hydrobiosidae	high	larvae	Kempnyia	larvae	gut	3

165	Hydrobiosidae	high	larvae	Macrogynoplax	larvae	gut	3
17	Hydroptilidae	high	larvae	Anacroneuria	larvae	gut	3
111	Hydroptilidae	high	larvae	Kempnyia	larvae	gut	3
166	Hydroptilidae	high	larvae	Macrogynoplax	larvae	gut	3
227	Insects	high	NA	Acentroniechlis leptos (correct name is Acentronichthys)	NA	gut	31
236	insects	high	NA	Acentroniechlis leptos (correct name is Acentronichthys)	NA	gut	33
238	insects	high	NA	Acentroniechlis leptos (correct name is Acentronichthys)	NA	gut	34
245	insects	high	NA	Acentroniechlis leptos (correct name is Acentronichthys)	NA	gut	35
246	insects	high	NA	Characidium lanei	NA	gut	34
249	insects	high	NA	Characidium lanei	NA	gut	33
290	insects	high	NA	Deuterodon iguape	NA	gut	35
293	insects	high	NA	Deuterodon iguape	NA	gut	34
300	insects	medium	NA	Deuterodon iguape	NA	gut	33
306	insects	high	NA	Deuterodon iguape	NA	gut	32
322	insects	high	NA	Gymninotus pantherinus (Gymnotus?)	NA	gut	33
329	insects	high	NA	Gymninotus pantherinus (Gymnotus?)	NA	gut	40
334	insects	low	NA	Gymninotus pantherinus (Gymnotus?)	NA	gut	41
335	insects	high	NA	Gymninotus pantherinus (Gymnotus?)	NA	gut	42
345	insects	high	NA	Hollandichthys multifasciatus	NA	gut	32
347	insects	high	NA	Hollandichthys multifasciatus	NA	gut	33
356	insects	high	NA	Hollandichthys multifasciatus	NA	gut	35
377	insects	high	NA	Mimagoniates lateralis	NA	gut	35
379	insects	high	NA	Mimagoniates lateralis	NA	gut	34
381	insects	low	NA	Mimagoniates lateralis	NA	gut	33
388	insects	high	NA	Mimagoniates lateralis	NA	gut	40
399	insects	high	NA	Mimagoniates lateralis	NA	gut	46
410	insects	high	NA	Mimagoniates microlepis	NA	gut	35
412	insects	high	NA	Mimagoniates microlepis	NA	gut	34
414	insects	low	NA	Mimagoniates microlepis	NA	gut	33
421	insects	high	NA	Mimagoniates microlepis	NA	gut	40
432	insects	high	NA	Mimagoniates microlepis	NA	gut	46

450	insects	low	NA	Phalloceros harpagos	NA	gut	42
458	insects	high	NA	Phalloceros harpagos	NA	gut	46
460	insects	high	NA	Phalloceros harpagos	NA	gut	32
466	insects	low	NA	Phalloceros harpagos	NA	gut	32
468	insects	low	NA	Phalloceros harpagos	NA	gut	34
524	Insects	high	NA	Symbranchus marmoratus (Synbranchus)	NA	gut	50
527	insects	low	NA	Symbranchus marmoratus (Synbranchus)	NA	gut	52
528	insects	high	NA	Symbranchus marmoratus (Synbranchus)	NA	gut	34
215	Lepidoptera	low	larvae	Synoestropsis	larvae	gut	27
233	Lepidoptera	high	larvae	Acentroniechlis leptos (correct name is Acentronichthys)	NA	gut	32
259	Lepidoptera	low	larvae	Characidium lanei	NA	gut	36
402	Lepidoptera	high	larvae	Mimagoniates lateralis	NA	gut	45
435	Lepidoptera	high	larvae	Mimagoniates microlepis	NA	gut	45
487	Lepidoptera	low	larvae	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	44
506	Lepidoptera	low	larvae	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	48
18	Leptoceridae	high	larvae	Anacroneuria	larvae	gut	3
112	Leptoceridae	high	larvae	Kempnyia	larvae	gut	3
167	Leptoceridae	high	larvae	Macrogynoplax	larvae	gut	3
19	Leptohyphidae	low	larvae	Anacroneuria	larvae	gut	3
113	Leptohyphidae	low	larvae	Kempnyia	larvae	gut	3
168	Leptohyphidae	low	larvae	Macrogynoplax	larvae	gut	3
9	Leptophlebiidae	low	larvae	Anacroneuria	larvae	gut	2
20	Leptophlebiidae	low	larvae	Anacroneuria	larvae	gut	3
103	Leptophlebiidae	low	larvae	Kempnyia	larvae	gut	2
114	Leptophlebiidae	low	larvae	Kempnyia	larvae	gut	3
158	Leptophlebiidae	low	larvae	Macrogynoplax	larvae	gut	2
169	Leptophlebiidae	low	larvae	Macrogynoplax	larvae	gut	3
216	Leptophlebiidae	medium	larvae	Synoestropsis	larvae	gut	27
3	macroalgae	low	NA	Anacroneuria	larvae	gut	1
97	macroalgae	low	NA	Kempnyia	larvae	gut	1
152	macroalgae	low	NA	Macrogynoplax	larvae	gut	1

223	macroalgae	medium	NA	Tanypodinae	larvae	gut	28
24	macroinvertebrates	high	larvae	Anacroneuria	larvae	gut	4
29	macroinvertebrates	medium	larvae	Argia	larvae	trial	5
118	macroinvertebrates	high	larvae	Kempnyia	larvae	gut	4
173	macroinvertebrates	high	larvae	Macrogynoplax	larvae	gut	4
37	macroinvertebrates	high	NA	Belostomatidae	adult	trial	7
42	macroinvertebrates	high	NA	Ceratopogoniae	larvae	gut	4
44	macroinvertebrates	high	NA	Cernotina	larvae	review	10
55	macroinvertebrates	high	NA	Corydalus	adult	gut	4
63	macroinvertebrates	medium	NA	Dythemis	larvae	trial	5
89	macroinvertebrates	high	NA	Hydrobiosidae	larvae	gut	4
92	macroinvertebrates	medium	NA	Hydropsychidae_spA	larvae	gut	4
126	macroinvertebrates	high	NA	Leptonema	larvae	gut	4
129	macroinvertebrates	medium	NA	Libellulidae_spA	larvae	trial	5
186	macroinvertebrates	high	NA	Oecetis	larvae	gut	22
199	macroinvertebrates	low	NA	Smicridea	larvae	gut	4
206	macroinvertebrates	high	NA	Smicridea	larvae	gut	26
214	macroinvertebrates	high	NA	Synoestropsis	larvae	gut	27
222	macroinvertebrates	high	NA	Tanypodinae	larvae	gut	28
225	macroinvertebrates	low	NA	Veliidae_spA	adult	observatio	30
4	macrophytes	low	NA	Anacroneuria	larvae	gut	1
48	macrophytes	low	NA	Chironomidae	larvae	gut	9
98	macrophytes	low	NA	Kempnyia	larvae	gut	1
153	macrophytes	low	NA	Macrogynoplax	larvae	gut	1
229	macrophytes	high	NA	Acentroniechlis leptos (correct name is Acentronichthys)	NA	gut	32
304	macrophytes	low	NA	Deuterodon iguape	NA	gut	32
514	macrophytes	high	NA	Schizolecis guntheri	NA	gut	49
500	Megaloptera	low	larvae	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	48
61	microcrustaceans	low	NA	Dugesia	NA	trial	13
38	microinvertebrates	high	NA	Blepharopus	larvae	gut	8
49	microinvertebrates	low	NA	Chironomidae	larvae	gut	9

54	microinvertebrates	high	NA	Corixidae	adult	trial	11
57	microinvertebrates	high	NA	Cyrnellus	larvae	gut	12
196	microinvertebrates	high	NA	Simulium	larvae	gut	25
197	microinvertebrates	low	NA	Simulium	larvae	gut	25
119	microphytes	low	larvae	Kempnyia	larvae	gut	4
174	microphytes	low	larvae	Macrogynoplax	larvae	gut	4
5	microphytes	low	NA	Anacroneuria	larvae	gut	1
25	microphytes	low	NA	Anacroneuria	larvae	gut	4
33	microphytes	high	NA	Baetidae	larvae	gut	4
39	microphytes	high	NA	Blepharopus	larvae	gut	8
43	microphytes	low	NA	Ceratopogoniae	larvae	gut	4
46	microphytes	low	NA	Chimarra	larvae	gut	4
50	microphytes	low	NA	Chironomidae	larvae	gut	9
58	microphytes	high	NA	Cyrnellus	larvae	gut	12
75	microphytes	high	NA	Gripopteryx	larvae	isotope	18
77	microphytes	high	NA	Helicopsyche	larvae	gut	4
83	microphytes	high	NA	Heterelmis_a	larvae	gut	4
85	microphytes	high	NA	Heterelmis_l	larvae	gut	4
87	microphytes	high	NA	Hexacylloepus_l	larvae	gut	4
90	microphytes	low	NA	Hydrobiosidae	larvae	gut	4
93	microphytes	medium	NA	Hydropsychidae_spA	larvae	gut	4
94	microphytes	high	NA	Hydroptilidae	larvae	trial	19
99	microphytes	low	NA	Kempnyia	larvae	gut	1
122	microphytes	low	NA	Leptoceridae	larvae	gut	4
124	microphytes	high	NA	Leptohyphes	larvae	gut	4
127	microphytes	high	NA	Leptonema	larvae	gut	4
135	microphytes	high	NA	Macrelmis_a	adult	gut	4
137	microphytes	high	NA	Macrelmis_l	larvae	gut	4
141	microphytes	high	NA	Macrobrachium_(<2cmBL)	NA	isotope_ar	18
145	microphytes	high	NA	Macrobrachium_(>4.5cmBL)	NA	isotope_ar	18
149	microphytes	high	NA	Macrobrachium_(2<4.5cmBL)	NA	isotope_ar	18

154	microphytes	low	NA	Macrogynoplax	larvae	gut	1
179	microphytes	high	NA	Macronema	larvae	gut	20
181	microphytes	high	NA	Miroculis	larvae	gut	21
183	microphytes	low	NA	Neoelmis_a	adult	gut	4
185	microphytes	low	NA	Neoelmis_l	larvae	gut	4
190	microphytes	medium	NA	Phylloicus	larvae	gut	24
194	microphytes	high	NA	Psephenus	larvae	gut	4
200	microphytes	low	NA	Smicridea	larvae	gut	4
209	microphytes	high	NA	Snail_spA	NA	obervation	NA
368	Mimagoniates microlepis	high	NA	Hoplias malabaricus	NA	gut	45
251	Mollusca	low	NA	Characidium lanei	NA	gut	36
289	Mollusca	low	NA	Deuterodon iguape	NA	gut	35
374	Mollusca	low	NA	Mimagoniates lateralis	NA	gut	35
407	Mollusca	low	NA	Mimagoniates microlepis	NA	gut	35
51	NA	NA	NA	Coleoptera_larvae	larvae	NA	NA
59	NA	NA	NA	Diptera_larvae_A	larvae	NA	NA
68	NA	NA	NA	Elmidae_larvaeA	larvae	NA	NA
192	NA	NA	NA	Pitlodactylidae_spA	larvae	NA	NA
261	Nematoda	low	NA	Characidium lanei	NA	gut	36
270	Nematoda	low	NA	Characidium lanei	NA	gut	37
309	Nematoda	low	NA	Deuterodon iguape	NA	gut	32
314	Nematoda	low	NA	Deuterodon iguape	NA	gut	38
355	Nematoda	low	NA	Hollandichthys multifasciatus	NA	gut	35
373	Nematoda	low	NA	Mimagoniates lateralis	NA	gut	35
383	Nematoda	high	NA	Mimagoniates lateralis	NA	gut	40
395	Nematoda	medium	NA	Mimagoniates lateralis	NA	gut	46
406	Nematoda	low	NA	Mimagoniates microlepis	NA	gut	35
416	Nematoda	high	NA	Mimagoniates microlepis	NA	gut	40
428	Nematoda	medium	NA	Mimagoniates microlepis	NA	gut	46
254	Odonata	low	larvae	Characidium lanei	NA	gut	36
263	Odonata	low	larvae	Characidium lanei	NA	gut	37

280	Odonata	low	larvae	Characidium lanei	NA	gut	39
338	Odonata	low	larvae	Hollandichthys multifasciatus	NA	gut	43
365	Odonata	low	larvae	Hoplias malabaricus	NA	gut	45
403	Odonata	low	larvae	Mimagoniates lateralis	NA	gut	45
436	Odonata	low	larvae	Mimagoniates microlepis	NA	gut	45
443	Odonata	low	larvae	Phalloceros harpagos	NA	gut	46
474	Odonata	low	larvae	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	47
501	Odonata	low	larvae	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	48
53	Oligochaeta	high	NA	Corixidae	adult	trial	11
62	Oligochaeta	high	NA	Dugesia	NA	trial	13
341	Oligochaeta	high	NA	Hollandichthys multifasciatus	NA	gut	43
464	Oligochaeta	high	NA	Phalloceros harpagos	NA	gut	32
482	Oligochaeta	low	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	44
502	Oligochaeta	low	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	48
269	Ostracoda	low	NA	Characidium lanei	NA	gut	37
228	periphyton	low	NA	Acentroniechlis leptos (correct name is Acentronichthys)	NA	gut	31
292	periphyton	low	NA	Deuterodon iguape	NA	gut	35
479	plant_seeds	high	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	44
522	plant_seeds	high	NA	Schizolecis guntheri	NA	gut	46
237	plant_tissue	low	NA	Acentroniechlis leptos (correct name is Acentronichthys)	NA	gut	33
239	plant_tissue	low	NA	Acentroniechlis leptos (correct name is Acentronichthys)	NA	gut	34
248	plant_tissue	low	NA	Characidium lanei	NA	gut	34
262	plant_tissue	low	NA	Characidium lanei	NA	gut	36
291	plant_tissue	high	NA	Deuterodon iguape	NA	gut	35
295	plant_tissue	low	NA	Deuterodon iguape	NA	gut	34
298	plant_tissue	high	NA	Deuterodon iguape	NA	gut	33
303	plant_tissue	high	NA	Deuterodon iguape	NA	gut	32
313	plant_tissue	high	NA	Deuterodon iguape	NA	gut	38
325	plant_tissue	low	NA	Gymninotus pantherinus (Gymnotus?)	NA	gut	33
332	plant_tissue	high	NA	Gymninotus pantherinus (Gymnotus?)	NA	gut	41
336	plant_tissue	high	NA	Gymninotus pantherinus (Gymnotus?)	NA	gut	42

343	plant_tissue	medium	NA	Hollandichthys multifasciatus	NA	gut	43
349	plant_tissue	low	NA	Hollandichthys multifasciatus	NA	gut	33
353	plant_tissue	low	NA	Hollandichthys multifasciatus	NA	gut	34
358	plant_tissue	low	NA	Hollandichthys multifasciatus	NA	gut	35
389	plant_tissue	medium	NA	Mimagoniates lateralis	NA	gut	40
394	plant_tissue	medium	NA	Mimagoniates lateralis	NA	gut	46
422	plant_tissue	medium	NA	Mimagoniates microlepis	NA	gut	40
427	plant_tissue	medium	NA	Mimagoniates microlepis	NA	gut	46
439	plant_tissue	high	NA	Phalloceros harpagos	NA	gut	46
451	plant_tissue	medium	NA	Phalloceros harpagos	NA	gut	42
457	plant_tissue	high	NA	Phalloceros harpagos	NA	gut	46
463	plant_tissue	high	NA	Phalloceros harpagos	NA	gut	32
499	plant_tissue	low	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	48
521	plant_tissue	high	NA	Schizolecis guntheri	NA	gut	46
191	plant_tissues	low	NA	Phylloicus	larvae	gut	24
207	plant_tissues	high	NA	Smicridea	larvae	gut	26
217	plant_tissues	low	NA	Synoestropsis	larvae	gut	27
224	plant_tissues	high	NA	Tipulidae_spA	larvae	gut	29
255	Plecoptera	low	larvae	Characidium lanei	NA	gut	36
264	Plecoptera	low	larvae	Characidium lanei	NA	gut	37
273	Plecoptera	medium	larvae	Characidium lanei	NA	gut	38
317	Plecoptera	medium	larvae	Deuterodon iguape	NA	gut	38
446	Plecoptera	low	larvae	Phalloceros harpagos	NA	gut	46
505	Plecoptera	low	larvae	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	48
371	Poecilia vivipara	high	NA	Hoplias malabaricus	NA	gut	45
208	pollen	low	NA	Smicridea	larvae	gut	26
218	Porifera	medium	NA	Synoestropsis	larvae	gut	27
523	Protist	high	NA	Schizolecis guntheri	NA	gut	46
10	Simuliidae	high	larvae	Anacroneuria	larvae	gut	2
21	Simuliidae	high	larvae	Anacroneuria	larvae	gut	3
28	Simuliidae	high	larvae	Anacroneuria	larvae	gut	16

32	Simuliidae	high	larvae	Argia	larvae	gut	16
67	Simuliidae	high	larvae	Dythemis	larvae	gut	16
73	Simuliidae	high	larvae	Gomphidae	larvae	gut	16
81	Simuliidae	high	larvae	Heteragrion	larvae	gut	16
104	Simuliidae	high	larvae	Kempnyia	larvae	gut	2
115	Simuliidae	high	larvae	Kempnyia	larvae	gut	3
133	Simuliidae	high	larvae	Libellulidae_spA	larvae	gut	16
159	Simuliidae	high	larvae	Macrogynoplax	larvae	gut	2
170	Simuliidae	high	larvae	Macrogynoplax	larvae	gut	3
177	Simuliidae	high	larvae	Macrogynoplax	larvae	gut	16
232	Simuliidae	high	larvae	Acentroniechlis leptos (correct name is Acentronichthys)	NA	gut	32
512	Simuliidae	low	larvae	Schizolecis guntheri	NA	gut	49
11	Smicridea	high	larvae	Anacroneuria	larvae	gut	2
105	Smicridea	high	larvae	Kempnyia	larvae	gut	2
160	Smicridea	high	larvae	Macrogynoplax	larvae	gut	2
22	Tabanidae	low	larvae	Anacroneuria	larvae	gut	3
116	Tabanidae	low	larvae	Kempnyia	larvae	gut	3
171	Tabanidae	low	larvae	Macrogynoplax	larvae	gut	3
201	terrestrial_invertebrates_	low	NA	Smicridea	larvae	gut	4
226	terrestrial_invertebrates_	high	NA	Veliidae_spA	adult	observatio	30
235	terrestrial_invertebrates_	high	NA	Acentroniechlis leptos (correct name is Acentronichthys)	NA	gut	32
244	terrestrial_invertebrates_	low	NA	Acentroniechlis leptos (correct name is Acentronichthys)	NA	gut	35
247	terrestrial_invertebrates_	low	NA	Characidium lanei	NA	gut	34
250	terrestrial_invertebrates_	low	NA	Characidium lanei	NA	gut	33
277	terrestrial_invertebrates_	medium	NA	Characidium lanei	NA	gut	38
294	terrestrial_invertebrates_	low	NA	Deuterodon iguape	NA	gut	34
297	terrestrial_invertebrates_	high	NA	Deuterodon iguape	NA	gut	33
310	terrestrial_invertebrates_	high	NA	Deuterodon iguape	NA	gut	32
319	terrestrial_invertebrates_	high	NA	Deuterodon iguape	NA	gut	38
330	terrestrial_invertebrates_	low	NA	Gymninotus pantherinus (Gymnotus?)	NA	gut	40
331	terrestrial_invertebrates_	low	NA	Gymninotus pantherinus (Gymnotus?)	NA	gut	41

342	terrestrial_invertebrates_	high	NA	Hollandichthys multifasciatus	NA	gut	43
346	terrestrial_invertebrates_	high	NA	Hollandichthys multifasciatus	NA	gut	32
352	terrestrial_invertebrates_	high	NA	Hollandichthys multifasciatus	NA	gut	34
354	terrestrial_invertebrates_	high	NA	Hollandichthys multifasciatus	NA	gut	35
366	terrestrial_invertebrates_	low	NA	Hoplias malabaricus	NA	gut	45
372	terrestrial_invertebrates_	high	NA	Mimagoniates lateralis	NA	gut	35
378	terrestrial_invertebrates_	high	NA	Mimagoniates lateralis	NA	gut	34
380	terrestrial_invertebrates_	high	NA	Mimagoniates lateralis	NA	gut	33
390	terrestrial_invertebrates_	high	NA	Mimagoniates lateralis	NA	gut	40
398	terrestrial_invertebrates_	high	NA	Mimagoniates lateralis	NA	gut	46
404	terrestrial_invertebrates_	high	NA	Mimagoniates lateralis	NA	gut	45
405	terrestrial_invertebrates_	high	NA	Mimagoniates microlepis	NA	gut	35
411	terrestrial_invertebrates_	high	NA	Mimagoniates microlepis	NA	gut	34
413	terrestrial_invertebrates_	high	NA	Mimagoniates microlepis	NA	gut	33
423	terrestrial_invertebrates_	high	NA	Mimagoniates microlepis	NA	gut	40
431	terrestrial_invertebrates_	high	NA	Mimagoniates microlepis	NA	gut	46
437	terrestrial_invertebrates_	high	NA	Mimagoniates microlepis	NA	gut	45
442	terrestrial_invertebrates_	low	NA	Phalloceros harpagos	NA	gut	46
475	terrestrial_invertebrates_	high	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	47
480	terrestrial_invertebrates_	low	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	44
493	terrestrial_invertebrates_	low	NA	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	48
12	Trichoptera	high	larvae	Anacroneuria	larvae	gut	2
106	Trichoptera	high	larvae	Kempnyia	larvae	gut	2
161	Trichoptera	high	larvae	Macrogynoplax	larvae	gut	2
219	Trichoptera	low	larvae	Synoestropsis	larvae	gut	27
258	Trichoptera	high	larvae	Characidium lanei	NA	gut	36
275	Trichoptera	medium	larvae	Characidium lanei	NA	gut	38
386	Trichoptera	high	larvae	Mimagoniates lateralis	NA	gut	40
419	Trichoptera	high	larvae	Mimagoniates microlepis	NA	gut	40
507	Trichoptera	low	larvae	Rhadmia quelamdia (Rhamdia quelen)	NA	gut	48
455	Zignemaphyceae	high	NA	Phalloceros harpagos	NA	gut	46

518	Zignemaphyceae	high	NA	Schizolecis guntheri	NA	gut	46
447	zooplankton	low	NA	Phalloceros harpagos	NA	gut	46

full.source	res.genus	res.subfam	res.family	res.order	res.class.pl	res.catego	con.genus	con.subfan	con.family	con.order	con.class	con.catego	information_resolutic
Barreto an	NA	NA	NA	Acarina	Chelicerata	invertebra	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	species
Aranha et	NA	NA	NA	Acarina	Chelicerata	invertebra	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	species
Costa 1987	NA	NA	NA	Acarina	Chelicerata	invertebra	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	genus
Aranha et	NA	NA	NA	Acarina	Chelicerata	invertebra	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	genus
Costa 1987	NA	NA	NA	Acarina	Chelicerata	invertebra	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	species
Aranha et	NA	NA	NA	Acarina	Chelicerata	invertebra	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	species
Deus and F	NA	NA	NA	Acarina	Chelicerata	invertebra	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Costa 1987	NA	NA	NA	NA	NA	algae	Gymnotus	NA	Gymnotida	Gymnotifo	Actinopter	fish	species
Costa 1987	NA	NA	NA	NA	NA	algae	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	genus
Costa 1987	NA	NA	NA	NA	NA	algae	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	species
Aranha et	NA	NA	NA	NA	NA	algae	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	species
Esteves et	NA	NA	NA	NA	NA	algae	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	genus
Costa 1987	NA	NA	NA	NA	NA	algae	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	genus
Wolff 2012	NA	NA	NA	NA	NA	algae	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	species
Aranha et	NA	NA	NA	NA	NA	algae	Schizolecis	NA	Loricariida	Siluriforme	Actinopter	fish	species
Brito_et_a	NA	NA	NA	NA	NA	allochtono	Macrobrac	NA	Paleomoni	Decapoda	Crustacea	invertebra	genus
Brito_et_a	NA	NA	NA	NA	NA	allochtono	Macrobrac	NA	Paleomoni	Decapoda	Crustacea	invertebra	genus
Brito_et_a	NA	NA	NA	NA	NA	allochtono	Macrobrac	NA	Paleomoni	Decapoda	Crustacea	invertebra	genus
Deus and F	NA	NA	NA	Amphipoda	Crustacea	crustacean	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Sierra-Laba	NA	NA	NA	NA	NA	invertebra	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebra	genus
Molina_et_	NA	NA	NA	NA	NA	invertebra	Dythemis	NA	Libellulidae	Odonata	Insecta	invertebra	genus
Alencar_et	NA	NA	NA	NA	NA	invertebra	NA	NA	Gomphida	Odonata	Insecta	invertebra	family
Molina_et_	NA	NA	NA	NA	NA	invertebra	Heteragrio	NA	Megapoda	Odonata	Insecta	invertebra	Order
Sierra-Laba	NA	NA	NA	NA	NA	invertebra	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Molina_et_	NA	NA	NA	NA	NA	invertebra	NA	NA	Libellulidae	Odonata	Insecta	invertebra	family
Brito_et_a	NA	NA	NA	NA	NA	invertebra	Macrobrac	NA	Paleomoni	Decapoda	Crustacea	invertebra	genus
Brito_et_a	NA	NA	NA	NA	NA	invertebra	Macrobrac	NA	Paleomoni	Decapoda	Crustacea	invertebra	genus
Brito_et_a	NA	NA	NA	NA	NA	invertebra	Macrobrac	NA	Paleomoni	Decapoda	Crustacea	invertebra	genus
Sierra-Laba	NA	NA	NA	NA	NA	invertebra	Macrogyno	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Gonçalves	NA	NA	NA	NA	Annelida	worm	Acentronic	NA	Heptapteri	Siluriforme	Actinopter	fish	species
Gonçalves	NA	NA	NA	NA	Annelida	worm	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	species

Mazzoni ar	NA	NA	NA	NA	Anura	anuran	Hoplias	NA	Erythrinida	Characifor	Actinopter	fish	species
Gonçalves	NA	NA	NA	Arachnida	Chelicerata	invertebra	Acentronic	NA	Heptapteri	Siluriforme	Actinopter	fish	species
Carmo et a	NA	NA	NA	Arachnida	Chelicerata	invertebra	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	genus
Gonçalves	NA	NA	NA	Arachnida	Chelicerata	invertebra	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	species
Barreto an	NA	NA	NA	Arachnida	Chelicerata	invertebra	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	genus
Gonçalves	NA	NA	NA	Arachnida	Chelicerata	invertebra	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	genus
Gonçalves	NA	NA	NA	Arachnida	Chelicerata	invertebra	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	species
Mazzoni ar	Astyanax	NA	Characidae	Characifor	Actinopter	fish	Hoplias	NA	Erythrinida	Characifor	Actinopter	fish	species
Aranha et a	NA	NA	NA	NA	Baccilariop	algae	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	genus
Aranha et a	NA	NA	NA	NA	Baccilariop	algae	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	species
Aranha et a	NA	NA	NA	NA	Baccilariop	algae	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	genus
Aranha et a	NA	NA	NA	NA	Baccilariop	algae	Schizolecis	NA	Loricariida	Siluriforme	Actinopter	fish	species
Buck and S	NA	NA	NA	NA	Baccilariop	algae	Schizolecis	NA	Loricariida	Siluriforme	Actinopter	fish	species
Harper_et_	NA	NA	NA	NA	NA	bacteria	NA	NA	NA	NA	Oligochaet	worms	class?
Abilhoa et	NA	NA	Belostoma	Hemiptera	Insecta	invertebra	Hollandich	NA	Characidae	Characifor	Actinopter	fish	species
Bentes_et_	NA	NA	NA	NA	Bryozoa	Bryozoa	Synoestrop	NA	Hydropsyc	Trichoptera	Insecta	invertebra	genus
Gonçalves	NA	NA	NA	NA	Bryozoa	invertebra	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	species
Gamboa_e	NA	NA	Calamocer	Trichoptera	Insecta	invertebra	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebra	genus
Gamboa_e	NA	NA	Calamocer	Trichoptera	Insecta	invertebra	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Gamboa_e	NA	NA	Calamocer	Trichoptera	Insecta	invertebra	Macrogyno	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Carmo 201	NA	NA	NA	NA	Chelicerata	invertebra	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	genus
Hurtado-B	NA	NA	Chironomi	Diptera	Insecta	invertebra	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebra	genus
Gamboa_e	NA	NA	Chironomi	Diptera	Insecta	invertebra	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebra	genus
Alencar_et	NA	NA	Chironomi	Diptera	Insecta	invertebra	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Alencar_et	NA	NA	Chironomi	Diptera	Insecta	invertebra	Argia	NA	Coenagrion	Odonata	Insecta	invertebra	family
Reynolds_a	NA	NA	Chironomi	Diptera	Insecta	invertebra	NA	NA	Corixidae	Hemiptera	Insecta	invertebra	family
Alencar_et	NA	NA	Chironomi	Diptera	Insecta	invertebra	Dythemis	NA	Libellulidae	Odonata	Insecta	invertebra	family
Alencar_et	NA	NA	Chironomi	Diptera	Insecta	invertebra	NA	NA	Gomphida	Odonata	Insecta	invertebra	family
Alencar_et	NA	NA	Chironomi	Diptera	Insecta	invertebra	Heteragrio	NA	Megapoda	Odonata	Insecta	invertebra	family
Hurtado-B	NA	NA	Chironomi	Diptera	Insecta	invertebra	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Gamboa_e	NA	NA	Chironomi	Diptera	Insecta	invertebra	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebra	family

Alencar_et	NA	NA	Chironomi	Diptera	Insecta	invertebra	NA	NA	Libellulida	Odonata	Insecta	invertebra	family
Hurtado-B	NA	NA	Chironomi	Diptera	Insecta	invertebra	Macrogyn	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Gamboa_e	NA	NA	Chironomi	Diptera	Insecta	invertebra	Macrogyn	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Alencar_et	NA	NA	Chironomi	Diptera	Insecta	invertebra	Macrogyn	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Bentes_et_	NA	NA	Chironomi	Diptera	Insecta	invertebra	Synoestrop	NA	Hydropsyc	Trichopter	Insecta	invertebra	genus
Esteves an	NA	NA	Chironomi	Diptera	Insecta	invertebra	Acentronic	NA	Heptapteri	Siluriforme	Actinopter	fish	species
Aranha et	NA	NA	Chironomi	Diptera	Insecta	invertebra	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	species
Barreto an	NA	NA	Chironomi	Diptera	Insecta	invertebra	Deuterodo	NA	Characida	Characifor	Actinopter	fish	genus
Costa 1987	NA	NA	Chironomi	Diptera	Insecta	invertebra	Gymnotus	NA	Gymnotida	Gymnotifo	Actinopter	fish	species
Abilhoa et	NA	NA	Chironomi	Diptera	Insecta	invertebra	Hollandich	NA	Characida	Characifor	Actinopter	fish	species
Costa 1987	NA	NA	Chironomi	Diptera	Insecta	invertebra	Mimagonia	NA	Characida	Characifor	Actinopter	fish	genus
Costa 1987	NA	NA	Chironomi	Diptera	Insecta	invertebra	Mimagonia	NA	Characida	Characifor	Actinopter	fish	species
Aranha et	NA	NA	Chironomi	Diptera	Insecta	invertebra	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	species
Villares Jur	NA	NA	Chironomi	Diptera	Insecta	invertebra	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Buck and S	NA	NA	Chironomi	Diptera	Insecta	invertebra	Schizolecis	NA	Loricariida	Siluriforme	Actinopter	fish	species
Ferreira 20	NA	NA	Chironomi	Diptera	Insecta	invertebra	Synbranch	NA	Synbranchi	Synbranchi	Actinopter	fish	species
Aranha et	NA	NA	NA	NA	Chlorophy	algae	Mimagonia	NA	Characida	Characifor	Actinopter	fish	genus
Aranha et	NA	NA	NA	NA	Chlorophy	algae	Mimagonia	NA	Characida	Characifor	Actinopter	fish	species
Aranha et	NA	NA	NA	NA	Chlorophy	algae	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	genus
Buck and S	NA	NA	NA	NA	Chlorophy	algae	Schizolecis	NA	Loricariida	Siluriforme	Actinopter	fish	species
Aranha et	NA	NA	NA	NA	Chlorophy	algae	Schizolecis	NA	Loricariida	Siluriforme	Actinopter	fish	species
Hurtado-B	NA	NA	NA	Coleoptera	Insecta	invertebra	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebra	genus
Hurtado-B	NA	NA	NA	Coleoptera	Insecta	invertebra	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Hurtado-B	NA	NA	NA	Coleoptera	Insecta	invertebra	Macrogyn	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Esteves an	NA	NA	NA	Coleoptera	Insecta	invertebra	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	genus
Deus and F	NA	NA	NA	Coleoptera	Insecta	invertebra	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Brazil-Souz	NA	NA	NA	Coleoptera	Insecta	invertebra	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Carmo 201	NA	NA	NA	Coleoptera	Insecta	invertebra	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	genus
Carmo et a	NA	NA	NA	Coleoptera	Insecta	invertebra	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	genus
Barreto an	NA	NA	NA	Coleoptera	Insecta	invertebra	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	species
Gonçalves	NA	NA	NA	NA	Collembola	invertebra	Acentronic	NA	Heptapteri	Siluriforme	Actinopter	fish	species

Aranha et	NA	NA	NA	NA	Collembola	invertebrat	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	species
Esteves an	NA	NA	NA	Copepoda	Crustacea	crustacean	Deuterodo	NA	Characida	Characifor	Actinopter	fish	species
Esteves an	NA	NA	NA	NA	Crustacea	crustacean	Acentronic	NA	Heptapteri	Siluriforme	Actinopter	fish	species
Gonçalves	NA	NA	NA	NA	Crustacea	crustacean	Acentronic	NA	Heptapteri	Siluriforme	Actinopter	fish	species
Gonçalves	NA	NA	NA	NA	Crustacea	crustacean	Deuterodo	NA	Characida	Characifor	Actinopter	fish	species
Silva 2009	NA	NA	NA	NA	Crustacea	crustacean	Gymnotus	NA	Gymnotida	Gymnotifo	Actinopter	fish	species
Abilhoa et	NA	NA	NA	NA	Crustacea	crustacean	Hollandich	NA	Characida	Characifor	Actinopter	fish	species
Silva 2009	NA	NA	NA	NA	Crustacea	crustacean	Hollandich	NA	Characida	Characifor	Actinopter	fish	species
Gonçalves	NA	NA	NA	NA	Crustacea	crustacean	Hollandich	NA	Characida	Characifor	Actinopter	fish	species
Silva 2009	NA	NA	NA	NA	Crustacea	crustacean	Hoplias	NA	Erythrinida	Characifor	Actinopter	fish	species
Costa 1987	NA	NA	NA	NA	Crustacea	crustacean	Hoplias	NA	Erythrinida	Characifor	Actinopter	fish	species
Deus and	NA	NA	NA	NA	Crustacea	crustacean	Hoplias	NA	Erythrinida	Characifor	Actinopter	fish	species
Gonçalves	NA	NA	NA	NA	Crustacea	crustacean	Mimagoni	NA	Characida	Characifor	Actinopter	fish	genus
Aranha et	NA	NA	NA	NA	Crustacea	crustacean	Mimagoni	NA	Characida	Characifor	Actinopter	fish	genus
Gonçalves	NA	NA	NA	NA	Crustacea	crustacean	Mimagoni	NA	Characida	Characifor	Actinopter	fish	species
Aranha et	NA	NA	NA	NA	Crustacea	crustacean	Mimagoni	NA	Characida	Characifor	Actinopter	fish	species
Deus and	NA	NA	NA	NA	Crustacea	crustacean	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Buck and S	NA	NA	NA	NA	Crustacea	crustacean	Schizolecis	NA	Loricariida	Siluriforme	Actinopter	fish	species
Buck and S	NA	NA	NA	NA	Cyanophyt	algae	Schizolecis	NA	Loricariida	Siluriforme	Actinopter	fish	species
Aranha et	NA	NA	NA	NA	Cyanophyt	algae	Schizolecis	NA	Loricariida	Siluriforme	Actinopter	fish	species
Deus and	NA	NA	NA	Decapoda	Crustacea	crustacean	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Brazil-Souz	NA	NA	NA	Decapoda	Crustacea	crustacean	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Tomanova_	NA	NA	NA	NA	NA	detritus	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebrat	family
Tomanova_	NA	NA	NA	NA	NA	detritus	Macrogyn	NA	Perlidae	Plecoptera	Insecta	invertebrat	family
Sierra-Lab	NA	NA	NA	NA	NA	detritus	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebrat	genus
Tomanova_	NA	NA	NA	NA	NA	detritus	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebrat	genus
Gattolliat_	NA	NA	NA	NA	NA	detritus	NA	NA	Baetidae	Ephemero	Insecta	invertebrat	family
Shimabuk	NA	NA	NA	NA	NA	detritus	Campsuru	Na	Polymitarc	Ephemero	Insecta	invertebrat	genus
Tomanova_	NA	NA	NA	NA	NA	detritus	NA	NA	Ceratopog	Diptera	Insecta	invertebrat	family
Tomanova_	NA	NA	NA	NA	NA	detritus	Chimarra	NA	Philopotan	Trichopter	Insecta	invertebrat	genus
Shimabuk	NA	NA	NA	NA	NA	detritus	NA	NA	Chironomi	Diptera	Insecta	invertebrat	family

Garelis_an	NA	NA	NA	NA	NA	detritus	Cyrnellus	NA	Polycentro	Trichopter	Insecta	invertebrat	family
Carvalho_a	NA	NA	NA	NA	NA	detritus	Farrodes	NA	Leptophleb	Ephemero	Insecta	invertebrat	family
Loureiro_e	NA	NA	NA	NA	NA	detritus	Gripoptery	NA	Gripoptery	Plecoptera	Insecta	invertebrat	family
Tomanova_	NA	NA	NA	NA	NA	detritus	Helicopsyc	NA	Helicopsyc	Trichopter	Insecta	invertebrat	genus
Tomanova_	NA	NA	NA	NA	NA	detritus	Heterelmis	NA	Elmidae	Coleoptera	Insecta	invertebrat	genus
Tomanova_	NA	NA	NA	NA	NA	detritus	Heterelmis	NA	Elmidae	Coleoptera	Insecta	invertebrat	genus
Tomanova_	NA	NA	NA	NA	NA	detritus	Hexacylloe	NA	Elmidae	Coleoptera	Insecta	invertebrat	family
Tomanova_	NA	NA	NA	NA	NA	detritus	NA	NA	Hydrobiosi	Trichopter	Insecta	invertebrat	family
Tomanova_	NA	NA	NA	NA	NA	detritus	NA	NA	Hydropsyc	Trichopter	Insecta	invertebrat	family
Sierra-Laba	NA	NA	NA	NA	NA	detritus	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebrat	family
Tomanova_	NA	NA	NA	NA	NA	detritus	NA	NA	Leptocerid	Trichopter	Insecta	invertebrat	family
Tomanova_	NA	NA	NA	NA	NA	detritus	NA	NA	Leptohyph	Ephemero	Insecta	invertebrat	genus
Tomanova_	NA	NA	NA	NA	NA	detritus	Leptonema	NA	Hydropsyc	Trichopter	Insecta	invertebrat	genus
Carvalho_a	NA	NA	NA	NA	NA	detritus	NA	NA	Leptophleb	Ephemero	Insecta	invertebrat	family
Tomanova_	NA	NA	NA	NA	NA	detritus	Macrelmis	NA	Elmidae	Coleoptera	Insecta	invertebrat	genus
Tomanova_	NA	NA	NA	NA	NA	detritus	Macrelmis	NA	Elmidae	Coleoptera	Insecta	invertebrat	genus
Brito_et_a	NA	NA	NA	NA	NA	detritus	Macrobrac	NA	Paleomoni	Decapoda	Crustacea	invertebrat	genus
Brito_et_a	NA	NA	NA	NA	NA	detritus	Macrobrac	NA	Paleomoni	Decapoda	Crustacea	invertebrat	genus
Brito_et_a	NA	NA	NA	NA	NA	detritus	Macrobrac	NA	Paleomoni	Decapoda	Crustacea	invertebrat	genus
Sierra-Laba	NA	NA	NA	NA	NA	detritus	Macrogyno	NA	Perlidae	Plecoptera	Insecta	invertebrat	family
Silveira-Ma	NA	NA	NA	NA	NA	detritus	Macronem	NA	Hydropsyc	Trichopter	Insecta	invertebrat	genus
Ceneviva-B	NA	NA	NA	NA	NA	detritus	Miroculis	NA	Leptophleb	Ephemero	Insecta	invertebrat	genus
Tomanova_	NA	NA	NA	NA	NA	detritus	Neoelmis	NA	Elmidae	Coleoptera	Insecta	invertebrat	genus
Tomanova_	NA	NA	NA	NA	NA	detritus	Neoelmis	NA	Elmidae	Coleoptera	Insecta	invertebrat	genus
Harper_et_	NA	NA	NA	NA	NA	detritus	NA	NA	NA	NA	Oligochaet	worms	class?
Ferreira_et	NA	NA	NA	NA	NA	detritus	Phylloicus	NA	Calamocer	Trichopter	Insecta	invertebrat	genus
Tomanova_	NA	NA	NA	NA	NA	detritus	Psephenus	NA	Psephenida	Coleoptera	Insecta	invertebrat	genus
Tomanova_	NA	NA	NA	NA	NA	detritus	Smicridea	NA	Hydropsyc	Trichopter	Insecta	invertebrat	genus
Gil_et_al._	NA	NA	NA	NA	NA	detritus	Smicridea	NA	Hydropsyc	Trichopter	Insecta	invertebrat	genus
Saito_and_	NA	NA	NA	NA	NA	detritus	NA	Tanypodina	Chironomi	Diptera	Insecta	invertebrat	subfamily
Gonçalves	NA	NA	NA	NA	NA	detritus	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	species

Wolff 2012	NA	NA	NA	NA	NA	detritus	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	species
Silva 2009	NA	NA	NA	NA	NA	detritus	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	species
Esteves an	NA	NA	NA	NA	NA	detritus	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	species
Barreto an	NA	NA	NA	NA	NA	detritus	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	genus
Silva 2009	NA	NA	NA	NA	NA	detritus	Gymnotus	NA	Gymnotida	Gymnotifo	Actinopter	fish	species
Esteves an	NA	NA	NA	NA	NA	detritus	Hollandich	NA	Characidae	Characifor	Actinopter	fish	species
Silva 2009	NA	NA	NA	NA	NA	detritus	Hollandich	NA	Characidae	Characifor	Actinopter	fish	species
Aranha et	NA	NA	NA	NA	NA	detritus	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	species
Esteves et	NA	NA	NA	NA	NA	detritus	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	genus
Esteves an	NA	NA	NA	NA	NA	detritus	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	genus
Wolff 2012	NA	NA	NA	NA	NA	detritus	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	species
Gonçalves	NA	NA	NA	NA	NA	detritus	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	species
Villares Jur	NA	NA	NA	NA	NA	detritus	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Deus and F	NA	NA	NA	NA	NA	detritus	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Alencar_et	NA	NA	NA	NA	NA	microphyt	Simulium	NA	Simuliidae	Diptera	Insecta	invertebra	genus
Gil_et_al._	NA	NA	NA	NA	NA	microphyt	Smicridea	NA	Hydropsyc	Trichopter	Insecta	invertebra	genus
Bentes_et_	NA	NA	NA	NA	NA	microphyt	Synoestrop	NA	Hydropsyc	Trichopter	Insecta	invertebra	genus
Saito_and_	NA	NA	NA	NA	NA	microphyt	NA	Tanypodin	Chironomi	Diptera	Insecta	invertebra	subfamily
Esteves an	NA	NA	NA	NA	NA	algae	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	species
Barreto an	NA	NA	NA	NA	NA	algae	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	genus
Esteves an	NA	NA	NA	NA	NA	algae	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	genus
Gonçalves	NA	NA	NA	Diplopoda	Chelicerat	invertebra	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	species
Carmo 201	NA	NA	NA	Diptera	Insecta	invertebra	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	genus
Carmo et a	NA	NA	NA	Diptera	Insecta	invertebra	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	genus
Barreto an	NA	NA	NA	Diptera	Insecta	invertebra	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	species
Brazil-Souz	NA	NA	NA	Diptera	Insecta	invertebra	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Aranha et	NA	NA	Dytiscidae	Coleoptera	Insecta	invertebra	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	species
Aranha et	NA	NA	NA	NA	NA	eggs	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	genus
Aranha et	NA	NA	NA	NA	NA	eggs	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	species
Brazil-Souz	NA	NA	NA	NA	NA	eggs	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Hurtado-B	NA	NA	NA	Ephemerop	Insecta	invertebra	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebra	genus

Alencar_et	NA	NA	NA	Ephemero	Insecta	invertebra	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Alencar_et	NA	NA	NA	Ephemero	Insecta	invertebra	Argia	NA	Coenagrio	Odonata	Insecta	invertebra	family
Alencar_et	NA	NA	NA	Ephemero	Insecta	invertebra	Dythemis	NA	Libellulida	Odonata	Insecta	invertebra	family
Alencar_et	NA	NA	NA	Ephemero	Insecta	invertebra	NA	NA	Gomphida	Odonata	Insecta	invertebra	family
Alencar_et	NA	NA	NA	Ephemero	Insecta	invertebra	Heteragrio	NA	Megapoda	Odonata	Insecta	invertebra	family
Hurtado-B	NA	NA	NA	Ephemero	Insecta	invertebra	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Alencar_et	NA	NA	NA	Ephemero	Insecta	invertebra	NA	NA	Libellulida	Odonata	Insecta	invertebra	family
Hurtado-B	NA	NA	NA	Ephemero	Insecta	invertebra	Macrogyn	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Alencar_et	NA	NA	NA	Ephemero	Insecta	invertebra	Macrogyn	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Bentes_et_	NA	NA	NA	Ephemero	Insecta	invertebra	Synoestro	NA	Hydropsyc	Trichopter	Insecta	invertebra	genus
Carmo 201	NA	NA	NA	Ephemero	Insecta	invertebra	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	genus
Barreto an	NA	NA	NA	Ephemero	Insecta	invertebra	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	species
Aranha et	NA	NA	NA	Ephemero	Insecta	invertebra	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	species
Barreto an	NA	NA	NA	Ephemero	Insecta	invertebra	Deuterodo	NA	Characida	Characifor	Actinopter	fish	genus
Costa 1987	NA	NA	NA	Ephemero	Insecta	invertebra	Gymnotus	NA	Gymnotida	Gymnotifo	Actinopter	fish	species
Costa 1987	NA	NA	NA	Ephemero	Insecta	invertebra	Mimagoni	NA	Characida	Characifor	Actinopter	fish	genus
Mazzoni a	NA	NA	NA	Ephemero	Insecta	invertebra	Mimagoni	NA	Characida	Characifor	Actinopter	fish	genus
Costa 1987	NA	NA	NA	Ephemero	Insecta	invertebra	Mimagoni	NA	Characida	Characifor	Actinopter	fish	species
Mazzoni a	NA	NA	NA	Ephemero	Insecta	invertebra	Mimagoni	NA	Characida	Characifor	Actinopter	fish	species
Aranha et	NA	NA	NA	Ephemero	Insecta	invertebra	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	species
Deus and F	NA	NA	NA	Ephemero	Insecta	invertebra	Rhamdia	NA	Pimelodida	Siluriform	Actinopter	fish	species
Brazil-Souz	NA	NA	NA	Ephemero	Insecta	invertebra	Rhamdia	NA	Pimelodida	Siluriform	Actinopter	fish	species
Tomanova_	NA	NA	NA	NA	NA	filamentou	NA	NA	Leptocerid	Trichopter	Insecta	invertebra	family
Gil_et_al._	NA	NA	NA	NA	NA	filamentou	Smicridea	NA	Hydropsyc	Trichopter	Insecta	invertebra	genus
Esteves an	NA	NA	NA	NA	NA	filamentou	Deuterodo	NA	Characida	Characifor	Actinopter	fish	species
Barreto an	NA	NA	NA	NA	NA	filamentou	Deuterodo	NA	Characida	Characifor	Actinopter	fish	genus
Aranha et	NA	NA	NA	NA	NA	filamentou	Mimagoni	NA	Characida	Characifor	Actinopter	fish	genus
Aranha et	NA	NA	NA	NA	NA	filamentou	Mimagoni	NA	Characida	Characifor	Actinopter	fish	species
Aranha et	NA	NA	NA	NA	NA	filamentou	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	genus
Esteves an	NA	NA	NA	NA	NA	filamentou	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	genus
Brazil-Souz	NA	NA	NA	NA	NA	filamentou	Rhamdia	NA	Pimelodida	Siluriform	Actinopter	fish	species

Aranha et a	NA	NA	NA	NA	NA	filamentou	Schizolecis	NA	Loricariida	Siluriforme	Actinopter	fish	species
Velasco_ar	NA	NA	NA	NA	NA	fish	NA	NA	Belostoma	Hemiptera	Insecta	invertebrat	family
Esteves an	NA	NA	NA	NA	Actinopter	fish	Acentronic	NA	Heptapteri	Siluriforme	Actinopter	fish	species
Esteves an	NA	NA	NA	NA	Actinopter	fish	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	species
Braga and	NA	NA	NA	NA	Actinopter	fish	Gymnotus	NA	Gymnotida	Gymnotifo	Actinopter	fish	species
Silva 2009	NA	NA	NA	NA	Actinopter	fish	Hoplias	NA	Erythrinida	Characifor	Actinopter	fish	species
Costa 1987	NA	NA	NA	NA	Actinopter	fish	Hoplias	NA	Erythrinida	Characifor	Actinopter	fish	species
Deus and F	NA	NA	NA	NA	Actinopter	fish	Hoplias	NA	Erythrinida	Characifor	Actinopter	fish	species
Aranha et a	NA	NA	NA	NA	Actinopter	fish	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	species
Villares Jur	NA	NA	NA	NA	Actinopter	fish	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Deus and F	NA	NA	NA	NA	Actinopter	fish	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Deus and F	NA	NA	NA	NA	Actinopter	fish	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Brazil-Souz	NA	NA	NA	NA	Actinopter	fish	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Wolff et al.	NA	NA	NA	NA	Actinopter	fish	Synbranch	NA	Synbranchi	Synbranchi	Actinopter	fish	species
Wolff 2012	NA	NA	NA	NA	Actinopter	fish	Synbranch	NA	Synbranchi	Synbranchi	Actinopter	fish	species
Silva 2009	NA	NA	NA	NA	NA	fruits_seec	Hollandich	NA	Characidae	Characifor	Actinopter	fish	species
Gil_et_al._	NA	NA	NA	NA	NA	fungi	Smicridea	NA	Hydropsyc	Trichoptera	Insecta	invertebrat	genus
Velasco_ar	NA	NA	NA	NA	Gastropoda	gastropod	NA	NA	Belostoma	Hemiptera	Insecta	invertebrat	family
Boddington	NA	NA	NA	NA	Gastropoda	gastropod	Dugesia	NA	NA	NA	Platyhelmi	worms	genus
Deus and F	NA	NA	NA	NA	Gastropoda	snail	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Mazzoni ar	Geophagus	NA	Cichlidae	Perciforme	Actinopter	fish	Hoplias	NA	Erythrinida	Characifor	Actinopter	fish	species
Gamboa_e	NA	NA	Glossomat	Trichoptera	Insecta	invertebrat	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebrat	genus
Gamboa_e	NA	NA	Glossomat	Trichoptera	Insecta	invertebrat	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebrat	family
Gamboa_e	NA	NA	Glossomat	Trichoptera	Insecta	invertebrat	Macrogyno	NA	Perlidae	Plecoptera	Insecta	invertebrat	family
Carmo 201	NA	NA	NA	Hemiptera	Insecta	invertebrat	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	genus
Carmo et a	NA	NA	NA	Hemiptera	Insecta	invertebrat	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	genus
Barreto an	NA	NA	NA	Hemiptera	Insecta	invertebrat	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	genus
Deus and F	NA	NA	NA	Hemiptera	Insecta	invertebrat	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Brazil-Souz	NA	NA	NA	Hemiptera	Insecta	invertebrat	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Gamboa_e	NA	NA	Hydrobiosi	Trichoptera	Insecta	invertebrat	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebrat	genus
Gamboa_e	NA	NA	Hydrobiosi	Trichoptera	Insecta	invertebrat	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebrat	family

Gamboa_e	NA	NA	Hydrobiosi	Trichopter	Insecta	invertebra	Macrogyn	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Gamboa_e	NA	NA	Hydroptilic	Trichopter	Insecta	invertebra	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebra	genus
Gamboa_e	NA	NA	Hydroptilic	Trichopter	Insecta	invertebra	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Gamboa_e	NA	NA	Hydroptilic	Trichopter	Insecta	invertebra	Macrogyn	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Reis et al. 2	NA	NA	NA	NA	Insecta	invertebra	Acentronic	NA	Heptapteri	Siluriforme	Actinopter	fish	species
Silva 2009	NA	NA	NA	NA	Insecta	invertebra	Acentronic	NA	Heptapteri	Siluriforme	Actinopter	fish	species
Wolff 2012	NA	NA	NA	NA	Insecta	invertebra	Acentronic	NA	Heptapteri	Siluriforme	Actinopter	fish	species
Gonçalves	NA	NA	NA	NA	Insecta	invertebra	Acentronic	NA	Heptapteri	Siluriforme	Actinopter	fish	species
Wolff 2012	NA	NA	NA	NA	Insecta	invertebra	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	species
Silva 2009	NA	NA	NA	NA	Insecta	invertebra	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	genus
Gonçalves	NA	NA	NA	NA	Insecta	invertebra	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	species
Wolff 2012	NA	NA	NA	NA	Insecta	invertebra	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	species
Silva 2009	NA	NA	NA	NA	Insecta	invertebra	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	species
Esteves an	NA	NA	NA	NA	Insecta	invertebra	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	species
Silva 2009	NA	NA	NA	NA	Insecta	invertebra	Gymnotus	NA	Gymnotida	Gymnotifo	Actinopter	fish	species
Costa 1987	NA	NA	NA	NA	Insecta	invertebra	Gymnotus	NA	Gymnotida	Gymnotifo	Actinopter	fish	species
Braga and	NA	NA	NA	NA	Insecta	invertebra	Gymnotus	NA	Gymnotida	Gymnotifo	Actinopter	fish	species
Esteves et	NA	NA	NA	NA	Insecta	invertebra	Gymnotus	NA	Gymnotida	Gymnotifo	Actinopter	fish	species
Esteves an	NA	NA	NA	NA	Insecta	invertebra	Hollandich	NA	Characidae	Characifor	Actinopter	fish	species
Silva 2009	NA	NA	NA	NA	Insecta	invertebra	Hollandich	NA	Characidae	Characifor	Actinopter	fish	species
Gonçalves	NA	NA	NA	NA	Insecta	invertebra	Hollandich	NA	Characidae	Characifor	Actinopter	fish	species
Gonçalves	NA	NA	NA	NA	Insecta	invertebra	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	genus
Wolff 2012	NA	NA	NA	NA	Insecta	invertebra	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	genus
Silva 2009	NA	NA	NA	NA	Insecta	invertebra	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	genus
Costa 1987	NA	NA	NA	NA	Insecta	invertebra	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	genus
Aranha et a	NA	NA	NA	NA	Insecta	invertebra	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	genus
Gonçalves	NA	NA	NA	NA	Insecta	invertebra	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	species
Wolff 2012	NA	NA	NA	NA	Insecta	invertebra	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	species
Silva 2009	NA	NA	NA	NA	Insecta	invertebra	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	species
Costa 1987	NA	NA	NA	NA	Insecta	invertebra	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	species
Aranha et a	NA	NA	NA	NA	Insecta	invertebra	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	species

Esteves et	NA	NA	NA	NA	Insecta	invertebra	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	genus
Aranha et	NA	NA	NA	NA	Insecta	invertebra	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	genus
Esteves an	NA	NA	NA	NA	Insecta	invertebra	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	genus
Esteves an	NA	NA	NA	NA	Insecta	invertebra	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	genus
Wolff 2012	NA	NA	NA	NA	Insecta	invertebra	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	species
Meschiatti	NA	NA	NA	NA	Insecta	invertebra	Synbranch	NA	Synbranchi	Synbranchi	Actinopter	fish	species
Wolff et al.	NA	NA	NA	NA	Insecta	invertebra	Synbranch	NA	Synbranchi	Synbranchi	Actinopter	fish	species
Wolff 2012	NA	NA	NA	NA	Insecta	invertebra	Synbranch	NA	Synbranchi	Synbranchi	Actinopter	fish	species
Bentes_et_	NA	NA	NA	Lepidopter	Insecta	invertebra	Synoestrop	NA	Hydropsyc	Trichopter	Insecta	invertebra	genus
Esteves an	NA	NA	NA	Lepidopter	Insecta	invertebra	Acentronic	NA	Heptapteri	Siluriform	Actinopter	fish	species
Carmo 201	NA	NA	NA	Lepidopter	Insecta	invertebra	Characidiu	NA	Crenuchid	Characifor	Actinopter	fish	genus
Mazzoni a	NA	NA	NA	Lepidopter	Insecta	invertebra	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	genus
Mazzoni a	NA	NA	NA	Lepidopter	Insecta	invertebra	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	species
Deus and F	NA	NA	NA	Lepidopter	Insecta	invertebra	Rhamdia	NA	Pimelodid	Siluriform	Actinopter	fish	species
Brazil-Souz	NA	NA	NA	Lepidopter	Insecta	invertebra	Rhamdia	NA	Pimelodid	Siluriform	Actinopter	fish	species
Gamboa_e	NA	NA	Leptocerid	Trichopter	Insecta	invertebra	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebra	genus
Gamboa_e	NA	NA	Leptocerid	Trichopter	Insecta	invertebra	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Gamboa_e	NA	NA	Leptocerid	Trichopter	Insecta	invertebra	Macrogyn	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Gamboa_e	NA	NA	Leptohyph	Ephemero	Insecta	invertebra	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebra	genus
Gamboa_e	NA	NA	Leptohyph	Ephemero	Insecta	invertebra	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Gamboa_e	NA	NA	Leptohyph	Ephemero	Insecta	invertebra	Macrogyn	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Hurtado-B	NA	NA	Leptophle	Ephemero	Insecta	invertebra	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebra	genus
Gamboa_e	NA	NA	Leptophle	Ephemero	Insecta	invertebra	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebra	genus
Hurtado-B	NA	NA	Leptophle	Ephemero	Insecta	invertebra	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Gamboa_e	NA	NA	Leptophle	Ephemero	Insecta	invertebra	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Hurtado-B	NA	NA	Leptophle	Ephemero	Insecta	invertebra	Macrogyn	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Gamboa_e	NA	NA	Leptophle	Ephemero	Insecta	invertebra	Macrogyn	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Bentes_et_	NA	NA	Leptophle	Ephemero	Insecta	invertebra	Synoestrop	NA	Hydropsyc	Trichopter	Insecta	invertebra	genus
Sierra-Lab	NA	NA	NA	NA	NA	macroalga	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebra	genus
Sierra-Lab	NA	NA	NA	NA	NA	macroalga	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Sierra-Lab	NA	NA	NA	NA	NA	macroalga	Macrogyn	NA	Perlidae	Plecoptera	Insecta	invertebra	family

Saito_and_	NA	NA	NA	NA	NA	microphyte	NA	Tanypodin	Chironomi	Diptera	Insecta	invertebra	subfamily
Tomanova_	NA	NA	NA	NA	NA	invertebra	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebra	genus
McPeek_a	NA	NA	NA	NA	NA	invertebra	Argia	NA	Coenagrior	Odonata	Insecta	invertebra	family
Tomanova_	NA	NA	NA	NA	NA	invertebra	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Tomanova_	NA	NA	NA	NA	NA	invertebra	Macrogyno	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Velasco_ar	NA	NA	NA	NA	NA	invertebra	NA	NA	Belostoma	Hemiptera	Insecta	invertebra	family
Tomanova_	NA	NA	NA	NA	NA	invertebra	NA	NA	Ceratopog	Diptera	Insecta	invertebra	family
Morse_et_	NA	NA	NA	NA	NA	invertebra	Cernotina	NA	Polycentro	Trichoptera	Insecta	invertebra	genus
Tomanova_	NA	NA	NA	NA	NA	invertebra	Corydalus	NA	Corydalida	Megalopte	Insecta	invertebra	genus
McPeek_a	NA	NA	NA	NA	NA	invertebra	Dythemis	NA	Libellulidae	Odonata	Insecta	invertebra	family
Tomanova_	NA	NA	NA	NA	NA	invertebra	NA	NA	Hydrobiosi	Trichoptera	Insecta	invertebra	family
Tomanova_	NA	NA	NA	NA	NA	invertebra	NA	NA	Hydropsyc	Trichoptera	Insecta	invertebra	family
Tomanova_	NA	NA	NA	NA	NA	invertebra	Leptonema	NA	Hydropsyc	Trichoptera	Insecta	invertebra	genus
McPeek_a	NA	NA	NA	NA	NA	invertebra	NA	NA	Libellulidae	Odonata	Insecta	invertebra	family
Chesire_et	NA	NA	NA	NA	NA	invertebra	Oecetis	NA	Leptocerid	Trichoptera	Insecta	invertebra	genus
Tomanova_	NA	NA	NA	NA	NA	invertebra	Smicridea	NA	Hydropsyc	Trichoptera	Insecta	invertebra	genus
Gil_et_al._	NA	NA	NA	NA	NA	invertebra	Smicridea	NA	Hydropsyc	Trichoptera	Insecta	invertebra	genus
Bentes_et_	NA	NA	NA	NA	NA	invertebra	Synoestrop	NA	Hydropsyc	Trichoptera	Insecta	invertebra	genus
Saito_and_	NA	NA	NA	NA	NA	invertebra	NA	Tanypodin	Chironomi	Diptera	Insecta	invertebra	subfamily
Moreira_e	NA	NA	NA	NA	NA	invertebra	NA	NA	Veliidae	Hemiptera	Insecta	invertebra	family
Sierra-Laba	NA	NA	NA	NA	NA	macrophyt	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebra	genus
Shimabuku	NA	NA	NA	NA	NA	macrophyt	NA	NA	Chironomi	Diptera	Insecta	invertebra	family
Sierra-Laba	NA	NA	NA	NA	NA	macrophyt	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Sierra-Laba	NA	NA	NA	NA	NA	macrophyt	Macrogyno	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Esteves an	NA	NA	NA	NA	NA	macrophyt	Acentronic	NA	Heptapteri	Siluriforme	Actinopter	fish	species
Esteves an	NA	NA	NA	NA	NA	macrophyt	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	species
Buck and S	NA	NA	NA	NA	NA	macrophyt	Schizolecis	NA	Loricariida	Siluriforme	Actinopter	fish	species
Brazil-Souz	NA	NA	NA	Megalopte	Insecta	invertebra	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Boddingto	NA	NA	NA	NA	NA	invertebra	Dugesia	NA	NA	NA	Platyhelmi	worms	genus
Boon_1985	NA	NA	NA	NA	NA	invertebra	Blepharop	NA	Hydropsyc	Trichoptera	Insecta	invertebra	genus
Shimabuku	NA	NA	NA	NA	NA	invertebra	NA	NA	Chironomi	Diptera	Insecta	invertebra	family

Reynolds_a	NA	NA	NA	NA	NA	invertebrat	NA	NA	Corixidae	Hemiptera	Insecta	invertebrat	family
Garelis_an	NA	NA	NA	NA	NA	invertebrat	Cyrnellus	NA	Polycentro	Trichoptera	Insecta	invertebrat	family
Alencar_et	NA	NA	NA	NA	NA	invertebrat	Simulium	NA	Simuliidae	Diptera	Insecta	invertebrat	genus
Alencar_et	NA	NA	NA	NA	NA	invertebrat	Simulium	NA	Simuliidae	Diptera	Insecta	invertebrat	genus
Tomanova_	NA	NA	NA	NA	NA	microphyte	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebrat	family
Tomanova_	NA	NA	NA	NA	NA	microphyte	Macrogyno	NA	Perlidae	Plecoptera	Insecta	invertebrat	family
Sierra-Laba	NA	NA	NA	NA	NA	microphyte	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebrat	genus
Tomanova_	NA	NA	NA	NA	NA	microphyte	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebrat	genus
Tomanova_	NA	NA	NA	NA	NA	microphyte	NA	NA	Baetidae	Ephemerop	Insecta	invertebrat	family
Boon_1985	NA	NA	NA	NA	NA	microphyte	Blepharopu	NA	Hydropsyc	Trichoptera	Insecta	invertebrat	genus
Tomanova_	NA	NA	NA	NA	NA	microphyte	NA	NA	Ceratopogo	Diptera	Insecta	invertebrat	family
Tomanova_	NA	NA	NA	NA	NA	microphyte	Chimarra	NA	Philopotan	Trichoptera	Insecta	invertebrat	genus
Shimabuku	NA	NA	NA	NA	NA	microphyte	NA	NA	Chironomi	Diptera	Insecta	invertebrat	family
Garelis_an	NA	NA	NA	NA	NA	microphyte	Cyrnellus	NA	Polycentro	Trichoptera	Insecta	invertebrat	family
Brito_et_a	NA	NA	NA	NA	NA	microphyte	Gripoptery	NA	Gripoptery	Plecoptera	Insecta	invertebrat	family
Tomanova_	NA	NA	NA	NA	NA	microphyte	Helicopsyc	NA	Helicopsyc	Trichoptera	Insecta	invertebrat	genus
Tomanova_	NA	NA	NA	NA	NA	microphyte	Heterelmis	NA	Elmidae	Coleoptera	Insecta	invertebrat	genus
Tomanova_	NA	NA	NA	NA	NA	microphyte	Heterelmis	NA	Elmidae	Coleoptera	Insecta	invertebrat	genus
Tomanova_	NA	NA	NA	NA	NA	microphyte	Hexacylloe	NA	Elmidae	Coleoptera	Insecta	invertebrat	family
Tomanova_	NA	NA	NA	NA	NA	microphyte	NA	NA	Hydrobiosi	Trichoptera	Insecta	invertebrat	family
Tomanova_	NA	NA	NA	NA	NA	microphyte	NA	NA	Hydropsyc	Trichoptera	Insecta	invertebrat	family
Keiper_and	NA	NA	NA	NA	NA	microphyte	NA	NA	Hydroptilid	Trichoptera	Insecta	invertebrat	family
Sierra-Laba	NA	NA	NA	NA	NA	microphyte	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebrat	family
Tomanova_	NA	NA	NA	NA	NA	microphyte	NA	NA	Leptocerid	Trichoptera	Insecta	invertebrat	family
Tomanova_	NA	NA	NA	NA	NA	microphyte	NA	NA	Leptohyph	Ephemerop	Insecta	invertebrat	genus
Tomanova_	NA	NA	NA	NA	NA	microphyte	Leptonema	NA	Hydropsyc	Trichoptera	Insecta	invertebrat	genus
Tomanova_	NA	NA	NA	NA	NA	microphyte	Macrelmis	NA	Elmidae	Coleoptera	Insecta	invertebrat	genus
Tomanova_	NA	NA	NA	NA	NA	microphyte	Macrelmis	NA	Elmidae	Coleoptera	Insecta	invertebrat	genus
Brito_et_a	NA	NA	NA	NA	NA	microphyte	Macrobrac	NA	Paleomoni	Decapoda	Crustacea	invertebrat	genus
Brito_et_a	NA	NA	NA	NA	NA	microphyte	Macrobrac	NA	Paleomoni	Decapoda	Crustacea	invertebrat	genus
Brito_et_a	NA	NA	NA	NA	NA	microphyte	Macrobrac	NA	Paleomoni	Decapoda	Crustacea	invertebrat	genus

Sierra-Laba	NA	NA	NA	NA	NA	microphyt	Macrogyn	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Silveira-Ma	NA	NA	NA	NA	NA	microphyt	Macronem	NA	Hydropsyc	Trichopter	Insecta	invertebra	genus
Ceneviva-B	NA	NA	NA	NA	NA	microphyt	Miroculis	NA	Leptophleb	Ephemeroj	Insecta	invertebra	genus
Tomanova_	NA	NA	NA	NA	NA	microphyt	Neoelmis	NA	Elmidae	Coleoptera	Insecta	invertebra	genus
Tomanova_	NA	NA	NA	NA	NA	microphyt	Neoelmis	NA	Elmidae	Coleoptera	Insecta	invertebra	genus
Ferreira_et	NA	NA	NA	NA	NA	microphyt	Phylloicus	NA	Calamocer	Trichopter	Insecta	invertebra	genus
Tomanova_	NA	NA	NA	NA	NA	microphyt	Psephenus	NA	Psephenid	Coleoptera	Insecta	invertebra	genus
Tomanova_	NA	NA	NA	NA	NA	microphyt	Smicridea	NA	Hydropsyc	Trichopter	Insecta	invertebra	genus
Saito_(po)	NA	NA	NA	NA	NA	microphyt	NA	NA	NA	NA	NA	gastropod	NA
Mazzoni ar	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	Hoplias	NA	Erythrinida	Characifor	Actinopter	fish	species
Carmo 201	NA	NA	NA	NA	Mollusca	Mollusca	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	genus
Gonçalves	NA	NA	NA	NA	Mollusca	Mollusca	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	species
Gonçalves	NA	NA	NA	NA	Mollusca	Mollusca	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	genus
Gonçalves	NA	NA	NA	NA	Mollusca	Mollusca	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	species
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Coleoptera	Insecta	invertebra	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Diptera	Insecta	invertebra	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA	Elmidae	Coleoptera	Insecta	invertebra	NA
NA	NA	NA	NA	NA	NA	NA	NA	NA	Ptilodactyl	Coleoptera	Insecta	invertebra	NA
Carmo 201	NA	NA	NA	NA	Nematoda	worm	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	genus
Carmo et a	NA	NA	NA	NA	Nematoda	worm	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	genus
Esteves an	NA	NA	NA	NA	Nematoda	worm	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	species
Barreto an	NA	NA	NA	NA	Nematoda	worm	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	genus
Gonçalves	NA	NA	NA	NA	Nematoda	worm	Hollandich	NA	Characidae	Characifor	Actinopter	fish	species
Gonçalves	NA	NA	NA	NA	Nematoda	worm	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	genus
Costa 1987	NA	NA	NA	NA	Nematoda	worm	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	genus
Aranha et a	NA	NA	NA	NA	Nematoda	worm	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	genus
Gonçalves	NA	NA	NA	NA	Nematoda	worm	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	species
Costa 1987	NA	NA	NA	NA	Nematoda	worm	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	species
Aranha et a	NA	NA	NA	NA	Nematoda	worm	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	species
Carmo 201	NA	NA	NA	Odonata	Insecta	invertebra	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	genus
Carmo et a	NA	NA	NA	Odonata	Insecta	invertebra	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	genus

Aranha et	NA	NA	NA	Odonata	Insecta	invertebra	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	species
Abilhoa et	NA	NA	NA	Odonata	Insecta	invertebra	Hollandich	NA	Characidae	Characifor	Actinopter	fish	species
Mazzoni a	NA	NA	NA	Odonata	Insecta	invertebra	Hoplias	NA	Erythrinida	Characifor	Actinopter	fish	species
Mazzoni a	NA	NA	NA	Odonata	Insecta	invertebra	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	genus
Mazzoni a	NA	NA	NA	Odonata	Insecta	invertebra	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	species
Aranha et	NA	NA	NA	Odonata	Insecta	invertebra	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	species
Villares Ju	NA	NA	NA	Odonata	Insecta	invertebra	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Brazil-Souz	NA	NA	NA	Odonata	Insecta	invertebra	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Reynolds_	NA	NA	NA	NA	Oligochaet	worm	NA	NA	Corixidae	Hemiptera	Insecta	invertebra	family
Boddingto	NA	NA	NA	NA	Oligochaet	worm	Dugesia	NA	NA	NA	Platyhelmi	worms	genus
Abilhoa et	NA	NA	NA	Oligochaet	Clitellata	worm	Hollandich	NA	Characidae	Characifor	Actinopter	fish	species
Esteves an	NA	NA	NA	Oligochaet	Clitellata	worm	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	genus
Deus and	NA	NA	NA	Oligochaet	Clitellata	worm	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Brazil-Souz	NA	NA	NA	Oligochaet	Clitellata	worm	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Carmo et a	NA	NA	NA	Ostracoda	Crustacea	crustacean	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	genus
Reis et al.	NA	NA	NA	NA	NA	periphyton	Acentronic	NA	Heptapteri	Siluriforme	Actinopter	fish	species
Gonçalves	NA	NA	NA	NA	NA	periphyton	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	species
Deus and	NA	NA	NA	NA	NA	plant_see	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Aranha et	NA	NA	NA	NA	NA	plant_see	Schizolecis	NA	Loricariida	Siluriforme	Actinopter	fish	species
Silva 2009	NA	NA	NA	NA	NA	plant_tissu	Acentronic	NA	Heptapteri	Siluriforme	Actinopter	fish	species
Wolff 2012	NA	NA	NA	NA	NA	plant_tissu	Acentronic	NA	Heptapteri	Siluriforme	Actinopter	fish	species
Wolff 2012	NA	NA	NA	NA	NA	plant_tissu	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	species
Carmo 201	NA	NA	NA	NA	NA	plant_tissu	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	genus
Gonçalves	NA	NA	NA	NA	NA	plant_tissu	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	species
Wolff 2012	NA	NA	NA	NA	NA	plant_tissu	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	species
Silva 2009	NA	NA	NA	NA	NA	plant_tissu	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	species
Esteves an	NA	NA	NA	NA	NA	plant_tissu	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	species
Barreto an	NA	NA	NA	NA	NA	plant_tissu	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	genus
Silva 2009	NA	NA	NA	NA	NA	plant_tissu	Gymnotus	NA	Gymnotida	Gymnotifo	Actinopter	fish	species
Braga and	NA	NA	NA	NA	NA	plant_tissu	Gymnotus	NA	Gymnotida	Gymnotifo	Actinopter	fish	species
Esteves et	NA	NA	NA	NA	NA	plant_tissu	Gymnotus	NA	Gymnotida	Gymnotifo	Actinopter	fish	species

Abilhoa et	NA	NA	NA	NA	NA	plant_tissu	Hollandich	NA	Characidae	Characifor	Actinopter	fish	species
Silva 2009	NA	NA	NA	NA	NA	plant_tissu	Hollandich	NA	Characidae	Characifor	Actinopter	fish	species
Wolff 2012	NA	NA	NA	NA	NA	plant_tissu	Hollandich	NA	Characidae	Characifor	Actinopter	fish	species
Gonçalves	NA	NA	NA	NA	NA	plant_tissu	Hollandich	NA	Characidae	Characifor	Actinopter	fish	species
Costa 1987	NA	NA	NA	NA	NA	plant_tissu	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	genus
Aranha et	NA	NA	NA	NA	NA	plant_tissu	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	genus
Costa 1987	NA	NA	NA	NA	NA	plant_tissu	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	species
Aranha et	NA	NA	NA	NA	NA	plant_tissu	Mimagonia	NA	Characidae	Characifor	Actinopter	fish	species
Aranha et	NA	NA	NA	NA	NA	plant_tissu	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	species
Esteves et	NA	NA	NA	NA	NA	plant_tissu	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	genus
Aranha et	NA	NA	NA	NA	NA	plant_tissu	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	genus
Esteves an	NA	NA	NA	NA	NA	plant_tissu	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	genus
Brazil-Souz	NA	NA	NA	NA	NA	plant_tissu	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Aranha et	NA	NA	NA	NA	NA	plant_tissu	Schizolecis	NA	Loricariida	Siluriforme	Actinopter	fish	species
Ferreira_et	NA	NA	NA	NA	NA	plant_tissu	Phylloicus	NA	Calamocer	Trichoptera	Insecta	invertebrat	genus
Gil_et_al._	NA	NA	NA	NA	NA	plant_tissu	Smicridea	NA	Hydropsyc	Trichoptera	Insecta	invertebrat	genus
Bentes_et_	NA	NA	NA	NA	NA	plant_tissu	Synoestrop	NA	Hydropsyc	Trichoptera	Insecta	invertebrat	genus
Vlug_and_	NA	NA	NA	NA	NA	plant_tissu	NA	NA	Tipulidae	Diptera	Insecta	invertebrat	family
Carmo 201	NA	NA	NA	Plecoptera	Insecta	invertebrat	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	genus
Carmo et a	NA	NA	NA	Plecoptera	Insecta	invertebrat	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	genus
Barreto an	NA	NA	NA	Plecoptera	Insecta	invertebrat	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	species
Barreto an	NA	NA	NA	Plecoptera	Insecta	invertebrat	Deuterodo	NA	Characidae	Characifor	Actinopter	fish	genus
Aranha et	NA	NA	NA	Plecoptera	Insecta	invertebrat	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	species
Brazil-Souz	NA	NA	NA	Plecoptera	Insecta	invertebrat	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish	species
Mazzoni an	Poecilia	NA	Poeciliidae	Cyprinodo	Actinopter	fish	Hoplias	NA	Erythrinida	Characifor	Actinopter	fish	species
Gil_et_al._	NA	NA	NA	NA	NA	pollen	Smicridea	NA	Hydropsyc	Trichoptera	Insecta	invertebrat	genus
Bentes_et_	NA	NA	NA	NA	Porifera	Porifera	Synoestrop	NA	Hydropsyc	Trichoptera	Insecta	invertebrat	genus
Aranha et	NA	NA	NA	NA	Protista	protist	Schizolecis	NA	Loricariida	Siluriforme	Actinopter	fish	species
Hurtado-B	NA	NA	Simuliidae	Diptera	Insecta	invertebrat	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebrat	genus
Gamboa_e	NA	NA	Simuliidae	Diptera	Insecta	invertebrat	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebrat	genus
Alencar_et	NA	NA	Simuliidae	Diptera	Insecta	invertebrat	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebrat	family

Alencar_et	NA	NA	Simuliidae	Diptera	Insecta	invertebra	Argia	NA	Coenagrio	Odonata	Insecta	invertebra	family
Alencar_et	NA	NA	Simuliidae	Diptera	Insecta	invertebra	Dythemis	NA	Libellulida	Odonata	Insecta	invertebra	family
Alencar_et	NA	NA	Simuliidae	Diptera	Insecta	invertebra	NA	NA	Gomphida	Odonata	Insecta	invertebra	family
Alencar_et	NA	NA	Simuliidae	Diptera	Insecta	invertebra	Heteragrio	NA	Megapoda	Odonata	Insecta	invertebra	family
Hurtado-B	NA	NA	Simuliidae	Diptera	Insecta	invertebra	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Gamboa_e	NA	NA	Simuliidae	Diptera	Insecta	invertebra	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Alencar_et	NA	NA	Simuliidae	Diptera	Insecta	invertebra	NA	NA	Libellulida	Odonata	Insecta	invertebra	family
Hurtado-B	NA	NA	Simuliidae	Diptera	Insecta	invertebra	Macrogyn	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Gamboa_e	NA	NA	Simuliidae	Diptera	Insecta	invertebra	Macrogyn	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Alencar_et	NA	NA	Simuliidae	Diptera	Insecta	invertebra	Macrogyn	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Esteves an	NA	NA	Simuliidae	Diptera	Insecta	invertebra	Acentronic	NA	Heptapteri	Siluriform	Actinopter	fish	species
Buck and S	NA	NA	Simuliidae	Diptera	Insecta	invertebra	Schizolecis	NA	Loricariida	Siluriform	Actinopter	fish	species
Hurtado-B	Smicridea	NA	Hydropsyc	Trichopter	Insecta	invertebra	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebra	genus
Hurtado-B	Smicridea	NA	Hydropsyc	Trichopter	Insecta	invertebra	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Hurtado-B	Smicridea	NA	Hydropsyc	Trichopter	Insecta	invertebra	Macrogyn	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Gamboa_e	NA	NA	Tabanidae	Diptera	Insecta	invertebra	Anacroneu	NA	Perlidae	Plecoptera	Insecta	invertebra	genus
Gamboa_e	NA	NA	Tabanidae	Diptera	Insecta	invertebra	Kempnyia	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Gamboa_e	NA	NA	Tabanidae	Diptera	Insecta	invertebra	Macrogyn	NA	Perlidae	Plecoptera	Insecta	invertebra	family
Tomanova	NA	NA	NA	NA	NA	Allochtono	Smicridea	NA	Hydropsyc	Trichopter	Insecta	invertebra	genus
Moreira_e	NA	NA	NA	NA	NA	Allochtono	NA	NA	Veliidae	Hemiptera	Insecta	invertebra	family
Esteves an	NA	NA	NA	NA	NA	Allochtono	Acentronic	NA	Heptapteri	Siluriform	Actinopter	fish	species
Gonçalves	NA	NA	NA	NA	NA	Allochtono	Acentronic	NA	Heptapteri	Siluriform	Actinopter	fish	species
Wolff 2012	NA	NA	NA	NA	NA	Allochtono	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	species
Silva 2009	NA	NA	NA	NA	NA	Allochtono	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	genus
Barreto an	NA	NA	NA	NA	NA	Allochtono	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish	species
Wolff 2012	NA	NA	NA	NA	NA	Allochtono	Deuterodo	NA	Characida	Characifor	Actinopter	fish	species
Silva 2009	NA	NA	NA	NA	NA	Allochtono	Deuterodo	NA	Characida	Characifor	Actinopter	fish	species
Esteves an	NA	NA	NA	NA	NA	Allochtono	Deuterodo	NA	Characida	Characifor	Actinopter	fish	species
Barreto an	NA	NA	NA	NA	NA	Allochtono	Deuterodo	NA	Characida	Characifor	Actinopter	fish	genus
Costa 1987	NA	NA	NA	NA	NA	Allochtono	Gymnotus	NA	Gymnotida	Gymnotifo	Actinopter	fish	species
Braga and	NA	NA	NA	NA	NA	Allochtono	Gymnotus	NA	Gymnotida	Gymnotifo	Actinopter	fish	species

Abilhoa et	NA	NA	NA	NA	NA	Allochtono	Hollandich	NA	Characidae	Characifor	Actinopter	fish		species
Esteves an	NA	NA	NA	NA	NA	Allochtono	Hollandich	NA	Characidae	Characifor	Actinopter	fish		species
Wolff 2012	NA	NA	NA	NA	NA	Allochtono	Hollandich	NA	Characidae	Characifor	Actinopter	fish		species
Gonçalves	NA	NA	NA	NA	NA	Allochtono	Hollandich	NA	Characidae	Characifor	Actinopter	fish		species
Mazzoni an	NA	NA	NA	NA	NA	Allochtono	Hoplias	NA	Erythrinida	Characifor	Actinopter	fish		species
Gonçalves	NA	NA	NA	NA	NA	Allochtono	Mimagonia	NA	Characidae	Characifor	Actinopter	fish		genus
Wolff 2012	NA	NA	NA	NA	NA	Allochtono	Mimagonia	NA	Characidae	Characifor	Actinopter	fish		genus
Silva 2009	NA	NA	NA	NA	NA	Allochtono	Mimagonia	NA	Characidae	Characifor	Actinopter	fish		genus
Costa 1987	NA	NA	NA	NA	NA	Allochtono	Mimagonia	NA	Characidae	Characifor	Actinopter	fish		genus
Aranha et	NA	NA	NA	NA	NA	Allochtono	Mimagonia	NA	Characidae	Characifor	Actinopter	fish		genus
Mazzoni an	NA	NA	NA	NA	NA	Allochtono	Mimagonia	NA	Characidae	Characifor	Actinopter	fish		genus
Gonçalves	NA	NA	NA	NA	NA	Allochtono	Mimagonia	NA	Characidae	Characifor	Actinopter	fish		species
Wolff 2012	NA	NA	NA	NA	NA	Allochtono	Mimagonia	NA	Characidae	Characifor	Actinopter	fish		species
Silva 2009	NA	NA	NA	NA	NA	Allochtono	Mimagonia	NA	Characidae	Characifor	Actinopter	fish		species
Costa 1987	NA	NA	NA	NA	NA	Allochtono	Mimagonia	NA	Characidae	Characifor	Actinopter	fish		species
Aranha et	NA	NA	NA	NA	NA	Allochtono	Mimagonia	NA	Characidae	Characifor	Actinopter	fish		species
Mazzoni an	NA	NA	NA	NA	NA	Allochtono	Mimagonia	NA	Characidae	Characifor	Actinopter	fish		species
Aranha et	NA	NA	NA	NA	NA	Allochtono	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish		species
Villares Jur	NA	NA	NA	NA	NA	Allochtono	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish		species
Deus and F	NA	NA	NA	NA	NA	Allochtono	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish		species
Brazil-Souz	NA	NA	NA	NA	NA	Allochtono	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish		species
Hurtado-B	NA	NA	NA	Trichopter	Insecta	invertebra	Anacroneu	NA	Perlidae	Plecoptera	Insecta		invertebra	genus
Hurtado-B	NA	NA	NA	Trichopter	Insecta	invertebra	Kempnyia	NA	Perlidae	Plecoptera	Insecta		invertebra	family
Hurtado-B	NA	NA	NA	Trichopter	Insecta	invertebra	Macrogyn	NA	Perlidae	Plecoptera	Insecta		invertebra	family
Bentes_et_	NA	NA	NA	Trichopter	Insecta	invertebra	Synoestrop	NA	Hydropsyc	Trichopter	Insecta		invertebra	genus
Carmo 201	NA	NA	NA	Trichopter	Insecta	invertebra	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish		genus
Barreto an	NA	NA	NA	Trichopter	Insecta	invertebra	Characidiu	NA	Crenuchida	Characifor	Actinopter	fish		species
Costa 1987	NA	NA	NA	Trichopter	Insecta	invertebra	Mimagonia	NA	Characidae	Characifor	Actinopter	fish		genus
Costa 1987	NA	NA	NA	Trichopter	Insecta	invertebra	Mimagonia	NA	Characidae	Characifor	Actinopter	fish		species
Brazil-Souz	NA	NA	NA	Trichopter	Insecta	invertebra	Rhamdia	NA	Pimelodida	Siluriforme	Actinopter	fish		species
Aranha et	NA	NA	NA	NA	Zignemaph	algae	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish		genus

Aranha et a	NA	NA	NA	NA	Zignemaph	algae	Schizolecis	NA	Loricariida	Siluriforme	Actinopter	fish	species
Aranha et a	NA	NA	NA	NA	NA	zooplankto	Phallocero	NA	Poeciliidae	Cyprinodo	Actinopter	fish	species

on

resource	frequency	res.genus	res.subfam	res.family	res.order	res.class.ph	res.category
Acarina	7	NA	NA	NA	Acarina	Chelicerata	invertebrates
algae	44	NA	NA	NA	NA	NA	algae
allochtonous_vegetation	3	NA	NA	NA	NA	NA	allochtonous_vegetation
Amphipoda	1	NA	NA	NA	Amphipoda	Crustacea	crustacean
animal_tissues	10	NA	NA	NA	NA	NA	invertebrates
Annelida	2	NA	NA	NA	NA	Annelida	worm
Anura	1	NA	NA	NA	NA	Anura	anuran
Arachnida	7	NA	NA	NA	Arachnida	Chelicerata	invertebrates
Astyanax_janeiroensis	1	Astyanax	NA	Characidae	Characiforn	Actinopter	fish
Baccilariophyceae	5	NA	NA	NA	NA	Baccilariop	algae
Bacteria	1	NA	NA	NA	NA	NA	bacteria
Belostomatidae	1	NA	NA	Belostomat	Hemiptera	Insecta	invertebrates
Bryozoa	2	NA	NA	NA	NA	Bryozoa	Bryozoa
Calamoceratidae	3	NA	NA	Calamocer	Trichoptera	Insecta	invertebrates
Chironomidae	26	NA	NA	Chironomi	Diptera	Insecta	invertebrates
Chlorophyceae	5	NA	NA	NA	NA	Chlorophyc	algae
Coleoptera	9	NA	NA	NA	Coleoptera	Insecta	invertebrates
Collembola	2	NA	NA	NA	NA	Collembola	invertebrates
Copepoda	1	NA	NA	NA	Copepoda	Crustacea	crustacean
Crustacea	16	NA	NA	NA	NA	Crustacea	crustacean
Cyanophyta	2	NA	NA	NA	NA	Cyanophyt	algae
Decapoda	2	NA	NA	NA	Decapoda	Crustacea	crustacean
detritus	54	NA	NA	NA	NA	NA	detritus
diatoms	7	NA	NA	NA	NA	NA	microphytes
Diplopoda	1	NA	NA	NA	Diplopoda	Chelicerata	invertebrates
Diptera	4	NA	NA	NA	Diptera	Insecta	invertebrates
Dytiscidae	1	NA	NA	Dytiscidae	Coleoptera	Insecta	invertebrates
eggs	3	NA	NA	NA	NA	NA	eggs
Ephemeroptera	23	NA	NA	NA	Ephemerop	Insecta	invertebrates
filamentous_algae	12	NA	NA	NA	NA	NA	filamentous_algae
fish	14	NA	NA	NA	NA	Actinopter	fish

fruits_seeds	1	NA	NA	NA	NA	NA	fruits_seeds
fungi	1	NA	NA	NA	NA	NA	fungi
Gastropoda	3	NA	NA	NA	NA	Gastropod	gastropod
Geophagus_brasiliensis	1	Geophagu	NA	Cichlidae	Perciform	Actinopter	fish
Glossomatidae	3	NA	NA	Glossomat	Trichopter	Insecta	invertebrates
Hemiptera	5	NA	NA	NA	Hemiptera	Insecta	invertebrates
Hydrobiosidae	3	NA	NA	Hydrobiosi	Trichopter	Insecta	invertebrates
Hydroptilidae	3	NA	NA	Hydroptili	Trichopter	Insecta	invertebrates
insects	35	NA	NA	NA	NA	Insecta	invertebrates
Lepidoptera	7	NA	NA	NA	Lepidopter	Insecta	invertebrates
Leptoceridae	3	NA	NA	Leptocerid	Trichopter	Insecta	invertebrates
Leptohyphidae	3	NA	NA	Leptohyph	Ephemero	Insecta	invertebrates
Leptophlebiidae	7	NA	NA	Leptophle	Ephemero	Insecta	invertebrates
macroalgae	4	NA	NA	NA	NA	NA	filamentous_algae
macroinvertebrates	19	NA	NA	NA	NA	NA	invertebrates
macrophytes	7	NA	NA	NA	NA	NA	macrophytes
Megaloptera	1	NA	NA	NA	Megalopte	Insecta	invertebrates
microcrustaceans	2	NA	NA	NA	NA	NA	crustacean
microinvertebrates	6	NA	NA	NA	NA	NA	invertebrates
Mimagoniates_microlepis	1	Mimagonia	NA	Characida	Characifor	Actinopter	fish
Mollusca	4	NA	NA	NA	NA	Mollusca	Mollusca
Nematoda	11	NA	NA	NA	NA	Nematoda	worm
Odonata	10	NA	NA	NA	Odonata	Insecta	invertebrates
Oligochaeta	6	NA	NA	NA	Oligochaet	Clitellata	worm
Ostracoda	1	NA	NA	NA	Ostracoda	Crustacea	crustacean
plant_seeds	2	NA	NA	NA	NA	NA	plant_seed
plant_tissue	26	NA	NA	NA	NA	NA	plant_tissue
plant_tissues	4	NA	NA	NA	NA	NA	plant_tissue
Plecoptera	6	NA	NA	NA	Plecoptera	Insecta	invertebrates
Poecilia_vivipara	1	Poecilia	NA	Poeciliidae	Cyprinodo	Actinopter	fish
pollen	1	NA	NA	NA	NA	NA	pollen

Porifera	1	NA	NA	NA	NA	Porifera	Porifera
Protist	1	NA	NA	NA	NA	Protista	protist
Simuliidae	15	NA	NA	Simuliidae	Diptera	Insecta	invertebrates
Smicridea	3	Smicridea	NA	Hydropsyc	Trichopter	Insecta	invertebrates
Tabanidae	3	NA	NA	Tabanidae	Diptera	Insecta	invertebrates
terrestrial_invertebrates_	34	NA	NA	NA	NA	NA	Allochtonous_animals
Trichoptera	9	NA	NA	NA	Trichopter	Insecta	invertebrates
Zignemaphyceae	2	NA	NA	NA	NA	Zignemaph	algae