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Short communication

The early life history of turbot (*Psetta maxima* L.) on nursery grounds along the west coast of Ireland: 2007–2009, as described by otolith microstructure

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ABSTRACT

The early life history of turbot (*Psetta maxima* Linnaeus) was investigated over a three year period (2007–2009). 0-group turbot were collected in September of each year, from three nursery areas along the Irish west coast. The timing of hatching and settlement and the duration of the larval stage were estimated using otolith microstructure analysis. Otolith increment widths were used to derive an index of relative growth rates before and after settlement. Turbot were estimated to have hatched between May and June and settled onto nursery grounds between June and July over the 3 years of the study. No inter-annual differences in the timing of hatching or settlement were observed. Spatial variability was detected, with turbot collected from one location hatching and settling significantly earlier compared to other locations. Turbot from the same location also displayed higher post-settlement otolith growth rates suggesting that this may be a nursery of high habitat quality. Turbot captured in 2009 exhibited significantly shorter larval durations and higher larval otolith growth rates compared to turbot collected in other years. Post-settlement growth rates displayed the opposite trend, with turbot showing lower post-settlement growth in 2009. The results provide valuable baseline data on critical events in the early life history of a data-poor species.

1. Introduction

Turbot (*Psetta maxima* Linnaeus) is a highly valued flatfish species, occurring in both marine and estuarine waters around Europe. Despite its high commercial value, there are currently no analytical assessments carried out for turbot, and little is known of the stock structure of wild populations (Anon., 2010). However, stocks are considered to be overexploited around Europe, including the Baltic (Draganik et al., 2005) and North Seas (Anon., 2010).

Adult turbot spawn in shallow waters just offshore, between April and August in the North Sea (Jones, 1974) and between late May and July in the Baltic Sea (Nissling et al., 2006). Turbot produce pelagic eggs and larvae, with the exception of the Baltic Sea, where eggs are demersal. Similar to many flatfish species, juvenile turbot inhabit shallow inshore nursery areas (Riley et al., 1981), settling at a length of between 2 cm and 3 cm onto predominantly exposed shores (Jones, 1973; Nissling et al., 2006).

In Ireland, turbot is one of the most valuable commercial non-quota species with landings increasing in recent years as a result of a more concentrated fishing effort (Anon., 2007). There is no specific turbot fishery in Ireland, and they are caught mainly as by-catch in demersal fisheries in the eastern Irish and Celtic Seas. The timing or location of spawning along the Irish coast is not known. However, a recent study identifies a number of turbot nursery grounds on the Irish west coast (Haynes et al., 2010).

Otolith microstructure analysis can provide important information on the timing of critical events in flatfish early life history. Daily increment deposition has been confirmed for many flatfish species (Nash and Geffen, 2005). A laboratory study has shown that for turbot, the rate of ring deposition is daily under rearing conditions that promote higher growth rates but that less than one ring is deposited each day when growth rates fall below 2 mm day^{-1} (Geffen, 1982). In general, where unfavorable conditions are not experienced otolith increments are assumed to be deposited at a daily rate and can be used to estimate age and as a proxy for growth (Campana and Neilson, 1985). When a flatfish undergoes metamorphosis from the pelagic to the flattened benthic form, the shape of the otolith changes dramatically producing distinctive checks known as accessory primordia (AP's) in the otolith microstructure (Nash and Geffen, 2005). Metamorphosis is coincident with settlement onto nursery grounds in the majority of flatfish species (Geffen et al., 2007) including turbot (Üstündağ, 2003); therefore the presence of AP's in the otolith microstructure allows the timing of settlement to be estimated. Given the lack of information available on wild turbot, the aim of the present work was to establish baseline data for hatch dates, larval durations, timing of settlement,

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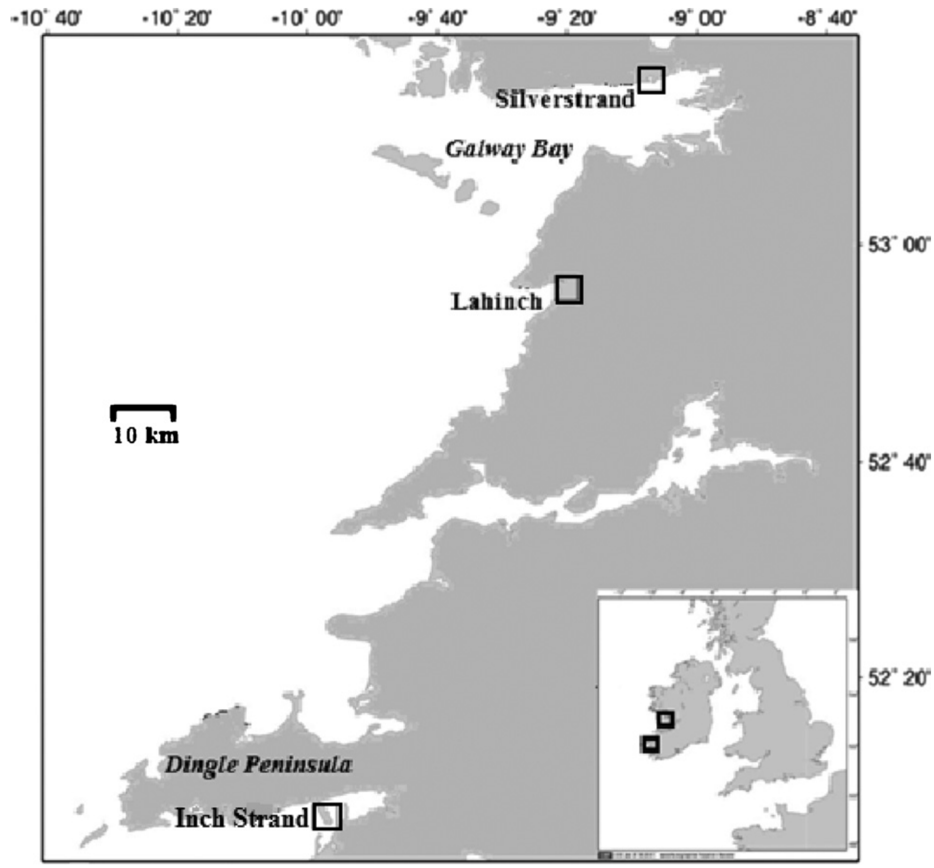

Fig. 1. Beaches assessed for 0-group turbot along the west coast of Ireland (2006–2009).

and relative growth rates, in addition to identifying any temporal or spatial variability in the investigated parameters.

2. Materials and methods

2.1. Sampling of fish

0-group turbot were collected from one sheltered and two exposed sandy beaches along the west coast of Ireland (Fig. 1) in September 2007–2009. Sampling occurred within 2 h either side of the low tide during daylight hours. In 2009 one location was sampled early in the settlement period (late August) in order to assess the extent to which the measured parameters in the population could change due to post-settlement mortality. Sampling details are summarized in Table 1.

Sampling was conducted using two Danish style beach seines. The seine used in 2008 and 2009 was 5.5 m long and 2 m deep, with a 5 mm × 5 mm mesh size. In 2009 a 20 m long and 2 m deep seine, with a 13 mm × 13 mm mesh size was used. Both nets captured a similar size range of juvenile turbot. Between 2 and 10 hauls were carried out, depending on the size of the beach. Sampling locations on each beach were randomly selected. Juvenile turbot were frozen on the day of capture before further analysis.

2.2. Otolith preparation and analysis

Sagittal otoliths were removed from 117 0-group turbot and cleaned. One of the pair was randomly selected for analysis. Otoliths were polished using the technique described by Brophy and Danilowicz (2002), until rings from the core to the outer edge of the otolith could be seen. Cracked or unreadable otoliths were rejected. Polished sections were examined using an Olympus BX51 compound microscope under 400× and 1000× magnifications, interfaced with a PC and the Image Pro Plus Analyzer version 6.2 software. The three life history stages examined were the larval (the region bounded by the first increment after the hatch check and the last full increment before the first accessory primordium or AP); metamorphic (the increments between the first and last AP), and post-settlement stages (the first complete increment after the last AP to the edge of the otolith). The first six increments after the final AP were used as an index of juvenile growth rate. Increments were measured to the nearest 0.1 μm, and counted along the longest axis. Hatch dates were estimated from total increment counts. To assess the reader's ageing precision, 25 otoliths were randomly selected and daily increments were counted for a second time, with no prior knowledge of the first count. The overall mean % coefficient of variation between the initial and second reading was calculated at 6.8%. All measured parameters were compared between right and left otoliths from a subsample of 10 fish and no significant differences were found (paired *t*-test, $p < 0.05$), justifying the use of randomly choosing the right of left otolith for the analysis.

2.3. Data analyses

After confirming that the assumptions of normality and equal variance were met, ANOVAs were used to examine variation in the measured parameters between locations and years. Beach was included as a fixed factor and year as a random factor. All significant differences were explored using Tukey's post hoc procedures with correction for multiple comparisons as described by Underwood (1997). Correlation analysis was used to investigate if