Seasonal variation on the ectoparasitic communities of Nile tilapia cultured in three regions in southern Brazil

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Abstract

A total of 240 Nile tilapia were examined between April 2007 and March 2008, gathered from three different fish farms, 20 fish in each fish farm, in the four seasons of the year. Fish ponds were located in Joinville, Blumenau and Ituporanga, Santa Catarina state, Brazil and each pond had a different culture system. Prevalence, mean intensity, mean abundance and mean relative dominance were compared among fish ponds and seasons. During this period, the water quality was kept in normal values. *Piscinoodinium pillulare* (Dinoflagellida) was the most dominant parasite followed by *Trichodina magna* and *Trichodina compacta* (Ciliophora), *Cichlydogyrus sclerosus*, *C. halli*, *C. thurstonae*, *Scutogyrus longicornis* (Monogenoidea), copepodids Lernaeidae gen. sp. The highest prevalence, mean intensity and mean abundance of ectoparasites were found on the body surface in fish from Joinville followed by Blumenau and Ituporanga. In the gills, the highest mean intensity and mean abundance were found in fish from Blumenau and Ituporanga in the winter. *Piscinoodinium pillulare* showed prevalence 100% during autumn in Blumenau and Ituporanga. In winter *P. pillulare* occurred in all study facilities. Fish from Joinville showed 100% prevalence of Monogenoidea during all seasons, as well as the highest mean intensity and abundance. The results showed that the majority of examined fish had higher infestations by protozoan during autumn and winter and higher infestations by metazoan have occurred in spring and summer.

Keywords: *Oreochromis niloticus*, ectoparasites, seasonality, Brazil.

Resumo

Um total de 240 tilápias-do-nilo foi examinado entre abril de 2007 e março de 2008, a partir de três diferentes localidades em quatro estações, 20 de cada piscicultura. As pisciculturas estavam localizadas em Joinville, Blumenau e Ituporanga, Estado de Santa Catarina, Brasil. Taxa de prevalência, intensidade média, abundância média e dominância média relativa foram comparadas entre as pisciculturas e entre as estações. Durante esse período, a qualidade da água se manteve em valores normais para tilápias. *Piscinoodinium pillulare* (Dinoflagellida) foi o mais dominante seguido por *Trichodina magna* e *Trichodina compacta* (Ciliophora), *Cichlydogyrus sclerosus*, *C. halli*, *C. thurstonae*, *Scutogyrus longicornis* (Monogenoidea), copepodidos Lernaeidae gen. sp. Os maiores valores de taxa de prevalência, intensidade média e abundância média de ectoparasitos foram encontrados na superfície do corpo de peixes de Joinville, seguidos pelos de Blumenau e Ituporanga. Nas brânquias, as maiores intensidades e abundâncias médias foram encontradas em peixes de Blumenau e Ituporanga examinados no inverno. *Piscinoodinium pillulare* apresentou prevalência de 100% no outono em Blumenau e Ituporanga. No inverno, a prevalência de *P. pillulare* ocorreu também em todas as pisciculturas. Peixes de Joinville apresentaram prevalência de 100% de Monogenoidea em todas as estações, assim como as maiores intensidades e abundâncias médias. Os resultados mostraram que a maioria dos peixes examinados apresentaram maiores infestações por protozoários no outono e inverno, e metazoários na primavera e no verão.

Palavras-chave: *Oreochromis niloticus*, ectoparasitos, sazonalidade, Brasil.
1. Introduction

Ectoparasites are among the major etiological agents in Brazil and their presence is directly related to water quality and pond management (Moraes and Martins, 2004). Parasitism occurs as a result of an interaction between host, parasite and environment (Buchmann and Lindestrøm, 2002). Some factors or substances are responsible for lowering the host immune response resulting in unbalanced host/parasite/environment interaction, factors such as water temperature, stress level (Xu et al., 2007), nutritional quality (Cavichiolo et al., 2002), age and natural immunity (Buchmann and Lindestrøm, 2002).

Trichodinids pathogenicity was confirmed by Madsen et al. (2000) and the level of parasitism was related with parasite number and water quality by Afifi et al. (2000). Experimental infestations with Trichodina jadranica Raabe, 1958 (Ciliophora) caused mortality in eels (Mellergaard and Dalsgaard, 1987). On the other hand, mixed infestation by T. murmanica Poljansky, 1955 and Gyrodactylus pleuronecti Cone, 1981 was observed in winter flounder (Pseudopleuronectes americus) by Barker et al. (2002).

Studying the seasonal dynamics of carp infestation by T. nobilis Chen, 1963 in Yugoslavia, Nikolic and Simonovic (1998) observed higher infestation percentages in autumn and spring. On the other hand, Özer (2003) observed higher mean intensities of round goby (Neogobius melanostomus) infestations by T. domerguei Wallengren 1897 during spring and summer in Sirakirkagadar River, Sinop coast. In Brazil, Ranzani-Paiva et al. (2005) related high infestations of tilapia (Oreochromis niloticus) to the lowest temperature and water quality in Guarapiranga reservoir, São Paulo. Consequently, Schalch and Moraes (2005), observed a constant presence of this parasite during summer, autumn and winter, not exceeding 50% prevalence in fee fishing ponds.

High infestations by Monogeneidea were related to high ammonia levels in the water (Skinner, 1982) and high prevalence rates were related to water temperature in fish from India (Singhal et al., 1986) and from Finland lakes (Halmetoja et al., 1992). Koskivaara et al. (1991) observed higher mean intensity of Gyrodactylus von Nordmann, 1832 infestation on fish from eutrophic and polluted lakes. In intensive cultures, high fish density, low water flow and high organic matter concentration favors the growth and reproduction of parasites (Moraes and Martins, 2004).

In Mexico, Flores-Crespo et al. (1992), studying the seasonal variation of tilapia parasitised by Dactylogyrus Diesing, 1850, observed lower infestation intensity during autumn and winter and related the parasite presence to water temperature increase. In turn, Rawson and Rogers (1973) observed high infestation levels by Gyrodactylus macrochir Hoffman and Putz, 1964 on Lepomis macrochirus and Micropterus salmoides during winter in Walter F. George Reservoir, Georgia.

In southern Brazil, the first fish parasitological study was performed by Azevedo et al. (2006) in tilapia from Nova Trento, Santa Catarina state, whom related higher ectoparasite infestation intensity with low water quality. Ghiraldelli et al. (2006), studying the parasitic fauna of tilapia cultured in three different production systems, demonstrated that the most abundant ectoparasites were T. magna Van As and Basson, 1989, T. compacta Van As and Basson, 1989 and Cichlydogyrus sclerosus Price and Kirk, 1967.

The hypothesis of this study was to verify whether parasitological indexes in Nile tilapia may vary according to the season of the year in different production systems in the state of Santa Catarina, Southern Brazil.

2. Material and Methods

A total of 240 fish were collected during the four seasons of the year, between April 2007 and March 2008, 20 animals from each fish farm in each season. The fish farms were located in three different cities, Joinville (26° 24' 52'' S and 48° 50' 44'' W), Blumenau (26° 55' 10'' S and 49° 03' 58'' W) and Ituporanga (27° 24' 52'' S and 49° 36' 09'' W), all of them in the state of Santa Catarina, Southern Brazil.

Every time the fishes were collected, water parameters such as pH, temperature, oxygen and transparency were analysed and a 500 mL water sample was frozen for further ammonia analysis, according to Grasshoff (1976). After biometry, the fish were sacrificed (Ethics Commission n° 23080055748/2006-04/CEUA/UFSC) for parasitological analysis according to Ghiraldelli et al. (2006) methodology. The collection and parasites fixation followed Kritsky et al. (1995) and Eiras et al. (2006) methods.

The quantification of protozoan was done by sampling five aliquot of 0.3 mL from a tissue (skin or gills) homogenate, counting the number of protozoan on the aliquot using a McMaster chamber and estimating the number of possible protozoan by the total homogenate volume. Monogeneidea and crustacean were counted under a stereomicroscope using marked Petri dish (Ghiraldelli et al., 2006). In tables, the species identified are referred as Monogeneidea. Trichodinids were identified according to Lom (1958), Van As and Basson (1989) and Ghiraldelli et al. (2006). Monogeneidea were identified according to Paperna and Van As and Basson (1989) and Ghiraldelli et al. (2006).

Prevalence, mean intensity and abundance data were obtained according to Bush et al. (1997) and the mean relative dominance according to Rohde et al. (1995). The results were submitted to ANOVA and, upon significance, to Tukey test for comparison among arithmetic means. Significance level adopted was of 5% (Zar, 1999). The data were compared between seasons for each fish farm and between farms for each season.

3. Results

Table 1 shows that Joinville was characterised by its traditional method of fish culture with stocking density of 0.75 fish/m², using 10% daily water renewal, sometimes using aeration and fish fed once a day. On the other hand,
Blumenau was a fee fishing facility in which the introduction of fish from other fish farms once a week was a common practice, fish stocking density 2.0 fish/m$^2$, and fish fed once a day. Due to the fact that the fish stocking density in Blumenau was frequently uncontrolled, they used aeration three times a day. Consequently, Ituporanga practiced the consorted system between fish and pig manure, fish fed only at the finish of cycle and kept 3.5 to 4.0 fish/m$^2$ without water renewal. Only Joinville and Ituporanga assessed the water quality regularly. Water pH was stable in all fish ponds during the whole study period. In Joinville, dissolved oxygen was higher in autumn, while the lowest dissolved oxygen levels were found during summer and winter, respectively in Blumenau and Ituporanga. The highest water temperatures were observed in Blumenau (Table 2). Table 3 shows the biometrical data from the availed fish for each season.

Parasitological analysis revealed the presence of *T. magna*, *T. compacta* (Protozoa: Ciliophora) on the skin mucus; *Piscinoodinium pillulare* (Schäperclaus, 1954) Lom, 1981 (Protozoa: Dinoflagellida), *Cichlidogyrus sclerosus*, *C. halli* Price and Kirk, 1967, *C. thurstonae* Ergens, 1981 and *Scutogyrus longicornis* Paperna and Thurston, 1969 (Monogenoidea: Dactylogyridae), as well as Lernaeidae gen. sp. Cobbold, 1879 (Crustacea: Copepoda) on the gills of the examined tilapia.

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| Characteristics | Joinville | Blumenau | Ituporanga |
|-----------------|-----------|----------|------------|
| Culture system  | Fry and juvenile production | Fee fishing | Consorted with pig |
| Total pond size (ha) | 2.35 | 0.8 | 8.0 |
| Fish stocking density/m$^2$ | 0.75 | 2.0 | 3.5-4.0 |
| Feeding | 1 time a day | 1 time a day | 2 times a day at the end of growth cycle |
| Ration | Extruded comercial diet 28% crude protein | Extruded comercial diet 32% crude protein | Extruded comercial diet 32% crude protein |
| Aeration use | In emergency cases | 3 times a day | No |
| Fish entrance | No | Yes | No |
| Water renewal | 10% a day | Little | No renewal |
| Water quality monitoring | Yes | No | Yes |

Table 2. Water quality of ponds measured at the sampling day in each season in the state of Santa Catarina, southern Brazil.

| Parameters | Autumn | Winter | Spring | Summer |
|------------|--------|--------|--------|--------|
| Dissolved oxygen (mg/L) | 8.94 | 6.2 | 5.33 | 5.86 |
| Transparency | 38 | 77 | 31 | 48 |
| pH | 7.7 | 7.5 | 6.5 | 6 |
| Ammonia (mg/L) | 0.5 | 0.3 | 0.5 | 0.15 |
| Temperature (°C) | 20.3 | 18.1 | 22.5 | 22.9 |

| Dissolved oxygen (mg/L) | 5.77 | 4.1 | 4.46 | 4.44 |
| Transparency | 11 | 15 | 15 | 8 |
| pH | 7.02 | 7.2 | 7.4 | 7.32 |
| Ammonia (mg/L) | 0.26 | 0.19 | 0.68 | 1.9 |
| Temperature (°C) | 16.8 | 19 | 24.8 | 26.5 |

| Dissolved oxygen (mg/L) | 7.95 | 2.34 | 6.12 | 2.75 |
| Transparency | 15 | 22 | 10 | 10 |
| pH | 7.07 | 7.01 | 7.22 | 6.85 |
| Ammonia (mg/L) | 0.39 | 1.2 | 0.89 | 0.79 |
| Temperature (°C) | 15.8 | 23.4 | 23.7 | 22.4 |
The water quality was maintained within the acceptable values for tilapia, fish that supports broad variation in water quality (Boyd, 1979; Zaniboni Filho, 2004). The higher dissolved oxygen and water transparency values observed in Joinville were related to a high pond water renewal, a fact that distinguished it from the other fish ponds. In Ituporanga, oxygen levels were low during winter and summer, due to water stratification, and despite the pig manure deposition, ammonia levels were tolerable, as also observed by Azevedo et al. (2006).

Water transparency in Blumenau and Ituporanga was lower due to aspects of pond management, especially lack of fish entrance control and pig manure deposition, respectively. Temperature levels were below those recommended for tilapia culture, whose thermal comfort is between 27 and 32 °C (Kubitza, 2000). As related by Ghiraldelli et al. (2006), water quality assessment must be emphasised throughout the fish culture. The variation in water quality parameters could present severe consequences on fish health in high temperature climate (Tavares-Dias et al., 2008).

With the increase of intensive tilapia culture in Brazil, trichodinids started to play an important role in the list of potential fish pathogens. (Moraes and Martins, 2004; Martins and Ghiraldelli, 2008). Studying eels (Anguilla anguilla) in a recirculation system, Madsen et al. (2000) classified infestation by T. jadranica in four categories:
Ectoparasites of Nile tilapia in southern Brazil

Table 4. Mean relative dominance of ectoparasites in the gills and body surface of Nile tilapia in each facility in the state of Santa Catarina, southern Brazil.

| Facility | Gills | Body surface |
|----------|-------|--------------|
|          | Joinville |            | Blumenau |            | Ituporanga |
|          | Monogenoidea | Trichodinids | P. pillulare | Copepodids | Monogenoidea | Trichodinids | P. pillulare | Copepodids | Monogenoidea | Trichodinids |
| Autumn   | 0.07051 | 0.77780 | 0.15159 | 0.00010 | 0.0015 | 0.9985 |
| Winter   | 0.02306 | 0 | 0.97694 | 0 | 0 | 1 |
| Spring   | 0.50664 | 0.38770 | 0.10566 | 0 | 0.0002 | 0.9998 |
| Summer   | 0.15267 | 0.21830 | 0.62903 | - | 0.0060 | 0.9940 |

Blumenau

| Autumn   | 0.00001 | 0.00108 | 0.99889 | 0.00002 | 0 | 1 |
| Winter   | 0.00005 | 0.04272 | 0.95723 | 0 | 0.0063 | 0.9937 |
| Spring   | 0.00005 | 0.07330 | 0.92660 | 0 | 0 | 1 |
| Summer   | 0.00037 | 0.07225 | 0.92738 | 0 | 0.0047 | 0.9953 |

Ituporanga

| Autumn   | 0.00001 | 0.00021 | 0.99978 | 0 | 0 | 1 |
| Winter   | 0 | 0.56376 | 0.43624 | 0 | 0 | 1 |
| Spring   | 0.00024 | 0.19138 | 0.80838 | 0 | 0 | 1 |
| Summer   | 0.00146 | 0.31507 | 0.68347 | 0 | 0 | 0 |

0 (no parasites), 1 (from 1 to 10 parasites), 2 (from 11 to 100), 3 (from 100 to 1000).

In the present study the highest mean intensities for trichodinids were found on the skin mucus of fish from Joinville, during autumn and spring, corresponding to category 3 of Madsen et al. (2000). Trichodinids were present in all seasons, but higher infestation levels were seen in spring.

On the gills, trichodinids parasitism was also classified as category 3 during autumn in Joinville, winter in Blumenau, spring and summer in Ituporanga. This study confirms that the high eutrophication caused by the deposition of pig manure in Ituporanga was responsible for keeping high levels of trichodinids, which agrees with the findings of Afifi et al. (2000).

Regarding seasonality, this study corroborates Nikolic and Simonovic (1998) and Özer (2003), who found higher infestation intensities by *T. nobilis* and *T. domerguei* during spring and autumn, and during spring and summer, respectively. Özer (2000) also found high mean intensity of *T. mutabilis* Kazubski and Migala, 1968 during spring. Comparatively, fish in this particular study presented higher infestation intensities than those studied by Özer (2000). Özer and Erdem (1999) verified that trichodinids occurred during all seasons, but with higher infestation levels during spring, which was also verified in the present study.

Prevalence of trichodinids found in this study were higher than those found in tilapia from Guarapiranga reservoir studied by Ranzani-Paiva et al. (2005) and than those found in the same farms by Ghiraldelli et al. (2006) in study carried between October 2004 and June 2005. Furthermore, in the study performed by Ghiraldelli et al. (2006), fish presented lower mean intensities of parasitism. In this study, neither mortality nor clinical signs of disease were observed, probably due to lower temperatures when compared to Southeast Brazil (Tavares-Dias et al., 2001a, 2008).

Massive infestations by the dinoflagellate *P. pillulare* most of the time culminates in high mortality rates in cultured fish (Martins et al., 2001) and its dissemination is related to water quality (Shaharom-Harrison et al., 1990; Moraes and Martins, 2004). Prevalence of *P. pillulare* in tilapia was higher in the present study than those observed by Tavares-Dias et al. (2001a, 2008) in pacu (*Piaractus mesopotamicus*), piauçu (*Leporinus macrocephalus*), matrinxã (*Brycon amazonicus*) and in the hybrid tambacu (*P. mesopotamicus* x *Colossoma macropomum*). Contrary to that related in this study, Tavares-Dias et al. (2001a) did not verify seasonality on the occurrence of *P. pillulare*, when the parasite number was lower in winter.

Great infestation values by *P. pillulare* on gills of tambacu can cause excessive skin mucus production, loss of epithelium, paleness and lamellar hyperplasia on gills, petechiae and congestion, resulting on the death of 4,000 fish in the first 24 hours and 3,000 more in the next 15 days (Martins et al., 2001). With its fixation structures, named rhizocysts, *P. pillulare* causes severe damage to gill tissue in high infestations (Lom and Schubert, 1983). Hundred percent mortalities were also observed in cultured...
Table 5. Prevalence (%) (P), mean intensity (MI) and mean abundance (MA) of Monogenoidea, *Piscinoodinium pillulare* and trichodinids in the gills of Nile tilapia from the different localities in the state of Santa Catarina, Brazil. Different uppercase letters indicate significant difference between the localities in each season and lowercase letters difference between seasons in the same localities (p < 0.05).

### Monogenoidea

| Locality | Autumn | Winter | Spring | Summer |
|----------|--------|--------|--------|--------|
|          | P      | MI     | MA     | P      | MI     | MA     | P      | MI     | MA     | P      | MI     | MA     | P      | MI     | MA     |
| Joinville|        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
|          | 100    | 36.9 Ab| 36.9 Ab| 100    | 216.2 Aa| 216.2 Aa| 100    | 179.1 Aa| 179.1 Aa| 100    | 90.8 Ab| 90.8 Aab|        |        |        |        |
|          | (3-81) | (41-443)|        | (34-542)|        |        | (14-205)|        |        |        |        |        |        |        |        |        |
| Blumenau | 15     | 1.3 Ba | 0.2 Ab | 5       | 1.0 Ba  | 0.1 Ba  | 20     | 1.5 Ba  | 0.3 Ba  | 30     | 1.5 Ba | 0.5 Ba  |        |        |        |        |
|          | (1-2)  | (1-1)  |        | (1-2)  |        |        | (1-4)  |        |        | (1-4)  |        |        |        |        |        |        |
| Ituporanga| 20     | 1.6 Ba | 0.4 Bb | 0       | 0 Cb    | 0 Cb    | 10     | 2.5 Ba  | 0.3 Bb  | 55     | 3.8 Ba | 2.1 Ba  |        |        |        |        |
|          | (1-2)  |        |        | (0)     |        |        | (1-4)  |        |        | (1-10) |        |        |        |        |        |        |

### *Piscinoodinium pillulare*

| Locality | Autumn | Winter | Spring | Summer |
|----------|--------|--------|--------|--------|
|          | P      | MI     | MA     | P      | MI     | MA     | P      | MI     | MA     | P      | MI     | MA     | P      | MI     | MA     |
| Joinville| 35     | 226.4 Bc| 79.3 Bb| 95     | 9,640.4 ABa| 9,158.4 ABa| 5      | 747 Bb  | 37.4 Bb | 45     | 830.9 Ab| 373.9 Ab|        |        |        |        |
|          | (94-540)|        |        | (1,680-13,920)|        |        | (747-747)|        |        | (160-2,027)|        |        |        |        |        |        |
| Blumenau | 100    | 33,133.5 Aa| 33,133.5 Aa| 90     | 17,270.6 Ab | 15,543.5 Ab | 80     | 3,057.3 Ac| 2,445.8 Ac| 60     | 1,909.3 Ac| 1,145.6 Ac|        |        |        |        |
|          | (21,547-42,120)|        |        | (347-75,534)|        |        | (214-13,940)|        |        | (100-4,860)|        |        |        |        |        |        |
| Ituporanga| 100    | 30,918 Aa| 30,918 Aa| 100    | 460.1 Bb  | 460.1 Bb  | 70     | 1,195.7 ABBb| 836.6 ABBb| 60     | 1,642.7 Ab| 985.6 Ab |        |        |        |        |
|          | (22,867-57,200)|        |        | (71-1,208)|        |        | (67-4,080)|        |        | (130-5,610)|        |        |        |        |        |        |

### Trichodinids

| Locality | Autumn | Winter | Spring | Summer |
|----------|--------|--------|--------|--------|
|          | P      | MI     | MA     | P      | MI     | MA     | P      | MI     | MA     | P      | MI     | MA     | P      | MI     | MA     |
| Joinville| 90     | 451.8 Aa| 406.6 Aa| 0      | 0 Bc    | 0 Cc    | 65     | 210.9 Ab| 137.1 Bb| 45     | 288.3 Ab| 129.8 Bb|        |        |        |        |
|          | (90-1,040)|        |        | (0)     |        |        | (69-774)|        |        | (54-769)|        |        |        |        |        |        |
| Blumenau | 20     | 180 Bb  | 36 Bc  | 70     | 901.1 Aa | 693.8 Aa | 65     | 297.6 Ab| 193.5 Ab| 45     | 198.3 Ab| 89.3 Bc |        |        |        |        |
|          | (120-240)|        |        | (67-3,468)|        |        | (107-499)|        |        | (1-1,003)|        |        |        |        |        |        |
| Ituporanga| 10     | 64 Bb  | 6,4 Bc | 90     | 660.1 Aa | 594.6 Ab | 45     | 440.1 Aa| 198.1 Ab| 75     | 605.8 Ab| 454.4 Aa|        |        |        |        |
|          | (56-72) |        |        | (89-1,093)|        |        | (2-1,334)|        |        | (130-1,700)|        |        |        |        |        |
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_Puntius gonionotus_ from Malaysia and were related to high ammonia levels in water by Shaharom-Harrison et al. (1990).

In this study, the highest values of _P. pillulare_ infestation on tilapia gills during winter in Joinville, autumn and winter in Blumenau and autumn in Ituporanga were probably related to low water temperature, which is in agreement with the data presented by Martins et al. (2001). These authors registered mortalities in Brazilian fish cultured during winter in southeast Brazil. Dinoflagellate was the most dominant parasite in all three fish farms, with higher mean abundance during autumn and winter, probably due to lower fish resistance in low temperatures. Also, it is worth mentioning that management characteristics do not seem to exert an influence on the infestation levels.

Monogenoidea, parasites with high host specificity, play an important role in intensive fish pond culture of both ornamental and food fish in Brazil (Garcia et al., 2003; Moraes and Martins, 2004; Lizama et al., 2007). _Cichlidogyrus sclerosus_ was considered a chemical pollution biomarker for tilapia (Sanchez-Ramirez et al., 2007).

The highest prevalence rates, mean intensities and mean abundance for Monogenoidea, for all study seasons, were observed on fish gills from Joinville. Water quality can influence on Monogenoidea parasitism, as reported by Flores-Crespo et al. (1992), who verified higher intensity of dactylogyrids in tilapia at higher temperatures. Similar results were verified by Cecchini et al. (1998) studying the life cycle of _Diplectanum aequans_ Wagener, 1857. Contrarily, Koskivaara et al. (1991) reported that gyrodactylikes on _Rutilus rutilus_ were more abundant during autumn in Finland. Mortality on carp fry parasitised by _Dactylogyrus vastator_ Nybelin, 1924 exposed to low water oxygen concentrations was observed by Molnár (1994).

Garcia et al. (2003) reported that parasitism by _Urocleidoides Mizelle and Price, 1969_ was negatively influenced by pH, temperature and electric conductivity of water.

In the present study, though, it was not possible to associate the presence of Monogenoidea, neither on the gills nor on the skin mucus, with water quality. Something worth reporting is the significantly higher mean parasitism intensities on fish gills from Joinville. These values were higher than those reported by Tavares-Dias et al. (2001b) in tilapia from fee-fishing ponds; by Ghiraldelli et al. (2006) in tilapia from the same farms assessed in this study; and by Ranzani-Paiva et al. (2005) in tilapia from Guarapiranga reservoir, southeast Brazil. Lizama et al. (2007), registered occurrence of Monogenoidea during all studied period in a fish pond from Assis city, such as observed in this study. The farm from Joinville monitored water quality regularly in its ponds and kept a high water renewal rate, which contributed to the higher water transparency observed. The only water parameter that distinguished Blumenau from Ituporanga was also water transparency.

These results show that most of the analysed fish had greater infestations by protozoan during autumn and winter and by metazoan during spring and summer seasons. The use of trichodiniids infestation as a good water quality biomarker for fish pond cultures can be suggested, since they are directly associated with high organic matter concentration. Contrarily to what was observed in southeastern Brazil, dinoflagellates were not influenced by management characteristics. The highest mean intensities of Monogenoidea in fish from Joinville could not be easily explained since this farm usually controlled the pond water quality in comparison to Blumenau and Ituporanga. But, it must be commented that Joinville’s fish pond was rarely dried. This fact could be associated to high stocking density and Monogenoidea proliferation.

It was evident that the parasitological assessment was influenced by seasonality, even though values of water quality analysis were among recommendations for tilapia culture. Contrary to other Brazilian regions, in southern Brazil, the seasons of the year are well defined, fact that have supported these results. Knowledge of seasonal influence over ectoparasite communities is an important tool for applying adequate prophylactic measures. Despite their importance, preventive programmes for fish disease control have not been established yet in Santa Catarina.

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