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PHOTOELECTRIC TECHNIQUE OF SALMONID EGG TURGOR RECORDING

FOTOELEKTRYCZNA METODA REJESTRACJI TURGORU JAJ RYB ŁOSOSIOWATYCH

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A photodiode as a sensor fitted to an electrocardiograph enables a precise recording of changes in fish egg turgor to be made.

INTRODUCTION

A method, proposed by one of the authors (Winnicki, 1967), for studies on water exchange between an egg and its environment involving an independent turgor recording makes it possible to observe currently, at different stages of the embryonic development, even the most subtle changes in egg as a whole, the changes being effected by factors such as temperature (Winnicki et al., 1968), pH, etc. (Winnicki et al., 1969; Cykowska and Winnicki, 1972).

The method, however, is not refined enough to be employed on a large scale, primarily because the recording of pen vibrations on a kymograph cylinder contains some error resulting from the friction between the pen and tape. Secondly, the kymograph cannot record long series of measurements nor a quick change of an object studied is possible. Therefore this technique is feasible in studies on relatively large objects such as salmonid eggs, while being rather unwieldy for smaller eggs under investigation.

The present work attempts to modify the turgor recording by means of a photoelectric record rather than of a mechanic one in order to eliminate any possible error and increase

sensitivity, which will in practice allow more precise results to be obtained and expand the scope of turgor studies to cover even the smallest eggs.

MATERIAL AND METHODS

The studies were carried out in the Fisheries Experimental Station, Darłowo. Eggs of rainbow trout (*Salmo gairdneri* Rich.) served as an experimental material.

Known properties of semi-conductors which, when light-excited produce an electromotive force of the magnitude order of several mV were taken advantage of in designing the experiments. The system presented (Fig. 1) includes an FG 2 germanium photodiode (1) fitted by IM delivery leads to a one-channel "Simlicard-2" electrocardiograph. A photodiode, direction-sensitive to changes in light, was placed 2 cm from an egg to be studied (4), at the level of its top. An electric torch equipped with a 4.5 V/0.2A bulb was used as a source of light placed 20 cm from the egg, in the photodiode optical axis (2). A hammer-pen (3), when falling on the egg placed on a stand (4) at the same time acts as a diaphragm modulating the light stream reaching the photodiode (1). A record on the ECG paper (5), similar to that on a kymograph, is obtained as a result. Both speeds, i.e., that of the kymograph paper and ECG record tape, are set at 50 mm/s. The ECG recording signal amplifier was calibrated as 10 mV/10 mm. The temperature of tap water

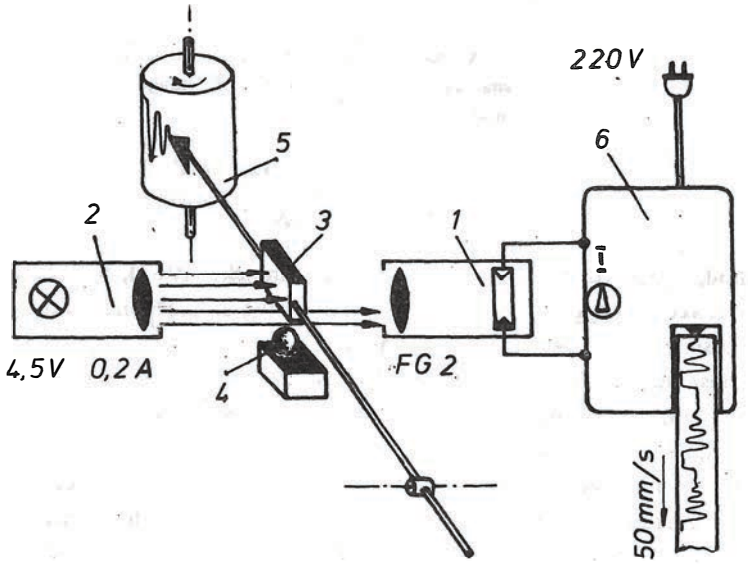

Fig. 1. Modified device for fish egg turgor record
1) FG 2 germanium photodiode, 2) electric torch with 4.5 V/0.2 A bulb, 3) hammer-pen with diaphragm, 4) egg studied on a stand, 5) „Zimmermann" kymograph cylinder, 6) ECG „Simlicard-2" recorder.

into which the rainbow trout eggs were put during the experiments was maintained at 10°C.

RESULTS AND DISCUSSION

Fig. 2 presents the recordings of egg turgor after 0, 10, 60, and 180 min. from placing the eggs in water. The row (A) contains kymograms obtained with the hammer-pen. The row (B) comprises the recordings obtained for other eggs, performed over the same periods of time; these recordings were made using a hammer (diaphragm) vibration-modulated light stream falling into the photodiode, on a thermosensitive ECG recording paper.

When the recordings obtained with the two methods (A and B) are compared, a significant resemblance in the vibration number, frequency, and amplitude of egg elasticity record can be observed.

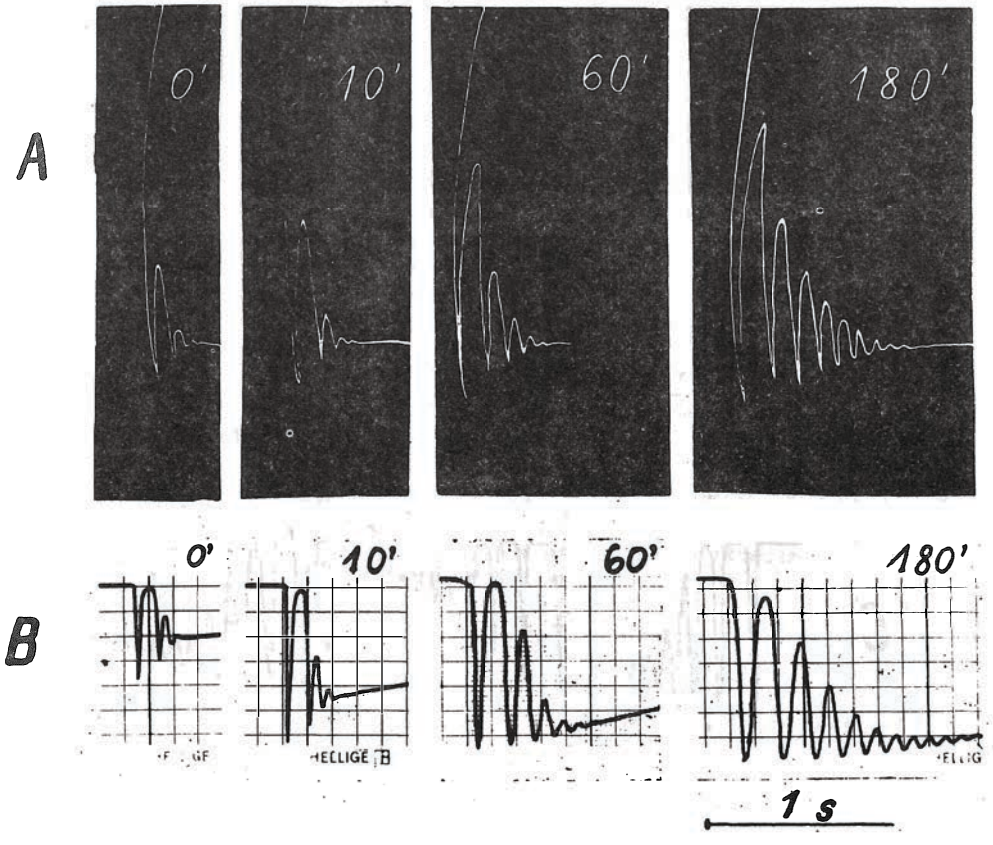

Fig. 2. Egg elasticity as recorded on a kymograph (A) and ECG recorder (B)

In order to detect a possible impact of resistances (difficult to unify and determine) of the pen in work, the elasticity of the same egg was studied using the two techniques applied jointly.

Fig. 3 presents the egg elasticity recorded after 70, 230, and 240 min. from placing the egg in water. The recordings (A) and (B) were performed simultaneously. After ca 1 s. needed to disconnect the hammer-pen and kymograph, the egg elasticity was recorded solely with the modified technique.

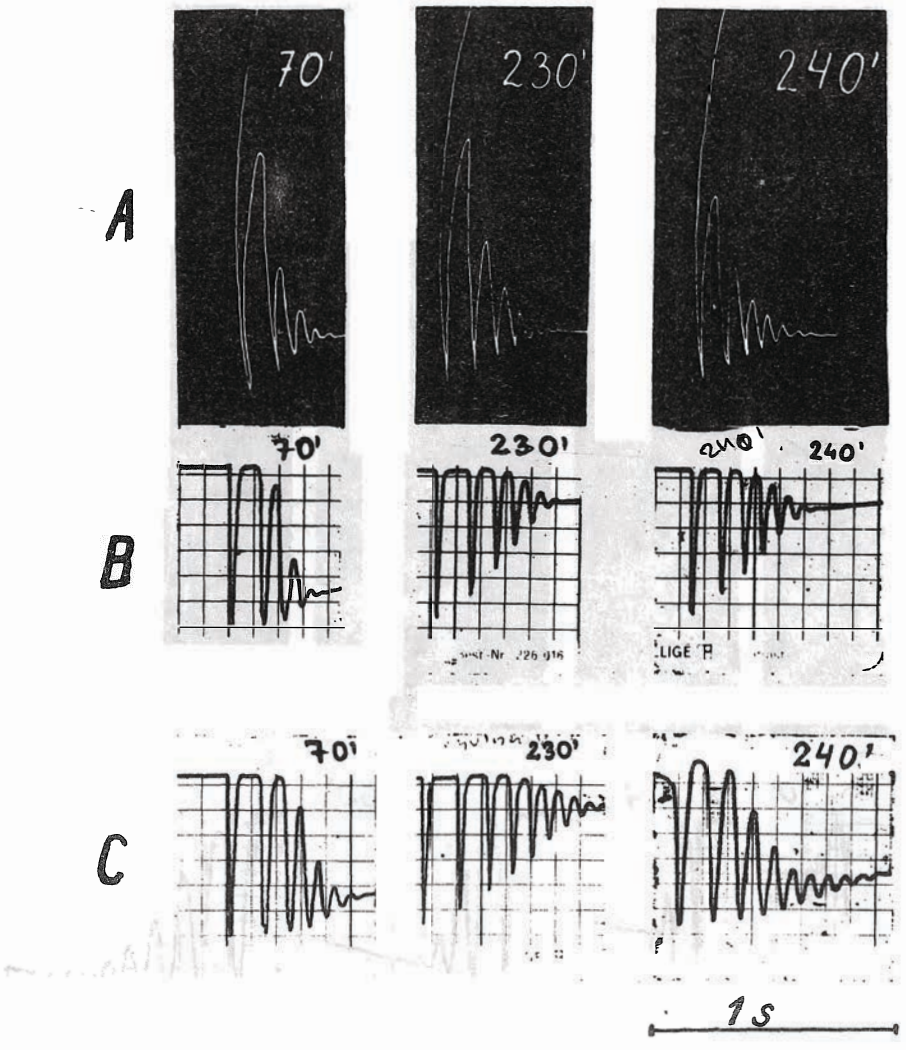

Fig. 3. Effect of kymograph pen friction on accuracy (as number of vibrations) of egg elasticity recordings
A and B – both methods employed jointly, C – modified recording

As seen from Fig. 3, the number of vibrations recorded for the same egg with the modified technique (C) increases with respect to the previous method by 2, 3, and 4 vibrations over 70, 230, and 240 min., respectively.

Taking the dynamics of vibration number increments in the 70th, 230th, and 240th minute of the experiment into account (Winnicki, 1968) it can be stated that the increased number of vibrations in the version (C) (Fig. 3) relative the (A) and (B) ones could have been obtained by eliminating the resistance caused by the pen – kymograph sooty paper friction.

The photoelectric technique of egg elasticity recording permits, following the assumptions presented in the Introduction, to avoid errors that are likely to occur during the kymograph work as a result of the pen-paper friction and the kymograph driving device skid resulting from on- and off-turning the kymograph, the kymograph roller being frictional gear-driven. The thermal recording on the millimeter paper makes it possible to analyse the results immediately on completion of the experiment. The 50 m standard length recorder tape can house a large number of recordings, the stable conditions of the experiment being maintained throughout.

It seems worthwhile to add that the electrocardiograph, apart from its originally designed function, can also act as an excellent recorder in a number of quickly changing biological processes when semi-conductive photoelectric elements are used as sensors.

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FOTOELEKTRYCZNA METODA REJESTRACJI TURGORU JAJ RYB ŁOSOSIOWATYCH

Streszczenie

Przedstawiono zmodyfikowaną, fotoelektryczną metodę rejestracji turgoru jaj pstrąga tęczowego (*Salmo gairdneri* Rich.) w trakcie wchłaniania wody.

W miejsce zapisu kimograficznego, wprowadzono rejestrację na termoczułej taśmie elektrokardiografu, z zastosowaniem fotodiody germanowej FG2 jako czujnika do odczytywania zmian sprężystości jaj, co wpłynęło na zwiększenie czułości metody i zakresu jej zastosowania.

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ФОТОЭЛЕКТРИЧЕСКИЙ МЕТОД РЕГИСТРАЦИИ ТУРГОРА ИКРИНОК ЛОСОСЁВЫХ РЫБ

Р е з ю м е

В работе представлен модифицированный фотоэлектрический метод регистрации тургора икринок радужной форели (Salmo gairdneri Rich.) при поглощении ими воды.

Вместо кимографической записи была использована регистрация на термочувствительной ленте электрокардиографа с применением германиевого фотодиода ФГ2 в качестве индикатора для определения упругости икринок, что повлияло на увеличение чувствительности метода и масштаба его применения.

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