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# Maternal influences on egg and larval characteristics of plaice (*Pleuronectes platessa* L.)

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**Abstract**

Maternal influences on various egg and larval characteristics were examined using plaice from the Irish Sea and Norwegian coastal waters. Thirty-nine batches of eggs were incubated during the spawning season of 2004 and 2005. Thirty-seven larvae from one batch were also monitored individually to examine the influence of egg size on larval size at hatching, yolk sac volume and growth at the individual level. The relationship between egg dry weight (EDW) and egg diameter (ED) differed between the fish from different origins. Egg size increased with maternal size and decreased with progression through spawning. Eggs from the Norwegian coast hatched on average two days earlier than eggs from the Irish Sea. This resulted in the larvae from the Norwegian coast hatching at a smaller size and with larger yolk sac volumes. Larger eggs gave rise to larvae with larger yolk sac volumes at hatching (independent of incubation period) both at the batch and individual level. Larval growth rate was influenced by larval hatching size and yolk sac volume with smaller larvae and larvae with larger yolk sacs having a greater growth rate between hatching and two weeks after hatching. The effects of egg size on larval plaice were present until the end of the yolk sac stage due to differences in the time taken to absorb the yolk sac. Neither hatching rate, age at first feeding nor larval survival was related to maternal size or egg dry weight.


*Keywords:* Plaice; *Pleuronectes platessa*; Maternal effects; Egg size; Larvae; Growth

## 1. Introduction

Current fisheries assessment models include only limited biological details for the processes occurring between spawning and recruitment. Instead they traditionally assume that total egg production (reproductive potential) and recruitment is proportional to the spawning stock biomass (SSB) (Marshall et al., 1998). However, SSB is not often an accurate measure of reproductive potential (Marshall et al., 1998; Marteinsdottir and Thorarinsson, 1998) because the reproductive potential of fish stocks varies with the age, size, spawning experience and condition of spawning fish (Marteinsdottir and Begg, 2002).

In many fish species, larger females often produce larger eggs and egg size for each female decreases with each progressive batch through spawning (Kjesbu et al., 1996; Marteinsdottir and Begg, 2002; Rideout

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et al., 2005). This has also been demonstrated in plaice (*Pleuronectes platessa*) (Rijnsdorp, 1991; Schmidt, 2001; Fox et al., 2003).

The constituents of an egg, genetic and nutritive, determines its quality since fish eggs take up little, if any, nutrients once ovulated (Brooks et al., 1997). Thus the nutritive investment in an egg must provide for the larvae through to first feeding. Egg size has been shown to be an important factor in the early life history of fish as larger eggs provide more energy for development (Hempel, 1979) and egg size is positively correlated with many larval traits including larval length at hatching (Blaxter and Hempel, 1963; Buckley et al., 1991; Rideout et al., 2005), incubation period (Dannevig, 1894; Chambers et al., 1989; Huang et al., 1999), yolk sac volume (Blaxter and Hempel, 1963; Beacham et al., 1985; Gisbert et al., 2000), first feeding age (Gisbert et al., 2000) and survival potential and resistance to starvation (Knutsen and Tilseth, 1985; Marteinsdottir and Steinarsson, 1998; Rideout et al., 2005).

Larvae with a greater size-at-age have been shown to have longer swimming endurance (Ojanguren et al., 1996) and a greater burst swimming speed both of which can help in the capture of prey items and escape from predators (Miller et al., 1988). In plaice, larger larvae have a greater escape swimming speed and are less vulnerable to planktonic invertebrate predators (Bailey and Batty, 1984).

Larger adult plaice begin spawning earlier in the season (Simpson, 1959; Rijnsdorp, 1989; Horwood, 1990), during which time the availability of food items for the hatched larvae is much lower in comparison to later in the season (Scrope-Howe and Jones, 1985). Since larger fish produce larger eggs, earlier hatched larvae may be better prepared to withstand starvation than later hatched individuals. Fishing pressure on the adult population can lead to the selective removal of larger fish thus changing the proportion of old and young spawners. To understand the implications of shifts in the structure of the spawning population it is critical to evaluate maternal influences on the characteristics of the eggs and larvae.

The aim of the present study was to examine how maternal size and the seasonal progression of spawning affects egg size, and how the egg size influences batch averages of various egg and larval characteristics. Individuals within a batch were also monitored to examine egg size influence at the individual level.

## 2. Materials and methods

Mature adult plaice were collected by trawl in February 2004, in the Irish Sea, from inshore areas to the east of the Isle of Man and transferred to the Port Erin Marine Laboratory (PEML). The fish were kept in circular tanks with a volume of 1800 L, 2 m diameter and a water depth of 60 cm. This had an inflow of filtered seawater at ambient temperature (6–10 °C). Each fish was measured (Total Length) and weighed and implanted with a passive integrated transponder tag (pit tag). Milt was obtained from males that were part of the broodstock of the Larval Rearing Centre in PEML.

In February 2005, mature adult plaice were obtained from local Bergen (Norway) fishermen and transported live to the Department of Biology, University of Bergen where they were kept in tanks with a volume of 500 L and dimensions $1 \times 1 \times 0.5$ ($L \times B \times H$) m with an inflow of water at 7 °C. The fish were measured, weighed and tagged. All fish were visually checked daily for signs of ovulation (high degree of swelling in abdominal area and reddening around the genital opening (Panagiotaki, 1992)). Milt was obtained from males that were caught at the same time as the females and maintained in a similar tank.

Fish that showed signs of ovulation were 'stripped' of their eggs. Egg batches that were chosen for incubation were fertilised with pooled milt, from three randomly chosen males, which was mixed with seawater then mixed in with the eggs. The eggs were then allowed to stand in a controlled temperature (CT) room at 7 °C. After 30 min, using a fine mesh hand net, the eggs were dipped in seawater to rinse off excess sperm and the entire batch was transferred to a larval rearing tank. In 2004 the larval rearing tanks consisted of black cylindrical tanks with a volume of 30 L and dimensions of $28 \times 40$ ($H \times D$) cm with a water depth of 24 cm; these were kept in a CT room at 7 °C. The tanks had an inflow of UV sterilised filtered seawater with a mesh covered outflow at the top of the tank. The inflow of water was of ambient temperature (6–10 °C) and had a low inflow rate in order to keep the water temperature in the tank at 7 °C ± 0.5 °C. The tank also had a central air stone to circulate and aerate the water.

In 2005, the larval rearing tanks consisted of black cylindrical tanks with a volume of 15 L and dimensions of $25 \times 32$ ($H \times D$) cm with a water depth of 19 cm. These had a gentle inflow of seawater at 7 °C ± 0.5 °C. The tanks had a mesh bottom where water flowed out to a larger holding tank. Each larval tank had a central air stone to circulate the water. All tanks were on a 10:14 hour light:dark cycle.

In all batches produced, the egg diameters of a sample of unfertilised eggs (10 in 2004, 30 in 2005) were measured to the nearest 0.01 mm using a dissecting microscope and graticule. Egg dry weight (EDW) was