Available online at www.sciencedirect.com
SCIENCE DIRECT
Biological Conservation 116 (2004) 319–326
BIOLOGICAL CONSERVATION
www.elsevier.com/locate/biocon

Assessing habitat use of the endangered marine mollusc *Patella ferruginea* (Gastropoda, Patellidae) in northern Africa: preliminary results and implications for conservation

José M. Guerra-García*, Juan Corzo, Free Espinosa, J. Carlos García-Gómez

Laboratorio de Biología Marina, Departamento de Fisiología y Zoología, Facultad de Biología, Universidad de Sevilla, Avda Reina Mercedes 6, 41012 Sevilla, Spain

Received 14 January 2003; received in revised form 5 April 2003; accepted 21 April 2003

Abstract

The limpet *Patella ferruginea* Gmelin, 1791, endemic to the Mediterranean, is the most endangered marine species on the list of the European Council Directive 92/43/EEC on the Conservation of Natural Habitat of Wild Fauna and Flora (1992). Its Mediterranean range has progressively contracted to a few restricted areas and the species is now threatened with extinction. Seventeen stations were sampled along the littoral zone on the coast of Ceuta, North Africa, for quantifying environmental factors (water movement, siltation and suspended solids), and 70 transects were selected for *P. ferruginea* sampling. The study revealed the presence of a well-established population of *P. ferruginea* with values of density and size of 0.67 individuals m^{-1} $\pm$0.96 and 48.94 mm$\pm$11.61 respectively (mean$\pm$standard error of mean). The biggest densities of *P. ferruginea* were found inside the harbour of Ceuta. The limpets were more abundant on artificial harbour stones than on natural rocky shores, and the areas under the highest human pressure were characterised by the lowest densities and the smallest specimens probably due mainly to the predation for food and fishing. Human pressure is probably the main contributing factor to the currently endangered status of *P. ferruginea*. Programmes of environmental education to avoid its collection for fishing, food or for fun as decorative objects should be conducted, and further experimental studies dealing with the reproductive biology of this species are needed to properly assess the future programmes of conservation.

Keywords: *Patella ferruginea*; Mollusc; Endangered species; Habitat use; Human pressure; Conservation

1. Introduction

The limpet *Patella ferruginea* Gmelin, 1791 is the most endangered marine invertebrate in the Western Mediterranean rocky shores (Laborel-Deguen and Laborel, 1991a; Ramos, 1998; BOE, 1999). Although its relative abundance in Palaeolithic and Neolithic deposits indicates an extensive former distribution in the Western Mediterranean Basin (East coast of Italy, Mediterranean France, Iberian Peninsula, Morocco, Tunisia and the Western Mediterranean islands), today its Mediterranean range has progressively contracted to a few restricted areas (Fischer-Piette, 1959; Cretella et al., 1994; Templado, 1996).

Little is known about the biology of *P. ferruginea*. The species has a very low growth and reproductive rate, reaching sexual maturation at 2–3 years. It is a protandric species, being initially male (from 25 mm length) and latterly female (from 40 mm length) with relatively large sized ovocites suggesting a short planktonic phase (Frenkiel, 1975; Templado, 1996). *P. ferruginea* is considered a k-strategist (Laborel-Deguen and Laborel, 1991b). The adults usually live in the high midlittoral zone (Pérès and Picard, 1964) but are also found in the suppra-littoral zone (Biagi and Poli, 1986). They feed mainly on cyanobacteria and the algae *Ralfsia* spp. and *Rissoella* spp.

The aim of this study was to explore the environmental and habitat preferences of the species and to evaluate the impact of anthropogenic pressure on the populations at Ceuta, Northern Africa.

* Corresponding author.
E-mail address: jmguerra@us.es (J.M. Guerra-García).

0006-3207/03/$ - see front matter © 2003 Elsevier Ltd. All rights reserved.
doi:10.1016/S0006-3207(03)00201-5

2. Material and methods

2.1. Study area

Ceuta is an Spanish enclave located in North Africa, in the Strait of Gibraltar (Fig. 1). The coastline, about 20 km long, is composed of heterogeneous environments due to the configuration of the coast as well as by intense port activity. At least 70% of Ceuta's coast is hard bottom. Of this, c. 45% is formed by natural rocky shores (sandstone) and the remaining 25% are artificial jetties and breakwaters (limestone).

On the coast of Ceuta, an important population of *P. ferruginea* occurs among the belt of *Chthamalus stellatus* Poli 1791 and *Lithophyllum lichenoides* Philippi, 1837, located below the zone of the lichen *Verrucaria* sp. The presence of *P. ferruginea* in Ceuta had been already reported by Fischer-Piette (1959) on the basis of two specimens found in the South Bay.

2.2. Environmental conditions

The environmental conditions along the coast of Ceuta were characterised by measuring levels of water movement, siltation and solids in suspension in shallow waters. Siltation (sedimentation rate) and water movement were estimated using sets of six sediment-collecting bottles for siltation and six plaster spheres for water movement (Moore, 1972), deplayed on bottom-mounted frames which were placed at 1 m depth under the maximum low tide level in 17 stations distributed throughout the coast (Fig. 1). The spheres were submerged for 72 h and the bottles for a whole month (June 2001). To estimate water movements the rate of plaster dissolution described by Muus (1968) and modified by Gambi et al. (1989) was used. Water movement was expressed as water speed equivalents (V) according to the formula suggested by Bailey-Brock (1979). The suspended solids were measured using methods describe by

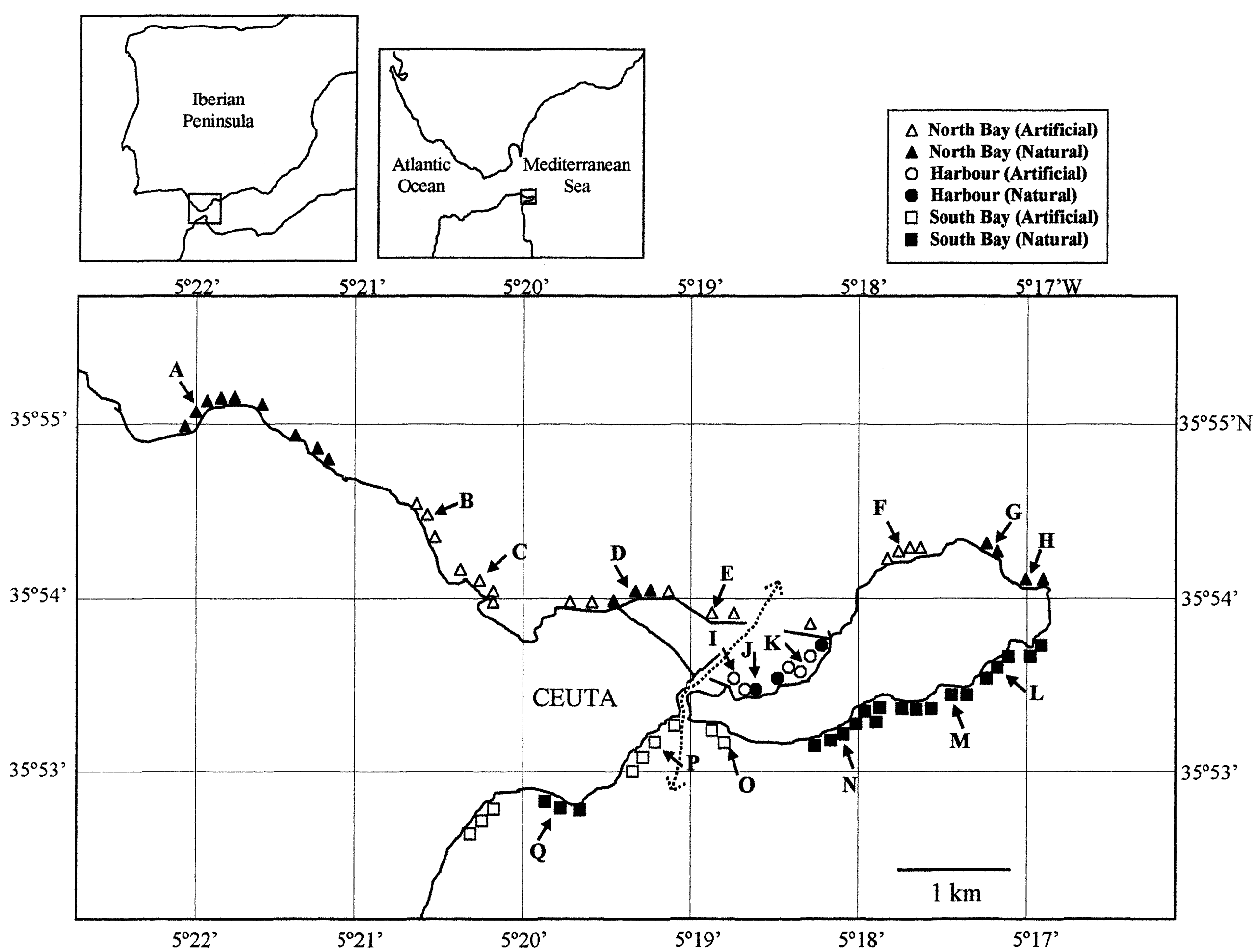

Fig. 1. Study area showing the location of the 70 sampling stations along the coast of Ceuta. The capital letters and arrows indicate the position of the 17 stations where the environmental data were measured. Note the channel connecting the North and South Bay.

Strickland and Pearson (1960). Six water samples were also analysed for suspended solids.

2.3. Limpet sampling

From the environmental data, three different areas (North Bay, South Bay and harbour) (Fig. 4), were distinguished and a total of 70 stations were selected in both natural and artificial rocky shores along Ceuta's coast (33 at the North Bay, 29 at South Bay and eight inside the harbour) (Fig. 1). The field survey was carried out between 15 July and 20 August 2000. The density of limpets in each of these stations was measured by counting the number of specimens found in a 10 m transect placed parallel to the coast (Laborel-Deguen and Laborel, 1991b). The size was estimated by measuring the shell length (Porcheddu and Milella, 1991) and the mean shell length was calculated for each transect. The degree of human pressures at the stations was estimated with the index of general anthropogenic stress (Fa, 1998). The index was calculated by the following equation:

$$S = \left(\sum P_a/D_t\right) \times A$$

where S is the general anthropogenic stress, P_a is the total area of each of the main population centres in a 5 km radius from the site, D_t is the distance of the focus of each population centre to the site, and A is a measure of disturbance based on a subjective assessment of both ease of access and levels of human activity, ranked in the following way:

1. Very difficult access–little or no direct influence
2. Difficult access–little human activity
3. Moderate ease of access–moderate human activity
4. Moderate access–high activity or easy access–moderate activity
5. Extremely easy access together with high levels of human activity

Taking into account the proximity among some stations (only a few metres), the 70 stations were grouped into 24 sites and the index was calculated for each site (Fig. 2). Observations by Fa (1998) indicated that sites under high levels of human pressure (such as the Costa del Sol, Málaga and the Manga del Mar Menor, Murcia, both in Southern Spain) were characterised by values of an index >20.

2.4. Statistical analysis

The affinities among the 17 stations used for the environmental assessment, were established through Cluster analysis using the UPGMA method (unweighted pair-group method using arithmetic averages) of Sneath and Sokal (1973) based on the inter-station euclidean distance. The environmental data were transformed using log $(x+1)$.

The influence of location and type of substrate on density and size of *P. ferruginea* was analyzed using two-way ANOVA after verifying the normality of the data with the Kolmogorov-Smirnov test and the homogeneity of variances with the Levene test. Variations of

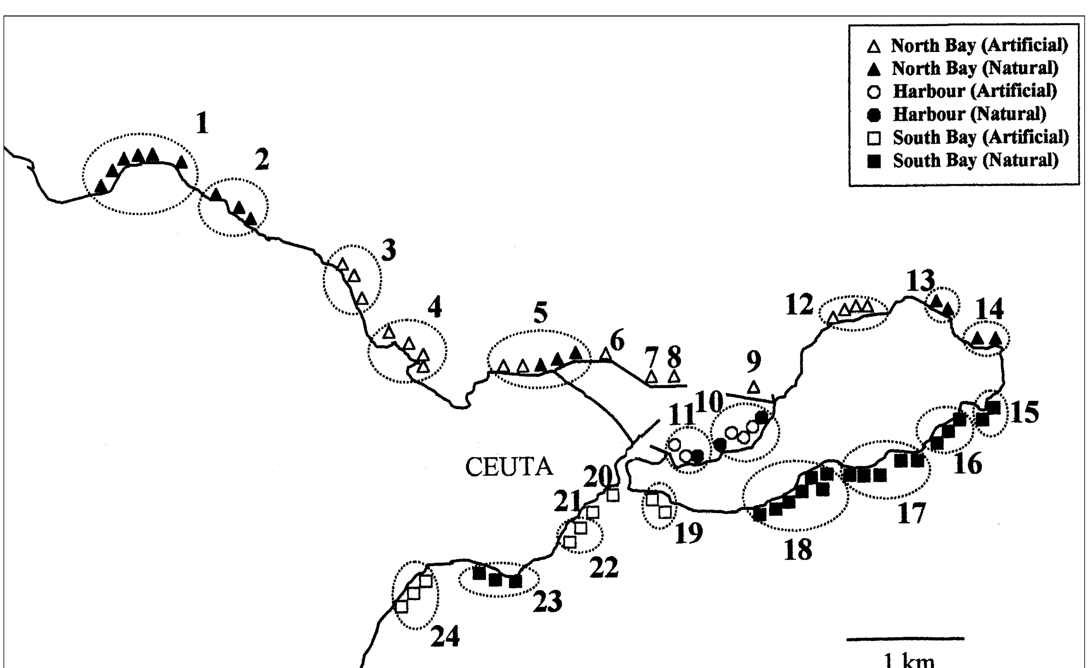

Fig. 2. Study area showing the groups of localities considered for the calculation of the index of anthropogenic stress. See Table 2 for details.

the density and size values according to the accessibility level were tested using one-way ANOVA.

Multivariate analyses were carried out using the Plymouth Routines In Multivariate Ecological Analysis (PRIMER) package (Clarke and Gorley, 2001) and for univariate analyses the Biomedical statistical package (BMDP) was used (Dixon, 1983).

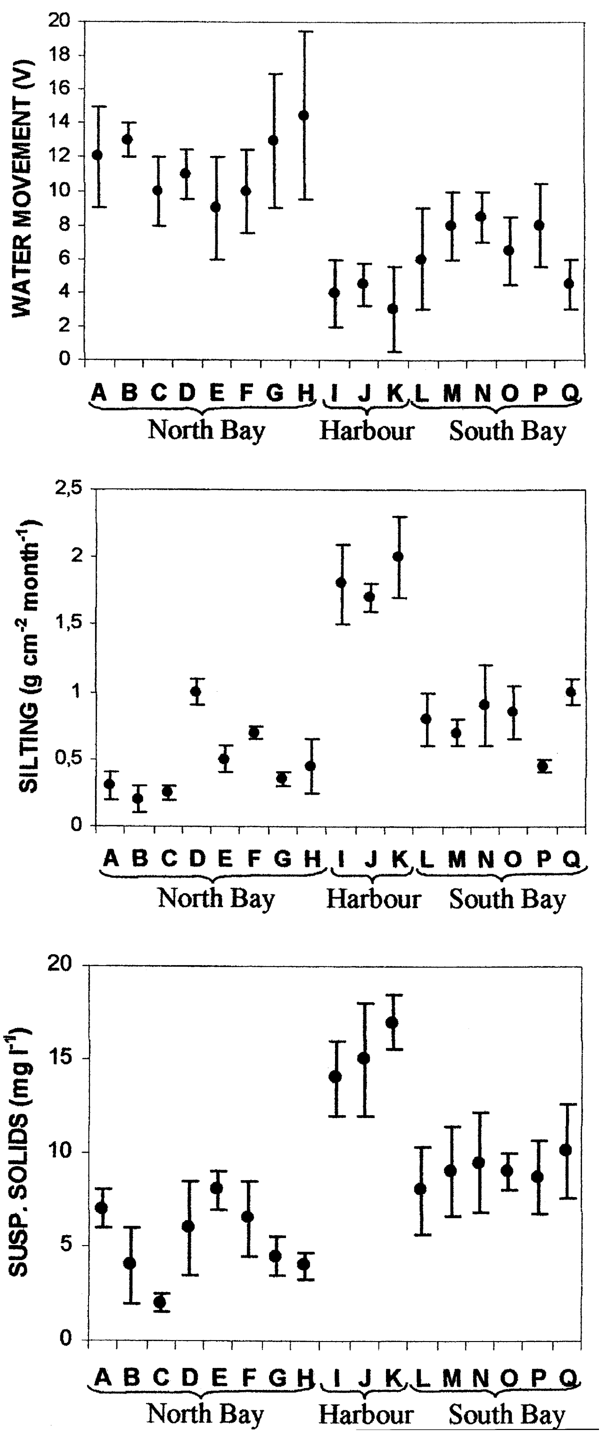

Fig. 3. Mean values and standard errors of the mean for the abiotic variables measured in the 17 stations selected for the environmental study. Six measurements for each variable were obtained at each station.

3. Results

3.1. Environmental variables

The cluster analysis based on levels of water movement, siltation and suspended solids (Fig. 3) showed that three groups of stations can be differentiated (Fig. 4) The first group included the stations I, J and K, located inside Ceuta's harbour and characterised by the lowest water movement ($V=3.0$–4.5) and the highest values of siltation (1.7–2.0 g cm^{-2} month $^{-1}$) and suspended solids (14–17 mg l^{-1}). In spite of having the lowest water movement and the highest values of siltation and solids in suspension, the harbour of Ceuta has an unusual structure being located between two bays connected by a channel, which greatly increases water movement and renovation along the harbour, resulting in the maintenance of moderate oxygen levels in the water column (Guerra-García, 2001). Stations A to H, located at the North Bay (the most exposed), were characterised by clean waters and strong currents with high hydrodynamic levels ($V=9.0$–14.5) and low siltation (0.2–1.0 g cm^{-2} $month^{-1}$) and suspended solids (2–7 mg l^{-1}). The remaining stations, all of them belonging

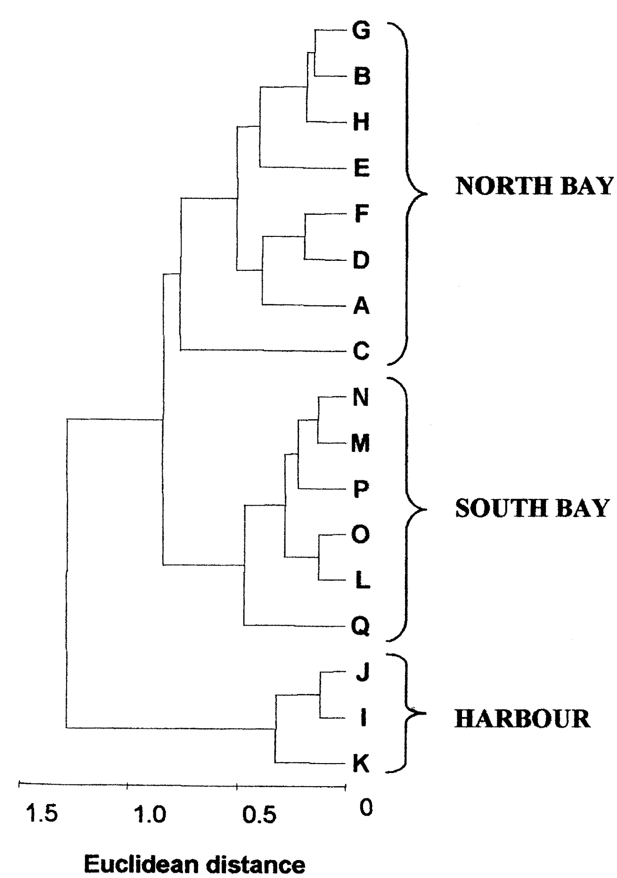

Fig. 4. Dendrogram of similarity between the stations based on the environmental data. The Euclidean distance and the UPGMA method were chosen.

Table 1
Two-way ANOVA results for the influence of the location and type of substrate on the density and size of *Patella ferruginea* at the coast of Ceuta

Source of variation	Density (Ind/10 m)				Size (mm)			
	Mean±SE	DF	SS	*F*	Mean±SE	DF	SS	*F*
Location		2	415.46	3.50*		2	226.36	1.02n.s.
North Bay	5.54±1.67				47.76±2.14			
South Bay	6.96±1.77				49.65±2.96			
Harbour	11.33±3.64				49.71±3.17			
Type of substrate		1	534.28	5.78*		1	877.69	7.94**
Natural	3.81±0.94				53.89±2.54			
Artificial	10.50±2.31				43.30±1.47			
Location×type of substrate		2	440.87	2.72n.s.		2	146.42	0.66n.s.

* $P<0.05$.

** $P<0.01$.

Table 2
Localities sampled at the coast of Ceuta and value of the index of anthropogenic stress (*S*)

Number	Sites	Index
1	Benzú	6.31
2	Calamocarro	6.84
3	Punta Bermeja	10.21
4	Laja Benítez	20.66
5	Aguja del Campo	19.24
6	Dique Poniente 1	28.33
7	Dique Poniente 2	30.85
8	Dique Poniente 3	33.21
9	Dique levante	22.07
10	Puerto Pantalanes	40.67
11	Puerto Muelle Comercio	77.11
12	Punta Sauciño	12.62
13	Laja Sargento	3.32
14	Punta Almina	3.00
15	Desnarigado	10.28
16	La Palmera	3.63
17	Islotes Caños	7.91
18	Sarchal	16.41
19	Bahía Sur	173.94
20	El Chorrillo Dique 1	218.24
21	El Chorrillo Dique 2	117.43
22	El Chorrillo Dique 3	63.38
23	Piedras Gordas	42.06
24	Tramaguera	27.21

See also Fig. 2.

to the South Bay (more sheltered), had intermediate values between the harbour and the North Bay.

3.2. *Population of* Patella ferruginea

The present study showed the presence of a well-established population of *P. ferruginea* inhabiting the coast of Ceuta, with a density of 6.7 ind/10 m±1.45 and a size of 48.94 mm±0.24 (mean±standard error).

The density was significantly higher inside the harbour and on artificial breakwaters. Although the size did not depend on the location, and similar values were registered in North Bay, South Bay and the harbour, the mean size was significantly higher on the natural rocky shores than on artificial jetties and breakwaters (Table 1).

When the influence of human pressure (see Table 2) on *P. ferruginea* populations were analysed using one-way ANOVA, significative differences in density and size were obtained between the two qualitative levels considered [high anthropogenic stress (>20) versus low-medium (<20) stress]. The areas under high levels of anthropogenic stress had the lowest densities and smaller specimens of *Patella ferruginea* (Table 3). Exceptionally, although the harbour area is theoretically very exposed to anthropogenic stress, the densities inside the harbour are even higher than at sites with low-medium anthropogenic stress (11.33±3.64 inside the harbour—see Table 1—versus 9.5±1.95 in sites with low-medium anthropogenic stress). The harbour is accessible to human pressure but it is not an attractive or tempting place for people to collect (Fig. 5).

4. Discussion

4.1. *Status of* Patella ferruginea

Patella ferruginea is an endemic species of the Western Mediterranean and its range has progressively contracted to restricted areas (Cretella et al., 1994). At present, the species can be found in the occidental sector of the north African coast, between Tetuan (Morocco) and Cap Bon and Zembra Island (Tunisia) (Templado, 1997). In Argelia, the species have been reported from Ghazaouet and Raschgoun Island (Frenkiel, 1975). The species also lives in Corsica, Sardinia, Pantellaria Island at the Sicily channel, Tuscan Archipelago and Aegen Sea (Cretella et al., 1994; Biagi and Poli, 1986; Ramos, 1998) although the populations of Corsica and Sardinia are in clear regression (Templado, 1997). On the Spanish coasts, *Patella ferruginea* was abundant in the past

Table 3
One-way ANOVA results for the influence of the anthropogenic stress on the density and size of *Patella ferruginea* at the coast of Ceuta

	Density (Ind/10 m)				Size (mm)			
	Mean ± SE	DF	SS	*F*	Mean ± SE	DF	SS	*F*
Anthropogenic stress		2	293.50	3.11*		1	1140.26	9.2**
High	5.25 ± 1.40				42.07 ± 2.71			
Low medium	9.50 ± 1.95				51.96 ± 1.95			

* $P < 0.05$.
** $P < 0.01$.

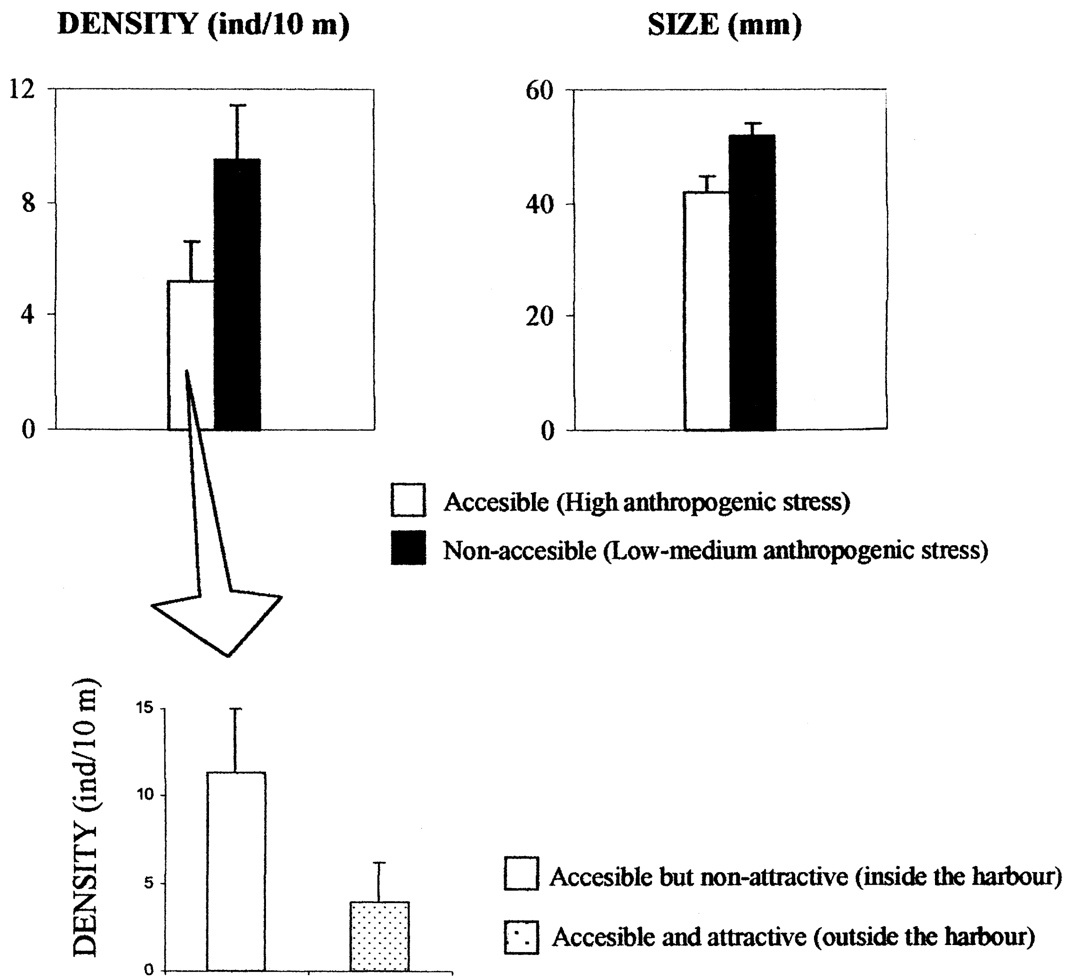

Fig. 5. Mean values and standard errors of the mean of the density and size of *Patella ferruginea* measured in sites with high anthropogenic stress and sites with low-medium anthropogenic stress. Separation of the high anthropogenic stress sites into sites inside and outside the harbour.

from the Strait of Gibraltar to Cabo de Gata but now, the species has almost disappeared. The only viable populations of the species are in Ceuta (Fischer-Piette, 1959; present study), Melilla and Chafarinas Islands (Templado, 1997). There is a population in Alborán Island but it is old and probably non-breeding and threatened with extinction (Ramos, 1998). The most recent cites of *P. ferruginea* in the Iberian Peninsula are reported by García-Gómez (1983) who recorded the species in Algeciras Bay and Moreno (1992), who found two specimens in Cabo de Gata. Several specimens have been recently recorded in the Gibraltar harbour by Templado in 1995 (personal communication in Ramos, 1998) and Templado and Fa in 2002 (personal communication). The presence of *P. ferruginea* at the Atlantic coast of Morocco has also been reported by several authors (Biagi and Poli, 1986; Cretella et al., 1994) but no exact localities are given. During a sampling programme on intertidal areas of the Strait of Gibraltar, Fischer-Piette (1959), did not find the species in the Atlantic coast of Morocco. This is supported by our own observations since we have not yet found the species in the Atlantic area of the Gibraltar Strait.

The mean density value of *P. ferruginea* from Ceuta (0.67 ind/m) is similar to that obtained in Corsica (0.79 ind/m; Laborel-Deguen and Laborel, 1991b) and Zembra Island, Tunisia (0.7 ind/m; Boudouresque and Laborel-Deguen, 1986), both places still containing viable relic populations of *P. ferruginea*.

4.2. Environmental and habitat use

Traditionally, *P. ferruginea* had been associated with rocky shores of a medium to strong exposure to surf, high water movement, high oxygen levels and low level of pollution (Aversano, 1986; Laborel-Deguen and Laborel, 1991b; Porcheddu and Milella, 1991). Nevertheless, this assumption is only supported for sporadic observations or qualitative data. The quantitative study carried out using Ceuta's populations from North Africa during the present survey, showed the highest densities being inside the harbour, the area with the lowest water movement along Ceuta's coastline. However, we should take into account the fact that the harbour of Ceuta is unusual with a channel which increases water movement and renewal. In fact, recent studies have showed that the benthic communities of the harbour of Ceuta are characterised by strikingly high species richness and diversity (Guerra-García, 2001).

Patella ferruginea has been usually reported from natural shores, and the construction of artificial port facilities has been considered a threat for the species since they destroys its natural rocky habitat (Ramos, 1998). However, the present study revealed the highest densities of *P. ferruginea* in artificial breakwaters, although the specimens were significantly smaller in this area. Taking into account that most of these artificial areas of Ceuta have been constructed a short time ago (less than 5 years), and the species has a very low reproductive and growth rate, the difference in size could be due to this. Interestingly, *P. ferruginea* has also been found on the breakwater at Estepona, Spain in the late 1980s and on breakwaters at Calvi in Corsica in the early 1990s (S.J. Hawkins, personal communication), and has been reported from artificial substrates (cement) in Arbatax harbour, Sardinia and Oran harbour, Argelia (Doneddu and Manunza, 1992). Regarding the substrate preferences, Doneddu and Manunza (op. cit.), made qualitative observations and pointed out that *P. ferruginea* seems to prefer granitic rocks but can also live on calcareous and schist substrates. In quantitative studies with other limpet species, Cantos et al. (1994) found that the species *Patella caerulea* Linnaeus, 1758 and *Patella aspera* Röding, 1798 preferred sandstone to ophites though, in this case, the size distribution of specimens was the same in both substrates.

4.3. Human pressure

The main threats for *P. ferruginea* have been its use as food, fishing bait and as a collector's item (Ramos, 1998; Laborel-Deguen and Laborel, 1991a,b; Templado, 1996, 1997). Our results are in agreement with the previous observations since significantly lower values of density and size have been recorded in the most accessible areas of Ceuta's coast under the highest level of anthropogenic stress. Taking into account that in this species the biggest specimens are females (Frenkiel, 1975; Laborel-Deguen and Laborel, 1991a,b), the influence of human predation directly affects the sex ratio and consequently the species' reproductive success along the most predated areas. This pattern of selective predation on the biggest individuals has also been obtained for other limpet species [e.g. the limpet *Cellana capensis* (Gmelin, 1791) at exploited sites tends to be much smaller than at protected sites (Lasiak, 1993)].

4.4. Implications for conservation

The marked reduction of *P. ferruginea* throughout the western Mediterranean has already revealed the need for a conservation approach. The present study also points to human pressure as probably the main factor contributing to their currently endangered status. However, even in the most accessible areas, Ceuta has no important influx of visitors (tourists, fishermen, etc.), and the industrial and urban activity around the coast is not as high as in similar sites in southern Spain. These reasons could explain the persistence of a well-established population in the area. Programmes of environmental education should be carried out at Schools and Universities to show the morphological differences between this endangered species and the other species of *Patella*. It is obvious that a necessary first step in reversing the trend towards extinction lies in a complete ban on collecting.

As was recently pointed by Ramos (1998) nothing is known yet about the reproductive biology of *P. ferruginea*, especially its larval life, recruitment areas and juvenile development. Further research on these aspects together with an experimental approach to the study of habitat preferences under laboratory conditions are urgently needed to properly address existing and future conservation programmes and hopefully avoid the extinction of this species.

Acknowledgements

We express our thanks to "Compañía del Mar" and "Club Calypso" for assistance in the field. Special thanks are also due to our colleague Paloma Serván for her help during the sampling program and to Dr. Darren

Fa, Gibraltar Museum, for his valuable comments and corrections on the manuscript and for the English revision. Our gratitude to "Asamblea de Ceuta" and "Autoridad Portuaria de Ceuta" for financial support.

References

Aversano, F.R., 1986. Esperimento di insediamento artificiale di *Patella ferruginea* Gmelin, 1791 nelle acque del Golfo di Arzachena (Sardegna settentrionale). Bolletino Malacologico 22, 169–170.

Bailey-Brock, J., 1979. Sediment trapping by chetopterid polychaetes on a Hawaiian fringing reef. Journal of Marine Research 37 (4), 643–656.

Biagi, V., Poli, D., 1986. Considerazioni su una popolazione di *Patella ferruginea* Gmelin, 1971 per le acque del Promontorio di Piombino. Bolletino Malacologico 22, 171–174.

BOE, 1999. Boletin Oficial del Estado. 22 junio 1999, n°148, pp. 23921–23922. Ministerio de la Presidencia, Spain.

Boudouresque, C.F., Laborel-Deguen, F., 1986. *Patella ferruginea*. In: Boudouresque, C.F., Harmelin, J.G., Jeudy de Grissac, A. (Eds.), Le benthos marin d l'ille de Zembre (Parc National, Tunisie). GIS Posidonie Publishers, Marseille, pp. 105–110.

Cantos, R., Mazón, P., Paredes, M.D., Picó, M.L., Sales, E., Sánchez-Jerez, P., 1994. Aportación al conocimiento de las poblaciones de *Patella caerulea* y *P. aspera* en la Reserva Marina de Tabarca (Alicante): densidad poblacional y frecuencia de tallas según el tipo de sustrato y grado de presión antrópica. In: Ramos-Esplá, A. (Ed.), Trabajos de campo en la Reserva Marina de Tabarca (Alicante). Secretariado de Publicaciones de la Universidad de Alicante, Murcia, pp. 45–52.

Clarke, K.R., Gorley, R.N., 2001. Primer (Plymouth routines in multivariate ecological research) v5: User Manual/Tutorial. PRIMER-E Ltd, Plymouth.

Cretella, M., Scillitani, G., Toscano, F., Turella, P., Picariello, O., Cataudo, A., 1994. Relationships between *Patella ferruginea* Gmelin, 1791 and the other Tyrrhenian species of Patella (Gastropoda: Patellidae). Journal of Molluscan Studies 60, 9. –17.

Dixon, W.J., 1983. BMDP Statistical Sofware. University California Press, Berkeley.

Doneddu, M., Manunza, B., 1992. Valutatione dell'impatto antropico relativo alla balneazione estiva su una popolazione di *Patella ferruginea* Gmelin, 1791 del littorale de Aglientu. Bolletino Malacologico, Milano 28, 161–168.

Fa, D., 1998. The Influence of Pattern and Scale on the Rocky-shore Macrobenthic Communities Through the Strait of Gibraltar. PhD thesis (unpublished), University of Southampton, UK.

Fischer-Piette, E., 1959. Contribution à l'ecologie intercotidale du Détroit de Gibraltar. Bulletin de l'Institut Océanographique 1145, 1–32.

Frenkiel, L., 1975. Contribution à l'étude des cycles de reproduction des Patellidae en Algérie. Pubblicacione de la Stazzione zoologica di Napoli 39, 153–189.

Gambi, M.C., Buia, M.C., Casola, E., Scardi, M., 1989. Estimates of water movement in *Posidonia oceanica* beds: a first approach. International Workshop on *Posidonia* Beds 2, 101–112.

García-Gómez, J.C., 1983. Estudio comparado de las tanatocenosis y biocenosis malacológicas del Estrecho de Gibraltar y áreas próximas. Iberus 3, 75–90.

Guerra-García, J.M., 2001. Análisis integrado de las perturbaciones antropogénicas en sedimentos del Puerto de Ceuta. Efecto sobre las comunidades macrobentónicas e implicaciones ambientales. PhD thesis (unpublished), University of Sevilla, Spain.

Laborel-Deguen, F., Laborel, J., 1991a. Statut de *Patella ferruginea* Gmelin en Méditerranée. In: Boudouresque, C.F., Avon, M., Gravez, V. (Eds.), Les spèces marines à protéger en Méditerranée. GIS Posidonie Publishers, Marseille, pp. 91–103.

Laborel-Deguen, F., Laborel, J., 1991b. Nouvelles observations sur la population de *Patella ferruginea* Gmelin de corse. In: Boudouresque, C.F., Avon, M., Gravez, V. (Eds.), Les spèces marines à protéger en Méditerranée. GIS Posidonie Publishers, Marseille, pp. 119–128.

Lasiak, T., 1993. Temporal and spatial variations in exploited and non-exploited populations of the intertidal limpet *Cellana capensis*. Journal of Molluscan Studies 59, 295–307.

Moore, P.G., 1972. The kelp fauna of Northeast Britain. I. Introduction and the physical environment. Journal of Experimental Marine Biology and Ecology 13, 97–125.

Moreno, D., 1992. Presencia de *Patella ferruginea* Gmelin, 1971 en el Cabo de Gata (Almería, SE España). Cuadernos de Investigación Biológica, Bilbao 17, 71.

Muus, B.J., 1968. A field method for measuring "exposure" by means of plaster balls. Sarsia 34, 61–68.

Pérès, J.M., Picard, J., 1964. Noveau manuel de Bionomie bentique de la Méditerranée. Recueil des Travaux de la Station Marine d'Endoume 31, 1–137.

Porcheddu, A., Milella, I., 1991. Aperçu sur l'écologie et sur la distribution de *Patella ferruginea* (L.) Gmelin, 1971 en mers italiennes. In: Boudouresque, C.F., Avon, M., Gravez, V. (Eds.), Les spèces marines à protéger en Méditerranée. GIS Posidonie Publishers, Marseille, pp. 105–117.

Ramos, M.A., 1998. Implementing the Habitats Directive for mollusc species in Spain. Journal of Conchology Spetial Publications 2, 125–132.

Sneath, P.H.A., Sokal, R.R., 1973. Numerical Taxonomy. The Principles and Practice of Numerical Classification. WH Freeman and Company, San Franciso.

Strickland, J.D., Pearson, T.R., 1960. A manual of seawater analysis. Fisheries Research Board Canadian Bulletin 122, 1–172.

Templado, J., 1996. *Patella ferruginea* (Gmelin, 1791). In: M.A. Ramos (Ed.), Inventario de las especies de invertebrados no artrópodos incluidas en los anejos de la Directiva 92/43/CCE del Consejo, pp. 1–15. Memoria final (ICONA, unpublished).

Templado, J., 1997. La lapa ferrugínea. Biológica 6, 80–81.