BIOLOGIA MARINA
Acta Cienttfica Venezolana 43: 125-128, 1992

SPATIAL DISTRIBUTION AND INTERRELATIONSHIP OF FOUR MONOGENOIDEA OF JACK MACKEREL, *Caranx hippos* (Carangidae) IN THE NORTH-EAST OF VENEZUELA.

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Received: 11/07/90; Revised: 30/04/91; Accepted: 11/02/92

ABSTRACT: A total of 224 Jack mackerel, *Caranx hippos* (Family Carangidae) of three size groups (Juveniles, subadults and adults) were examined for monogenoidea. Each branchial arch was divided into six sections and gill parasites were collected, classified, and counted from each section separately. Four monogeneans, namely, *Protornicrocotyle mirabilis, Cemocotyle noveboracensis, Allopyragraphorus hippos* and *Cernocotyllela elongata* were common in both subadult and adult fish. Distribution of parasites in the mid-posterior and mid-anterior sections was significantly different from the other sections *(P* = 0.001). The attachment of parasites on the second and third gill arches were markedly different from the first and fourth. *P. mirabilis* was the most abundant species in both subadult and adult host, while the least common was *C. noveboracensis* in the adult, and *C. elongate* in the subadult. Statistical analysis between the different combinations made with four species of parasites revealed close association in most of the combinations, with the exception of *P. mirabilis* and *C. elongate,* which showed a negative correlation in the subadults, but the same combination was positive in the adult host. Key words: *Caranx hippos,* ecology, monogenoidea.

DISTRIBUCION ESPACIAL E INTERRELACIONES DE CUATRO MONOGENOIDES DEL JUR.EL *Caranx hippos* (carangidae) EN EL NORESTE DE VENEZUELA

RESUMEN: Se estudiaron 224 jureles, *Caranx hippos* (Familia Carangidae) correspondiente a tres grupos de tanialio (juveniles, subadultos y adultos) para recolectar monogenoidea de las branquias. Cada arco branquial se dividiO en seis secciones y los monogeneticos de calla section fueron clasificados y enumerados. Cuatro monogeneos, *Protornicrocotyle mirabilis, Cernocotyle noveboracensis, Allopyragraphorus hippos* y *Cemocotyllela elongate,* fueron comunes a los peces subadultos y adultos. La distribuciOn de parisitos en las secciones posterior media y anterior media fue diferente a la de otras secciones *(P* = 0.001). La fijaciOn de parisitos al 2ª° y 3" arcobranchial tambien fue diferente a las observadas en el primero y el cuarto. *P. mirabilis* fue uuly abundante en los grupos subadultos y adultos, mientras que *C. noveboracensis* fue poco comiin en adultos y *C. elongate* en subadultos. El analisis estadIstico revelci una estrecha asociaciOn en la mayoria de las combinaciones entre las cuatro especies. Sin embargo, la combinaciOn de *P. mirabilis* y *C. elongate* demostr6 una rela. ciOn negativa en los subadultos, pero no en los adultos. Palabras slave: Caranx *hippos,* ecologia, monogenoides.

INTRODUCTION

Since most fish harbour several species of parasites simultaneously, the entire parasite community of a host must be considered to properly understand host-parasites relationship.[2,10,11] Studying populations of parasites, Dogiel[3] stressed the fact that the host and the host's enviroment form the overall enviroment of the parasite, a factor especially true for the gill parasites which are in direct contact with the external enviroment of the host. A number of workers[5,7,8,12,13,14] studied the spatial distribution of various monogenea, and observed certain specificity for particular areas of attachment of monogenea by dividing each arch arbitrarily into several regions.

The Jack Mackerel, *Caranx hippos* Linn. 1766 is a migratory fish, the adult reaching the Eastern coast of Venezuela annually, mostly between May to August; while the juveniles are found throughout the year in the shallow water of the Gulf of Cariaco, Venezuela. The subadults are caught occassionally in the deeper waters of the region (Pers. obs.).

A group of monogenetic parasites of different morphological identity in *Caranx hippos* (Fam. Carangidae) has been considered in the context of their distribution in the gills of three different size groups of that fish. In addition, their occurrence and position are studied to find out their specific areas of attachment in each gill arch, and at the same time their interrelationships.

MATERIALS AND METHODS

Juvenile fish of *Caranax hippos* were collected monthly with the help of a beach seine from the southern coast of the Gulf of Cariaco, Venezuela, between March 1983 and February 1984. Subadult and adult fishes were collected from the fishermen's catch in Cumana during the months of April through August. Juvenile fish were transported to the laboratory, some alive and some fixed in 5% neutral formaldehyde while the gills of the juvenile and adult fish were ex-

amined fresh. The fish were weighed, sexed and their fork length recorded. Gill arches were separated and placed individually in petri dishes with sea water, and numbered I—IV anteroposteriorly. Sides of each hemibranch were designated anterior (outer) and posterior (inner). Each hemibranch was divided into three sub—equal sections (dorsal, medial and ventral), thus giving six equal sections per gill arch.

Monogenea were removed from sections of each gill arch. They were fixed in hot Formalin—Acetic—Alcohol (F. A. A.) and stored separately for later identification. The number of monogenea obtained from each section was recorded.

A two way ANOVA was run to test the various combinations of spatial distribution of monogenea between sides and sections of the gill. Significance was noted at 0.01 and 0. 001 levels to indicated the degree of abundance. Duncan's Multiple Range test was employed to determine especially the preference for section or sides of gills. Students t-test was used to compare the occurrence of monogenean in male and female adult fishes.

An analysis of correlation was employed to compare the association of parasites in the different hosts. The term prevalence (percentage of infection), intensity (numerical range) and mean intensity have been used in accordance with Margolis'.

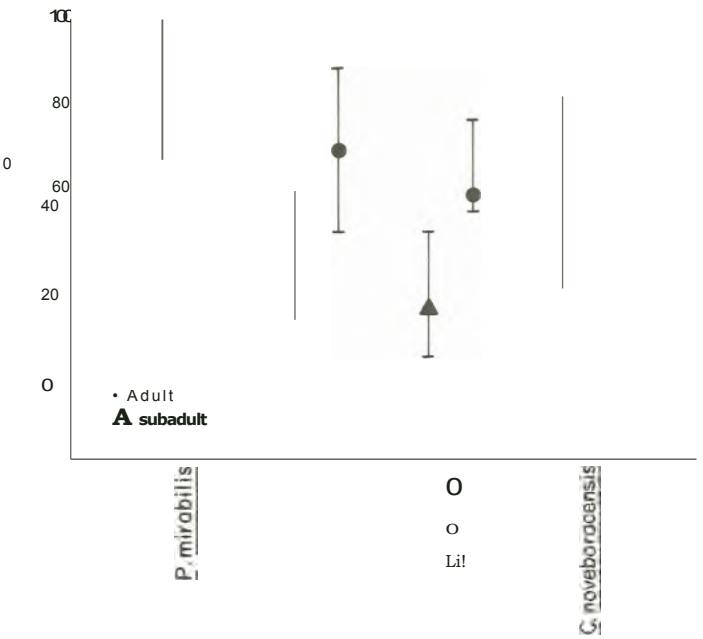

FIGURE 1 Occurrence of four species of monogenetic trematodes in subadult and adult hosts, *Caranx hippos*. (The bar is the rarge of 95% confidence level and symbol on the bar is the mean).

RESULTS

A total of 224 *Caranx hippos* of different sizes were examined for monogenetic parasites in the gills. None of the 78 juvenile fishes with a fork length between 40 and 110mm, were infected with monogeneans; 50 subadults, ranging from 140 to 240mm., harboured seven different species of Monogenea; while the 96 adults fishes, with sizes varyng between 590 and 800mm, carried 10 different species of Monogenea in the gills. Of these, four species were common in both the subadults and the adults: *Protornicrocotyle mirabilis* (MacCallum, 1918) Johnston and Tiegs, 1962, (Protomicrocotylidae), *Cemocotyle noveboracensis* Price, 1962, (Cemococotylidae), *Ceinocotyllela dongala* Meserve, 1938, (Cemocotylidae) and *Allopyragraphorus hippos* Hargis, 1956, (Heteraxinidae).

A total of 719 specimenes of these four parasites from subadults and 3223 from the adults were collected and analysed (Tabl. 1). *Protornicrocotyle mirabilis* was the most abundant species with 98% in the adults (Fig. 1).

No difference was observed in the attachment of monogeneans in the gill of either side of the fish. The parasites in both the subadults and adults tended to occur mostly on the anterior (outer) side of hemibranch *(F* = 547.07; *P* = 0.001; *df* = 48 for the subadults and *F* = 39.29; *P* = 0.01; *df* = 94 for the adults).

The parasites attached preferentially on the gill arches 2 and 3 *(F* = 6.39; *P* = 0.01 for the subadults and *F* = 111.43; *P* = 0.001; *df* = 3 for the adults). All four parasites preferred to attach on the antero—medial and postero—medial sections of the hemibranchs of the subadults *(F* = 144.41; *P* = 0.001) and on the postero—antero—ventral and postero—medial sections in the case of adults *(F* = 50.60; *P* = 0.001, and with Duncan's Test *P* = 0.001, *df* = 5).

The percentage of infection of four species of monogeneans in three different size groups of hosts with their intensity is shown in Table 1. The intensity of infection of *P. inirabilis* varied between one and 39 in the subadults, with 42% of the host having 5-9 parasites and 4% carried 15-39 parasites per host. The intensity in adults varied between one and 111 parasites. Only 2% of the host of both male and female carried an intensity of 95-111; while 53% adult male had 4-16 parasites and 38% female carried 14-27 parasites. The female fish had more parasites than the male *(I* = 2.25; *P* = 0.050, *df* = 94) with a 1.45:1 proportion. *P. mirabilis* was the most dominant species with high intensity of infection in both subadults and adults host, which survived well with other gill parasites.

Cemocotyle noveboracensis was the the second most dominant species in the subadults, but was the least in the adult hosts. The intensity varied between 1-16 in the subadults and 1-5 in the adult. No diference was found in parasite load between males and females *(1* = 1.93; *P* = 0.05, *df* = 13); and the proportion between the sexes was 1:1.1.

The intensity of *Allopyragraphorus hippos* in the subadults was 1-11 and 1-26 in the adult. Only 2% of the subadults carried 18-26 parasites and 42% had 1-2

TABLE I

Occurrence of four species of Monogenea in three sizes of host Caranx *hippos*

Host Stage	Species	Number	% Infection	Range	Intensity
Adults (n = 96)	*P. mirabilis*	2377	98	1-111	25.02
	A. hippos	557	69	1-26	8.43
	C. elongata	255	59	1-23	4.46
	C. noveboracensis	34	15	1-5	2.42
Subadults (n=50)	*P. mirabilis*	472	96	1-39	9.83
	A. hippos	76	46	1-11	3.3
	C. elongata	53	36	1-8	2.94
	C. noveboracensis	118	58	1-15	4.07
Juveniles (n=78)	No parasites were found				

TABLE 2

Results of statistical analysis on interrelationship of different combination of four parasites. (NS= Not significant, * = 0.05 > *P* > *0.01*,** = *0.01*> *P* > *0.001*,*** = *P* < 0.001) SA= Subadult and A = Adult.

Parasites combination	Number (n)		Correlation Coeffient, r		SA	A
	SA	A	SA	A		
P. mirabilis—A. hippos	50	96	0.09 NS	0.23*	0.013 NS	2.21*
P. mirabilis—C. noveboracensis	50	96	0.05 NS	0.24*	2.18***	2.31ˆ
A. hippos—C. elongata	50	96	0.55**	0.26**	0.35*	2.61¨
C. elongata—C. noveboracensis	50	96	0.63**	0.43**	1.63***	4.41¨
P. mirabilis—C. elongata	50	96	6.58**	0.10 NS	-2 84***	0.99 NS
A. hippos—C. noveboracensis	50	96	0.61**	0.22*	0.77**	2.20ˆ

parasites per host. The occurrence of parasites in the female was significantly different from that of the male (t = 2.09; P = 0.05, df = 65), with a 1.82:1 proportion.

Ceinocotyllela elongata had 1-8 parasites per host in the subadults, while the intensity varied between 1-15 in the females and 1-23 in the adult males. No significant difference in occurrence of parasites between males and females was observed (t = 0.24; P = 0.05, df = 56), with approximately 1:1. the theoretical ratio.

Four monogenetic parasites common in subadults and adults hosts were used in correlation analysis between them (Table-2). Different combinations made with the parasites revealed mostly positive relationship, with the exception of the combination between *P. mirabilis* and *C. elongata* which showed significant negative correlationship in the subadult hosts, but the same combination in the adults was insignificant. The combination of *P. mirabilis* and *A. hippos* showed no significant relation in the subadults while it produced significant relationship in the adult hosts. The combination between *A. hippos* and *C. elongata* as well as *C. elongata* and *C. noveboracensis* showed close association in both adults and subadults.

DISCUSSION

None of the juveniles were found infected with any monogeneans. This may be attributed to the pattern of life cy-

cle of the host. *C. hippos* is a pelagic and migratory fish, living offshore as an adult but moving inshore during the spawning period. The adult may transfer the monogeneans infection to the younger fish when sharing the same habitat. Juveniles mostly live in the shallow water and are free of any monogeneans, as they probably do not share the same habitat of the adult or may be due to absence of infective stages of the monogenea in the area.

P. mirabilis, A. hippos, C. elongata and *C. noveboracensis* occurred commonly on the gill arches II and III of *C. hippos*, both subadult and adult. This conforms with the finding of Hanek & Fernando[5]. A defined affinity of attachment for the mid-posterior section was observed in the subadult as well as in the adult host. Preference for attachment of gill parasites on the mid-region of II and III gill arches may be accidental rather than directional. A major water flow probably passes through the mid-region of the operculum (II and III), while the anterior and posterior gill arches (I and IV) could receive a less intense flow.

Suydam' suggested that the direction of the ventilation current may influence the position of monogenea on the gills, usually with the gradient from buccal to opercular cavity. However, very little has been done to determine whether all of the gill arches play an equal part in gaseous exchange or whether more of the respiratory current passes over some gill arches than others. considering the size alone, one might suspect that the most posterior gill arch (IV) receives less water flow than the anterior ones. Hanek & Fernando[5] and also the present study, observed the least number of parasites in the 4th gill arch.

Several authors[1,4,5,7,14,15] have indicated that some parasites of fish exhibited a site specificity for a particular site or gill arch; but no such constant pattern of attachment can be predicted in different species of fishes in different regions. Attachment of each monogenetic parasites in different gill arches of the host may probably be influenced by individual requirement of microhabitat.

Four genera of monogenetic trematodes coexisted in the gills of *C. hippos* but speculation arises as to whether one genus of parasites influences the presence of the another when several parasites coexist in a particular environment of a host. The correlation analysis in the present study suggested association in most of the combinations. Some combination of species displayed significant positive relation in both subadult and adult hosts, with the exception of *P. mirabilis* and *A. hippos* in the subadult and adult hosts (Tabla 2). *C. elongata* coexisted with *P. mirabilis* without any interaction in the subadult, but showed no interrelationship in the adult fish; and *A. hippos* showed no statistical evidence of any realtionship with *P. mirabilis* in the subadult, while the same species displayed significantly positive correlation in the adult hosts. These differences may be influenced by the size and age of host, time of capture, intensity of infection, location and surface area of the gills, which may need to be investigated.

REFERENCES

1. Buchamann, K. Spatial distribution of *Pseudodactylogyros anguillae* and *P. bini* (Monogenea) on the gills of the European eel, *Anguilla anguilla. J. Fish. Biol.* 32: 801-802, 1988.
2. Cloutman, D. G. Parasites community structure of Large-Mouth Bass, Warmouth and Bluegill in Lake Fort Smith, Arkansas, *Trans. Amer. Fish. Soc.* 2: 277-283, 1975.
3. Dogiel, V. A., Petruchevski, G. K. and Polynsky, Yu. I. Parasitology of fishes. *Eng. Edition, Oliver Boyd, Landa,* 384 p, 1961.
4. Frankland, H. M. The life stories and bionomics of *Dichidophora denticulata* (Trematoda: monogenea). Par*asitol,* 45: 313-351, 1955.
5. Hanek, G. and Fernando, C. H. Spatial distribution of gill parasites of *Lepornis gibbosa* and *Arnbloplites rupestris. Can. J. Zool.* 56: 1235-1240, 1978.
6. Hughes, G. M. and Shelton, G. The mechanics of gill ventillation in three freshwater teleost. *J. Exp. Biol.* 35: 807-823, 1958.
7. Llewellyn, J. The host specificity, microecology and comparative morphology of some trematode gill parasites. *J.* Mar. *Biol. Assoc. U. K.* 35: 113-127, 1956.
8. Llewellyn, J. and Owen, I. L. The attachment of the monogenean, *Discocotyle sagittate* to the gills of *Salmo trutta. Parasitol.* 50: 51-59, 1960.
9. Margolis, L.; Esch, G. W.; Holmes, J. C.; Kuris, A. M. and Schad, G. A. The use of the ecological terms in parasitology (Report of an Ad. Hoc. committee of the American Society of Parasitologists). *J. Parasitol.* 68: 131-133, 1982.
10. Noble, E. R. Fishes-their parasitemix as object for ecological studies. *Ecology.* 41: 593-596, 1960.
11. Noble, E. It.; King, E. R. and Jacobs, B. L. Ecology of gill 'parasites of *Gillichthys mirabilis. Ecology* 44: 295305, 1963.
12. Owen, I. L. The attachment of monogenean *Diplozoon* paradoxurn to the gills of *Rutilis I.* Microhabitat and adhesive attitude. *Parasitol.* 53: 455-461, 1963.
13. Slinn, D. J. Occurrence of *Discocotyle sagittata* on sea trout. Nature. 197: 306, 1963.
14. Suydam, E. L. The macroecology of three species of monogenetic trematodes of fishes from the Beaufort-Cape Hatteras area. *Proc. Helrninth. soc. Wash.* 38: 240-246, 1976.
15. Wiles, M. The occurrence of *Diplozoon* paradorum (Trematoda: Monogenea) in certain water of Northern England and its distribution on the gills of certain Cyprinidae. *Parasitol.* 58: 61-70, 1968.