Pesq. Vet. Bras. 26(4):205-210, out./dez. 2006

Main diseases of pejerrey (*Odontesthes bonariensis*) in central Argentina[1]

M. Mancini[2*], C. Rodriguez[2], C. Prosperi[3], V. Salinas[2] and C. Bucco[4]

ABSTRACT.- Mancini M., Rodriguez C., Prosperi C., Salinas V. & Bucco C. 2006. **Main diseases of pejerrey (*Odontesthes bonariensis*) in central Argentina.** *Pesquisa Veterinária Brasileira 26(4):205-210.* Facultad de Agronomía y Veterinaria. Universidad Nacional de Río Cuarto, Ruta Nac. 36 Km 601, Río Cuarto (5800) Córdoba, Argentina. E-mail: mmancini@ayv.unrc.edu.ar

Argentina's central region includes an important area covered by shallow pampean lakes and dams. In these environments, fishing of pejerrey *Odontesthes bonariensis* Valenciennes, 1835 (Pisces, Atherinopsidae), the most important fresh-water fish of the country, is a relevant social activity and also a considerable economic resource. The main diseases found in this species were studied from 1992 to 2003 in the provinces of Córdoba, La Rioja and Santa Fe (30° and 35° S, 61° and 67° W). Most cases were registered in high temperature months. *Lernaea* sp and *Aeromonas hydrophila* were the etiological agents most frequently found. The trophic characteristics of the aquatic environments enhanced disease processes and caused massive death of *O. bonariensis,* due to complex hydrochemical interactions.

INDEX TERMS: *Odontesthes bonariensis*, fish diseases, pathological agents, water quality.

RESUMO.- [Principais enfermidades do peixe-rei (*Odontesthes bonariensis*) registradas na Argentina Central.] A região central de Argentina possui uma importante superfície coberta por represas e lagunas pampianas. Nestes ambientes, a pesca do peixe-rei *Odontesthes bonariensis* Valenciennes, 1835 (Pisces, Atherinopsidae), peixe de água doce mais importante do país, é uma atividade social relevante e de significado valor econômico. Estudaram-se as principais enfermidades que afetaram esta espécie de peixe no período de 1992-2003, nas províncias de Córdoba, La Rioja e Santa Fe (30 e 35ºS, 61 e 67ºW). A maior quantidade de casos foi registrada nos meses de temperaturas elevadas. *Lernaea* sp e *Aeromonas hydrophila* foram os agentes etiológicos mais importantes. As características tróficas particulares dos ambientes aquáticos estudados foram importantes por potenciarem alguns casos, mas em outros a causa da mortandade dos peixes esteve relacionada a complexas interações hidroquímicas.

TERMOS DE INDEXAÇÃO: *Odontesthes bonariensis,* doenças de peixes, agentes patológicos, qualidade da água.

INTRODUCTION

Argentina's central region has numerous shallow pampean lakes and dams. While limnoecology of these systems is different, they are all known for their high trophic state, remarkable instability and frequent cyanobacterial and dinoflagelates blooms during high temperature months (Bustamante et al. 2002, Quirós et al. 2002). One of the main activities in these environments is recreative fishing, being the pejerrey *Odontesthes bonariensis (*former *Basilichthys bonariensis)* the target species (Fig.1), generating a several fold millionaire economic income and also a very important crop of protein with high biological value (Grosman & Mancini 2001).

The significance of this species in fisheries, the easiness of its artificial reproduction, as well as the excellent quality of its flesh, have made it rank as the most important in Argentina and has improved for many years its commercial distribution around the country and abroad (Bonetto & Castello 1985, Saint-

Fig.1. Pejerrey, *Odontesthes bonariensis.*

[1] Received on March 20, 2006.

Accepted for publication on April 25, 2006.

[2] Facultad de Agronomía y Veterinaria, Universidad Nacional de Río Cuarto, Ruta Nac.36 Km 601, Río Cuarto (5800), Argentina. * Corresponding author: mmancini@ayv.unrc.edu.ar

[3] Facultad de Ciencias Exactas, Físicas y Naturales, Universidad Nacional de Córdoba, Córdoba, Argentina.

[4] Guardafauna de Córdoba, Argentina.

Paul 1986). *Odontesthes bonariensis* is a eurihaline species with remarkable plasticity, inhabiting environments with different degrees of salinity. Its reproduction is external, with a fecundity potential higher than 10,000 eggs in specimens more than 2 years old (Iwaszkiw & Freyre 1980). It feeds mainly on zooplankton in the first years of its lifetime, and later on changes to a carnivorous regimen, close to cannibalism (Escalante 2001), being highly dependant on environmental conditions.

Due to its scientific, sportive and commercial interest, numerous studies have been published on its biological and population structure in the context of different governmental programs (López & García 2001). On the other hand, studies regarding diseases of this species in the central region of the country, that often cause important economic losses, are few and mostly focused on parasitic and bacterial etiology (Mancini et al. 2000). In this investigation of the main diseases found in Argentina's central region, the etiological agents involved and their relationship with environmental factors in the area were studied.

MATERIALS AND METHODS

Diseases outbreaks in *Odontesthes bonariensis* were registered in Argentina's central region, in the provinces of Córdoba, Santa Fe and La Rioja (30º and 35ºS, 61º and 67ºW) warm weather area corresponding to the "humid Pampa" and hill regions (Fig.2). They were reported by the Córdoba Environment Agency, Environment

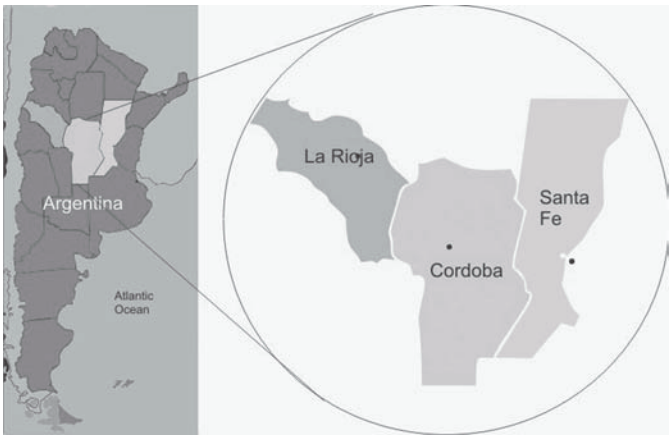


Fig.2. Map of Argentina's central region showing location of the study area.

Foundation and other non governmental institutions. Studies were conducted in the National University of Río Cuarto, Córdoba between 1992 and 2003.

The fishes were captured alive and/or moribund with seine and gill nets. Afterwards, they were transported to the lab in plastic aseptic sealed bags for internal and external examination. After visual examination, the skin and gills were biopsied to look for pathogen agents and histological lesions. Scratching of skin and observation of gills were made for identification of internal parasites and fungus (Blanch 1988, Collins 1993, Noga 1996, Moeller 2001). The Nematoda were cleared previously with Amman lactophenol and classified according to Alvarez Pellitero (1988) and Moravec et al. (1993). Particularly in cases where a bacterial disease was suspected, samples from kidney, liver and skin lesions of moribund pejerrey were cultured on blood agar and tripticase soya agar (TSA) and incubated at 30-37ºC for 24-48 h. Standard methods were applied (Barja & Estevez-Toranzo 1988, Austin & Austin 1989, Collins 1993, Noga 1996).

In parasited fishes, mean intensity was calculated applying the average number of parasite for positive host and the prevalence, P = A(n) / Nt, where A(n) is the number of infected hosts and Nt the number of total hosts (Margolis et al. 1982).

In those cases where fishes showed a poor corporal condition, weight (in g), cephalic length and standard length (in mm) was evaluated. Weight-length relationships were calculated, $W = a * SL^b$, where W is weight, a and b are constants of adjustment gained through regression analysis, and SL is the standard length; the cephalic index, CI = CL * 100 / SL, where CL is cephalic length; and the condition factor, $K = W * 10^5 / SL^3$, for which specific standards were applied (Freyre 1976).

Furthermore, *in situ* temperature, pH (digital thermo-pHmetre Lutron 206), dissolved oxygen (digital oxymetre Lutron LT 5508) and Secchi disk transparency were measured. The water samples for plankton and bacteriological studies were collected at 30cm depth from the surface of the lakes at the litoral and limentic zones. The isolation of *Escherichia coli, Pseudomonas aeruginosa* and *Aeromonas* sp was evaluated (APHA 1992). The collection was carried out using sterile flasks. When phytoplankton blooms occurred, species were fixed in formalin 3% and determined according to Streble & Krauter (1987). Chlorophyll-a was measured by photocolorimetry (Prosperi 1994)

RESULTS AND DISCUSSION

A total of 21 cases of disease in *Odontesthes bonariensis* were observed in the present study. Parasitic and bacterial were the most common etiologies. Morbility and mortality were unstable. Most of the diseases were found at periods of high temperatures and with the presence of environmental stress, and with cyanobacterial and dinoflagelates blooms (Table 1).

Parasites affecting fish are numerous and include different groups. Anisakides larvae always have a wide distribution and are involved in zoonosis known as Anisakiasis (Alvarez Pellitero 1988). In *O. bonariensis,* the nematode *Contracaecum* is located in the abdominal cavity and produced a deficient general condition in cases with moderate parasitic intensity (Table 1). Fishes became thin and "big-headed". In Cases 1, 9 and 19, the prevalence was 76, 64 and 24%, while the average intensity was 4.4 ± 3.1, 15.2 ±7.1, and 3.6 ± 2.2 larvae per fish, respectively. The poor general condition of the fish was noted in the cephalic index and the (K) condition factor (Case 9, Fig.3), the weight-length relationship was $W = 4451 * 10^{-5} * SL^{2.623}$ ($R^2 = 0.95$). Bad water quality made infection with other parasitic agents easier. A deficient fish condition originated by *Contracaecum* sp was also observed in Case 19.

The degree of parasite pathogenicity varies between fish species, and depends on the affected organ, parasitism intensity, environmental conditions and concomitant infections, among other factors (Alvarez Pellitero 1988). In Cases 12 and 16 (Table 1), the trematode (Heterophyidae) was introduced in the gills with a 100% prevalence and a medium intensity of 38.8 ±26.3 and 172.1 ±58.8 metacercarias/fish, respectively (Fig.4); the severity of the disease was increased by high water temperatures. At histological evaluation, the presence of several cysts and secondary lamellae degeneration with loss of epithelium was observed.

Table 1. Characteristics of main disease outbreaks in *Odonthestes bonariensis* registered in Argentina's central region

Case	Date	Origin	Province	Morbility[a]	Mortality[a]	Pathological agents observed	Environment factors
1[b]	1992/09	Shallow lake	Córdoba	++	+	*Contracaecum* sp	(1)[b]
2[d]	1992/12	Shallow lake	Santa Fe	+++	+++	(-)	(2)
3[a]	1993/08	Dam	Córdoba	++	(-)	*Lernaea* sp *Aeromonas hydrophila*	(3)
4[a]	1994/03	Dam	Córdoba	++	(-)	*Lernaea* sp *A. hydrophila*	(4)
5[a]	1995/02	Dam	Córdoba	++	(-)	*Lernaea* sp	(5)
6[b]	1997/04	Dam	Córdoba	+	+	(-)	(6)
7[a]	1998/02	Dam	Córdoba	++	(-)	*Lernaea* sp *A. hydrophila*	(7)
8[b]	1999/03	Dam	Córdoba	++	+	*Lernaea* sp *Dactylogyrus* sp	(8)
9[b]	1999/03	Shallow lake	Córdoba	+++	++	*Lernaea* sp *Gyrodactylus* sp *Trichodina* sp *Contracaecum* sp *Aeromonas* sp	(9)
10[b]	1999/12	Dam	Córdoba	+	+	(-)	(10)
11[c]	2000/03	Dam	Córdoba	++	++	(-)	(11)
12[e]	2001/01	Shallow lake	Córdoba	+++	+++	Trematoda, Heterophyidae	(12)
13[a]	2001/02	Dam	La Rioja	+	(-)	*Lernaea* sp	(13)
14[c]	2001/03	Dam	Córdoba	++	++	*Lernaea* sp	(14)[c]
15[c]	2001/12	Dam	Córdoba	++	++	(-)	(15)
16[e]	2001/12	Shallow lake	Córdoba	++	++	Trematoda, Heterophyidae	(16)[c]
17[c]	2002/02	Dam	Córdoba	+	+	(-)	(17)
18[e]	2002/11	Shallow lake	Córdoba	+++	+++	(-)	(18)
19[d]	2003/01	Shallow lake	Córdoba	++	++	*Contracaecum* sp	(19)
20[b]	2003/08	Shallow lake	Córdoba	++	+	*Saprolegnia* sp	(20)
21[a]	2003/09	Shallow lake	Santa Fe	+	(-)	*Argulus* sp	(21)

Number of dead fish (range): [a] none, [b] <500, [c] 500-1000, [d] 1000-2000, [e] >2000.

[a] (-) Absent, + low, ++ moderate, +++ high.

[b] **(1)** Mean temperature 29.1ºC, high salinity; **(2)** Poisoning with benzoic + sulfonylurea herbicide (TLC), thin layer chromatography; **(3)** Temperature 17ºC, pH 7.3; **(4)** Mean temperature 25ºC; **(5)** Mean temperature 25.5ºC; **(6)** Mean pH 7.5, presence of *Pseudomonas aeruginosa* and *Escherchia coli* in water; **(7)** Not available; **(8)** Bloom, *Anabaena spiroides* (185/25uL), mean chlorophyll 20.9mg/m^3, presence of *Aeromonas* sp in water, mean temperature 27.9ºC, highest pH 9.4; **(9)** Bloom, *A. spiroides,* average pH 9.2, mean temperature 26.6ºC, mean oxygen concentration at 6 pm 7.5mg/L, NO_2 0.60 mg/L, NO_2 0.60mg/L; **(10)** Bloom, Cyanobacteria; **(11)** Bloom, Cyanobacteria and Dinoflagelates; **(12)** pH 9.1, mean temperature 30.5ºC, mean oxygen concentration at 7 pm 9.5mg/L, mean chlorophyll 19.6mg/m^3, Secchi disk 0.45m; **(13)** Not available; (14) Bloom, *Ceratium hirundinella* and later die-off, pH 8.6, mean temperature 23ºC; **(15)** Bloom, *C. hirundinella;* **(16)** Mean pH 8.6, mean temperature 28.3ºC, mean oxygen concentration at 5 pm 7.2mg/L; **(17)** Bloom, *A. spiroides,* Secchi disk 0.40m, pH 9.2, temperature 28ºC; **(18)** mean pH 10.1, mean temperature 26ºC, mean oxygen concentration at 6 pm 8.3mg/L, Secchi disk 0.15m, bloom, *A. spiroides* and *Microcystis* sp**;** **(19)** Reports of cyanobacterial bloom, mean pH 8.6, mean temperature 28.2ºC, Secchi disk 0.32m; **(20)** Important amount of macrophytes; **(21)** Secchi disk 0.25m.

[c] Data from Cordoba Agency, Argentina.

Argulus sp and *Lernaea* sp are ectoparasite crustaceans that may be the cause of secondary infections with virus and bacteria due to the skin lesion they produce (Woo & Shariff 1990). *Odontesthes bonariensis* is very susceptible to *Lernaea* sp, being one of the reasons for failure of its introduction in other countries (Hepher & Pruginin 1991). On the other hand, *O. bonariensis* seems less susceptible to *Argulus* sp, due to the fact that in Case 21, the registered prevalence was 3.5% compared to 100% obtained in catfish *Rhamdia quelen*. Prevalence, abundance and medium intensity of *Lernaea* sp had bigger seasonal occurrence during warm months. Similar observations were reported by Marcogliese (1991), even though, some cases beneath 20°C were found. The prevalence in Cases 5 and 7 were 85.1 and 95.0%, with an average intensity of 3.9 and 5.1 copepods per fish.

Aeromonas hydrophila can cause extensive mortality among aquacultured ecotherms with significant economic loss

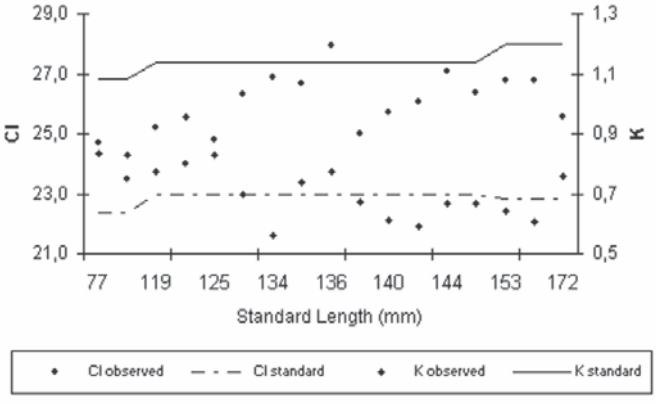
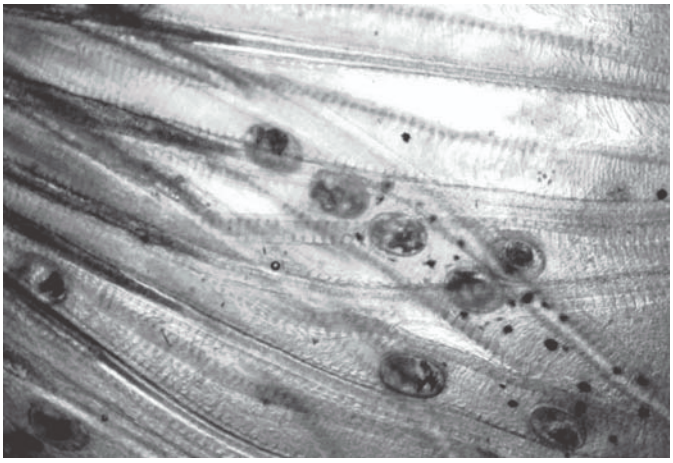
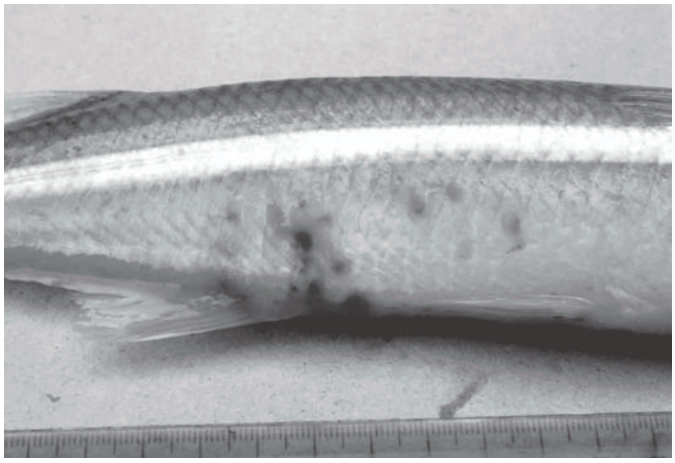


Fig.3. Cephalic index (CI) and condition factor (K) observed with presence of *Contracaecum* sp and standard values of *Odontesthes bonariensis* (Case 9).



4



5

6

Fig.4. Wet mount of a heavy Trematode infestation of pejerrey gills (Case 12).

Fig.5. *Aeromonas hydrophila* skin infection (Case 7).

Fig.6. Acute mortality by inadaquate water quality (Case 18).

(Amborski et al.1984, Yesmin et al. 2004). This species was isolated frequently in water of the studies dams (Mancini et al. 2003). *Lernaea* sp can cause severe fin damage (Piasecki et al. 2004). In this study, the association between *A. hydrophila* and *Lernaea* sp was observed. Lesions were usually located at the fin's base, where the crustaceans were observed strongly attached through its anchor-like process, with the presence of a characteristic ulcer with red spots, external haemorrhages of diffuse character and presence of septicaemia (Fig.5). In general, fish were aesthetically not pleasant for consumption. In relation to clinical pathology, and according to the evaluated signs, most of the cases were evident in ulcerous and chronic forms (Mancini 1997).

Water quality plays an important role in the occurrence of some pathologies. Physical and chemical water variables, as well as algal blooms may be the main cause of death. Many of the registered diseases, specially the ones with high mortality index, had among their causes environmental stress. Gómez (1998) established for pejerrey a value of incipient lethal pH level at 10.4, with a mean mortality rate of 11.3. High temperatures and pH, as well as the presence of algal blooms, were the origin of numerous *O. bonariensis* deaths (Fig.6). In shallow pampean lakes, disbalances of dissolved oxygen and the status of ionization and toxicity of some chemicals such as hydrogen sulfide and ammonia, could be the main mechanisms involved in the pathogenesis of massive fish deaths (Mariñelarena 2000). High pH values increases unionized ammonia concentrations (Branson1993), being frequent in eutrophic lakes with high temperatures.

The characteristics of high eutrophicated environments, occurrence of Cyanobacteria and oxygen depletion, also produce massive death of *O. bonariensis* in summer and autumn, in natural and artificial lakes in Chile (Vila, personal commun.*)*. As observed, high algal density produces important oxygen disbalances, supersaturation at sunset and very low values at sunrise (Boyd, 1984). The later situation was observed in several cases along with dead fishes presenting their mouths open and flared opercula, signs that suggest oxygen depletion (Noga1996). Similar observations were reported in other environments of Argentina, matching with cyanobacterial bloom (Grosman & Sanzano 2002). In many cases, the situation was aggravated due to low atmospheric pressure and high temperatures, which caused a lower amount of dissolved oxygen (Arredondo Figueroa & Ponce Palafox 1998). In Case 18, mortality reached its highest levels in days with temperatures of 37.6°C and atmospheric pressures of 716.9mm Hg (normal for the region: 721.9mm Hg).

Infection with *Saprolegnia* sp was one of the few cases registered in winter months. Mortality was moderate, while prevalence was 100%. The fishes had fluffy mass, mostly in the gills, reaching outside the operculum, and an important breathing difficulty. This etiology, associated with infection with *A. hydrophila* has been described for *O. bonariensis* in other countries (Lawhavinit et al. 1986).

In several cases, fishes showed a high abundance of *Proteocephalus* sp in their intestinal content, but were not included among the etiological primary agents due to its low pathogenicity in many species (Reichenbach-Klinke 1982, Garcia Romero 2001).

In conclusion, the outbreaks in wild populations of *O. bonariensis* are produced mainly during high temperature seasons and Cyanobacteria and Dinoflagelates blooms. The risk is greater at or above 25°C. *Odontesthes bonariensis* is very susceptible to infections with *Lernaea* sp. Most cases are common in warm months and they often carry complications produced by regular water flora microorganisms. *Lernaea* sp affects fish aesthetically for consumption. With regards to public health, the role played by *Contracaecum* larvae and *A. hydrophila* is remarkable within the zoonosis.

The high trophic state of Argentine's central region shallow lakes and dams produces important and complex variations in physical and chemical water characteristics. These variations are the cause of *O. bonariensis* massive deaths, increasing, in many cases, the presence of other pathological agents due to environmental stress. Considering its importance, it is necessary to implement further studies of water chemical variations along the different seasons, and its relation with the pathological agents described in this report.

Acknowledgments.- We would like to acknowledge the Secretary of Science and Technology of the National University of Río Cuarto. We thank Liliana Semenas and Verónica Flores (Centro Regional Universitario Bariloche) for the identification of some parasitic agents, and also Héctor Gonzalez Quintana for his cooperation with the histological procedures.

REFERENCES

Alvarez Pellitero P. 1988. Enfermedades producidas por parásitos en peces, p.215-326. In: Espinosa J. & Ubarta U. (ed.) Patología en Acuicultura. Editora Mundi Prensa, Madrid.

Amborski R., Borall R. & Thune R. 1984. Effects of short-term cold storage on recoverry of proteases from extracellular products of *Aeromonas hydrophila*. Appl. Environ. Microbiol. 48(2):456-458.

APHA 1992. Standard Methods for the Examination of Water and Wastewater. 18th ed. American. Public Health Association, Washington, DC.

Arredondo Figueroa J. & Ponce Palafox J. 1998. Calidad de Agua en Acuicultura: conceptos y aplicaciones. AGT Editora, México.

Austin B. & Austin D. 1989. Methods for the Microbiological Examination of Fish and Shellfish. Ellis Horwood Ltd, Chichester, West Sussex, England.

Barja J. & Estevez-Toranzo A. 1988. Enfermedades bacterianas de peces, p.475-550. In: Espinosa J. & Ubarta U. (ed.) Patología en Acuicultura. Editora Mundi Prensa, Madrid, Espanha.

Blanch A. 1988. Técnicas diagnóstico en enfermedades de peces, p.391-428. In: Espinosa J. & Ubarta U. (ed.) Patología en Acuicultura. Editora Mundi Prensa, Madrid, Espanha

Bonetto C. & Castello H. 1985. Pesca y Piscicultura en Aguas Continentales de América Latina. OEA, Secretaria General, Washington, DC., USA.

Boyd C. 1984. Water Quality Management for Pond Fish Culture. Elsevier Scientific Publ. Co., Amsterdam, Netherlands.

Branson E. 1993. Environmental Aspects of Aquaculture, p.57-67. In: Brown L. (ed.) Aquaculture for Veterinarians, Fish Husbandry and Medicine. Pergamon Veterinary Handbook Series, Pergamon, Great Britain.

Bustamante M., Granero M., Bonetto M., Morillo, S. & Lopez F. 2002. The rol of nutrients, physical processes and climatological factors on cyanophytes and dinoflagellates summer blooms. 4th Int. Conf. on Reservoir Limnology and Water Quality, Eeske Budijovia, Czech Republic, p.58-61.

Collins R. 1993. Principles of diseases diagnosis, p.69-90. In: Brown L. (ed.) Aquaculture for Veterinarians, Fish Husbandry and Medicine. Pergamon Veterinary Handbook Series, Pergamon, Great Britain.

Escalante A. 2001. Alimentación natural del pejerrey, p.67-75. In: Grosman F. (ed.) Fundamentos Biológicos, Económicos y Sociales para una Correcta Gestión del Recurso Pejerrey. Editora Astyanax, Azul, Buenos Aires, Argentina.

Freyre L. 1976. Normas para la Inspección y Determinación de Ambientes Pesqueros Pampásicos. Dir. Rec. Nat. Min. Asuntos Agrarios, La Plata, Argentina.

Garcia Romero N. 2001. Alteraciones patológicas del pejerrey *Odonthestes bonariensis* em ambientes naturales y bajo condiciones de cultivo. Revisión. In: Grosmann F. (ed.) Fundamentos Biológicos, Económicos y Sociales para una Correcta Gestión del Recurso Pejerrey. Editora Astyanax, Buenos Aires, Argentina.

Gómez S. 1998. Niveles letales de pH en *Odontesthes bonariensis* (Atheriniformes, Atherinidae). Iheringia, Sér. Zool. 85:101-108.

Grosman F. & Mancini M. 2001. Alcances socioeconómicos de la pesca deportiva de pejerrey (*Odontesthes bonariensis*). Realidad Económica 184:106-121.

Grosman F. & Sanzano P. 2002. Mortandad de pejerrey *Odontesthes bonariensis* originados por floraciones de cianofíceas en dos ambientes de Argentina. AquaTIC 17:1-14.

Hepher B. & Pruginin Y. 1991. Cultivo de Peces Comerciales. Editora Limusa, Mexico.

Iwaszkiw M. & Freyre L. 1980. Fecundidad del pejerrey *Basilichthys bonariensis* (Pisces, Atherinidae) del embalse Rio Tercero, Cordoba. Limnobios 2(1):36-49.

Lawhavinit O., Hatai K. & Kubota S. 1986. Studies on fungus diseases of pejerrey, *Odontesthes bonariensis* C.&V. I. *Aeromonas hydrophila* isolated from pejerrey with saprolegniasis. Bull. Nippon. Vet. Zootech. Coll. 35:135-140.

López H. & García M. 2001. Aspectos históricos e importancia regional del pejerrey bonaerense, p.15-20. In: Grosmann F. (ed.) Fundamentos Biológicos, Económicos y Sociales para una Correcta Gestión del Recurso Pejerrey. Editora Astyanax, Azul, Buenos Aires, Argentina.

Mancini M. 1997. Rol de la bacteria *Aeromonas hydrophila* en Ictiopalogía. Revta Med. Vet., B.Aires, 78(6):380-387.

Mancini M., Larriestra, A. & Sanchez J. 2000. Estudio ictiopatológico en poblaciones silvestres de la región centro-sur de la provincia de Córdoba, Argentina. Revta Med. Vet., B.Aires, 81(2):104-108.

Mancini M., Rodriguez C., Prosperi C. & Finola M. 2003. Monitoreo de reservorios del centro de Córdoba (Argentina) como base para una adecuada gestión ambiental. In: XIII Congreso Argentino de Saneamiento y Medio Ambiente, Buenos Aires, p.1-19.

Marcogliese D. 1991. Seasonal occurrence of *Lernaea cyprinacea* on fishes in Belews Lake, North Carolina. J. Parasitol. 77(2):326-327.

Margolis L., Esch G., Holmes C., Kuris M. & Schad A. 1982. The use of ecological terms in Parasitology. J. Parasitol. 68(1):131-133.

Mariñelarena A. 2000. Efectos secundarios de la eutrofización en las lagunas pampeanas. I Jornada sobre Ecología y Manejo de Ecosistemas Acuáticos Pampeanos. Junín, Buenos Aires, Argentina.

Moeller R 2001. Diseases of Fish. California. Available in: www.afip.org/CLDavis/GrossCourse0.1/fish.htm.

Moravec F., Kohn A. & Fernandes B. 1993. Nematode parasites of fishes of the Paraná River, Brazil. Part 2. Sueuratoidea, Ascaridoidea, Habranematoidea and Acuarioidea. Folia Parasitol. 40:115-134.

Noga E. 1996. Fish Disease. Diagnosis and Treatment. L. Duncan (ed.), Mosby-Year Book Inc., St Louis, Missouri, USA. 367p.

Quirós R., Renella A., Boveri M., Rosso J. & Sosnovsky A. 2002. Factores que afectan la estructura y funcionamiento de las lagunas pampeanas. Ecología Austral 12:175-185.

Piasecki W., Goodwin A., Eiras J. & Nowak B. 2004. Importance of Copepoda in freshwater aquaculture. Zoological Studies 43(2):193-205.

Prosperi C. 1994. A cyanophyte capable of fixing nitrogen under high levels of oxigen. J. Physiol. 30(2):222-224.

Reichenbach-Klinke H. 1982. Enfermedades de los peces. Editora Acribia, Zaragoza, Espanha.

Saint-Paul U. 1986. Potential for aquaculture of South American freshwater fishes: a review. Aquaculture 54:205-240.

Streble H. & Krauter D. 1987. Atlas de los Microorganismos de Agua Dulce. Editora Omega, Barcelona, Espanha.

Woo P. & Shariff M. 1990. *Lernaea cyprinacea* L. (Copepoda: Caligidea) in *Helostoma temmincki* Cuvier and Valenciennes: the dynamics of resistance in recovered and naive fish. J. Fish Dis. 13:485-493.

Yesmin S., Rashman M., Afzal Hussain M., Kahn A., Pervin F. & Hossain M. 2004. *Aeromonas hydrophila* infection in fish of swamps in Bangladesh. Pakistan J. Biol. Sciences 7(3):409-411.