Artificial propagation of African catfish (*Clarias gariepinus*): differences between reproduction effects after stimulation of ovulation with carp pituitary homogenate or GnRH-a and dopaminergic inhibitor

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ABSTRACT: The results of controlled reproduction of African catfish (*Clarias gariepinus*) females after ovulation stimulation with carp pituitary (4 mg/kg body weight) or with Aquaspawn preparation (complex of GnRH-a and domperidone) (0.5 ml/kg) were examined. It was found that after pituitary stimulation 100% and after Aquaspawn treatment 87.5% of females yielded eggs of satisfactory quality. In the group treated with the synthetic stimulator females yielded eggs of higher weight. The statistically significant ($P \leq 0.05$) higher weight of eggs was found if it was expressed in percentages of female body weight. After 12-, 24-, and 28-hour incubation the quality of eggs obtained after Aquaspawn treatment was better than that recorded in the case of pituitary application and differences between the results being statistically significant ($P \leq 0.05$). In the presented experiment the investigated material was composed of females from two categories determining their body weight, i.e. lighter females (average body weight of 4.89 ± 0.49 kg) and heavier females (average body weight of 6.96 ± 0.72 kg). No statistically significant differences were recorded between the investigated averages for any of the traits determining the weight or the quality of obtained eggs, however heavier females yielded eggs of higher weight expressed in grams.

Keywords: African catfish; artificial propagation; carp pituitary; Aquaspawn

In fish reproduction under controlled conditions attempts are made to obtain eggs of the highest weight possible and of the best quality, and hence to produce the highest possible numbers of good quality hatch. For this purpose various preparations stimulating ovulation are experimentally tested to find stimulators that would ensure such effects. It is obvious that appropriate maternal (and paternal) material should be used to obtain satisfactory results of stimulated fish breeding. With respect to African catfish (*Clarias gariepinus* Burchell 1822), the species of a well-grounded position in European fish culture (Huisman and Richter, 1987; Kuczyński *et al.*, 1999), such experiments were carried out by numerous authors (among others by Eding *et al.*, 1982; De Leeuw *et al.*, 1985; Richter *et al.*, 1985, 1987; Goos *et al.*, 1987; Kouřil *et al.*, 1992; Inyang and Hettiarchichi, 1994).

Up to 1995 in the Institute of Ichthyobiology and Fish Culture of the Polish Academy of Sciences at Gołysz ovulation stimulation was carried out in this fish species using carp pituitary homogenate (Hogendorn and Vismans, 1980; Adamek, 1995). In later years within a program of investigations on the effects of reproduction after ovulation stimulation numerous experiments were carried out using various preparations (of both natural and synthetic origin) (Brzuska, 1998, 2002; Brzuska *et al.*, 1998a,b,c, 1999, 2000).

In the present paper the results of a successive experiment in the series are described, the tested stimulator being Aquaspawn. The Aquaspawn preparation used for ovulation and spermation stimulation is the product of Spawnrite Ltd, Touws River in the Republic of South Africa. The preparation is a liquid ready for injection with two active ingredients: synthetic GnRH-a and domperidone. In 5 ml of Aquaspawn 100 µg of GnRH-a and 500 mg of dopamine receptor blocker – domperidone are contained in sterile physiologic saline. The

Table 1. Substances used as ovulation stimulators and their doses, method of application and number of females in group

Group	No. of females and range of body weight values (kg)		Ovulation stimulator	Dose*
I	4(4.70–5.40)	4(6.30–8.30)	carp pituitary	4 mg (i.p.)
II	4(3.90–5.30)	4(6.70–7.80)	Aquaspawn	0.5 ml (i.p.)
Σ	8	8		

Aquaspawn (Reg. No. G1957 Act 36/1947) was kindly provided by Mr L. V. Read Spawnrite Ltd Touws River, Republic of South Africa

*dose per 1 kg of female body weight: i.p. – intraperitoneally

formulation of Aquaspawn prevents overdosing. As Burton *et al*. (1998) claimed in the stimulated reproduction of fish the Aquaspawn preparation can also be applied orally.

As the Reports (kindly made available by L. V. Read) on the effects of Aquaspawn inform, this preparation can also be applied to fish as a slow-release pellet (cellulose/cholesterol mixture) implanted into the dorsal muscle. Experiments concerning the induction of spawning used this application method on the yellow fish (*Barbus copensis*). The results of these experiments show that Aquaspawn applied by implantation or injected as a liquid is not only an effective spawning agent but also it appears to have no adverse effects on the health of the treated fish. The reports show that after the application of Aquaspawn no side effects were observed on the breeders on which it had been used. The same fish were successfully induced to spawn in consecutive years. Particularly interesting results of the Aquaspawn preparation were obtained using this product successfully in getting difficult fish to breed (*Barbus androwi*, *Barbus copensis*, *Myais copensis*). In the species mentioned above the only way to maintain or increase the present population is to induce them to breed under natural conditions. The above information was given in Spawnrite Ltd. Reports according to A. Bok (specialist scientist for Cape Nature Conservation in East London) and T. Pike (fisher expert at the National Parks Board in Pietermarithburg).

A very important detail of the information given in the Reports is that from the environmental aspect the product Aquaspawn is not considered to pose any threat to the environment when used to induce fish spawning. The product is considered safe for the environment due to low dosages used, rapid degradation within the fish's body by enzymes as well as very short half-life. The synthetic decapeptide contained in Aquaspawn has never been shown to have any pathological effects and it is thus extremely unlikely to affect humans consuming flesh from fish that have been bred from parents receiving a single dose of this spawning agent. An interesting note in one Report is that Aquaspawn seems to have a good potential for artificial spawning in frogs.

For the ovulation stimulation in carp (*Cyprinus carpio* L.) females Aquaspawn was applied alone (at the dose given in the instruction; see References) and in combination with carp pituitary homogenate (Brzuska, 2001a). After the Aquaspawn treatment the obtained results of reproduction were very good (and better than after hypophysation), encouraging the author to undertake tests with ovulation stimulation in some fish species outside the Cyprinidae family.

The aim of the investigations presented here was to show the effects of reproduction in African catfish (*Clarias gariepinus*) females stimulated with Aquaspawn in comparison with the effects obtained after hypophysation. It was also attempted to determine whether the weight of females used in the experiment significantly affected the results of controlled reproduction.

MATERIAL AND METHODS

The investigation included 16 females of African catfish of the body weight 3.90–8.30 kg. The females were selected out of a greater population of spawners that were reared from eggs to maturity in the hatchery of the Institute of Ichthyobiology and Aquaculture in Gołysz, Polish Academy of Science. The fish were divided into two groups of eight females. In both groups a half of the indi-

viduals were characterized by a lower body weight (with the average of 5.05 kg in group I and 4.80 kg in group II). The other half included fish of higher body weight (with the average of 7.12 kg in group I and 6.95 kg in group II) (Table 1). The fish were placed in the hatchery in eight tanks 2.5 m^3 in volume each. Two females, one heavier and one lighter were kept in each tank. During the experiment the temperature of water in the tanks ranged from 24 to 25°C. Ovulation was stimulated with two stimulators; in group I the females were treated with carp pituitary and in group II with Aquaspawn. The doses are given in Table 1. The control of ovulation started within 11 hours of the treatment with the two stimulators. The fish were checked for ovulation by gently pressing the abdomen (Richter *et al.*, 1987).

The eggs obtained from stripping each female were weighed and then fertilized with mixed milt obtained from macerated testes of three killed males. Eggs from each female separately were incubated in a Weiss glass in water at 24°C. After 12-h incubation the percentage of fertilization and after 24 and 28 hours the percentage of live embryos were calculated for each female. After the hatch of larvae the percentage of deformed individuals was calculated. Statistical characteristics of the obtained data are given in Table 2.

Analysis of variance using the least-squares method was carried out to evidence the effect of the applied stimulator on the investigated traits. The traits were: weight of eggs in grams, weight of eggs in percentage of female body weight, and the percentage of fertilization and of live embryos after 24- and 28-hour incubation. Analysis of variance was carried out according to the following linear model:

$$Y_{ij} = \alpha + g_i + bW_{ij} + e_{ij}$$

where: α = theoretical general mean with the assumption that $W_{ij} = 0$
g_i = effect of group i (i =1…. 2)
b = regression on female body weight
W_{ij} = body weight of a female
e_{ij} = random error associated with observation j

Table 2. Statistical characteristics of the data

Variable	Descriptive statistics					
	n	$\bar{x}$	S	min	max	SD
Weight of females (kg)						
Group I	8	6.20	0.43	4.70	8.30	1.21
Group II	8	5.75	0.48	3.90	7.50	1.29
Weight of eggs (g)						
Group I	8	532.50	95.71	120.00	800.00	270.71
Group II	7	679.28	53.33	485.00	860.00	141.10
Weight of eggs (% of female body weight)						
Group I	8	8.55	1.43	2.22	13.19	4.07
Group II	7	12.21	2.56	8.40	16.27	0.96
Fertilised eggs after 12-h incubation						
Group I	8	75.75	4.09	61.00	92.00	11.58
Group II	7	84.14	3.48	69.00	95.00	9.22
Live embryos after 24-h incubation (%)						
Group I	8	64.00	3.76	50.00	78.00	10.63
Group II	7	71.28	2.31	59.00	77.00	6.12
Live embryos after 28-h incubation (%)						
Group I	8	49.07	2.72	40.00	61.00	7.69
Group II	7	53.57	2.51	49.00	62.00	6.65

$\bar{x}$ = arithmetical mean; S = standard error of the mean; SD = standard deviation

The significance of the effect of ovulation stimulator (group) on the investigated traits was checked using the *F*-test. The analysis allowed to estimate the least-squares constants and the least-squares means, this leading to the determination of deviations from the general means for the investigated traits within the main classification factor (Harvey, 1960, 1987).

The significance of differences between the arithmetical means for lighter and heavier females, calculated for the investigated traits, was checked using the *t*-test. The correlation between the investigated traits was computed for group I and group II separately. For each group separately the multiple regression equation was calculated using Statistica Version 5 (1997) to predict the percentage of live embryos after 24-h of incubation.

RESULTS

Ovulation time

In all the females of group I ovulation occurred 12 h after pituitary treatment. In fish of group II the synchronization of ovulation was also recorded in all the investigated individuals though the time of ovulation was later by one hour.

Percentage of females ovulating after hormonal stimulation

After hormonal stimulation eggs were obtained from all the females both in group I and in group II. In group II, i.e. in fish treated with Aquaspawn, one female gave eggs of a very poor quality (<30% fertilization), therefore in this case the recorded data were disregarded for the calculation.

Effect of ovulation stimulators on the weight and quality of eggs

The values of the least-squares means determining the weight of eggs obtained from the two groups of females distinctly show that in group II the weight of eggs was higher both if expressed in grams and in the percentage of female body weight (Table 3). However, the results of analysis of variance and the *F*-test allowed to determine a statistically significantly ($P \leq 0.05$) higher weight of eggs only if expressed as percentage of female body weight. The respective values for groups I and II were 8.61% and 12.15% (Table 3).

In considering the values of the least-squares means for traits determining the quality of eggs it should be noted that after 12-, 24-, and 28-hour incubation the eggs yielded by females of group II manifested better quality (Table 3). It was determined that the effect of group on all three traits characterising the quality of eggs was statistically significant ($P \leq 0.05$).

Regression on female body weight was statistically significant ($P \leq 0.01$) only for the percentage of live embryos after 28-hour incubation of eggs.

Effect of body weight of females used for reproduction on the weight and quality of eggs

The mean body weight of lighter and heavier females used for reproduction and the values of arithmetical means for five investigated traits within the classification in which the body weight of fish is taken into consideration, are given in Table 4. The heavier females used for reproduction yielded eggs of higher weight than the lighter fish (the respective values being 666.00 g and 533.57 g), though the difference between the means was statistically insignificant. In calculating the weight of eggs as percentage of female body weight a higher (though statistically insignificant) value was obtained for lighter fish in comparison with the heavier ones (the respective values being 10.98% and 9.64%). Within this classification no statistically significant differences were recorded between the means determining the quality of eggs after 12-, 24-, or 28-hour incubation (Table 4).

Relations between the investigated traits

The values of correlation coefficients between the investigated traits calculated within groups I and II are given in Table 5.

In group I the body weight of females was positively correlated with all the other traits investigated, the correlation being statistically significant only between this trait and the percentage of live embryos after 28-h incubation. In this group a statistically significant ($P \leq 0.05$) correlation was determined between the percentage of egg fertilization and the percentage of live embryos both

Table 3. Constants (LSC) and least-squares means (LSM) estimated for investigated traits

Classification factor	Weight of eggs (g)			Weight of eggs as % of female body weight			Percentage of fertilized eggs after 12 h incubation			Percentage of live embryos					
										after 24 h incubation			after 28 h incubation		
	LSC	LSM	SE	LSC	LSM	SE	LSC	LSM	SE	LSC	LSM	SE	LSC	LSM	SE
α		607.13			10.38			80.00			67.68			51.78	
Ovulation stimulator															
Carp pituitary (group I)	–91.91	515.22	72.01	–1.77	8.61	1.28	–4.95	75.05	3.59	–4.17	63.51	3.09	–2.69	49.09	2.02
Aquaspawn (group II)	91.91	699.03	77.07	1.77	12.15	1.37	4.95	84.94	3.84	4.17	71.85	3.31	2.69	54.47	2.16
Regression/ body weight		83.61	44.68		–0.28	0.79		3.38	2.23		2.38	1.92		3.81	1.25

SE = standard error of least-squares means; α = theoretical general mean

after 24- and 28-h incubation (+0.87 and +0.77) and between the percentage of live embryos after 24-and 28-h incubation (+0.87).

In group II the highest value was found for the coefficient of correlation between the percentage of egg fertilization and that of live embryos after 24-h incubation (+0.87), the correlation between these traits being significant only within this group. A high correlation value (+0.75) was also determined between the weight of obtained eggs expressed in grams and the percentage of live embryos after 28-h incubation. In this group the weight of females was positively correlated with all the traits investigated except for the weight of eggs expressed as percentage of female body weight (Table 5).

Regression

The results of multiple regression are given in Table 6. The R^2 values given in this Table allow to determine whether the results of prediction obtained on the basis of the presented equations can be regarded as satisfactory.

For both groups the R^2 values show that the prediction of the percentage of live embryos after 24-h incubation based on these equations is satisfactory. Almost 88% for group I and 92% for group II of the variance are explained by these equations, but a statistically reliable R^2 is calculated for group II only.

Occurrence of deformed larvae

The occurrence of larvae with body deformations was found in both groups. In the investigated populations only several percentages of larvae with body deformations were recorded. No effect of the weight of females used for reproduction on the percentage of deformed larvae was observed.

DISCUSSION

The data obtained in the presented experiment show that in African catfish the treatment with the Aquaspawn preparation gave satisfactory results of reproduction effects. All the fish treated with this stimulator spawned, however one female yielded eggs of very poor quality. The synchronization of ovulation in fish after the application of this stimulator is a very important aspect. In the investigation

Table 4. Mean (±SD) body weight of lighter and heavier females of African catfish (*Clarias gariepinus* Burchell), mean weight of eggs (expressed in grams and as % of female body weight), mean percentage of fertilization after 12-hour incubation, and the mean percentage of live embryos after 24- and 28-hour incubation. Arithmetical means in the same row with different letters are significantly ($P \leq 0.05$) different

Investigated traits	Lighter fish $n = 8$	Heavier fish $n = 7$
Weight of females (kg)	4.89 ± 0.49a	6.96 ± 0.72b
Weight of eggs (g)	533.57 ± 216.55a	666.00 ± 230.48a
Weight of eggs (% of female body weight)	10.98 ± 4.37a	9.64 ± 3.46a
Fertilization of eggs after 12-h incubation (%)	77.43 ± 7.91a	81.63 ± 13.47a
Live embryos		
after 24-h incubation (%)	66.14 ± 9.54a	68.50 ± 9.62a
after 28-h incubation (%)	48.71 ± 6.42a	50.13 ± 7.31a

Table 5. Correlation between the investigated traits of females treated with carp pituitary – group I (above the diagonal) and Aquaspawn – group II (under the diagonal)

Variable	Weight of females (kg)	Weight of eggs (g)	Weight of eggs as percentage of female body weight	Percentage of fertilized eggs after incubation	Percentage of live embryos after incubation	
				12h	24 h	28 h
	1	2	3	4	5	6
1		0.50	0.05	0.32	0.36	0.76*
2	0.50		0.88*	0.68	0.56	0.66
3	-0.37	0.59		0.60	0.42	0.32
4	0.53	0.43	0.04		0.87*	0.77*
5	0.33	0.34	0.05	0.87*		0.87*
6	0.54	0.75	0.39	0.44	0.37	

*$P \leq 0.05$

Table 6. Results of multiple regression

Group	Regression equation	R^2	F
I	$y = 85.758 - 1.6x_1 + 3.59x_2 - 3.2x_3 + 0.846x_4$	0.875	5.26
II	$y = 24.816 - 0.73x_1 + 0.497x_2 - 0.54x_3 + 1.00x_4$	0.915	8.12*

Dependent variable: y = percentage of live embryos after 24-h incubation
Independent variables: x_1 = weight of females; x_2 = weight of eggs in grams; x_3 = weight of eggs as percentage of female body weight; x_4 = percentage of fertilized eggs after 12-h incubation
*$P \leq 0.05$

on the carp the synchronization of ovulation was also observed in all the females after the injection of Aquaspawn (Brzuska, 2001a). It should be stressed that the higher weight of eggs both expressed in grams and as the percentage of female body weight was obtained from African catfish females treated with Aquaspawn than from the hypophysed ones. It also seems important that in the group of fish treated with Aquaspawn no female yielded eggs of low weight while in the group after the carp pituitary application two females gave eggs of low weight, not exceeding 160 g.

The results of previously conducted studies showed that in general from females of the investigated fish species a higher quantity of eggs was obtained after the application of synthetic ovulation stimulators than after the treatment with stimulators of natural origin, such as carp pituitary or human chorionic gonadotropin (Biogonadyl) (Brzuska 2002; Brzuska *et al*., 1998b,c, 1999, 2000).

It is interesting that the applied dose of des-Gly^{10} (D-Ala^{6})-Ethylamide did not affect the weight of obtained eggs and after the two doses (50 µg/kg and 20 µg/kg) the weight of obtained eggs was higher than that recorded after hypophysation (Brzuska *et al*., 1998b, 1999).

The investigation on the use of Ovopel (a complex of a synthetic mGnRH analogue and metoclopramide; Horváth *et al*., 1997) as an ovulation stimulator shows that the yield of eggs from fish treated with this preparation was higher than that from the hypophysed ones (Brzuska, 2002; Brzuska *et al*., 1998c).

Kouřil *et al*. (1992) also reported that from females of this fish species treated with a synthetic ovulation stimulator (D-Ala^{6} GnRH ProNHEt) alone or with isofloxythepin (a dopaminergic inhibitor) the weight of obtained eggs expressed as percentage of female body weight exceeded that recorded after hypophysation. It should be stressed here that in the experiment reported by Kouřil *et al*. (1992) and in experiments described by Brzuska (2002) and Brzuska *et al*. (1998b,c, 1999) the dose of carp pituitary per 1 kg body weight of females was the same, amounting to 4 mg, as given by Hogendorn and Vismans (1980).

In discussing the results of the presented experiment it is worth stressing that the quality of eggs obtained from African catfish females treated with Aquaspawn was better (after 12, 24 and 28 hours of incubation) than after hypophysation. The investigation conducted on the carp of the Lithuanian line B showed that the treatment with this preparation (at the dose recommended in the instruction and a lower one) ensured the yield of eggs of better quality than those obtained from hypophysed females (Brzuska, 2001a). Also in the investigation carried out by Brzuska *et al*. (2000) and Brzuska (2002) on African catfish females a better quality of eggs was recorded after Ovopel application in comparison with the effects of hypophysation. On the other hand, the results of studies described by Brzuska *et al*. (1998b, 1999) showed that the application of DesGly^{10}[D-Ala^{6}] LHRH Ethylamide did not effect the yielding of better quality eggs than the pituitary treatment.

A very important point is that the application of Aquaspawn to females of African catfish did not increase the numbers of deformed larvae in comparison with the number of larvae hatched from eggs yielded by hypophysed fish. The application of Des-Gly^{10} [D-Ala^{6}]-LHRH Ethylamide (irrespective of the dose) to African catfish females increased the percentage of deformed larvae in comparison with the groups of fish treated with stimulators of natural origin, i.e. the pituitary or HCG (Brzuska, 1998b, 1999). In herbivorous fish, the silver carp (*Hypothalamichthys molitrix* Val.) and the grass carp (*Ctenopharyngodon idella* Val.) the application of Des-Gly^{10}[D-Ala^{6}]-LHRH Ethylamide also induced a higher percentage of deformed larvae than the carp pituitary homogenate.

The experiments conducted by De Leeuw *et al*. (1985) on African catfish (*Clarias gariepinus*) with the use of Des-Gly^{10}[D-Ala^{6}] Ethylamide showed that the percentages of deformed larvae hatched from eggs yielded by individual females greatly varied. Hogendoorn and Vismas (1980) gave the percentage of deformed larvae of African catfish in relation to the time from hypophysation to stripping at three different temperatures.

In the present experiment an interesting observation was made concerning the percentage of larvae with body deformations that did not depend on the body weight of females. In earlier studies carried out on European catfish (*Silurus glanis* L.) body deformations were observed only among larvae hatched from eggs yielded by heavy females (of the body weight exceeding 9.3 kg) irrespective of the ovulation stimulator applied (Brzuska, 2000, 2001b).

The problem taken into consideration in the present work concerning the dependence between the body weight of females and the effects of reproduction is also interesting from the aspect

of fish culture practice. In earlier studies of this problem the investigated material was European catfish (Brzuska, 2000, 2001b) and African catfish (Brzuska, 2002). In the present experiment the average body weight of lighter and heavier females used for the reproduction differed by about 2 kg only and no statistically significant differences were found between the means for traits determining the weight and quality of eggs. However, the obtained results distinctly show that from lighter females a lower weight of eggs was obtained only if it was expressed in grams.

In the present investigation the percentage of live embryos was determined not only after 24-hour incubation but also additionally after additional four hours. The aim of this control was to determine whether during these four hours a rapid decline of larvae occurred due to the application of preparation Aquaspawn to African catfish for the first time in conditions of our hatchery. The obtained results showed that in relation to the group of hypophysed females no intensified death of larvae occurred after the Aquaspawn treatment. Brzuska and Adamek (1999) recorded a considerable number of dead larvae in the last phase of incubation of eggs obtained from European catfish (*Silurus glanis* L.) females treated with Des Gly^{10} [D-Ala^{6}] LHRH Ethylamide.

In summing up the obtained results it can be stated that after the application of Aquaspawn at the dose of 0.5 ml/kg of body weight to African catfish females the effects of reproduction were satisfactory, exceeding those recorded after pituitary treatment at the dose of 4 mg/kg. A very significant point is that the above preparation is applied in the form of one injection. The producer suitably prepares this inducing ovulation agent and its application to fish is really easy. In the ovulation stimulation one injection of the stimulator reduces the handling, post-breeding mortality, and stress to females of this very sensitive fish species. The synchronization of ovulation in all the females treated with Aquaspawn, satisfactory weight and quality of eggs, and a more precise prediction of the percentage of live embryos justify further tests with this preparation in African catfish (*Claries gariepinus*).

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ABSTRAKT

Umělý výtěr sumečka afrického (*Clarias gariepinus*): výsledky reprodukce po stimulaci ovulace kapří hypofýzou a přípravkem obsahujícím analog GnRH a dopaminergní inhibitor

Byla provedena umělá reprodukce sumečka afrického (*Clarias gariepinus*), k dosažení ovulace byly jikernačky stimulovány pomocí kapří hypofýzy (4 mg/kg hmotnosti ryb) a přípravku Aquaspawn (GnRH-a a domperidon;

0,5 ml/ g). Při použití hypofýzy bylo dosaženo ovulace u 100 % jikernaček, při použití přípravku Aquaspawn u 87,5 % jikernaček, získané jikry byly uspokojivé kvality. U skupiny jikernaček ošetřených syntetickým přípravkem byla získána vyšší hmotnost vytřených jiker. Byla zjištěna statisticky signifikantní ($P \leq 0.05$) závislost hmotnosti vytřených jiker v procentech na hmotnosti jikernaček. Po 12, 24, a 28 hodinách inkubace byla zjištěna vyšší kvalita jiker při použití přípravku Aquaspawn ve srovnání s použitím hypofýzy, rozdíl byl statisticky signifikantní ($P \leq 0,05$). K pokusu byly použity jikernačky dvou hmotnostních kategorií, lehčí jikernačky (průměrná hmotnost 4,89 ± 0,49 kg) a těžší jikernačky (průměrná hmotnost 6,96 ± 0,72 kg). Nebyly zjištěny statisticky významné rozdíly mezi hodnotami hmotnosti jikernaček a kvality jiker, i když od jikernaček s vyšší hmotností byly získány jikry o větší hmotnosti.

Klíčová slova: sumeček africký; umělý výtěr; kapří hypofýza; Aquaspawn

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