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OCCURRENCE OF *KUDOA* SP. (MYXOZOA) IN *TRACHURUS TRACHURUS* L. (OSTEICHTHYES) IN PORTUGAL

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Summary:

Specimens of *Trachurus trachurus* L., obtained monthly in a fish market of Oporto from October 1998 to August 1999, were examined for the presence of *Kudoa* in the muscle. *Kudoa* sp. spores were found in 84.7 % of the specimens (n = 209). The prevalence was not significantly different between seasons and was not related to the host's length. The infection does not seem to have negative effects on the fish quality once no macroscopic pseudocysts or myoliquefaction were detected.

KEY WORDS : *Kudoa*, Myxozoa, *Trachurus trachurus*, Portugal.

Résumé : PRÉSENCE DE *KUDOA* SP. (MYXOZOA) CHEZ *TRACHURUS TRACHURUS* L. (OSTEICHTHYES) AU PORTUGAL

La présence de Kudoa *sp. a été recherchée dans la musculature de* Trachurus trachurus *L. prélevé mensuellement sur un marché de Porto, entre octobre 1998 et août 1999. Des spores de* Kudoa *sp. ont été observées chez 84,7 % des poissons (n = 209). La prévalence de l'infection n'était pas corrélée avec la saison ou la taille des hôtes. En l'absence de pseudokyste visible macroscopiquement et de liquéfaction musculaire, l'infection ne cause pas d'effet perturbateur sur la commercialisation de ces poissons.*

MOTS CLÉS : Kudoa, *Myxozoa*, Trachurus trachurus, *Portugal.*

The genus *Kudoa* (Myxozoa: Myxosporea) has a worldwide distribution and comprises about 50 species reported from a large number of marine and anadromous fish species (Moran *et al.*, 1999; Pampoulie *et al.*, 2001; Swearer & Robertson, 1999). Several *Kudoa* species infect the musculature and some of them can cause unsightly macroscopic cysts or post-mortem myoliquefaction (Moran *et al.*, 1999) which may reduce the market value of fish. An unusual *Kudoa* sp. infection was described in gobies by Davies *et al.* (1998). In this infection the muscle loss occurred while the fish where alive, rather than post-mortem which is usual for *Kudoa* infections. Recently, *Kudoa* sp. infection, associated to post-mortem myoliquefaction, was also reported from an octopus (Yokoyama & Masuda, 2001).

Although a few *Kudoa* species, usually associated with negative effects in commercial important marine fishes, are very well documented (*K. thyrsites* from *Salmo salar* and other fish species, and *K. paniformes* from *Merluccius productus* are probably the best examples); information about a great number of other *Kudoa* species is very scarce.

In Portugal *Kudoa* sp., probably *K. thyrsites*, has been reported only from *Sardina pilchardus* (Gilman & Eiras, 1998). Losses for the Portuguese canning industry attributable to this infection, associated to post-mortem myoliquefaction, was estimated by those authors in about 1 million US $ per year.

In order to assess the possible occurrence of *Kudoa* in other fish species captured in Portugal, a survey was carried out on horse mackerel, *Trachurus trachurus* L., an important fish resource for the Portuguese population.

MATERIALS AND METHODS

Specimens of *Trachurus trachurus* were obtained monthly in a fish market of Oporto from October 1998 to August 1999.

The fish were screened to determine the prevalence of *Kudoa* infection in muscle. A sample of skeletal muscle of approximately 5 mm^3 was collected from the dorsal muscle just behind the head. Screening was performed by microscopic examination, under 400 × magnification, of wet mount preparations of minced muscle portions. The prevalence of the infection was calculated for each season by combining the values from October, November and December (autumn), January, February and March (winter), April, May and June (spring) and July and August (summer). Additionally, the fish were grouped into five size classes (15.0-17.9 cm; 18.0-20.9 cm; 21.0-23.9 cm; 24.0-26.9 cm; 27.0-29.9 cm) and the prevalence of infection in each group was calculated.

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Light, moderate and heavy infections were defined as one to 10 spores per 100 fields, 11 to 100 spores per 100 fields and more than 100 spores per 100 fields respectively, under 400 × magnification.
The measurements of spores were made according Lom & Dykova (1992) under 1000x magnification.
The significance of the differences in *Kudoa* prevalence among seasons and among size host classes were analysed by a Chi-square test.

RESULTS

Kudoa sp. spores were observed in skeletal muscle of *T. trachurus*. The spores were rounded both in apical view and in lateral view, with four equal sized polar capsules (Fig. 1). The dimensions of spores are recorded in Table I.
Kudoa spores were found in 84,7 % of the fish examined. The prevalence was high in all seasons (Table II) as well as in all host size classes (Table III). No significant differences in prevalence were detected among seasons $\chi^2 = 4.90$; d.f. = 3; $p > 0.05$) or among host size classes $\chi^2 = 6.42$; d.f. = 4; $p > 0.05$).
The intensity of the infection was generally low. 71,2 % of the infected fish (126 out of 177) presented light infections, 22,6 % (40 out of 177) presented moderate infections and only 6,7 % (11 out of 177) presented heavy infections.
No pseudocysts were seen macroscopically and no alteration in the muscle texture was detected.

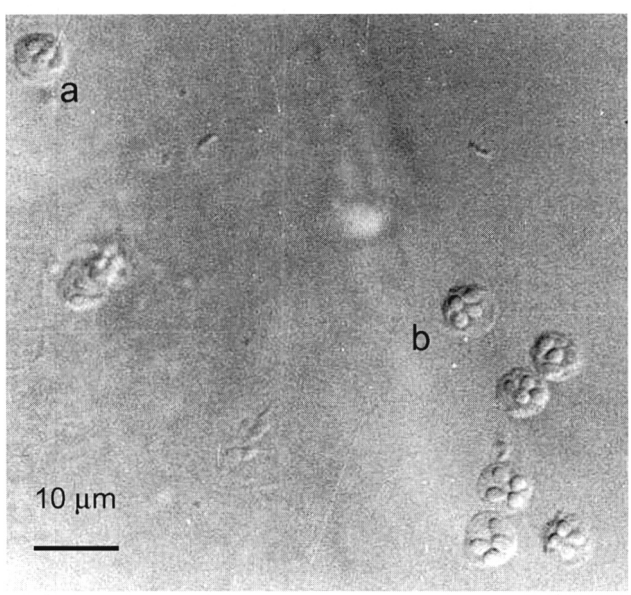

Fig. 1. – *Kudoa* sp. spores (a: lateral view; b: apical view) in muscle.

	Apical view (n = 30)	**Lateral view** (n = 30)
Spore length	–	5.5 ± 0.8 (4.0-7.0)
Spore width	6.5 ± 0.9 (5.0-8.5)	–
Spore thickness	5.4 ± 1.0 (4.0-7.5)	–
Polar capsule length	1.9 ± 0.5 (1.0-3.0)	2.1 ± 0.4 (1.5-3.0)
Polar capsule width	1.2 ± 0.3 (0.8-2.0)	1.4 ± 0.3 (1.0-2.0)

Mean ± standard deviation (minimum-maximum); n = number of measurements.

Table I. – Dimensions, in µm, of *Kudoa* sp. spores from the muscle of *Trachurus trachurus*.

Season	**N**	**Fish length (cm)**	**Prevalence**
Autumn	49	21.3 ± 2.8 (17.3-26.2)	89.8 %
Winter	60	24.4 ± 2.9 (17.8-29.4)	90.0 %
Spring	60	22.1 ± 4.1 (15.1-29.5)	80.0 %
Summer	40	19.0 ± 4.6 (15.6-29.9)	77.5 %
Total	209	22.0 ± 4.1 (15.1-29.9)	84.7 %

N: number of fish examined. Fish Length: mean ± standard deviation (minimum-maximum).

Table II. – Prevalence of *Kudoa* sp. infection in *Trachurus trachurus* captured in different seasons.

Fish length (cm)	**N**	**Prevalence**
15.0-17.9	48	77.0 %
18.0-20.9	39	89.7 %
21.0-23.9	41	90.2 %
24.0-26.9	58	87.9 %
27.0-29.9	23	73.9 %

N: number of fish examined.

Table III. – Prevalence of *Kudoa* sp. infection in the different host size classes.

DISCUSSION

Kudoa nova and *K. quadratum* are species reported in the musculature of *Trachurus* spp. in the Atlantic ocean (Lom & Dyková, 1992; Moran *et al.*, 1999; Swearer & Robertson, 1999). The spores in the present work differ from the spores of the above mentioned species: the spores observed are rounded (*K. quadratum* has quadrate spores, and *K. nova* has quadrate or rounded quadrate spores) and they are smaller than *K. nova*. Unfortunately, the data and the descriptions obtained (Lom & Dyková, 1992; Moran *et al.*, 1999; Swearer & Robertson, 1999) are insufficient to conclude if our material belongs or not to any of these species.
The different morphological features of the spores observed in *Trachurus trachurus* in the present work, and in *Sardina pilchardus* by Gilman & Eiras (1998), namely equal and unequal sized polar capsules respectively, lead us to conclude that the *Kudoa* infec-

ting *T. trachurus* and *S. pilchardus* in the Portuguese coast belong to different species.

The prevalence of the infection was very high in all seasons and in all fish size classes, and the intensity was generally low. The prevalence was higher and the intensity lower than the reported for the infection in *S. pilchardus* (Gilman & Eiras, 1998).

The life cycle of *Kudoa* is unknown but annelids are suspected to be the alternative host in a possible two-host life cycle (Langdon *et al.*, 1992; Pampoulie *et al.*, 2001) as in other myxosporean parasites. If *Kudoa* has a fish-invertebrate life cycle, the high values of prevalence found in the present work may reflect the abundance of infected invertebrate species in the Portuguese coast.

The infection does not seem to have negative effects on the fish quality for human consumption once no macroscopic pseudocysts or alteration in muscle texture were detected, which is in accordance to the reported for *K. quadratum* and in discordance to the reported for *K. nova*, which forms macroscopic pseudocysts (Moran *et al.*, 1999).

Besides the *Kudoa* species, it must be stressed out that the myoliquefaction depends on the intensity of infection. According to St-Hilaire *et al.* (1997) a threshold level of *K. thyrsites* intensity is necessary in Atlantic salmon to produce noticeable post-mortem muscle deterioration. A similar threshold effect has been reported in *S. pilchardus* (Gilman & Eiras, 1998). As in the present work the heavy infections found in 11 specimens reached higher intensities than the threshold reported for *S. pilchardus*, the absence of post-mortem muscle deterioration seems to indicate that *Kudoa* sp. detected in *T. trachurus* does not cause myoliquefaction.

The occurrence of *Kudoa* spp. in other commercially important fish species in Portugal, the assessment of its economic impact and the host-parasite interactions will be studied in future research.

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