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GROWTH RATES IN CULTURED COMMON WOLFFISH (*Anarhichas lupus*) AND SPOTTED WOLFFISH (*A. minor*)

by

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ABSTRACT

Field caught common wolffish (*Anarhichas lupus*) and spotted wolffish (*A. minor*) have been raised from fry on dry pellets. The two species have experienced annual fluctuations in temperature between 6 and 12 °C and the results indicates that both species have there best growth rates below 10 °C. With initial average wet weights of 2.6 g (common wolffish) and 6.3 g (spotted wolffish), and at equal experimental conditions, the spotted wolffish reached four times the wet weight of the common wolffish over a period of two years and 10 months, 3.4 and 0.9 kg respectively. The specific growth rate, however, were 0.62 $\%d^{-1}$ and 0.58 $\%d^{-1}$ respectively, indicating only small differences in growth rates in that period. Estimates based upon the fastest growing fish in the experimental groups indicated that at optimum temperature conditions (approx 6 °C) the spotted wolffish will probably reach a total wet weight of 6 Kg in two years from start-feeding, while the common wolffish (below 10 °C) will reach a weight of 3 kg in that same period. The common wolffish mature at a size from 0.5 - 1.0 kg, while the spotted wolffish mature at a size above 4 kg.

INTRODUCTION

Fish farming has become an important and constantly growing industry. Tilseth (1990) gives an overview of the research activities on cold-water marine fishes in Norway. Beside halibut and cod, Tilseth (1990) considers two species of wolffish, common wolffish (*A. lupus*) and spotted wolffish (*A. minor*), as promising species in future fish farming. As mentioned by Tilseth (1990), the two species are candidates because they have large eggs, the newly hatched larvae are ready to feed on comparatively big particles and there has been indication of high growth rates in captivity. In addition, the larvae are similar to salmon larvae in physiological characteristics (McIntoch and Prince, 1890; Pavlov, 1986), and it is believed that it should be possible to use aspects of the technology developed for salmonids. However, as pointed out by Tilseth (1990), fertilization of the wolffish eggs has been a big problem.

Although spawning of wolffish has been observed in aquaria (Hognestad, 1965; Marliave, 1987; Ringø and Lorentsen, 1987), there has been problems in fertilizing the eggs of the wolffish. However, during the last spawning season, eggs from several females were fertilized at Møre Marine Fish, Norway (R. Kvalsund, pers. comm, 1990). As the technique involved to fertilize the eggs now is known, a high number of eggs are expected to be fertilized during the next spawning season. This will probably give an increasing number of newly hatch larvae of both species in the coming years. Recent reports have concluded that the wolffish larvae are easy to startfeed as Ringø et al. (1987) succeeded in rearing larvae of *A. lupus* on a diet containing zooplankton and Moksness et al. (1989) startfed the same species on dry pellets. In addition, Pavlov and Novikov (1987) reared *A. lupus marisalbi* on artificial food and the Pacific wolffish (*Anarrhichtys ocellatus*) has also been successfully startfed (Marlive, 1987). The distribution and diet of wild common wolffish larvae has been reported by Falk-Pedersen et al. (1989) and gives valuable information for a future composition of dry pellets for the newly hatched larvae. In addition, wild caught common wolffish larvae are reported easy to wean either to dry or moist pellets (Moksness, in press). These observations indicate that high numbers of seeds of wolffish might be produced in the coming years. However, feasibility must be tested to examine whether raising of wolffish can be economical in the future. One of the important parameters in such a model will be the growth rate of the fish from startfeeding till it obtain a suitable marked-size.

This paper reports growth rates of both common wolffish and spotted wolffish kept in captivity from larvae.

MATERIAL AND METHOD

The fish used in this study were collected as fry during 0-group surveys in the Barents Sea in August/September 1986 and 1987. The fry were transported by air to the Marine Research Station Flødevigen. In Table 1 gives an overview of the groups from which the data in this report have

been obtained. At arrival, the fry were kept in green-walled tanks of 1m x 1m x 0.3 m (260-280 l) and at a size of 100 g the juvenile were transferred to green tanks of 2-3 m^3. All the fish have been fed dry pellets (Skretting Elite Plus) through the whole experiment. The annual temperature in the inlet have fluctuated between minimum 6.0 °C and maximum 12.0 °C with approximately 0.2 °C higher temperature in the experimental groups. A indication of the annual fluctuations are given in Figure 1, where data from 1989 are presented. The oxygen content in the inlet varied depending on the time of the year. Usually, in the period from June to December the oxygen content in the inlet has been below 6 ml/l. In the outlets from the tanks the oxygen content in this period was below 5 ml/l, which created problems like reduced food uptake and thereby reduced growth rate. However, from November 1988 the inlet water have been oxygenated and the oxygen content has since been kept above 7 ml/l (fig. 2). The ammonium content in the inflowing water was mainly below 1 µgat/l during the whole year. All the fish were exposed to a 16 L : 8 D light cycle.

Table 1. An overview of the experimental groups used in this study.

Group ID	Year collected	Species	Initial wet weight (g)	Initial number
86-4	1986	Common	1.6	55
87-4	1987	Common	2.5	108
87-5	1987	Spotted	6.3	65

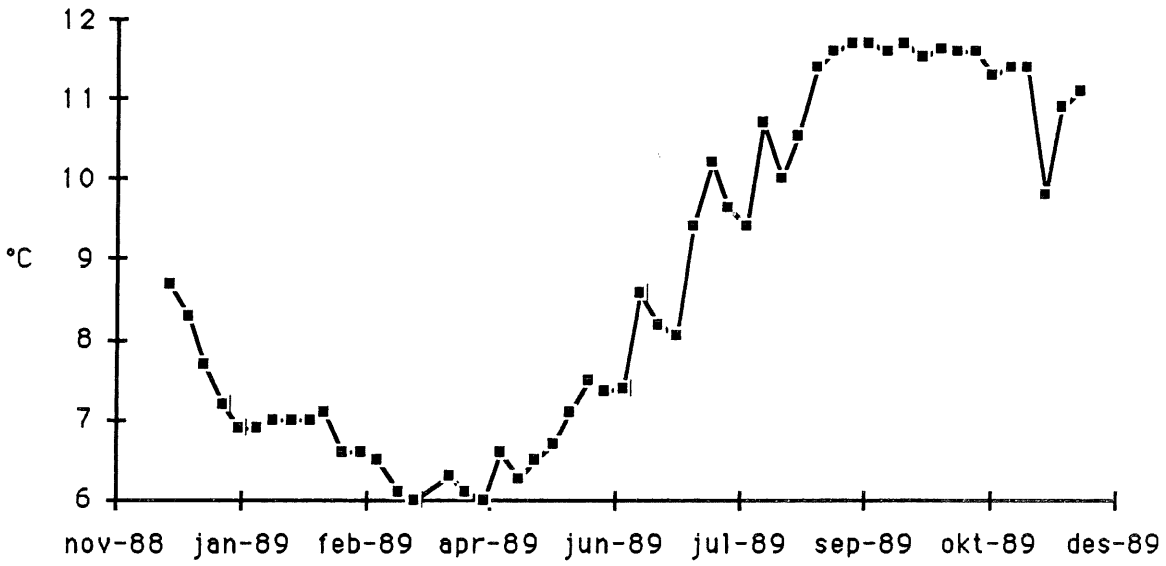

Figure 1. Typical annual fluctuation in temperature (°C) in the inlet water. The salinity varied between 33.1 and 34.7 (°/oo).

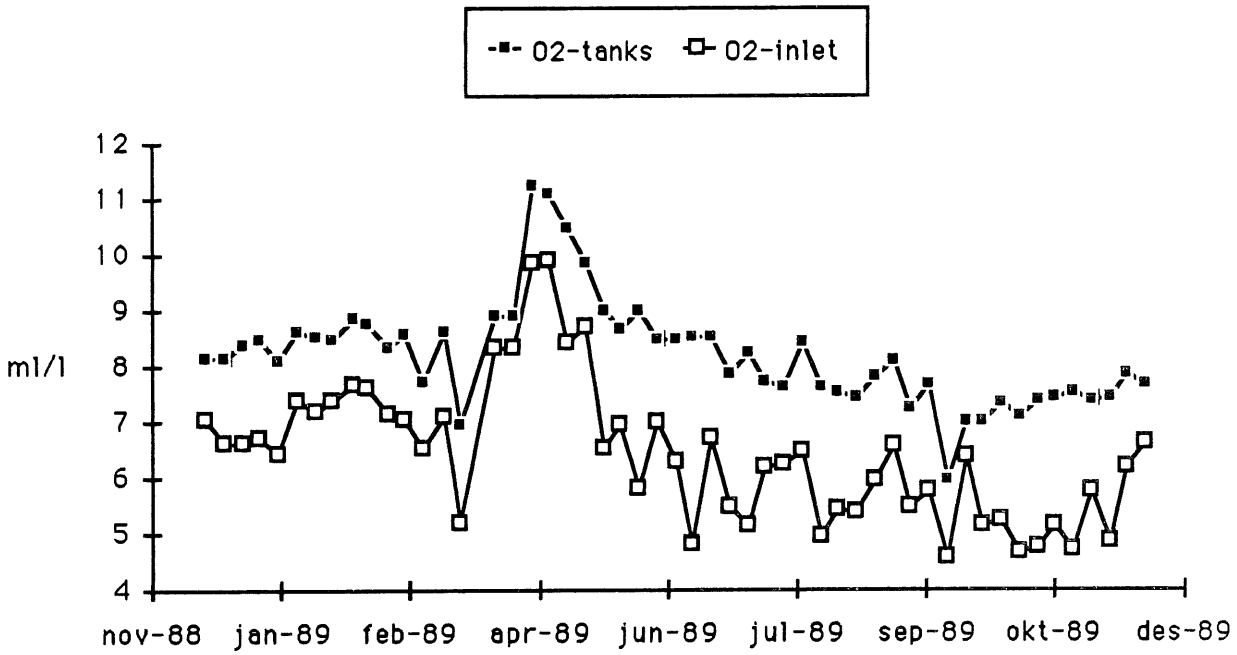

Figure 2. Oxygen content (ml/l) in the inlet water before (O2-inlet) and after (O2-tanks) oxygenation.

The fish were weighted ones a month and the larvae in each group were weighed live as total biomass in a preweighed bucket of water, while the weight of each individual juvenile or adult were measured using a preweighed bucket without water. Specific growth rate, SGR, was calculated according to the formulae (Houde and Schekter, 1981):

SGR = (exp((Ln W_{t2} - Ln W_{t1}) / (t_2-t_1))-1)*100, where W_{t1} and W_{t2} are wet weight of the fish at day t_1 and t_2.

RESULT AND DISCUSSION

In Figure 3 are the average wet weight of the 87-4 group (common wolffish) and 87-5 group (spotted wolffish) given. The two species were reared at almost identical conditions, as the same temperature, oxygen-content, salinity and same type of dry pellets. The initial average wet weight was almost 2,5 times higher in 87-5 (6.3 g) compare to 87-4 (2.49 g). During a period of 2 years and 10 months the spotted wolffish reached almost four times the average wet weight of the common wolffish, 3.4 and 0,9 kg respectively. Their overall specific growth rate in that period differ with 0.62%d^{-1} for the spotted wolffish and 0.58 %d^{-1} for common wolffish. The main reason for the big difference in size after 2 year and 10 months is the initial differences in weight. This phenomen has earlier been reported for common wolffish (Moksness et al., 1989) and turbot (Iglesias et al., 1985). However, the higher growth rate of the

spotted wolffish caused the increased difference between the two. The growth rates of both the common and spotted wolffish are far much higher compared to growth rates estimated from field observations. Shevelev (1988) estimated that common wolffish needed 6 years to reach a weight of 1 kg and 10 years to 4 kg, corresponding to a specific growth rate of 0.16 and 0.13 $\%d^{-1}$ respectively. The spotted wolffish used 5 and 8 years to reach weights of 1 and 4 kg respectively, giving specific growth rates of 0.19 and 0.17 $\%\ d^{-1}$ respectively. The ratio between the specific growth rates of spotted and common wolffish are higher (1.2 - 1.3) in the field estimates compared to the ratio in this study (1.1), indicating that the experimental conditions probably favour the common wolffish.

Similar growth rates (0.22 $\%d^{-1}$) of common wolffish in captivity, as in this study, have been observed at Møre Marine Fish, Norway over a period of one year (Kvalsund, pers. comm., 1990). The fishes in that experiment had an average size of 3.5 Kg and a range from 1 to 11 Kg. Some fishes had during the one year a growth rate of 0.45 $\%d^{-1}$, indicating that by selecting out the fastest growing fishes for breeding a even higher average growth rate is to be expected.

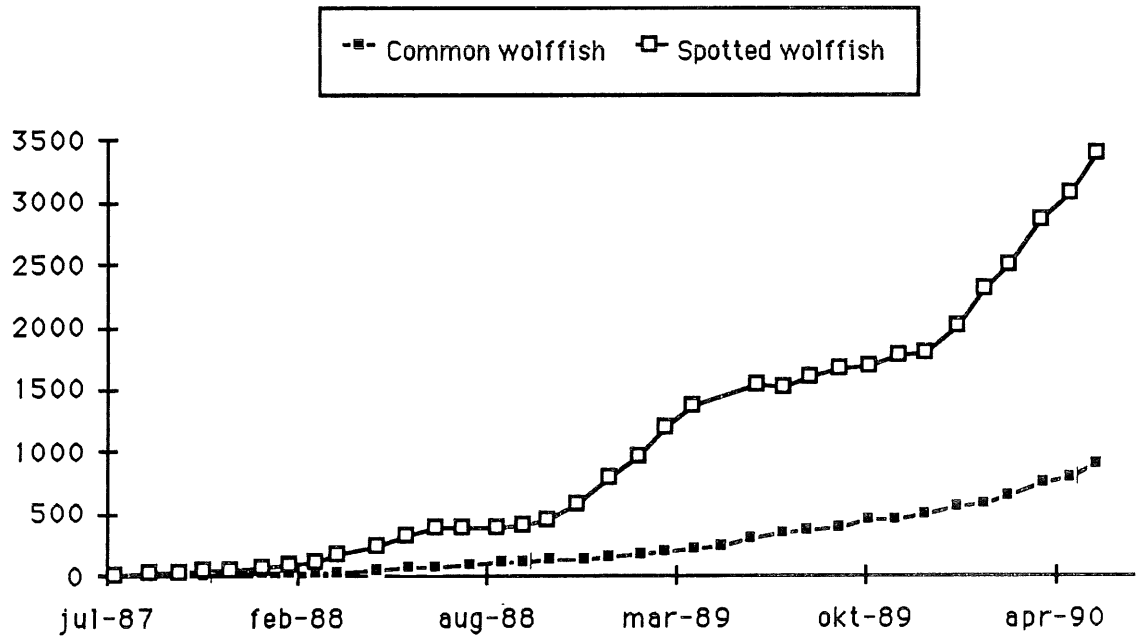

Figure 3. Average wet weight (g) observed in common and spotted wolffish at identical experimental conditions over a period of 2 years and 10 months.

The specific growth rate in percentage, calculated monthly in the three experimental groups, are given as a function of average wet weight and temperature in Figure 4 and 5, for common and spotted wolffish respectively. Initially (not given in the two figures) the specific growth rate was high (above 2.5 $\%d^{-1}$) for both species. As indicated in the two figures the specific growth rate decrease with increasing weight of the

two species. The specific growth rate of common wolffish decreased from 0.59 $\%d^{-1}$ at a weight of 200 - 800 g to 0.35 $\%d^{-1}$ at 1200 g. These growth rates are below the values of spotted wolffish which decreased from 0.96 $\%d^{-1}$ at 500 g to 0.4 $\%d^{-1}$ at 3000 g. For both species these growth rates have been observed at temperatures below 10 °C (see Figure 4 and 5). The results indicates that the optimum temperature for spotted wolffish are lower than for the common wolffish and below 6 °C. The temperature range for common wolffish have earlier been reported to be between -1° to 10.2 °C (Beese und Kändler, 1968) and for spotted wolffish -1.3 to 6.8 °C (Barasukov, 1972) indicating that spotted wolffish prefer colder waters than the commom wolffish.

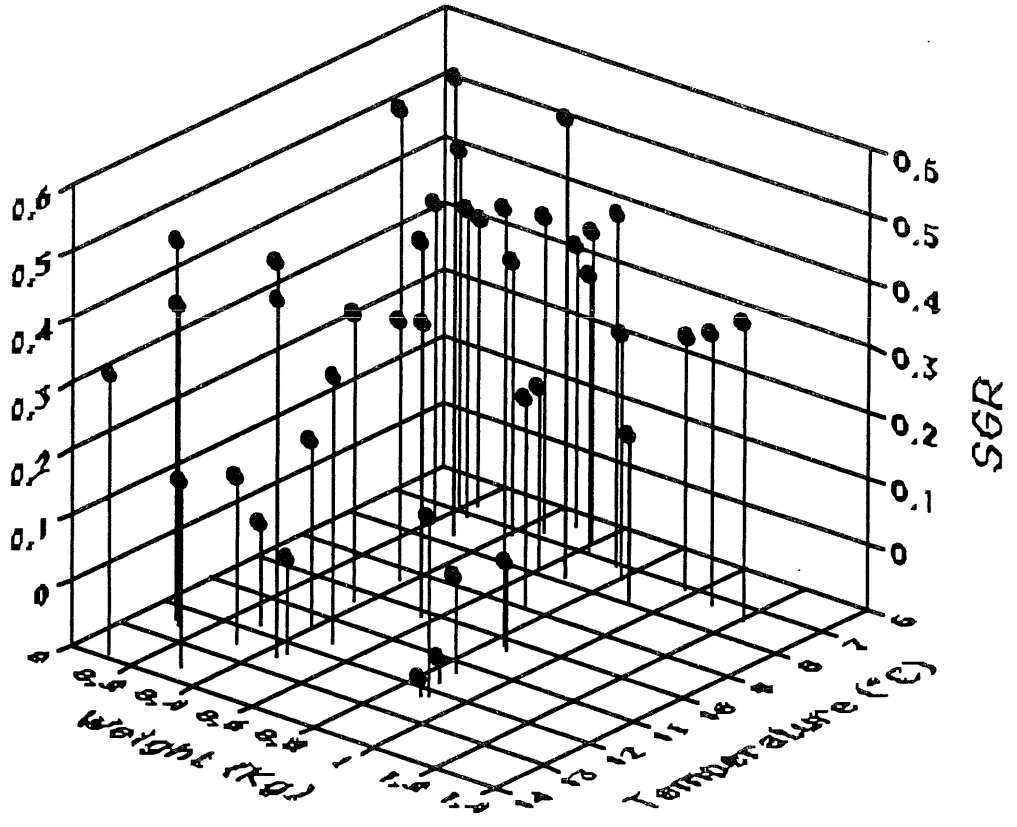

Figure 4. Specific growth rate ($\%d^{-1}$) of the common wolffish in relation to the size of the fish and the temperature.

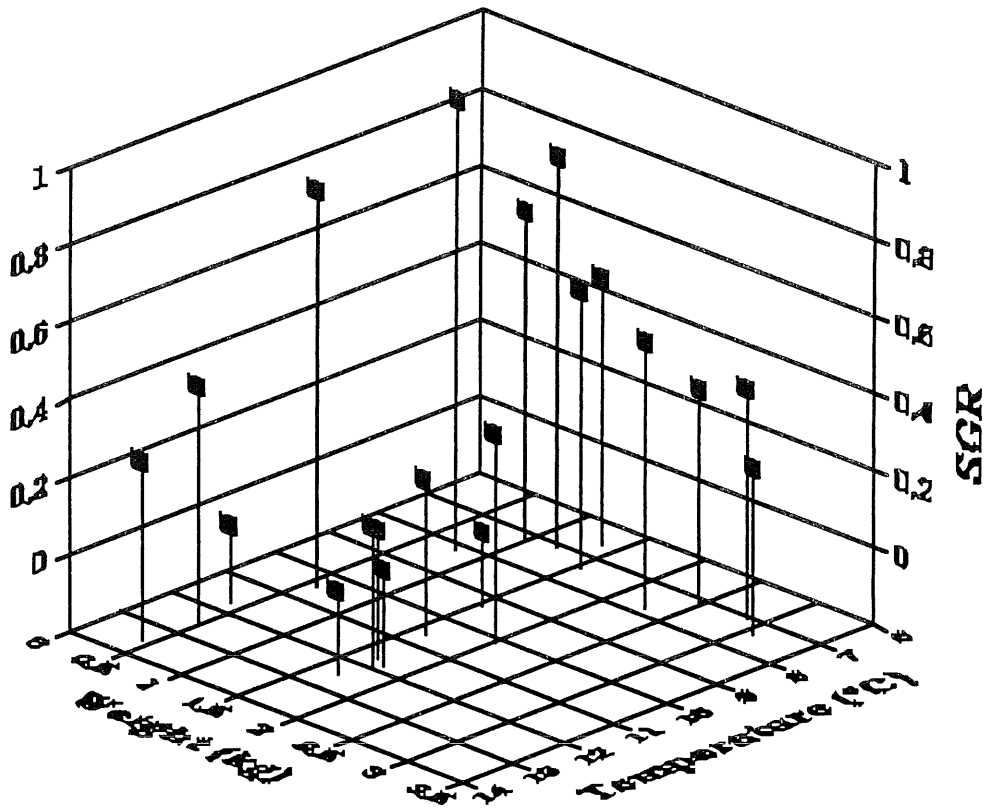

Figure 5. Specific growth rate (%d^{-1}) of the spotted wolffish in relation to the size of the fish and the temperature.

By examine the highest growth rate obtained by single fishes in the three groups of both species and grouped the growth rates according to the size of the two, the results indicates that an average total wet weight of 6 Kg can be obtained for spotted wolffish within two years from startfeeding and 3 Kg for common wolffish for the same time period. This corresponds to a overall specific growth rate calculated from hatching of 1.39 %d^{-1} in spotted wolffish and 1.29 %d^{-1} in common wolffish. High specific growth rates have also been observed in the field. Østvedt (1963) reported from tagging of spotted wolffish in the Barents Sea that one fish increased its length from 78 cm to 120 cm in 1 year and 9 months. This correspond to a increase in weight from 5 kg to 19 kg, which gives a specific growth rate of 0.21 %d^{-1}.

Maturation was only observed in the two groups with common wolffish. The females who matured ranged from 0.5 to 1.0 kg in wet weight. Shevelev (1988) reported from a field investigation that among the spotted wolffish, the females usely matured at a weight of 4 kg and the males at a weight 8 kg. Since few of the spotted wolffish in this study had a weight above 5 kg, this might be the reason that matured fishes has not been observed in this group.

Only few of the fishes in this study died during the experimental period. Initially some fishes died due to predation, which is in accordance with earlier observations (Moksness in press) where predation occured in groups of field caught common wolffish larvae up to a size of 8 g. In addition, infection of the ectoparasitt *Trichodina* caused some mortality and reduced growth rate. However, infections of *Trichodina* is easy to control with formaldehyde. There is likely to belive that other problems both with bacteria's and parasites will occur as the cultivation experiments with wolffish proceeds.

The experiments have shown that wolffish are easy to keep in captivity. It is likely that the fertilization of the eggs will be controlled in the near future and thereby production of seeds for fish farming should be a rather easy task. Of the two species, spotted wolffish is the most promising one, because of their high growth rates at low temperatures, the fish mature at a larger size than the common wolffish and have a larger file portion. A overview of some of the parameters for wolffish are given in Table 2.

Table 2. Comparation of some parameters for the wolffish.

Parameter	Common Wolffish	Spotted wolffish
Egg number	2 - 20.000	10 - 50.000
startfeeding	dry pellets	dry pellets
Optimum temperature	< 10 °C	< 10 °C
Wet weight - 2 yr	~ 3 Kg	~ 6 Kg
1st x spawning	0,5 - 1.0 kg	> 4,0 Kg
File portion	35 - 45 %	40 - 50 %

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