Evaluating the impact of extensive clam culture on the biodiversity of coastal lagoons in Morocco

OUALIDIA LAGOON

MOULAY BOUSSELHAM LAGGON

BY

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FOR

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Summary

The high market demand for the carpet-shell clams in Europe and their resultant over exploitation have induced a drastic decrease of natural stocks and to certain degree their extinction in the coastal wetlands of Morocco. National and international development agencies are encouraging the local fisherwomen to implement small scale and extensive clam culture programmes so that natural stocks can be restored and exploited in a sustainable manner. The present project was implemented to evaluate the impacts of such extensive clam culture operations on the biodiversity and the functioning of two lagoons in Morocco and will recommend measures to regulate such operations for the safeguard of the environment.

A 1½ year filed experiment conducted in the lagoons of Oualidia and Moulay Bousselham to collect data on the biodiversity of these wetlands culture. It gives an account major species occurring in culture and fallow grounds at theses sites. Several public awareness meetings were organised to create sensibleness among the local communities for the safeguard and sustainable exploitation of Moroccan wetlands.

During the period of observation (May 2004 to December 2005), the growth of the clam was important for both techniques of culture (direct plantings and net protected culture) with higher growth rates for small clams. Morality rates for the small, mean and large clams were 18%, 12%, 10% respectively in the case of the direct seedling and 11%, 10.92%, 8% in the case of the net protected culture.

The macrofaune registered in the two survey zones of Oualidia and Moulay Bousselham consisted of four taxonomical groups: mollusca, crustacean, polychaeta, and cniderea. In the lagoon of Oualidia, these groups were found at proportion of 69%, 19%, 6% and 6% respectively in culture plots and 59%, 26%, 6% and 9% in control plots. In the lagoon of Moulay Bousselham, they were found at proportion of 77%, 26%, 6% and 0% respectively in culture plots, and 76%, 26%, 4% and 4% respectively in control plots. The macroflore in the two lagoons is made up in general of about fifteen species belonging to three big classes: the Rhodophycaes, the Phéophycaes, the Chlorophycaes, and eel-grass (Zostera nana), and this latest being highly predominant in culture plots.

The particle content and the organic content did not show any noticeable changes due to culture operations. Short term sedimentation rates on the netted plot were up to five times higher than the fallow grounds. The nettings encouraged the settlement of Ulva species, which in turn attracted several gastropods to feed on these grounds. Culture grounds with net protection have greater abundance of deposit feeding polychaetes.

The most important effect appears to be the increased sedimentation rate over plots with net protected culture and the accumulation of macrophytes from spring to autumn.

I. INTRODUCTION

The author has been granted funding from The Rufford Maurice Laing Foundation through its Grant awarding programme namely the Rufford Small Grants for Nature Conservation (RSGs). The project is intended for a period of 18 months and has been awarded during the month of March 2004 to study the impacts of extensive calm culture operations in Moroccan lagoons and to implement public awareness programmes dealing with Nature conservation in Morocco. The present report gives an account of all the research and development activities carried out during the period from June 2004 to December 2005.

Morocco possesses two coastlines, one along the Atlantic Ocean, extending up to 3000 km long and another along the Mediterranean Sea, up to 500 km long (Fig. 1). Along these coastlines, there are several coastal wetlands that are being exploited by local fishing communities for clam harvest. One of the commercially important species is the carpet-shell clam *Ruditapes decussatus*. The high market demand for the carpet-shell clams in Europe and their resultant over exploitation have induced a drastic decrease of natural stocks and to certain degree their extinction in the coastal wetlands of Morocco. National and international development agencies are encouraging the local fisherwomen to implement small scale and extensive clam culture programmes so that natural stocks can be restored and exploited in a sustainable manner. The present project was implemented to evaluate the impacts of such extensive clam culture operations on the biodiversity and the functioning of two lagoons in Morocco and will recommend measures to regulate such operations for the safeguard of the environment.

II. MATERIALS AND METHODS

II.1. Study sites

A hectare wide culture and fallow grounds were selected in 2 lagoons on the Atlantic coast: Oualidia Lagoon (Fig. 2: situated between El Jadida and Safi) and Moulay Bousselham Lagoon (Fig. 3: situated between Larache and Kénitra). Both these lagoons are of great biological interest: the latter is a protected site under Ramsar convention and the former is being exploited by fisherwomen for net protected clam culture. The selected sites were comprised of stable muddy sand sediment, and were situated near low water of springtides (LWST) on intertidal grounds where the experimental plots were exposed for 3 to 6 hours during spring tides.

Fig.1: Map of Morocco Showing the coastlines

Fig.2: Localisation of Moulay Bousselham Lagoon (also called as Merja Zerga)

Fig.3: Localisation of Oualidia Lagoon

II.2. Preparation of culture sites

An experimental approach was adapted to evaluate the possible impacts of extensive clam culture on the sediment composition and composition of the benthic community of two lagoons on the Moroccan Atlantic coast. In extensive culture operations, the clam seeds were covered by nylon nettings (in the form large buried

bags of 2 to 3 m² size) to protect them against predation by gastropods, crabs and other animals. The nettings had 8 mm mesh apertures. Avenues of 1-m wide, for access as walkways for sampling and harvest, were left around the perimeters of each plot. A further set off control plots without clams or net covers was established nearly 100 m away from the culture plots in each lagoon.

Carpet-shell clams normally reach a commercial size of 30 mm within two years; however large size clams measuring more than 35 mm may take up to 3 years. They are harvested by hand-ranking the sediment. The harvest in each bag is completed by washing them in lagoon waters to cleanse off all the sediments inside the bag so that clams can be collected rapidly. During the period of this study (1½ years), the physical and biological variables of the sediments were monitored in control as well as culture plots. The nature of certain culture grounds just after harvest has also been studied. This paper also describes some of the changes that occurred in the culture grounds early in the cultivation cycle before the clams had reached commercial sizes.

Fig. 4 : Clam culture grounds

Fig. 5 : Washing net bags in lagoon waters to recover remaining clams

II. 3. Biodiversity studies:

Samples were collected regularly to study the impacts of culture changes in macroflora and macrofauna on these sites. The nets were brushed off accumulated silt and flora and fauna. Macrophytes such as *Ulva* developed actively over the nets from April to October. Infauna, cultured clams and other components of the soil were sampled, 4 times per year covering all the seasons. The observations and further laboratory analyses included:

1. Particle content of the sediment
2. Organic content of the sediment
3. Epiphytes over the netting
4. Epifauna over the netting
5. Infauna in the sediments

III. RESULTS

III. 1. Clams

Mean Growth rate of carpet shell clams at the two sites are shown in Fig. 4. The blue line indicates the growth of clams inside netted plots while the red line indicates the growth in unprotected plots (without net coverings). Mortality rates of clams are shown in Fig. 5.

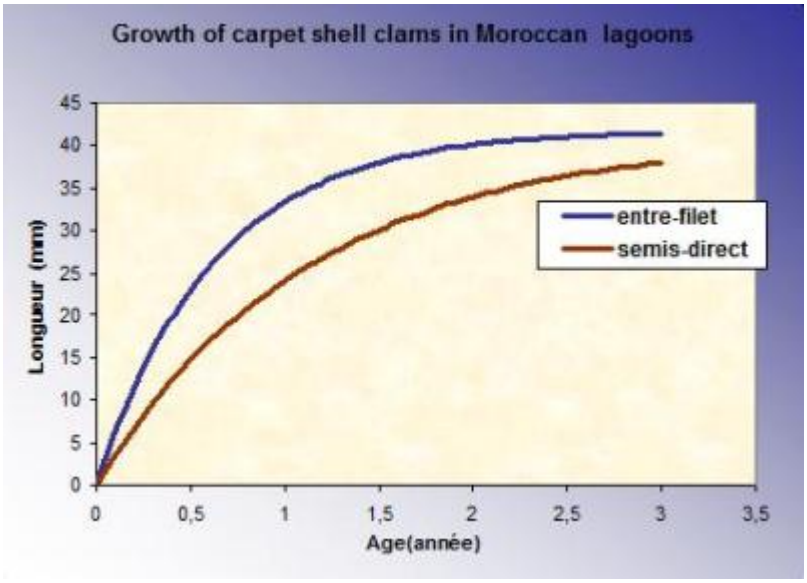


Fig. 4: Growth of clams; Blue Line: Net protected, Red line: unprotected

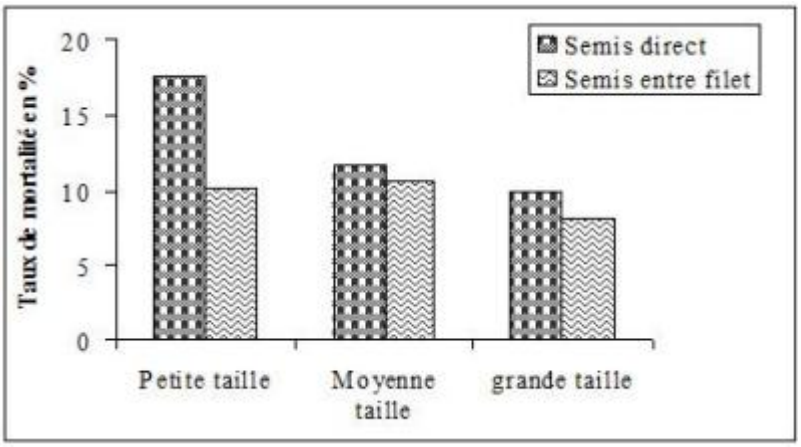


Fig. 5: Mortality rates of different size clams

III. 2. Sediments

The particle contents of the two lagoons are shown in Fig. 6 and Fig. 7. The organic content of the sediments at different plots did not vary significantly: 1.4 % to 2.2 % in the two lagoons.

Fig.6 : Particle content of the sediment (Oualidia Lagoon)

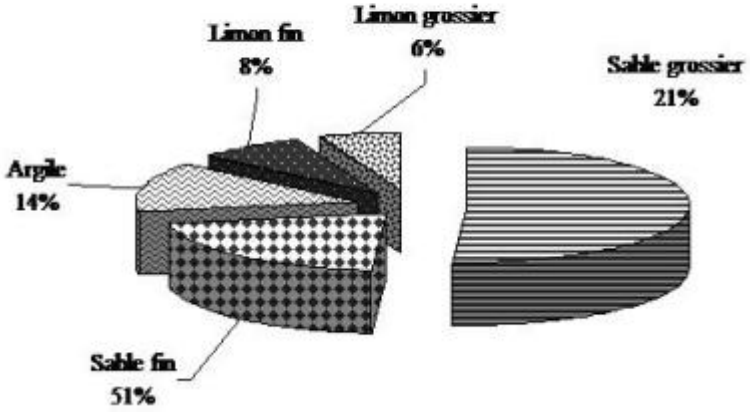
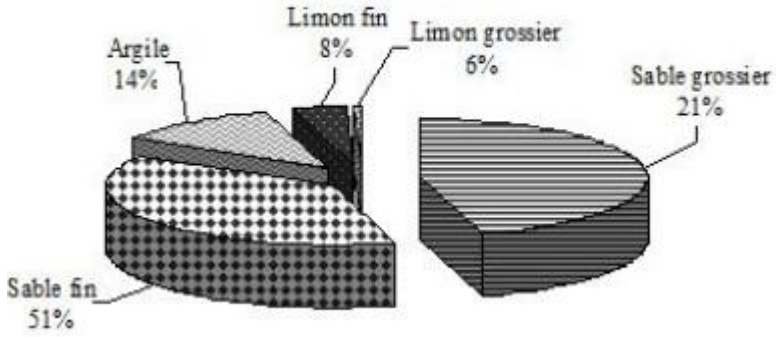


Fig.7: Particle content of the sediment Moulay Bousselham Lagoon



III. 3. Biodiversity

III. 3. 1. Oualidia Lagoon

Fig. 8: Biodiveristy in culture plots

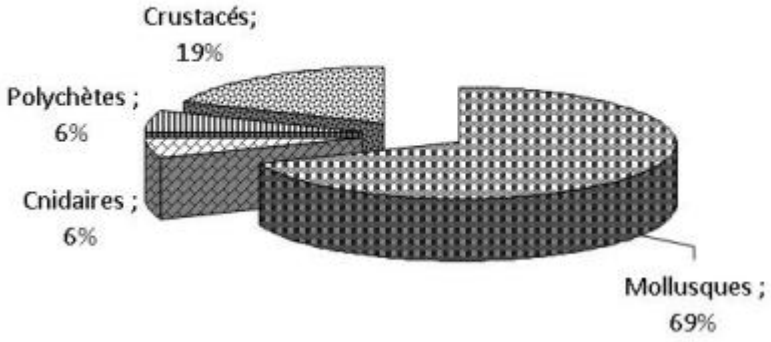
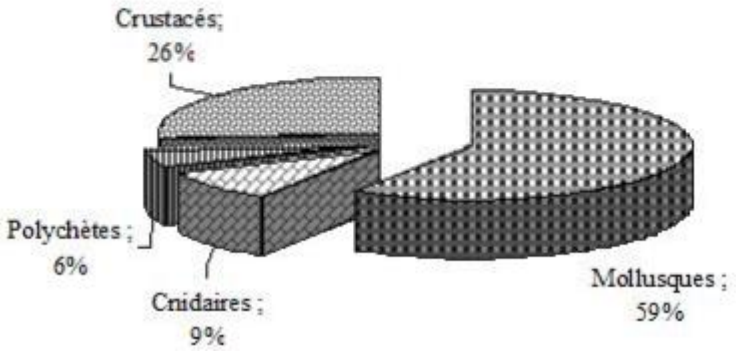


Fig. 9: Biodiversity in fallow grounds



III. 3. 2. Moulay Bousselham Lagoon

Fig. 10: Biodiveristy in culture plots

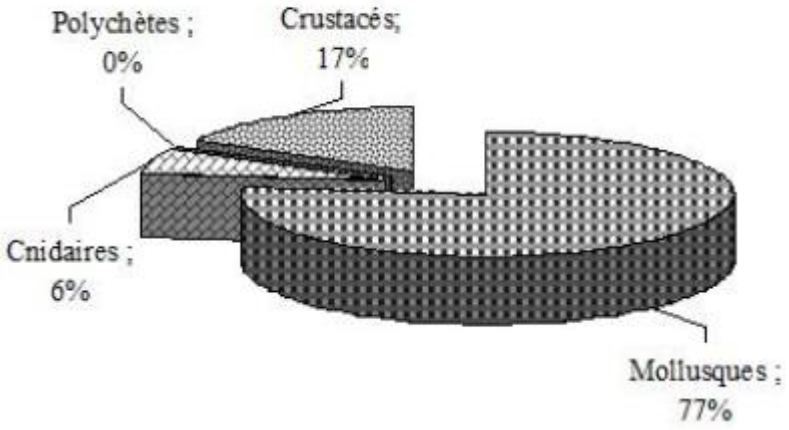


Fig.11: Biodiversity in fallow grounds

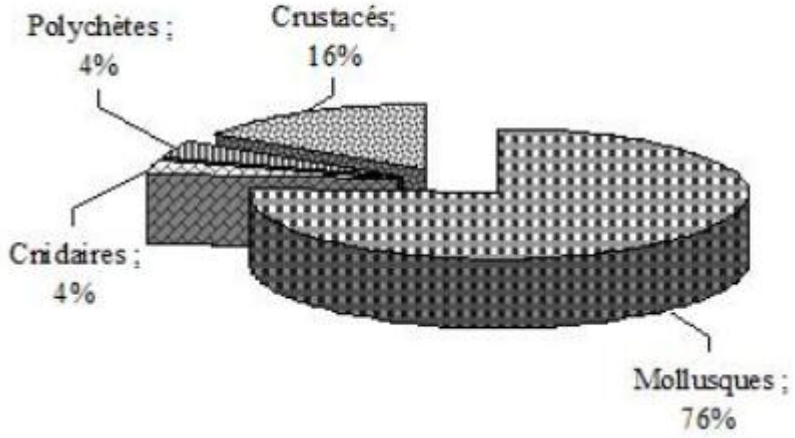


Table 1 : Macrofauna encountered in culture grounds of **Oualidia lagoon (ind/m²)**					
	N	Min	Max	Moyenne	Ecart type
Gibbula philberti	7	20	63	46,14	14,80
Monodonta crassa	7	10	60	23,57	16,76
Monodonta lineata	7	5	38	19,71	11,71
Ocenebra trunculus	7	0	10	3,57	4,76
Nassarius reticulatus	7	0	20	4,29	7,32
Cerithium vulgatum	7	0	10	5,00	5,00
Spheronassa mutabilis	7	185	340	253,57	60,67
Carcinus maenas	7	0	35	16,43	13,45
Aplysia punctata	7	0	5	0,71	1,89
Clibanarius misanthropus	7	15	60	33,57	17,49
Calliactis parasitica	7	0	25	11,43	9,00
Nereis diversicolor	7	0	10	2,14	3,93
Cerastoderma edule	7	25	65	42,86	13,18
Donax variegatus	7	0	5	1,43	2,44
Tellina fabula	7	0	70	33,57	27,80
Scrobicularia plana	7	0	30	12,86	12,20
Ruditapes deccussatus	7	150	235	180,71	32,97

Tableau 2 : Macrofauna encountered in fallow grounds of **Oualidia lagoon (ind / m²)**					
	N	Min	Max	Moyenne	Ecart type
Cerastoderma edule	7	25	60	42,86	11,13
Donax trunculus	7	25	75	41,43	17,25
Ruditapes deccussatus	7	0	20	5,71	7,87
Tellina fabula	7	0	25	7,14	9,06
Dosinia lupinus	7	0	15	6,43	5,56
Scrobicularia plana	7	0	20	6,43	7,48
Ensis siliqua	7	0	10	3,57	3,78
Solen marginatus	7	0	25	12,14	10,35
Gibbula philberti	7	35	75	58,57	14,35
Monodonta crassa	7	20	60	45,00	12,25
Monodonta lineata	7	10	60	34,29	18,58
Ocenebra erinacea	7	0	5	1,43	2,44
Ocenebra trucculus	7	0	15	3,57	5,56
Spheronassa mutabilis	7	150	330	246,43	61,29
Nassarius reticulatus	7	0	10	2,14	3,93
Ocenebra brandarix	7	0	5	1,43	2,44
Cerithium vulgatum	7	10	40	21,43	10,29
Aplysia punctata	7	0	10	2,14	3,93
Idothea balthica	7	0	10	2,14	3,93
Nereis diversicolor	7	0	5	0,71	1,89
Polydora antennata	7	0	10	2,86	3,93
Euspongia officinalis	7	0	25	7,86	8,59
Capitella capitata	7	0	25	5,71	9,32
Carcinus maenas	7	0	25	5,71	9,32
Clibanarius misanthropus	7	35	85	63,57	18,64
Calliactis parasitica	7	0	15	3,57	6,27

Table 3: Macroflora encountered in the lagoons of Oualidia and Moulay Bousselham

Espèces	Classes	Ordres
Hypnea musciformis	Rhodophycées	Gigartinales
Gigartina pistillata	Rhodophycées	Gigartinales
Gigartina teedi	Rhodophycées	Gigartinales
Gélidium sesquipédale	Rhodophycées	Gélidiales
Gélidium spinosum	Rhodophycées	Gélidiales
Gracilaria multipartita	Rhodophycées	Gigartinales
Ulva lactuca	Chlorophycées	Uvales
Enteromorpha clathrata	Chlorophycées	Uvales
Enteromorpha ramulosa	Chlorophycées	Uvales
Fucus spiralis	Phéophycées	Fucales

Table 4: *Macrofauna encountered at the culture grounds of MoulayBousselham Lagoon* ***(ind/m2)***

	N	Min	Max	Moyenne	Ecart type
Cerastoderma edule	7	10	75	43,57	23,22
Donax trunculus	7	0	20	12,86	6,99
Dosinia lupinus	7	0	5	1,43	2,44
Tellina fabula	7	5	70	34,29	26,84
Scrobicularia plana	7	0	20	7,86	6,36
Gibbula philberti	7	20	65	44,29	17,18
Monodonta crassa	7	20	55	35,00	12,91
Littorina penctata	7	0	20	8,57	6,27
Spheronassa mutabilis	7	150	330	246,43	61,29
Littorina neritoide	7	10	30	19,29	7,87
Nassarius reticulatus	7	0	10	3,57	4,76
Cerithium vulgatum	7	5	50	22,14	14,96
Carcinus maenas	7	0	25	9.24	9,05
Clibanarius misanthropus	7	10	65	42,14	19,76
Calliactis parasitica	7	0	10	3,57	4,76
Mediomastus ambiseta	7	0	10	2,14	3,93
Ruditapes deccussatus	7	100	300	200,00	77,73

Table 5 :*Macrofauna encountered a fallow grounds of Moulay Bousselham Lagoon (ind/m2)*					
	N	Min	Max	Moyenne	Ecart type
Gibbula pennanti	7	30	75	52,14	16,04
Monodonta crassa	7	10	60	32,86	17,99
Ocenebra erinacea	7	0	5	0,71	1,89
Phyllonotus trunculus	7	0	10	2,86	3,93
Nassarius reticulatus	7	0	15	6,43	5,56
Cymbium rubiginosum	7	0	5	1,43	2,44
Cerithium vulgatum	7	0	25	10,00	8,16
Natica variabilis	7	0	5	1,43	2,44
Lunatia fusca	7	0	10	2,14	3,93
Littorina penctata	7	10	50	25,00	14,14
Littorina neritoide	7	35	80	60,43	15,04
Spheronassa mutabilis	7	140	259	230,23	59,29
Cerastoderma edule	7	15	60	35,00	15,00
Donax variegatus	7	5	20	8,57	5,56
Solen marginatus	7	0	10	2,14	3,93
Chamelea gallina	7	0	10	2,14	3,93
Tellina fabula	7	0	50	20,71	16,94
Ensis silliqua	7	0	5	0,71	1,89
Scrobicularia plana	7	0	30	12,14	11,13
Dosinia lupinus	7	0	5	2,14	2,67
Carcinus maenas	7	0	5	2,14	2,67
Clibanarius misanthropus	7	25	75	46,43	21,35
Calliactis parasitica	7	25	75	45,71	20,50
Polydora antennata	7	0	5	1,43	2,44
Mitella pollicipes Cornucopia	7	0	5	0,71	1,89
Cymbium rubiginosum	7	0	5	0,71	1,89
Ruditapes deccussatus	7	0	10	2,86	3,93

IV. PUBLIC AWARENESS MEETINGS

Fig. 12 : Meeting with local authorities

Fig. 13 : Meeting with local fisher women

Fig. 14 : Meeting in Research Centres

Fig. 15: Enrolling fisherwomen for attending teaching classes on environment

IV. PUBLIC AWARENESS MEETINGS (CONTINUED)

Fig. 16 :Question and answer section in a classroom

Fig. 17: Video and TV section

Fig. 18: Explaining the biology of clams to fisherwomen

Fig. 18: Some of the participants in teaching sessions

V. CONCLUSION

The net protection given to culture installations enhances the abundance of some species of infauna, but does not seem to have any serious impacts on the biodiversity of the lagoons studied. The slight alterations observed in flora and fauna are due to the increased sedimentation in net protected grounds and the accumulation of macrophytes, mostly *Ulva sp*. Herbivorous gastropods, deposit feeding polychaetes and shore crabs were much more abundant in net protected culture grounds.

Financial Report

Total Amount of Grant Awarded in April 2004: 4900.-£

Expenditure during a 1½ year period

Expenditure items	Amount in £ (1 £ = 15 MDH)
Field works including bimonthly visits to Oualidia and Moulay Bousselham	2500.-£
Laboratory Supplies, chemicals and computer supplies	900.-£
4 Public awareness meetings including refreshments and meals	1400.-£
TOTAL	4800.-£