Insular stock identification of *Serranus atricauda* (Pisces: Serranidae) through the presence of *Ceratothoa steindachneri* (Isopoda: Cymothoidae) and *Pentacapsula cutanea* (Myxozoa: Pentacapsulidae) in the Canary Islands*

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SUMMARY: *Ceratothoa steindachneri* (Isopoda: Cymothoidae) and *Pentacapsula cutanea* (Myxozoa: Pentacapsulidae) parasites infecting the blacktail-comber (*Serranus atricauda*) were considered suitable as biological tags for stock identification around the islands of La Palma and Gran Canaria, in the Western and Eastern areas of the Canarian archipelago, respectively. The ecological parameters of both species differed significantly between the islands. While individuals caught off La Palma showed a high degree of infection by the isopod, a single infected fish was found off Gran Canaria. Also, the myxozoans showed a high level of infection on fish from Gran Canaria but it was reported on only a single specimen from La Palma.

Key words: Canary Islands, *Serranus atricauda*, parasites, *Ceratothoa steindachneri*, *Pentacapsula cutanea*.

RESUMEN: – *Ceratothoa steindachneri* (Isopoda, Cymothoidae) y *Pentacapsula cutanea* (Myxozoa, Pentacapsulidae) se consideran marcadores biológicos adecuados para la identificación de stocks de la cabrilla (*Serranus atricauda*) en las islas de La Palma y Gran Canaria, en las áreas occidental y oriental del Archipiélago Canario, respectivamente. Los parámetros ecológicos para ambas especies difieren significativamente entre islas. Mientras que los peces capturados en La Palma muestran un alto grado de infestación por el isópodo, sólo se encontró un único individuo afectado por este parásito en Gran Canaria. También, el myxozoo mostró un alto nivel de infestación sobre los peces procedentes de Gran Canaria, aunque únicamente se encontró en un pez muestreado en La Palma.

Palabras clave: Islas Canarias, *Serranus atricauda*, parasitos, *Ceratothoa steindachneri*, *Pentacapsula cutanea*.

INTRODUCTION

The blacktail-comber, *Serranus atricauda* (Günter, 1874), is a benthic and highly territorial species which is abundant on rocky bottoms from the coastline to 150 m depth all around the Canary Islands (Brito, 1991). This species is mainly caught with traps and handline, according to traditional small-scale fishery techniques (Bas *et al*., 1995).

Due a significant decrease in the catches since the second half of the 1980s, the Canarian Government established a minimum length of capture (15 cm total length) for the Archipelago (Laws 154 and 155; 9 October 1986). In this general regulation, it is

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assumed that the blacktail consists of a single exploited stock with population parameters common for all the islands. However, recent investigations (Castro *et al*., 2002) suggested that there is sufficient evidence to assume the existence of different stocks located around each of the islands. Brito *et al*. (1996) noted the existence of perceptible differences in the specific fauna composition, particularly between the Eastern and Western islands due to the great depths between islands (2000-3000 m depth) and the Canary Current. These observations led us to examine whether there are any different stocks associated with each insular shelf (Lanzarote and Fuerteventura are considered as a single unit with a continuous shelf between the two islands).

Different techniques are used for stock differentiation (including morphometric and meristic differences, genetic analysis, and differences in the growth rate, fecundity, spawning period and parasitological fauna composition) (Guerra-Sierra and Sánchez-Lizaso, 1998). The application of these methods depends on simplicity, number of samples and, in a general context, the cost-effectiveness of the results obtained. Parasites are thus considered as biological tags (Kennedy, 1979; Chenoweth *et al*., 1986; Leaman and Kabata, 1987; Lester, 1990; Dalton, 1991; MacKenzie and Longshaw, 1995; Grutter, 1998) and the analysis of their geographical distributions is an excellent source of information on the movements of the host fish species (Campbell *et al*., 1980; Wichowski, 1990; Carbonell *et al*., 1999). Although such an analysis may allow us to discriminate between distinct fish populations or stocks, the unequivocal discrimination usually requires methods based on genetics.

In assessing movements in fish species, parasites may have two advantages over conventional tags: they can indicate mass migration more readily, and data are less expensive to obtain because no recaptures are necessary. The most important criterion for selecting a parasite species as a tag is its longevity on the host species: while short-lived parasites may give short-term information on the movements of the host species, long-lived parasites may be more appropriate to reveal longer term tendencies in the migrations of the hosts (Sindermann, 1983; Lester, 1990; MacKenzie and Abaunza, 1998; Margolis, 1998).

METHODS

Fish specimens (N = 1325) were collected by means of traps and handline at a monthly rate of 50 individuals off Gran Canaria (N = 512) and La Palma (N = 813), from January 2000 to March 2002 (Fig. 1).

In the laboratory, the individuals were measured to the nearest centimetre, weighed and sexed. Integument, fins, natural openings and gills on each individual were examined both to locate and sample the parasites. Any pathological alterations on the hosts were recorded and cysts and tumours were fixed and preserved in buffered formalin (6%) for histological analysis. Parasites were collected and their number, size (measured with a micrometer) and shape were recorded. Subsequently, they were preserved in ethanol (70%) and classified to the species level. For taxonomic classification, the parasites were observed under either stereoscopic or

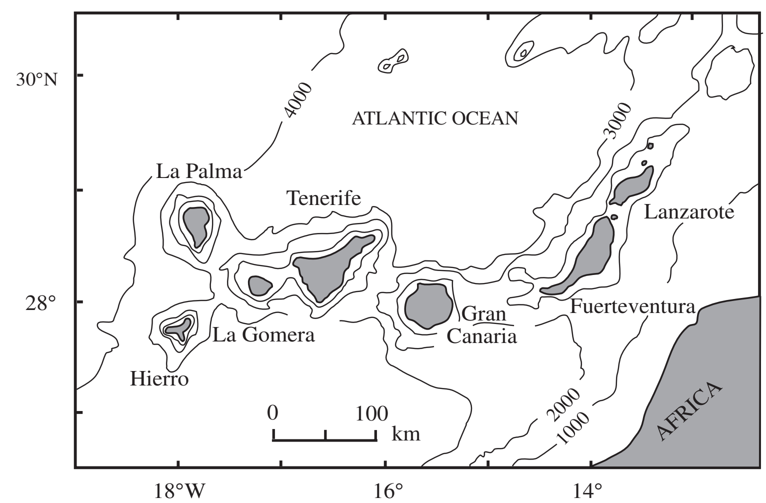

FIG. 1. – Bathimetric chart of the Canary Islands (Central-East Atlantic).

TABLE 1. – Ecological parameters of *Ceratothoa steindachneri* and *Pentacapsula cutanea*, parasites associated with *Serranus atricauda* caught off Gran Canaria and La Palma islands from January 2000 to March 2001.

		Infected fishes	No. parasites	Prevalence	Abundance	Intensity	Range
Ceratothoa steindachneri	Gran Canaria	1	1	0.22	0.0022	1	
	La Palma	36	47	4.43	5.79	1.31	1-2
Pentacapsula cutanea	Gran Canaria	16	33	3.54	0.073	2.063	1-3
	La Palma	1	1	0.12	0.0012	1	

optic microscopes and were identified following the different dichotomy keys that are in use (Trilles, 1968; Bruce and Bowman, 1989, for Cymothoidae; Richardson, 1905, for Gnathiidae; Lom and Dyková, 1992, for Myxozoa; Skryabin *et al*., 1991 for Nematoda). Prevalence, intensity, abundance and range of infection were determined according to Bush *et al*. (1997).

RESULTS

Four species of parasitic taxa were identified: (i) a myxozoan parasite, the Pentacapsulidae *Pentacapsula cutanea* Naidenova and Zaika, 1970, appearing as a skin cyst; (ii) a parasitic hirudinean, the leech Pontobdella (*Pontobdella* sp.) and two isopods crustacean; (iii) the cymothoid *Ceratothoa steindachneri* Koelbel, 1878 (not previously reported from Canary Islands), found in the oral cavity around the mouth and on the fins; and (iv) the gnathiidae *Gnathia* sp., found on gills and operculum. Due to abundance and frequency, we considered *C. steindachneri* and *P. cutanea* only as tags.

From the total number (N = 36) of collected *Ceratothoa steindachneri,* 21 were females and 15 males. They were mainly found in the oral cavity of the host, although some were located on both pectoral and caudal fins (a position that is not habitual and is probably caused by the death of the fish). The mean length was 21.94 mm and 11.82 mm for females and males respectively. Otherwise, *Pentacapsula cutanea*, which appears as round white-yellowish cysts (1-1.5 mm in size), were located in the musculature, along the body. Cysts are characterised by thousands of spores up to 13-14 µm in diameter with the presence of five polar capsules.

The ecological parameters of the parasites which infect *Serranus atricauda* for both islands are shown in Table 1. The frequency of fish infected by *Ceratothoa steindachneri* was higher in the sample from La Palma than that from Gran Canaria, where a single isopod was found. The infection rates (prevalence, intensity and abundance) were significantly higher in the sample from La Palma than in that from Gran Canaria (Fisher's exact probability test, chi-square= 17.27; $p< 0.001$). Also, the infection pattern was significantly different between the islands (Friedman ANOVA, $p< 0.005$).

Similar but inverse results were obtained for *Pentacapsula cutanea.* The infection rate by the myxozoans was significantly higher for fish caught off Gran Canaria (Fisher's exact probability test, chi-square= 24.70; $p< 0.001$) because a single individual in the sample from La Palma showed this parasite. On the blacktail-combers sampled off Gran Canaria, cysts were observed during the months of January, February and June while the single infected individual from La Palma was caught in July.

DISCUSSION

Differences in the infection rates by *Ceratothoa steindachneri* and *Pentacapsula cutanea* on *Serranus atricauda* may suggest the existence of local stocks associated with the waters that surround each of the islands (Gran Canaria and La Palma are, in a straight line, 250 km. apart; Fig. 1). Our results are in agreement with those reported by Castro *et al*. (2002), who suggested that the population of blacktail comber at the Canary Islands consists of several local stocks, with phenotypic and populational dynamic features that differ between the islands.

These local variations may be possible due to the physical barrier imposed by depths of over 3000 m, which may prevent the migration of adults between the islands but not the drift of eggs and larvae. This partial geographic isolation and the local climatic differences between the islands certainly has an influence on the abundance of parasites. This is also reflected in the fish fauna composition between the eastern and western Islands (Brito, 1984; Brito *et al*., 1996).While the eastern islands (from east to west, Lanzarote, Fuerteventura and Gran Canaria) are under the influence of the north-west African upwelling (Bas *et al*., 1995; Rodríguez *et al*., 1999), the western ones (Tenerife, Gomera, La Palma and Hierro) are more oceanic, and influenced by thermal fronts approaching from the Central Atlantic (Castro and Ramos, 2002). For instance, the sea surface temperature difference can reach 5ºC between La Palma and Fuerteventura (A.G. Ramos, Univ. Las Palmas G.C.; pers. comm.).

Otherwise, it is well known that parasites are potentially useful as biological tags and their environmental specificity allows host movements to be determined (Sindermann, 1983; Lester, 1990; Wichowski, 1990; Carbonell *et al.* 1998, 1999; Grutter, 1998), because fish can acquire parasites during their movement between areas. Also, due to their high specificity, parasites may indicate local, bioecological features between both individuals and populations or stocks from areas with different conditions (Margolis, 1998). Royce (1984) pointed out that since larval or juvenile fish acquire parasites and carry them (or the scars) during their lifetime, they are considered as good markers for the geographic origin, allowing them to be identified to a specific stock.

Both *Ceratothoa steindachneri* and *Pentacapsula cutanea* may be suitable as biological tags and marks for the spatial origin of *Serranus atricauda.* The parasites leave a well-defined scar after the death of the host (Trilles, 1986; Charfi-Cheikhrouha *et al*., 2000; Moran *et al*., 1999) and their time span is sufficiently long for an investigation (Trilles, 1964; 1991). Infections of cymothoid or myxozoan parasites are produced by contact between healthy and infected individuals (Moran *et al*., 1999; Horton and Okamura, 2001; Papapanagiotou *et al*., 1999; Papapanagiotou and Trilles, 2001). Therefore, the fact that a single fish infected by *C. steindachneri* and *P. cutanea* was found in Gran Canaria and La Palma respectively may indicate that under certain climatic conditions an oceanic east-west or vice versa transport of larvae and/or juveniles between the islands may be possible.

The east-west larval transport was confirmed by Rodríguez *et al*. (1999), who found sardine and anchovy larvae off Gran Canaria drifting into filament structures from the north-west African upwelling. These upwelling filaments have been observed to reach as far as the west of El Hierro island, the westernmost island of the Canary archipelago (A.G. Ramos, Univ. of Las Palmas G.C.; personal communication). Moreover, the stagnation point and the lee areas of retention for neritic fish eggs and larvae up and downstream of the islands respectively (Rodríguez *et al*., 2001) can work to disperse larvae between the closest islands. Otherwise, west-east surface larval transport can occasionally be due to the south-westerly winds from September to March (P. Sangrá, Univ. of Las Palmas G.C.; personal communication). Hence, the parasites could infect fish larvae and/or juveniles at the level of an island and drift with their host towards another island.

Under the environmental regime to which both host and parasite drifted, some conditions may allow the parasites to survive but not colonise. This could be due to three main factors:

(i) The newly approached local environment may not be appropriate for the intermediate hosts, which are necessary to complete the reproductive cycle of the parasite. However, it seems that this is not the case here, because both parasites have a monoxene cycle and, once fixed to their host, they complete their life cycle and do not require intermediate hosts (Trilles, 1991);

(ii) The new environmental conditions may have negative effects on the parasite metabolism, allowing them to survive but preventing their reproductive process. It is known that the reproductive processes are very sensitive to temperature, photoperiod and quality of food. (Calderon, 1989; Reynolds and Casterlin, 1980);

(iii) For *Ceratothoa steindachneri*, the probability of finding an individual of the opposite sex in the new area could be uncertain or very low.

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