

Full Length Research Paper

Gill arch occupation models of parasite communities of *Barbus martorelli* (Teleostean: Cyprinidae)

TOMBI Jeannette* and BILONG BILONG Charles Félix

Laboratory of Parasitology and Ecology, Faculty of Science, University of Yaounde I, P. O. BOX 812, Yaounde, Cameroon.

.Accepted 19 July, 2013

Changes in *Barbus martorelli* gill arch occupation models by its parasite component community were investigated for nine months. The work revealed three different categories of models. The first category follows the combined action of the respiratory water current and the colonized surface of each gill arch. The second category based on the mode of infestation of Monopisthocotylean larvae while the third category is established as a result of perturbations. Thus, the occupation models of *B. martorelli* gill arches by its microfauna are constantly changing.

Key words: *Barbus martorelli*, gill parasites, arch occupation models, perturbations, month.

INTRODUCTION

For many decades now, fish parasites have been the subject of several ecological community studies (Smith, 1969; Rohde, 1979; Silan and Maillard, 1989; Dzika, 1999; Howard et al., 2002; Poulin, 2002). The specific richness of fish gill parasites is generally high and as a result, several species share a limited surface area (Koskivaara et al., 1991). The regular ecological problem concerned here is to understand how these communities exploit their biotope. It has been observed that gill parasites are attached mostly to specific sites within the hosts. The study of the occupation models of gill arch preferences is usually done globally without considering variations with time. For instance, various works carried out globally within a given time, have resulted in different occupation models: Bagge and Valtonen (1999) found that *Dactylogyrus nanus* and *Dactylogyrus micracanthus* occurred mostly on the second gill arch of *Rutilus rutilus*; Dzika (1999) observed the presence of *Pseudodactylogyrus anguillae* on the median arches and

Pseudodactylogyrus bini on the three anterior gill arches of *Anguilla Anguilla*. Koskivaara et al. (1991) found that while *Dactylogyrus suecicus* and *Dactylogyrus similis* were more abundant on both second and third gill arches, *Dactylogyrus fallax* was more abundant on the first and second gill arches of *R. rutilus*. Although Euzet and Combes (1998) and Kearns (1998) showed that monogeneans commonly exhibit very precise site specificity, fish parasites equally respond strongly to physico-chemical characteristics of the aquatic environment and also to modifications in the physiological and biological conditions of the host (Ferrari-Hoeinghaus et al., 2006). According to Vidal-Martinez and Poulin (2003); Tavares and Luque (2004), these factors might influence parasite community structure. For these reasons, Combes (1995) recommended the analysis of ecological variations within a very short period because, the overall stability can dissimulate many local perturbations. The aim of this paper is to determine if the

*Corresponding author. E-mail: tombijeannette2007@yahoo.fr. Tel: +237 75 85 43 20.

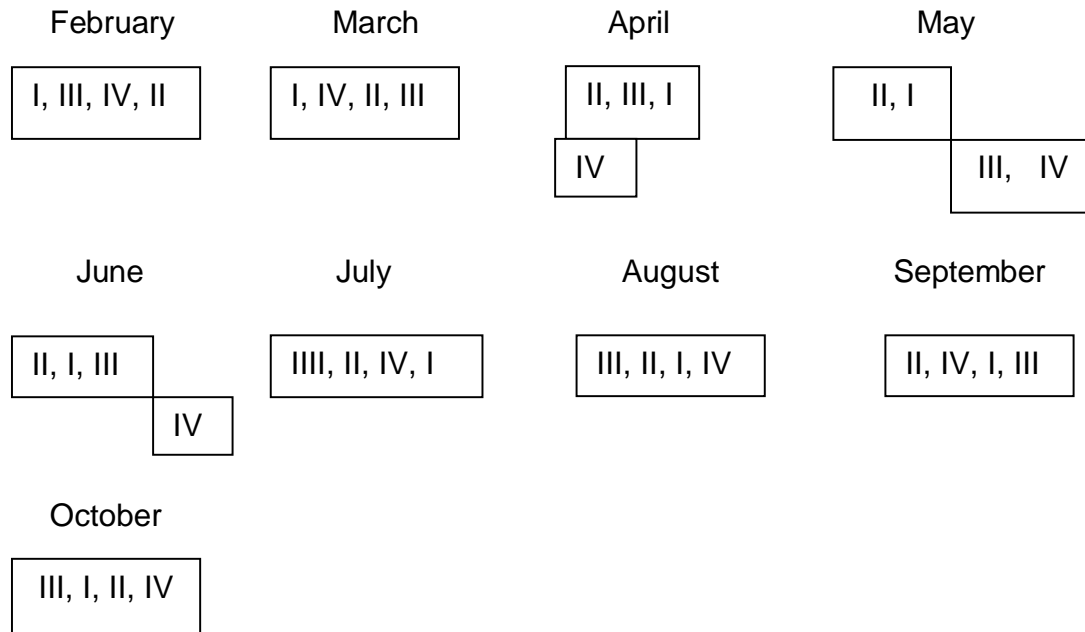


Figure 1. *Dactylogyrus bopeleti* monthly gill arch occupation models (gill arches from anterior to posterior are numbered I to IV).

gill arch occupation models of *B. martorelli* parasite communities are affected by various perturbations over a period of nine months.

MATERIALS AND METHODS

From the months of February to October 1998, 270 host specimens were collected using mesh gillnet (1 cm by 1 cm) in the Foulou watercourse at Nkoloulou locality (3°53'N, 11°34'E), at the outskirts of Yaounde, the capital of the Republic of Cameroon. Two samples were collected monthly and an effort was made to catch at least 30 fishes per month. After capturing a fish, it was immediately fixed and kept in 10% formalin before transferring from the sampling site to the laboratory. In the laboratory, the gills from each side were dissected and the gill arches from the anterior to the posterior were placed in various Petri dishes numbered from I to IV respectively, prior to examining under a stereoscopic microscope. Myxosporidian cysts present on the filaments or on the bony part of each gill arch were counted. The monogeneans collected were mounted on slides on which a drop of hematoxylin (eosin) was added to stain the parasites. Parasite species were identified and counted.

Component community and infra-population were defined according to Combes (1995). The Student t-test was used to compare two monthly mean parasitic charges of various gill arches. For each parasite species, the different models were then established, on one hand, based on the number of helminthes or protozoan cysts harbored monthly by each arch, and on the other hand, on the t-test results. The model is termed anteroposterior if the parasitic charge reduces progressively from the first arch (anterior position) towards the fourth (posterior position). The term equipartition is used when the number of individual species does not vary statistically from one gill arch to another, while unequipartition is used for cases where the number of gill arch parasites varies statistically.

RESULTS

A total of six parasite species were collected on the gill of *Barbus martorelli*. Four of them (*Dactylogyrus bopeleti*, *D. insolitus*, *D. simplex* and *D. maillardi*) were monogeneans and the other two (*Myxobolus barbi* and *M. njinei*) were myxosporidia. The analysis based on the infrapopulation size and the monthly evolution of the occupation models of gill arches provided various results depending on each parasite species.

It was observed that for six months (February, March, July, August, September and October),

Dactylogyrus bopeleti displayed an equipartition occupation pattern ($P > 0.5$). During the remaining three months, this parasite indicated an unequipartition pattern comprising three models namely: The gill arch II was statistically more colonized than the three others but, a significant difference was observed only between arches II and IV in April; the gill arches I and II have statistically similar parasitic charge and were more parasitized than the gill arches III and IV in May; the difference of infestation between the gill arches I, II, III compared with IV were observed in June (Figure 1).

In the case of *D. insolitus*, an equipartition pattern was observed during the months of March, April, June, July and September ($P > 0.5$). This equipartition was perturbed, as the only model observed more than once, that is, "III, II, IV, I" was in June and July (Figure 2). Unequipartition pattern was observed during the remaining four months. In February, arch I was statistically more parasitized than arch IV. Although the

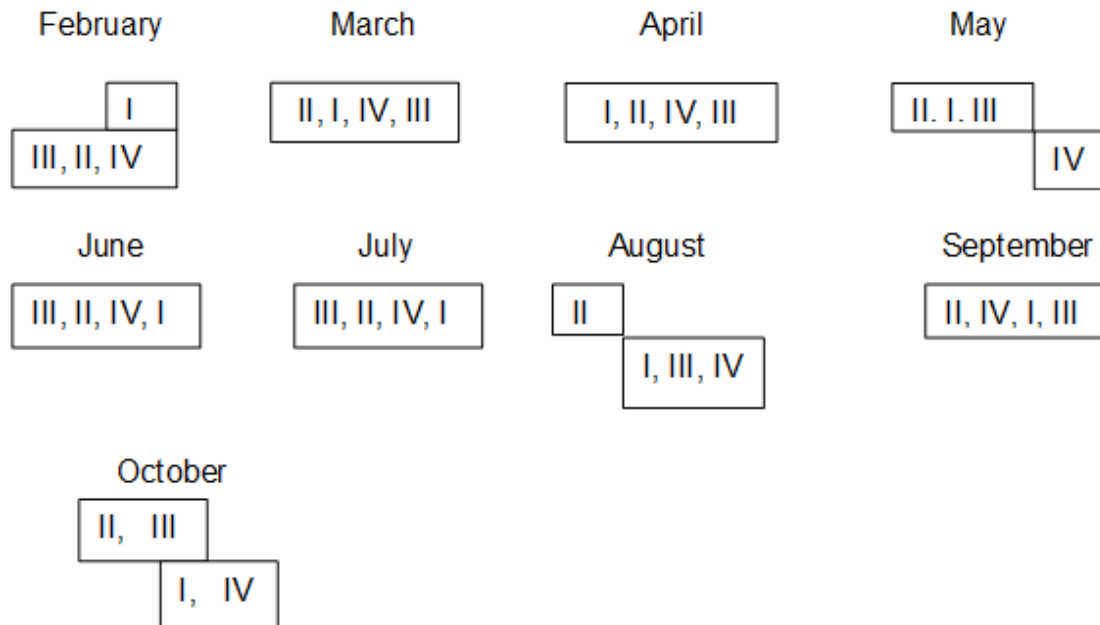


Figure 2. *Dactylogyrus insolitus* monthly gill arch occupation models (gill arches from anterior to posterior are numbered I to IV).

parasite loads of the arches II and III were superior to that of arch IV, the difference remained statistically insignificant ($P > 0.5$). Arch IV was statistically less infected than the three others whose parasitic charge was statistically insignificant in May ($P > 0.5$). In August, arch II was statistically more infested than the three others whose parasitic loads remained statistically equal. In October, the median gill arches II and III harbored statistically more parasites than arches I and IV however, the parasitic loads of arch IV remained less important.

D. simplex exhibited an equipartition spatial occupation pattern presenting different models for six months (February, May, June, July, August and September) in addition, an unequipartition pattern was observed for the rest of the months (March, April, October). In March, arch I was statistically less colonized than the three others whose parasitic charges were statistically insignificant. Though a high parasitic charge of arch IV was observed compared to arches III and II respectively and a high parasitic load of arch III was observed compared to arch II, the difference was insignificant. In April, arch IV was statistically less infested than arches II and III, their respective parasite loads being statistically equal to that of arch I. Moreover, all the various models observed for *D. simplex* occurred once during the study period. In October, arch II was more colonized than the three others but, a significant difference was noted only between arches I and II (Figure 3).

Considering *D. maillardi*, the gill arch colonization showed several perturbations. An equipartition pattern was observed during the months of February, June, August and September ($P > 0.5$). This species was

completely disappeared from all the arches in July. An unequipartition was noted for the remaining months. *D. maillardi* was absent on arch III in the month of March. In April, arch I was less colonized than the three others but a significant difference was observed only between arches I and III. In the months of May and October, arch IV statistically harbored more individuals (Figure 4).

The colonization of the four gill arches of *B. martorelli* by *Myxobolus barbi* was less perturbed. The models observed were « I, IV, II, III » in February; « I, II, III, IV » in April, July, August and October; « I, II, IV, III » in May, June and September. The only case of unequipartition was observed in March. Within this month, arch IV was statistically less colonized than arches I and II and no significant difference was observed for the three anterior arches (Figure 5).

An unequipartition of *M. njinei* cysts on the different gill arches was highly perturbed. This myxosporidia disappeared during the months of March for arch IV, April for arch IV, May for arches II, III, IV, June for arches III, IV and July for arches II and IV while an equipartition was observed during February, September and October (Figure 6).

DISCUSSION

This work has revealed that, the gill parasites of *Barbus martorelli* colonized the four arches in two patterns: Equipartition which consisted of equal statistical distribution of individuals of the same species on the four pairs of gill arches; and unequipartition, when one or

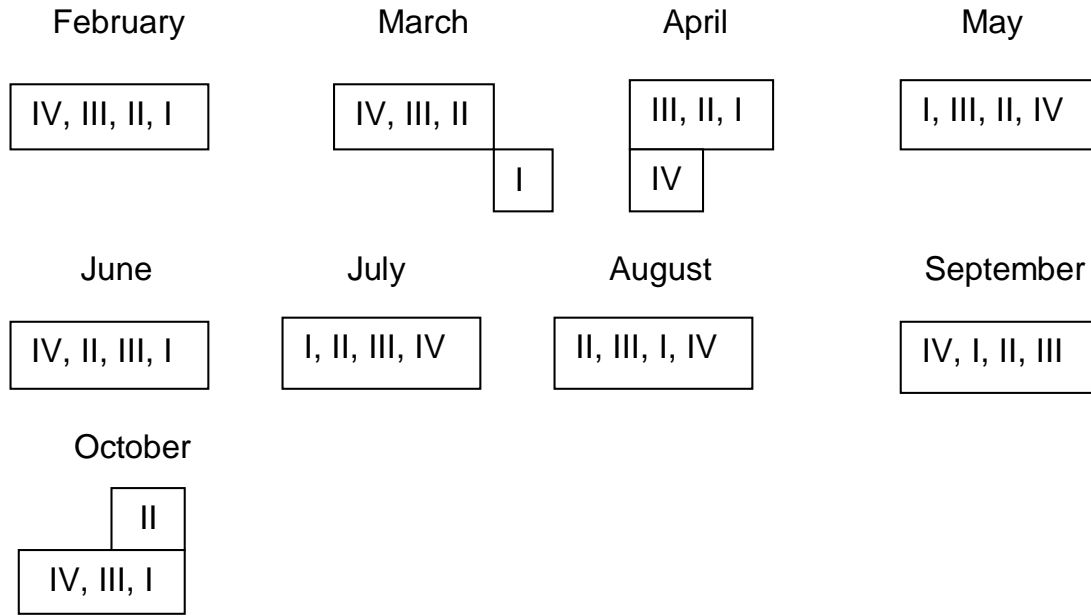


Figure 3. *Dactylogyrus simplex* monthly gill arch occupation models (gill arches from anterior to posterior are numbered I to IV).

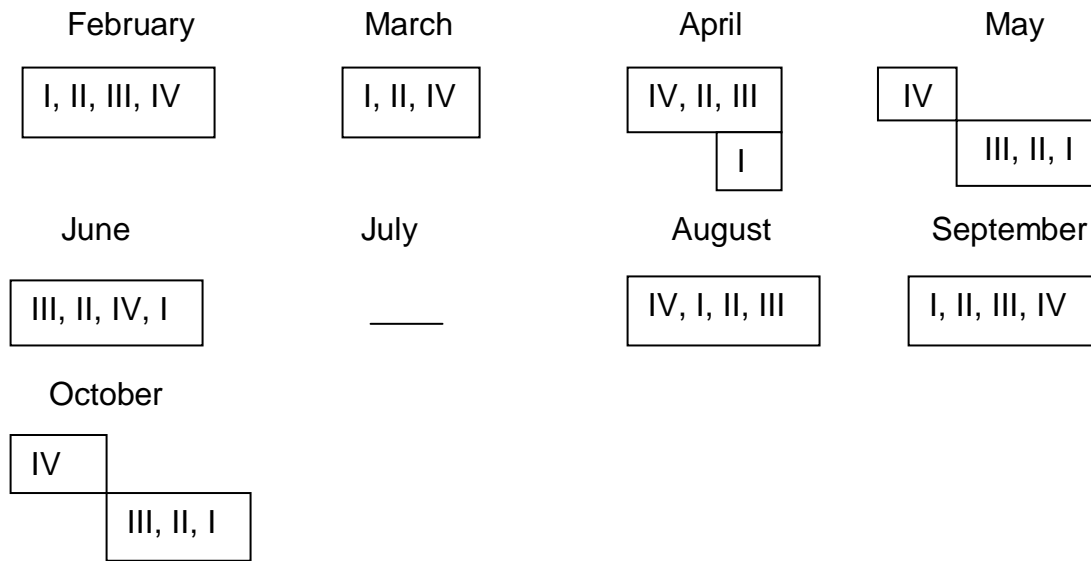


Figure 4. *Dactylogyrus maillardi* monthly gill arch occupation models (gill arches from anterior to posterior are numbered I to IV).

more gill arches were statistically more colonized than the others by the same parasite species. During the study period, each parasite species adopted both patterns of colonization. However, each pattern had several models. Although very little studies are found in literature, some authors nevertheless had obtained similar results. For instance, Bilong Bilong et al. (2004) showed that in *Hemichromis fasciatus*, the monogenean *Onchobdella voltensis* adopted equipartition during the months of June

and November despite some gill arches being statistically more or less infested throughout the year. These authors also revealed that in the same host, *Cichlidogyrus longicirrus* occupied the four gill arches with equal statistical values for seven months and an unequipartition with different models was obtained during the months of November and December 1989 and then in March, July and October 1990. Koskivaara et al. (1992) studied the gills of *R. rutilus* between February 1988 and April 1989

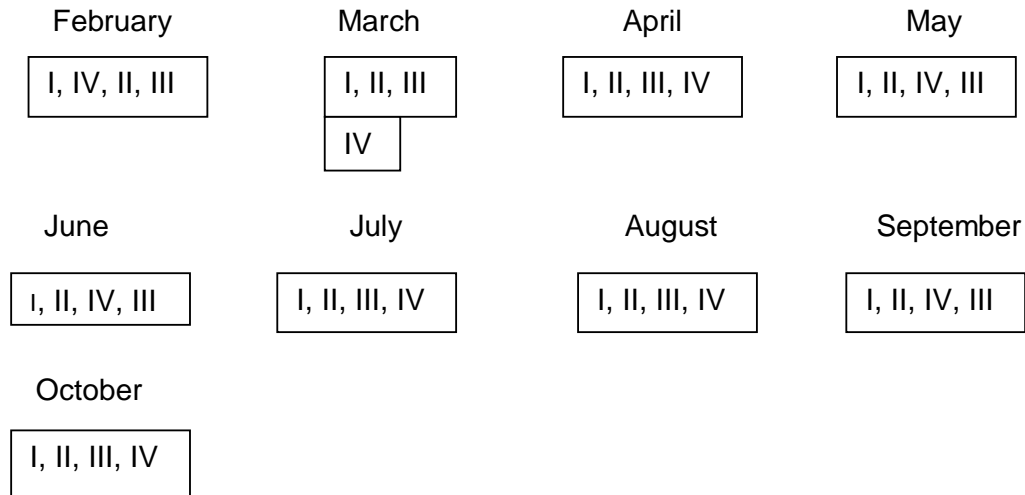


Figure 5. *Myxobolus barbi* monthly gill arch occupation models (gill arches from anterior to posterior are numbered I to IV).

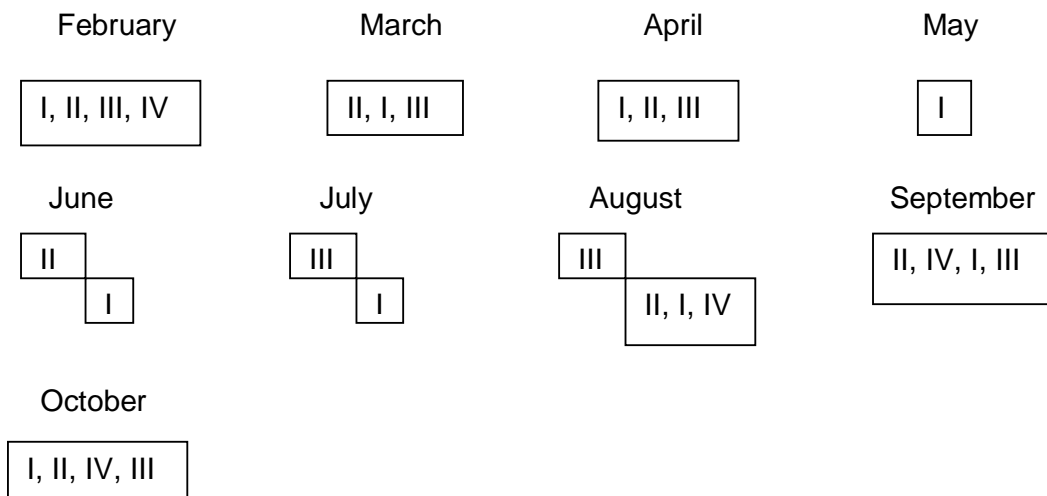


Figure 6. *Myxobolus njinei* monthly gill arch occupation models (gill arches from anterior to posterior are numbered I to IV).

and noted some differences in the occurrence of *Dactylogyrus nanus* on the four gill arches when comparing preferences between the months of May and June. In May, this monogenean had a statistically lower abundance on the first than on the other arches but, in June there were no significant differences between the various arches.

This study has shown that the spatial occupation patterns of arches (equipartition and unequipartition) by the gill parasites of *B. martorelli* presented three different categories of models. The first involved, on one hand, those in which the concentration of parasites reduced in the anteroposterior direction and, on the other hand, those in which the parasites concentrated more on the median arches. This type of model can be explained

based on either the respiratory water current or the colonized gill surface of each arch. According to Guitierrez and Martorelli (1994) and Lo and Morand (2001), the median arches II and III were more infested due to the large volume of ventilated water current flowing across. Additionally, Koskivaara et al. (1991) estimated that, the preference of median arches was linked to the large colonizing gill surface available to the parasites. For Bilong Bilong and Tombi (2004), the surfaces of the first three arches of *B. martorelli* seemed to be equivalent, while arch IV often presented the smallest colonizing surface. The combined action of the water current and the colonizing arch surface might explain the establishment of the first category of models.

The second category of models involved those in which

the fourth arch, which is the smallest and the least ventilated was more infested. This implies that in the case of monogenean concerned, this type of models could reflect the colonization pattern of oncomiracidium of Monopisthocotylea. Actually, Combes and Jourdan (2003) had shown that these infesting larvae generally were first attached on the body of their host before migrating towards the gill. This second category of models might imply that, after attaching to the fish body, the migration of oncomiracidium towards the gills was done in the posteroanterior direction.

The last category of models concerned those in which some arches were either not colonized at all or those in which the colonization was done in disorder, that is, «I, III, V, II»; «I, IV, II, III»; «III, II, IV, I»; «II, I, IV, III». In this last category, arch colonization was neither done in the direction of respiratory water current, nor in the direction of colonization arch surfaces and was not depend on the colonization pattern of gill by oncomiracidium of Monopisthocotylea. Such models might reveal that spatial structure of *B. martorelli* gill parasites had undergone several perturbations. These perturbations were also identified through the constant changing observed in the specific occupation models of gill arches; consequently no species adopted a statistically dominant model. The term perturbation in this case, refers to ruptures that could be either lightly or violently, scarcely or frequently occurring in any environment. For tropical species, it is known that the presence or abundance of parasites is influenced by both host and environmental factors (Esch et al., 1990). However, to our knowledge, these perturbations cannot be clearly associated with specific causal factors or environmental variations.

Therefore, it can be concluded that *B. martorelli* component community adopts three main categories of arch occupation models. Each category presents several types of models and no species indicated a statistically dominant model during the study period.

REFERENCES

- Bagge AM, Valtonen ET (1999). Development of monogenean communities on the gills of roach flies (*Rutilus rutilus*). Parasitology 118:479-487.
- Bilong Bilong CF, Tombi J (2004). Hétérogénéité du système branchial de *Barbus martorelli* Roman, 1971 (Poisson Cyprinidae) et modèle de croissance. J.C.A.S. 4(3):191-286.
- Bilong Bilong CF, Atyame Ntem CM, Njine T (2004). Structure de la guildes des monogènes parasites branchiaux du poisson *Hemichromis fasciatus* au lac municipal de Yaoundé. J.C.A.S. 4(1):33-40.
- Combes C (1995). Interactions durables. Ecologie et évolution du parasitisme. Collection d'écologie, n° 26. Paris. Ed. Masson: P. 524.
- Combes C, Jourdan J (2003). Taxonomie écologie et évolution des métazoaires parasites - taxonomy, ecology and evolution of metazoan parasites. (Livre hommage à Louis Euzet) Tome I. PUP, Perpignan France. pp. 161-201.
- Dzika E (1999). Microhabitat of *Pseudodactylogyrus anguillae* and *P. bini* (Monogenea: Dactylogyridae) on the gills of large-size European eel *Anguilla anguilla* from Lake Gaj, Poland. Folia Parasit. 46:33-36.
- Esch GW, Shostak AW, Marcogliese DJ, Goater TM (1990). Patterns and processes in helminthes parasite communities: An overview. In: Parasites communities: Patters and processes, Esh GW, Bush AO and Aho JM (Eds). Chapman and Hall, London, UK. pp. 1-20
- Euzet L, Combes C (1998). The selection of habitats among the monogenea. Int. J. Parasitol. 28:1645-1652.
- Ferrari-Hoeinghaus AP, Takemoto RM, Oliveira LC, Makrakis MC, Baumgartner G (2006). Host-parasite relationships of monogeneans in gills of *Astyanax altiparanae* and *Rhamdia quelen* of the São Francisco Verdadeiro river, Brazil. Parasite 13:315-320.
- Gutiérrez PA, Martorelli SR (1994). Seasonality distribution and preference sites of *Demidospemus Valenciennesi* (Monogenea: Ancrocephalidae). Res. Rev. Parasitol. 54:259-261.
- Howard SC, Donnelly CA, Kabatereine NB, Ratard RC, Brooker S (2002). Spatial and intensity - dependant variations in associations between multiple species helminth infestations. Acta Trop. 83:141-149.
- Kearn GC (1998). Parasitism and the Platyhelminths. Chapman and Hall, London, P. 544.
- Koskivaara M, Valtonen ET, Prost M (1991). Dactylogyrids on the gills of roach in Central Finland: features of infection and species composition. Int. J. Parasitol. 21:565-572.
- Koskivaara M, Valtonen ET, Vuori KM (1992). Microhabitat distribution and coexistence of *Dactylogyrus* species (Monogenea) on the gills of roach. Parasitology 104:273-281.
- Lo CM, Morand S (2001). Gill parasites of *Cephalophobis argus* (Teleostei: Serranidae) from Moorea (french Polynesia): site selection and coexistence. Folia Parasit. 48:30-36.
- Poulin R (2002). The evolution of monogenea diversity. Int. J. Parasitol. 32:245-254.
- Rohde K (1979). A critical evaluation of intrinsic and extrinsic factors responsible for niche restriction in parasites. Am. Nat. 114(5):648-671.
- Silan P, Maillard C (1989). Biology of *Serranicotyle labracis*, ectoparasite of *Dicentrarchus* (Teleostei): Contribution to the study of its populations. Mar. Biol. 103:481-487.
- Smith JW (1969). The distribution of one Monogenean and two copepod parasites of Whiting, *Merlangius merlangus* (L.), caught in British waters. Nytt. Mag. Zool. 17:57- 63.
- Tavares LER, Luque JL (2004). Community ecology of the metazoan parasites of White Sea catfish, *Netuma barba* (Osteichthyes: Ariidae), from the coastal zone of the state of Rio de Janeiro, Brazil. Braz. J. Biol. 64(1):169-176.
- Vidal-Martinez VM, Poulin R (2003). Spatial and temporal repeatability in parasite community structure of tropical fish hosts. Parasitology. 127:387-398.