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The freshwater crab *Trichodactylus petropolitanus* (Goeldi, 1886) (Decapoda, Trichodactylidae) associated with roots of *Hedychium coronarium* Koenig (Zingiberacea)

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Abstract. This study analyzed aspects of the biology of the freshwater crab *Trichodactylus petropolitanus* from a population inhabiting a small montane stream in the Atlantic Forest (23°10´37´´S and 45°41´28´´W), located in the city of Caçapava, state of São Paulo, Brazil. Sampling was carried out monthly from February 2003 to January 2004, always during the day. The animals were found in association with roots of *Hedychium coronarium*, an invasive alien aquatic macrophyte. Juvenile (unsexed animals) and young crabs were dominant in the samples, while adults were rare. No ovigerous females or females brooding young were recorded. The analysis of relative growth showed that females reach morphological maturity at a smaller size than males. Analysis of the size-frequency distributions indicated that females grew faster than males. These differences may be related to the reproductive strategies of freshwater crabs. Our findings indicate that *H. coronarium* is used as a microhabitat by juveniles of *T. petropolitanus* along stream borders in remnants of the Atlantic Forest.

Key words: Brachyura, endemic species, population biology, montane stream

Resumo. O caranguejo de água-doce *Trichodactylus petropolitanus* (Goeldi, 1886) (Decapoda, Trichodactylidae) associado com raízes de *Hedychium coronarium* Koening (Zingiberacea). Este estudo analisa aspectos biológicos do caranguejo de água doce *Trichodactylus petropolitanus* a partir de uma população habitante de um córrego de montanha da Mata Atlântica (23°10´37´´S e 45°41´28´´W), localizado no município de Caçapava, SP, Brasil. Amostragens foram realizadas mensalmente de fevereiro de 2003 a janeiro de 2004 durante o dia. Os animais foram encontrados em associação com raízes de *Hedychium coronarium*, uma espécie introduzida e invasora de macrófita aquática. Juvenis (animais cujo sexo não pode ser identificado) e jovens foram dominantes nas amostragens enquanto adultos foram raros. Nenhuma fêmea ovígera ou incubando juvenis foi registrada. Analises do crescimento relativo mostraram que fêmeas atingem a maturidade morfológica em menores tamanhos que machos, além disso, podem apresentar maior taxa de crescimento conforme evidenciado pelas analises de distribuição de freqüência em classes de tamanho. Tais características podem estar relacionadas com a estratégia reprodutiva de caranguejos de água doce. Nossos resultados indicam que *H. coronarium* é usada como microhabitat para juvenis de *T. petropolitanus* ao longo das margens de rios nos remanescentes ciliares da Mata Atlântica.

Palavras chave: Brachyura, espécie endêmica, biologia populacional

Introduction

Freshwater crabs complete their life cycles independently of marine environments, and also have different reproductive strategies from most marine crabs. Worldwide, there are 1280 species of freshwater crabs, in four superfamilies, Gecarcinucoidea, Potamoidea, Pseudothelphusoidea and Trichodactyloidea and eight families (Martin & Davis 2001, Ng *et al*. 2008, Yeo *et al.* 2008). In Brazil, over 45 species are known, of which 29% are

endemic (Cumberlidge *et al*. 2009), and mostly of the families Pseudothelphusidae and Trichodactylidae (Magalhães 2003). The genus *Trichodactylus* is represented in Brazil by nine species, of which four occur in the state of São Paulo (Magalhães 2003, Mossolin & Mantelatto 2008).

Because of their high abundance and biomass, freshwater crabs are important members of limnetic environments, where they play an important role in the trophic web, acting in nutrient cycling (Goulding *et al*. 1988, Hill & O'Keeffe 1992, Dobson *et al.,* 2007). Their use as human food was reported by Magalhães *et al*. (2006), and their economic and medical importance was well documented by Yeo *et al*. (2008).

Despite their wide distribution and ecological importance, studies on biological aspects of freshwater crabs are relatively recent in Brazil (Alarcon *et al*. 2002, Mansur & Hebling 2002, Mansur *et al*. 2005, Pinheiro & Taddei 2005a, b, Rosa *et al*. 2009).

In a recent review, Cumberlidge *et al*. (2009) noted that the extinction risk for many species of freshwater crabs is significant, because of a set of factors including high endemism at the country level, life-history traits that include direct development with limited dispersal ability, small populations, and increased environmental threats that include climate changes, ecosystem degradation, and other anthropogenic pressures from economic development.

Endemic species merit special attention because of their importance to conservation biology and their priority when designating areas for protection. The freshwater crab *Trichodactylus petropolitanus* (Goeldi, 1886) is endemic to southern Brazil, in the states of Minas Gerais, Rio de Janeiro, São Paulo, Paraná, and Santa Catarina. Its distribution largely coincides with the domain of the almost extinct Atlantic Forest (Magalhães 2003). Similarly to many freshwater crabs (Okano *et al*. 2000, 2003, Alarcon *et al*. 2002), the species is more active at night (Valente & Edwards 1955). However, in pilot surveys carried out during the daytime, a large number of crabs were observed in the study area. This area is located in the outskirts of the city of Caçapava, state of São Paulo. Because the area is not safe at night, the sampling for this study was carried out only during the day. We opted to do the study under this limitation, considering that studies on freshwater crabs in Brazil are still very few, and the current situation of environmental degradation. Therefore, we aimed to characterize aspects of the population biology of the freshwater crab *T. petropolitanus* in a small montane stream located in a degraded remnant of the Atlantic Forest.

Material and Methods

Sampling was carried out monthly from February 2003 through January 2004, in a small stream (23°10'37"S and 45°41'28"W) located at an altitude of 640 m in the city of Caçapava, state of São Paulo, Brazil. The depth of the stream averaged about 0.30 m in the 300-m stretch surveyed. This stretch has clean, calm water, which is used by the local cattle. The dissolved oxygen content ranged from 4.4 mg/L in the dry season to 7.2 mg/L in the rainy months, and the pH was about 7.0 in almost all months. The stream borders are dominated by the aquatic macrophyte *Hedychium coronarium* Koenig (Zingiberacea), an invasive plant known as white garland-lily or white ginger.

The crabs were caught by two people collecting for two hours, using sieves and turning over the roots of *H. coronarium* and other marginal vegetation and the small stones on the sandy bottom, always during the day.

In the laboratory, the sex of each crab was determined by inspecting the number of pleopods and the morphology of the abdomen. Smaller individuals with a narrow abdomen and bearing pleopods with incomplete setation were considered to be juveniles (unsexed animals). The remaining crabs were classified according to their morphological maturity as adult females, young females, adult males, young males, and juveniles.

The following body dimensions were measured with a vernier caliper to the nearest 0.05 mm: maximum carapace width (CW), abdomen width for males and females (AW, recorded at the base of somite 5), and gonopod length for males (GL; this structure was dissected and then measured from the base to the tip).

For the age structure analysis, the specimens were grouped into nine size classes of 3 mm CW, according to Sturges' formula: $K= 1 + 3.222 \log_{10}N$. To construct the temporal histograms, data from two or four months were combined in order to increase the number of specimens for analysis.

The size of morphological maturity was evaluated by plotting the morphometric data in dispersion graphs, and the relative growth was described from the adjustment of the points to the allometric equation $y=ax^b$. The CW was used as an independent variable and related to the AW, for both sexes, and to GL for males. We assumed that the breakpoint, i.e., the inflection point of the regression curve, indicates the transition phase from young to

adult (Hartnoll, 1974). We fitted a regression curve for the different phases, and analyzed the allometric growth equation for each phase. Departures from isometry (Ho: $b \neq 1$) were tested using Student's t test for the slope values obtained ($\alpha = 5\%$). Only intermolt and sexed crabs were used in this analysis.

The relationship between air temperature and the number of crabs was assessed using Pearson's correlation analysis and considering a significance level of 0.05. Monthly air temperature data were obtained from Weather Station/8384/INMET of the Agrarian Sciences Department, University of Taubaté. Data on dissolved oxygen and pH were taken sporadically, with an oximeter and pH meter.

Results

A total of 260 specimens of *T. petropolitanus* were examined, including 71 males, 79 females, and 110 juveniles (unsexed individuals). No ovigerous females or brooding females were captured during the surveys. The specimens were found on or around the roots of *Hedychium coronarium*. Another species of freshwater crab, *Trichodactylus fluviatilis* (Latreille, 1828), also inhabits the stream, but was collected very sporadically.

Males showed a mean size of 16.4 ± 4.5 mm CW, ranging from 10.4 to 29.1 mm; and females a mean of 16.7 ± 4.5 mm, ranging from 10.5 to 29.2 mm CW. There was no significant difference between the sizes of males and females (t test, $p > 0.05$). Juveniles were dominant in the samples, and their sizes ranged from 3.8 to 11.0 mm CW with a mean of 7.8 ± 1.5 mm CW. Overlap between juveniles and sexed individuals (with pleopods completely formed) occurred from 10.4 to 11 mm CW, indicating the size range when this secondary sex character appears in this population.

The shape of the size-frequency distributions for the overall population exhibited marked asymmetry, with the smaller size classes better represented than the larger ones (Fig. 1). The modal size classes were 12.1–15.0 mm CW for males and 15.1–16.0 mm CW for females (Fig. 2).

A cohort of juveniles was well represented from February to September, occupying the size class of 6.1 – 9.0 mm CW (Fig. 3). The size of these individuals increased from June to November, when larger crabs began to appear in the surveys. The largest crabs were more frequently observed in summer months, e.g., February/March 2003 and December/January 2004. A good correlation was observed between the number of crabs and the temperature (Pearson correlation, $r = 0.73$, $p < 0.05$), indicating that the crabs are more active in the warmer months (Fig. 4), which correspond to the rainy season in southeastern Brazil.

Analyses of relative growth were carried out to evaluate the size of morphological maturity. A total of 65 males and 64 females in intermolt were analyzed. The breakpoint of the growth curve in the dispersion graphs was distinct for both males and females. A trend line was fitted separately for young and adult animals of each sex, and the equation for each relationship is shown in Figures 5, 6, and 7. The analysis of the relationship AW *vs*. CW evidenced positive allometry for juvenile males and juvenile females, whereas the adults of both sexes showed isometry (t test, $p < 0.05$) (Figs. 5-6). The same occurred for the relationship GL *vs*. CW (Fig. 7). The variations in the degree of allometry of the structures analyzed reflect changes in the rate of growth between the immature and mature phases. The breakpoint of the curve occurs at around 23 mm CW for females and at 25 mm CW for males, indicating the size at onset of morphological maturity for each sex. Few adults were sampled in this study.

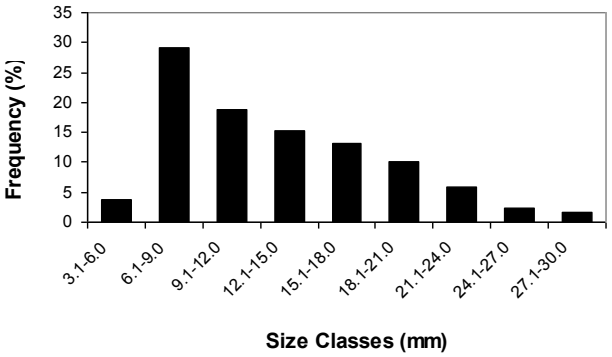

Figure 1. Size-class frequency distribution for sexed and unsexed individuals of *Trichodactylus petropolitanus*.

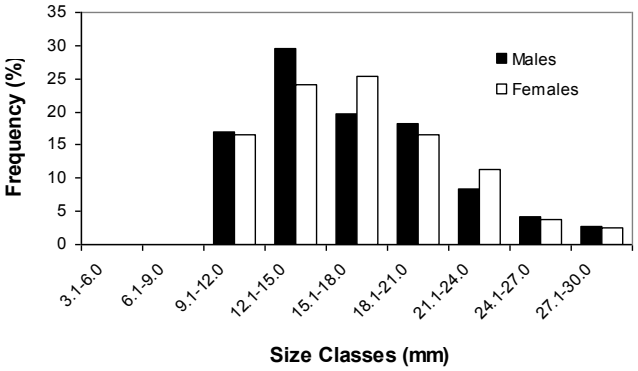

Figure 2. Size-class frequency distribution of *Trichodactylus petropolitanus* males and females.

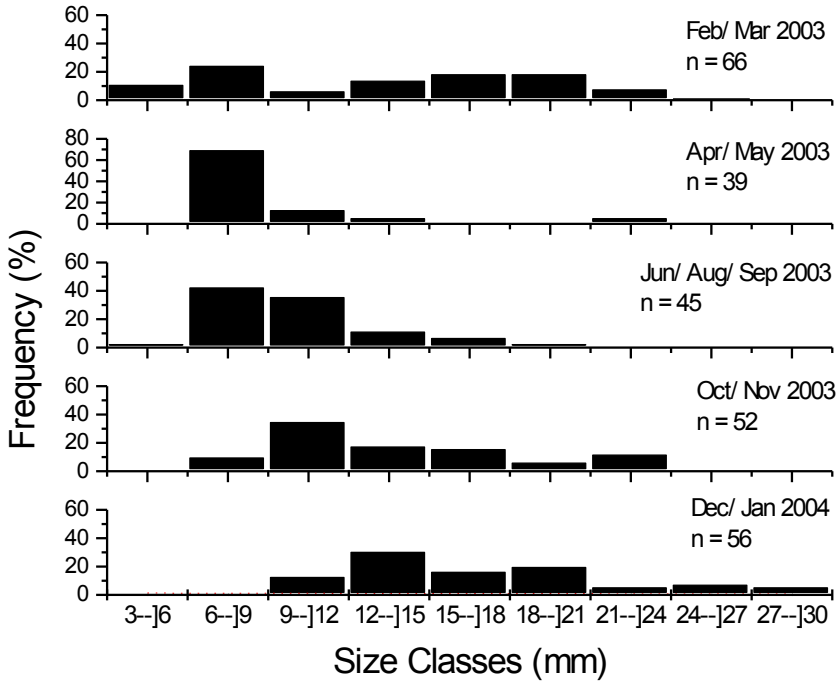

Figure 3. Size-class frequency distribution of *Trichodactylus petropolitanus* males, females, and juveniles. Data for every two months were combined, except for June, July, August, and September which were combined, because of the small number of individuals sampled. The monthly data were grouped in order to increase the number of specimens in the analyses.

Discussion

The specimens of *T. petropolitanus* were associated with the roots of the aquatic macrophyte that dominates the borders of the stream. Most individuals were juveniles, indicating that they are using this vegetation as a microhabitat. The overall size-frequency distribution showed a decreasing number of individuals in the larger classes. This is a result of the high mortality rate of young crabs, and also indicates the migration of crabs to another stream microhabitat as they grow.

Several aspects regarding the growth of individuals can be inferred from the analysis of the modal size classes (Conde & Díaz 1989). The modal class of males was biased to the left, suggesting different growth rates of males and females (Wenner 1972, Conde & Díaz 1989, Leme 2002). Pinheiro & Taddei (2005), using the von Bertalanffy growth model, showed that in *Dilocarcinus pagei*, females grow faster than males and reach sexual maturity before males. The latter agrees with our findings, and it is suggested that faster growth of females may be advantageous for freshwater crabs because it may enable them to increase their reproductive output.

Generally, freshwater crabs have direct development, incubating few but large eggs. With maternal care, the females also incubate the newly hatched young in their abdomen for a time (Liu & Li, 2000). Therefore, a wider abdomen is advantageous for such crabs. This sex character shows allometric growth in young females and decreases after the puberty molt, indicating energy allocation for reproductive processes (Somers & Nel, 1998). The same occurs in the gonopod growth after the maturity molt of males, indicating that this structure has reached an appropriate size to copulate successfully (Micheli *et al*., 2006).

Fewer individuals were collected in the colder months (the dry season), suggesting that they are less active in this period. Increased activity in the warmer months may be related to greater food availability in this season, as reported by Gherardi *et al.* (1988) for the freshwater crab *Potamon fluviatile* (Herbst, 1785) and by Pillai & Subramoniam (1984) for *Parathelphusa hydrodromus* (Herbst, 1794).

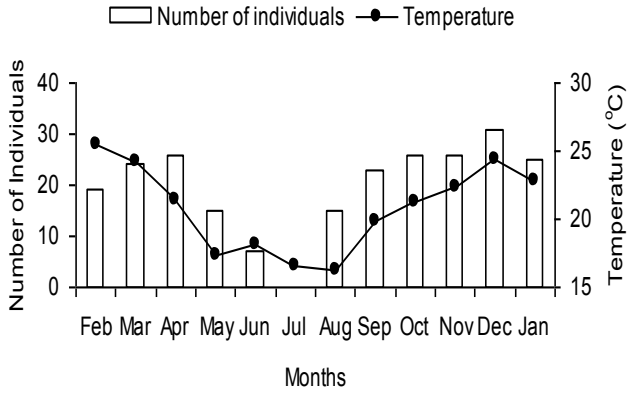

Figure 4. Numbers of individuals of *Trichodactylus petropolitanus* and mean air temperature recorded from February 2003 through January 2004 in the region of Caçapava, São Paulo, Brazil.

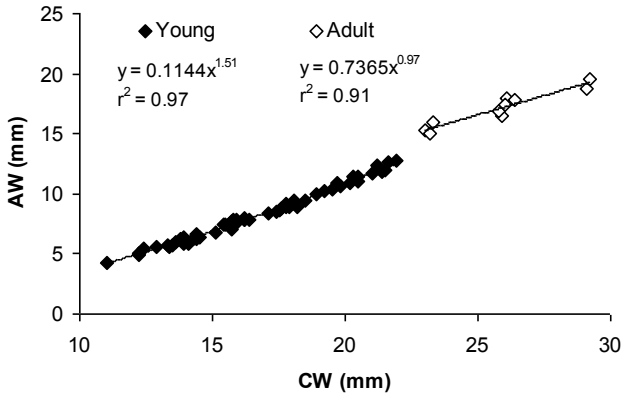

Figure 5. Relationship between abdomen width (AW) and carapace width (CW) for young and adult females of *Trichodactylus petropolitanus*.

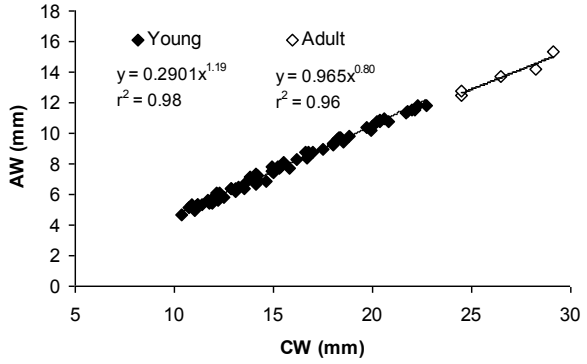

Figure 6. Relationship between abdomen width (AW) and carapace width (CW) for young and adult males of *T. petropolitanus*.

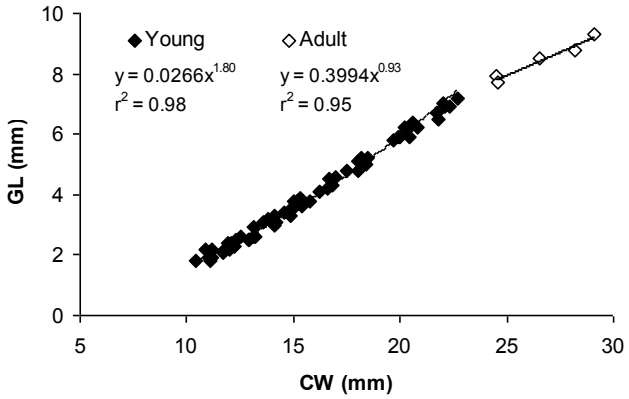

Figure 7. Relationship between gonopod length (GL) and carapace width (CW) for young and adult males of *Trichodactylus petropolitanus*.

The predominance of younger crabs inhabiting the roots of *Hedychium coronarium* indicates that this plant, native to the Himalayas and an invasive alien species in the Americas (Pio Corrêa 1984, Macedo 1997), is being used as a substrate and a recruitment and refuge site. Mansur *et al*. (2005) and Pinheiro & Taddei (2005a,b) found trichodactylid species in association with *Eichhornia* species. Rosa *et al.* (2009) emphasized the importance of vegetation cover as a refuge for younger freshwater crabs in the floodplain areas of the Pantanal (Mato Grosso). Freshwater shrimps have also been found among the roots of *E. crassipes* (see Montoya 2003).

This study showed that the young of *T. petropolitanus* occupy a different microhabitat from the adults, as reported for other freshwater crabs (Mello 1967, Gherardi & Micheli 1989, Liu & Li 2000, Okano *et al*. 2003, Rosa *et al*. 2009). Such habitat partitioning may result from active competition and dominance of adults over smaller individuals, since large crabs may eat the young crabs (Gherardi & Micheli 1989, Somers & Nel 1998, Liu & Li 2000). Another explanation for the high proportion of young in the survey concerns the time of day of the sampling, since adults of *T. petropolitanos* are more active during the night (Valente & Edwards, 1955).

According to Galdean *et al*. (2001) and Moretti *et al*. (2003), aquatic macrophytes have great importance in the maintenance of many species of benthic macroinvertebrates, acting as an "ecological tool" for the periphytic fauna. This must be taken into account in local programs for management and control of exotic species, since this macrophyte species now plays a fundamental role in

the maintenance of the populations of these vulnerable freshwater crabs.

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References

Alarcon, D. T., Leme, M. H. A. & Cobo, V. J. 2002. Population structure of the freshwater crab *Trichodactylus fluviatilis* Latreille, 1828 (Decapoda, Trichodactylidae) in Ubatuba, Northern Coast of São Paulo State, Brazil. Pp. 179-182. *In*: Escobar-Briones, E. & Alvarez, F. (Eds.) **Modern Approaches to the Study of Crustacea.** Kluwer Academic/ Plenum Publishers, New York.

Conde, J. E. & Díaz, H. 1989. The mangrove tree crab *Aratus pisonii* in a tropical estuarine coastal lagoon. **Estuarine, Coastal and Shelf Science**, 28: 639-650.

Cumberlidge, N., Ng, P. K. L. Yeo, D. C. J., Magalhães, C. Campos, M. R., Alvarez, F, Naruse, T., Daniels, S. R., Esser, L. J., Attipoe, F. Y. K., Clotilde-Ba, F-L., Darwall W., McIvor, A., Baillie, J. E. M., Collen, B. & Ram, M. 2009. Freshwater crabs and the biodiversity crisis: Importance, threats, status, and conservation challenges. **Biological Conservation**, 142: 1665–1673.

Dobson, M. K., Magana, A. M., Lancaster, J. & Mathooko, J. M. 2007. Aseasonality in the abundance and life history of an ecologically dominant freshwater crab in the Rift Valley, Kenya. **Freshwater Biology**, 52: 215-225.

Galdean, N., Calisto, M., Barbosa, F. A. R. 2001. Biodiversity assessment of benthic macroinvertebrates in altitudinal lotic ecosystems of Serra do Cipó (MG, Brazil). **Revista Brasileira de Biologia,** 61 (2): 239-248.

Gherardi, F. & Micheli, F. 1989. Relative growth and population structure of the freshwater crab, *Potamon potamios palestinensis*, in the Dead Sea area (Israel). **Israel Journal of Zoology**, 36:133-145.

Gherardi, F., Micheli, F., Monaci, F. & Tarducci, F. 1988. Note sulla biologia ed ecologia del granchio di fiume, *Potamon fluviatile*. **Bolletino del Museo di Storia Naturale della Lunigiana**, 6-7:169-174.

Goulding, M. G., Carvalho, M. L. & Ferreira, E. G. 1988 (Eds.). **Rio Negro, rich life in poor water. Amazonian diversity and food chain ecology as seen through fish communities**. The Hague, SPB Academic, 200p.

Hartnoll, R. G. 1974. Variation in growth pattern between some secundary sexual characters in crabs (Decapoda, Brachyura). **Crustaceana**, 27: 131–136.

Hill, M. P. & O´Keeffe, J. H. 1992. Some aspects of the ecology of the freshwater crab (*Potamonautes perlatus* Milne Edwards) in the upper reaches of the Buffalo River, eastern Cape Province, South Africa. **South African Journal of Aquatic Sciences,** 18: 42-50.

Leme, M.H.A. 2002. A comparative analysis of the population biology of the mangrove crabs *Aratus pisonii* and *Sesarma rectum* (Brachyura, Grapsidae) from north coast of São Paulo State, Brazil. **Journal of Crustacean Biology**, 22(3): 553-557.

Liu, C. H. & Li, C. W. 2000. Reproduction in the fresh-water crab *Candidiopotamon rathbunae* (Brachyura: Potamidae) in Taiwan. **Journal of Crustacean Biology,** 20(1): 89-99.

Macedo, J. F. 1997. O gênero *Hedychium* Koening (Zingiberaceae) no Estado de Minas Gerais. **Daphne**, 7(2): 27-31.

Magalhães, C. 2003. Famílias Pseudothelphusidae e Trichodactylidae. Pp. 143-287. *In*: Melo, GAS. (Ed). **Manual de Identificação dos Crustacea Decapoda de Água Doce do Brasil**. Editora Loyola, São Paulo.

Magalhães, C., Barbosa, U. C. & Py-Daniel, v. 2006. Decapod crustaceans used as food by the Yanomami Indians of the Balawa-ú village, State of Amazonas, Brazil. **Acta Amazônica,** 35(3): 369-374.

Mansur, C. B. & Hebling, N. J. 2002. Análise comparativa entre a fecundidade de *Dilocarcinus pagei* Stimpson e *Sylviocarcinus australis* Magalhães e Türkay (Crustacea, Decapoda, Trichodactylidae) no Pantanal do Rio Paraguai, Porto Murtinho, Mato Grosso do Sul. **Revista Brasileira de Zoologia**,19(3):797- 805.

Mansur, C. B., Hebling, N. J. & Souza, J. A. 2005. Crescimento relativo de *Dilocarcinus pagei* stimpson, 1861 e *Sylviocarcinus australis* Magalhães e Türkay, 1996 (Decapoda:Trichodactylidae) no pantanal do Rio Paraguai, Porto Murtinho, Mato Grosso do

Sul. **Boletim do Instituto de Pesca**, 31(2): 103 – 107.

Martin, J. W. & Davis, G. E. 2001. **An Updated Classification of the Recent Crustacea**. Natural History Museum of Los Angeles County, California, Science Series no. 39, 132p.

Mello, G. A. S. 1967. Diferenciação geográfica e dimorfismo sexual de *Trichodactylus* (*Trichodactylus*) *fluviatilis* Latreille, 1825 (Crustacea, Brachyura). **Papéis Avulsos de Zoologia,** 3(20):13-44.

Micheli, F., Gherardi, F. & Vannini, M. 2006. Growth and reproduction in the freshwater crab, *Potamon fluviatile* (Decapoda, Brachyura). **Freshwater Biology**, 23(3): 491-503.

Montoya, J. V. 2003. Freshwater shrimps of the genus *Macrobrachium a*ssociated with roots of *Eichhornia crassipes* (Water Hyacinth) in the Orinoco delta (Venezuela). **Caribbean Journal of Science**, 39(1): 155-159.

Moretti, M. S., Goulart, M. D. C. & Callisto, M. 2003. Avaliação rápida da macrofauna associada a *Eichhornia azurea* (Swartz) Kunth, 1843 e *Pontederia lanceolata* Nutt., 1818 (Pontederiaceae) na Baía do Coqueiro, Pantanal de Poconé (MT/ Brasil). **Revista Brasileira de Zoociências**, 5: 7-21.

Mossolin, E. C. & Mantelatto, F. L. 2008. Taxonomic and distributional results of a freshwater crab fauna survey (Family Trichodactylidae) on São Sebastião Island (Ilhabela), South Atlantic, Brazil. **Acta Limnologica Brasiliensia**, 20(2): 125-129.

Ng, P. K. L., Guinot, D., Davie, P. J. F. 2008. Systema Brachyurorum: Part I. An annotated checklist of extant brachyuran crabs of the World. **Raffles Bulletin of Zoology** (Suppl. 17), 1–286.

Okano, T., Suzuki, H. & Miura, T. 2000. Comparative biology of two freshwater crabs *Geotheuphusa exigua* and *G. dehaani* (Decapoda, Brachyura, Potamidae). **Journal of Crustacean Biology**, 20(2):299-308.

Okano, T. Suzuki, H. & Horie, M. 2003. Habitat and activity patterns of three japanese freshwater crabs of the genus *Geothelphusa* (Decapoda, Brachyura, Potamidae). **Journal of Crustacean Biology**, 23(2):308-317.

Pillai, C. K. & Subramoniam, T. 1984. Monsoon-dependent breeding in the field crab *Parathelphusa hydrodromus* (Herbst). **Hydrobiologia**, 119:7-14.

Pinheiro, M. A. A. & Taddei, F. G. 2005a. Crescimento do caranguejo de água doce, *Dilocarcinus pagei* Stimpson (Crustacea, Brachyura, Trichodactylidae). **Revista Brasileira de Zoologia**, 22(3): 522-528.

Pinheiro, M. A. A. & Taddei, F. G. 2005b. Relação peso/largura da carapaça e fator de condição em *Dilocarcinus pagei* Stimpson (Crustacea, Trichodactylidae) em São José do Rio Preto, São Paulo, Brasil. **Revista Brasileira de Zoologia,** 22(4): 825-829.

Pio Corrêa, M. 1984. **Dicionário de plantas úteis do Brasil e das exóticas cultivadas**. Rio de Janeiro: Instituto Brasileiro de Desenvolvimento Florestal, v.6, 777p.

Rosa, F. R., Lopes, I. R., Sanches, V. Q. A. & Resende, E. K. 2009. Distribuição de caranguejos Trichodactylidae (Crustacea, Brachyura) em alagados do Pantanal Mato-Grossense (Brasil) e sua correlação com a proximidade do rio Cuiabá e cobertura vegetal. **Papéis Avulsos de Zoologia**, 49(24): 311-317.

Somers, M. J. & Nel, J. A. J. 1998. Dominance and population structure of freshwater crabs (*Potamonautes perlaturs*, Milne Edwards). **South African Journal of Zoology**, 33: 31-36.

Valente, D. & Edwards, G. A. 1955. The regulation of the activity rhythm of the crab (*Trichodactylus petropolitanus*). **Boletim da Faculdade de Filosofia, Ciências e Letras da Universidade de São Paulo** (Zoologia) (20): 5-12.

Wenner, A. M. 1972. Sex ratio as a function of size in marine Crustacea. **The American Naturalist**, 106(949):321-350.

Yeo, D. J. C., Ng, P. K.L., Cumberlidge, N., Magalhães, C., Daniels, S. R. & Campos, M. R. 2008. Global diversity of crabs (Crustacea: Decapoda: Brachyura) in freshwater. **Hydrobiologia**, 595: 275-286.

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