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Zootechnical performance and body composition of *Perca fluviatilis* pelleted diet in a floating cage: Effect of daily ration

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Mass rearing performances and body composition of perch *Perca fluviatilis* (25 g) fed on a pellet diet in floating cages were studied during July to September 1993. At the end of this period, they weighed 48 to 49 g and the survival rates were 70 to 79%. The feeding rates (3 or 4%) had no direct influence on the zootechnical potentialities or body composition. In September the gonadosomatic index increased, particularly for males. Sexual maturity triggered a regression of hepatosomatic index and a modification of fish body composition. In comparison with perch bred in a closed system at 22.0°C, the fish in cages had a higher protein and a lower lipid and energy content. Triacylglycerol fractions and phospholipids evolve reversely as function of the rearing system.

1. Introduction

Floating cages provide many advantages for the production of fish: production costs are reduced (Duarte *et al*. 1994) and captive fish are maintained in their own environment. Their importance as rearing systems has been emphasized by Webster *et al*. (1992) and Awaluddin *et al*. (1994). However, their use in France is still limited, particularly with freshwater fish. The fishfarmers prefer more convenient sites and fear connected with problems (bad weather and vandalism) cage protection (Barbato *et al*. 1993).

The progress of new rearing systems mainly concerns technical and economical aspects (Fontaine 1994). The biological potentialities of fish species have been less studied. According to Porrello *et al*.

(1993), adaptation of *Seriola dumerili* is better in floating cages than in tanks; this is also true for *Piaractus brachypomus*, a characid species, whereas another (*Colossoma macropomum*) has a better growth rate in tanks (Mélard *et al.* 1993). Perch (*Perca fluviatilis*) fed at 2% daily ration is grows well to both systems, as shown in a preliminary experiment (Tamazouzt *et al.* 1993). However, the specific growth rate was higher in tanks (0.7 %/day) than in cages (0.4%/day). Contrary to the tanks, perch kept in cages are assumed to receive a diet over 2% because an unknown amount of food passes through the net.

In the present study, we evaluated the zootechnical performances of perch reared in cages. We tested the influence of two diets (3 and 4% of body weight) on the quantitative (survival rate, growth) and qualitative characteristics (*GSI*, *HSI* and body composition) of perch reared in floating cages, during 8 weeks. We also compared their weight gain with perch reared during the summer, in closed system tanks (Tamazouzt 1995).

2. Materials and methods

2.1. Study site

Perch were reared at the Fishfarm Center of the Lindre pond (Department of Moselle, France), from July to September 1993. The pond characteristics were: altitude: 210 m, surface area: 62×10^5 m^2, volume: 12×10^6 m^3, maximal length: 5 450 m, maximal width: 1 050 m, maximal depth: 6 m, mean depth: 3 m.

2.2. Experiments

A floating structure with 3 cages on both sides was established at a distance of 50 m from the dike, where the water depth was 3 m. The 6 rearing cages ($2.5 \times 2.5 \times 4$ m, useful volume 12 m^3) had a net with a mesh size of 8 mm. Four of them contained a smaller cage 1 m^3 ($0.9 \times 0.9 \times 2$ m) for the perch, the larger outer cage was filled with carp (*Cyprinus carpio*), which was to prevent the clogging of the inner net by grazing on the attached filamentous algae.

1 520 perch (mean individual weight 24.8 g), already fed an artificial diet were randomly divided into 6 groups: 380 fish were put in each of the 2 large cages (12 m^3) and 190 in each of the small cages (1 m^3). Perch were acclimatized for two weeks without food. Ill and dead fish were removed.

During the study, fish were fed with artificial pellets (Trouvit, France), continuously delivered (12 h/day) at the top center of the cages at 3 and 4% feeding rates (% of biomass). For each test 1 large and 2 small cages were used.

Water temperature was continuously recorded (clockwork thermograph), but the values of other parameters (dissolved O_2, pH, NH_4^+–N, NO_2^-–N) were measured weekly. Mean and extreme values are given in Table 1.

The lack of measures on chlorophyll concentrations in the pond prevented any evaluation of the photosynthetic activity and trophic state. However, values recorded by Dubost (1992) in the same pond (depth 1 m) varied between 5 to 100 mg/l chlorophyll a, at the beginning of July and the end of August, respectively. This value is characteristic of eutrophic conditions.

2.3. Sampling

Every 10 days, 30 percent of the initial fish population in each group were randomly sampled and anesthetized with ethylenglycolmonophenyl-ether (C_8–H_{10}–O_2; 0.3 ml/l water). Individual fish were weighed and measured, then reintroduced into the cages; only one or two specimen were killed, preserved in 5% formalin and their stomach contents determined. Growth was calculated and the amount of feed re-evaluated according to the new total biomass. At the beginning and the end of the experiment, 5 fish from each diet group were killed and frozen, and their body composition analysed. Sex of all fish autopsied was determined on the basis in shape of the gonads (testes were singles and ovaries were bilobed).

2.4. Stomach content

Analysis of stomach contents was made in the INRA laboratory, Thonons-les-Bains. After autopsy, the fullness of the stomach was estimated visually and the contents weighed to the 0.1 mg and identified under a binocular microscope (Olympus-magnification 7 to 70), according to the classification of Pourriot and Francez (1986). The percentage of each item was evaluated.

2.5. Body composition

Food (2 to 3 g) and body composition of perch were analysed for each analysis to determine the following parameters: (1) dry

Table 1. Physico-chemical values (mean and extreme) recorded in the pond in the vincinity of the floating cages during the 8-week experiment.

Parameters	T (°C)	pH	O_2 (mg/l)	NH_4^+–N (mg/l)	NO_2^-–N (mg/l)
Mean	22.5	7.8	10.1	0.02	0.01
Max.	27.0	8.7	11.0	0.08	0.04
Min.	16.0	7.2	8.6	0.00	0.00

matter after a 24-hour lyophilisation, (2) ash content after 24 hours in an oven at 600°C, (3) protein (N × 6.25) using the Kjeldahl method, (4) total lipids using the method of Folch *et al*. (1957).

Triacylglycerols were extracted via hexane partitioning, the solvent phase was evaporated and the dry extract was transmethylated using BF3 in methanoll (Morrison & Smith 1964). The phospholipids in the hydro-alcohol phase were estimated through phosphorus determination (Rouser *et al*. 1970).

2.6. Statistical analysis

ANOVA (StatView 512) with one factor (diet) was used to compare the means of survival, weight, total length and feed conversion of perch in the cages. Comparisons between cages and tank systems (growth, survival, body composition of perch), according to their diets were treated by the analysis of variance factor by factor. The Kruskal-Wallis test was used to analyse the coefficient of variation, the specific growth rate and length and weight gains as a percent of the initial values. The survival rates were analysed after angular arc-sine transformation.

3. Results

3.1. Survival and Growth

Before the first day of feeding high mortalities were recorded, mainly due to the stress of manipulation and transport. Such mortalities, independant from the feeding study, were not taken into account. Possible cannibalism was estimated by a comparison between cages (difference between initial and final counts) to 1 and 6% of total mortality. During the study, the sampled fish (12 fish per cage) were subtracted from the dead fish for the calculation of the final survival rates, according to the feeding rates, which is presented in the Table 2.

The relationship of the final survival rate (Y) *versus* (vs.) the number of fish/m^2 of cage (X) is given by :

$$Y = 0.12X + 90.18,\ r^2 = 0.53;\ p = 0.28;\ df = 4.$$

During the experiment, length and weight increases of perch groups were comparable between the 3 and 4% feeding daily ration (3 cm and 23–24 g, respectively, Fig. 1). Intraspecific variability of *P. fluviatilis* is partly due to the difference in growth between sexes. The females grew more quickly than the males in the floating cages (Fig. 2), ($p < 0{,}05$).

The coefficients of variation (*c.v.*) of the final mean weight were 54 and 62% for the 4 and 3% rations, respectively. Thus rations have no particular effect on the *c.v.* Nevertheless, the variation with the perch reared in the floating cages was not as constant as in the tanks. The perch fed 3 and 4% rations had relatively similar daily growth rate (1.09 and 1.12 %, respectively). However, mean food conversions were 2.99 and 4.14 respectively.

The analysis of the perch stomach content indicated that, in floating cages, the fish feed mainly on the artificial food (Fig. 3).

3.2. Gonadosomatic and hepatosomatic indices

There was no significant effect of the feeding rates on the gonadosomatic or hepatosomatic indices (*GSI* and *HSI*) measured at the end of the experiment, whatever the rearing system. However, the *GSI* values of the perch in the floating cages were higher than those in the tanks; the trend with *HSI*

Table 2. Survival rate of *Perca fluviatilis*, fed with artificial pellets. Two feeding rates (3 and 4% daily ration) were delivered during 8 weeks in 6 floating cages. The density of fish is given in ind./m^2)

Cage N°(m^3)	Initial number	Initial density	Death counting	Final survivors	Final density	Surv. rate (%)
			Ration 3%			
1(1)	158	195	57	81	100	56
2(1)	140	173	15	107	132	84
I(12)	376	60	08	352	56	97
			Ration 4%			
3(1)	117	144	23	80	99	76
4(1)	146	183	43	87	107	65
II(12)	305	49	72	203	32	69

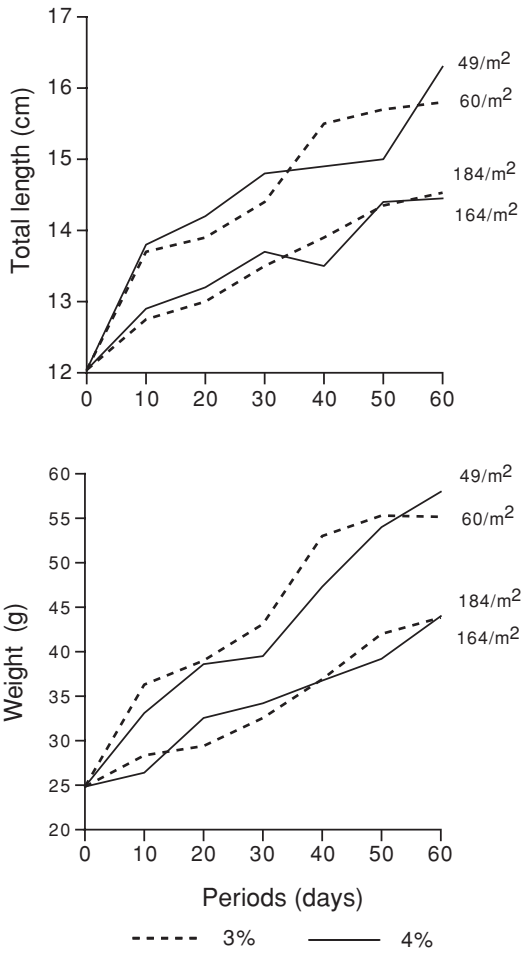

Fig. 1. Means of length and weight increase in perch reared in floating cages (of 12 and 1 m^3) during 8 weeks with 2 different feeding rates (3 and 4% of fresh weight). The values are expressed according to the fish density (ind./m^2).

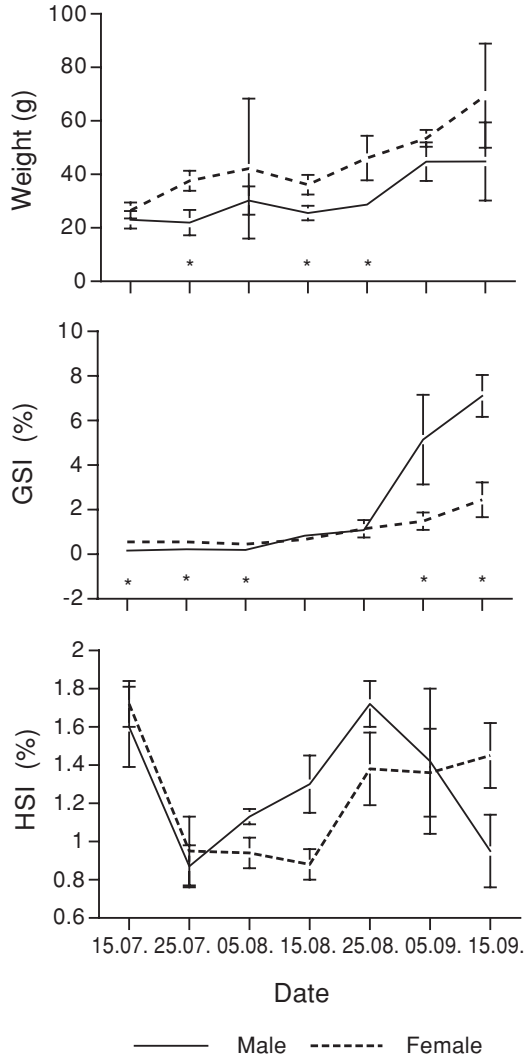

Fig. 2. Weight, *GSI* and *HSI* variations (means and standard error) of males and females *P. fluviatilis*, reared during summer in floating cages and receiving an artificial diet. Asterisk (*) indicate a significant difference at the 95% level. The samples ($3 \le n \le 9$), coming from the different plots are grouped by sex, for the diet effect is not significant.

was reversed (Table 3). Moreover, in the tanks, the *GSI* was higher for the females than for the males (0.6 vs 0.4; $F = 9.62$; $p = 0.003$); this is the reverse in the floating cages (2.4 for the females vs 7.1 for the males; $F = 14.42$; $p = 0.005$). There was no significant difference between the *HSI* of the males and the females ($F = 3.94$; $p = 0.08$) in the floating cages (Fig. 2).

3.3. Body Composition

No notable difference can be found in the chemical constituents of the perch within the same rearing system (ANOVA test, $p > 0.05$). However some differences existed between the rearing systems (Table 4).

The moisture (67 to 70%) and ash (13 to 14% of dry weight) contents at the end of the experiment were not significantly affected by the rearing system ($p > 0.05$). On the other hand, the crude protein content is higher for the fish in cages than in the tanks ($F = 4.19$; $p = 0.05$), with a significant differ-

ence for the 3% diet. Lipids tended to decrease in groups in the cages, and to increase in the tanks. Anyhow, the phospholipid fraction is more important in the perch reared in the cages ($F = 0.08$; $p = 0.0001$). Phospholipids are inversely related to the triacylglycerol content and are more important in the perch reared in the tanks ($F = 4.74$; $p = 0.007$).

4. Discussion

4.1. Quantitative characteristics in perch

This work shows that there are no statistical differences in the zootechnical potentialities (survival, growth, *c.i.*, *c.v.*) of perch fed at different rates (3 or 4% of the fish weight). The survival rates of perch reared in cages are relatively high, even if they are less than those obtained in the tanks (98%) (Tamazouzt 1995). Firstly, the fish in the tanks have not been subjected to stress through transport. Secondly, cannibalism must be taken into account: in the cages it causes mortality rates of between 1 and 6%, whereas it is insignificant in the tanks, clearly due to the size disparity among the perch between the two systems. The variability, as well as the sexual dimorphism, is more pronounced in the cages.

Even if they can feed on aquatic organims, perch in cages feed principally on a distributed artificial diet. The feeding conversion (*c.i.*) value is better for the 3% (2.99) than for the 4% feeding rate (4.14). More tests on a large feeding scale will be necessary to determine the best productivity. Those *c.i.* values are significantly more affected than those obtained in the tank (2%). Specific growth rates are comparable in the tank (1.4% /day) and in the cages (1.1%/day), but still higher than those recorded in a cage system with a 2% feed rate (< 0.4%/day; Tamazouzt *et al*. 1993).

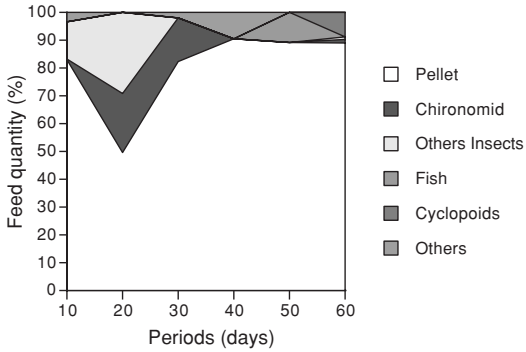

Fig. 3. Variation of the food composition in the stomach of perch reared in the floating cages, during 8 weeks. The part of each item is evaluated by the relative (bio)volume it occupies.

Growth was lower between July 25 and August 15. This was also the case with other fish species (carp, sturgeon), maintained in nearby cages. Persson (1983), and Jamet and Desmolles (1994) noted a low summer growth phase in perch in eutrophicated Swedish and French lakes; the fish may have been handicapped by a decrease of food avaibility and deteriorating tranparency conditions. This period was characterized here by temperature peaks (27°C) and marked trophic conditions. Nevertheless, whatever the conditions were, growth gain in our perch was more important when compared with wild perch. Jamet and Desmolles (1994) collected data on perch growth in different European lakes. For the same

Table 3. Final sample means (*c.i.* 95%) for weight, *GSI* and *HSI* values of *P. fluviatilis* reared during 8 weeks in floating cages. The diet effect is not significant, the perch are grouped in males and females. The numbers of fish analysed are given in brackets.

	Floating cage	
	Male (6)	Female (6)
Weight (g)	44.8 ± 40.6 a	69.4 ± 55.4 a
GSI (%)	7.1 ± 2.6 b	2.4 ± 2.17 c
HSI (%)	1.0 ± 0.52 d	1.5 ± 0.47 d

The mean values with the same letter, along the same line, are not significantly different.

Table 4. Mean body composition (*c.i.* 95%) of perch reared during 8 weeks in cages with different feeding rates. The mean values of fish constituents along the same line, are not significantly different at the 5% level.

Constituents (% DM)	3%	4%	Food (trouvit)
Water (%)	70.0 ± 1.2	67.6 ± 2.3	5.2
Crude protein	60.5 ± 2.3	58.3 ± 2.2	60.9
Ash	13.4 ± 0.9	13.2 ± 0.9	9.3
Total lipids	22.7 ± 2.5	23.4 ± 1.3	15.1
Triacylglycerol	10.6 ± 1.8	12.7 ± 2.2	12.95
Phospholipids	12.1 ± 1.6	10.7 ± 1.1	2.15
Energy (kJ/g)	21.6 ± 0.6	22.0 ± 0.5	21.2

initial size (*TL* = 12 cm), the growth gains we have obtained in 8 weeks were only achieved after 1 or even 2 years in natural conditions.

4.2. Qualitative characteristics in perch

Body composition of perch in the cages, with two feeding rates, were not significantly different. Differences appear in perch, according to the rearing system. In cages, their final lipid and energy content were lower, and their protein content higher than in tanks. This seems to be due to the temperature variations in the cages during September. This has already been observed with congeneric species in natural conditions (Craig 1977, Tanasichuck & Mackay 1989). As a result, the change in the lipid content of perch was related to the gonadal development, which cannot take place in the tank system, with a constant water temperature (22°C). A cold temperature period is necessary for the gonadogenesis of percids (Hokanson 1977), whereas the photoperiod has a minor effect (Kayes & Calbert 1979).

The gonadal development leads to important metabolic changes, of which much is still unknown (Rosemblum *et al.* 1994). In the percids, that physiological phase is mainly supplied by the energy from the somatic tissues (Tanasichuck & Mackay 1989). The reverse change in the gonadosomatic and hepatosomatic indices, most significant in males, can be explained by the gonadogenesis induction of perch in cages which is more intensive from mid August. Such a situation has already been emphasized with mature females in a later period (Tamazouzt *et al.* 1994). Tanasichuk and Mackay (1989) noted that the growth of the gonads causes the consumption of liver lipids. However, Makarova (1973) thinks that it is rather a use of the liver proteins of *P. fluviatilis*. All these modifications seem to be precursors to the sexual maturity in perch (males and females), (Parent *et al.* 1976).

In the European perch, spermatogenesis has not the same intensity and speed as oogenesis (Le Cren 1951).

The impact of the two rearing systems on *GSI* and *HSI* interferes mainly with the water temperature difference. This effect established at the end of the sexual resting period in males (Turner 1919) is induced by the progressive cooling of the water at the beginning of August. In the tanks, the gonads are probably still in a resting state.

In our experiment, the significant decrease in the lipid content of the perch in cages affects the triacylglycerol fraction. conversely, the phospholipids are strongly increasing. This situation has already been highlighted by Rosemblum *et al.* (1994) in *Micropterus salmoides floridanus* and has been attributed to the synthesis of hepatic phosphatidylinositol and phosphatidylcholine, essential products in the development of the gonadal functions of fish.

The high protein level recorded in September in the perch reared in cages is also partly due to the water temperature. This confirms the results of Parent *et al.* (1993), on perch (*P. fluviatilis*) and roach (*Rutilus rutilus*) in reservoirs (Pareloup, France). These two species, with the same environmental variations, have different feeding spectra; in both species, there is an increase of some amino acids (proline, arginine, lysine). In our experiment, there is the same tendency (high lipid content of the perch in the tanks and high protein content in the fish in the cages). A high protein content in the food with optimal temperature seems to induce the lipogenesis from protein (Huh 1975, Reinitz & Austin 1980). In the case, the energy level of the feed distributed (21.2 kJ/g) could also favour the lipid synthesis in perch.

Our investigations show that the European perch fed on 4% rates could neither improve growth nor body composition. In any case, the fish reared in cages have less lipids and more protein than those in the tanks. A 3% feeding rate seems to be the most appropriate in the floating cages. The food has a high crude protein content (60.9% DM), more than the ones used with the yellow perch (Huh 1975), (27.4 or 50% DM), giving no significant differences in the fish growth. Further studies would be very beneficial to find the optimal protein content in food, in order to lower the costs of feeding without altering the fish growth.

References

Awaluddin, A. B., Mustafa, S. & Mokhtar, M. B. 1994: Quality management in production of sea bass (Lates calcarifer) through cage culture system. — In: Muir, J. & Sevilla, F. (eds.), Measures for success (Abstracts): 133–134. European Aquaculture Society. Spec. Publ. N°21, Oostend, Belgium.

Barbato, F., Fanari, A., Meloni, F. & Savarino, R. 1993: Cage culture of gilthead sea bream (Sparus aurata) in

two sardinian coastal lagoons. — In: Barnabé, G. & Kestemont, P. (eds.), Production, environment and quality: 95–103. European Aquaculture Society. Spec. Publ. N°18, Ghent, Belgium.

Craig, J. F. 1977: The body composition of adult perch, Perca fluviatilis in Windermere, with reference to seasonal changes and reproduction. — J. Anim. Ecol. 46: 617–632.

Duarte, S. A., Robert, G. N. & Masser, M. P. 1994: Profit-maximizing stocking rates for channel catfish in cages. — J. World Aquacult. Soc. 25: 442–447.

Dubost, N. 1992. Etude de la fertilité et de la sedimentation à l'etang de Lindre. — Rapp. Cent. Rech. Ecolog. Université de Metz, (C.R.E.U.M), France. 80 pp.

Folch, J., Lees, M. & Sloane-Stanley, G. H. 1957: A simple method for the isolation and purification of total lipides from animal tissues. — J. Biol. Chem. 226: 497–509.

Fontaine, P. 1994: Application de techniques aquariologiques à la production d'alevins de truite arc-en-ciel Oncorhynchus mykiss W. en circuit fermé: importance des facteurs alimentaires. — Thèse de l'I.N.P.L., Nancy, France. 153 pp.

Hokanson, K. E. F. 1977: Temperature requirements of some Percids and adaptations to the seasonal temperature cycle. — J. Fish. Res. Board Can. 34: 1524–1556.

Huh, H. T. 1975: Bioenergetics of food conversion and growth of yellow perch (Perca flavescens) and walleye (Stizostedion vitreum vitreum) using formulated diets. — Ph.D.-thesis, University of Wisconsin-Madison, USA. 196 pp.

Jamet, J. L. & Desmolles, F. 1994: Growth, reproduction and condition of roach (Rutilus rutilus (L.)), perch (Perca fluviatilis (L.)), and ruffe (Gymnocephalus cernuus (L.)) in eutrophic Lake Aydat (France). — Int. Revue ges. Hydrobiol. 79: 305–322.

Kayes, T. B. & Calbert, H. E. 1979: Effects of photoperiod and temperature on the spawning of yellox perch, Perca flavescens. — Proc. World Maricult. 10: 306–316.

Le Cren, E. D. 1951: The lengh-weight relationship and seasonal cycle in gonad weight and condition in the perch (Perca fluviatilis). — J. Anim. Ecology 20: 201–219.

Mélard, C., Orozco, J. J., Uran, L. A. & Ducarme, Ch. 1993: Comparative growth rate and production of Colossoma macropomum and Piaractus brachypomus (Colossoma bidens) in tanks and cages using intensive rearing. — In: Barnabé, G. & Kestemont, P. (eds), Production, environment and quality: 433–441. European Aquaculture Society. Spec. Publ. N°18, Ghent, Belgium.

Morrison, W. R. & Smith, L. M. 1964: Preparation of fatty acid methyl esters and dimethylacetals from lipids with boron fluoride-methanol. — J. Lipid Res. 5: 600–608.

Murray, M. W., Andrew, J. W. & Loach, H. L. 1977: Effects of dietary lipides, dietary protein and environmental temperatures on growth, feed conversion and body composition of channel catfish. — J. Nutr. 107: 272–280.

Parent, J. P., Bouche, G. & Vellas, F. 1976: Effet du réchauffement artificiel des eaux sur quelques paramètres physiologiques de deux Téléostéens d'eau douce : le gardon et la perche. — Cah. Lab. Hydrobiol. Montereau 3: 5–14.

Parent, J. P., Ferroni, J. M., Escorihuela, D. & Vellas, F. 1993: Teneurs en acides aminés du soma, à différentes saisons, chez deux espèces sauvages : la perche (Perca fluviatilis) et le gardon (Rutilus rutilus). — In: Kaushik, S. J. & Luquet, P. (eds.), Fish nutrition in practice: 313–318. INRA.

Persson, L. 1983: Effects of intra and interspecific competition on dynamics and size structure of a perch Perca fluviatilis and roach Rutilis rutilis population.— Oikos 41: 126–132.

Porrello, S., Andaloro, F., Vovona, P. & Marino, G. 1993: Rearing trial of Seriola dumerili in floating cage. — In: Barnabé, G. & Kestemont, P. (eds.), Production, environment and quality: 299–307. European Aquaculture Society. Spec. Publ. N°18, Ghent, Belgium.

Pourriot, R. & Francez, A. J. 1986: Introduction pratique à la systématique des organismes des eaux continentales françaises. — Bull. Soc. Linn. Lyon 55ème année, 5: 37 pp.

Reinitz, G. & Austin, R. 1980: Experimental diets for intensive of culture yellow perch. — Prog. Fish-Cult. 42: 29–31.

Rosemblum, P. M., Brandt, T. M., Mayes, K. B. & Huston, P. 1994: Annual cycles of growth and reproduction in hatchery-reared Florida largemouth bass, Micropterus salmoids floridanus, raised on forage or pelleted diets. — J. Fish Biol. 44: 1045–1059.

Rouser, G., Fleicher, S. & Yamamoto, A. 1970: Two dimensional their-layer chromatographie separation of polar lipids and determination of phospholipids by phosphorus analysis of spots. — Lipids 5: 494–496.

Tamazouzt, L. 1995: L'alimentation artificielle de la perche Perca fluviatilis en milieux confinés (eau recyclée, cage flottante): incidence sur la survie, la croissance et la composition corporelle. — Thèse de doctorat, Université Nancy-I, France. 128 pp.

Tamazouzt, L., Capdeville, B., Fontaine, P., Terver, D. & Georges, A. 1993: Growth of perch Perca fluviatilis fed on a formulated diet reared in two culture systems: closed circuit and floating cage. — In: Kestemont, P. & Billard, R. (eds.), From discovery to commercialisation (Abstacts): 272. European Aquaculture Society, Spe. Publ. N°20, Oostend, Belgium.

Tamazouzt, L., Fontaine, P. & Terver, D. 1994: Décalage de la période de reproduction de la perche commune (Perca fluviatilis L.) en eau recyclée. — Ichtyophysiologica Acta 17: 29-40.

Tanasichuk, R. W. & Mackay, W. C. 1989: Quantitative and qualitative characteristics of somatic and gonadal growth of yellow perch Perca flavescens, from lac Ste Anne, Alberta, Can. — J. Aquat. Sci. 46: 989–994.

Turner, C. L. 1919: The seasonal cycle in the spermary of the perch. — J. Morphol. 32: 681–711.

Webster, C. D., Tidwell, J. H. & Yancey, D. H. 1992: Effect of protein level and feeding frequency on growth and body composition of cage-reared channel catfish. — Prog. Fish Cult. 54: 92–96.