EFFECTS OF PHOTOPERIOD AND TEMPERATURE ON GONADAL MATURATION OF BLENNIUS (= SALARIA) PA VO (TELEOSTEI, BLENNIIDAE)

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EFFECTS OF PHOTOPERIOD AND TEMPERATURE ON GONADAL MATURATION OF *BLENNIUS (= SALARIA) PAVO* (TELEOSTEI, BLENNIIDAE)

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PHOTOPÉRIODE
TEMPERATURE
MATURATION DES GONADES
BLENNIUS
TELEOSTEI

RÉSUMÉ. – L'action de la photopériode et de la température sur la maturation des gonades de *Blennius pavo* est étudiée par différentes combinaisons de ces facteurs sur le Poisson en période d'inactivité sexuelle. Une longue photopériode (jour : 20 h/obscurité : 4 h) associée à une basse température (8 °C) entraîne l'arrêt de l'ovogenèse et de la spermatogenèse; il en est de même avec la combinaison jour court (lumière : 6 h – obscurité : 18 h) avec une température élevée (17 °C). Les deux conditions réunies, longue photopériode et température élevée, permettent la poursuite de la maturation des gonades mâles et femelles de *Blennius pavo*.

PHOTOPERIOD
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ABSTRACT. – The effects of photoperiod and temperature on gonadal maturation of *Blennius pavo* were investigated by treating the fish with different combinations of these factors during their phase of sexual inactivity. A stop of oogenesis and spermatogenesis was caused by conditions of long photoperiod (20 L : 4 D) and low temperature (8 °C) as well as by combination of short day (6 L : 18 D) and high temperature (17 °C). Only condition of both, long photoperiod and high temperature effected a significant progress of maturation of male and female gonads of *Blennius pavo*.

INTRODUCTION

Gonadal maturation in teleosts is a cyclic process taking place at regular intervals of time. A combination of special external factors and a socalled "intrinsic" factor determines spawning at that time of the year when the environmental conditions are most suitable for the growth of the fry (Baggerman, 1958, 1972). These environmental factors tend to recur cyclically and therefore have an effect on the onset of maturation. They can either be biotic (e.g. social conditions, quality and quantity of food, material for the building of nests), or abiotic (e.g. length of photoperiod, intensity of light, temperature, rainy season) (Baggerman, 1958; Billard and Breton, 1978). In regions of temperate climate zones – for example the Mediterranean – mainly periodic alterations of the length of photoperiod and temperature are considered as the most effective factors controlling the advance of gonadal maturation.

The aim of the present investigation was to determine those factors that are most effective for the progress of oogenesis and spermatogenesis in *Blennius pavo*. There is evidence that *Blennius pholis*, an Atlantic species, needs both – a high temperature and a long photoperiod for the development of the gonads (Shackley and King, 1977a).

MATERIAL AND METHODS

A number of *Blennius pavo* were caught in the Adriatic Sea near Trieste, Italy, and Umag, Yugoslavia. The spawning period of *B. pavo* reaches from the begin-

ning of June till the middle of August. Further details about timing and conditions of the reproductive cycle of *B. pavo* will be given (Patzner, 1983). At the time of capture the daylength was about 10 1/2 hours. The ovaries contained oocytes of the stages 1 and 2 (Shackley and King, 1977), the stage of the testes was defined as stage II (Fives, 1980).

For acclimatization *B. pavo* were maintained in an aquarium containing 150 l of sea-water. The temperature was about 17 °C, the illumination being automatically controlled and the length of photoperiod was adjusted to natural conditions. The fish were fed on dry food daily. After a period of two weeks, the fish were exposed to winter conditions : the temperature was then maintained at 8 °C, the period of light was reduced to 6 hours. After a further 20 days, control fish were killed and fixed. Sex was determined by secondary sex characteristics of male animals (helmet on the head and two anal glands on the anal fin (Eggert, 1931, 1932)). The remaining fish were divided into three groups, each containing the same number of females and males and put into three aquaria with different experimental conditions. These tanks were subdivided by walls in order to prevent interactions between the sexes and territorial fights.

The periods of light and darkness were adjusted after Follet and Farner (1966) :

tank I : 20 L : 4 D; 8°C
tank II : 6 L : 18 D; 17°C
tank III : 20 L : 4 D; 17°C.

After 8 weeks the fish were killed; sex, body-length and weight of each were taken. The gonads were excised and weighted to the nearest 0.001 g and the gonadosomatic index (GSI = gonad weight × 100/body weight) was calculated. After fixation in Bouin's fluid, paraffin sections were stained with haematoxylin and eosin. The stages of development of the oocytes were determined by the criteria described by Shackley and King (1977b), who distinguished 11 different stages in the oogenesis of *B. pholis*.

RESULTS

A. Controls

The GSI of the female control animals was 0.56 ± 0,02 (mean ± standard error), the GSI of the male control animals was 0.18 ± 0.04 (Fig. 1, Fig. 2). The ovaries contained oocytes of the stages 1 and 2 and very few stage 3 oocytes (Fig. 3). The testes were filled with spermatogonia and spermatocytes of late stages of development (Fig. 7). The anal glands of all males were small.

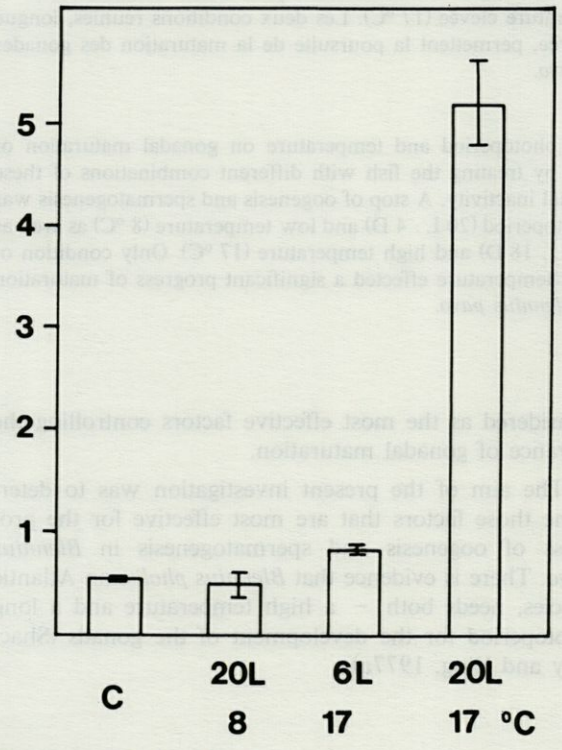

Fig. 1. – Effects of photoperiod and temperature on the GSI of female *Blennius pavo*. C : control animals; L : hours of light.

Effets de la photopériode et de la température sur le GSI (index gonado-somatique) des femelles de Blennius pavo. *C : anim. de référence; L : lumière en heures/jour.*

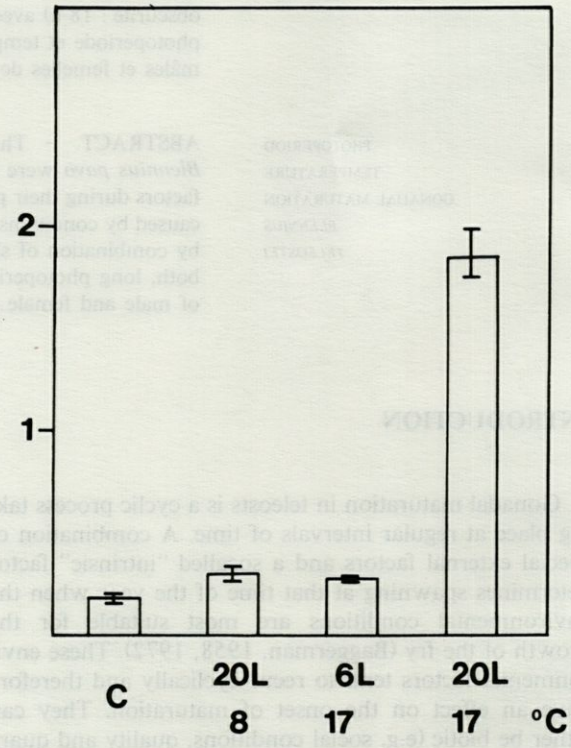

Fig. 2. – Effects of photoperiod and temperature on the GSI of male *Blennius pavo*. C : control animals; L : hours of light.

Effets de la photopériode et de la température sur le GSI des mâles de Blennius pavo. *C : animaux de référence; L : lumière en heures/jour.*

B. Long photoperiod, low temperature

In comparison with the control animals very little development was observed.The GSI of the females was 0.51 ± 0.25 (Fig. 1) and the oocytes had remained in the same stages as in the controls (Fig. 4). The GSI of the males had increased a little to 0.35 ± 0.78 (Fig. 2). Histologically, no development was to be noticed (Fig. 8). The anal glands were still small.

C. Short photoperiod, high temperature

Little development in comparison with the control animals had taken place. The GSI of the females was 0.86 ± 0.08 (Fig. 1), the GSI of the male animals was 0.27 ± 0.03 (Fig. 2). The ovaries mainly contained oocytes of stage 2 and 3 (Fig. 5). The testes were developed further, they contained spermatocytes of different stages and also spermatids (Fig. 9). The anal glands of the males were still small.

D. Long photoperiod, high temperature

In comparison to the fish of all the other experimental groups progress in development was apparent. The GSI of the females was 5.21 ± 0.83, the GSI of the males 1.81 ± 0.34 (Fig. 1, Fig. 2). The ovaries mainly contained oocytes of the stages 7 and 8. Between them there were many stage 2 and stage 3 oocytes (Fig. 6). The testes were densly filled with ripe spermatozoa and

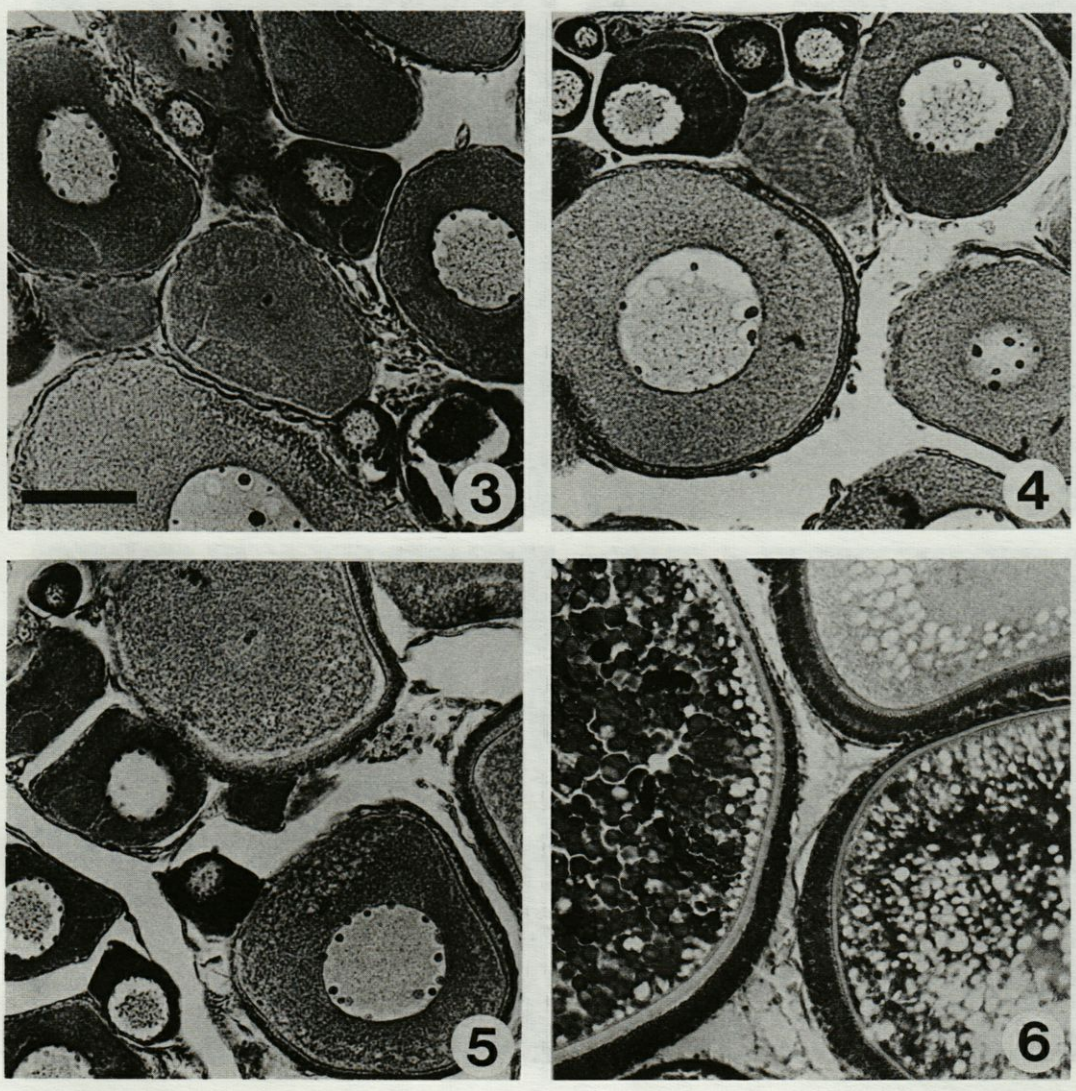

Fig. 3 à 6. – Cross sections through ovaries. Scale shows 50 μm. 3 : ovary of control animal; 4 : ovary under long photoperiod-low temperature conditions; 5 : ovary under short photoperiod-high temperature conditions; 6 : ovary under long photoperiod-high temperature conditions.

Sections transversales des ovaires. Échelle : 50 μm. 3 : ovaire d'un animal de référence; 4 : ovaire soumis à une longue photopériode et une basse température; 5 : ovaire soumis à une courte photopériode et une température élevée; 6 : ovaire soumis à une longue photopériode et à une température élevée.

different stages of spermatids (Fig. 10). The ducts of the testicular gland were also filled with ripe spermatozoa and in some of the specimens the vas deferens also contained sperm (Fig. 11). The anal glands of the males of this experimental group were remarkably larger.

DISCUSSION

Up to now the effect of different photoperiod and temperature conditions on the gonads has been examined in many species of teleosts. Various patterns of annual periodicity have been identified in temperate and cold climate zones. In most experiments either temperature or daylength, sometimes a particular combination of both, proved to be the most effective factors controlling the onset of gonadal maturation (Liley, 1969; Htun-Han, 1977).

Billard and Breton (1978) investigated general patterns which are characteristic of larger groups of teleosts, but they concluded that very little can be said about whole families. The maturation of gonads in most salmonids is caused by the decrease of daylength and fall of temperature in autumn. In cyprinids it seems that is only a decrease in temperature which is effective. However, for the group of Percoidei, which also includes the blennies, nothing can be said in general (Htun-Han, 1977).

The described experiments were started with a short period of winter conditions with low temperature and

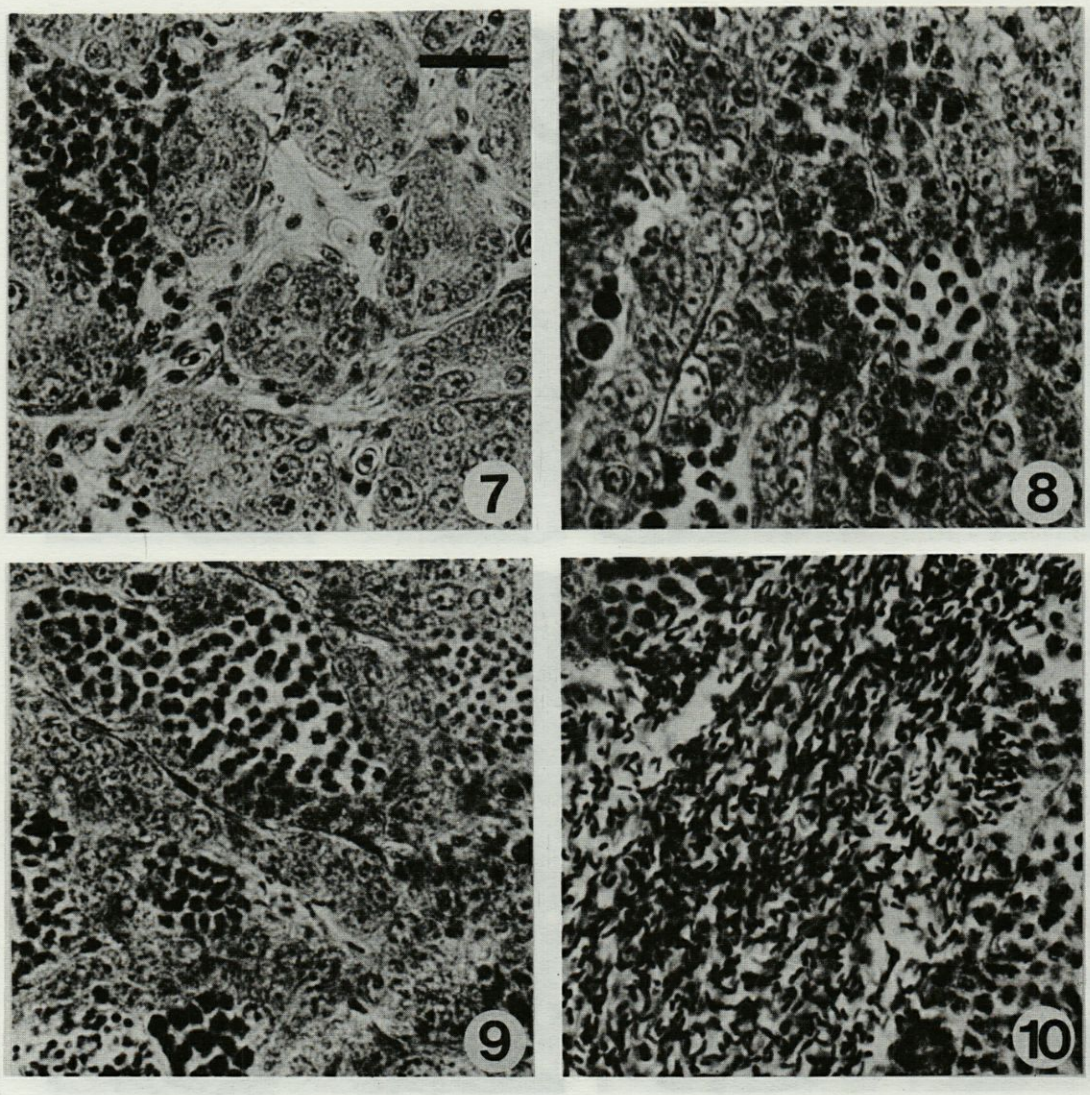

Fig. 7 à 10. – Cross sections through testes. Scale shows 20 μm. 7 : testis of control animal; 8 : testis under long photoperiod-low temperature conditions; 9 : testis under short photoperiod-high temperature conditions; 10 : testis under long photoperiod-high temperature conditions.

Coupes transversales des testicules. Échelle : 20 μm. 7 : testicule d'un animal de référence; 8 : testicule soumis à une longue photopériode et une basse température; 9 : testicule soumis à une photopériode courte et à une haute température; 10 : testicule soumis à une longue photopériode et une température élevée.

short photoperiod, because many fishes, for example *Gasterosteus aculeatus,* need a period of winter conditions to mature in spring (Baggerman, 1958). Results of the present experiments show that photoperiod and temperature manipulations strongly influence the gonadal maturation of *Blennius pavo.* Development was rapidly accelerated by high temperature and long photoperiod. A sharp rise in the gonadosomatic indices of male and female *Blennius* was observed under these conditions. Oocytes of late stages of development were to be seen. Oocytes of the females of the other experimental groups remained at the same stages as those of the control animals taken at the beginning of the experiments. The male *Blennius* seemed to be almost ready to spawn.

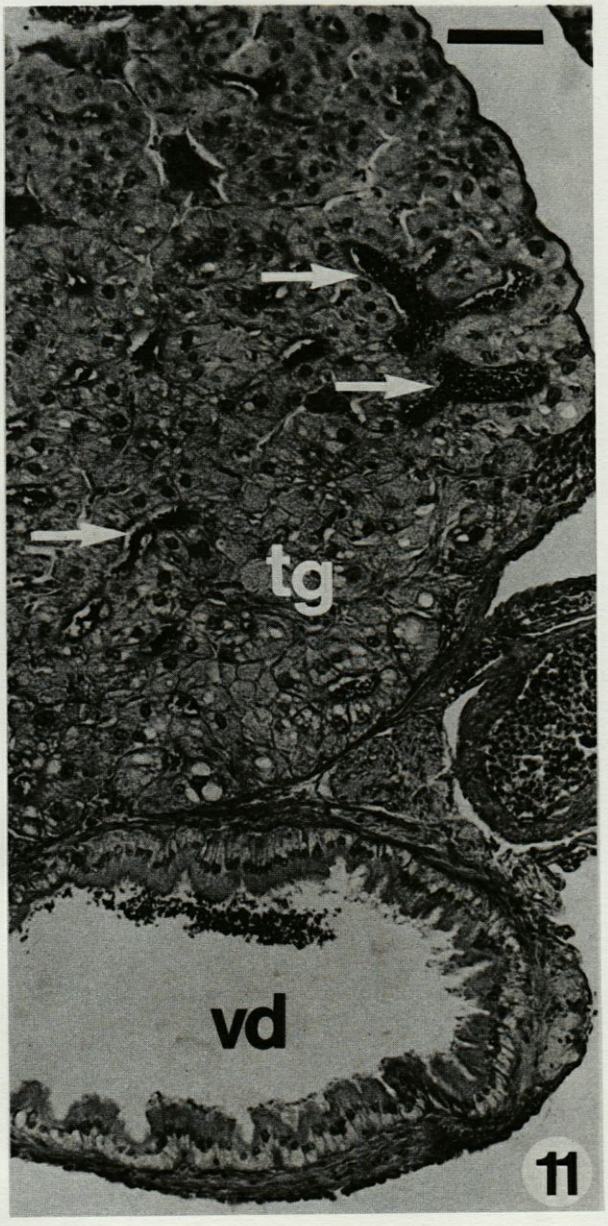

Fig. 11. – Cross section through testicular gland (tg) and vas deferens (vd) under long photoperiod-high temperature conditions. Ripe spermatozoa in the ducts of the testicular gland (arrows) and in the vas deferens. Scale shows 100 μm.

Coupe transversale de la glande testiculaire (tg) et du canal déférent (cd) soumis à une longue photopériode et à une température élevée. Spermatozoïdes mûrs dans la lumière de la glande (flèches) et du canal déférent. Échelle : 100 μm.

It is possible that rise in temperature is more important than longer photoperiod for the development of the gonads in *Blennius pavo,* because the "short day-high temperature"-fish were a little further developed than those of the "long day law temperature". However, the precise onset of gonadal maturation in both – male and female *B. pavo* – can take place only under conditions of high temperature and long photoperiod.

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