

# Relationship between condition and recruitment success of red shrimp (*Aristeus antennatus*) in the Balearic Sea (Northwestern Mediterranean)

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## Abstract

This study evaluates the reproductive potential and condition of the red shrimp (*Aristeus antennatus*) population inhabiting the waters around the Balearic Islands (Northwestern Mediterranean Sea), between 1991 and 2004. Red shrimp is one of the most valuable exploited demersal fishery resources in the western Mediterranean. To assess the condition of this species, we use two indices based on weight and length data, one including the gonad weight and another excluding it. Different biological parameters of the population dynamics and reproductive biology, such as sex-ratio, maturity, gonadosomatic index and presence of the spermatophore in females have also been analysed. A negative relationship was found between the gonadosomatic index and the condition of red shrimp, indicating that energy reserves are transferred from the body to the gonad during the reproductive period. The condition of adults reached minimum values during the maturation and spawning period after mating, when the gonadosomatic index, the spermatophore presence in females and the proportion of females in the population were highest. The relationship between the condition of adults during the months prior to spawning and the number of recruits in the following year was significant and positive. This relationship was stronger when only male condition was considered, suggesting that males have an important role on the reproductive potential of this species. Overall, our results suggest that condition of red shrimp, particularly males, is an important aspect for the reproductive and recruitment success of this species. The observed decreasing trend in male condition over years may raise concern on the future reproductive potential of that population.

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**Keywords:** Red shrimp; Sex-ratio; Size at maturity; Reproductive and recruitment potential; Condition index; Balearic Islands

## 1. Introduction

The evaluation of the reproductive and recruitment potential of exploited stocks has become increasingly

important in studies of population dynamics (Marshall et al., 2000; Lambert et al., 2003; Hutchings, 2005). Recent studies have shown that the physiological condition of individual organisms affects their reproductive and recruitment potential by way of the fecundity, egg quality, larvae survival and maturity (reviewed by Lambert et al., 2003). Inadequate energy reserves have

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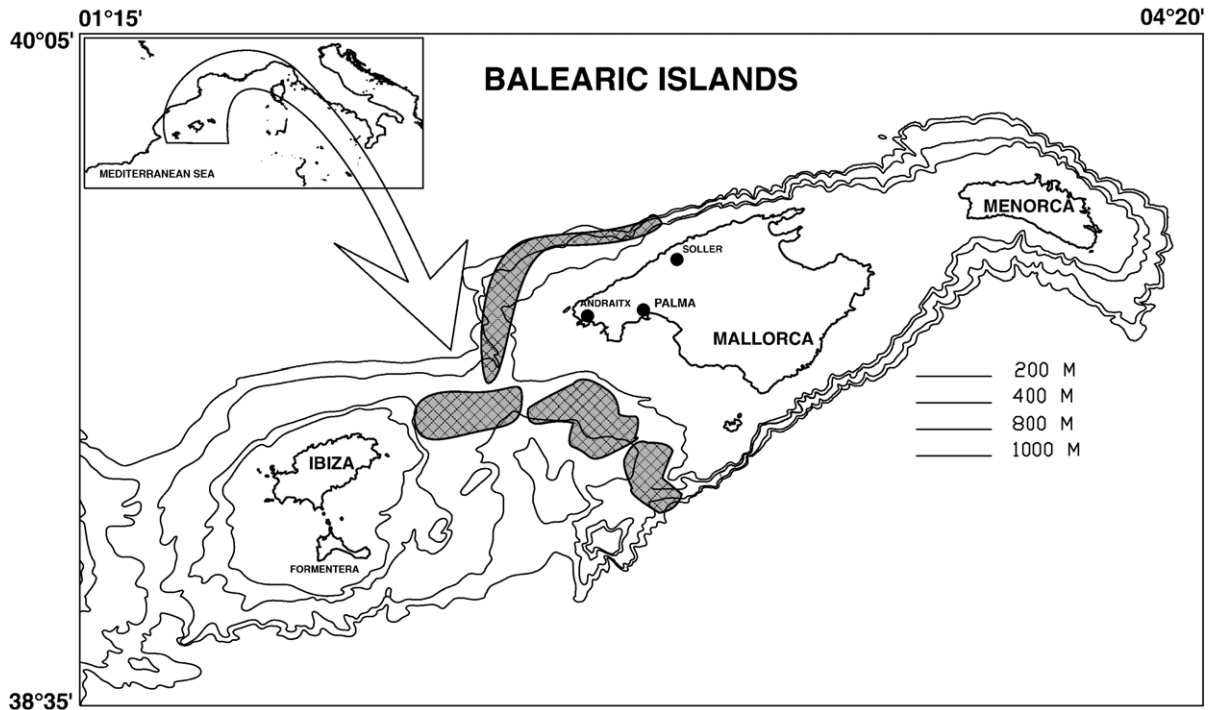


Fig. 1. Map of the Balearic Islands (northwestern Mediterranean) showing in dark colour, the four fishing grounds around the islands where red shrimp (*Aristeus antennatus*) were collected. From the Southeast to Northwest: Fishing ground of Cabrera; Sa Badia; Es Gambussi; Es Clots-Sóller.

been related to reduced reproductive potential of fish stocks (Kjesbu et al., 1998; Marshall and Frank, 1999; Rätz and Lloret, 2003). Their poor condition may also decrease the chances of the fish's survival, leading to an increase in natural mortality (Shulman and Love, 1999). All these studies indicate that the dynamics of exploited populations is affected by the condition of spawners, which at the same time depends on the fishing activity, environmental variability and food availability (Shulman and Love, 1999; Lloret et al., 2001; Kurita et al., 2003).

The red shrimp (*Aristeus antennatus*, Risso 1816) is one of the most valuable resources exploited by trawlers in the deep waters (500–800 m depth) surrounding the Balearic Islands (Northwestern Mediterranean Sea). Adult females predominate in the exploited population, while males and recruits are spread over a deeper depth range (Sardà and Demestre, 1987; Sardà and Cartes, 1997; Cartes and Demestre, 2003; Sardà et al., 2004). The spatial and temporal changes in the red shrimp population inhabiting the southern Balearic Islands are the result of the life cycle characteristics and seasonal fluctuations of environmental factors (López-Jurado et al., 2001; Carbonell, 2005). Furthermore, changes in size and stock composition are due to mating, spawning and recruitment events (Demestre, 1995; Carbonell, 2005). Differences in lipid composition and in ovary weight increments have been observed

during these reproductive phases (Rosa and Nunes, 2003). The red shrimp is a synchronous spawner and the reproductive period occurs during spring and summer with peaks in June, July and August (Relini-Orsi and Pestarino, 1981; Demestre and Fortuño, 1992; Carbonell et al.,

Table 1

Parameters used to calculate the relative condition factors ( $K_n$ ,  $K_{ne}$ ) of red shrimp (*Aristeus antennatus*), in the period 1992–2003 for  $K_n$  and for the period 1991–1994 for  $K_{ne}$ . a and b are the coefficients of the length–weight relationship  $W=aL^b$

	Value	$r^2$ adj.	DF
$K_n$ Females			
(a)	0.00244	0.9644	12843
(b)	2.4536		
$K_n$ Males			
(a)	0.00246	0.9301	4515
(b)	2.4311		
$K_{ne}$ Females			
(a)	0.00274	0.9631	2986
(b)	2.4324		
$K_{ne}$ Males			
(a)	0.00794	0.8278	1561
(b)	2.0926		

$r^2$  adj (adjusted correlation coefficient), degrees freedom  $DF=(n-2)$ .

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