NOCTURNAL ACTIVITY OF A BLENNY *LIPOPHRYS TRIGLOIDES* (PISCES, BLENNIIDAE) AT THE SPANISH MEDITERRANEAN COAST

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Nocturnal activity of a blenny Lipophrys trigloides *(Pisces, Blenniidae) at the Spanish Mediterranean coast.*– Specimens of this species were observed at night (20.45 h to 03.30 h) at Cala de la Mora (Tarragona, Spain) and other sites along the coast of Catalonia during snorkeling excursions in 1990 (January, April, July, September and December). *L. trigloides* could be seen moving on the surface of rocky substrate, away from shelter and in general close to the surface. Other blennies were generally not active at night. Regular members of the nocturnally active fish assemblage in the rocky litoral of the site were *Scorpaena* spp., *Gaidropsarus mediterraneus* and *Gobius cobitis*. Nocturnally active *L. trigloides* were significantly larger than specimens caught during the day. The position of food items in their guts suggest that the purpose of nocturnal activity is feeding.

Key words: Blenniidae, *Lipophrys trigloides*, Nocturnal behaviour, Feeding, Depth of sojourn.

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INTRODUCTION

Lipophrys trigloides is one of the 19 Blenniid species of the Mediterranean coast and is quite abundant in the upper litoral zone. Its general pattern of activity was described as strikingly reduced compared to other Blenniidae (ZANDER, 1972) and further investigations showed nocturnal terrestrial sojourns (HEYMER, 1982; ZANDER, 1983; LOUISY, 1987). Its nocturnal behaviour under water has not been described, and no underwater observation of nocturnal activity of any blenniid species exists.

While exploring resource utilization strategies of Blenniidae in the Mediterranean (NIEDER, 1992) specimens of *Lipophrys trigloides* were regularly found outside their holes during darkness. Repeated underwater observations throughout the year 1990 showed that this behaviour is not a phenomenon restricted to a particular time of year.

This paper describes the occurrence of nocturnal activity of *L. trigloides*, their depth distribution at night, length of specimens and gut contents analyses.

MATERIAL AND METHODS

1. Field observations

Surfaces of rocks and large crevices were searched for fish while swimming along a shore transect (length: 73 m) (fig. 1) below the Torre de la Mora (Playa la Mora, Cala de la Mora, Tarragona, Spain) at night with an underwater torch. The transect was searched on three nights each in April, July and September 1990 and on two nights in December 1990.

The Blenniidae, Gadidae, Gobiidae, and Scorpaenidae found exposed on the surface of the substrate were counted. As blennies usually use holes for shelter (KOTRSCHAL, 1988), specially during the night, they could be assumed to be "active". The depth of each fish below the surface was estimated to the nearest 10 cm and recorded on a plastic slate. Inactive ("sleeping") fish like *Diplodus* spp. were ignored. Blennies inside their holes could not be counted, because they usually hid so deep within their shelter that the light of the torch did not reach them. So, it was technically impossible to count the total population of blennies at night.

In order to determine whether nocturnally active *L. trigloides* represent the whole population of this species at Cala de la Mora, the number of daytime sightings of *L. trigloides* was estimated on the basis of an average sighting frequency per running meter of shoreline. In contrast to the number of nocturnally active *L. trigloides* it includes *L. trigloides* moving around on the rock surface (which were rare) and *L. trigloides* resting in their holes.

Field observations of nocturnally active *L. trigloides* –without fixed transects– were also made in July 1990 at other sites in northern Catalonia (table 1). They were Sa Riera, Cala Montgó, Port Lligat, Colera (all Prov. Girona). Similar nocturnal observations in Moneglia (Liguria, Italy) in February 1989 and in Banyuls-sur-Mer (France) in September 1990 were carried out

2. Food analysis

Specimens of *L. trigloides* were caught in plastic bags and immediately preserved in 10% formalin.

Each fish was measured to the nearest 1 mm, and weighed to the nearest 0.01 g.

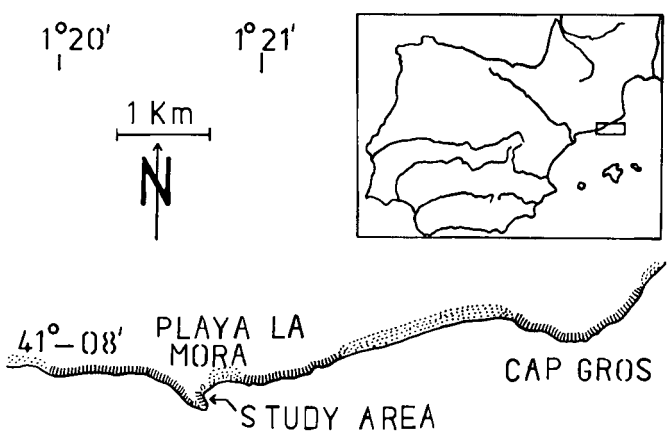

Fig. 1. Situation of study area: Sandy beaches; Rocky shore.
Situación del área de estudio: Playas de arena; Litoral rocoso.

Table 1. Observations of nocturnally active *L. trigloides* at the coast of Catalonia
Observación de L. trigloides *activos durante la noche en la costa catalana.*

Locality	Date	Time
Cala de la Mora (Tarragona)	I 90	19.00h-20.00h
Cala de la Mora	IV 90	21.15h-23.30h
Cala de la Mora	VII 90	22.00h-23.00h
Sa Riera (Girona)	VII 90	22.00h-22.30h
Cala Montgó (Girona)	VII 90	22.20h-23.45h
Port Lligat (Girona)	VII 90	22.30h-23.30h
Colera (Girona)	IX 90	21.00h-21.30h
Cala de la Mora	IX 90	20.45h-03.30h
Cala de la Mora	XII 90	20.20h-21.30h
Torredembarra (Tarragona)	XII 90	21.00h-21.30h

The gut was removed and measured, then its contents identified and sorted out. The volume of the gut contents and its qualitative and quantitative composition was measured.

The analysis of gut contents was performed on 12 specimens from Cala de la Mora. Additionally, three specimens from Moneglia (Liguria, Italy), two specimens from L'Escala (Girona, Spain) and two specimens from Banyuls-sur-Mer (France), all caught at night, were dissected.

Frequencies of food items (= percentage of individuals in which a certain food item was found) were determined. The volume of each type of food was measured in wet state, using a simple food volume measuring device (NIEDER, 1992). This device consists of two layers of glass plates of 1 mm thickness glued on top of each other. The top layer leaves open a measuring cavity of 1 mm depth, 10 mm width and 100 mm length. After preparation, the gut contents are put into the cavity. The gut contents are covered by another glass plate. The horizontal extension of the gut contents in the cavity is measured and allows determination of the volume (in the wet state) to the nearest 5 mm^3.

The taxonomy of blennies follow ZANDER (1987).

RESULTS

1. Nocturnal abundance of *L. trigloides* and other species

Places, dates and time of observation of *L. trigloides* in various localities of Catalonia are presented in table 1.

Table 2 shows the nocturnal observations of *L. trigloides* and other nocturnally active species. Abundances vary considerably on subsequent nights.

2. Depth of *L. trigloides*

The average depths at which *L. trigloides* were found at Cala de la Mora by night and by day are given in table 3. *L. trigloides* stays close to the surface at night, the average depth of sojourn ranging from the waterline 0.07 m (in April) to 0.33 m (in December). Depths of sojourn between each month of observation are significantly different (one-way ANOVA, $F = 11.2$, $p < 0.05$). When

Table 2. Sightings of nocturnally active species at Cala de la Mora.
Observaciones de especies activas durante la noche en Cala de la Mora.

	Dates										
Month	IV 90			VII 90			IX 90			XII 90	
Day	13	15	17	17	18	19	12	13	14	27	28
Lipophrys trigloides	14	6	11	17	19	39	30	34	23	14	5
Scorpaena sp.	6	2	2	0	0	0	0	1	0	1	0
Scartella cristata	0	0	0	3	2	3	1	1	0	0	0
Parablennius gattorugine	0	0	0	2	0	1	0	0	0	0	0
Gaidopsarus mediterraneus	2	1	0	0	0	0	0	1	0	1	0

differences between depths of sojourn during the day and at night are compared, they are not significant in September (one-way ANOVA, $F = 1.01$, $p > 0.1$) and December (one-way ANOVA, $F = 1.57$, $p > 0.5$). In contrast, depths differ significantly in July (one-way ANOVA, $F = 9.36$, $p < 0.05$) and April (one-way ANOVA, $F = 15.96$, $p < 0.05$). In April, *L. trigloides* is found in relatively very shallow water at night (table 3).

3. Nocturnal and diurnal abundances of *L. trigloides* at Cala de la Mora

Table 4 shows the nocturnal and diurnal abundances of *L. trigloides* along the 70 m shore section. Nocturnally active fish represent only part of the whole population; the proportion of nocturnally active individuals increases drastically towards December, while the total number of diurnal *L.trigloides* declines through the course of the year.

4. Length of specimens

Table 5 shows measurements of specimens and of their guts. Measures from diurnal and

Table 3. Average depth of *L. trigloides* at Cala de la Mora (cm): n. Number of individuals observed; d. Average depth; SD. Standard deviation.
Profundidad media de L. trigloides *en la Cala de la Mora (cm): n. Número de individuos observados; d. Profundidad media; SD. Desviación estándar.*

		Months			
		IV 90	VII 90	IX 90	XII 90
Night	n	31	75	64	19
	d ± SD	7 ± 9	32 ± 17	23 ± 14	33 ± 20
Day	n	48	48	18	26
	d ± SD	25 ± 21	22 ± 17	19 ± 17	55 ± 35

Table 4. Nocturnal and diurnal abundances of *L. trigloides* at Cala de la Mora.
Abundancias nocturna y diurna de L. trigloides *en la Cala de la Mora.*

Month	Night	Day
IV 90	10	68
VII 90	25	45
IX 90	29	55
XII 90	10	13

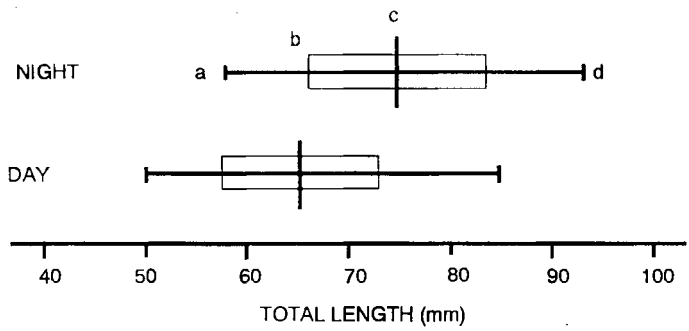

Fig. 2. Total length of *L. trigloides* specimens from Cala de la Mora (Spain) caught by night and by day: a. Minimum total length; b-c. Standard deviation; c. Medium total length; d. Maximum length.

Longitud total de ejemplares de L. trigloides, *capturados en la Cala de la Mora durante la noche y durante el día: a. Longitud total mínima; b-c. Desviación estándar; c. Longitud total media; d. Longitud máxima.*

nocturnal *L. trigloides* are compared in figure 2. Nocturnal *L. trigloides* are significantly larger than diurnal ones ($p < 0,05$, $n = 49$, WELCH-Test).

5. Food analysis

The volume of the gut contents varies to a great degree between specimens caught at different times of the year (table 5). Lowest food amounts were found in *L. trigloides* which were caught in July, and the highest in those caught in April. The position of food in the gut showed a characteristic pattern: all except one specimen had full anterior parts of the gut ("stomach"). Although only detailed studies on retention time of food items in the gut can definitely confirm this result, it may be concluded that most nocturnal *L. trigloides* had fed immediately before being caught.

Amphipoda and Polychaeta were the most important food items (fig. 3). In most cases Amphipoda and Polychaeta filled the anterior part of the gut, whereas small *Mytilus* and other food items could be found in the posterior part.

Relation of gut length to total length is low (ranging from 0.43 to 0.73), compared to other blennies (GOLDSCHMID et al., 1984).

DISCUSSION

Lipophrys trigloides is a species which is active at night throughout the year. The only other report on nocturnal activity of a blenny was by FISHELSON (1963) for *Lipophrys pavo*, but the observation was made from the shore and never confirmed on a systematic basis. The individuals of *L. trigloides* that LOUISY (1987) found above the surface of the water were apparently asleep.

Because of the regularity and geographical range of its occurrence, nocturnal activity may be assumed to be a characteristic behaviour of *L. trigloides*. In contrast, other blenniid species were only occasionally found outside their holes during darkness.

In terms of the number of active individuals, *L. trigloides* was the most important element of the typical nocturnal fish assemblage in the western Mediterranean

Table 5. Measurements of *L. trigloides* caught at night at Cala de la Mora: TL. Total length; SL. Standard length; GL. Gut length; G/L. Gut length/total length; W. Weight of individuals; GV. Volume of gut contents.

Medidas de ejemplares de L. trigloides *capturados durante la noche en la Cala de la Mora: TL. Longitud total; SL. Longitud estándar; GL. Longitud del intestino; G/L. Longitud de intestino/ longitud total; W. Peso; GV. Volumen del contenido del intestino.*

			Measurements					
Month	Specimen	Sex	TL (mm)	SL (mm)	GL (mm)	G/L	W (g)	GV (mm^3)
IV 90	1	♀	70	59	41	0.58	3.75	150
	2	♂	80	68	49	0.61	6.75	135
	3	♂	88	76	51	0.58	9.35	40
	4	♂	78	66	55	0.70	5.72	220
	5	♂	93	78	73	0.78	9.12	250
VII 90	6	♂	79	67	45	0.57	6.52	10
	7	♂	78	66	42	0.54	5.93	25
	8	♀	67	58	29	0.43	3.62	25
	9	♀	58	48	28	0.48	2.70	15
XII 90	10	♀	74	62	48	0.65	5.50	110
	11	♀	61	52	28	0.46	3.33	70
	12	♀	66	56	34	0.52	4.11	65

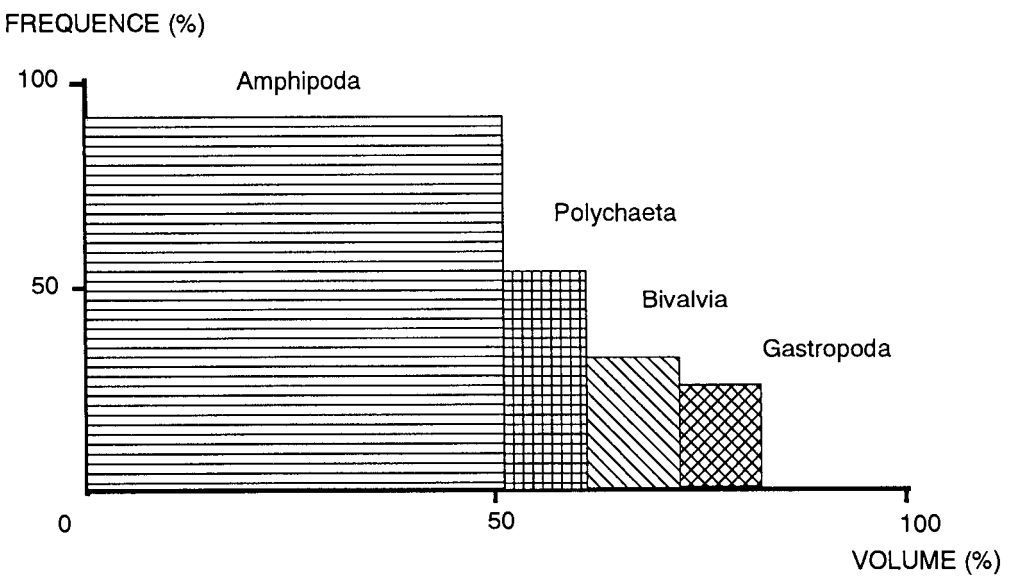

Fig. 3. Frequence and volume of food items (in % of total) in guts of *L. trigloides* caught at Cala de la Mora (Spain), L'Escala (Spain), Moneglia (Italy) and Banyuls (France). (n = 19)

Frecuencia y volumen de alimento en el intestino de L. trigloides, *capturados en Cala de la Mora (España), L'Escala (España), Moneglia (Italia) y Banyuls (Francia). (n = 19).*

rocky shore habitat which was examined, to which *Scorpaena* sp., *Gobius cobitis* and *Gaidropsarus* sp. could be added as regular participants.

The numbers of active individuals at Cala de la Mora on subsequent nights varied considerably between nights. No apparent factor (e.g. moonlight) could be found to explain this variability, but the average frequency for April, July, September and December showed a growing number of "nocturnal" *L. trigloides* from April to September and a subsequent decline in the number in December (one-way ANOVA, $F = 4.4$, $p < 0.05$).

The data of April showed a relatively low number of *L. trigloides* which stayed in a very shallow depth, and a relatively high abundance of *Scorpaena* sp. *Scorpaena notata* is known to feed on blennies (KOTRSCHAL & REYNOLDS, 1982); *L. trigloides* (average depth in April: 0.07 m) may avoid contact with *Scorpaena* (average depth in April: 1.10 m) by keeping as close to the surface as possible. A similar, but horizontal predator avoidance behaviour was shown by HANYCH et al. (1983) for a Canadian freshwater fish.

Specimens caught at night were significantly larger than those caught by day (fig. 2). This and the fact that nocturnal individuals clearly represent only part of the population suggested possible behavioural differentiation between different size classes of the *L. trigloides* population. That behavioural patterns in fish concerning "diurnalism versus nocturnalism" are rather complicated, has been shown by ERIKSSON (1978). *L. trigloides* will likely be found one of the species which cannot be labelled clearly as diurnal or nocturnal.

The analysis of gut contents allowed the assumption that the principal objective of nocturnal activity of *L. trigloides* was related to feeding. The distribution of food items in the gastrointestinal tract suggested food ingestion immediately before the capture in 92% of the specimens. The "stomach" contents consisted mostly of Amphipoda (fig. 3), which obviously represented the staple food of *L. trigloides*, as ZANDER & BARTSCH (1972) already found for specimens from Banyuls-sur-Mer. It is possibly the nocturnal foraging behaviour of *L. trigloides* that enables it to be such an efficient predator of Amphipoda. Carnivorous diets seem to be a characteristic of nocturnally active fish (HARMELIN-VIVIEN, 1982). The diets of other blennies present at Cala de la Mora (*Scartella cristata* and *Parablennius pilicornis*) comprised significantly less Amphipoda (NIEDER, 1992).

Temporal distinction in foraging behaviour has been described by ROBERTSON & KLUMPP (1983) for an Australian garfish, a diurnal herbivore and nocturnal carnivore. The main prey items fed on by this species at night are Amphipoda, an interesting parallel to *L. trigloides*.

Nocturnal activity of *L. trigloides* evokes some questions. At the rock wall examined at the Cala de la Mora eight other blenniid species (*Lipophrys canevai, Scartella cristata, Coryphoblennius galerita, Parablennius gattorugine, Parablennius incognitus, Parablennius pilicornis, Aidablennius sphynx* and *Parablennius zvonimiri*) can be found.

Is nocturnal foraging the decisive evolutionary adaptation which enables *L. trigloides* to exist in the ecologically dense Mediterranean Blenniid guild? The importance of temporal niche differentiation for coexistence of such similar species as littoral dwelling blennies cannot be underestimated. In the Galaxiidae of New Zealand, nocturnal activity has been shown to be the most important factor for coexistence of native species with

introduced competitors (GLOVA & SAGAR, 1989, 1991). The species composition of the blenniid fish assemblage at Cala de la Mora is perhaps the outcome of similar niche differentiation which has taken place on the evolutionary time scale.

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RESUMEN

Actividad nocturna de un blénido, Lipophrys trigloides *(Pisces, Blenniidae), en la costa mediterránea española.*

Lipophrys trigloides, pez bastante común en el litoral rocoso de las costas méditerraneas, ha sido encontrado y observado en estado activo en la superficie de las rocas de la Cala de la Mora (Tarragona, Cataluña) y otros lugares de la costa catalana (fig. 1, tabla 1, tabla 2) durante todo el año. Los individuos se encontraron a muy poca profundidad, en muchos casos directamente debajo de la superficie (tabla 3). Su actividad nocturna parece ser típica de la especie, pero no todos los individuos del área muestran este comportamiento (tabla 4). Los individuos activos durante la noche son más grandes que los individuos capturados durante el día (fig. 2). El 92% de los ejemplares "nocturnos" capturados y disseccionados contenían anfípodos en la parte anterior de sus intestinos. Se supone pues que esta especie, hasta ahora la única especie de blénido con ritmo de actividad diurno/ nocturno, utiliza las excursiones nocturnas para alimentarse.

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