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The development and mortality of mackerel eggs (*Scomber scombrus* L.) in different temperatures.

by

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INTRODUCTION

Mackerel is an importent economic pelagic species in the North Sea. The spawning takes place in late May to early July, and more than 80% of the eggs are found in the upper 5 m of the sea (IVERSEN 1973). Very little is known about the egg development, and it is therefore of interest to investigate this under different temperatures. The intention with the experiments were 1) to investigate if natural and artificial fertilization methods will give the same egg mortality during the incubation, and 2) the variation of egg development in different temperatures. The experiments have earlier been reported in Norwegian (DANIELSSEN and IVERSEN 1977).

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MATERIAL AND METHODS

An open aquarium system was used in the experiments (DANIELSSEN and IVERSEN 1974), except for the eggs from the sea which were held in closed 1 litres plastic bottles in a Hetofrig temperature regulation bath. The egg development was determined according to WESTERNHAGEN (1968). Four different methods to get newly fertilized eggs were used, viz. artificially fertilized eggs from both live fish and fish which had been dead for 3-4 hours, and naturally spawned eggs in a basin and in the sea.

The eggs from the sea were sampled in the surface with a speed of 1-2 knot in 2-3 minutes. The eggs were immediately sorted, and only eggs in blastula-stages were used. A sample of these eggs showed that all of them were in the stage 1aβ. The temperature in the surface was 10.7°C, and the salinity 33.5‰. The temperature in the experiments was raised to 14°C in a few hours, and after 24 hours to 15°C.

All the other experiments were carried out in the temperatures: 12°, 14°, 16°, 18°, 20° and 22°C. In the experiments with artificially fertilized eggs the mortality and egg development were examined once a day. In the two other experiments the mortality was examined twice a day, and the egg development was only investigated in the experiment with eggs from the sea. Mortality was in all the experiments estimated from the number of dead eggs on the bottom.

RESULTS

Egg development

The development in different temperatures during the incubation periode with artificially fertilized eggs from live and dead fish is shown in Fig. 1 and 2. In all the experiments the time to hatching was strongly reduced with increasing temperature. As both figures indicate, the hatching starts after about 6 days

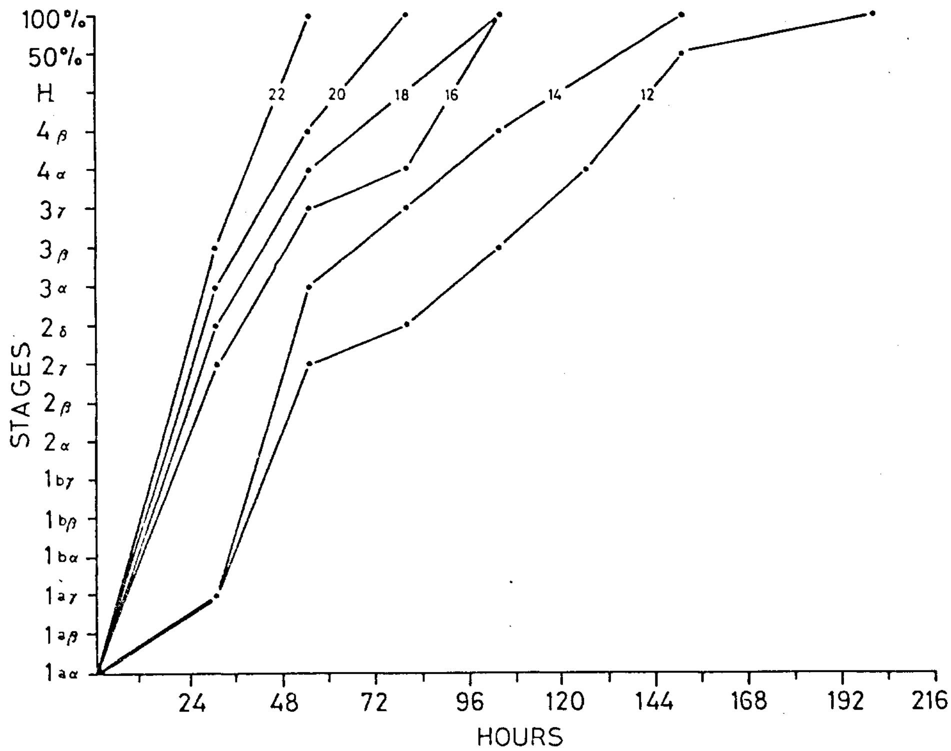

Fig. 1. The development of mackerel eggs from live fish in different temperatures.

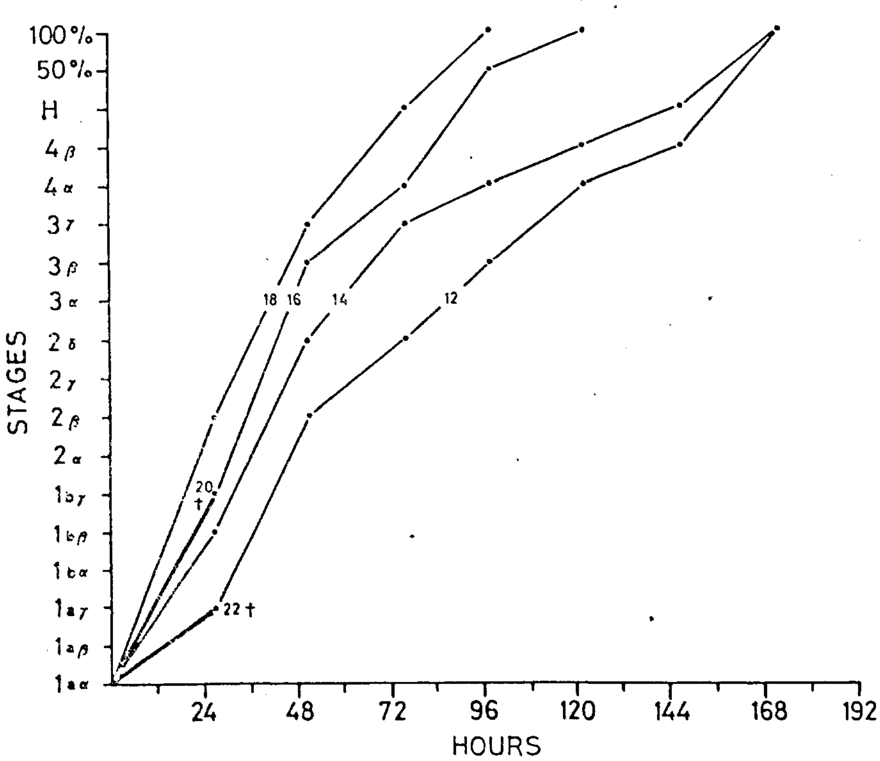

Fig. 2. The development of mackerel eggs from dead fish in different temperatures.

in 12°C, and in 18°C after about 3 days. With eggs from dead fish the development in 20° and 22°C stopped in the blastula and gastrula stages (1aγ and 1bγ). In the experiments, however, with eggs from live fish the eggs hatched even in 20° and 22°C and the incubation time was about 2 days (Fig. 1). In temperatures above 14°C the egg development passed the gastrula stage about one day after fertilization. The naturally spawned eggs in the sea were in the blastula stage 1aβ when the experiment started. The development from this stage to hatching is shown in Fig. 3. The hatching started after 66 hours, within 90 hours 61% was hatched and it was finished 113 hours after the beginning of the experiment. From the rate of development in 12°C in the other experiments and a sea temperature of about 11°C these eggs were supposed to be between 24 and 48 hours old when they were sampled.

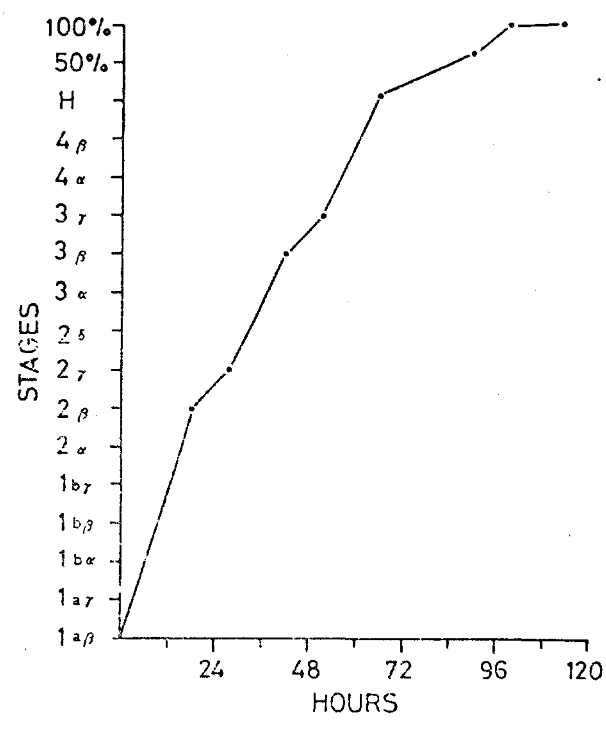

Fig. 3. The development of mackerel eggs spawned in the sea.

Mortality

The mortality in the experiment with eggs from dead fish increased with increasing temperature (Fig. 4). Most of the eggs in 20° and 22°C were probably dead after one day as no development was observed in the eggs after that time. As the eggs floate for some time after they die, and often did not reach the bottom before the second or third observation, will this effect give a certain underestimation of the mortality (Figs. 4-7).

The larvae lived considerable longer in lower temperatures without food than in higher ones. In 12°C all was dead after 13 days, and in 18°C after only about 4 days.

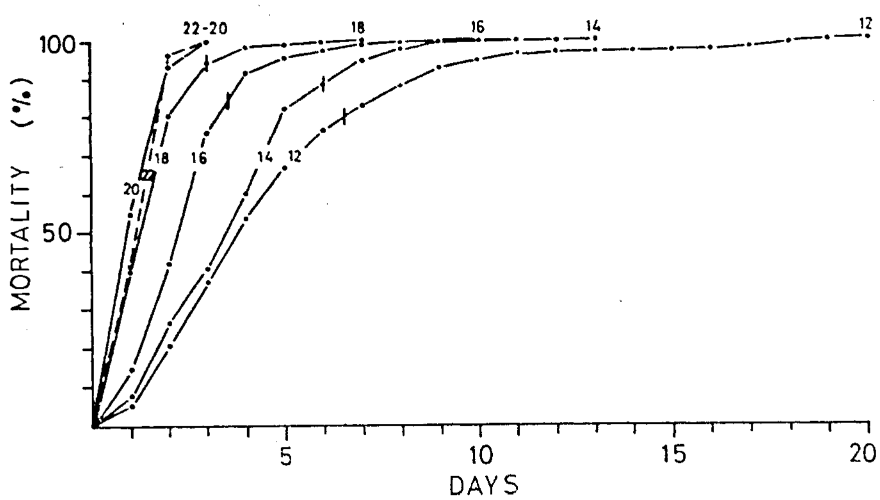

Fig. 4. The cumulative mortality in the different temperatures of the mackerel eggs and larvae from dead fish. Vertical lines points out the commencement of hatching.

The mortality in the experiments with eggs from live fish was more or less the same in all temperatures during the experimental period except in 20° and 22°C where it was much higher the first day (Fig. 5). In this experiment the eggs hatched even in these high temperatures. The mortality, however, was high (75-90%) in all the temperatures when the hatching started.

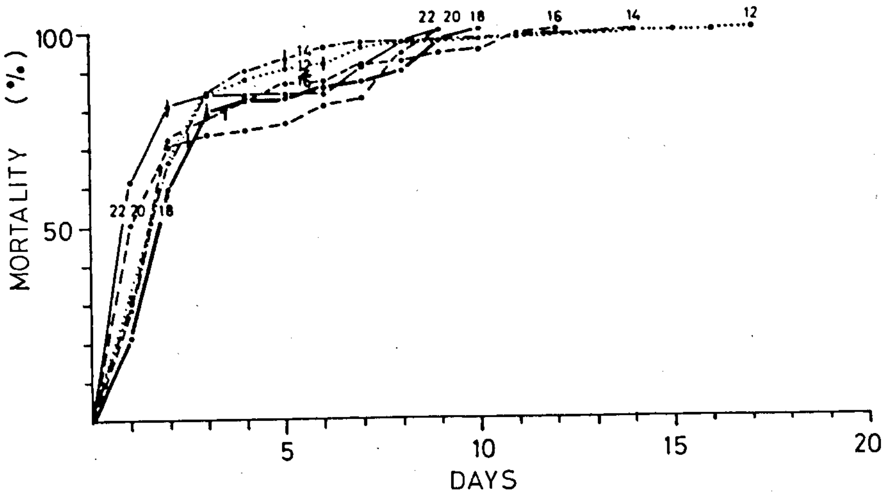

Fig. 5. The cumulative mortality in the different temperatures of mackerel eggs and larvae from live fish. Vertical lines points out the commencement of hatching.

Eggs from natural spawning in a basin showed an increased mortality with increasing temperatures during the incubation time (Fig. 6) as with eggs from dead fish. By the time of hatching the mortality was above 90% in all the temperatures.

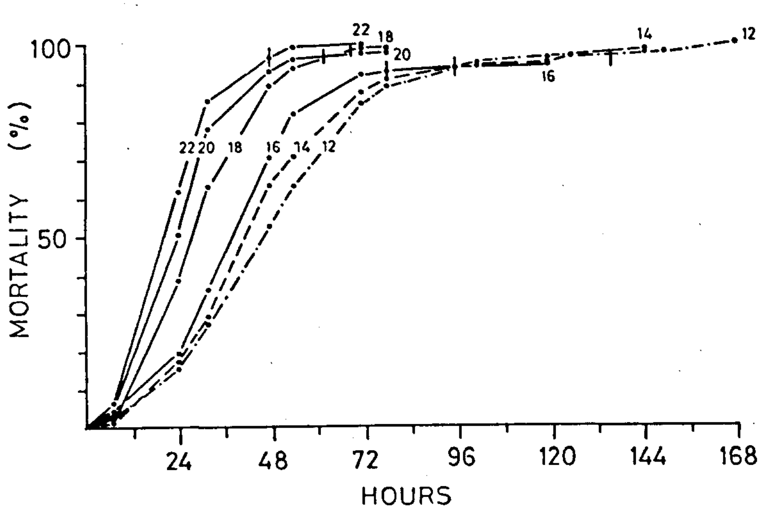

Fig. 6. The cumulative mortality in the different temperatures of the mackerel eggs and larvae from spawning in the basin. Vertical lines points out the commencement of hatching.

In the experiments with eggs from natural spawning in the sea there was no significant difference in the mortality, which also was very low (20-25%) in the four parallel experiments (Fig. 7). This level of mortality was reached within 18 hours in two of the experiments, and within 28 hours in the other two. Beyond this time the mortality was negligible.

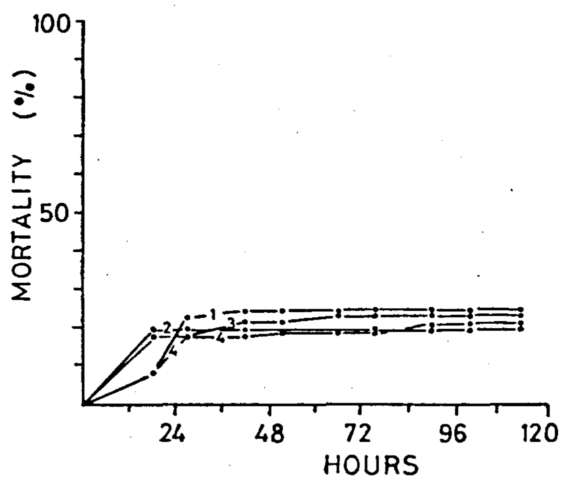

Fig. 7. The cumulative mortality of the mackerel eggs in the four parallel experiments with eggs from natural spawning in the sea.

DISCUSSION AND CONCLUSION

Concerning the egg development the experiments with eggs from live and dead fish in the temperatures 12°, 14°, 16° and 18°C are in good accordance with each other. The disagreement is mostly due to some small variation in the temperatures, which because of the fast egg development would give some differences. In the experiment with eggs from dead fish all the eggs died within the first 24 hours in 20° and 22°C, in contrast with this, eggs from live fish hatched even in those temperatures. It appear therefore that mackerel eggs at least can develop in temperatures up to 22°C. The eggs stripped from dead fish were probably of a poorer quality than those from live fish. Experiments by WORLEY (1933) from the American east coast showed, however, that stripped eggs from living mackerel exposed to 21°C died within 22 hours after fertilization. The difference in temperature tolerance between the present results and WORLEY's could be that the American and European mackerel are two separate races (GARSTAND 1898). In all the experiments the incubation time was rather fast and more or less the same as found by WORLEY (1933) for the American mackerel.

The hatching periode in 15°C with eggs from the sea appeared to be longer than found by WORLEY (1933) in 16°C. All the eggs in his experiment hatched in less than 10 hours compared to 90% of the eggs in 24 hours in the present experiment.

As in the present stripping experiments, the American experiments showed also a high mortality (more than 60%) during the incubation, except in 15° and 16°C (50 and 40%). In his experiments in 10° and 21°C all the eggs died before hatching. Such an optimum temperature as demonstrated by WORLEY was not found in the present material where the mortality was high in all the experiments except in the naturally spawned eggs from the sea. In this experiment, the mortality in the sea (before stage 1aβ) was unknown. A relatively high mortality could be expected in the first hours after the experiments started due to the sampling and handling of the eggs. The mortality, however, terminated more or less within 24 hours and was then only about 20-25%. The temperature in the sea when the eggs were sampled was about 11°C, and the mortality in 12°C with eggs from live and dead fish to the first observed stage 1aγ was respectively 30 and 5%. Even a mortality of that size in the early egg development in the sea would give a rather small total mortality compared with the other experiments with eggs from stripped fish. Sampling newly fertilized mackerel eggs in the sea appear therefore to be a better method than stripping the fish. The reason could partly be that mackerel is a continuous spawner, and therefore a lot of the stripped eggs would not be of a proper quality. The quality of the eggs from the basin appeared not to be good either, possibly because the fish was stressed. They spawned only the first two days, and would not eat for the first 3-4 weeks either.

A poor quality of the stripped eggs could be the reason why no special temperature effect on mortality between 12° and 22°C has been found, if such an effect exist.

SUMMARY

1) From methods were used to fertilize mackerel eggs to investigate egg development and mortality in different temperatures (12° - 27°C). The methods were 1) stripping dead 2) and live fish and 3) natural spawning in a basin 4) and sampling naturally spawned eggs in the sea.

2) The incubation time showed a great variation with temperatures, from about 6 days in 12°C to about 2 days in 22°C.

3) The mortality was high in all the experiments except with naturally spawned eggs from the sea. This appeared to be the best method to get proper mackerel eggs for such experimental purposes.

REFERENCES

DANIELSSEN, D.S. and IVERSEN, S.A. 1974. Egg og larveutvikling hos rødspette (Pleuronectes platessa L.), torsk (Gadus morhua L.) og vårgytende sild (Clupea harengus L.) ved konstante temperaturer. Fisken og Havet Ser. B, 1974 (22): 1-29.

DANIELSSEN, D.S. and IVERSEN, S.A. 1977. Temperaturens innvirkning på utviklingen av naturlig og kunstig befruktete makrellegg (Scomber scombrus L.) Fisken og Havet Ser. B, 1977 (2): 1-18.

GARSTANG, W. 1898. On the variation, races and migrations of the mackerel (Scomber scomber). J.mar.biol.Ass.U.K.,5: 235-295.

IVERSEN, S.A. 1973. Utbredelse og mengde av makrellegg (Scomber scombrus) og zooplankton i Skagerak og nordlige del av Nordsjøen i årene 1968-1972. Hovedoppgave i fiskeribiologi, Norges Fiskerihøgskole Univ. i Bergen 1973: 1-71. [Mimemo.]

WESTERNHAGEN, H. von, 1968. Versuche zur Erbrütung der Eier des Schellfisches (Melanogrammus aeglefinus L.) unter kombinierten Salzgehalts- und Temperaturbedingungen. Ber.dt.wiss.Komm.Meeresforsch 19: 270-287.

WORLEY, L.G. 1933. Development of the egg of the mackerel at different constant temperatures. J.genet.Physiol., 16: 841-857.