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The golden mackerel: first report of a xanthic Mediterranean horse mackerel *Trachurus mediterraneus* (Steindachner, 1868) from Sines, Portugal

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Abstract: In this study, a single xanthic case of the Mediterranean horse mackerel *Trachurus mediterraneus* is reported. The individual, with a total lenght (TL) of 306 mm, was captured off Sines (Portugal) in March 2018, by a local fishing boat, using a seine net. This represents the first record of xanthism for this species and for any species of mackerel. The specimen is described here and compared with those of normal pigmentation. Considerations about the paucity of records for this or similar species are presented here, and the possibility of this condition being more frequent than previously thought is discussed

Résumé : *Le maquereau doré : premier signalement d'un chinchard méditerranéen xanthique* Trachurus mediterraneus *(Steindachner, 1868) de Sines, Portugal.* Cette étude décrit une forme xanthique de chinchard de la Mediterranée *Trachurus mediterraneus.* L'individu, d'une longueur totale de 306 mm, a été capturé au large de Sines (Portugal) en mars 2018, par un bateau de pêche local, à l'aide d'une senne. Il s'agit du premier signalement de xanthisme pour cette espèce ainsi que pour toutes les espèces de maquereau. L'individu est décrit et comparé à ceux de pigmentation normale. Des considérations sur la rareté des signalements pour cette espèce ou espèces proches sont présentées. La possibilité que cette forme soit plus fréquente qu'on ne le supposait auparavant est discutée.

Keywords: Xanthochromism ● Horse mackerel ● Fisheries ● NE Atlantic ● Predator ● Prey

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Introduction

Xanthochromism (also known as xanthochroism or xanthism) is a genetic pigmentary anomaly in which the melanophores are missing, though other pigment is present, typically producing a golden-orange colour (Colman, 1972). Individuals can either present partial or full xanthochromism (xanthic phenotype) (Pawar & Jawad, 2017; Jawad & Ibrahim, 2018).

Several fish groups have shown variable cases of xanthism including members of the marine families like Batrachoididae (Lewis, 1968), Sebastidae (Cripe, 1998), Pomacanthidae (Luiz-Júnior, 2003), Gadidae (Quigley et al., 2017) and Carangidae (Jawad & Ibrahim, 2018).

The xanthic phenotype in particular is rare and generally assumed to reflect magnified predation risks that attend conspicuity (Carson, 2011); this supposition is indirectly supported by Endler (1980), who found in both laboratory and field experiments on wild-type guppies that increased conspicuousness is associated with elevated predation risk.

The genus *Trachurus* (horse mackerel) is widely distributed along tropical and temperate seas (Cárdenas et al., 2005). It is an important source of income for local economies and, in the northeast Atlantic and Mediterranean Sea, it is common to find shoals with different *Trachurus* species, namely *Trachurus mediterraneus*, *T. trachurus* (Linnaeus, 1758) and *T. picturatus* (Bowdich, 1825) (FAO, 2020). Horse mackerel is caught mainly with pelagic and bottom trawls and purse seines (Abaunza et al., 2003), but is also a common catch in small-scale fisheries, using gill-nets and long-lines (Erzini et al., 1996 & 2003).

Overlapped morphological characters between different species and controversial phylogenetic relationships (Cárdenas et al., 2005; Gurlek et al., 2016) make horse mackerel taxonomic identification difficult. In addition, their interspecific genetic similarities (Landi et al., 2014) also requires the use of alternative markers for DNA barcoding. Cárdenas et al. (2005) showed the usefulness of the mitochondrial control region (D-loop) to unambiguously discriminate these species.

The objective of this study is to report a case of xanthochromism in a horse mackerel specimen collected at Sines, Portugal. The taxonomic identity of the anomalous specimen was confirmed both by morphological traits and DNA barcoding. This study is important as the report of this case of colour anomalies is the first for *T. mediterraneus*.

Materials and Methods

Sampling

On March 4th 2018, one abnormal xanthochromic specimen of Atlantic horse mackerel was captured at a depth of 35-40 m, by a local fishing boat, using a seine net, off Sines (37°55’44.2”N-8°51’57.1”W), Portugal. The specimen was deposited in the fish collection of the Museu de História Natural de Lisboa (MUHNAC) under the donation number 05/2018.

DNA extraction, amplification and sequencing

Total genomic DNA was extracted with the REDExtract-N-Amp Kit (Sigma-Aldrich) following the manufacturer’s instructions. A 412 bp fragment from the mitochondrial control region (CR) was amplified using primers L-pro1 and H-DL1 (Ostellari et al., 1996). The DNA sequence was edited with Codon Code Aligner (Codon Code Corporation) was deposited in GenBank (submitted/waiting to be assigned).

DNA barcoding assignment

DNA barcoding was performed with a NCBI Blast search to check for highly similar DNA sequences available in Genbank. In order to confirm these results, DNA sequences from additional *Trachurus* species available in GenBank were aligned with Clustal X 2.1 (Larkin et al., 2007) and a phylogenetic analysis including the xanthic form of the specimen described in this study was performed with PAUP 4.0b10 Win (Swofford, 2002). Bootstrapping was used to determine robustness of the nodes in the trees with 1000 replicates for maximum parsimony (MP) and neighbour joining (NJ) and maximum likelihood (ML).

Results and Discussion

The xanthic specimen was compared with a specimen having normal colouration (Fig. 1).

The xanthic fish dorsal side, head and fins were bright orange in colour. The orange tone decreased gradually from the upper part to the lower part of the body, eventually turning silver on the ventral side. The eye colour was normal (black), which is typical in xanthic animals. It measured 306 mm TL and weighed 340 g. The normally coloured specimen followed the description by FAO (2020): a normally coloured specimen has the upper part of body and top of head dusky to nearly black or grey to bluish green; lower two thirds of body and head usually paler, whitish to silvery; caudal fin yellowish.

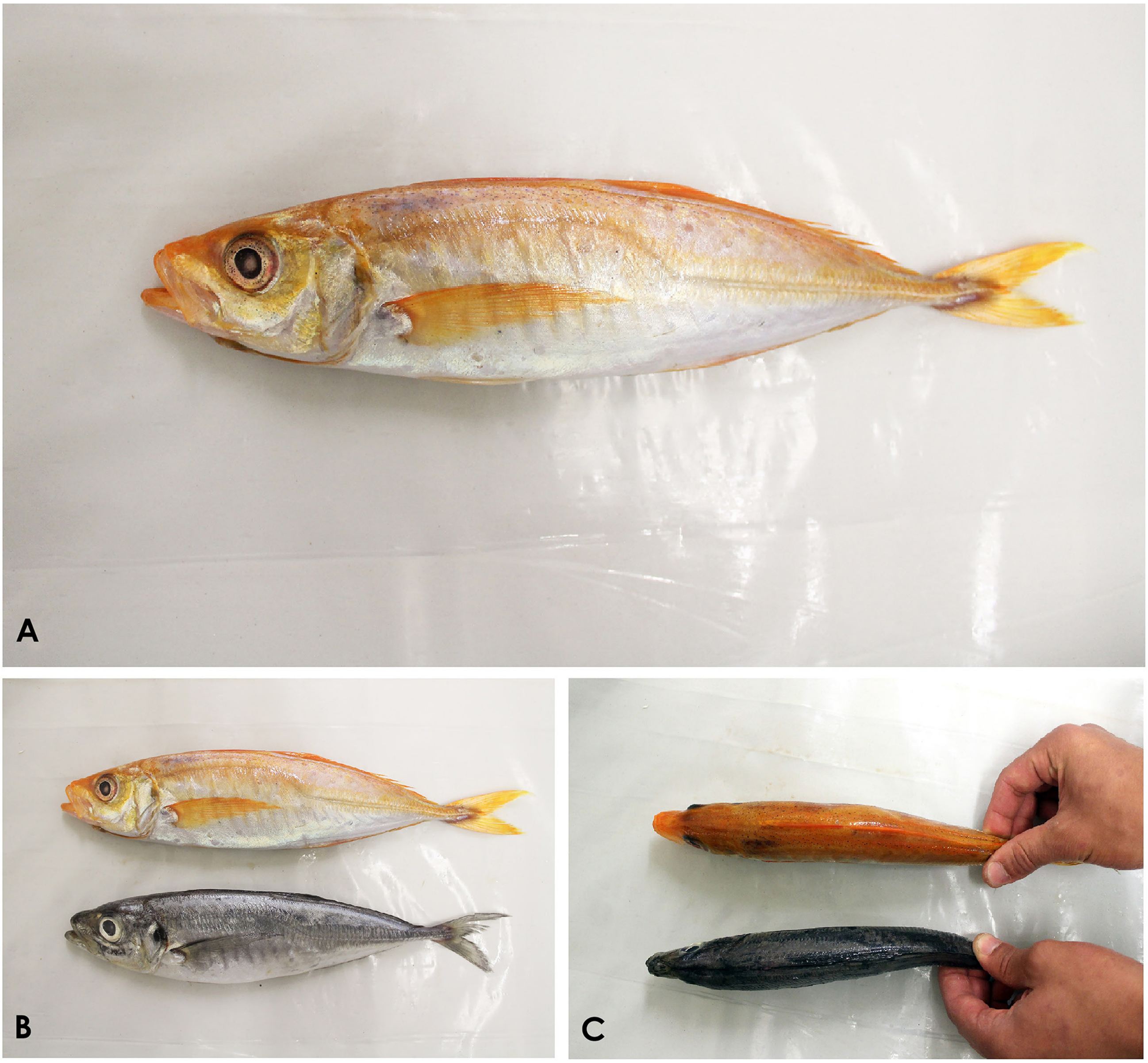

Figure 1. *Trachurus mediterraneus.* Mediterranean horse mackerel. **A.** Lateral view of xanthic specimen. **B.** Lateral view of xanthic specimen (top) and normal specimen (bottom). **C.** Dorsal view of xanthic specimen (top) and normal specimen (bottom).

Considering the xanthic form of the specimen described in this study, the closest DNA sequences assigned by NCBI Blast search correspond to *T. mediterraneus* (Genbank accession number EU246429) with 99.7% similarity. Other *Trachurus* species presented similarity values below 97.0% (e.g. *T. japonicus* (Temminck & Schlegel, 1844) FJ914984 with 96.93% similarity).

The phylogenetic tree (Fig. 2) unambiguously assigned the xanthic form of this horse mackerel to the *T. mediterraneus clade* (> 90% bootstrap) independently of the inference method used.

This specimen represents the first reported case of xanthochromism for *T. mediterraneus* and for any species of mackerel worldwide.

Endler (1980) refers the impact that xanthism can have on the survival of the individuals, which are more visible to predators, but this is also true for their prey, as these can more easily detect the presence of a xanthic predator than a normally coloured conspecific, and, therefore, avoid being eaten. As such, and according to Quigley et al. (2017), this condition may be more frequent in wild populations than the current paucity of records would indicate, but the survival rate for these individuals is considerably lower than for normally coloured ones.

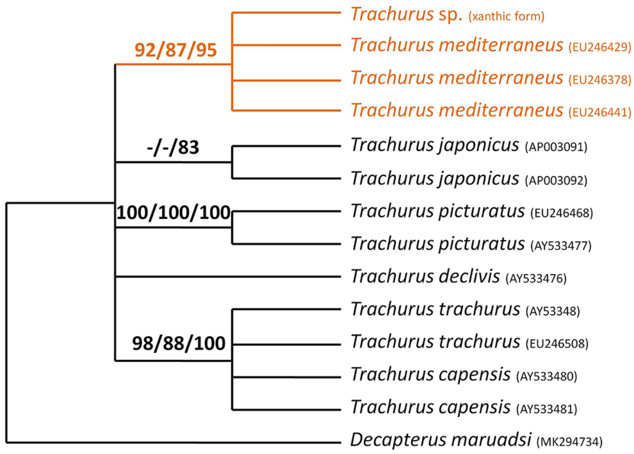

Figure 2. Phylogenetic tree obtained for the Dloop rDNA comparing the xanthic specimen sequenced in this study with other sympatric congeneric species whose sequences are available in Genbank (reference numbers from https://www.ncbi.nlm.nih.gov/genbank/). *Decapterus maruadsi* was used as outgroup. Bootstrap values for each node are shown as percentages for maximum-parsimony, maximum-likelihood and neighbour-joining, respectively. Parsimony analysis parameters: tree length = 187; consistency index = 0.77; retention index = 0.68. Only bootstrap values above 80% are shown.

Considering *Trachurus* spp. play an important role in its area of distribution as one of the prey items for larger fish (Massuti et al., 1998; Battaglia et al., 2012), marine mammals (Silva, 1999; Meynier et al., 2008) and seabirds (Valeiras, 2003), it is intriguing that this specimen was able to thrive and reach adulthood.

A closer collaboration between fishers and researchers, eventually in parallel with other ongoing studies (e.g. tag-release programs), would eventually result in a higher number of “abnormal” specimens reported and, consequently, a better understanding of the incidence and nature of these abnormalities.

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References

Abaunza P., Gordo L., Karlou-Riga C., Murta A., Eltink A.T., GarcíaSantamaría M.T., Zimmermann C., Hamme, C., Lucio P., Iversen S., Molloy J. & Gallo E. 2003. Growth and reproduction of horse mackerel, *Trachurus trachurus* (Carangidae). *Reviews in Fish Biology and Fisheries*, 13: 27-61. Doi: 10.1023/A:1026334532390

Battaglia P., Andaloro F., Consoli P., Esposito V., Malara D., Musolino S., Pedà C. & Romeo T. 2012. Feeding habits of the Atlantic Bluefin Tuna, *Thunnus Thynnus* (L. 1758), in the Central Mediterranean Sea (Strait of Messina). *Helgoland Marine Research*. 67: 97-107. Doi: 10.1007/s10152-012-0307-2

Cárdenas L., Hernández C.E., Poulin E., Magoulas A., Kornfield I. & Ojeda F.P. 2005. Origin, diversification, and historical biogeography of the genus *Trachurus* (Perciformes: Carangidae). *Molecular Phylogenetics and Evolution,* 35: 496-507. Doi: 10.1016/j.ympev.2005.01.011

Carson E. 2011. Low but stable frequency of xanthic phenotypes in a population of the twoline pupfish, *Cyprinodon bifasciatus*. *American Midland Naturalist*, 166: 462-466. Doi: 10.1674/0003-0031-166.2.462

Cripe D. 1998. Occurrence of xanthic grass rockfish, *Sebastes rastrelliger*. *California Fish and Game*, 84: 100-101.

Colman J.A. 1972. Abnormal pigmentation in the sand flounder. *New Zealand Journal of Marine and Freshwater Research*, 6: 208-213. Doi: 10.1080/00288330.1977.9515419

Endler J. 1980. Natural selection on color patterns in *Poecilia reticulata*. *Evolution: International Journal of Organic Evolution*, 34: 76-91. Doi: 10.2307/2408316

Erzini K., Gonçalves J.M.S., Bentes L., Lino P.G. & Cruz J. 1996. Species and size selectivity in a Portuguese multispecies artisanal long-line fishery. *ICES Journal of Marine Science*, 53: 811-819. Doi: 10.1006/jmsc.1996.0102

Erzini K., Gonçalves J.M.S., Bentes L., Lino P., Ribeiro J. & Konstantinos S. 2003. Quantifying the roles of competing static gears: Comparative selectivity of longlines and monofilament gill nets in a multi-species fishery of the Algarve (southern Portugal). *Scientia Marina*, 67: 341-352. Doi: 10.3989/scimar.2003.67n3341

FAO 2020. *Trachurus mediterraneus*. Species fact sheet. Retrieved from https://www.fao.org/fishery/species/2311/en

Gurlek M., Erguden D., Dogdu S.A. & Turan C. 2016. First record of greenback horse mackerel, *Trachurus declivis* (Jenyns, 1841) in the Mediterranean Sea. *Journal of Applied Ichthyology*, 32: 976-977. Doi: 10.1111/jai.13159

Jawad L.A. & Ibrahim M. 2018. Partial xanthism and xanthic phenotype in two fish species from Jubail City, Arabian Gulf, Saudi Arabia. *Cahiers de Biologie Marine*, 59: 37-42. Doi: 10.21411/CBM.A.9F358FD8

Landi M., Dimech M., Arculeo M., Biondo G., Martins R., Carneiro M., Carvalho G.R., Brutto S.L. & Costa F.O. 2014. DNA barcoding for species assignment: the case of

Mediterranean marine fishes. *PLoS One,* 9(9): e106135. Doi: 10.1371/journal.pone.0106135

Larkin M.A., Blackshields G., Brown N.P., Chenna R., McGettigan P.A., McWilliam H., Valentin F., Wallace I.M., Wilm A., Lopez R. & Thompson J.D. 2007. Clustal W and Clustal X version 2.0. *Bioinformatics*, 23: 2947-2948. Doi: 10.1093/bioinformatics/btm404

Lewis R.R. 1968. A comparative study of pigmentation of wild and xanthic forms of toadfish, *Opsanus beta*. *American Zoologist*, 9: 1106.

Luiz-Júnior O. 2003. Colour morphs in a Queen Angelfish *Holacanthus ciliaris* (Perciformes: Pomacanthidae) population of St. Paul's Rocks, NE Brazil. *Tropical Fish Hobbyist*, 51: 82-90.

Massutí E., Deudero S., Sánchez P. & Morales-Nin B. 1998. Diet and feeding of dolphin (*Coryphaena hippurus*) in Western Mediterranean Waters. *Bulletin of Marine Science*, 63: 329-341.

Meynier L., Pusineri C., Spitz J., Santos M.B., Pierce G.J. & Ridoux V. 2008. Intraspecific dietary variation in the short-beaked common dolphin *Delphinus delphis* in the Bay of Biscay: importance of fat fish. *Marine Ecology Progress Series*, 354: 277-287. Doi: 10.3354/meps07246

Ostellari L., Bargelloni L., Penzo E., Patarnello P. & Patarnello T. 1996. Optimization of single-strand conformation polymorphism and sequence analysis of the mitochondrial control region in *Pagellus bogaraveo* (Sparidae, Teleostei): rationalized tools in fish population biology. *Animal Genetics*, 27: 423-427. Doi: 10.1111/j.1365-2052.1996.tb00510.x

Pawar T. & Jawad L. 2017. First report of a xanthic phenotype of the silver carp, *Hypothalamichthyes molitrix* (Valenciennes, 1844) (Teleostei: Cyprinidae) from Maharashtra fish seed production centre, India. *International Journal of Aquaculture*, 7: 101-105.

Quigley D.T.G., Lord R., MacGabhann D. & Flannery K. 2017. First records of xanthochromism in three-bearded rockling *Gaidropsarus vulgaris* (Cloquet, 1824) and pollack *Pollachius pollachius* (Linnaeus, 1758). *Journal of Applied Ichthyology*, 33: 1208-1210. Doi: 10.1111/jai.13456

Silva M. 1999. Diet of common dolphins, *Delphinus delphis*, off the Portuguese continental coast. *Journal of the Marine Biological Association of the United Kingdom*, 79: 531-540. Doi: 10.1017/S0025315498000654

Swofford D.L. 2002. *PAUP*: phylogenetic analysis using parsimony (*and other methods)*, Version 4. Sunderland, MA: Sinauer Associates.

Valeiras J. 2003. Attendance of scavenging seabirds at trawler discards off Galicia, Spain. *Scientia Marina*, 67: 77-82. Doi: 10.3989/scimar.2003.67s277