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## FISHING EXPERIMENTS WITH AN ALTERNATIVE LONGLINE BAIT BASED ON NYLON BAGS.

by

Svein Løkkeborg
Institute of Fishery Technology Research
Fishing Gear and Methods Division
P.O.Box 1964, 5024 Bergen,
Norway.

**ABSTRACT**

This report describes two fishing trials using an alternative longline bait, one in the fishery for torsk and ling, the other in the fishery for cod and haddock. A bait based on fine-meshed nylon bags as reinforcement and minced raw materials as feeding stimulants was tested. Possible negative effects on the catch rate caused by the nylon bag or the metal clip that closes the bag were investigated. The nylon bag caused a negative effect on the catch rate, while the clip showed no effect.

Adding different types of binders to the bait showed that the binder affects the catchability. Redusing the bait loss from the bags without binding the stimulants too hard proved to be an important property of the binder.

Compared with natural bait, nylon bags containing minced herring gave higher catch rates for torsk, ling and haddock, but lower catch rate for cod.

## INTRODUCTION

Considering that the main bait species represent high quality resources for human consumption, the development of new forms of bait is important. This work has achieved increasing interest as rising bait costs, variable availability and introduction of mechanised baiting systems have made the alternatives more restrictive for fishermen.

Until recently, this work has been concentrated on incorporating feeding stimulants (synthetic chemicals or liquid extracts) into synthetic polymers. Despite many investigations having been carried out to identify the chemical nature of attractants and feeding stimulants for fish, only limited success is evident in the exploitation of this knowledge to produce artificial baits that are as acceptable to fish as natural baits.

The present paper describes a new approach to this problem. The method is based on reinforcing an alternative longline bait with bags made from fine-meshed nylon fabric. In addition to natural prey organisms, raw materials such as fish processing waste and trash fish are suitable as feeding stimulants in this bait.

Possible negative effects on the catch rate caused by the nylon bag and the metal clip that closes the bag were tested. Such effects may explain why this type of bait in earlier experiments has given lower catch rates than natural bait (LØKKEBORG 1986, JOHANNESSEN and LØKKEBORG 1987). Adding binder to the bait has been shown to influence the bait loss and the catchability (LØKKEBORG 1986), and so the properties of different types of binders were compared. Herring were tested as feeding stimulants in the nylon bag.

Two fishing trials were carried out, one in the fishery for torsk (*Brosme brosme*) and ling (*Molva molva*), the other in the fishery for cod (*Gadus morhua*) and haddock (*Melanogrammus aegle-*

*finus*). In Norway these species represent 90% of the total landings attributed to longlining.

## MATERIAL AND METHODS

### Fishing ground and gear.

The fishing trial for torsk and ling was conducted on the coastal banks off Ålesund (Western Norway) in September 1986, and the trial for cod and haddock off the coast of Finnmark (Northern Norway) in November 1986. Both trials were conducted on a longliner operating with bottom set lines in commercial longlining. The soak time varied between 3 and 13 hours in the fishery for torsk and ling, and between 7 and 28 hours in the fishery for cod and haddock.

### Experimental design.

The experiments were based on paired comparison between two types of baits. The experimental longlines were baited with the two baits in clusters of intervals of about 50 similary baited hooks. 1000-3000 hooks were set in each comparison.

The following experiments were carried out to test possible effects on the catch rate caused by the nylon fabric or the metal clip in an alternative bait based on nylon bags closed with clips:

Exp. 1: Bait put in stocking made from nylon fabric compared with standard bait.

Exp. 2: Bait put in stocking closed at each end by a metal clip compared with bait put in stocking.

Exp. 1 was carried out in both fishing trials, while 2 was carried out only in fishing trial for cod and haddock.

Compared with standard bait the effectiveness of nylon bags containing minced mackerel and the following types of binders was tested in the fishery for torsk and ling:

Exp. 3: No binder.
Exp. 4: 2% guar gum.
Exp. 5: 50% gelatin.
Exp. 6: 2% PHB/PHV (93% polyhydroxybutyrate and 7% poly-
        hydroxyvalerate).

Herring were tested as feeding stimulants in the nylon bag in
both fishing trials:
Exp. 7: Nylon bags containing minced herring and guar gum (2%
        in the fishery for torsk and ling and 4% in the
        fishery for cod and haddock, respectively) compared
        with standard bait.

The stockings without clips were made such that they did not
increase the bait size. Stockings closed with clips had to be
made longer than the bait to give room for the clip (Fig. 1).

The baits tested in Exp. 3-7 were made by mincing the raw
material in a mincer and simultaneously adding the binder.
The minced raw material was put into a long nylon stocking by
a filling machine, the stocking being then cut into sections
and closed at each end by a metal clip (Fig. 1).

The binder used in Exp. 5 was prepared by converting a
collagen made from fish skin into gelatin. The concentration
was recommended by the producer (Nils H. Nilsen A.S, Båts-
fjord). The concentrations used in Exp. 4, 6 and 7 were
chosen on the the basis of earlier findings (LØKKEBORG 1986).
A higher concentration was used in the fishery for cod and
haddock because of longer soak time in this fishery (Exp. 7).

Mackerel and squid, in a 2:1 ratio, are normally used in the
fishery for torsk and ling. Because the nylon bags and
stockings were filled with mackerel (except in Exp. 7),
mackerel alone was used as standard bait in Exp. 3, 4, 5 and
6. The catch rates were, however, very low in these experi-
ments, probably because mackerel alone is not as attractive
as when in combination with squid (FRANCO et al. 1987).

Therefore, in Exp. 1 and 7 every third hook were baited with squid both on the standard and the experimental line.

Squid is usually used as bait in the fishery for cod and haddock. Therefore, squid was used as standard bait and bait in stocking in this case.

Data recording.

Data were recorded during hauling of the gear on a portable data terminal (Micronic 445, FLOEN 1985). For every hook that had caught a fish, the species and hooking position (mouth, swallowed or not observed) were recorded. Torsk, ling, cod and haddock lengths were measured (total length) to the nearest cm.

Hooks without catch were classified according to the hook status: hook missing, bait loss, empty nylon bag/stocking, bait remnant and intact bait. Because of bad weather condition during the hauling of the lines in Exp. 1 and 2 in the fishery for cod and haddock, it was difficult to distinguish between empty stocking and stocking containing bait remnant. Empty stockings were therefore recorded as bait remnant and a rough estimate of the proportion of empty stocking made.

## RESULTS

The effect of the nylon bag.

The results are given i Tables 1a-c. Bait in nylon stocking gave significantly higher catch rate for torsk (34%, $p<0.05$, two-tailed binomial test, ZAR 1974) and significantly lower catch rates for cod and haddock (37%, $p<0.001$ and 79%, $p<0.001$, respectively) than the standard bait. For ling there was no difference.

The mean lengths of cod and ling caught on bait in stocking were significantly higher than on standard bait, while there

were no differences for torsk and haddock (two-sample t
test). The length distributions are shown in Fig. 2a-d.

The hooking position for torsk showed that bait in stocking
hooked more fish in the mouth compared with standard bait
(not significant, chi-square analysis, ZAR 1974). There were
no differences for the other species. In addition, the
results showed a difference between the species. There was a
significant proportion of swallowed hook for torsk and cod,
while ling and haddock were hooked mainly in the mouth.

The proportion of bait left on the hooks was higher for bait
in stocking than for standard bait (chi-square analysis).
Furthermore, the bait loss was considerably higher in the
fishery for torsk and ling than in the fishery for cod and
haddock despite a shorter soak time in the former case.

The effect of the clip.

There was no difference in the catch rate for cod between
bait with clip and bait without clip, whereas the catch rate
was 32% lower for haddock caught on bait with clip (Table
2a). Bait with clip caught larger cod than bait without clip,
while there was no such difference for haddock (Fig. 3).
There were no differences in the hooking position, neither
for cod nor haddock (Table 2b).

Bait with clip gave a higher proportion of intact bait and
lower proportion of bait remnant than bait without clip
(Table 2c). There were, however, few empty stockings in the
category "bait remnant" in both cases.

Different types of binders.

Nylon bags containing minced mackerel without binder.

Minced mackerel in nylon bags gave lower catch rates than
standard bait (Table 3a). There were no differences in mean

length or hooking position. Table 3b indicates, however, a lower proportion of swallowed hook for torsk caught on the experimental bait. There were only small differences in the bait status (Table 3c).

**Nylon bags containing minced mackerel and guar gum.**

There were no significant differences between the experimental bait and the standard bait, neither for catch rates, mean length nor hooking position (Table 4a and b). The results indicate, however, about 20% catch decrease for the nylon bags. The nylon bags gave more bait loss compared with the standard bait (Table 4c).

**Nylon bags containing minced mackerel and gelatin.**

The results showed a significant catch decrease for the experimental bait (Table 5a). There were no significant differences in mean length or hooking position, but again the nylon bags gave a lower proportion of torsk that had swallowed the hook (Table 5b).

Furthermore, there was an insignificant bait loss for the nylon bags, while most of the standard baits were lost (Table 5c).

**Nylon bags containing minced mackerel and PHB/PHV.**

There were no differences between the nylon bags and the standard bait, neither for catch rates, mean length nor hooking position (Table 6a and b). The bait loss was, however, significantly greater for the nylon bags (Table 6c).

**Nylon bags containing minced herring and guar gum.**

Nylon bags containing minced herring gave significantly better catch rate for haddock (58%), a not significant catch increase for torsk and ling (24% and 15%, respectively) and a

significant catch decrease for cod (82%, Table 7a). None of
the species showed any differences in their mean lengths. For
cod and haddock the nylon bags gave a significantly higher
proportion of fish that were hooked in the mouth compared
with standard bait (Table 7b). The same tendency is seen for
torsk. Furthermore, the nylon bags gave less bait loss (Table
7c).

## DISCUSSION

Experiment 1 clearly shows that the nylon fabric has a
negative effect on the catch rates for cod and haddock, while
the results for torsk and ling do not demonstrate the same
effect. This difference may partly be explained by the
influence of bait loss.

Bait loss was much more frequent in the fishery for torsk and
ling. When the line was hauled the proportion of intact bait
was 50% higher for bait in stocking compared with standard
bait (18% and 12%, respectively). The data does not indicate
when this difference in bait loss came into being. Some bait
loss occurred as the gear was set, and this was probably less
for bait in stocking. Therefore, there has been a difference
in the fishing power between the two types of bait during the
whole of the active fishing period, probably small at the
beginning and 50% at the end. From this it is not unreason-
able to assume that the difference in bait loss alone is due
to the observed catch increase for torsk (34%), indicating
that the nylon fabric does not effect the catchability for
torsk.

However, the hooking position showed that there was a catch
increase only for torsk hooked in the mouth. A lower propor-
tion of swallowed hook for the nylon bags is also seen in the
other experiments. The hooking position therefore indicates
that a bait reinforced with a nylon bag is not as acceptable
to torsk as a natural bait.

Nylon bags have earlier been reported to give catch decrease for small torsk, while there was no difference in the catch rate for big torsk (JOHANNESSEN and LØKKEBORG 1987). This difference was explained by the fact that the bag made the bait in bag bigger than the standard bait. The same result has been reported for cod (JOHANNESSEN 1984).

Higher fishing power due to less bait loss for bait in stocking did not give any catch increase for ling. This indicates that the nylon fabric has a negative effect on the catchability for ling. The length-frequency distribution indicates that the nylon fabric also effects the selectivity for ling.

For cod and haddock the results clearly demonstrate that the nylon fabric negatively affects the catchability. Such a strong negative effect was not found for torsk and ling, and is not reported in other experiments where possible effects of the nylon fabric have been tested (JOHANNESSEN 1984, JOHANNESSEN and LØKKEBORG 1987).

Earlier fishing experiments with nylon bags filled with minced raw materials gave lower catch decrease for haddock than for cod in comparison with standard bait (LØKKEBORG 1986), whereas the opposite effect was shown in this experiment.

Additional factors may therefore have influenced the results. Even though bait in stocking was of same type as the standard bait, the quality may have been poorer. According to fishermen, boxes of bait from the same consignment may show significant difference in catchability.

Smaller bait size has been demonstrated to increase the efficiency for haddock (JOHANNESSEN 1983, LØKKEBORG 1986), and the bait size may have influenced the results for this species. Due to bait predation the bait size will decrease during the soaking period, and hence the catching power for

haddock increases. Bait predation will not affect the size of bait in stocking in the same way because this bait will still appear big because of the stocking. In addition the bait status showed that the stocking reduced bait predation.

These factors have, especially for haddock, probably affected the observed catch decrease and made the result somewhat unclear. It is, however, most reasonable to assume that the nylon stocking has had negative impact on the catch rate for both cod and haddock.

The results for cod in Experiment 2, with a difference in mean length but equal catch rates, demonstrate an effect of the clip on the selectivity but not the effectivity. The bait size has been shown to effect the selectivity for cod (JOHANNESSEN 1983). Bait with clip was bigger than bait without clip because the stocking had to be made longer for this bait and because the clip reduced the bait predation. Therefore, the difference in selectivity is probably due to the bait size and not the clip.

The fact that bait with clip gave lower catch rate for haddock than bait without clip may also be explained by difference in bait size. Minor reduction in bait size has been shown to give significant increase in catching power for haddock, and experiments using nylon bags gave lower catch decrease for haddock than for cod (LØKKEBORG 1986). This indicates that the clip has had no impact or only a minor impact on the catch rate for haddock.

In conclusion, the experiments demonstrate that the nylon fabric has negative impact on the catching power of a bait using a nylon bag as reinforcement, while the metal clip has no effect.

The experiments with different types of binders clearly demonstrate that the binder affects both the bait status and the catch rate.

Among the experimental baits, nylon bags containing guar gum gave highest catch rate and highest proportion of bait remnant/empty bag, while bags containing gelatin gave lowest catch rate and lowest proportion of bait remnant/empty bag. This indicate that the binder affects the proportion of bait remnant/empty bag which in turn affects the catch rate. A plausible explanation is that binders giving low bait loss have high binding power that leads to a slow rate of release of feeding stimulants and therefore a low catch rate.

Releasing experiments showed that guar gum gave a softer bait with faster rate of release of small particles than a bait containing sodium alginate (LØKKEBORG 1986). Release of small particles may influence the catching power, and explain the promising results for guar gum as binder for this type of bait.

The results of Experiment 3 (nylon bags without binder) are not comparable with the other experimental results because more skinny mackerel were used for the bags in this experiment. The fact that skinny mackerel are regarded as poor bait (BJORDAL 1984), may explain the low catch rate and high proportion of intact bait for nylon bags without binder compared with bags with binder. There was also less bait loss for the standard bait in Experiment 3 compared with the other experiments indicating a general low bait predation in this experiment.

Nylon bags containing minced herring gave higher catch rates for torsk, ling and haddock compared with standard bait. The low catch rate for cod is probably due to lack of critical attractants and stimulants in herring for this species. Low proportion of swallowed hook supports this.

The promising results for three out of the four main species in Norwegian longlining achieved with herring as raw material are interesting considering the present recovery of herring

stocks (ANON. 1986). This resource may therefore prove to be a suitable raw material in a bait based on nylon bags as reinforcement.

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**Table 1a.** Comparison of bait in nylon stocking (E) and standard bait (S). Catch and length data.

| Species | Bait type | Catch | | | | Length (cm) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | No. | Rate | Diff.% | p | Mean | Conf.95% | No. | p |
| Torsk[a] | S | 94 | 8.9 | +34.4 | <0.05 | 51.0 | 1.3 | 95 | >0.5 |
| | E | 125 | 11.9 | | | 51.5 | 1.1 | 129 | |
| Ling[a] | S | 41 | 3.9 | -6.3 | >0.5 | 87.7 | 3.9 | 40 | <0.05 |
| | E | 38 | 3.6 | | | 94.1 | 4.6 | 40 | |
| Total[a] | S | 150 | 14.2 | +17.9 | >0.1 | | | | |
| | E | 175 | 16.7 | | | | | | |
| Cod[b] | S | 516 | 34.1 | -36.9 | <0.001 | 60.9 | 0.7 | 504 | <0.05 |
| | E | 299 | 21.5 | | | 62.2 | 0.8 | 303 | |
| Haddock[b] | S | 199 | 13.2 | -78.7 | <0.001 | 46.1 | 0.9 | 180 | >0.5 |
| | E | 39 | 2.8 | | | 46.8 | 1.7 | 42 | |
| Total[b] | S | 725 | 48.0 | -48.0 | <0.001 | | | | |
| | E | 346 | 24.9 | | | | | | |

[a] The fishery for torsk and ling.
[b] The fishery for cod and haddock.

**Table 1b.** Hooking position for torsk, ling, cod and haddock caught on bait in nylon stocking and standard bait.

| Species | Bait type | Mouth | | Swallowed | | Not obs. | | p |
|---|---|---|---|---|---|---|---|---|
| | | % | No. | % | No. | % | No. | |
| Torsk[a] | Standard | 69.1 | 65 | 22.3 | 21 | 8.5 | 8 | >0.1 |
| | Stocking | 80.0 | 100 | 14.4 | 18 | 5.6 | 7 | |
| Ling[a] | Standard | 87.8 | 36 | 0.0 | 0 | 12.0 | 5 | >0.25[c] |
| | Stocking | 78.9 | 30 | 0.0 | 0 | 21.1 | 8 | |
| Cod[b] | Standard | 35.1 | 181 | 51.2 | 264 | 13.8 | 71 | >0.25 |
| | Stocking | 30.1 | 90 | 56.9 | 170 | 13.0 | 39 | |
| Haddock[b] | Standard | 78.4 | 156 | 7.5 | 15 | 14.1 | 28 | >0.25 |
| | Stocking | 76.9 | 30 | 2.6 | 1 | 20.5 | 8 | |

[a] The fishery for torsk and ling.
[b] The fishery for cod and haddock.
[c] The category "swallowed" is not included in the test.

Table 1c. Bait status for bait in nylon stocking and standard bait.

| Bait type | Intact | | Remnant | | Empty | | Loss | | p |
|---|---|---|---|---|---|---|---|---|---|
| | % | No. | % | No. | % | No. | % | No. | |
| Standard[a] | 11.7 | 106 | 8.6 | 78 | 0.0 | 0 | 79.7 | 722 | <0.005 |
| Stocking[a] | 17.7 | 153 | 9.7 | 84 | 24.7 | 214 | 47.9 | 415 | |
| Standard[b] | 51.7 | 358 | 4.5 | 31 | — | — | 43.8 | 303 | <0.001 |
| Stocking[b] | 75.9 | 767 | 18.9 | 191 | — | — | 5.2 | 53 | |

[a] The fishery for torsk and ling.
[b] The fishery for cod and haddock.

Table 2a. Comparison of bait in nylon stocking closed with clips (E) and bait in nylon stocking without clips (S). Catch and length data.

| Species | Bait type | Catch | | | | Length (cm) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | No. | Rate | Diff.% | p | Mean | Conf.95% | No. | p |
| Cod | S | 175 | 12.4 | +1.2 | >0.5 | 60.8 | 1.2 | 179 | <0.05 |
| | E | 168 | 12.6 | | | 62.6 | 1.1 | 173 | |
| Haddock | S | 97 | 6.9 | -31.6 | <0.05 | 44.6 | 1.0 | 99 | >0.1 |
| | E | 63 | 4.7 | | | 45.9 | 1.3 | 53 | |
| Total | S | 277 | 19.6 | -10.6 | >0.1 | | | | |
| | E | 235 | 17.6 | | | | | | |

Table 2b. Hooking position for cod and haddock caught on bait in nylon stocking closed with clips and bait in nylon stocking without clips.

| Species | Bait type | Mouth | | Swallowed | | Not obs. | | p |
|---|---|---|---|---|---|---|---|---|
| | | % | No. | % | No. | % | No. | |
| Cod | Without clips | 33.7 | 59 | 52.6 | 92 | 13.7 | 24 | >0.25 |
| | With clips | 36.9 | 62 | 53.6 | 90 | 9.5 | 16 | |
| Haddock | Without clips | 77.3 | 75 | 5.2 | 5 | 17.5 | 17 | >0.5[a] |
| | With clips | 84.1 | 53 | 3.2 | 2 | 12.7 | 8 | |

[a] The category "swallowed" is not included in the test.

Table 2c. Bait status for bait in nylon stocking closed with clips and bait in nylon stocking without clips.

| Bait type | Intact | | Remnant | | Loss | | p |
|---|---|---|---|---|---|---|---|
| | % | No. | % | No. | % | No. | |
| Without clips | 76.3 | 838 | 19.8 | 218 | 3.9 | 43 | <0.001 |
| With clips | 94.6 | 1014 | 3.1 | 33 | 2.3 | 25 | |

**Table 3a.** Comparision of nylon bags containing minced mackerel without binder (E) and standard bait (S). Catch and length data.

| Species | Bait type | Catch | | | | Length (cm) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | No. | Rate | Diff.% | p | Mean | Conf.95% | No. | p |
| Torsk | S | 115 | 7.4 | -45.3 | <0.001 | 53.3 | 1.4 | 113 | >0.5 |
| | E | 61 | 4.1 | | | 52.8 | 2.4 | 60 | |
| Ling | S | 32 | 2.1 | -32.3 | >0.1 | 95.0 | 5.3 | 32 | >0.5 |
| | E | 21 | 1.4 | | | 94.7 | 5.9 | 19 | |
| Total | S | 165 | 10.6 | -31.3 | <0.005 | | | | |
| | E | 110 | 7.3 | | | | | | |

**Table 3b.** Hooking position for torsk and ling caught on nylon bags containing minced mackerel without binder and standard bait.

| Species | Bait type | Mouth | | Swallowed | | Not obs. | | p |
|---|---|---|---|---|---|---|---|---|
| | | % | No. | % | No. | % | No. | |
| Torsk | Standard | 42.6 | 49 | 50.4 | 58 | 7.0 | 8 | >0.1 |
| | Bags | 59.0 | 36 | 36.1 | 22 | 4.9 | 3 | |
| Ling | Standard | 93.8 | 30 | 3.1 | 1 | 3.1 | 1 | >0.5[a] |
| | Bags | 100.0 | 20 | 0.0 | 0 | 0.0 | 0 | |

[a] Only the category "mouth" is included in the test.

**Table 3c.** Bait status for nylon bags containing minced mackerel without binder and standard bait.

| Bait type | Intact | | Remnant | | Empty | | Loss | | p |
|---|---|---|---|---|---|---|---|---|---|
| | % | No. | % | No. | % | No. | % | No. | |
| Standard | 19.1 | 264 | 10.4 | 144 | 0.0 | 0 | 70.5 | 975 | <0.001 |
| Bags | 22.6 | 315 | 5.7 | 80 | 46.1 | 642 | 25.5 | 355 | |

Table 4a. Comparison of nylon bags containing minced mackerel and 2% guar gum (E) and standard bait (S). Catch and length data.

| Spesiec | Bait type | Catch | | | | Length (cm) | | | |
|---------|-----------|-------|------|--------|------|------|-----------|------|--------|
| | | No. | Rate | Diff.% | p | Mean | Conf.95% | No. | p |
| Torsk | S | 62 | 8.1 | -12.8 | >0.5 | 54.3 | 1.6 | 63 | >0.05 |
| | E | 53 | 7.1 | | | 52.2 | 1.5 | 52 | |
| Ling | S | 10 | 1.3 | -28.6 | >0.5 | 85.6 | 6.2 | 11 | >0.25 |
| | E | 7 | 0.9 | | | 90.1 | 14.7 | 7 | |
| Total | S | 81 | 10.6 | -20.7 | >0.5 | | | | |
| | E | 63 | 8.4 | | | | | | |

Table 4b. Hooking position for torsk and ling caught on nylon bags containing minced mackerel and 2% guar gum and standard bait.

| Species | Bait type | Mouth | | Swallowed | | Not obs. | | p |
|---------|-----------|-------|------|-----------|------|----------|------|---|
| | | % | No. | % | No. | % | No. | |
| Torsk | Standard | 48.4 | 30 | 46.8 | 29 | 4.8 | 3 | >0.5[a] |
| | Bags | 50.9 | 27 | 39.6 | 21 | 9.4 | 5 | |
| Ling | Standard | 90.0 | 9 | 10.0 | 1 | 0.0 | 0 | >0.5[b] |
| | Bags | 85.7 | 6 | 14.3 | 1 | 0.0 | 0 | |

[a] The category "not observed" is not included in the test.
[b] Only the category "mouth" included in the test.

Table 4c. Bait status for nylon bags containing minced mackerel and 2% guar gum and standard bait.

| Bait type | Intact | | Remnant | | Empty | | Loss | | p |
|-----------|--------|-----|---------|-----|-------|-----|------|-----|---|
| | % | No. | % | No. | % | No. | % | No. | |
| Standard | 10.1 | 69 | 13.8 | 94 | 0.0 | 0 | 76.1 | 518 | <0.001 |
| Bags | 3.9 | 27 | 1.8 | 12 | 65.9 | 451 | 28.4 | 194 | |

**Table 5a.** Comparison of nylon bags containing minced mackerel and 50% gelatin (E) and standard bait (S). Catch and length data.

| Species | Bait type | Catch | | | | Length (cm) | | | |
|---------|-----------|-------|------|--------|----------|------|-----------|------|-------|
| | | No. | Rate | Diff.% | p | Mean | Conf.95% | No. | p |
| Torsk | S | 40 | 7.7 | −52.2 | <0.01 | 51.9 | 2.7 | 42 | >0.25 |
| | E | 19 | 3.7 | | | 50.1 | 4.3 | 19 | |
| Ling | S | 7 | 1.4 | −85.6 | >0.05 | 91.8 | 14.5 | 6 | >0.25 |
| | E | 1 | 0.2 | | | 74.0 | − | 1 | |
| Total | S | 47 | 9.1 | −57.2 | <0.005 | | | | |
| | E | 20 | 3.9 | | | | | | |

**Table 5b.** Hooking position for torsk and ling caught on nylon bags containing minced mackerel and 50% gelatin and standard bait.

| Species | Bait type | Mouth | | Swallowed | | Not obs. | | p |
|---------|-----------|-------|-----|-----------|-----|----------|-----|------|
| | | % | No. | % | No. | % | No. | |
| Torsk | Standard | 35.0 | 14 | 40.0 | 16 | 25.0 | 10 | >0.25 |
| | Bags | 57.9 | 11 | 26.3 | 5 | 15.8 | 3 | |
| Ling | Standard | 100.0 | 7 | 0.0 | 0 | 0.0 | 0 | |
| | Bags | 100.0 | 1 | 0.0 | 0 | 0.0 | 0 | a |

[a] The sample size is not sufficiently large for an unbiased chi-square calculation.

**Table 5c.** Bait status for nylon bags containing minced mackerel and 50% gelatin and standard bait.

| Bait type | Intact | | Remnant | | Empty | | Loss | | p |
|-----------|--------|-----|---------|-----|-------|-----|------|-----|--------|
| | % | No. | % | No. | % | No. | % | No. | |
| Standard | 6.9 | 32 | 4.8 | 22 | 0.0 | 0 | 88.3 | 408 | <0.001 |
| Bags | 93.5 | 462 | 1.2 | 6 | 0.0 | 0 | 5.3 | 26 | |

**Table 6a.** Comparison of nylon bags containing minced mackerel and 2% PHB/PHV (E) and standard bait (S). Catch and length data.

| Species | Bait type | Catch | | | | Length (cm) | | | |
|---------|-----------|-----|------|--------|------|------|------------|-----|-------|
| | | No. | Rate | Diff.% | p | Mean | Conf.95% | No. | p |
| Torsk | S | 68 | 4.7 | -1.5 | >0.5 | 52.4 | 1.6 | 69 | >0.25 |
| | E | 63 | 4.6 | | | 51.5 | 1.7 | 59 | |
| Ling | S | 19 | 1.3 | -16.1 | >0.5 | 92.8 | 6.1 | 21 | >0.5 |
| | E | 15 | 1.1 | | | 91.2 | 6.8 | 16 | |
| Total | S | 97 | 6.6 | -3.6 | >0.5 | | | | |
| | E | 88 | 6.4 | | | | | | |

**Table 6b.** Hooking position for torsk and ling caught on nylon bags containing minced mackerel and 2% PHB/PHV and standard bait.

| Species | Bait type | Mouth | | Swallowed | | Not obs. | | p |
|---------|-----------|-------|-----|-----------|-----|----------|-----|---|
| | | % | No. | % | No. | % | No. | |
| Torsk | Standard | 73.5 | 50 | 23.5 | 16 | 2.9 | 2 | >0.5[a] |
| | Bags | 73.0 | 46 | 25.4 | 16 | 1.6 | 1 | |
| Ling | Standard | 73.7 | 14 | 10.5 | 2 | 15.8 | 3 | >0.5[b] |
| | Bags | 100.0 | 14 | 0.0 | 0 | 0.0 | 0 | |

[a] The category "not observed" is not included in the test.
[b] Only the category "mouth" is included in the test.

**Table 6c.** Bait status for nylon bags containing minced mackerel and 2% PHB/PHV and standard bait.

| Bait type | Intact | | Remnant | | Empty | | Loss | | p |
|-----------|--------|-----|---------|-----|-------|-----|------|-----|---|
| | % | No. | % | No. | % | No. | % | No. | |
| Standard | 20.6 | 280 | 12.4 | 168 | 0.0 | 0 | 67.0 | 910 | <0.001 |
| Bags | 4.5 | 58 | 4.0 | 52 | 63.2 | 812 | 28.2 | 362 | |

Table 7a. Comparison of nylon bags containing minced herring and guar gum (E) and standard bait (S). Catch and length data.

| Species | Bait type | Catch | | | | Length (cm) | | | |
|---------|-----------|------|------|--------|---------|------|-----------|------|--------|
| | | No. | Rate | Diff.% | p | Mean | Conf.95% | No. | p |
| Torsk[a] | S | 47 | 3.1 | +24.4 | >0.25 | 51.8 | 1.9 | 49 | >0.25 |
| | E | 59 | 3.9 | | | 52.9 | 2.2 | 60 | |
| Ling[a] | S | 44 | 2.9 | +14.8 | >0.5 | 95.2 | 5.0 | 41 | >0.5 |
| | E | 51 | 3.4 | | | 97.4 | 5.1 | 52 | |
| Total[a] | S | 111 | 7.4 | +12.5 | >0.25 | | | | |
| | E | 126 | 8.3 | | | | | | |
| Cod[b] | S | 352 | 27.4 | −81.5 | <0.001 | 62.0 | 0.8 | 357 | >0.1 |
| | E | 64 | 5.1 | | | 63.7 | 2.9 | 66 | |
| Haddock[b] | S | 173 | 13.4 | +58.3 | <0.001 | 47.6 | 1.0 | 158 | >0.5 |
| | E | 269 | 21.3 | | | 47.7 | 0.8 | 236 | |
| Total[b] | S | 531 | 41.3 | −32.7 | <0.001 | | | | |
| | E | 351 | 27.8 | | | | | | |

[a] The fishery for torsk and ling.
[b] The fishery for cod and haddock.

Table 7b. Hooking position for torsk, ling, cod and haddock caught on nylon bags containing minced herring and guar gum and standard bait.

| Species | Bait type | Mouth | | Swallowed | | Not obs. | | p |
|---------|-----------|-------|-----|-----------|-----|----------|-----|---|
| | | % | No. | % | No. | % | No. | |
| Torsk[a] | Standard | 40.4 | 19 | 48.9 | 23 | 10.6 | 5 | >0.1[c] |
| | Bags | 61.0 | 36 | 37.3 | 22 | 1.7 | 1 | |
| Ling[a] | Standard | 93.2 | 41 | 4.5 | 2 | 2.3 | 1 | >0.5[d] |
| | Bags | 88.2 | 45 | 3.9 | 2 | 7.8 | 4 | |
| Cod[b] | Standard | 38.4 | 135 | 51.7 | 182 | 9.9 | 35 | <0.001 |
| | Bags | 65.6 | 42 | 23.4 | 15 | 10.9 | 7 | |
| Haddock[b] | Standard | 86.1 | 149 | 6.9 | 12 | 6.9 | 12 | <0.001 |
| | Bags | 93.3 | 251 | 0.4 | 1 | 6.3 | 17 | |

[a] The fishery for torsk and ling.
[b] The fishery for cod and haddock.
[c] The category "not observed" is not included in the test.
[d] Only the category "mouth" is included in the test.

**Table 7c.** Bait status for nylon bags containing minced herring and guar gum and standard bait.

| Bait type | Intact | | Remnant | | Empty | | Loss | | p |
|---|---|---|---|---|---|---|---|---|---|
| | % | No. | % | No. | % | No. | % | No. | |
| Standard[a] | 40.4 | 562 | 4.4 | 61 | 0.0 | 0 | 55.2 | 767 | <0.005 |
| Bags[a] | 47.5 | 655 | 3.8 | 53 | 18.0 | 248 | 30.7 | 423 | |
| Standard[b] | 62.3 | 423 | 3.7 | 25 | 0.0 | 0 | 34.0 | 231 | <0.001 |
| Bags[b] | 68.1 | 557 | 21.5 | 176 | 2.3 | 19 | 8.1 | 66 | |

[a] The fishery for torsk and ling.
[b] The fishery for cod and haddock.

a        b        c        d
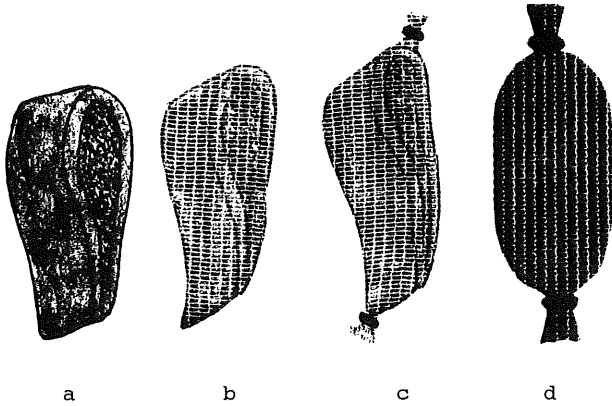
**Fig. 1.** Different types of baits: (a) standard bait (squid), (b) squid bait put in stocking, (c) squid bait put in stocking closed with clips and (d) nylon bag containing minced raw material.
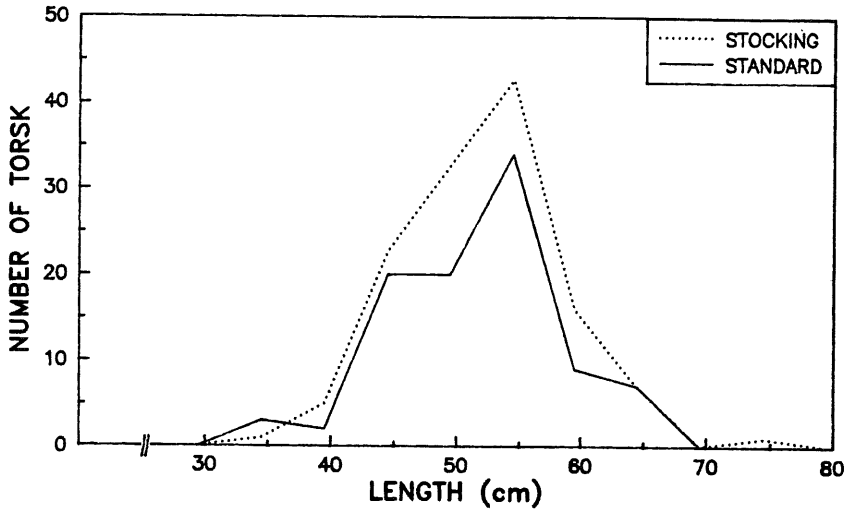
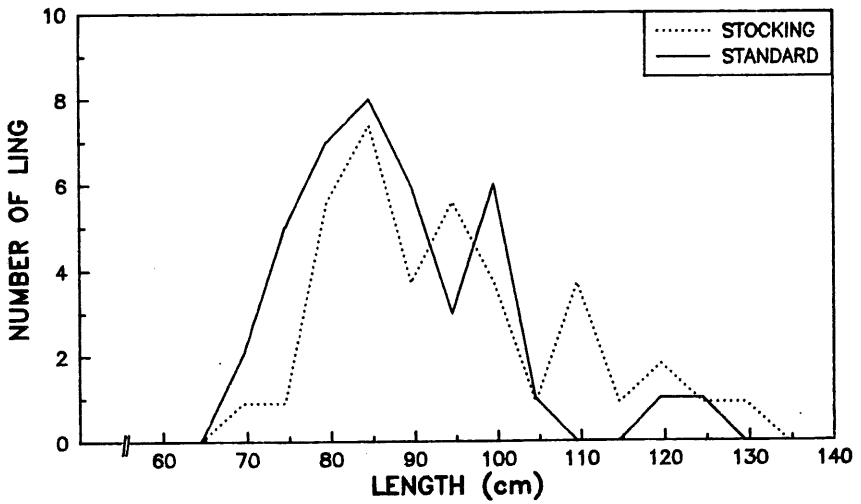Fig. 2a. Length-frequency distributions of torsk caught on bait in nylon stocking and standard bait.



Fig. 2b. Length-frequency distributions of ling caught on bait in nylon stocking and standard bait.
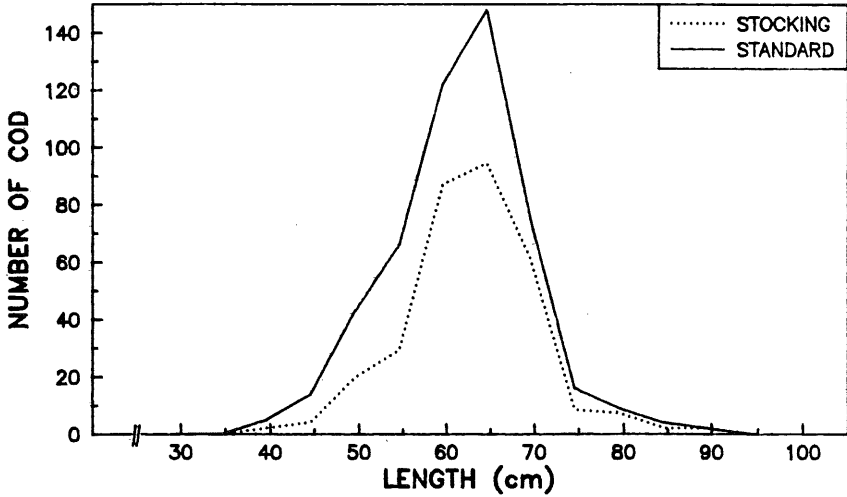
**Fig. 2c.** Length-frequency distributions of cod caught on bait
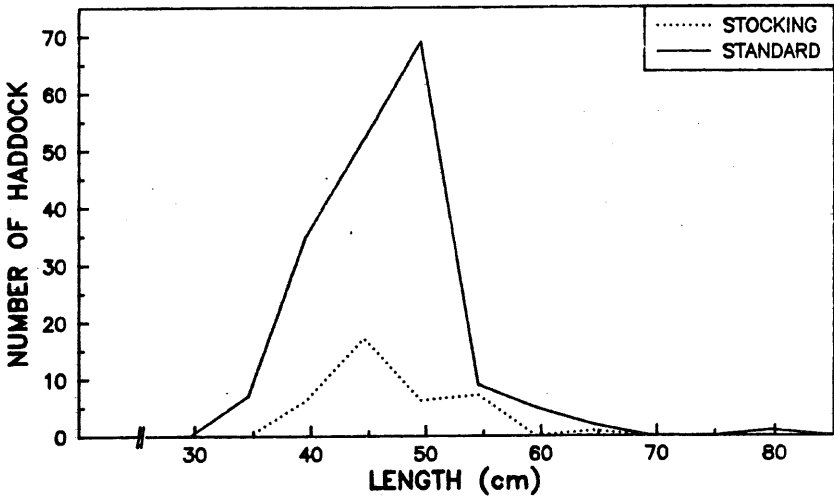in nylon stocking and standard bait.



**Fig. 2d.** Length-frequency distributions of haddock caught on
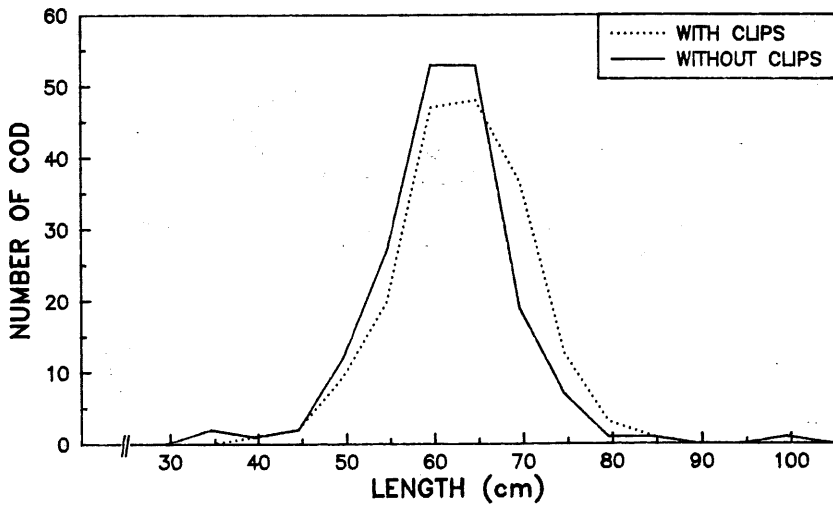bait in nylon stocking and standard bait.

**Fig. 3.** Length-frequency distributions of cod caught on bait in nylon stocking closed with clips and bait in stocking without clips.