(Holliman *et al.*, 1991). In both these cases the condition was accompanied by yellow color or yellow nodules in the vicinity of the lesions and a *Cytophaga* like bacterium was isolated from the diseased fish (Hilger *et al.*, 1991, Holliman *et al.*, 1991). Jaw erosion in pike (*Esox lucius*) was reported from Finland already in 1896. According to the author the initial symptoms of this disease too, was yellow color at the tip of the jaws. In the final stage the bones of the jaws were exposed (Anon., 1896). Neither yellowish color of affected tissues nor isolates of *Cytophaga* like bacteria were recorded in affected fish in the present investigation, thus indicating an etiology different from that suggested for the diseases in cod (Hilger *et al.*,. 1991) and rainbow trout (Holliman *et al.*, 1991).

The etiology behind the jaw erosion syndrome in smelt in the present investigation is unknown. However, the severity of the disease signs suggest that this disease most probably is lethal to the affected fish. An explanation to the extremely high prevalences observed (~50%) in some samples from one site might be a changed migration pattern of affected fish, i.e. that affected fish remain stationary and do not migrate with the schools of unaffected fish. A similar behavior has been described for cod affected by skeletal deformities (Möller, 1984).

Summary

During a study of fish diseases along the Finnish west coast in 1988 and 1989, a previously unrecorded disease affecting the lower jaw of smelt, *Osmerus eperlanus*, was observed. The disease was characterized by fissure of the two bones forming the lower jaw, with subsequent swelling of the jaw tip. The final disease symptoms included a complete erosion of the soft tissue exposing the bone tissue. The disease was observed in fish from 5 sites out of 11 examined. The highest disease prevalences were recorded in sites receiving heavy pollution from industries and human settlement. So far unidentified Gram positive rods were isolated from diseased specimens.

Author's Address

Institute of Parasitology, Åbo Akademi University, BioCity, Artillerig. 6, 20520 Åbo, Finland.

Acknowledgements

The authors are grateful to Inger Böckerman, Staffan Eklöw, Barbro Nyström and Diana Toivola for skillful technical assistance. The study was financed by the Ministry of Agriculture and Forestry, and the Ministry of Environment.

References

Anacker, R. L. and Ordal, E. J. (1959). Studies on the myxobacterium *Chondrococcus columnaris*. 1. Serological typing. *J. Bacteriol.* **78**, 25-32.

Anders, K. and Möller, H. (1987). Food-induced granulomatosis in European smelt, *Osmerus eperlanus*. *Can. J. Fish. Aquat. Sci.* **44**, 1848-1854.

Anon. (1896). Fiskepidemi. *Fiskeritidskrift för Finland* **5**, 146.

Bullock, G. L. (1971). The identification of fish pathogenic bacteria. In: *Diseases of fishes* (Snieszko, F. and Axelrod, R. Eds.), Book 2B: p. 29. T.F.H. Publications, Jersey City.

Cowan, S. T. (1974). *Cowan & Steel's manual for the identification of medical bacteria*. 2nd edn. Cambridge University Press, Cambridge

Hilger, I., Ullrich, S. and Anders, K. (1991). A new ulcerative flexibacteriosis-like disease ('yellow pest') affecting young Atlantic cod *Gadus morhua* from the German Wadden Sea. *Dis. aquat. Org.* **11**, 19-29.

Holliman, A., Austin, B. and Pottinger, T. G. (1991). A previously unrecognized *Cytophaga*-like bacterium (CLB) causing jaw erosion in farmed rainbow trout (*Oncorhynchus mykiss*). *Bull. Eur. Ass. Fish Pathol.* **11**, 114-115.

Lee, S. and Whitfield, P. J. (1992). Virus associated spawning papillomatosis in smelt, *Osmerus eperlanus* L., in the River Thames. *J. Fish. Biol.* **40**, 503-510.

MacFaddin, J. F. (1983). *Biochemical tests for identification of medical bacteria*, 2nd edn. Williams & Wilkins, Baltimore.

Möller, H. (1981). Fish diseases in German and Danish coastal waters in summer 1980. *Meeresforsch.* **9**, 1-16.

Möller, H. (1984). Dynamics of fish diseases in the lower Elbe river. *Helgoländer Meeresunters.* **37**, 389-413.

Pohl, C. (1990). Skeletal deformities and trace metal contents of European smelt, *Osmerus eperlanus*, in the Elbe Estuary. *Meeresforsch.* **33**, 76-89.

MARTEILIA REFRINGENS IN MUSSEL (*MYTILUS GALLOPROVINCIALIS* LMK.) BEDS IN SPAIN

BY J. A. F. ROBLEDO, J. CÁCERES-MARTÍNEZ & A. FIGUERAS.

Protozoan parasites of the genus *Marteilia* (Protozoa, Ascetospora) have been found in a number of different mollusc species of commercial importance (Comps, 1970; Grizel *et al.*, 1974; Wolf, 1976). Since 1968 *M. refringens* (Grizel *et al.*, 1974) has caused serious and recurrent mortalities in the flat oyster (*Ostrea edulis*) in Europe (Alderman, 1979). The occurrence of different stages of a *Marteilia* sp. has been described in mussels from Galicia and only recently the species affecting mussels from this area has been identified as *M. refringens* (Villalba *et al.*, 1993). Our studies with the Transmission Electron Microscope lead us to identify the Marteilia from mussels in the Ría de Vigo as *M. refringens*, although a comparative (biochemical, genetic and experimental infections) is urgently needed to solve this important question for the development of European molluscan culture. Although Spain is the largest producer of cultured mussels in the world (Figueras, 1989), in decades of culture, no mass mortalities had been recorded in cultured mussels from Galicia (Figueras *et al.*, 1991). Most of the literature about *M. refringens* in mussels refers to cultured mussels (Gutiérrez, 1977; Figueras *et al.*, 1991). There is a lack of information about this parasite in natural mussel beds, despite these being the main source of mussel spat for culture and that mussel culture is carried out close to the natural mussel beds.

In this study we present the prevalence of *M. refringens* le *Mytilus galloprovincialis* from natural mussel beds and from culture rafts in the inner and outer areas of the Ría

Table 1. Numbers of infected and uninfected mussels on R, Rafts, and MB, Mussel Beds in Galicia. NE: Number examined, NI: Number infected, Prev.: Prevalence. *G*-test of independence with contingency tables was used to compare the presence of parasites at San Adrián (R) and San Adrián (MB) gave no significance at $P>0.05$)

	San Adrián (R)		S. Adrián (MB)		Liméns (R)		Cabo Home (MB)	
Date	NE/NI	Prev.	NE/NI	Prev.	NE/NI	Prev.	NE/NI	Prev.
Nov-1991	-	-	30/8	26.67	-	-	30/0	0.00
Dec-1991	30/2	6.67	30/0	0.00	29/0	0.00	23/0	0.00
Jan-1992	30/4	13.33	30/4	13.33	30/0	0.00	28/0	0.00
Feb-1992	26/3	11.54	28/5	17.86	26/0	0.00	28/0	0.00
Mar-1992	-	-	30/5	16.67	-	-	24/0	0.00
Apr-1992	-	-	30/6	20.00	-	-	24/0	0.00
Oct-1992	-	-	29/4	13.79	30/0	0.00	30/0	0.00
Nov-1992	27/4	14.81	29/5	17.24	-	-	30/0	0.00
Dec-1992	24/1	4.17	30/1	3.33	30/0	0.00	30/0	0.00
Jan-1993	29/2	6.90	29/3	10.34	23/0	0.00	-	-
Feb-1992	26/0	0.00	30/6	20.00	-	-	-	-

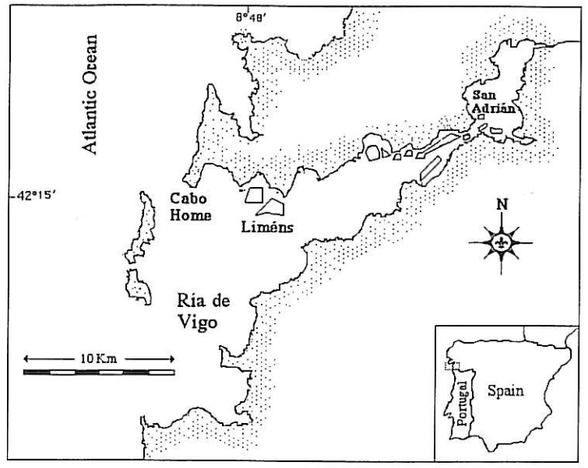

Figure 1. Map showing the mussel beds (Cabo Home and San Adrián) and rafts (Liméns and San Adrián) where mussels were collected.

de Vigo.

Materials and methods

Between late 1991 and early 1993, adult mussels (*Mytilus galloprovincialis*) were collected from mussel beds in San Adrián, Cabo Home and from the floats of the rafts placed in areas close to the mussels beds (Fig. 1). The animals were processed for histology following the usual protocols.

Results and Discussion

Parasites were present in the epithelial cells of the stomach (plasmodia) and in the epithelial cells of the primary and secondary digestive tubules (plasmodia and sporangia). These stages did not differ from those reported by other authors for this host and area (Figueras *et al.*, 1991; Villalba *et al.*, 1993). The prevalence of *Marteilia refringens* varied depending on the site from which the mussels were sampled (Table 1). The protozoan was present in all samples taken from rafts and natural mussel beds in San Adrián. The results of the *G*-test for independence showed that the presence of *M. refringens* was not influenced by the location (natural mussel beds or rafts) (df=1, n=438, *G*=0.998 Not Significant). In mussels from Liméns and Cabo Home *M. refringens* was not detected at all.

Figueras *et al.* (1991) and Villalba *et al.* (1993) recorded higher prevalence of *Marteilia* in cultured mussels located in the inner part than in the outer part of the Ría de Arosa. They suggested the occurrence of a gradient in the prevalence of *Marteilia* from the inner to the outer areas of the Ría. Our results confirm this gradient for the Ría de Vigo. If the infection depends on a chance encounter between the parasite and the host, one reason for this gradient could be the higher density of cultured mussels in the inner part of the Ría that decreases towards to the outer part.

We did not find differences between mussels taken from mussel beds where they are exposed to tidal cycles and mussels taken from rafts where they are submerged permanently, suggesting that this factor has no influence in the prevalence of the parasite.

Mussel culture commences when farmers collect mussel spat, mainly from the natural mussel beds. The present study records the presence of *Marteilia refringens* in mussel beds; which means that young mussels are exposed to the parasite early in their lives, although the spat of mussels under 22mm in total length is almost free of *Marteilia* (only 2.5% were parasitised). Moreover, mussels from natural beds will contribute to the total load of parasites present in the environment. It could be valuable to find mussel beds free of *Marteilia* and to monitor if their use by the mussel growers contributes to a reduction in the prevalence of the parasite in the mussel rafts. In conclusion, it is quite important to study the pathology of mussels from natural beds located close to culture areas.

Summary

The prevalence of *Marteilia refringens* parasitising *Mytilus galloprovincialis* from natural beds in Ría de Vigo (NW Spain) was monitored for one year. Individuals taken from the inner part of the Ría were the only ones to be found to be infected, ranging between 3.33 and 26.67%. Mussels from the outer part of Ría were *M. refringens*-free.

Author's address

Instituto de Investigaciones Marinas-CSIC, Departamento de Biología y Patología de Organismos Marinos, Eduardo Cabello 6, 36208 Vigo, Spain.

Acknowledgements

We thank J. R. Caldas, I. Loureiro and H. Álvarez for providing technical assistance for histological technical. We also thank the mussel farmers Mr. R. Currás and Mr. L. Rosales for providing the rafts where experiments were carried out. J. A. F. Robledo acknowledges the Xunta de Galicia, Spain, for his research fellowship in the IIM-CSIC. J. Cáceres-Martínez acknowledges CONACyT for his research fellowship in the IIM-CSIC.

References

Alderman, D. J. (1979). Epizootiology of *Marteilia refringens* in Europe. *Mar. Fish. Rev.* **41**,. 67-69.

Comps, M. (1970). Observations sur les causes d'une mortalité anormale des huîtres plates dans le bassin de Marennes. *Rev. Trav. Inst. Pêches Marit.* **34**(3), 316-326.

Figueras, A. J. (1989). Mussel culture in Spain and France. *World Aquac.* **20**(4), 8-17.

Figueras, A., J, Jardón, C. F. and J. R.Caldas. (1991). Diseases and parasites of rafted mussels (*Mytilus galloprovincialis*): preliminary results. *Aquaculture*. **99**, 17-33.

Grizel, H., Comps, M., Bonami, J. R., Cousserans, F., Duthoit, J. L. and Le Pennec, M. A. (1974). Recherche sur l'agent de la maladie de la glande digestive de *Ostrea edulis* Linné. *Bull. Institut Pêches Marit.* **240**, 7-30.

Gutiérrez. (1977). Nota sobre marteiliasis en el mejillón *Mytilus edulis* (L.), de la costa Noroeste de España. *Invest. Pesq.* **41B**, 637-642.

Villalba, A, Mourelle, S. G., Carballal M. J., López, M. C and Azevedo, C. (1993). Marteiliasis affecting cultured mussels *Mytilus galloprovincialis* of Galicia (NW Spain). I. Etiology, phases of the infection, and temporal and spatial variability in prevalence. *Dis. aquat. Org.* **16**, 61-72.

Wolf, P. H. (1976). Life cycle and ecology of *Marteilia sydneyi* in the Australian oyster, *Crassotrea commercialis*, *Mar. Fish. Rev.* **41**, 70-72.