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Diet of juvenile meagre, *Argyrosomus regius*, within the Tagus estuary

Henrique N. CABRAL[1]* and Barbara OHMERT [2]
[1] *Instituto de Oceanografia, Faculdade de Ciências da Universidade de Lisboa, R. Ernesto Vasconcelos, 1700 Lisboa, Portugal*
** - corresponding author: Fax: (351) 21 750 00 09; E-mail: hcabral@fc.ul.pt*
[2] *Zoologisches Institut, Universität zu Köln, Weyertal 119, D-50923 Köln, Germany*

Abstract: The feeding ecology of juvenile meagre, *Argyrosomus regius*, was studied in order to determine the potential for competition with other fish species within the nursery areas of the Tagus estuary. The stomach contents of 274 individuals revealed that juvenile meagre had a low prey diversity: the major prey items being Mysidacea and the shrimp *Crangon crangon*. The importance of larger prey items in the diet, namely Decapoda and Teleostei, increased with fish size. The dietary overlap between meagre and seabass, *Dicentrarchus labrax*, is high in the Tagus estuary but the competition between the two species is probably minimized by a different use of the habitat.

Résumé : *Le régime alimentaire des juvéniles du maigre,* Argyrosomus regius, *dans les aires de nourriceries de l'estuaire du Tage.* La nourriture des juvéniles du maigre *Argyrosomus regius* a été étudiée pour déterminer l'importance de la compétition avec d'autres espèces de poissons dans les nourriceries de l'estuaire du Tage. Les contenus stomacaux de 274 individus ont été examinés. Les jeunes maigres présentent un spectre trophique étroit, où les Mysidacea et la crevette *Crangon crangon* constituent les proies principales. L'importance des proies de plus grande taille, en particulier des Décapodes et des Téléostéens augmente avec la taille des poissons. Le chevauchement alimentaire entre le maigre et le bar, *Dicentrarchus labrax*, est élevé dans l'estuaire du Tage, mais la compétition entre ces espèces sympatriques est sans doute limitée, du fait d'une différence dans la répartition de l'habitat.

Keywords: meagre, diet overlap, nursery, Tagus estuary, Portugal.

Introduction

The meagre, *Argyrosomus regius* Asso, 1801, is a commercially important fish species. Its distribution extends along the Atlantic coast, from Congo to North Sea and southern Norway and Sweden, and to the Mediterranean (Chao, 1986). Adults are found in the continental shelf from 10 m to 200 m depth, while juveniles are common in estuaries and shallow coastal areas (Quero, 1985; Chao, 1986; Quero & Vayne, 1987). Several authors (e.g. Brégeon et al., 1978; Castelnaud et al., 1978; Quero & Vayne, 1987) mainly for the North of France suggested that meagre spawn in estuaries. Quero & Vayne (1987) reported that, in the Gironde estuary, the spawning period extends from May to July. Despite the high commercial value of this species, knowledge of its ecology is very scarce.

The occurrence of meagre in the Tagus estuary (Portugal) has been reported in several studies (e.g. Costa, 1982; Cabral, 1998). Adults, mainly mature females during

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spawning, as well as juveniles, are subjected to both commercial and recreation fisheries within this estuarine system.

The few data on meagre abundance available for the Tagus estuary (Cabral, 1998) showed an extreme inter-annual variability. This variability in year class strength was also outlined by Brégeon et al. (1978) for the North coast of France.

Within the Tagus estuary, juvenile meagre occurs mainly in the upper part. Several other fish species, namely *Solea solea* (Linnaeus, 1758), *Solea senegalensis* Kaup, 1858 and *Dicentrarchus labrax* (Linnaeus, 1758) also use this estuarine area as a nursery (Cabral, 1998). In this paper we analyse the diet of juvenile meagre and assess the trophic overlap with other juvenile teleosts in the estuary.

Material and Methods

Specimens were caught in the main nursery area for juvenile meagre within the Tagus estuary (Figure 1), determined in previous studies (Cabral, 1998). Sampling was carried out monthly using a 4 m beam trawl with one tickler chain and 10 mm mesh size, from April 1995 to November 1996. All trawls were made during daylight, at low water of spring tides, and had a 20 minutes duration.

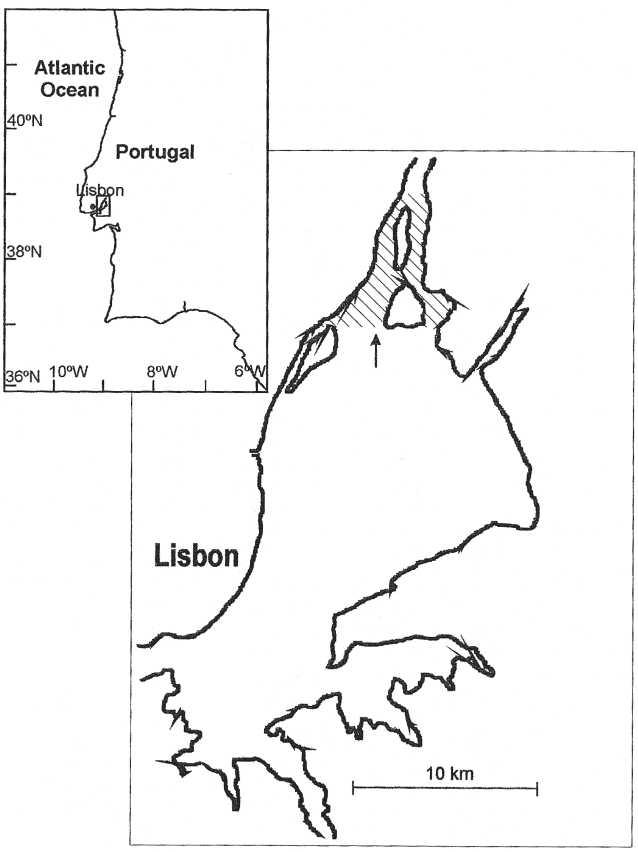

Figure 1. Location of the sampling area within the Tagus estuary (arrow points to the nursery areas).

Figure 1. Localisation de l'aire d'échantillonnage dans l'estuaire du Tage (la flèche indique les aires de nourriceries).

All fish caught were identified, counted, measured (total length to the nearest 1 mm) and weighed (wet weight with 0.01 g precision). Stomach contents were removed for identification and preserved in 4% buffered formalin. The stomach contents of 274 individuals of meagre were analysed. Each prey item was identified to the lowest taxonomic level possible, counted and weighed (wet weight with 0.001 g precision).

The relative importance of each prey item in the diet was expressed by three indices: the numeric index (*NI*) = percentage of the number of individuals of a prey over the total number of individuals of all preys; the occurrence index (*OI*) = percentage of non-empty stomachs in which a prey occurred; and the gravimetric index (*GI*) = percentage in weight of a prey over the total weight of all preys (Hyslop, 1980).

In order to study diet variation with fish size, data were grouped in regular 50 mm length classes. Differences in the number of preys per food item were tested using the *G*-test of independence (Sokal & Rohlf, 1981; Zar, 1996). A significance level of 0.05 was considered. If the null hypothesis was rejected, a posteriori G-tests of homogeneity were performed to evaluate which length classes were significantly different from others (Sokal & Rohlf, 1981).

Feeding activity was evaluated by the vacuity index defined as the percent of empty stomachs (Hyslop, 1980).

Diet overlap of meagre with other fish species was measured using Schoener index (*SI*), which was defined as $SI = 1 - \frac{1}{2}\left(\sum_{i=1}^{n} |p_{iA} - p_{iB}|\right)$, where p_{iA} and p_{iB} were the numerical frequencies of item *i* in the diet of species A and B, respectively (Linton et al., 1981). Values of diet overlap vary from 0, when there is no food resources shared, to 1, when there is the same proportional distribution of use among food resources. The data on the diet of juveniles of *Solea solea*, *S. senegalensis* and *Dicentrarchus labrax* found in Cabral (1998), collected simultaneously with that for *Argyrosomus regius*, were used in the analysis of the trophic overlap.

Results

The size of the individuals analysed varied from 55 mm to 225 mm (Figure 2). The trophic spectrum of juvenile meagre was extremely narrow. The main food items were Mysidacea (mainly *Neomysis integer*), and the brown shrimp, *Crangon crangon* (Table 1). The relative importance of these two prey groups varied according to the

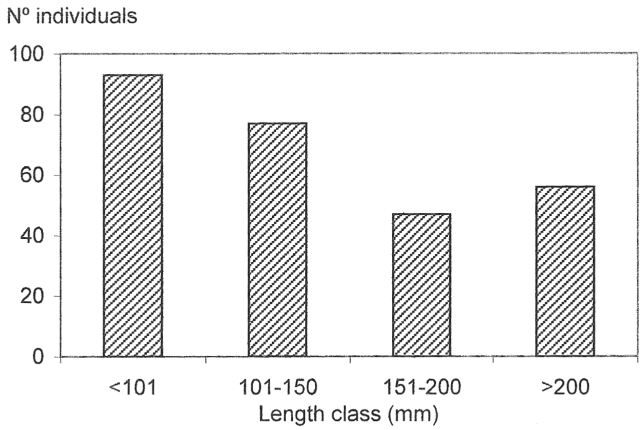

Figure 2. Size distributions of the specimens of meagre analysed for stomach contents.

Figure 2. Distribution de taille des spécimens de maigre analysés pour l'étude des contenus stomacaux.

Table 1. Numerical (*NI*), occurrence (*OI*) and gravimetric (*GI*) index values of prey found in stomachs of juvenile meagre (*Argyrosomus regius*) in the Tagus estuary.

Tableau 1. Valeurs des indices numériques (*NI*), d'occurence (*OI*) et gravimétrique (*GI*) de chaque proie identifiée dans les estomacs des juvéniles du maigre (*Argyrosomus regius*) dans l'estuaire du Tage.

Index		NI	OI	GI
Crustacea	Σ	*99.69*	*98.96*	*96.41*
Mysidacea	Σ	*70.47*	*43.75*	*15.65*
Neomysis integer (Leach, 1815)		34.78	21.35	7.65
Mesopodopsis slabberi (van Beneden, 1861)		0.69	1.30	0.09
Mysidacea n.i.		35.00	21.10	7.91
Decapoda	Σ	*29.22*	*55.21*	*80.76*
Palaemon serratus (Pennant, 1777)		0.84	2.86	4.46
Palaemon longirostris H. Milne Edwards, 1837		2.52	8.60	10.25
Crangon crangon (L., 1758)		25.86	43.75	66.05
Teleostei	Σ	*0.31*	*1.04*	*3.59*
Gobiidae	Σ	*0.31*	*1.04*	*3.59*
Pomatoschistus minutus (Pallas, 1770)		0.08	0.26	0.85
Pomatoschistus spp.		0.23	0.78	2.74

index used. Mysidacea were the most important prey when assessed by the numerical index (*NI* = 70%, *GI* = 26%), while *Crangon crangon* presented the highest value when the gravimetric index was used (*NI* = 16%, *GI* = 66%). The occurrence index values of these two prey items were similar (for both *OI* = 44%). *Palaemon longirostris* was also a common prey but its index values were much lower comparatively to Mysidacea and *Crangon crangon*.

Significant differences in the frequencies of each food item were found between the four length classes considered (G=126.1, P<0.05). Homogeneity tests revealed that the number of prey items in the diet of individuals larger than 200 mm was different from those found in all the other length groups (G=117.7, P<0.05). The three smaller length classes, on the other hand, were homogeneous (G=8.4, P>0.05). In the diet of juvenile meagre, smaller than 200 mm, Mysidacea were more important than in those larger than this length, which fed on a higher proportion of Decapoda and Teleostei (Figure 3).

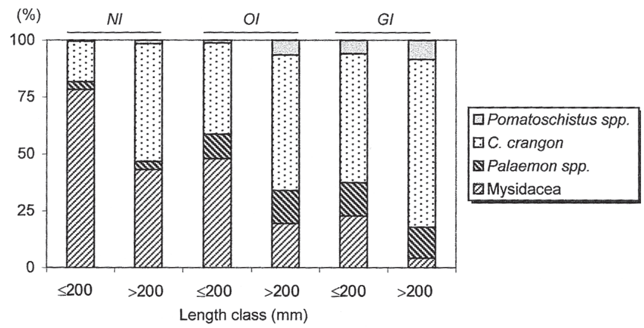

Figure 3. Relative importance of food items in the diet of juvenile meagre (*Argyrosomus regius*) according to fish size, based on numerical (*NI*), occurrence (*OI*) and gravimetric (*GI*) indices.

Figure 3. Importance relative de chaque proie i dans la nourriture des juvéniles du maigre (*Argyrosomus regius*) par classe de taille, sur la base des indices numérique (*NI*), d'occurrence (*OI*) et gravimétrique (*GI*).

The number of empty stomachs was very low (only four of the 274 stomachs analysed), with a vacuity index of 1.5%. The percentage of empty stomachs obtained for individuals with less than 200 mm length (1.4%) was slightly lower than that determined for the other length class (1.8%).

The Schoener index values of diet overlap, obtained between meagre and both sole species (i.e. *Solea solea* and *S. senegalensis*), were very low indicating no resource partitioning (Table 2). On the contrary, the dietary overlap between meagre and seabass (*Dicentrarchus labrax*) was high (*SI* = 0.64).

Discussion

Juvenile meagre within the Tagus estuary showed a low dietary variation, which is consistent with information on its

Table 2. Schoener index values of dietary overlap between juvenile meagre (*Argyrosomus regius*), soles (*Solea solea* and *S. senegalensis*) and seabass (*Dicentrarchus labrax*).

Tableau 2. Valeurs de l'indice de Schoener de chevauchement trophique entre les juvéniles du maigre (*Argyrosomus regius*), les soles (*Solea solea* and *S. senegalensis*) et le bar (*Dicentrarchus labrax*).

	S. solea	*S. senegalensis*	*D. labrax*
A. regius	0.04	0.01	0.64

feeding ecology in other estuarine systems. In the Gironde estuary, the most important food items of meagre diet were the same that those reported for the Tagus estuary, i.e. Mysidacea and *Crangon crangon* (Quero & Vayne, 1987).

The diet of juvenile meagre varied with fish length, showing in larger fish, an increase in the importance of larger prey, namely Decapoda and Teleostei. Quero & Vayne (1987) noted a similar trend in the Gironde estuary. Also, on the Tunisian coast Chakroun & Ktari (1981), analysing a wider range of fish lengths, reported a higher consumption of Teleostei relative to Crustacea, in fish of larger sizes.

Despite the differences in taxa, geographical distribution and environmental conditions, the diet of juveniles of other Sciaenidae species, namely *Argyrosomus japonicus*, presented several common aspects with that of *Argyrosomus regius*, in particular the high importance of Mysidacea as food (e.g. Griffiths, 1997).

The diet composition of juvenile meagre in the Tagus estuary suggests a feeding specialization. However, considering the high abundance of Mysidacea and *Crangon crangon* within the estuary (Cabral, 1998), the feeding behaviour of the meagre may be considered mainly generalist.

For several fish species, a strong relationship between its abundance and prey availability has been described. For the Tagus estuary, Cabral & Costa (1999) reported that juvenile soles, *Solea solea* and *S. senegalensis*, occurred in high abundance in the area where their major preys presented higher densities. This was also outlined for seabass juveniles (*Dicentrarchus labrax*) for which the major nursery area was in the eastern upper part of the Tagus estuary (near Alcochete, see Figure 1) (Cabral, 1998). For juvenile meagre, fish abundance was not so markedly related to prey density, since the area where this species occurred in higher abundance was not coincident with the estuarine zone that presented the highest densities of both Mysidacea and *Crangon crangon* (Cabral, 1998).

Considering the high value of dietary overlap between meagre and seabass juveniles, the differences in the distribution and abundance outlined above could indicate a spatial segregation to avoid niche overlap.

Predation avoidance could also be a major factor determining the spatial distribution of juveniles. Griffiths (1997) reported that small juveniles of *Argyrosomus japonicus* were known to avoid areas of highest prey abundance because of the presence of larger conspecifics, which were known to eat them. However, it is rather difficult to distinguish if the occurrence of juvenile meagre in the upper part of the estuary is due to a preference for specific environmental conditions or to habitat segregation from a potential competitor species. For *Argyrosomus japonicus*, Griffiths (1996) reported that the distribution of juveniles within South African estuaries varied. In some systems their abundance was higher in the middle part, while in other estuaries juveniles occurred mainly in the upper reaches. The absence of a general pattern in the distribution of juveniles in relation to particular physico-chemical conditions suggests that biotic interactions may be the major determinant of fish distribution.

In conclusion, juvenile *Argyrosomus regius* feed on a low variety of prey, have a high feeding activity, and a diet variation occurs with fish size. It is probable that competition with other fish and predation avoidance determine the spatial distribution patterns of juveniles within estuarine habitats.

References

Brégeon L., Chandor M. & Njock J.-C. 1978. *Études écologiques liées au développement du Port de Verdon. IV. Etude sommaire de l'ichthyoplancton et des nurseries.* C.R.E.B.S., Rennes, ISTPM: La Rochelle.

Cabral H.N. 1998. *Utilização do estuário do Tejo como área de viveiro pelos linguados, Solea solea (L., 1758) e Solea senegalensis Kaup, 1858, e robalo, Dicentrarchus labrax (L., 1758).* Ph. D. Thesis, Universidade de Lisboa: Lisboa. 396 pp.

Cabral H.N. & Costa M.J. 1999. Differential use of nursery areas within the Tagus estuary by sympatric soles, *Solea solea* and *Solea senegalensis*. *Environmental Biology of Fishes*, **56**: 389-397.

Castelnaud G., Clément O., Trouvery M. & de Verdilhac P. 1978. La pêche dans l'estuaire de la Gironde (France): ses particularités et ses problèmes. In: *Allocation of fishery resources* (J. H. Grover ed), pp. 34-36. Proceedings of the Technical Consultancy on Allocation of Fishery Resources.

Chakroun N. & Ktari M.H. 1981. Régime alimentaire des Sciaenidae (Poissons Téléostéens) du Golfe de Tunis. *Bulletin de l'Institut National Scientifique et Technique d'Océanographie et de Pêche de Salammbô*, **8**: 69-80.

Chao L.N. 1986. Sciaenidae. *In*: *Fishes of the North-eastern Atlantic and the Mediterranean* (P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen & E. Tortonese eds), pp. 865-874. Unesco, Paris.

Costa M.J. 1982. *Contribution à l'étude de l'écologie des poissons de l'estuaire du Tage (Portugal).* Ph. D. Thesis, Université Paris VII : Paris. 256 pp.

Griffiths M.H. 1996. Life history of the dusky kob *Argyrosomus japonicus* (Sciaenidae) off the east coast of South Africa. *South African Journal of Marine Science*, **17**: 135-154.

Griffiths M.H. 1997. Influence of prey availability on the distribution of dusky kob *Argyrosomus japonicus* (Sciaenidae) in the great fish river estuary, with notes on the diet of early juveniles from three other estuarine systems. *South African Journal of Marine Science*, **18**: 137-145.

Hyslop E.J. 1980. Stomach contents analysis: a review of methods and their application. *Journal of Fish Biology*, **17**: 415-429.

Linton L.R., Davies R.W. & Wrona F.J. 1981. Resource utilization indices: an assessment. *Journal of Animal Ecology*, **50**: 283-293.

Quero J.-C. 1985. Le maigre, *Argyrosomus regius* (Asso) (Pisces, Sciaenidae) en Méditerranée occidentale. *Bulletin de la Socíeté Zoologique de France*, **114**: 81-89.

Quero J.-C. & Vayne J.-J. 1987. Le maigre, *Argyrosomus regius* (Asso, 1801) (Pisces, Perciformes, Sciaenidae) du Golfe de Gascogne et des eaux plus septentrionnales. *Revue des Travaux de l'Institut de Pêches Maritimes*, **49**: 35-66.

Sokal R.R. & Rohlf F.J. 1981. *Biometry*. W. H. Freeman & Company: New York. 887 pp.

Zar J. 1996. *Biostatistical analysis*. 3rd ed., Prentice Hall: Engelwood Cliffs. 662 pp.