Does predator benefits prey? Commensalism between Corynoneura Winnertz (Diptera, Chironomidae) and Corydalus Latreille (Megaloptera, Corydalidae) in Southeastern Brazil

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ABSTRACT. Commensalism between Corydalus Latreille, 1802 (Megaloptera, Corydalidae) and Corynoneura Winnertz, 1846 (Diptera, Chironomidae, Orthocladiinae) larvae was recorded in Indaiá stream, at 1,380 m a.s.l. (Parque Nacional da Serra do Cipó, 19º-20ºS, 43º-44ºW) and in the headwaters of São Francisco river, at 1,300-1,700 m a.s.l. (Parque Nacional da Serra da Canastra, 20º00'-20º30'S, 46º15'-47º00'W), in Minas Gerais state, Brazil. Seventy eight Corydalus larvae (range 22-88 mm) were sampled: 61 in the Indaiá stream and 17 in other two streams. Twelve Corydalus larvae (22-79 mm) in the Indaiá stream and three out of 15 larvae in the headwaters of São Francisco river (38-50 mm) had Corynoneura, larvae and pupae on their gills (3º to 6º) and a few larvae attached to the abdominal segments of larger Corydalus larvae (> 25 mm). Sixty-nine larvae of Corynoneura were found in the regurgitated material from Corydalus. It is remarkable that by attaching to larger body size predators, prey could become free from predator bouts and could also be transported by them.

KEY WORDS. Headwater stream; phoresy; predator-prey relationship; São Francisco river.

RESUMO. O predador beneficia sua presa? Comensalismo entre Corynoneura Winnertz (Diptera, Chironomidae) e Corydalus Latreille (Megaloptera, Corydalidae) no Sudeste do Brasil. Comensalismo entre Corydalus Latreille, 1802 (Insecta, Megaloptera, Corydalidae) e Corynoneura Winnertz, 1846 (Insecta, Diptera, Chironomidae, Orthocladiinae) foi registrado no córrego Indaiá situado a 1.380 m de altitude no Parque Nacional da Serra do Cipó (19-20ºS, 43-44ºW) e nas nascentes do rio São Francisco a 1.300-1.700 m de altitude no Parque Nacional da Serra da Canastra (20º00'-20º30'S, 46º15'-47º00'W), Minas Gerais, Brasil. Setenta e oito larvas de Corydalus (tamanho: 22-88 mm) foram coletadas: 61 no córrego Indaiá e 17 em outros córregos. Doze larvas de Corydalus (tamanho: 22-79 mm) no córrego Indaiá e três encontradas nas nascentes do rio São Francisco (tamanho: 38-50 mm) apresentaram larvas e pupas de Corynoneura em suas brânquias (3º a 6º) e algumas larvas fixadas nas segmentos abdominais de grandes Corydalus (> 25 mm). Sessenta e nove larvas de Corynoneura foram retiradas do material regurgitado por Corydalus. É importante observar que fixados aos predadores de grande tamanho corporal as presas se tornam livres de outros predadores além de serem transportados por eles.

PALAVRAS-CHAVE. Foresia; relação predador-presa; rios de cabeceira; rio São Francisco.

Commensalism has received less attention from ecologists than competition, predation and parasitism. Associations between chironomids and their hosts have been often interpreted as commensalisms, whereby the chironomid derives certain advantages from its association with its host, while the host is unharmed but derives nothing in return (Pennuto 2002). Roque et al. (2004) emphasized an increasing number of studies on this subject in the Neotropical region, but the knowledge about these ecological interactions is fragmented and no summary of information is available. Chironomid-host associations have involved symbioses, including parasitism (Jacobsen 1998) and phoresy (de La Rosa 1992, Pennuto 1997). Commensalism and phoretic associations have been also reported between Chironomidae and a variety of aquatic macroinvertebrates including Trichoptera (Steffan 1967), Ephemeroptera (Callisto & Goulart 2000), Plecoptera (Steffan 1967, Dorville et al. 2000), Hemiptera (Roback 1977), Odonata (Rosenberg 1972), Megaloptera (Furnish et al. 1981, Pennuto 1998, 2000, 2003, de La Rosa 1992) and snails (Mancini 1979). Nevertheless, some authors assume that phoresy is relatively uncommon among chironomids (e.g. White et al. 1980), while others argued for the opposite (e.g. Roback 1977).

This paper describes commensalism between Corydalus and Corynoneura. We tested the hypothesis that Corydalus body size influences the occurrence and numbers of commensal Corynoneura larvae and pupae that could be attached to their bodies.
MATERIAL AND METHODS

Seven stream sections (ranging from 2nd to 7th order and between 1,300-1,700 m a.s.l.), 6 located in Doce River basin, Cardeal Mota and Jaboticatubas municipalities, Serra do Cipó National Park (19º 2'-34", 43º27'-38'W); and one headwater stream in São Francisco River basin, São Roque de Minas village, Serra da Canastra National Park (20º00'-20'30"S, 46º15'-47º00'W), Minas Gerais State, Southeastern Brazil were sampled. These are black-water streams, acidic (pH 4.0-5.0), well oxygenated (> 90% saturation), with low electrical conductivity (< 150 mS/cm), and low nutrient contents (e.g., P-PO₄ < 10µg/l, N-NH₄ < 970 µg/l) (see details in Callisto et al. 2004).

Megaloptera larvae were collected manually in rainy (November-March) and dry (May-September) seasons from 1993-1997 and 1999-2000, following a stream order (2nd-7th) longitudinal gradient along Indaiá stream, Peixe river (Doce river watershed) and from headwaters of the São Francisco river watershed (a 2nd order reach). The two most representative substrates (gravel and sand, leaves and branches of riparian vegetation) were sampled along each river stretch totaling 252 samples (18 samples in each sampling period, two times per year in rainy and dry seasons). Samples were taken using a Surber sampler (0.250 mm mesh) with an area of 0.0625 m² and additional qualitative samples were collected in all studied ecosystems by using hand nets (0.250 mm mesh) from which Corydalids were sorted.

Five Corydalus specimens with no attached chironomids larvae and pupae were placed in vials with 10% formalin in order to induce regurgitation. Abdominal gills of Corydalus larvae were also checked for chironomids presence in laboratory. Eggs were counted by direct observations. Commensal larvae of Corynoneura attached to Corydalus bodies were sorted out from their hosts, mounted in slides, identified, preserved in 70% alcohol and deposited in the Collection of Benthic Macroinvertebrates of the Institute of Biological Sciences, Federal University of Minas Gerais.

RESULTS AND DISCUSSION

Seventy-eight Corydalus larvae were collected, 16 of which hosted Corynoneura (eggs = 16, larvae = 145, and pupae = 29). Body length of Corydalus larvae ranged from 22 to 88 mm, with a 40-50 mm modal class. Amongst the 16 larvae of Corydalus carrying commensals, 1 up to 33 Corynoneura larvae were found per individual (Corydalus body size between 30 and 88 mm). Corynoneura larvae were attached mainly to abdominal segments and under gills (Tab. I). Eggs and pupae of Corynoneura were found only ventrally under gills and on the 1st to 4th abdominal segments, on both sides of the host. Differences between the location of attachment of larvae versus eggs and pupae were not found. Up to five pupae were found once on the same larva of Corydalus. These results reinforce De la Rosa (1992), Tokeshi (1999), and Roque et al. (2004) claims that amongst the insects, Megaloptera is one of the most frequent host group, together with Plecoptera, Ephemeroptera and Odonata. Bigger low mobile cryptic benthic species are also pointed out as responsible for their suitability as hosts. The same authors assume that this interaction might benefit the chironomids by decreasing predation risks, increasing mobility, improving protection from disturbances, improving opportunity to feed, and eliminating metabolic waste. Nevertheless, information on natural environments concerning prey preferences, foraging behavior, and life history characteristics may be involved, but are still unavailable to the Neotropics.

Filamentous algae were found attached to the dorsal proleg filaments on the abdomen of two Corydalus larvae. Observations under a dissecting microscope showed Corynoneura larvae among the algae. Larval position on the host seems not to vary with the developmental stage of the chironomid (1st-2nd larvae group versus 3rd, 4th, and pupae, χ² = 19.35, p > 0.05). Our data suggest there is no evidence of intraspecific competition for certain positions on hosts. Therefore there are no apparent benefits for occupying a particular site on host body.

The regurgitated gut contents from five Corydalus larvae (58-83 mm body size) from Indaiá stream (5th order reach) in February 2000, yields sixty-nine Corynoneura larvae (10, 25, 7, 13, 14 in each). It is supposed that eaten Corynoneura were directly taken from their preferred stream substrates (filamentous algae, mosses and debris), since those attached to the Corydalus larvae were unavailable as prey.

Commensal relationships between Corynoneura and Corydalus were relatively common in sandy bottom streams, such as in the Indaiá stream (2nd up to 6th order stretches) and in the Peixe river (7th order stretch). Previous studies on stream ecosystems in the headwaters of Serra do Cipó and Serra da Canastra National Parks showed that Corynoneura was very abundant (Galdean et al. 1999b, 2001). Corynoneura was normally found on surfaces covered by filamentous algae, mosses and debris (Galdean et al. 1999 a, b). The Corynoneura Megaloptera host colonizing behavior is unknown. De la Rosa (1992) suggested that drifting Thienemanniella Kieffer, 1911 could settle on the substrates and actively seek megalopteran larvae. Hayashi (1988) suggested that large megalopterans tend to prey on insects much larger than chironomids and thus, the size of the megalopteran used as a host by the chironomids seem to diminish the risk of becoming prey.

Bigger Corydalus larvae had higher numbers of larvae and pupae of Corynoneura (R² = 0.752, p < 0.05). The location of eggs, larvae and pupae on the gills suggests that eggs can be laid on the water and then drift to Corydalus gills, where the Corynoneura life cycle takes place. This association only occurs on larger Corydalus larvae (> 20 mm), in headwater streams probably because: 1) larger larva are more active predators than smaller ones, showing fast movements and higher amount of prey ingestion; 2) the greater trophic resources are (greater surface area, larger surface structures) associated with a larger host.
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(TOKESHI 1986); 3) larger hosts are larger “islands” for drifting or searching larvae (TOKESHI 1986). Alternatively, *Corydalus* larvae may search for prey in those microhabitats where eggs, larva, and pupae of *Corynoneura* are. Sediment then is lifted from the substrate into the water column and *Corynoneura* may attach to the gills or abdominal segments of *Corydalus* (JACOBSEN 1998). *Corynoneura* larvae may also actively seek *Corydalus* larvae, larger *Corydalus* larvae may release a stronger chemical or physical cue for searching larvae than smaller larvae (SVENSSON 1979). *Corydalus* gills seem to be a safe site for *Corynoneura* development (out of predation pressure). We believe that the use of isotopic comparisons would confirm this commensal relationship in studied streams and rivers. Alternatively, it could clarify if *Corynoneura* were functioning as parasites, as proposed by DOUCETT *et al.* (1999), when attached chironomids feed directly on the host rather than on detritus.

ROQUE *et al.* (2004) reported forty-nine cases of *Chironomidae* larvae living on other animals in Brazilian freshwaters, including invertebrates and fishes. Biotic interactions such as commensalism and predator-prey relationships could be key factors in the maintenance of species diversity, especially in the tropics (ROBINSON 1978, ROHDE 1992).

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**Table I. Summary statistics for *Corynoneura* attached to *Corydalus* sp. hosts in study streams in Minas Gerais State, Brazil. Terminology according to Margolis *et al.* (1982) and Bush *et al.* (1997): Prevalence = % of hosts examined harboring > 1 midge. Infestation intensity = number of *Corynoneura* on the *Corydalus* host. Location = stream name and stretch where *Corydalus* were collected. Location of attachment = typical local environment in which midges occur in the *Corydalus* body. (AS) Ventral and lateral surfaces of abdominal segment, (AS) dorsal surface of abdominal segment, (bG) below gill, (d) dorsal, (G) gill.

<table>
<thead>
<tr>
<th>Location</th>
<th>Samplings</th>
<th>Prevalence</th>
<th>Infestation intensity</th>
<th>Location of attachment</th>
<th># Hosts midges</th>
<th># Hosts pupae</th>
<th># Hosts eggs</th>
<th>Midge</th>
<th>Pupa</th>
<th>Egg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indaiá stream</td>
<td>Rainy/dry 1999-2000</td>
<td>bG, AS</td>
<td>1</td>
<td>1-3</td>
<td>2</td>
<td>0.2</td>
<td>0.28</td>
<td>22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indaiá stream</td>
<td>Rainy/dry 1999-2000</td>
<td>bG, AS</td>
<td>2</td>
<td>2</td>
<td>8</td>
<td>0.25</td>
<td>0.31</td>
<td>30-50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indaiá stream</td>
<td>Rainy/dry 1999-2000</td>
<td>bG, AS, AS, G</td>
<td>7</td>
<td>25</td>
<td>13</td>
<td>0.28</td>
<td>0.29</td>
<td>30-83</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peixe river</td>
<td>Rainy/dry 1999-2000</td>
<td>As, G, Asd</td>
<td>1</td>
<td>16</td>
<td>1</td>
<td>0.14</td>
<td>0.06</td>
<td>79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>São Francisco Headwater</td>
<td>Dry 1999</td>
<td>As, G</td>
<td>3</td>
<td>15</td>
<td>1</td>
<td>0.20</td>
<td>0.30</td>
<td>38-50</td>
<td></td>
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</tr>
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</table>

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ROSENBerg, D. 1972. A chironomid (Diptera) larva attached to a libellulid (Odonata) larva. Quaestiones Entomologicae, Florida, 8: 3-4.


