

NOTE

Haddock *Melanogrammus aeglefinus* (L.) with atypical orange-red flesh

D. T. G. Quigley

Sea Fisheries Protection Authority, Eastern Region, Howth, Co Dublin, Republic of Ireland

Abstract

The author describes a case of an abnormal Haddock *Melanogrammus aeglefinus* (L.) with atypical orange-red flesh from Irish waters and summarises previous reports of similar abnormal flesh colouration in haddock, Atlantic Cod *Gadus morhua* L., Saithe *Pollachius virens* (L.), Golden Redfish *Sebastes norvegicus* (Ascanius, 1772), Beaked Redfish *Sebastes mentella* Travin, 1951, and Dab *Limanda limanda* (L.).

During early November 2016, the MFV 'Progress II SO966' (Skipper: Mr Malcolm Johnston, Bruckless, Co Donegal) captured a haul of haddock *Melanogrammus aeglefinus* (L.) while demersal trawling at a depth of c.375 m, west of Achill Island, Co Mayo, NW Ireland (c.54°44'41"N, 11°26'55"W). The entire catch of haddock, weighing 960 kg, was landed into Killybegs (Co Donegal) and transported to Kerry Fish Ltd (Renard, Caherciveen, Co Kerry) where the unusually coloured specimen was noticed during filleting (Fintan Quinlan, *pers. comm.*).

Although the external colouration of the specimen, which weighed c.800 g and measured c.30 cm total length, was normal, internally the muscle tissue was orange-red in colour, with the peritoneal lining the usual black colour (Figure 1). All of the other haddock from this landing (c.1200 individuals) exhibited the typical white flesh colouration of this species.

Abnormal orange-red flesh colouration has rarely been reported in *M. aeglefinus*. In Canadian waters (NW Atlantic), Templeman and Sandeman (1958) described two unusual haddock with pale red flesh resembling that of Atlantic salmon (*Salmo salar* L.) which were found at a fish processing plant in Fortune (SW Newfoundland) during 1955. Bligh and Dyre (1959) subsequently detected levels of zeaxanthin in another haddock with 'slightly pink' flesh captured in the same region. In Scottish waters, Rae and Johnson (1963) reported 4 pink-fleshed haddock, one from Fraserburgh during September 1955, one from Shetland during September 1957, and two from Aberdeen, the first during March 1959 and the second during November 1962. They reported minute traces of astaxanthin and taraxanthin in the abnormally coloured flesh.

Abnormal orange-red flesh has also been recorded, albeit rarely, in other species of fish.



Figure 1. Haddock *Melanogrammus aeglefinus* fillets. (A) Haddock with normal flesh colour, (B) Haddock with discoloured flesh colour.

During September 1956, Baalsrud (1956) recorded unusually high levels of astaxanthin in the muscle of an atypical pink-fleshed Atlantic cod *Gadus morhua* L. found at a fish market in Drammen, near Oslo, Norway. Bligh and Dyre (1959) recorded 5 cod with atypical orange-red flesh and detected high levels of both astaxanthin and zeaxanthin in one intensely

pigmented specimen measuring 63.5 cm captured off Devil's Island in the mouth of Halifax Harbour (Nova Scotia) during June 1958. They noted that the entire fish exhibited pronounced orange-red pigmentation throughout the muscle tissue, including the head, fins and the lining of the visceral cavity. During June 1957, Templeman and Sandeman (1958) reported a single

specimen of Golden Redfish *Sebastes norvegicus* (Ascanius, 1772) [*S. marinus*] with abnormally coloured red flesh which was taken at Ramea, on the south coast of Newfoundland. During August 1957, the same authors detected high levels of astaxanthin in 4 abnormally coloured 'salmon-pink' fillets of beaked redfish *Sebastes mentella* Travin, 1951 from Canadian waters (Anticosti Channel, Gulf of St. Lawrence), and noted that a red-fleshed saithe *Pollachius virens* (L.) had also been taken in Norwegian waters. In Scottish waters, Rae and Johnson (1963) reported an unusual pink-fleshed dab *Limanda limanda* (L.) from Arbroath during July 1960. In Canadian waters (Georges Bank, Bay of Fundy, and Gulf of St. Lawrence), Bourne and Bligh (1965) discovered unusually high levels of zeaxanthin in abnormally coloured orange-red adductor muscle of Atlantic deep-sea scallops *Placopecten magellanicus* (Gmelin, 1791).

The aetiology of the observed atypical orange-red muscle pigmentation is currently unresolved. The condition may be related to a diet rich in carotenoids (e.g. crustaceans), but it does not explain why only a small number of individuals exhibited atypical orange-red flesh (e.g. 1/c.1200 haddock in the current study). Although various species of wild gadoids are not infrequently entrapped in marine-based salmonid farms where they opportunistically feed on food pellets containing relatively high levels of astaxanthin, their flesh colour is invariably white (Hamish Rodger and Susie Mitchell, *pers. comm.*). Indeed, the majority of the infrequent reports of atypical orange-red flesh in wild gadoids and other species from both sides of the North Atlantic pre-date the advent of marine-based salmonid farming during the 1960s and 1970s (Monahan, 1993).

Although atypical orange-red-yellow external skin colouration (xanthochromism) has occasionally been observed in haddock (Quigley et al., 2015) and other gadoids e.g. *G. morhua* (Kijewska et al., 2012), Alaska pollack *Theragra chalcogramma* (Pallas, 1814) (Honma, 1959), Burbot *Lota lota* (L.) (Wilson, 2015), pollack *Pollachius pollachius* (L.), and Three-bearded rockling *Gaidropsarus vulgaris* (Cloquet, 1824) (Quigley et al., in press), their flesh colour was invariably reported as normal (white). Xanthochromism is generally considered to be caused by a genetic mutation.

Saha et al. (2006) remarked that fish, like all other animals, are unable to synthesize carotenoid pigments *de novo* and must obtain these from dietary sources. They noted that among fish species, adult salmonids have the unique ability to deposit dietary carotenoids (e.g. astaxanthin) in their muscle tissues, which results in their distinctive red flesh colouration. Saha et al. (2006) discovered that although the astaxanthin binding capacity of Atlantic salmon solubilized muscle proteins was similar to those of haddock and Atlantic halibut *Hippoglossus hippoglossus* L., the pigment was only deposited in salmon flesh. They hypothesized that the lack of pigment deposition in haddock and halibut may be related to their reduced ability to either metabolise or transport carotenoids across membrane barriers from the blood to the muscle. Perhaps haddock and other species exhibiting atypical orange-red flesh may represent genetic mutants with the necessary receptors and/or transport proteins to overcome these barriers?

Acknowledgements

I am grateful to Mark McCarthy (Marine Times, Inver, Co Donegal) and Fintan Quinlan (Kerry

Fish Ltd, Caherciveen, Co Kerry) for bringing the current specimen to my attention. I also wish to thank the following for their help: Chilekwa Chisala (Flanders Marine Institute, Oostende, Belgium), Jane Dorman (Ottawa, Canada), Erling Holm (Royal Ontario Museum, Toronto, Canada), Hamish Rodger and Susie Mitchill (Vet Aqua International, Oranmore, Co Galway), and Laura Urbonaviciene (Sea Fisheries Protection Authority, Howth, Co Dublin).

References

- Baalsrud K (1956). Astaxanthin in the muscle of cod. *Nature* **178**, 1182-1183.
- Bligh, EG and Dyer WJ (1959). Orange-red flesh in Cod and Haddock. *Journal of the Fisheries Research Board of Canada* **16**(4), 449-452.
- Bourne N and Bligh EG (1965). Orange-red meats in Sea Scallops. *Journal of the Fisheries Research Board of Canada* **22**(3), 861-864.
- Honma Y (1959). A specimen of a golden Alaska Pollack, *Theragra chalcogramma* (Pallas), from the Sea of Japan. *Collecting & Breeding (Saishu to Shiiku) Tokyo* **21**(7), 222.
- Kijewska A, Wicaszek B, Kalamarz-Kubiak H, Szulc J, and Sobecka E (2012). Skin structure studies and molecular identification of the Atlantic cod *Gadus morhua* L. of unique golden pigmentation from the Svalbard Bank. *Journal of Applied Ichthyology* **28**(1), 60-65.
- Monahan RL (1993). An overview of salmon aquaculture. Chapter 1, 1-9. In K. Heen, R.L. Monahan & F. Utter (eds) *Salmon Aquaculture*. Fishing News Books, UK.
- Quigley DTG, Lord R, MacGabhann D and Flannery K (in press). First records of xanthochromism in Three-bearded Rocking Gaidropsarus vulgaris (Cloquet, 1824) and Pollack Pollachius pollachius (L.). *Journal of Applied Ichthyology*.
- Quigley DTG, MacGabhann D and Duane P (2015). Further specimens of xanthochromic Haddock (*Melanogrammus aeglefinus* (L.)) from Irish waters. *Irish Naturalists' Journal* **34**(2), 145-146.
- Rae BB and Johnson R (1963). Pink-fleshed haddock. *Scottish Fisheries Bulletin, Department of Agriculture and Fisheries for Scotland* **19**, 19-20.
- Saha MR, Ross NW, Olsen RE and Lall SP (2006). Astaxanthin binding to solubilised muscle proteins of Atlantic salmon (*Salmo salar* L.), haddock (*Melanogrammus aeglefinus* L.) and Atlantic halibut (*Hippoglossus hippoglossus* L.). *Comparative Biochemistry and Physiology* **144B**, 488-495.
- Templeman W and Sandeman EJ (1958). Red flesh in Redfish, *Sebastes marinus* (L.). *Journal of the Fisheries Research Board of Canada* **15**(4), 659-700.
- Wilson R (2015). Back Cast. *North Dakota Outdoors* **78**(1), 25.