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Krzysztof FORMICKI[1], Andrzej SOBOCIŃSKI[1], Aleksander WINNICKI[1]
Zbigniew MONGIAŁO[2]

Embriology

EFFECTS OF FERTILIZING SEA TROUT (*SALMO TRUTTA* L.) EGGS WITH SPERMATOZOA EXPOSED TO A MAGNETIC FIELD

EFEKTY ZAPŁODNIENIA JAJ TROCI (*SALMO TRUTTA* L.) PLEMMNIKAMI ZE SPERMY PODDANEJ DZIAŁANIU POLA MAGNETYCZNEGO

[1]Department of Fish Anatomy and Embryology, Institute of Ichthyology, Academy of Agriculture, Szczecin
[2]Department of Statistics, Institute of Economics, Organization and Management, Academy of Agriculture, Szczecin

Sea trout (*Salmo trutta* L.) eggs were fertilized with spermatozoa which had been exposed for 4 hours to the effect of a steady magnetic field of 200 mT and 250 mT and for 5 hours to 200 mT. Percentage of fertilized eggs was calculated, and observations were made on the course of egg incubation.

The experiments confirmed the suggestions on beneficial effect of magnetic field upon the success of egg fertilization. Samples of eggs fertilization with spermatozoa which had been previously exposed to a magnetic field were characterized by significantly higher percentage of fertilized eggs compared to the control.

INTRODUCTION

It is commonly known that the effects of egg fertilization depend on spermatozoa motility. Hence, attempts are being made to find the methods of prolonging the period of spermatozoa motility (increasing the viability) and, thus, of increasing the success of fertilization (Scott and Baynes 1980, Stoss 1983). This is especially important in case of highly valuable fish species which are cultured basing on artificial fertilization and controlled egg incubation.

New solutions have been found in the last two decades. Methods have been worked out of short- and long-term storage and transportation of fish sexual products, assessment of gamete quality, and artificial fertilization (Billard 1980, Scott and Baynes 1980). Some environmental factors which affect spermatozoa motility have been determined (Turdakov 1971, Stoss et al. 1977, Tomasik and Sobociński 1979, Morisawa and Suzuki 1980, Baynes et al. 1981).

However, it is still necessary to increase the percentage of successfully fertilized eggs during artificial fish reproduction. Methods used so far to increase spermatozoa motility proved to be of little use.

Studies carried out in the Department of Fish Anatomy and Embryology revealed that motility of huchen (*Hucho hucho* L.) eggs increased considerably under the effect of magnetic fields (Formicki et al. 1989). Hence, it was decided to check the effects of fertilizing sea trout (*Salmo trutta*) eggs with spermatozoa which had been previosuly exposed to the effect of a magnetic field. Similar experiments have also been made in other laboratories (Strand et al. 1983). Preliminary results of these studies have induced the authors to undertake broader studies in this field.

MATERIALS AND METHODS

Sperm and eggs of sea trout (*Salmo trutta* L.) from the Rega River were collected in 1987 and 1988 in the vicinity of Trzebiatów; they were transported in isothermic containers (in 3 ± 1°C) to the laboratory in Szczecin (4–5 h). Sperm of each male was divided into two parts; one of these was placed for 4 or 5 hours in a magnetic field of 200 or 250 mT, generated by an electromagnet. Sperm samples exposed to the magnetic field were placed in a container cooled with water. Temperature inside the container was kept at 8°C during the exposure. Control sperm and egg samples were kept in the same temperature but were not exposed to the magnetic field.

Spermatozoa exposed to the magnetic field were used to fertilize eggs (about 200). In each series, eggs originating from one female were fertilized separately with spermatozoa from a few males. Totally, eggs from 12 females and spermatozoa of 52 males were used in 12 series of the experiment. Eggs were placed in 300 ml crystallizers, and 3 drops of sperm were added using Pasteur pipette. Then water was added, the gametes were mixed, and thoroughly washed with water after several minutes.

Eggs were incubated in Petri dishes in 6–9°C. Water was changed every 24 hours. Number of fertilized eggs was calculated in the period of blastopore closing. The results were analysed using Student's t test for the differences between the control and the experimental samples in particular series.

RESULTS

Data on the percentage of sea trout (*Salmo trutta* L.) eggs fertilized with spermatozoa which had been exposed to the magnetic field are presented in Table 1. It appeared that magnetic field increased the success of egg fertilization compared to the control. This was noticeable in case of 5 h spermatozoa exposure to 200 mT magnetid field (significant differences). In case of 4 h exposure (200 and 250 mT), the effects of fertilization were not always significantly different. Notwithstanding this, percentage of fertilized eggs tended to increase in the series 1–4, 6 and 8. Only the series 5 and 7 did not confirm this trend.

Table 1

Percent of sea trout (*Salmo trutta* L.) eggs fertilized with spermatozoa exposed to a magnetic field

Series	4 h exposure						s.l.[xx]
	Control			200 mT magnetic field			
	$\bar{x}$	S.E.	n[x]	$\bar{x}$	S.E.	n[x]	
1	54.9	10.57	8	71.0	8.63	8	$p < 0.007$
2	49.9	18.13	4	50.8	19.14	4	$p < 0.34$
3	56.7	8.05	4	64.2	6.93	4	$p < 0.25$
4	63.4	16.58	4	67.9	17.17	4	$p < 0.25$
5	35.9	13.65	5	34.3	14.29	5	$p < 0.55$
	Control			250 mT magnetic field			s.l.
	$\bar{x}$	S.E.	n[x]	$\bar{x}$	S.E.	n[x]	
6	13.4	9.44	4	15.5	12.93	4	$p < 0.31$
7	58.1	18.87	4	50.3	22.76	4	$p < 0.57$
8	29.0	19.50	3	40.6	22.23	3	$p < 0.12$
	5 h exposure						
	Control			200 mT magnetic field			s.l.
	$\bar{x}$	S.E.	n[x]	$\bar{x}$	S.E.	n[x]	
9	65.1	18.10	4	94.4	2.28	4	$p < 0.08$
10	56.2	17.86	4	81.1	9.53	4	$p < 0.03$
11	22.4	10.38	4	46.4	17.59	4	$p < 0.03$
12	11.6	8.62	4	38.5	13.15	4	$p < 0.04$

[x]Number of males. Egg samples from one female were fertilized separately with spermatozoa of each male.

[xx]Level of significance.

It can be concluded that 5 h exposure of spermatozoa to 200 mT magnetic field increased significantly percentage of successfully fertilized eggs. The effect of 4 h exposure to 250 mT magnetic field was not noticeable.

DISCUSSION

It is known that magnetic field affects life processes of the organisms (Barnothy 1964, 1969, Maret et al. 1986). It is taken advantage of by fish and birds for orientation and navigation (Keeton 1979, Kalmijn 1982, Quinn and Brannon 1982), it deform liquid crystals (Roudelez 1974) which form cell membranes (Rościszewski 1973), thereby affecting their permeability. It is also known that fish eggs are characterized by very brief period of readiness for fertilization, and that the period of spermatozoa motility is also limited.

Strand et al. (1983) kept unfertilized eggs and spermatozoa of rainbow trout (*Salmo gairdneri* Rich.) in a magnetic field of 1 mT, and achieved 2% increase of fertilized eggs compared to the control. These authors explained that possibly the egg micropyle was opened for a longer period, and permeability of yolk membrane changed, or else that spermatozoa exposed to a magnetic field retained their motility for a longer period, but they gave no evidence to prove these suggestions.

We are of the opinion that motility and viability of spermatozoa increased under the effect of magnetic field (Formicki et al. 1989). Increased motility is probably due to lower permeability of the head cell membrane. Spermatozoa of salmonids activated in sea water were motile for a longer period due to the differences in osmotic pressure and slower penetration of water into the spermatozoa (Billard 1978, Tomasik and Sobociński 1979).

Cell membrans are composed of liquid crystals (Rościszewski 1973), and these change their properties under the effect of a magnetic field (Roudelez 1974). Hence, magnetic field may decrease water penetration into the spermatozoa, thereby decreasing the energy losses and prolonging the period of spermatozoa motility and viability.

In view of the results of our experiments, it can be assumed that the exposure period is more important than the value of the magnetic field within certain limits.

It seems that beneficial effect of magnetic fields on spermatozoa noted in our experiments, consisting of increased success of fertilization, might be of considerable importance for the fishery practices, but it requires further studies also on other fish species.

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Krzysztof FORMICKI, Andrzej SOBOCIŃSKI, Aleksander WINICKI, Zbigniew MONGIAŁO

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STRESZCZENIE

Jaja troci (*Salmo trutta* L.) zapładniano plemnikami poddanymi uprzednio działaniu stałego pola magnetycznego o wartości 200 lub 250 mT przez okres 4 i 5 godz., a następnie obliczano procent zapłodnienia i śledzono przebieg inkubacji.

Przeprowadzone doświadczenia potwierdziły przypuszczenia o pozytywnym wpływie pola magnetycznego na efekty zapłodnienia. W próbach ikry, gdzie do zapłodnienia użyto plemników poddanych działaniu pola magnetycznego uzyskano wyższy procent zapłodnienia w porównaniu z kontrolą.

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Author's addresses:

Dr. Krzysztof Formicki, mgr inż. Andrzej Sobociński,
prof. dr hab. Aleksander Winnicki
Instytut Ichtiologii
Akademia Rolnicza
ul. K. Królewicza 4, 71—550 Szczecin
Polska (Poland)

Dr. Zbigniew Mongiało
Instytut Ekonomiki, Organizacji i Kierowania
Akademia Rolnicza
ul. Armii Czerwonej 16
70—466 Szczecin
Polska (Poland)