IMPACT OF ENVIRONMENTAL FACTORS ON THE DISTRIBUTION AND DENSITY OF FAN MUSSEL *PINNA NOBILIS* ALONG THE EASTERN AND SOUTH-EASTERN TUNISIAN COASTLINE

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Abstract

The distribution and density of *Pinna nobilis* was estimated along the eastern and south-eastern Tunisian coasts, with the use of a density surface modelling (DSM) approach. A marked relationship between the fan mussel density and two spatial parameters (depth and distance from a pollution source) was revealed. The adopted technique was found advantageous to better understand the ecology of the species.

Keywords: Pollution, Sampling Methods, Density

Introduction

Pinna nobilis is a Mediterranean endemic species. It is the largest Mediterranean bivalve which occurs in coastal soft-bottom areas, usually in association with seagrass meadows [1]. It is also one of the Mediterranean endangered species. To effectively protect this mollusc, it is necessary to assess the status and distribution of all major local *P. nobilis* populations.

Material and Methods

In the present study, a distance sampling method was applied to model the population distribution and density of *P. nobilis* along the eastern and south-eastern Tunisian coastline (from Hergla to Elketef) taking into account spatial and environmental parameters. To do so, forty five line transects, perpendicular to the shoreline and extending from 0 to 6 m depth, were defined randomly along the study area; each line transect was marked every meter and divided into 8-m segments. After deploying the line, all detected *P. nobilis* individuals within 150 cm from the line were counted. For each observed individual, the following variables were recorded: the corresponding segment in which it was found, the perpendicular distance from the line (= y_i), and the shell size (= s_i), defined as the maximum dorso-ventral length of the shell. In addition, at the mid-point of each segment of the line transect the exact depth was measured. The dominant habitat type (*H*) of each segment was also recorded. Six different habitat types were identified: unvegetated sandy/muddy bottoms (UN), *Posidonia oceanica* beds (PO), *Cymodocea nodosa* beds (CN), *Caulerpa prolifera* beds (CP), *Caulerpa racemosa* beds (CR), and *Zostera noltii* beds (ZN).

For the detection function modelling, two functions were considered as candidate detection functions: the one-parameter half-normal function $\hat{g}(y) = exp\left(\frac{-y^2}{2\sigma^2}\right)$ and the two-parameter hazard-rate function $\hat{g}(y) = 1 - exp\left[-\left(\frac{y}{\sigma}\right)^{-b}\right]$, where σ is a scale parameter and *b* a shape parameter. Considering different conditions, eight models were included in the set of candidate models and the selection between them was based on the small-sample, bias-corrected form AIC_c of the Akaike Information Criterion. The population density of *P. nobilis* was modelled using the 'count method' of [2]. For that, one categorical and two continuous potential predictor variables were used: habitat type (*H*), depth (*d*), and the distance of each site (along the coastline) from the city of Gabes (*x*) respectively. Negative values were given to *x*'s southwards and positive values for *x*'s northwards of Gabes. With respect to the considered variables, eight models were used and model selection was done based on GCV score.

Results

A total of 318 fan mussel individuals were recorded in the line transects. The best model of the detection function among those tested (based on AIC_c) was the half normal function with no scale covariate. It is given by the equation $\hat{g}(y) = exp\left(\frac{-y^2}{2\sigma^2}\right) = exp\left(-1.602y^2\right)$, where distance from line (*y*) is in m. The best density model was the model which included univariate functions of depth (*d*) and the distance from the city of Gabes (*x*). The expression of this model was $ln\left(E\left[\hat{n}_i\right]\right) = c + s_1(d) + s_2(x) + ln(\alpha)$, where c = -20.0, *a* = 18.4 m^2, and the smooth functions s_i are given in Figure 1.

The fan mussel population density was zero at very shallow waters (<0.3 m depth) and was increasing within the depth range of this study (0–6 m). Zero fan mussel densities were observed near the city of Gabes. Population density increased with the distance from the city of Gabes and was higher in the south than in the north.

Discussion

Pinna nobilis density-depth correlation is well known with the fan mussel. Similar results were noted in Spain [3] and in Greece [4]. Regarding the relationship between the fan mussel density and the distance from Gabes city, this correlation could be attributed to pollution. Among the big cities located in the Gulf of Gabes (Gabes, Sfax, and Skhira), Gabes city is considered as the main source of pollutants, in particular phosphogypsum discharge in the open sea. According to figure 2, the farer from Gabes city the higher was *P.nobilis* population density. Almost all transects close to Gabes city had null densities. The absence of *Pinna nobilis* from the coast of Gabes and surrounding coasts is probably due to the large quantities of phosphogyps wasted from the industries of phosphoric acid and chemical products in the open sea since the seventies [5].

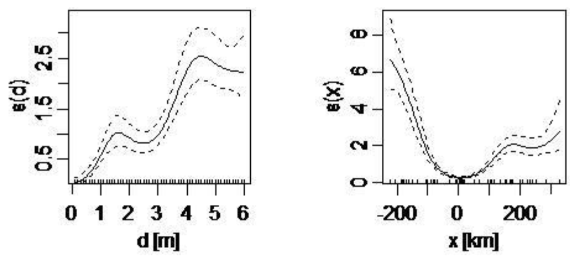

Fig. 1. Estimated smooth terms *s(d)* and *s(x)*, for the best model of *Pinna nobilis* abundance in the study area. The smooth terms are given in the response scale and the corresponding 95% confidence intervals are given with dotted lines. A one-dimensional scatterplot is given at the bottom of each graph, using a vertical bar as the plotting symbol, to illustrate the distribution of available data

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