Controlled reproduction of chub, *Leuciscus cephalus* (L.) in captivity

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Abstract

The chubs studied in this experiment hatched after artificial fertilization of wild spawners. Young chubs were reared in captivity and submitted to high temperatures (20-25°C), natural photoperiod, and maximum feeding level. These environmental conditions resulted in an accelerated growth rate, bringing the males (n=60) to 72g (mean weight) and the females (n=71) to 143g in 2 years. At that moment, it was possible to induce (injection of carp pituitary extract) the first ovulation in the females (the males matured spontaneously) and to carry out artificial fertilization. In the culture system, females reached sexual maturity very early in the year (January as compared to May-June in the river). The optimal rearing conditions allowed three reproductions to take place in 1 year (in January, June, and July).

KEYWORDS: *Leuciscus cephalus*, Control of reproduction.

Introduction

Control of the reproduction is a major step in the development of the culture of a fish species, such as the chub, *Leuciscus cephalus*, a European cyprinid. In addition to its practical implication for aquaculture, this study is also included in a more basic research context concerning the experimentation of the adaptive potentialities of the chub to captivity, and involving the study of the role played by environmental factors (temperature and photoperiod) in controlling reproduction of this species.

Material and methods

The chubs studied (n=2500) at the beginning of the experiment hatched after artificial fertilization of wild spawners electro-fished in the River Ourthe (Belgium, latitude: 11° North, longitude 5° East) on July 7, 1983. At the Fish Research Center (CERER) of the University of Liège. The fish were reared in 4m³ (1.5m³ fiber-glass tanks (Méillard and Philippart, 1981) in which the temperature was artificially maintained between 20 and 25°C. Photoperiod was natural, ranging from a maximum of 16.5L/7.5D in June to a minimum of 8L/16D in December. Chubs were fed to satiation (1.5% to 2.5% of the body weight) with commercial 45% crude proteins trout pellets. This feeding level allowed chubs to exhibit a fast growth rate. Nothing is known about food consumption just after reproduction.

Males were marked (partial clipping of a pelvic fin) at the time of their first maturity, in May-June 1984. From October 1984 on, chubs were checked every 3 months. At each control, a sample of fish was dissected and their gonadosomatic index calculated (GSI = gonad weight x 100/total body weight). When 1) the GSI of females was higher than 8%; 2) most of them exhibited stoutness; and 3) the males were mature, "spawning" was induced by hypo-
GSI cycle and reproduction

The variations of the GSI of females and males from October 1984 are shown in Fig. 3. The GSI is always higher in females (more important development of the ovaries) than in males. The GSI remained low till April 1985, then reached maximum values in June, 1985. At that time it was possible to induce a first ovulation in a sample of females (n=18) of a much smaller size (200-231 mm) than wild spawners (Philipart, 1977).

After that first "spawning", the GSI remained low during the autumn of 1985, suggesting an inhibiting effect of the decreasing daylength (Poncin et al., 1987). Indeed, the hypophysation of 10 females performed in December was quite unsuccessful whereas a month later, 84% of the hypophysated females (the whole population: n=50) reached maturity and ovulated for the first time (5 months before spawning in the wild).
Fig. 2. Length-frequency distributions of male (---) and female (---) chubs from October 9, 1984 till July.

Fig. 3. (A) GSI values of the female chubs from October 1984 to November 1986. The number of fish in each sample is indicated; (B) PHFO: percentage of ovulating females after hypophysation (the number of hypophysated females is indicated); (C) GSI values of the male chubs; (D) PSMM percentage of spontaneously mature males.
average weight loss of the ovaries just after spawning (dotted lines on Fig. 3) was estimated in the samples of dissected fish using the relations "weight of stripped ova/length of fish" established with "complete" ovulated females. In April 1985, the ovaries and testes were poorly developed. The GSI reached again a maximal value in May, allowing to induce a second ovulation in all the females (n=41). A month and a half later, a third reproduction was made possible, revealing a particular phenomenon discussed later. After that spawning, the GSI of females and males fell back to low values during the autumn.

**Egg production**

Fig. 4 shows the frequencies distribution of the relative weight (total egg weight x 100/total body weight) of ova stripped from the females, referring to the four periods of reproduction described before. The average production of eggs in July 1986 was 46% lower than the one that could be expected considering the results obtained in June. It seems that rapid consecutive spawnsings act against a high production of eggs. It is also possible that in July, the moment of hyphophyasation comes either too soon or too late resulting in a lower production of ova.

**Discussions and conclusions**

The use of heated water and high feeding rates result in growth rates being faster in cultured chubs than in wild ones (160mm at 1.5 years in captivity and at 3 years in the River Ourthe) (Philippart, 1977). A consequence of this fast growth rate is that sexual dimorphism appears at a very early age (15-16 months in captivity, 4 years in the River Ourthe). The culture conditions are also responsible for reaching maturity at a smaller length and an earlier age than in nature. The same phenomenon is observed in several other cyprinid species among which the common barbel, *Barbus barbus* recently studied by our research team (Poncin et al., 1985). But unlike in the barbel (or the tench in most cases), the ovulation of female chub has to be induced by hyphophyasation.

Cultured chubs reach maturity early in the year (January) whereas wild ones reach maturity once a year in May-June when the temperature reaches 15-18°C (Penaz, 1968; Penaz and Sterba, 1969; Philippart, 1977). This phenomenon of reproduction early in the year is observed in many other cyprinids such as the roach, *Rutilus rutilus* (Mattheeuws et al., 1981), the tench, *Tinca tinca* (Horoszewicz, 1981), and the barbel *Barbus barbus* (Poncin et al., 1987) when the fish are kept in naturally or artificially heated water.

The occurrence of three annual "spawnings" in chubs reared in captivity is the more significant result of our research on that species. That phenomenon was previously described in the carp *Cyprinus carpio* (Gupta, 1975; Kossman, 1975) and in the barbel (Poncin et al., 1985). The existence of two reproductive cycles is clearly demonstrated in both males and females. The fact that three artificial spawnsings were obtained in the female population does not necessarily mean that all the females (which were not individualised) exhibited a third complete reproductive cycle.

![Graphs showing frequencies distribution of the relative weight (total egg weight x 100/total body weight) of ova stripped from the females.](image)

**Fig. 4.** Frequencies distribution of the relative weights of ova (total ova weight x 100/total body weight) of the female chubs for each period of reproduction. Figures below 0.49% were not taken into account to calculate the average.
That the chubs never reach maturity from August to January seems to be caused by the decreasing daylength occurring during this period as revealed by another experiment (Poncin et al., 1987, 1988).

Conclusions

To conclude, we may say that this study reveals some unknown aspects of the biology of the chub reared in captivity. A further step of the research will be an analytical examination of the influence of environmental factors (temperature, photoperiod, and feeding rate) on the reproduction of the chub.

From a practical point of view, this study made possible a production of 100 000 larvae which were reared in heated or natural ponds and used later for restocking rivers.

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References