Present status of the endangered limpet *Cymbula nigra* (Gastropoda, Patellidae) in Ceuta: how do substrate heterogeneity and area accessibility affect population structure?

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Abstract
Present status of the endangered limpet Cymbula nigra *(Gastropoda, Patellidae) in Ceuta: how do substrate heterogeneity and area accessibility affect population structure?— Cymbula nigra* (Gastropoda, Patellidae) is a threatened giant patellid limpet found on the North African coast from Namibia to Algeria. The objective of this study was to estimate the total number of individuals present in Ceuta (Strait of Gibraltar) and to determine the effect of certain physical parameters on population structure and abundance. Between 2006 and 2010 we conducted an exhaustive census in the area. Results indicate that Ceuta could be home to 48,473 individuals. The most important populations were recorded on the North Bay, characterized by its Atlantic influence. While for other similar species, such as *Patella ferruginea,* human accessibility to the area plays an important role in determining the structure of populations, we found that substrate roughness (small scale topographic heterogeneity) is the main determining factor in this species. Populations located on medium to low topographic heterogeneity substrates showed higher percentages of medium and large size individuals. However, recruitment rates did not differ between substrata of different roughness. Finally, and through the analysis of the *C. nigra* populations located on some recently constructed jetties, we obtained interesting new data regarding individual growth rates, thus contributing to our knowledge of the population structure of the species.

Key words: Limpet, Endangered species, *Cymbula nigra*, Substrate heterogeneity, Strait of Gibraltar, Ceuta.

Resumen
Situación actual en Ceuta de la lapa Cymbula nigra *(Gastropoda, Patellidae), una especie en peligro: ¿cómo afecta la heterogeneidad del substrato y la accesibilidad del área a la estructura de las poblaciones?— Cymbula nigra* (Gastropoda, Patellidae) es una lapa gigante amenazada que se encuentra distribuida por las costas norteafricanas desde Namibia a Argelia. El objetivo del presente estudio era estimar el número total de individuos presentes en Ceuta (Estrecho de Gibraltar) y determinar el efecto de ciertos parámetros físicos sobre la abundancia y estructura de las poblaciones. Para conseguirlo, entre 2006 y 2010, se llevó a cabo un censo exhaustivo en la zona. Los resultados indicaron que Ceuta podría albergar unos 48.473 individuos. Las poblaciones más importantes fueron registradas en la Bahía del Norte de la ciudad, caracterizada por su influencia atlántica. Mientras que en otras especies similares, como *Patella ferruginea,* la accesibilidad de la zona por parte del hombre juega un papel importante en la determinación de la abundancia y estructura de las poblaciones, nuestros resultados indicaron que en esta especie el principal factor determinante es la rugosidad del sustrato (heterogeneidad topográfica a pequeña escala). En este sentido, aquellas poblaciones localizadas sobre sustratos de media a baja complejidad mostraron mayores porcentajes de individuos de tamaño mediano y grande. Sin embargo, las tasas de reclutamiento no variaron entre sustratos de diferente rugosidad. Finalmente, a través del análisis de poblaciones de *C. nigra* localizadas sobre algunos diques de construcción reciente, se obtuvieron nuevos e interesantes datos relacionados con tasas individuales de crecimiento, contribuyendo así al conocimiento de la estructura de poblaciones de esta especie.

Palabras clave: Lapas, Especies amenazadas, *Cymbula nigra*, Heterogeneidad del sustrato, Estrecho de Gibraltar, Ceuta.

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Introduction

The commonly known Black limpet (*Cymbula nigra*) (da Costa, 1771) (former *Patella nigra*) is the largest limpet in Europe, reaching up to 13.3 cm (Rivera–Ingraham et al., 2011a). It is present in the southernmost area of the Iberian peninsula, having been located in Algeciras (Guerra–García et al., 2006; Rivera–Ingraham, 2010), Fuengirola (Spada & Maldonado Quiles, 1974; Grandfils & Vega, 1982; Christiaens, 1983), Mijas (Martínez & Peñas, 1996) and, more recently, in Granada (Moreno & Arroyo, 2008). It has also been found at Alboran Island (Moreno, 2006; Peñas et al., 2006; Templado et al., 2006; Moreno & Arroyo, 2008), although its presence here is considered rare.

Along the north African coast, the species occurs from Namibia to Algeria (Koufopanou et al., 1999) and has large populations in Ceuta (Templado et al., 2004; Espinosa et al., 2007) and Melilla (Pasteur–Humbert, 1962). The coast of Senegal was thought to be the centre of the species' dispersion (Christiaens, 1974) but more recent morphological and molecular studies suggest that the species might have originated on the south–western African coasts (Ridgway et al., 1998; Koufopanou et al., 1999; Templado et al., 2004).

Cymbula nigra is currently catalogued as an 'endangered or threatened species' by the Barcelona Convention (Annex II, 1993), as 'strictly protected' by the Berne Convention (Annex II, 1995), and as 'vulnerable' by the Andalusian Red List of Threatened Invertebrate Species (Moreno & Arroyo, 2008). It is surprising therefore that little is known about the biology and ecology of the species. Most of the recent literature that mentions *C. nigra* is related to phylogenetic studies of the family Patellidae (Ridgway et al., 1998; Koufopanou et al., 1999; Sá–Pinto et al., 2005) or genetic aspects of the species (Espinosa et al., 2010; Nakano & Espinosa, 2010). Recent studies indicate that *C. nigra* recruits in the upper intertidal levels while the largest individuals occupy the lower intertidal areas (Rivera–Ingraham et al., 2011a) and can be found up to 5 m deep (Rivera–Ingraham, 2010). It is a protandric hermaphrodite species that reproduces mainly in late autumn but also, to a lesser extent, in spring (Frenkiel, 1975; Rivera–Ingraham, 2010). *Cymbula nigra* is a territorial species, and individuals defend a well defined area from other macroorganisms (Rivera–Ingraham, 2010).

Despite the interest in quantifying populations of endangered species (*e.g.* Paracuellos et al., 2003) this has not been done to date for *C. nigra.* The present study describes the population of *C. nigra* from the coast of Ceuta, and estimates the total number of individuals. Moreover, and taking into account that *C. nigra* has been previously observed to be especially abundant on smooth surfaces (Rivera–Ingraham et al., 2011a), special attention was paid to the influence of substrate heterogeneity on population density. We also analysed the effect of the area's accessibility on the distribution and population structures, and we compared the results with those previously obtained for other similar species, such as *Patella ferruginea.* Finally, we studied C. *nigra* populations located on recently created jetties.Knowing the date when these structures were finished allowed us to obtain average growth rates and compare these with previous data available for the species.

Material and methods

Study site

The present study was conducted in Ceuta, located on the African coast of the Strait of Gibraltar (fig. 1A) . This area is known to have large *C. nigra* populations (Rivera–Ingraham, 2010). The coasts of this city are composed of natural rocky shores, beaches and islets. There are also many breakwaters and jetties, and a commercial port.

Sampling methods

To estimate the total number of *C. nigra* individuals present in Ceuta we used the methodology described in Rivera–Ingraham et al. (2011b).The complete coastline was divided into 14 sectors (see fig. 1B) and for each one, and only for rocky shores, a total of 10 transects of 10 m were randomly established on the coastline. These transects occupied the whole vertical distribution range of the species (intertidal areas and the upper sublitoral regions, up to 5 m depth). Surveys were always carried out during low tide (tide amplitudes usually ranging from 0.41 to 1.01) and subtidal regions were sampled by diving. Each *C. nigra* individual located in these transects was measured to the nearest millimetre using a calliper as in Guerra–García et al. (2004), Espinosa (2009) or Rivera–Ingraham (2010). The number of individuals present in these transects was extrapolated to the total length of coastline in the sector, which was measured using 1:9,000 maps. For the specific case of islets, jetties and breakwaters, a complete census was carried out when possible. The complete coastline was inspected from 2006 to 2010. Additionally, and for each of the prospected locations, some physical parameters were recorded and sectors were classified based on: i) type of substrate (natural/artificial) ii) accessibility by humans (high/medium/low) and iii) substrate roughness or small scale 'topographical heterogeneity index' (THI) (high/medium/low) (refer to Rivera–Ingraham et al. (2011b) for further details). It is also important to note that in the present study, individuals present in Ceuta are considered part of a metapopulation composed of genetically connected sub–populations (see review by Badii & Abreu, 2006).

Analyses

Univariate analyses were carried out using the statistical package SPSS 15.0. Multivariate analyses were also performed to compare size distributions among populations, taking into account that the reduction of data to summarise statistics (such as means, medians, etc.) can significantly reduce the amount of available information (Sagarin et al., 2007). We used the total number of individuals for each size class (1 cm

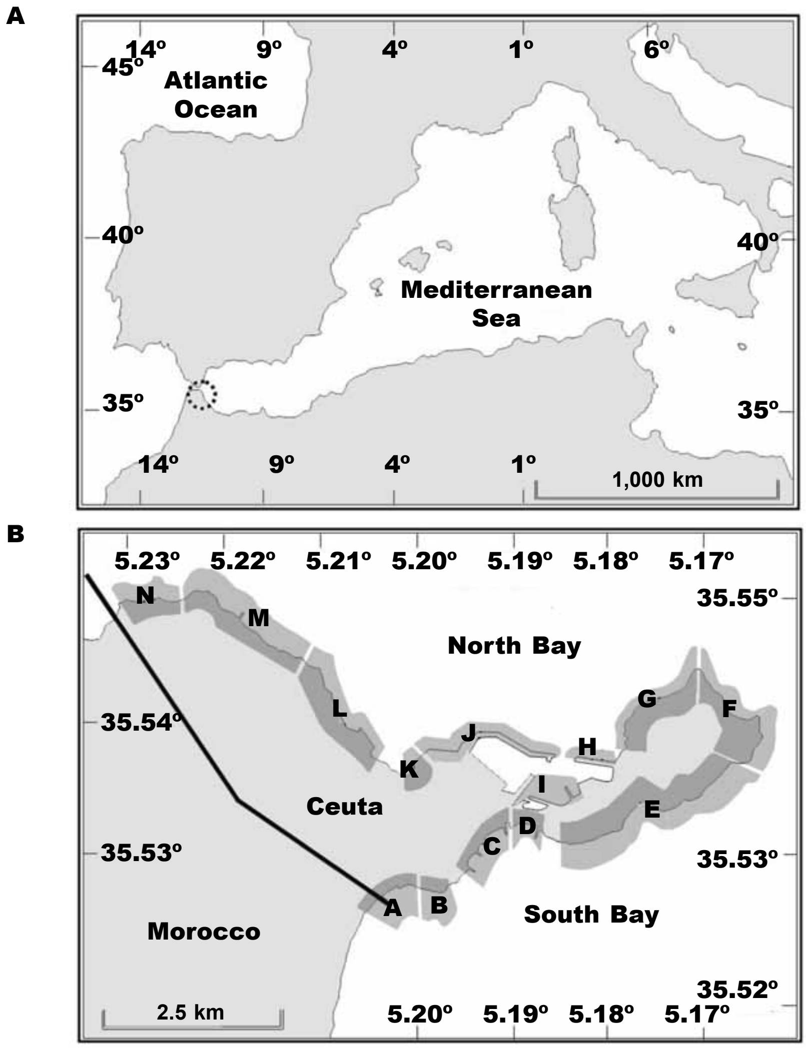

Fig. 1. A. Location of Ceuta; B. Sectors into which the study site was divided to estimate the total number of individuals of *C. nigra*.

Fig. 1. A. Localización de Ceuta; B. Sectores en los que se dividió la zona de estudio para la estimación del número total de individuos de C. nigra*.*

intervals) and sector. This methodology has been satisfactorily used by other authors (*e.g.* Sagarin et al., 2007; Espinosa, 2009; Rivera–Ingraham et al., 2011b). As the total length of shoreline inspected varied considerably between locations, these frequency values were standardized by transforming them to percentages (over the total number of recorded individuals in the sector). Additionally, these data were later transformed to log (x + 1) to homogenize variances. An MDS (multi–dimensional scaling) analysis was carried out using PRIMER–E v.6.0 and based on the UPGMA (Unweigh Pair–Group Method using arithmetic means) method and the Bray–Curtis similarity index (Bray & Curtis, 1957). The Kruskal stress coefficient was used to determine ordination (Kruskal & Wish, 1978).

Results

Species' distribution and estimates of total number of individuals

A total of 3,076 individuals were counted during our survey (including both intertidal and subtidal levels) which covered 1,961 m of the coast of Ceuta (12.13% of the total rocky shore that could potentially house *C. nigra* individuals). We estimated that 48,473 individuals can be found in the intertidal and subtidal areas of this coastline (table 1).

The average densities recorded for the main locations surveyed are shown in figure 2. The species had larger populations in the North Bay and populations

Table 1. Data corresponding to each of the considered sectors: Tr. Total rocky shore length (m); N. Number of individuals recorded; Sl. Shore length inspected (m); Te. Total number of individuals estimated

Tabla 1. Datos correspondientes a cada uno de los sectores considerados: Tr. Longitud total de la orilla rocosa (m); N. Número de individuos censados; Sl. Longitud de costa inspeccionada (m); Te. Número total estimado de individuos.

Sector	Sector name	Tr	N	Sl	Te
A	Frontier shoreline and 'Pineo' islet	300	2	100	6
B	'Piedras Gordas' islets and 'Brazo' islet	311	36	311	36
C	Chorrillo and Foso jetties	712	14	200	50
D	Fuentecaballos jetty	350	34	350	34
E	Mellizos–Desnarigado	3,202	28	100	897
F	Desnarigado–Point Sirena	3,472	112	100	3,889
G	San Amaro	959	342	100	3,280
H	Dique de Levante	555	84	100	466
I	Parque del Mediterráneo	463	296	100	1,371
J	Dique de Poniente (concrete block section)	1,156	1,038	50	23,999
J	Dique de Poniente (limestone section)	1,115	367	50	8,184
K	Benítez	316	160	100	506
L	Desaladora–Point Bermeja	1,217	239	100	2909
M	Point–Bermeja–Point Blanca	1,138	84	100	956
N	Point Blanca–Benzú	900	240	100	2,160
Total		16,167	3,076	1,961	48,743

became scarcer towards the South Bay. A Kruskal Wallis test indicated that the average density of individuals in populations in North Bay (6.26 ± 10.80 ind./m) was significantly higher than that recorded for populations in South Bay (0.42 ± 0.69 ind./m) (K = 9.86; p = 0.002).

C. nigra showed an aggregated distribution that was especially patent in areas with the highest number of individuals.

Population structure

All individuals recorded were classified in size classes (established at 1 cm intervals). Figure 3 and table 2 show size structures and general descriptive parameters for each sector (see fig. 3, table 2).

Effect of physical parameters on population structure

A Pearson correlation test was carried out between several physical parameters (nature of substrate, natural/artificial, and substrate heterogeneity) and the most common population parameters (density of individuals per size class, average shell size, maximum and minimum shell size and total density). Results showed the following patterns:

Nature of substrate:

Substrate did not seem to influence any of the population parameters, such as recruit density (F = 2.38; p = 0.14), average shell size (F = 2.77; p = 0.11), maximum shell size (F = 1.03; p = 0.33), or overall density (F = 1.40; p = 0.25).

Effect of substrate heterogeneity on population structure

Figure 4 was produced after conducting the multivariate analyses (based on population size structures). Figure 4A shows how a total of 4 subgroups of populations can be differentiated for a similarity of 70%: sectors I and J were both characterized for presenting the largest percentage of large individuals (75.67% and 67.40% respectively); sector C had the highest percentage of recruits recorded (50%); sectors E, H and M all presented between 25–50% of recruits and more than 65% of medium size individuals; the last group was composed of the remaining sectors, with 45–65% of medium size individuals and up to 41% of large individuals. Taking the results of the MDS analyses into account, we found no clear influence of substrate heterogeneity and accessibility on popula-

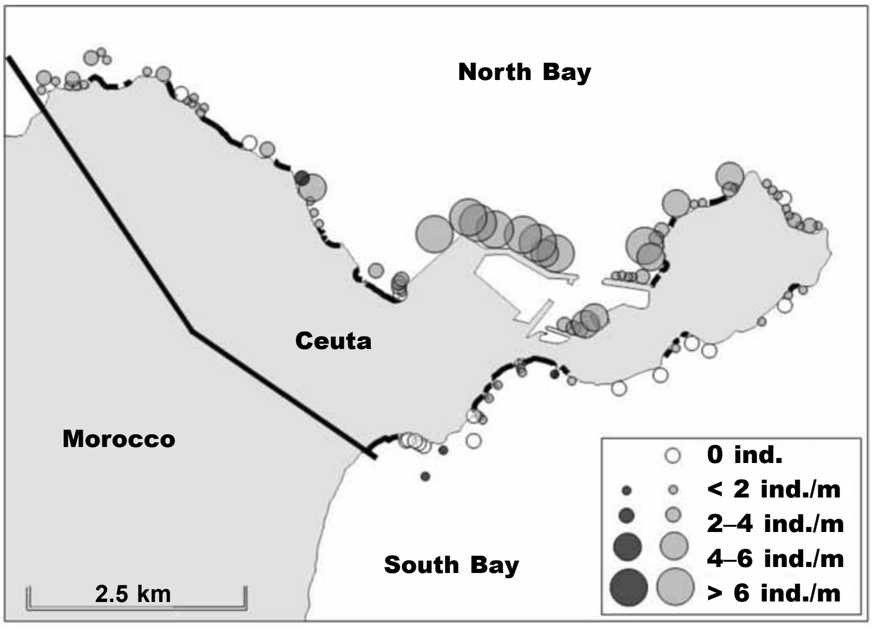

Fig. 2. General distribution of *C. nigra* in Ceuta. Circle diameter corresponds to the density of individuals. Light grey circles indicate the density recorded for each transect established (except for sectors C, D, H, I and K where only some transects are represented because of lack of space). Darker circles represent the density of individuals in an area where a complete census of the coastline was carried out. Coastline sections plotted with thicker lines indicate the location of non–suitable areas (*e.g.* beaches) for the species.

Fig. 2. Distribución general de C. nigra *en Ceuta. El diámetro de los círculos se corresponde con la densidad de individuos. Los círculos claros indican la densidad registrada en cada uno de los transectos realizados (excepto para los sectores C, D, H, I y K para los que sólo se ha representado algún transecto por falta de espacio). Los círculos oscuros representan la densidad de individuos en un área costera tras la realización de un censo completo. Aquellas secciones de costa marcadas con trama más gruesa indican la localización de zonas no útiles para la especie (*p.ej. *playas).*

tion structure. However, the data in figure 5 show how substrate heterogeneity correlated with the density of individuals. Recruitment rates did not vary between substrates, but the density of medium and large size individuals was significantly higher in substrates of low heterogeneity (fig. 5).

To corroborate these results we considered the specific case of 'Dique de Poniente'. This sector presents the same physical parameters throughout the area, except for the fact that half of the breakwater is composed of rocks with high surface roughness, while the other half is made of smooth 3 x 3 m cement blocks. The Kruskal–Wallis test evidenced that the area with the lowest THI had significantly higher densities of *C. nigra* individuals (34.10 ± 8.62 ind./m) than the pier area composed of rugged rocks (7.34 ± 1.23 ind./m) ($K = 5.00$; $p = 0.025$).

Effect of the area's accessibility on population structure

Figure 4B shows no clear pattern regarding the effect of accessibility on population structure. Kruskal–Wallis tests indicated that this factor does not influence any of the population parameters taken into consideration: density of recruits ($K = 0.307$; $p = 0.858$), density of large–size individuals ($K = 1.495$; $p = 0.749$), average shell size ($F = 0.833$; $p = 0.454$) or maximum shell size ($F = 0.974$; $p = 0.404$).

Estimated individual growth rates

We considered two recently created artificial structures: Fuentecaballos (sector D) and the concrete block breakwater area of Dique de Poniente (Sector J). For the former, a density of 0.10 ind./m was recorded, and maximum shell length was 7 cm. Taking into account that this breakwater was finished in April 2005 (J. L. Ruiz, pers. com.), and that the census was carried out in March 2010, we could estimate that individuals had an average growth rate of 1.40 cm/year. The area where *C. nigra* subpopulations reached the maximum shell length recorded for the species, 13.3 cm (February 2010), was Sector J, where there is one of the largest populations of the species in Ceuta (34.6 ind./m). This

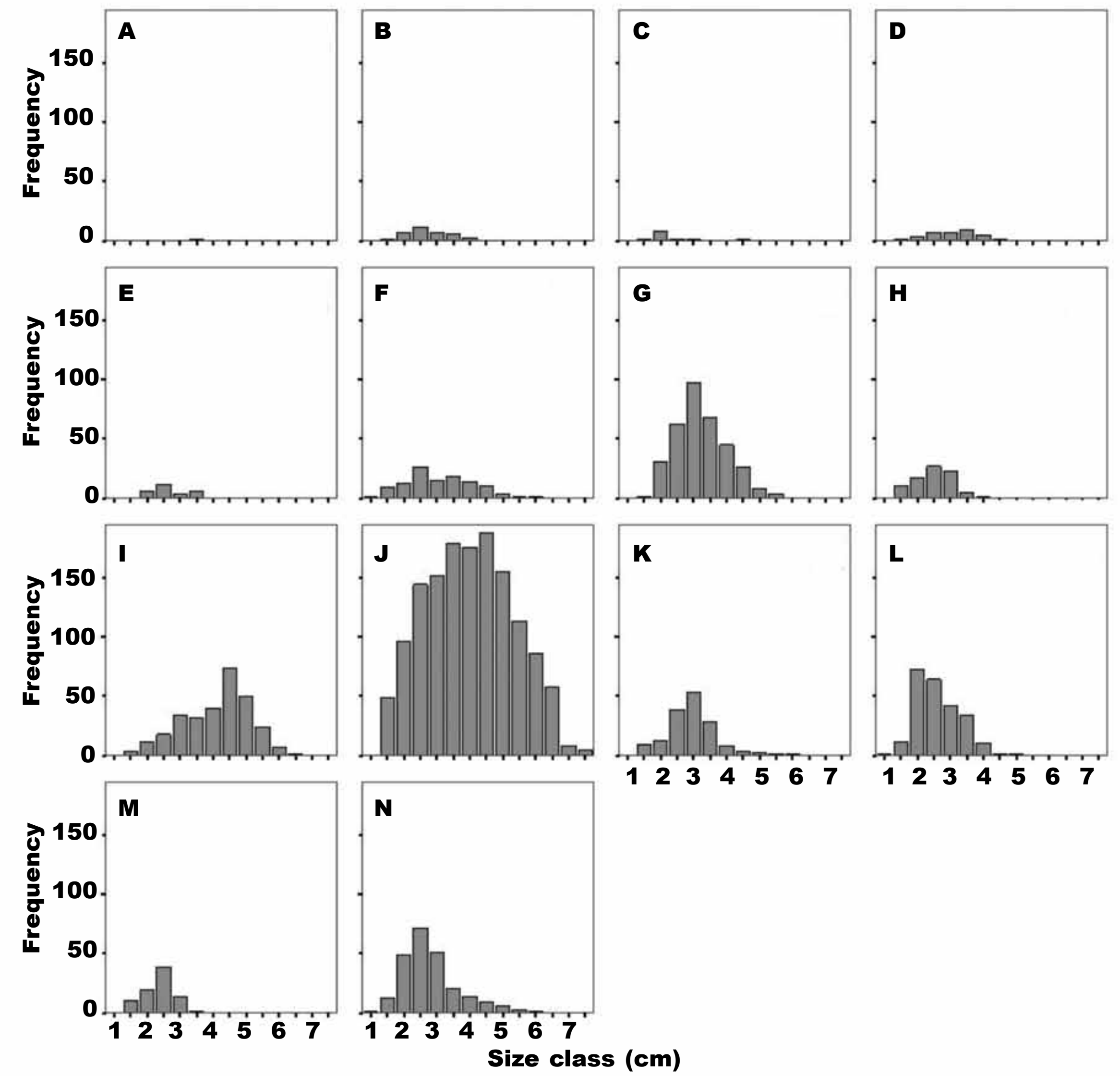

Fig. 3. Size frequencies for each of the sectors considered. Letters correspond to the code used in table 1 and figure 1: 1 (0–1), 2 (2–3), 3 (4–5), 4 (6–7), 5 (8–9), 6 (10–11), 7 (12–13).

Fig. 3. Frecuencias de tamaño para cada uno de los sectores considerados. Las letras corresponden al código usado en la tabla 1 y la figura 1. (Para las abreviaturas de los tamaños de clase, ver arriba.)

area was constructed in the early months of 2004 (J. Medina, pers. com.), so we were able to estimate a growth rate of 2.66 cm/year.

Discussion

After inspecting 12.13% of the coast of Ceuta that could potentially present *C. nigra* individuals, we estimated that there could be about 48,473 individuals in this area. The methodology used to reach this estimate has been used successfully by other authors to calculate the total number of *Patella ferruginea* individuals in places such as Habibas Islands (Espinosa, 2009), Zembra Island (Boudouresque & Laborel–Deguen, 1986) and Ceuta (Rivera–Ingraham et al., 2011b). Although it has been emphasised that it would be of interest to quantify endangered invertebrate populations such as *P. ferruginea* (Paracuellos et al., 2003), this is the first quantification of a *C. nigra* population. It should additionally be considered that our estimates may be conservative, as even though special attention was paid to locating recruits (< 20 mm), this fraction of the population can easily be underestimated (Rivera–Ingraham, 2010). The idea of this estimate being conservative is also supported by the recent location

Table 2. Summary statistics for each *C. nigra* population considered in the study: Sc. Sector; P. Population; D. Density (ind./m); As. Average shell size (cm); Ms. Maximum shell size (cm); K. Kurtosis († Kurtosis is considered significant when its absolute value is greater than 2*SE Kurtosis); Kt. Kurtosis type (Pk. Platikurtic; Lk. Leptokurtic); Sk. Skewness (Skew is considered significant when its absolute value is greater than 2*SE Skew); Am. Asymmetry (P. Positive; N. Negative).

Tabla 2. Estadística resumen para cada subpoblación de C. nigra *considerada en el estudio. Sc. Sector; P. Población; D. Densidad (ind./m); As. Tamaño medio de la valva (cm); Ms. Tamaño máximo de la valva (cm); K. Curtosis († la curtosis se considera significativa cuando su valor absoluto es mayor que el doble de su EE); Kt. Tipo de curtosis (Pk. Platicúrtica; Lk. Leptocúrtica); Sk. Coeficiente de asimetría (la desviación se considera significativa cuando su valor absoluto es mayor que el doble de su EE); Am. Asimetría (P. Positiva; N. Negativa).*

Sc	P	D	As	Ms	K	Kt	Sk	Am
A	Frontier shoreline	0	–	–	–	–	–	–
A	'Pineo' islet	2	5.4	5.40	–	–	–	–
B	'Piedras Gordas' islets	0.12	4.0	6.60	–0.937	–	0.343	–
B	'Brazo' islet	0	–	–	–	–	–	–
C	Chorrillo jetty	0.02	4.60	4.70	–	–	–	–
C	Foso jetty	0.12	2.82	7.10	8.457†	Lk	2.784	–
D	Fuentecaballos jetty	0.10	4.54	7.00	–0.878	–	–0.284	–
E	Mellizos–Desnarigado	0.28	3.28	5.90	–0.749	–	0.560	–
F	Desnarigado–Point Sirena	1.12	4.65	10.00	–0.519	–	0.334	–
G	San Amaro	3.42	4.91	9.50	–0.103	–	0.493*	P
H	Dique de Levante	0.84	3.42	6.00	–0.748	–	–0.134	–
I	Parque del Mediterráneo	2.96	6.67	11.10	–0.461	–	–0.407	–
J	D. Poniente (concrete cube section)	7.34	7.19	8.80	–0.571†	Pk	0.127*	P
J	D. Poniente (limestone section)	34.6	4.38	13.30	–0.468†	Pk	–0.275*	N
K	Benítez	1.6	4.43	10.70	2.178†	Lk	0.938	–
L	Desaladora–Point Bermeja (natural substrate section)	1.16	4.10	8.20	–0.905	–	0.058	–
L	Desaladora–Point Bermeja (breakwater section)	2.32	3.44	7.50	1.081†	Lk	0.838*	P
M	Point Bermeja–Point Blanca	0.84	3.15	5.90	0.179	–	–0.048	–
N	Point Blanca–Benzú	2.40	4.09	10.40	1.675†	Lk	1.223*	P

of isolated subtidal rocks (1–5 m deep and with no intertidal regions) on Ceuta's North Bay, within the limits of sectors L and M. These structures are around 150–250 m from the coast and are fully colonized by large *C. nigra* individuals. Our preliminary observations indicate that around 220 individuals could be living in these areas. However, further surveys are needed to determine the presence of similar sublitoral regions in the area.

The density of *C. nigra* individuals on the coast of Ceuta is clearly influenced by the location of the population. The largest populations were located in North Bay, which is mainly influenced by Atlantic waters. It was in this area where a contagious distribution pattern was especially patent, agreeing with the results previously obtained by Rivera–Ingraham et al. (2011a). However, these populations become scarcer as we moved southwest. This is a predictable pattern considering that *C. nigra* is a typically Atlantic species. This distribution contrasts with that shown by *P. ferruginea*, endemic to the Mediterranean, and mainly distributed in South Bay (which has a greater Mediterranean influence) (Rivera–Ingraham et al., 2011b).

No significant differences were obtained between populations located on artificial or natural substrates. One of the main differences between natural and artificial surfaces is their heterogeneity (Bulleri & Chapman, 2010). The substrates presenting the highest irregularities showed coefficients higher than 1.30 (using the equation provided by Blanchard & Bourget, 1999) and around 1.017 (Rivera–Ingraham, 2010) using fractal dimensions (Mandelbrot, 1967),

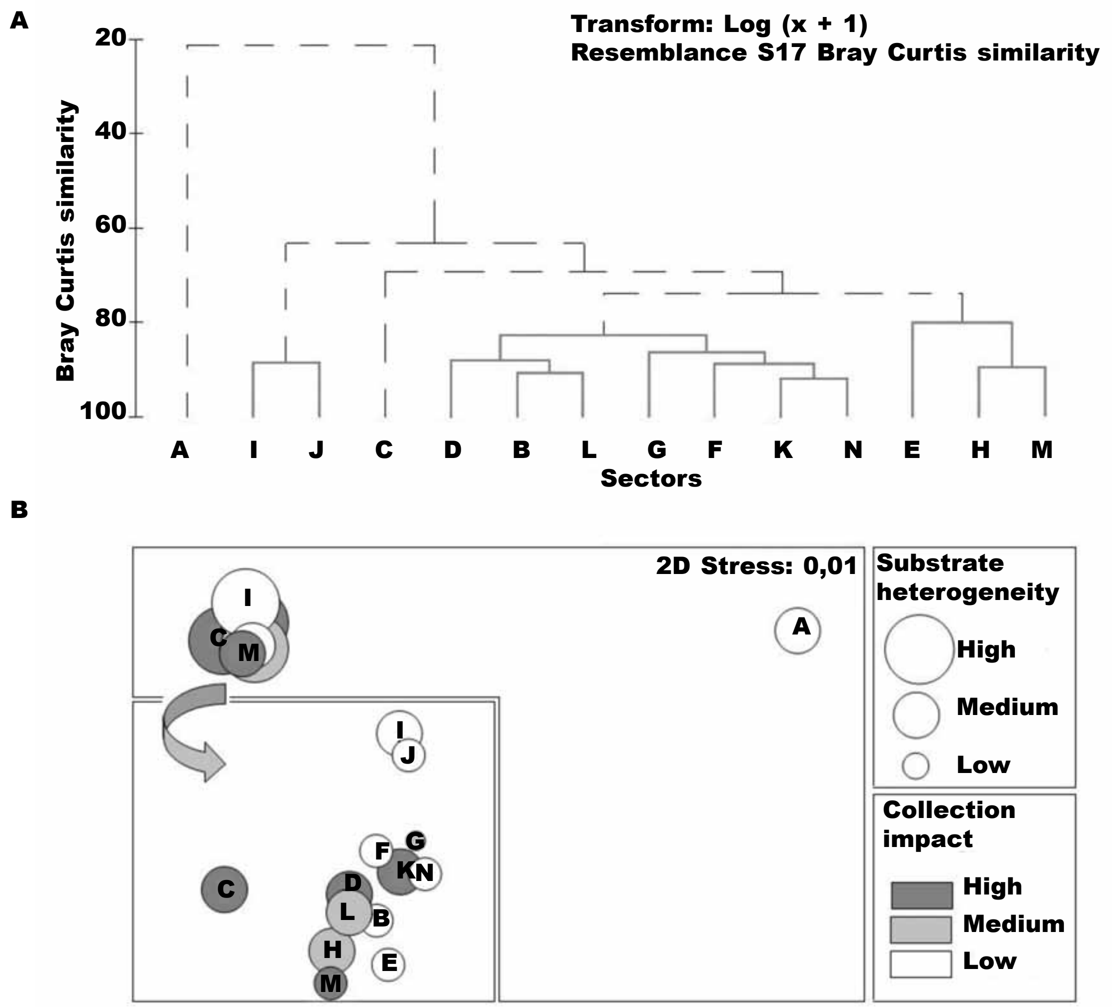

Fig. 4. Multivariate analyses: A. Cluster analysis (continuous lines indicate significantly different groups, SIMPROF analysis, $p < 0.05$); B. Spatial representation of centroids (MDS) for each sector: circle diameter is positively correlated with the area's substrate roughness (THI) (Blanchard & Bourget, 1999): high (> 1.30), medium (1.15–1.30), low (< 1.15); colours are associated with the different grades of impact by collection suffered by individuals in the area: high (easily accessible areas, where is common to find people collecting intertidal macro–invertebrates), medium (areas of relatively easy access, although they do not present high impact by collection), low (areas with difficult or no access by land to the intertidal fringe, and where no people have been seen).

Fig. 4. Análisis multivariante: A. Análisis de conglomerados (las líneas continuas indican grupos significativamente distintos, análisis SIMPROF de perfil de similitud, p < 0,05); B. Representación espacial de los centroides (MDS, escalamiento multidimensional) para cada sector: el diámetro de los círculos está correlacionado positivamente con la rugosidad del sustrato de la zona (THI, índice de heterogeneidad topográfica) (Blanchard & Bourget, 1999): alta (> 1,30), media (1,15–1,30), baja (< 1,15); los colores se asocian con los distintos grados de impacto debido a la recolección sufrida por los individuos de la zona: alta (áreas muy accesibles, donde es común ver gente recolectando macroinvertebrados intermareales), media (áreas de acceso relativamente fácil, aunque no presentan un gran impacto de recolección), baja (áreas sin acceso o con un acceso difícil desde tierra a la franja intermareal, donde no se ha visto a nadie recolectando).

according to an adapted method from Beck (2000) and using profile gauges to obtain rock profiles as in Frost et al. (2005). Irregularities in substrates are associated with high recruitment rates (as these structures can enhance settlement and provide shelter for juvenile limpets) (*e.g.* Creese, 1982). This is also true for other limpet species such as *P. ferruginea* (Rivera–Ingraham et al., 2011b). However, no dif-

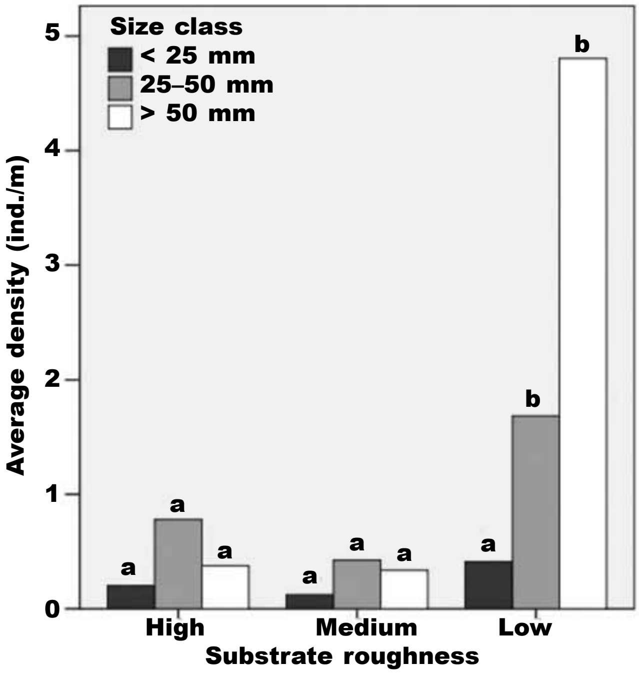

Fig. 5. Average density values recorded for populations located on substrates of high (THI > 1.30), medium (THI = 1.30–1.15) and low (THI < 1.15) roughness (measured using equation provided by Blanchard & Bourget, 1999). Results are divided into three size classes (< 25 mm, 25–50 mm, > 50 mm). Values associated with the same letter (a, b) and colour belong to the same roughness subset based on a one-way ANOVA and a *a posteriori* multiple comparison test Student–Neuman–Keuls.

Fig. 5. Valores promedio de densidad registrados para poblaciones localizadas sobre sustratos de alta (THI > 1,30), media (THI = 1,30–1,15) y baja (THI < 1,15) rugosidad (medida utilizando una ecuación proporcionada por Blanchard & Bourget, 1999). Los resultados se dividen en tres clases de tamaño (< 25 mm, 25–50 mm, > 50 mm). Los valores asociados con la misma letra (a, b) y color pertenecen al mismo subconjunto de rugosidad, basándose en un ANOVA de un solo factor, y un test de Student–Neuman–Keuls de comparación múltiple realizado a posteriori.

ferences in recruitment rates were detected among different substrates for *C. nigra.* Therefore, some other factor could influence recruitment (aside from the physical influence of the substrate's irregularities). Previous studies have shown that the species is not homogenously distributed on the coast, and that is has an aggregated distribution (Rivera–Ingraham et al. 2011a). This was later attributed to the possibility that *C. nigra* larvae are attracted by adult conspecifics through chemical signalling (Rivera–Ingraham et al., 2011c), as occurs in other mollusc species (Morse et al. 1979; Hadfield, 1984; García–Lavandeira et al., 2005; Mesías–Gansbiller et al., 2008). Small scale topographical heterogeneity did influence the density of medium sized and large individuals, increasing as THI decreased. Based on these facts, it appears that a high topographical index may indeed favour recruitment, while on smooth surfaces recruitment may be equally important thanks to the influence of the presence of adult individuals.The area's accessibility may highly influence population structures in intertidal communities. It has been frequently observed that human collection of organisms reduces population density and preferentially affects the largest fraction of populations. This is true for giant limpets such as *Lottia gigantea* (Kido & Murray, 2003), and *P. ferruginea* (Espinosa et al., 2009; Rivera–Ingraham, 2010). It is true that the largest *C. nigra* individuals were found at Parque del Mediterráneo (11.10 cm) and at the concrete block breakwater area of 'Dique de Poniente' (13.30 cm). These areas show low THI and are hard to access, the former because it is private property, and the latter because it is physically difficult to reach. The low collection rate in these port areas can be explained by their inaccessibility and also by the fact that people are usually reluctant to consume organisms from port areas (presumably living in more polluted waters) (Doneddu & Manunza, 1992). This in turn favours the survival of large individuals (Espinosa et al., 2009). However, no statistical differences were recorded among the three groups of populations, and all of them showed similar mortality rates. This could be partly due to the fact that *C. nigra* shells, regardless of the enormous sizes they can reach, lack radial ribs or vivid colours (see Rivera–Ingraham et al., 2011a), so they are not as conspicuous as limpet species like *P. ferruginea*. Moreover, the species shows a clear vertical segregation, with the largest individuals being located in the lower intertidal areas or even at subtidal levels (Rivera–Ingraham et al., 2011a). Because of this, shells are usually colonized by macroalgae tuffs such as *Corallina elongata* (Rivera–Ingraham, 2010), making individuals even less noticeable.

Finally, two recently created artificial structures provide additional interesting information regarding individual growth rates: Fuentecaballos (sector D) and the new area of 'Dique de Poniente' (sector J). For the former, individuals should have an average growth rate of 1.40 cm/year, while for the latter, values would be around 2.66 cm/year. It has previously been observed that growth rates in the species highly depend on the age of the individuals, and smaller/ younger individuals show higher growth rates than larger/ older individuals (Rivera–Ingraham, 2010). The same study also determined that for well established populations (*e.g*. Parque del Mediterráneo or *C. nigra* populations located in Algeciras Bay), *C. nigra* individuals showed an average growth rate of 0.95 cm/ year (being 2.6 and 0.1 cm/year for individuals with initial sizes of < 3 and > 10 cm respectively). For both structures, values are considerably greater than those recorded in normal conditions. The same was observed for *P. ferruginea* (Rivera–Ingraham et al., 2011b) and these differences were attributed to the fact that the recorded individuals were probably the first to colonize these new structures (with abundant microalgae biofilm and almost no fauna). If this were the case, newly settled individuals would have abundant trophic resources at their disposal and this could result in higher growth rates than those for individuals that settle in areas with well developed subpopulations (where individuals would have to compete for space and food) (Branch, 1975). Furthermore, a shore may contain individuals in very different conditions of wave exposure or emersion. It may be inappropriate to average the population dynamics of such assemblages at the shore scale when demographic rates are likely to vary greatly within shores (Johnson, 2006).

The present study provides the first quantitative data of a *C. nigra* population. We recommend, however, that this work be repeated in coming years in order to monitor the evolution of the species and to promptly implement adequate conservation measures if needed.

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