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Correlation between the size of mature female perch (*Perca fluviatilis* L.) and the width of their egg strands in Lake Geneva

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The size of the mature perch females were estimated from the width of the egg strands that were laid on their spawning grounds. By separately sampling egg strands and mature females in 1992–1995, general relationships were established for perch in Lake Geneva. Because of the high variability in the ova content of smallest perch, this relationship could be applied to perch with a total length 150–350 mm.

1. Introduction

Spawning perch (*Perca fluviatilis* L.) gather in shallow waters (Craig 1987), where the females usually attach their egg strands to physical supports (plants, branches, etc.) (Thorpe 1977, Treasurer 1981). Egg strands are in the form of ribbons or flat cylinders. There is only one egg strand per perch each year (Thorpe 1977). Overall, the size of the egg strands is related to the size of the females (Lang 1987), but no relationship have been proposed. No experimental study has been done yet and,in natural conditions, it is nearly impossible to collect both the fertilised egg strand and the female that laid it.

Given the assumption that mature females and egg strands having the same number of ova or eggs are related, we propose in this study a relationship of female perch total length and egg strand size for Lake Geneva, from separate samples of mature fish and egg strands, collected in 1992 to 1995 in the same area and during the spawning period (end of April–beginning of June), in a depth range of 3 to 12 m (Lang & Büttiker 1985, Gillet *et al.* 1995). The width of the ribbon is used as a characteristic parameter of perch egg strands, as shown in studies in Lake Geneva, in natural spawning areas (Lang 1987) or on artificial spawning substrates (Gillet & Dubois 1995, Gillet *et al.* 1995).

2. Material and methods

Studies were made in Lake Geneva, along the south shore, in the vicinity of Thonon-les-Bains (France), where perch come to spawn.

Firstly, pre spawning female perch were caught in traps (mesh size 23 mm) by professional fishermen on May 2 and 3, 1994, April 26 and 28 and May 4, 1995. At the laboratory, their 2 opercular bones were taken for age determination. The total length (*TL*, in mm) from the head to the end of the caudal fin was determined on 123 fish. Ova were extracted from the

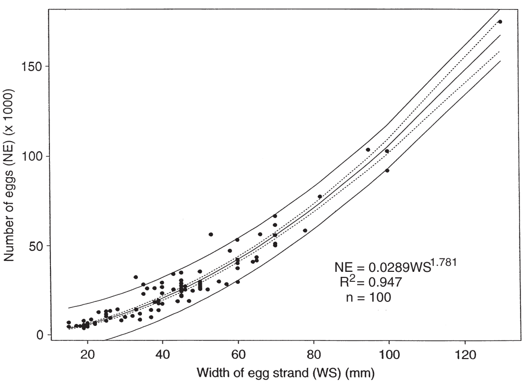

Fig. 1. The relationship between the number of perch eggs and the width of their egg strands, in Lake Geneva. The regression (full line) and the 95% incertitude curves on the model (dotted lines) and on the observations (full lines) are shown.

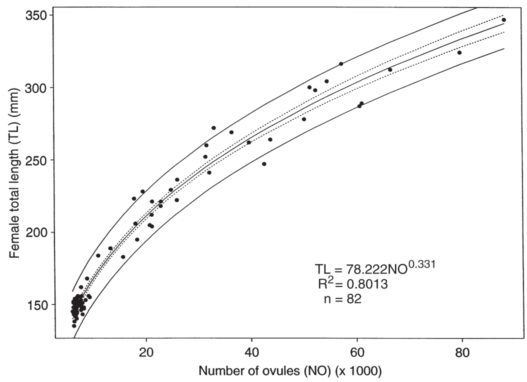

Fig. 2. The relationship between the size of female perch and their number of ova in Lake Geneva. The regression curve (full line) is drawn for a number of ova > 6 000. Incertitude curves, on the model (dotted lines) and on the observations (full lines) are shown.

ovaries and their number evaluated from a subsample, weighed to the nearest 0.1 mg. The number of ova of each subsample was precisely determined. All the subsamples contained between 100 and 400 ova. The stage development of the ovaries we observed were in the "developing, late" and "gravid" stages, according to Treasurer and Holliday (1981).

Secondly, during the spawning periods 1992, 1994 and 1995, egg strands that were laid on artificial spawning substrates (conifer branches deposited on the lake bottom at 4, 6, 8 12 and 15 m) were sampled. One hundred complete egg strands could be collected. These were brought into the laboratory. Their width (mm), which corresponds to one half of the egg cylinder circumference, was determined. Three measurements were made in water, in the central part of each ribbon. The length and fresh weight were also recorded; the number of eggs was evaluated from a weighed subsample of 50 to 300 eggs to the nearest 1 mg.

Thirdly, during the fishing seasons 1993–1994 and 1994–1995, samples of perch were taken in the same zone using gill nets of different mesh sizes (15, 18, 20, 23, 25 and 30 mm). The total length (mm) of maturing females was measured.

Statistical analysis has been done on the data. Non linear regression curves ($y = a \times x^b$) were calculated and incertitudes of the model curves and of the observations are given by the Student's test at the 95% level. Incertitude of the resulting curve has been estimated on the assumption that both observed relationships were independent.

3. Results

The relationship between the number of eggs (*NE*) and the width of the egg strand (*WS*) is presented in Fig. 1. The equation of the regression curve is:

$$NE = 0.0289WS^{1.781},\ n = 100,\ R^2 = 0.947. \quad (1)$$

The 30 perch collected in 1994, with a size between 183–347 mm, were bigger than the 93 fish sampled in 1995, whose size was between 134–228 mm. In 1994, 7 of the 30 fish were 2 years old, 16 were 3, 2 were 4, 4 were 5 and 1 was 6 years old. In 1995, 27 of the 93 fish were 2 and 66 were 3 years old.

Two groups could be distinguished. For perch having less than 6 000 ova (total length < 150 mm, 41 fish, 26 being 3 years old), there was high variability in the ova number and no general relation to the female length could be shown. In the fish with > 6 000 ova (82 fish ≥ 150 mm, 56 being 3 years old), the total length of the female (*TL*) could be deduced from the number of ova (*NO*) (Fig. 2). The equation of the regression curve is:

$$TL = 78.222NO^{0.331},\ n = 82,\ R^2 = 0.8013. \quad (2)$$

Therefore, for perch larger than 150 mm and smaller than 350 mm, a relationship between the size of the female and the size of the egg strand could be derived from the eqs. 1 and 2 (Fig. 3). The equation of the regression curve is:

$$TL = 24.210WS^{0.589}. \quad (3)$$

When applying eq. 3 to the data recorded in 1993–1995 the general size distribution of egg strands (Fig. 4a) corresponds to the distribution of the females we caught (Fig. 4b), and their modes are the same. The range of the fish lengths deduced from the egg strand data is wider than that obtained

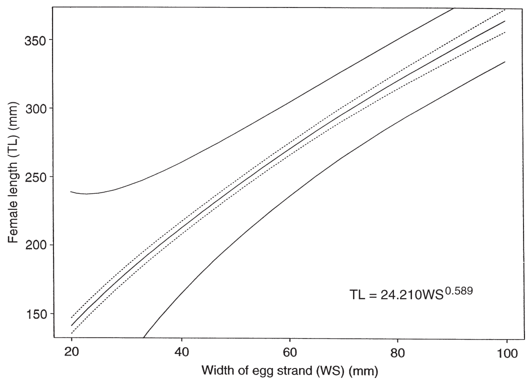

Fig. 3. The relationship between the size of female perch and the width of their egg strands in Lake Geneva. The relation was derived from the equations 1 and 2. Incertitude curves, on the model (dotted lines) and on the observations (full lines) are shown.

directly from fish. This is because the number of large-sized fish was probably underestimated in gill net sampling with mesh sizes ≤ 30 mm.

4. Discussion

Female perch lay their eggs in a sole egg strand with their ends heavily folded. Fertilised egg strands have a regular width, except for the ends (each end is < 5% of the total length). The general aspect of the egg strands is similar to the ovum strands of the mature females. In our study no ovum was left in the ovary after spawning, but Treasurer and Holliday (1981) observed that a small number could be left inside.

The relationship between animal body size and other physiological characteristics such as fecundity can be described with a power relation (Blueweiss *et al.* 1978). Such a relation could be applied for egg strands of perch longer than 150 mm.

Few studies have been made linking the size of female perch and the size of egg strands together. In Lake Geneva, Lang and Lang (1983) estimated the absolute fecundity of female perch, while Lang (1981) recorded the width of egg strands in spawning grounds, but, probably owing to lack of data, no attempt was even made to combine the fish length and the egg strand width. In Lake Zürich, the relationship between the length of perch and the length and width of egg strands was studied; the egg strand surface was the best descriptor of the perch size, but the width was nearly as precise (Ritter 1990).

The width of the egg strands is easy to record under natural conditions, because it is not necessary to collect the entire strand, which is very fragile. For a field survey, the other parameters such as length and weight can be discarded.

The fecundity of perch is variable among fish populations (Craig 1987). It has been established that the number and size of eggs laid by a female can vary according to many factors such as age, localities and food supply (review by Thorpe 1987). In

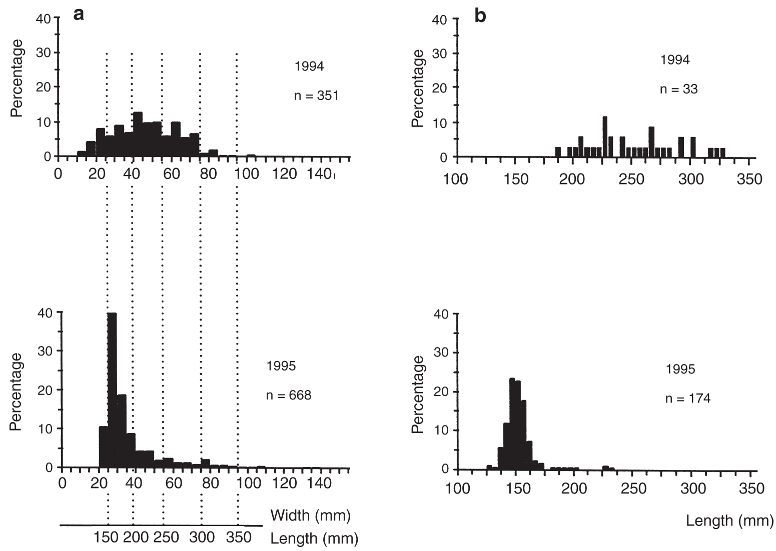

Fig. 4. A-size distribution of the egg strands of perch collected in 1994–1995 in Lake Geneva. The correspondence with the size of the female perch is given below according to the relationship presented in eq. 3. B-size distribution of the mature perch females, caught in Lake Geneva in 1994–1995.

our study, the incidence of age was minor. Most of the fish were 3 years old, and there was no differences with other fish, when plotting the female size versus the number of their ova. On the other hand, the fish growth was slower in 1995 than in 1994, because of an inadequate food supply available for the large number of fish. This food limitation could explain the high variability in the absolute fecundity, particularly with the smallest perch of < 150 mm *TL*.

In order to estimate the number of female perch in a lake, it may be simpler to study their egg strand distribution than to capture the fish in nets. This method may also yield more information about large fish.

The relationships given in this study are limited to Lake Geneva. In order to improve their accuracy, particularly for eq. 2, and to discuss the incidence of intra specific and environmental parameters, particularly for small fish, further observations should be made.

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