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Krzysztof *FORMICKI*, Aleksander *WINNICKI*

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A DEVICE FOR TRANSPORTING FISH GAMETES AND FERTILISED EGGS IN A MAGNETIC FIELD

URZĄDZENIE DO TRANSPORTU GAMET I ZAPŁODNIONYCH JAJ RYB W POLU MAGNETYCZNYM

Department of Fish Anatomy and Embryology, Agricultural University of Szczecin, Poland

A device for transporting and storage of fish gametes, developing eggs, and newly hatched fry in a constant, adjustable (3–9 mT) magnetic field was constructed. The device has a relatively large, thermally insulated, biological material storage compartment, exposed to highly uniform (± 2.5%) magnetic field.

INTRODUCTION

Transportation of fish eggs from spawning ground to the hatchery is one of the major operations in the fisheries practice. The widely used conventional method involves obtaining sperm and roe from spawners after capture, artificial fertilisation of eggs, and transporting them in water-filled containers to hatcheries, frequently situated far away from the spawning ground. Another method, albeit more seldom used, involves transporting, in separate containers and without water, the eggs and sperm obtained in the spawning ground, fertilisation occurring after delivery to the hatchery.

It has been shown that the other method may be more appropriate for some salmonid species. It allows to reduce handling time in the spawning ground; the gametes under anabiosis are not affected by shocks induced by transportation and do not respire; moreover, transportation of water is avoided, hence more space is saved and more efficient the whole procedure becomes (Cykowska et al. 1973; Winnicki 1993).

Our studies on magnetic field effects on fish early in their ontogenesis, carried out for several years, allow to conclude that both fish eggs and sperm, when placed in a constant magnetic field of a certain value, retain their viability and ability to fertilise and get fertilised for a longer time. The proportion of activated spermatozoa increases and duration of their motility becomes significantly extended after contact with water. As a result, effects of fertilisation (the eggs are longer prone to become fertilised) are significantly better on exposure to magnetic field than without it (Formicki et al. 1990, 1991; Formicki and Winnicki 1993).

Those promising results have prompted the authors to investigate a possibility of applying a constant magnetic field to transportation of fish gametes and fertilised eggs.

Results of the 2-year-long period of studies confirmed the earlier laboratory findings and seem to demonstrate the usefulness of the method. Application of a magnetic transporting device significantly increases fertilisation rate and reduces losses, usually incurred during transportation of fertilised eggs (Winnicki et al. 1994). Moreover, the device provides an opportunity to store, for up to several days, the viable spermatozoa without a necessity to use other, more complicated procedures, e.g., deep freezing (Legendre and Billard 1980).

To translate the observations into practical use, there arose a need to construct a special device which would make it possible to carry out comprehensive studies on behaviour of gametes, embryos at different developmental stages, and larvae, during transportation in magnetic field with adjustable induction value and spatial characteristics, and to find optimal parameters for different species.

Thus the present paper describes a device for transporting fish eggs and sperm, or other biological material, exposed to constant magnetic field of induction value adjustable within 3–9 mT.

DESCRIPTION OF THE DEVICE

The device (Fig. 1) consists of two magnetic circuits: external and internal (with a working space to house a container with biological material to be transported) and two sets of magnets.

The external magnetic circuit consists of four pipes connected with elbows, which form the transporter frame (1); two trestles for mounting the pipes (2); distance adjusters attached to the trestles (3); and external magnet poles (4).

The internal magnetic circuit consists of two sets of internal magnetic poles with expanders (5) and two working space poles (6). The constant distance between the working space poles is secured by brass distancers (7), one of which forms a pivot for the thermally insulated cylindrical container (8) for storing biological material. The container is made of a brass plate. Thermal insulation is provided by a layer of styrofoam, covered with a thin aluminium sheet. Inside, the container consists of two parts: a 220 mm diameter, 40 mm high lower compartment for live material, and an upper, wider, compartment, 250 mm in diameter and 50 mm high for coolant containers. When the latter are not necessary, the live material may occupy the entire inner space of the container.

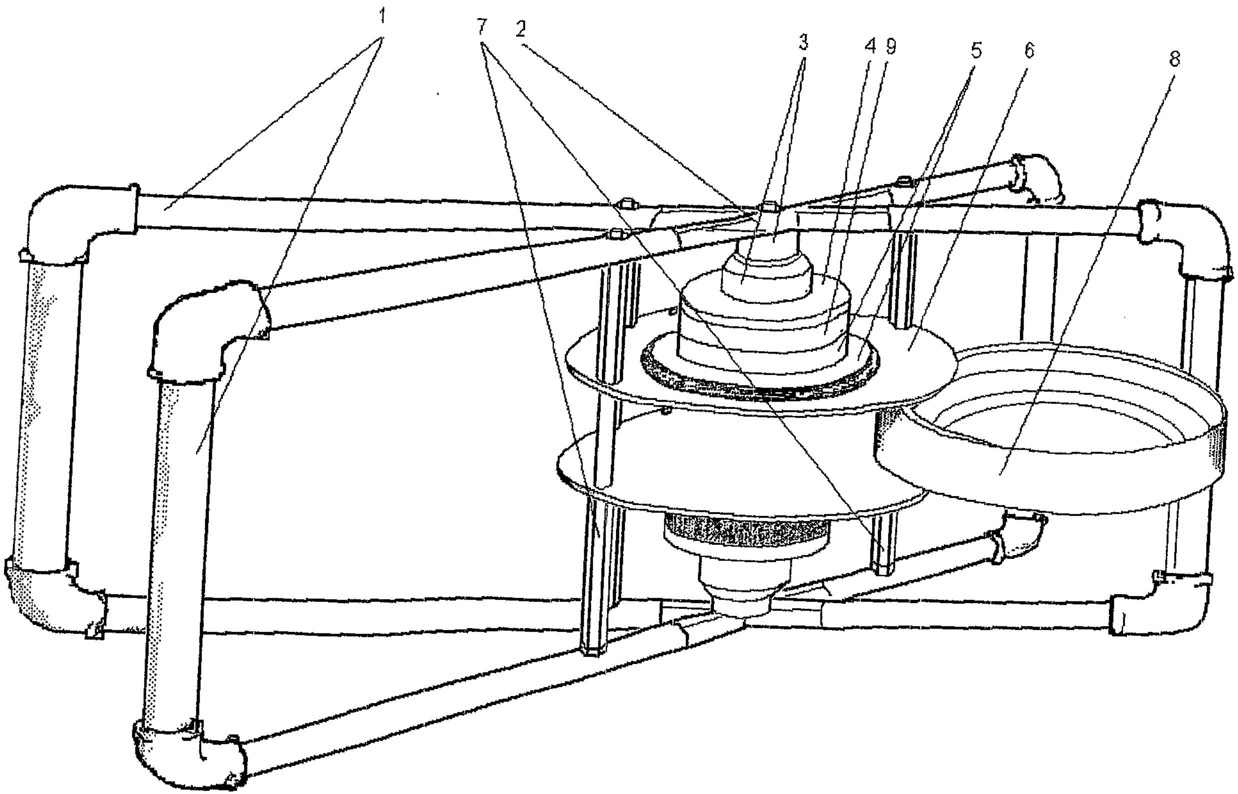

Fig. 1. Magnetic transporter (1—transporter frame; 2—trestles; 3—distance adjusters; 4—external magnet poles; 5—two sets of internal magnetic poles with expanders; 6—two working space poles; 7—brass distancers; 8—insulated container)

Magnetic field is produced by two sets of stable ferritic magnets (120, 12, and 17.6 mm diameter) made of FB-27 and magnetised along the symmetry axis (9). Magnetic field adjustment within the magnetic circuit working space (container) occurs by placing an appropriate amount of magnetic cramps onto the magnetic poles circuit. In this way a sizeable part of the magnetic flux is arrested. The adjustment is achieved by placing equal numbers of regular cramps (out of a total number of 10 pairs) and arch cramps (out of a total number of 3 pairs) on each pole. Changes in the magnetic field as a function of number of cramps are shown in Tab. 1.

Table 1

Magnetic field induction in the magnetic transporter working space as function of type and number of cramps applied

Number of regular cramps	0	1	2	3	4	5	6	7	8	9	10
Magnetic field induction (mT) without arch cramps	8.9	8.4	7.9	7.3	6.8	6.2	5.7	5.2	4.7	4.4	4.1
Magnetic field induction (mT) with arch cramps	4.8	4.5	4.2	4.0	3.9	3.7	3.6	3.4	3.3	3.1	3.0

The magnetic field induction was measured in the central part of the working space, intended for the biological material container where average field values occur. Magnetic induction in that space changes within ± 2.5% only (Fig. 2), which is quite satisfactory in view of a relatively small size (850 × 335 × 460 mm) and weight (50 kg) of the device. The large weight, relative to the volume of the space housing the biological material, has resulted from efforts to provide the most uniform magnetic field in that space (the magnetic circuit is enclosed by the frame).

Corrosion of all the corrosion-prone parts of the device has been prevented by zincifying.

The design of the transporter prevents dissipation of the magnetic field around the device. The magnetic field induction at a distance of 1 m is comparable with the geomagnetic field.

Preliminary results of field and laboratory tests will form a basis for future designs of simple "magnetic transporters", useful—in our view—in practice, i.e., for storage and transport of fish gametes and fertilised eggs.

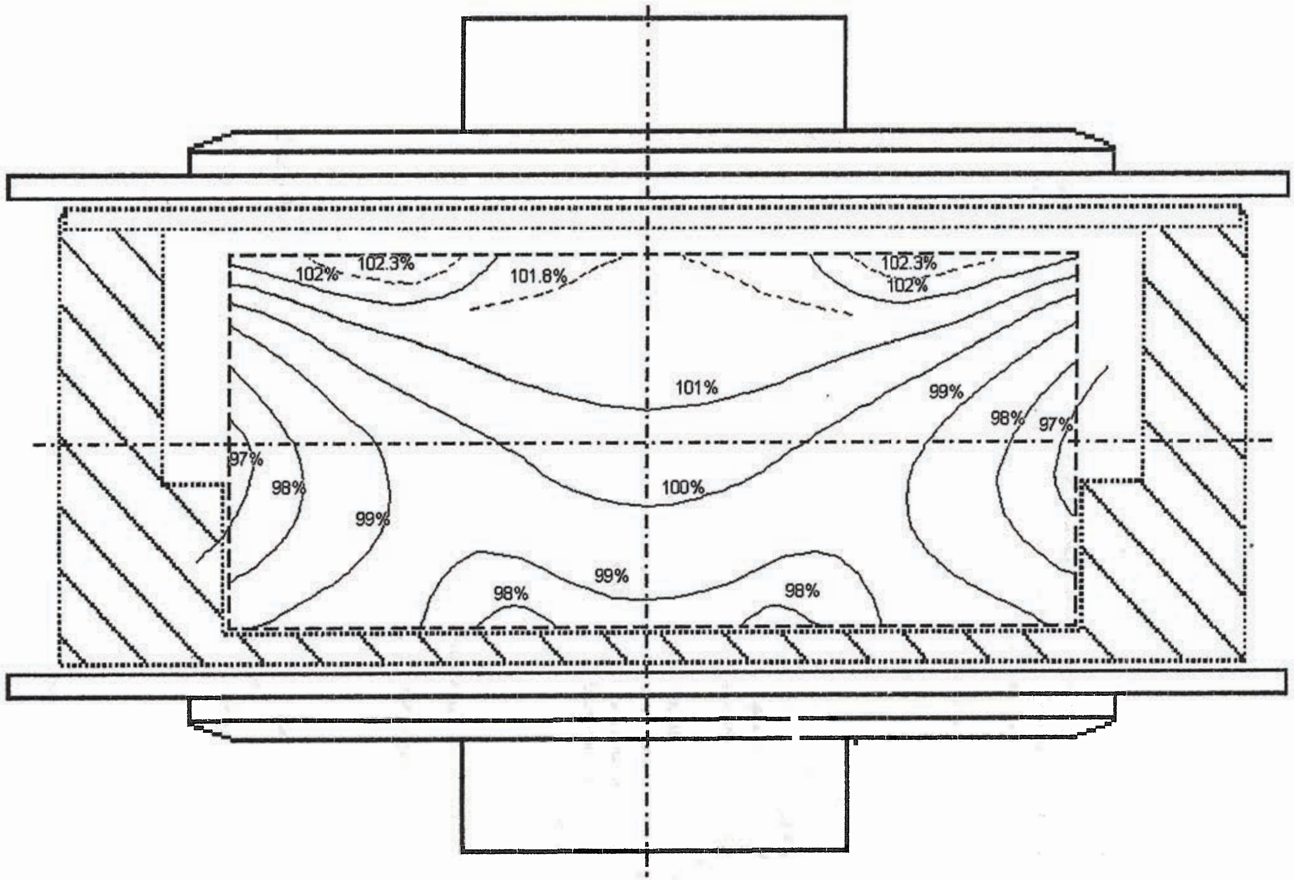

Fig 2. Distribution of magnetic field induction in transporter container (induction values are expressed as % of average)

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STRESZCZENIE

Skonstruowano urządzenie do transportu i przetrzymywania gamet, rozwijających się jaj ryb oraz wylęgu w stałym, o regulowanej wartości (3–9 mT), polu magnetycznym. Urządzenie posiada stosunkowo dużą, izolowaną termicznie przestrzeń na materiał biologiczny, o wysokiej jednorodności pola (± 2,5%).

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Author's address:

Aleksander Winnicki DSc Prof tit
Krzysztof Formicki DSc Prof
Department of Fish Anatomy and Embryology,
Agricultural University of Szczecin
Kazimierza Królewicza 4, 71-550 Szczecin, Poland