



## Functional feeding habits of Chironomidae larvae (Insecta, Diptera) in a lotic system from Midwestern region of São Paulo State, Brazil

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**Abstract.** Functional feeding habits of Chironomidae larvae (Insecta, Diptera) in a lotic system from Mid-western region of São Paulo State, Brazil were analyzed. Collectors were the dominant organisms, represented by genera *Chironomus*, *Fissimentum* and *Cryptochironomus*, following by shredders and predators.

**Key words:** Diet, food habits, functional feeding groups, gut contents.

**Resumo. Hábitos alimentares de larvas de Chironomidae (Insecta, Diptera) em um sistema lótico da região centro-oeste do Estado de São Paulo, Brasil.** Foram analisados os hábitos alimentares de larvas de Chironomidae (Insecta, Diptera) em um sistema lótico da região centro-oeste do Estado de São Paulo, Brasil. Os coletores foram os organismos dominantes, representados pelos gêneros *Chironomus*, *Fissimentum* e *Cryptochironomus*, seguidos por fragmentadores e predadores.

**Palavras-chave:** Conteúdo estomacal, dieta, grupos funcionais de alimentação, hábitos alimentares.

In recent decades, two general approaches using invertebrates are being employed worldwide to conduct biological assessments of aquatic systems. One is taxonomic, and the other is functional. The first involve measures, such as species density, specific diversity or richness, while the second is focused in food webs and energy flow (Cummins *et al.* 2005). According to Cummins & Klug (1979), the use of the functional approach may be more adequate if the goal is to characterize ecosystem condition. Within this context, the concept of guild has become useful, since it can be considered a functional unit in community analysis, making it unnecessary to consider each and every species as a separate entity (Odum 1988).

The family Chironomidae has an important role in aquatic food webs, representing a major link between producers, such as phytoplankton and benthic algae, and secondary consumers (Tokeshi 1995). These organisms can occupy important

positions in the trophic dynamics of aquatic ecosystems, due to their numeric abundance and role in nutrient cycling. The chironomids alter the composition of fine organic matter (< 1mm) and supply important subsidies for predators (Sankarperumal & Pandian 1992). Moreover, due to their long life cycle and low mobility, chironomids integrate various biological processes and may be used as indicators of environmental conditions (Kuhlmann *et al.* 2001).

In recent years, interest towards the feeding behavior of chironomid larvae has increased, primarily because of (1) improvements in taxonomic keys that allow their identification, (2) attempts to control pestiferous emergences in lentic habitats and (3) recognition of their energetic importance in freshwater ecosystems (Berg 1995).

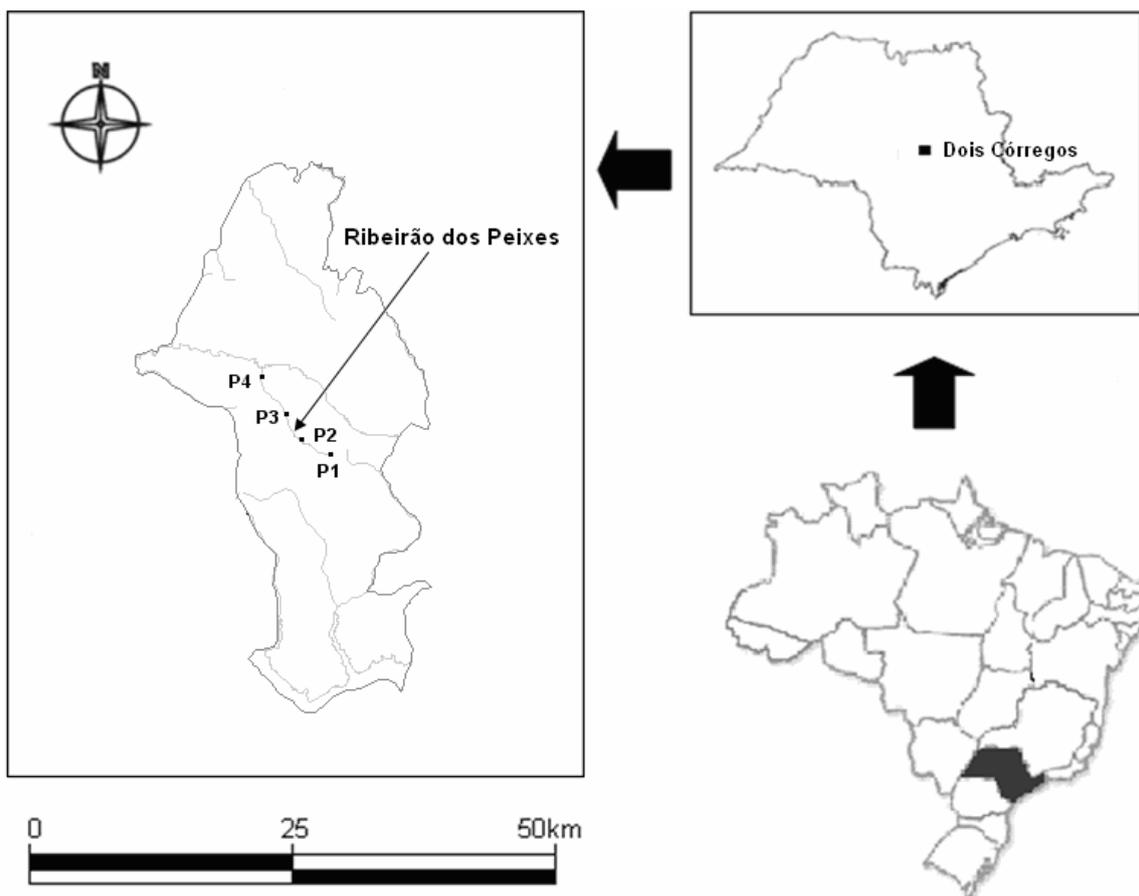
Despite pioneer attempt of Coffman & Ferrington (1996) to categorize the functional feeding habits of chironomids from Nearctic zone and

this work be considered the main treaty on the subject, various studies on the feeding ecology of Chironomidae from Neotropical region indicate a diversity of feeding habits and functions, although most are considered omnivorous (Nessimian & Sanseverino 1998, Nessimian *et al.* 1999, Henriques-Oliveira *et al.* 2003). With this in mind, this study aims to analyze the functions and feeding habits of chironomid larvae in a lotic system from Midwestern region of São Paulo State (Brazil). We believe that there are divergences between the feeding strategies of larvae sampled in this study, carried out in lotic system from Neotropical zone, and the information gathered by Coffman & Ferrington (1996) from the North American literature.

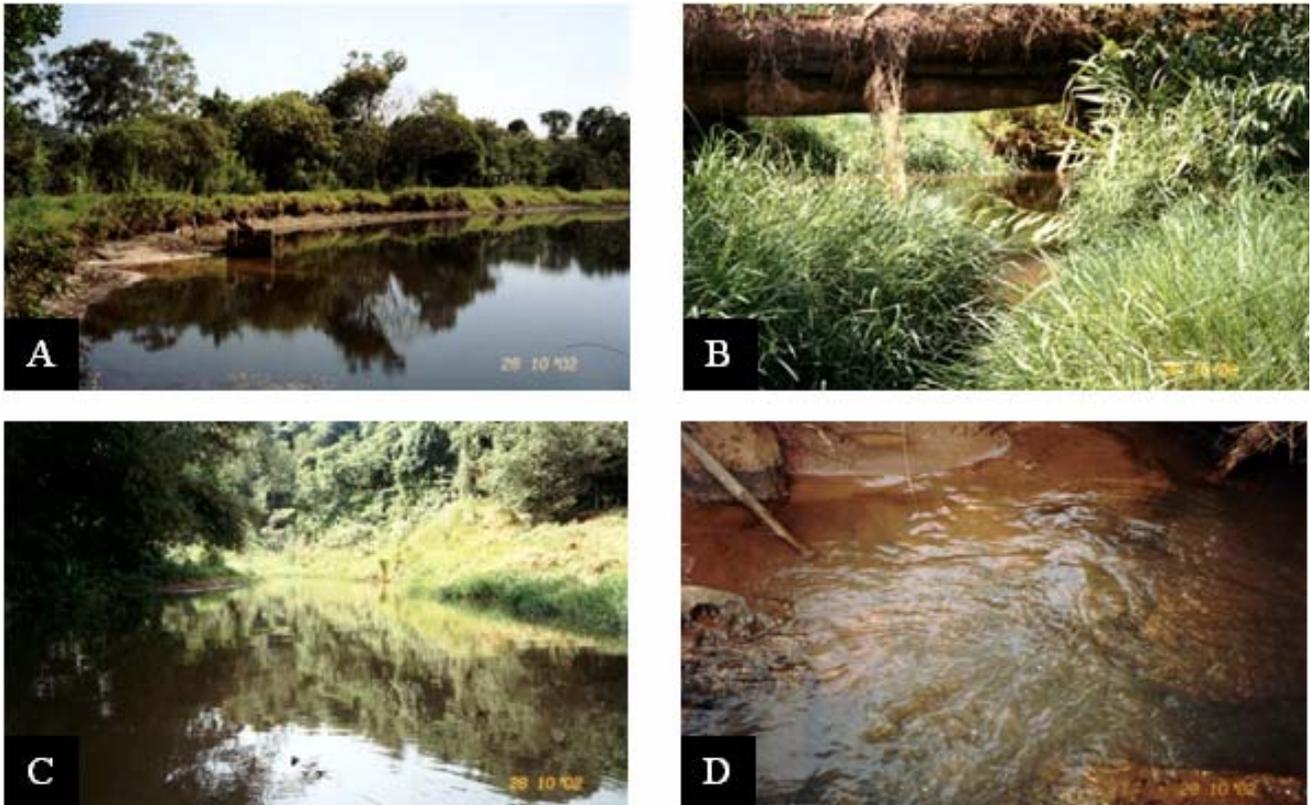
This study was carried out in Ribeirão dos Peixes, in the municipality of Dois Córregos (22° 22' S; 48° 22' W), located in the Midwestern region of São Paulo State, Brazil (figure 1). This water body runs through the municipality and is under a high sedimentation process due to marginal vegetation deforestation, beyond receiving discharges of domestic sewage and industrial effluents in different points along its course (Lucatto & Talamoni 2007).

For sediment collection were made seven samplings (02, 04, 07, 08, 10, 11 e 14/IV/2003), in four points along Ribeirão dos Peixes (figure 2), previously determined (Mazzini 2002): Point 1 (P1) is a spring of lentic character, it show better environmental conditions than the other points; Point 2 (P2), located below a fish culture tank, receives input of organic matter from this activity. This place is a narrow stretch, resulting in higher draught and the formation of depositional areas; Point 3 (P3) is an impounded area with more intense sedimentation; Point 4 (P4), in urban area, exhibits alterations due to human activity. This place received discharges of domestic sewage until the year prior to this study (Silva *et al.* 2008).

Each sample corresponded to 3 subsamples. By this way a total of 84 subsamples were collected using an Ekman-Birge grab (0,0225m<sup>2</sup> area) and immediately fixed in a 10% formalin solution. In the laboratory, the samples were washed using 0.250 mm sieve, sorted and preserved in 70% ethanol. The organisms were mounted on slides in Hoyer's medium after it were examined under an optical microscope and identified using appropriate literature (Epler 1995, Trivinho-Strixino & Strixino 1995), being subsequently counted.



**Figure 1.** Map of Ribeirão dos Peixes (Dois Córregos, SP, Brazil), illustrating the samplings points.



**Figure 2.** Sampling points of Ribeirão dos Peixes (Dois Córregos, SP, Brazil): A) Point 1, B) Point 2, C) Point 3, D) Point 4.

For the fauna analysis was considered absolute (N) and relative (ni) abundance, which this work corresponded to sum of three subsamples of all samples taken at each point. Gut content analyses were made according to Mcshaffrey & Olive (1985), based on previously prepared slides of larvae. No attempt was made during collection to prevent regurgitation of food in the gut, however all specimens presented some gut content. Guts were left in the bodies and examined microscopically by transparency through the cuticle, being identified as detritus, plant material, or animal material. Individuals were grouped according to their trophic position as detritivorous, herbivorous, carnivorous and omnivorous; the percentage calculation was based on the total number of individuals sampled at each point. Another analysis categorized genera according to feeding mode: (1) collectors (gatherers and filterers) - ingest decomposition matter; (2) shredders - chew vascular plants, macrophytes and submerged leaves or excavate wood; (3) grazer-scrapers - remove firmly attached algae from exposed surfaces, sediments and submerged organic matter; (4) predators - feed on living animal tissue, attack and ingest their prey whole or in pieces, or bore the prey tissues removing their body fluids (Berg 1995, Coffman & Ferrington 1996). In this classification, functional group designations are closely related to feeding mode than the food

ingested, given that a determined feeding mechanism, such as filtering, can result in the intake all food categories (Cummins 1973).

In this study, 1439 specimens were collected, belonging to 14 Chironomidae genera (table I). In P1, the genus that presented highest relative abundance was *Fissimentum* (51.7%), this place displayed low draught and arenaceous substrate. Cranston & Nolte (1996) recorded this detritivorous genus in marginal sediments of slowly-flowing, tropical, lowland rivers from South America, Florida and Texas. In Brazil, *Fissimentum* has been observed in courses with low draught and arenaceous and/or muddy substrate (Strixino & Trivinho-Strixino 1998). Sanseverino & Nessimian (2001) recorded this genus in lotic systems and reservoirs associated to arenaceous substrate. Therefore, we can suppose that the environmental conditions of P1 (lentic character and arenaceous substrate) may have contributed for the abundance of *Fissimentum*.

P2 presents depositional areas, resulting of a higher draught. In this point *Cryptochironomus* (72.3%) was the dominant genus (table I). According to Simpson & Bode (1980), this genus is commonly found in various types of habitats and water conditions. Higuti & Takeda (2002) has been observed this genus associated to substrate composed of fine sand. Sanseverino & Nessimian

**Table I.** Absolute (N) and relative (ni) abundance of larvae Chironomidae collected in the four sampling points along Ribeirão dos Peixes (Dois Córregos, SP, Brazil) in April 2003.

| Genera                                    | Point 1 |       | Point 2 |       | Point 3 |       | Point 4 |       |
|---|---------|-------|---------|-------|---------|-------|---------|-------|
|   | N       | ni    | N       | ni    | N       | ni    | N       | ni    |
| <b>Chironominae</b>                       |         |       |         |       |         |       |         |       |
| <b>Chironomini</b>                        |         |       |         |       |         |       |         |       |
| <i>Chironomus</i> Meigen, 1803            | 58      | 0.143 | 24      | 0.202 | 8       | 0.229 | 808     | 0.919 |
| <i>Cladopelma</i> Kieffer, 1921           | -       | -     | -       | -     | -       | -     | 2       | 0.002 |
| <i>Cryptochironomus</i> Kieffer, 1918     | 28      | 0.069 | 86      | 0.723 | 7       | 0.200 | 42      | 0.048 |
| <i>Dicrotendipes</i> Kieffer, 1913        | 2       | 0.005 | -       | -     | -       | -     | -       | -     |
| <i>Endotribelos</i> Grodhaus, 1987        | -       | -     | -       | -     | 1       | 0.029 | -       | -     |
| <i>Fissimentum</i> Cranston & Nolte, 1996 | 210     | 0.517 | -       | -     | 6       | 0.171 | -       | -     |
| <i>Goeldichironomus</i> Fittkau, 1965     | -       | -     | -       | -     | -       | -     | 2       | 0.002 |
| <i>Harnischia</i> Complex Kieffer, 1921   | 1       | 0.002 | -       | -     | -       | -     | -       | -     |
| <i>Polypedilum</i> Kieffer, 1912          | 33      | 0.081 | 7       | 0.059 | 12      | 0.343 | 24      | 0.027 |
| <b>Tanytarsini</b>                        |         |       |         |       |         |       |         |       |
| <i>Caladomyia</i> Säwedal, 1981           | 14      | 0.034 | -       | -     | -       | -     | -       | -     |
| <i>Tanytarsus</i> Van der Wulp, 1874      | 2       | 0.005 | -       | -     | 1       | 0.029 | -       | -     |
| <b>Tanypodinae</b>                        |         |       |         |       |         |       |         |       |
| <b>Pentaneurini</b>                       |         |       |         |       |         |       |         |       |
| <i>Ablabesmyia</i> Johannsen, 1905        | 45      | 0.111 | 2       | 0.017 | -       | -     | 1       | 0.001 |
| <b>Procladiini</b>                        |         |       |         |       |         |       |         |       |
| <i>Djalmabatista</i> Fittkau, 1968        | 7       | 0.017 | -       | -     | -       | -     | -       | -     |
| <i>Procladius</i> Skuse, 1889             | 6       | 0,015 | -       | -     | -       | -     | -       | -     |

(2001) found *Cryptochironomus* inhabit areas composed of arenaceous substrate. Such information allows infer that the dominance of this genus occurred due to presence of sandy substrate in P2, a habitat also examined by Higuti *et al.* (1993).

P3 registered lowest abundance of Chironomidae specimens, with *Polypedilum* as the most abundant genus (34.3%) (Table I). It is composed of herbivorous (Coffman & Ferrington 1996) and according to Barton & Smith (1984), belongs to the psammophilic group of Chironomidae, generally associated to arenaceous sediments. *Polypedilum* inhabit a wide variety of substrate and different environmental conditions (Armitage *et al.* 1995, Sanseverino & Nessimian 1998). Amorim *et al.* (2004) found *Polypedilum* in areas formed by arenaceous substrate. The presence of sedimentation process and formation of deposition zones in P3 may have contributed to the predominance of this genus.

In P4, the dominant genus was *Chironomus* (91.9%) (Table I). According to Simpson & Bode (1980), this genus is ecologically versatile, with various species living in standing or flowing waters as well as polluted or clean. *Chironomus* is commonly associated to presence of decomposing organic matter and aquatic macrophytes (Sanseverino & Nessimian 2001). Resende &

Takeda (2007) and Fusari (2006) recorded the genus in areas strongly impacted by anthropic actions. The elevated abundance of *Chironomus* in P4, possibly is relating to input of a large quantity of organic matter from riparian vegetation and previous stretches of the stream.

The majority of chironomids collected in Ribeirão dos Peixes was classified as detritivorous (table II), followed by herbivorous and omnivorous. There was no record of carnivore organisms. These results agree with Nessimian & Sanseverino (1998), who found detritivorous organisms to be the most abundant chironomids collected in the Paquequer River (Teresópolis, State of Rio de Janeiro, Brazil).

A predominance of collectors was recorded in all sampling stations of this study, followed by shredders in P2, P3 and P4 and by predators in P1 (figure 3).

Collectors were the dominant organisms in all studied habitats, highlighted by the high abundance of *Chironomus*, *Cryptochironomus* and *Fissimentum*. The organisms pertaining to this category feed on fine organic matter (< 1mm) and are thus named because of the reaggregation of small particles resulting from their ingesting activities, being either suspension feeders or gatherers of

**Table II.** Percentage (%) of detritivores, herbivores and omnivores collected in the four sampling points along Ribeirão dos Peixes (Dois Córregos, SP, Brazil) in April 2003.

|         | Detritivores | Herbivores | Omnivores |
|---------|--------------|------------|-----------|
| Point 1 | 80.5         | 3.0        | 16.5      |
| Point 2 | 97.5         | -          | 2.5       |
| Point 3 | 97.1         | -          | 2.9       |
| Point 4 | 99.5         | -          | 0.5       |

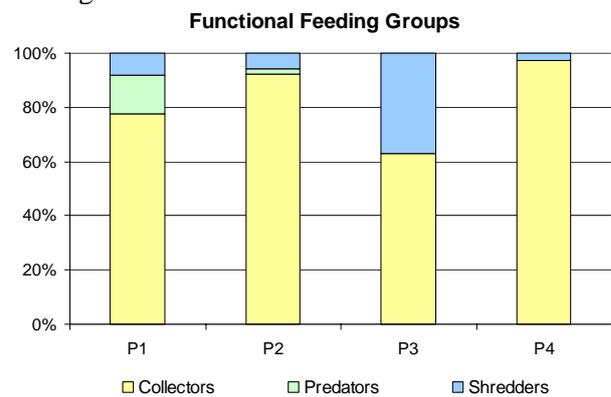
deposited material (Oliver 1971). Ribeirão dos Peixes is a small aquatic system and receives a high quantity organic matter of allochthonous origin, showing advanced degradation state (Lucatto & Talamoni 2007), thus favouring the abundance of this trophic category. This result agrees with Callisto *et al.* (2001), who identified this trophic group as the main category sampled in rivers of the Serra do Cipó National Park, located in Minas Gerais State and attributed this predominance to increase of organic matters in the system.

Grazer-scrappers were not recorded in Ribeirão dos Peixes and shredders had low relative participations at all points, being more representative in P3. The shredders use chewing, mining, gouging or grating (rasping) to acquire food. These organisms are associated with coarse particulate organic matter, such as living vascular plants (Berg 1995). The low density of organisms pertaining to this guild may be attributed to the scarcity of plant sources in the system and to their habit of feeding on colonized substrate (Cummins & Klug 1979). Given that this process can take weeks or even months, depending on the plant species and water temperature, and that the high temperatures of the region result in a rapid rate of decomposition of vegetable matter (Moretti 2005), it is possible that the substrate colonization is insufficient to withhold a larger density of shredders.

The data obtained in this study indicate that predators were the organisms that had lower participation, being more abundant in P1, possibly due to better environmental conditions that allowed the development of a wider variety of potential prey. The predators were represented by the genera *Ablabesmyia*, *Djalmabatista* and *Procladius*. These larvae pertaining to the subfamily Tanypodinae, are commonly depicted as predators of others benthic macroinvertebrates (Berg 1995).

Results obtained indicate that collectors were the dominant organisms, following by shredders and predators. According to Berg (1995), many factors, such as larval size, food quality and type of sediment, may influence larval feeding behavior. The present study have raised some interesting points: (1) *Cryptochironomus*, a genus

considered an obligated predator of Oligochaeta, Protozoa and others Chironomidae larvae by Coffman & Ferrington (1996), ingested mainly detritus in Ribeirão dos Peixes; (2) *Cladopelma* and *Polypedilum*, classified as herbivorous, also consumed detritus as a primary food source; (3) *Procladius*, considered predator of Protozoa, microcrustacea and several larvae insects, in this study had algae as their main food item. These results are in accordance with Nessimian & Sanseverino (1998), Nessimian *et al.* (1999) and Henriques-Oliveira *et al.* (2003) that recognize that most chironomids are not restricted to a single feeding behaviour.



**Figure 3** – Relative abundance of functional feeding groups in the four sampling points along Ribeirão dos Peixes (Dois Córregos, SP, Brazil) in April 2003.

The present findings, therefore, confirmed the original hypothesis that the chironomids of Ribeirão dos Peixes would show different functions and feeding habits than that gathered by Coffman & Ferrington (1996). Their functions and feeding habits are probably conditioned by environmental characteristics of the aquatic system, such as the modification of substrate and input of organic matter of allochthonous origin, which reflect directly on the quality of food sources available. However the data obtained in this study are not extensive enough to determine the validity of all aspects argued. Samplings in different seasons are necessary, since the functional feeding habits of Chironomidae can also be associated to an opportunistic response to increased amounts of food particles carried by the increased flow rains, as suggested by Mcshaffrey & Olive (1985).

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