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BEHAVIOUR STUDIES ON FISH REACTION TO LONG LINES

by

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INTRODUCTION

This study is a continuation of a field investigation on the behaviour of fish towards long lines, started in 1976 (Fernø et al., 1976, 1977).

The present paper gives an analysis of the effect of current and time of the day on the activity of whiting (Gadus merlangus) and haddock (Melanogrammus aeglefinus).

Further, the influence of hook size and shape on hooking probability are shown.

MATERIALS AND METHODS

The experiments were carried out in Verrabotn in the Trondheimfjord during October 26 - November 3, 1977. The locality is situated close to the Borgenfjord, where the experiments took place in the summer 1977 (Fernø et al., 1977). The present investigation was planned in the Borgenfjord, but the abundance of fish was too low.

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A total of 75 experiments were carried out in Verrabotn at a depth of 40 metres. The main species observed were whiting (Gadus merlangus) and haddock (Melanogrammus aeglefinus). These species could not be separated with certainty under the observation conditions in this study, and were recorded together. It was, however, obvious from the observations as well as from the hooked fish that whiting predominated. The results are considered to be relevant particularly for this species.

The underwater equipment with an underwater camera mounted in an aluminium frame has been described earlier (Fernø et al., 1977). Four snoods, 40 cm long, were attached to the line, 40 cm apart.

In experiments nos. 16-49 one Mustad hook No. 8, one Mustad treble hook No. 5/0, one Mustad hook No. 10 and one Mustad treble hook No. 3/0 were used. In experiments nos. 50-90, Mustad hook No. 10 was used on all four snoods.

The size of the bait on hook No. 10 and treble hook No. 3/0 was 1/4 cross-section of large mackerels, 1 cm thick. For hook No. 8 and treble hook No. 5/0 we used 1/2 cross-section, 1 cm thick. The single hook was baited by penetrating the mackerel skin twice. The treble hook was baited with one piece of mackerel on two of the three hooks. During experiments 50-90, 20 tests were performed with other baits than mackerel (mainly artificial baits). These tests covered the 24-hour cycle and the data were pooled.

The current velocity in a previous study (Fernø et al., 1977) was measured with a current meter giving only one measurement during the first 3 minutes of an experiment. However, both the speed and direction of the current often changed rapidly during one experiment. We therefore observed the movement of planktonic particles, which was easily seen due to reflection of the artificial light.

According to this method the current velocity was divided into 2 categories:

- 1) No particle movement or very slow movement.
- 2) Medium to strong particle movement.

The current speed and direction relative to the line were observed every 5 minutes during the experiments.

The behaviour towards the baited hooks was divided in the following behaviour patterns: Smell response, inhibited bite, bite, jerk and rush. For a general description of the behaviour see Fernø et al., (1977).

A fish was considered hooked if the baited hook was retained in the mouth for more than 30 seconds while the fish were violently fighting to get free, and recorded caught if still hooked at the end of the experiment. The number of fish that came free during hauling was also recorded.

RESULTS

Influence of time of the day and the current.

There was a maximum number of fish attacking the baited hooks in daytime, 7 a.m. - 4 p.m., Fig. 1. The number of hooked fish per time unit was distributed in a similar way within the day. No obvious connection between high and low tide is apparent from the figure.

In Fig. 2 activity is given as the sum of all behaviour patterns directed against the baited hooks. Experiments lasting less than 30 minutes because no free baited hooks were left, are given separately. The other experiments were divided according to the presence of current. The main features in Fig. 2 are the same as in Fig. 1, with a peak of activity around noon.

Fig. 2 also seems to indicate that the activity is higher during experiments with current than without current. When testing this possible difference, the daily rhythm in activity must be taken into account. Therefore the day was divided in two periods: one period with high general activity, from 7 a.m. to 4 p.m., and one period with low general activity, from 4 p.m. to 7 a.m.

Experiments when medium or strong current was observed had a higher number of hooked fish and sum of behaviour patterns than experiments with no current (Table 1). These differences were statistically significant

for the active period ($p < 0.05$), (Mann-Whitney U-test), but not significant for the passive period, although the tendencies were the same. In the same way there was an increase in the number of fish attacking baited hooks when current was present (active period $p < 0.10$, passive period $p < 0.05$). Concerning fish not attacking the baited hooks there was no statistically significant effect of the current. The difference between the active and passive period is also clearly demonstrated.

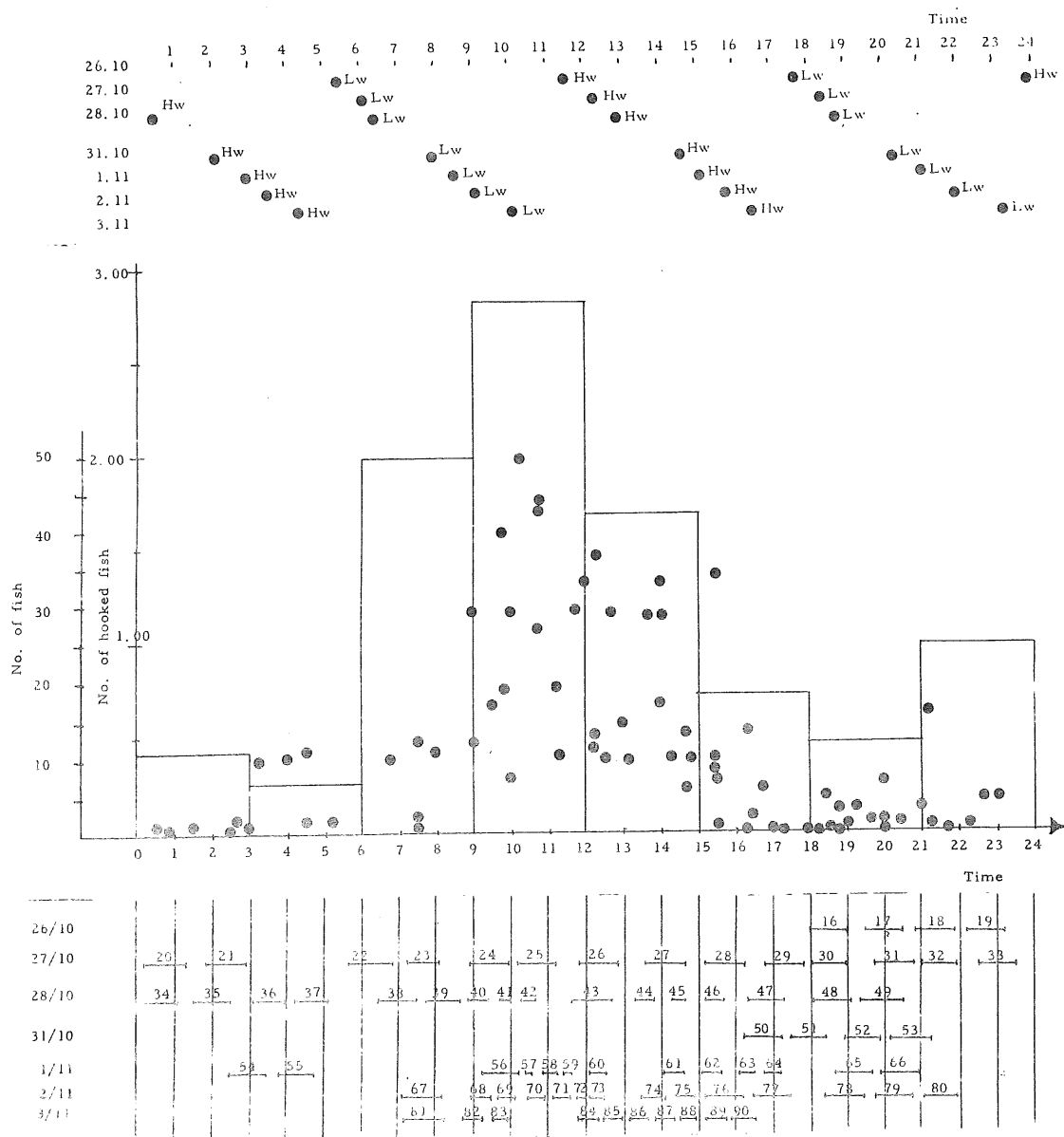


Fig. 1. The number of fish making any kind of behaviour patterns towards the baited hooks during the first 30 minutes of experiment related to the time of the day. - The histogram gives the mean numbers of hooked fish per 30 minutes in periods of 3 hours. - The time of high and low tide is indicated above, and below is given the date and length of the experiments.

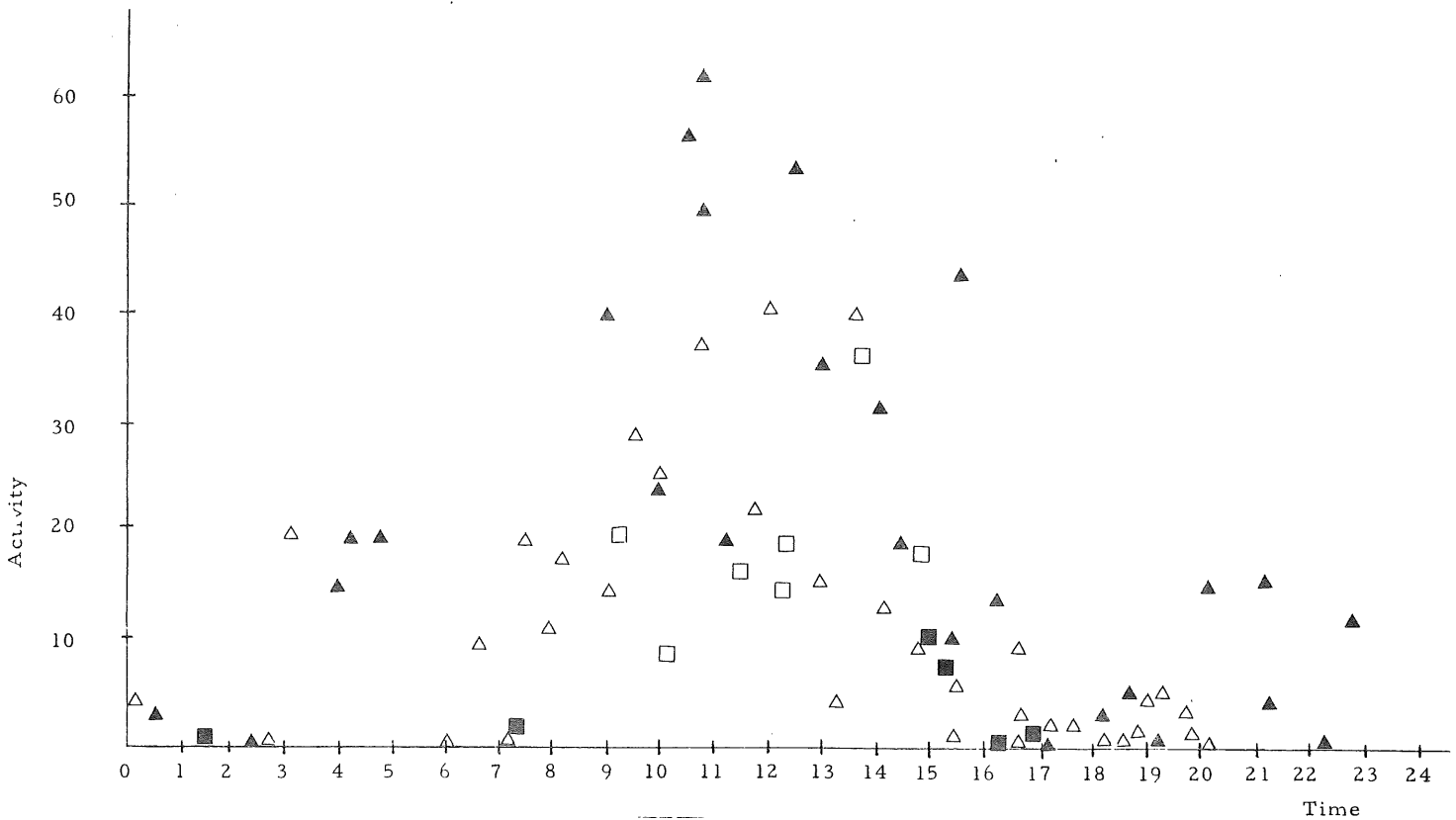


Fig. 2. The sum of all behaviour patterns towards the baited hooks during the first 30 minutes of observations shown against the time of the day.

- ▲ Experiments with current
- △ Experiments without current
- Experiments where strength or direction of current vary
- Experiments lasting less than 30 minutes. The values not adjusted to a 30 minute level.

Table 1. The influence of the current on the number of hooked fish, sum of all behaviour patterns towards the baited hooks, and number of fish attacking/ not attacking the baited hooks during the active and passive period. A mean value per experiment based on the first 30 minutes is given. Experiments lasting less than 10 minutes and experiments with variable current are disregarded.

	Active period		Passive period	
	Current	No current	Current	No current
Hooked fish	2.6	1.5	0.7	0.4
Behaviour patterns	33.6	17.7	9.2	3.8
Fish attacking bait	24.7	16.7	5.4	2.2
Fish not attacking bait	52.0	47.0	9.6	3.6

Twelve of a total of 58 hooked fish during the active period were haddock. During the passive period only whittings were hooked.

Hooking probability.

The hooking probability based upon the number of hooked fish in relation to the number of jerks and rushes was 0.18 in the active period in experiments both with and without current. In the passive period the hooking probability was not significantly different in experiments with (0.14) and without (0.20) current. There was no difference in the hooking probability when the active and passive periods were compared.

The hooking probability was about the same on hook No. 10 (0.15) and hook No. 8 (0.14). There was also about the same hooking probability on the small (0.31) and large (0.27) treble hook.

Not taking hook size into account, the hooking probability of the treble hooks was greater than that of single hooks ($p < 0.001$).

Larger fish were caught on the treble hook No. 3/0 (mean length 39.4 cm) than on the single hook No. 10 (mean length 36.7 cm); ($p < 0.05$). A similar difference existed between treble hook No. 5/0 (mean length 40.0 cm) and single hook No. 8 (mean length 36.3 cm); ($p < 0.001$).

Response strength.

The response strength was estimated as the ratio between the number of behaviour patterns with high intensity (bites, jerks, rushes) and those with low intensity (inhibited bites, smell responses). No difference in response strength was found during periods with and without current in either the active (1.19 and 1.27) or passive (2.44 and 1.96) periods. The response strength was, however, significantly greater during the passive period than the active period ($p < 0.001$).

DISCUSSION

Whiting and haddock were most active during mid-day in October-November in Verrabotn. In the Borgenfjord, situated nearby there was in June-July

one active period in the morning and one in the evening (Fernø et al., 1977). A high morning and evening activity was also found in August in the Jarfjord, East Finnmark, for haddock and dab (Fernø et al., 1976). This change in activity may be due to a seasonal shift in the daily rhythm of feeding behaviour and diurnal vertical migration caused by the change in light intensity. Blaxter and Parrish (1958) showed that whiting in Loch Striven adjusted their vertical depth distribution during the day in accordance with the prevailing light distribution. However, Gordon (1977) points out that different sizes of whiting may have a different vertical migration pattern and that the aspect of diurnal vertical migration of whiting requires further study.

Haddock was only caught during daytime and this could probably be connected to the diurnal vertical migration of this species which is clearly demonstrated by Bagenal (1958) and Beamish (1966).

Superimposed upon this daily rhythm in activity was the effect of the change in current velocity, leading to more hooked fish and higher activity during periods of medium to strong current than periods of no or weak current. The importance of olfaction in perception of food has been demonstrated by several authors c. q. Parker (1910) and Strieck (1924). Steven (1959) showed that fish increased their activity and exploratory feeding behaviour when injecting extremely diluted extracts of prey organisms into the experimental aquaria. Sutterlin (1975) demonstrated that winterflounder (Pseudopleuronectes americanus), mummichog (Fundulus heteroclitus) and Atlantic silverside (Menidia menidia) moved upstream to locate the source of odour attractants, and exhibited feeding behaviour in the vicinity of the outlet, when these compounds were pumped out into the water of their natural habitat. About ninety per cent of whiting attacked bait swam against the current (Fernø et al., 1977). It is therefore good reasons to believe that a strong current velocity transports the odour from bait over a larger distance and would probably attract more fish to the line, than a weak current.

The higher hooking probability of a treble compared to a single hook could be explained by the fact that in order to hook efficiently the point of the hook must have a certain position in the mouth of the fish. The probability to have this position would obviously increase with several hooks in different positions together at the same time.

The difference in response strength but not hooking probability between the periods of high and low activity is not easily explained. Other evidence also suggest that hooking probability is determined by an intricate balance between the properties of the hook and bait and the behaviour of the fish. This will be dealt with in more detail in another context.

SUMMARY

1. Whiting (Gadus merlangus) and haddock (Melanogrammus aeglefinus) showed the most intense feeding activity during daytime in October-November.
2. The effect of current velocity on the feeding activity towards baited hooks is significant.
3. No difference in hooking probability exist between active and passive periods of the day, or between Mustad hook No. 8 and No. 10.

The hooking probability was significantly higher for a treble hook compared to a single hook.

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