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EFFECT OF TIME OF FIRST DEPLOYMENT AND DURATION ON THE SUCCESSION OF BENTHIC ORGANISMS ON BIOFILTERS USED TO MITIGATE IMPACT OF FISH FARMS ON WATER QUALITY IN CRETE

Eugenia APOSTOLAKI, Manolis TSAPAKIS, Tatiana TSAGARAKI, Kostantía PAPADOPOULOU
& Ioannis KARAKASSIS

Institute of Marine Biology of Crete, GR-71003 Heraklion, POB 2214

E-mail: jkarak@imbc.gr

ABSTRACT

A total of 18 biofilters were deployed in an open coastal bay of Crete, in order to study the efficiency of biofilters using the locally available fouling communities for mitigation of pollution effects by fish farms. Wet biomass, abundance and species diversity of fouling organisms increased with increasing deployment time during all seasons and for all the filters deployed. Shannon diversity index and average taxonomic distinctness found to be quite stable after the first two months of deployment. Multidimensional scaling (MDS) of wet biomass and species abundance revealed biofilters clustering in relation to deployment period, regardless of deployment season.

Key words: biofilters, succession, fish farming, Eastern Mediterranean, Crete

EFFETTO DI PERIODO DEL PRIMO POSIZIONAMENTO E DURATA SU SUCCESSIONI DI ORGANISMI BENTONICI SU BIOFILTRI USATI PER RIDURRE L'IMPATTO DI ALLEVAMENTI DI PESCI SULLA QUALITÀ DELL'ACQUA A CRETA

SINTESI

Diciotto biofiltri sono stati posizionati in una baia aperta di Creta, allo scopo di studiare l'efficienza dei biofiltri nell'uso di comunità di fouling disponibili per ridurre gli effetti dell'inquinamento provocato da allevamenti di pesci. La biomassa umida, il numero di specie ed individui degli organismi del fouling sono aumentati con l'aumentare del periodo di impiego dei filtri in tutte le stagioni e per tutti i filtri posizionati. L'indice di diversità di Shannon e la precisione media tassonomica sono risultati abbastanza stabili dopo due mesi di posizionamento. Il metodo "multidimensional scaling" (MDS) applicato alla biomassa umida e all'abbondanza di specie ha rivelato un raggruppamento di biofiltri in relazione al periodo di posizionamento, a prescindere dalla stagione di posizionamento.

Parole chiave: biofiltri, successione, allevamento di pesci, Mediterraneo orientale, Creta

INTRODUCTION

Fish farms release a substantial amount of wastes in both particulate and solute forms reaching more than 70% of the nitrogen and phosphorus supplied through fish feed (Holby & Hall, 1991; Hall et al., 1992). The most severe environmental problems affecting other users of the coastal zone could arise from the solute and fine particulate wastes that may be transported at large distance from the farming sites, thus affecting water quality and marine resources over large areas (Pitta et al., 1999). The use of filtering systems based on marine organisms as a means for minimizing these effects has been suggested by various authors in different contexts (Kautsky & Folke, 1989; Neori et al., 2000; Chopin et al., 2001). It has been recently suggested (Angel & Spanier, 2002) that the deployment of biofilters using the locally available fouling communities could provide a mean for mitigation of pollution effects by fish farms. In the present paper, we have investigated the performance of *in situ* biofilters deployed during the warm season of the year (May to November), when most of the wastes are discharged into the marine environment. This paper addresses the issue of colonization of these substrates depending on the time and duration of deployment.

MATERIALS AND METHODS

The area selected for the deployment of biofilters is an exposed coastal bay at eastern part of Crete, characterized by fairly rough weather, ensuring adequate water flushing, and low background concentrations of nutrients and particulate matter. The fish farm operating there has a mean annual production of 1000-1200 tons of European seabass (*Morone labrax*) and gilthead seabream (*Sparus auratus*). Biofilters were constructed of hard plastic net and rolled to a total surface area of 0.5 m². A total of 18 biofilters (BF) were deployed at 6 m distance from the fish cages and 5 m depth from the sea surface (Plate II: Fig. 10). Nine biofilters were deployed in May 2002, three of which were retrieved two months later (July 2002) [code number 2(M-J)- number refers to total duration of deployment in months, and the two letters to deployment and retrieval month respectively]. In July 2002, six new biofilters were deployed. In September 2002, 3 biofilters deployed in May [4(M-S)] and 3 deployed in July [2(J-S)] were retrieved, whereas 3 new biofilters were deployed. In November 2002, all standing biofilters were collected [3 BF 6(M-N), 3 BF 4(J-N) and 3 BF 2(S-N)]. Sampling was made by means of scuba diving. Biofilters were enclosed in plastic bags, to prevent loss of epifauna, and transferred to the laboratory and photographed. Fouling organisms were sorted

and weighed and animals were identified to species level where possible. Differences in community structure were assessed by means of both uni- and multivariate analysis using the PRIMER software package (Clarke & Warwick, 1994). Species abundance and biomass were transformed with $\log(x+1)$ and square root respectively, prior to performing multidimensional scaling (MDS).

RESULTS AND DISCUSSION

Wet biomass of fouling organisms increased with increasing deployment time (Fig. 1). The largest increase in biomass was observed on the filters deployed in May between the 4th and 6th month of deployment. Multidimensional scaling (MDS) of wet biomass (Fig. 3a) showed a weak clustering reflecting time of deployment. The number of species showed a monotonic increase during all seasons and for all the filters (Fig. 2a). During the first two months of deployment, 19 to 29 species had colonized the filters (Plate II: Fig. 10).

Macrofaunal abundance also increased with time of deployment (Fig. 2b), showing very similar patterns for all three series of biofilters deployed during different months of the year. Shannon diversity was found to be quite stable after the first two months of deployment (Fig. 2c) and this was also the case with average taxonomic distinctness (Fig. 2d). Multidimensional scaling (MDS) of species abundance revealed biofilters clustering in relation to deployment period, regardless of deployment season (Fig. 3b).

The results of the present paper indicate that there is little change in fouling community attributes regarding the time of first deployment whereas the effect of duration of deployment is the major factor affecting the community structure.

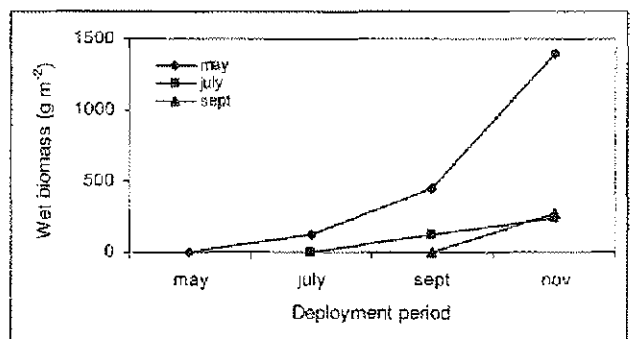


Fig. 1: Wet biomass of fouling organisms with deployment period.

Sl. 1: Biomasa organizmov obrasti v času postavitve biofiltrov.

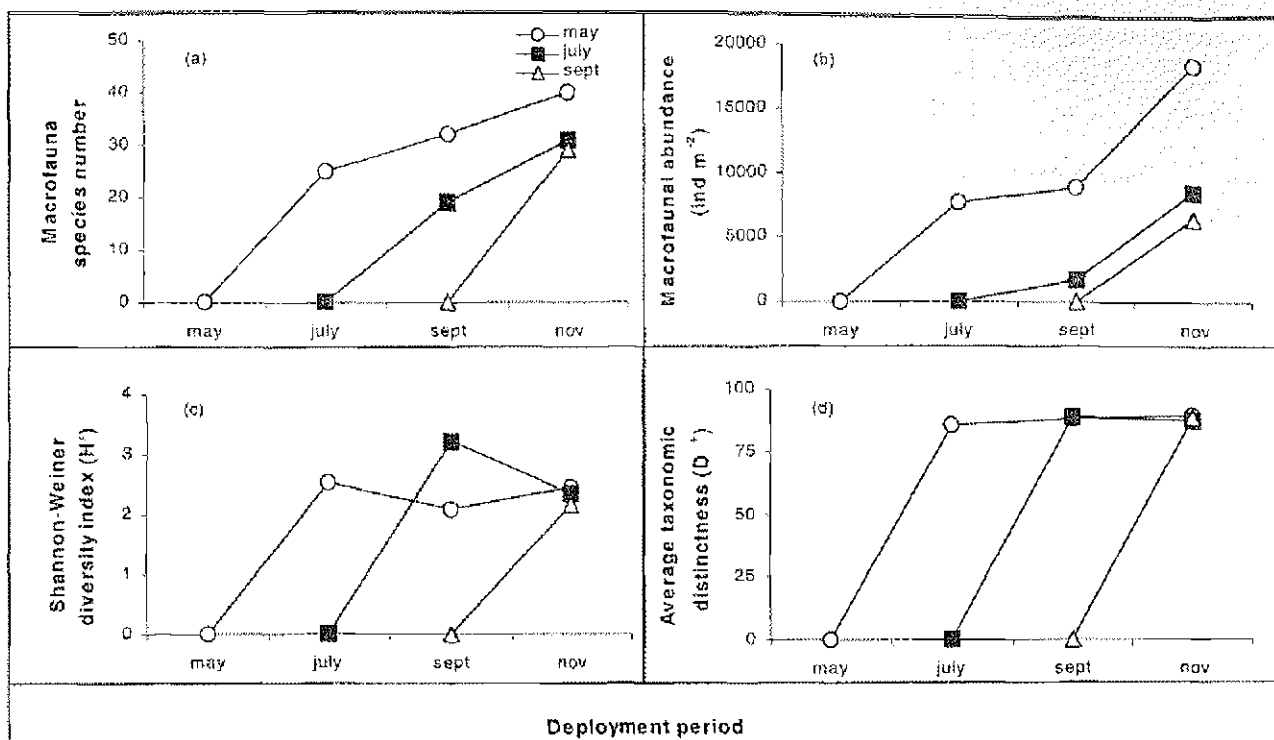


Fig. 2: (a) Species number; (b) macrofaunal abundance; (c) Shannon-Wiener diversity index; (d) average taxonomic distinctness with deployment period.

Sl. 2: (a) število vrst; (b) abundanca makrofavne; (c) Shannon-Wienerjev indeks diverzitete; (d) povprečna taksonomska različnost glede na obdobje postavitve.

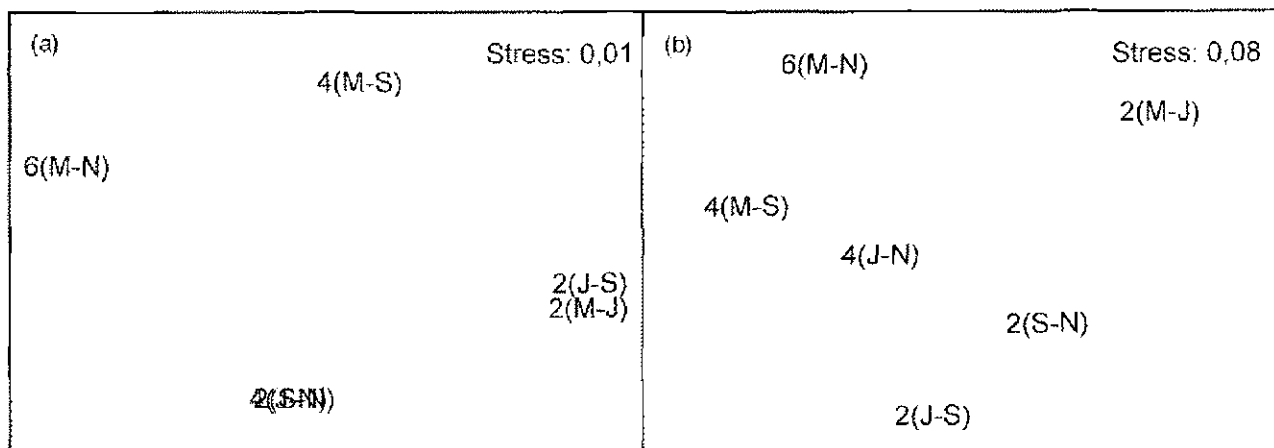


Fig. 3: (a) MDS of biofilters biomass; (b) MDS of species abundance at the biofilters.

Sl. 3: (a) MDS biomase biofiltriv; (b) MDS abundance vrst na biofiltrih.

UČINEK ČASA PRVE POSTAVITVE IN TRAJANJA NA SUKCESIJO BENTOŠKIH ORGANIZMOV NA BIOFITRIH, UPORABLJENIH ZA ZMANJŠEVANJE UČINKOV RIBOGOJNIC NA KAKOVOST VODE NA KRETI

Eugenia APOSTOLAKI, Manolis TSAPAKIS, Tatiana TSAGARAKI, Kostantia PAPADOPOULOU
& Ioannis KARAKASSIS

Institute of Marine Biology of Crete, GR-71003 Heraklion, POB 2214

E-mail: jkarak@imbc.gr

POVZETEK

V enem izmed zaprtih zalivov na Kreti so avtorji postavili 18 biofiltrrov, da bi lahko preučevali njihovo učinkovitost ob uporabi lokalno razpoložljive združbe obrasti za zmanjšane učinke onesnaževanja, ki ga povzročajo lokalne ribogojnice. Biomasa, gostota in diverzitetna vrst med organizmi obrasti so se povečevale s podaljševanjem časa uporabe biofiltrrov v vseh letnih časih in za vse razvrščene biofiltre. Po prvih dveh mesecih je bilo ugotovljeno, da sta Shannonov diverzitetni indeks in povprečna taksonomska različnost precej stabilna. Multidimenzionalna primerjava biomase in gostote vrst je razkrilo kopičenje na biofiltrih glede na čas njihove postavitve in ne glede na letni čas njihove postavitve.

Ključne besede: biofiltri, sukcesija, marikultura, vzhodni Mediteran, Kreta

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