International Council for the
Exploration of the Sea

C.M. 1977/B:42
Gear and Behaviour Committee
Ref. Demersal Fish (N) Cttee

Studies on the behaviour of some gadoid species in relation to traps

by

J.W. Valdemarsen[x], A. Fernø[xx] and A. Johannessen[xx]

INTRODUCTION

Fish behaviour around and within traps has previously been studied using scuba diving from an undersea habitat (HIGH & BEARDSLEY 1970, HIGH & ELLIS 1973). In connection with developing traps for catching demersal fish in Norway (VALDEMARSEN 1976), some preliminary studies of the behaviour of cod, haddock and whiting in and near traps have been made using underwater television. Special emphasis has been laid on how the direction of the current and the presence of bait influence the behaviour of the fish.

MATERIALS AND METHODS

The observations on behaviour of fish around and within traps were carried out with the aid of a low-light underwater television camera (Hydro Products TC-125 SIT-W) at depths between

x) Institute of Fishery Technology Research,
Box 1964, N-5011 Bergen-Nordnes, Norway

xx) Department of Fisheries Biology,
University of Bergen,
Box 1839, N-5011 Bergen-Nordnes, Norway

25 and 35 m in the Skogsvåg near Bergen (test S1-S4) and the Varangerfjord, northern Norway (test V1-V8). The experiments were conducted during March - April and July - August 1976.

The trap, which was rectangular in shape measuring 75 x 75 x 200 cm, was constructed of an aluminium frame and covered by a black nylon net (60 mm mesh size). In most of the experiments the entrance funnel was mounted in the front part of the trap, with a second funnel about 50 cm posterior to it inside the trap. During the tests S4, V1 and V8, the entrance funnel at the end was replaced by a funnel at the top of the trap , anterior to the inside funnel. In the tests V6 and V7 the trap was equipped with both kinds of entrance funnels. Bait bags, when used, were attached to the funnel part of the trap. The trap was tied to an aluminium bottom frame (weight 20 kg) (Fig. 1). A small meshed nylon net, which covered an area of about 2.5 x 5 m, was mounted to the bottom frame in order to give better contrast between the dorsal side of the fish and the background.

The camera was mounted within an aluminium frame held in a fixed position about two meters above the trap, pointing vertically down. The area of observation comprised about 4 x 5 m (20 m^2) with the trap in center position.

Continuous recordings of the direction of the current relative to the trap were carried out with the aid of a current indicator, a white piece of plastic kept buoyant by a small float. The observations were interrupted for some hours during the night (11 p.m. - 3 a.m.) due to too bad light conditions. The most interesting sequences were recorded on videotape for a more detailed analysis.

Fish entering the area of observation with a component opposite to the direction of the current were recorded as A1, and fish entering with a component in the direction of the current were recorded as A2. The sum of A1 and A2 is designated as A. Fish interested in the trap, indicated by alteration of direction and/or speed of swimming in the area of observation were recorded

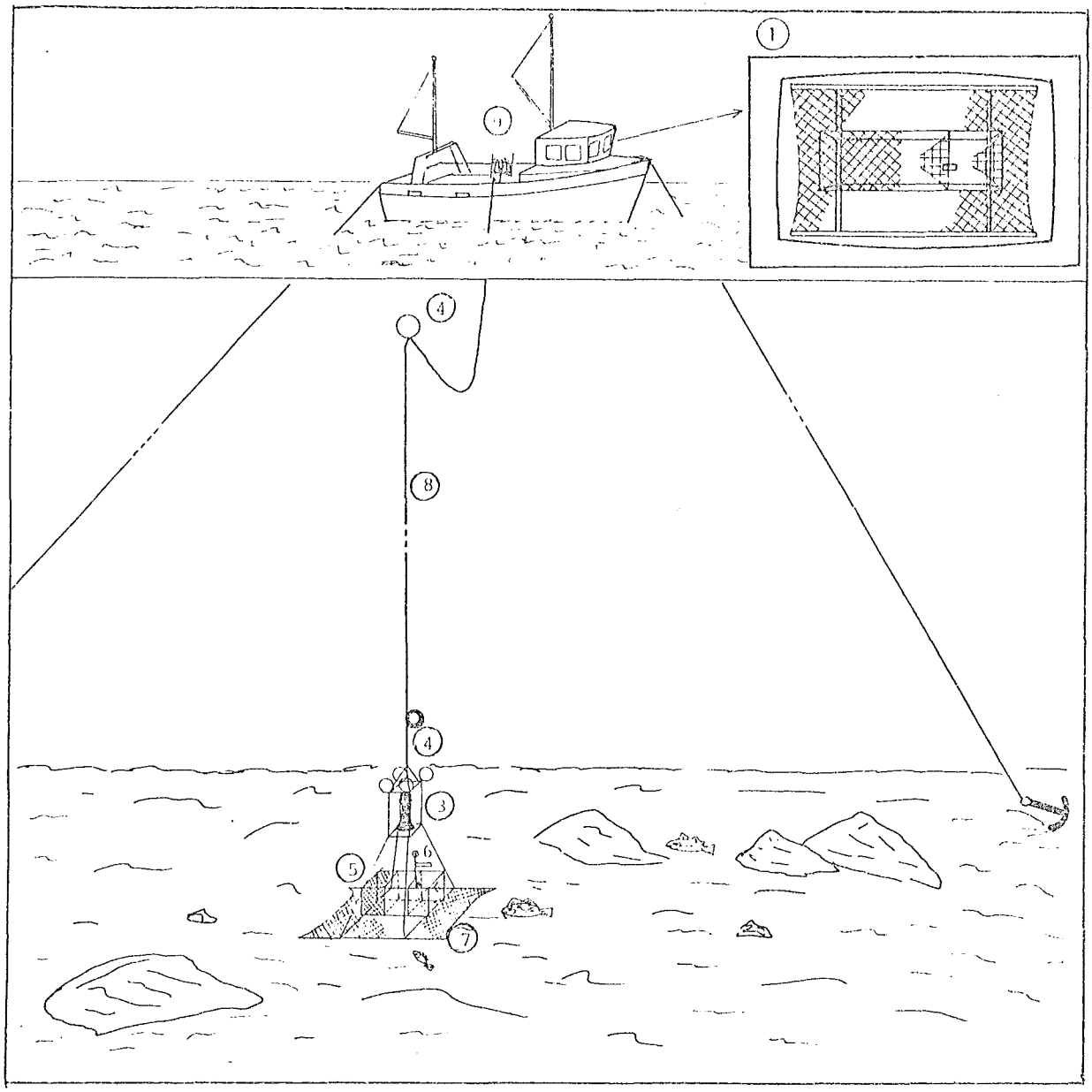

Fig. 1. Equipment used.
1) Area of observation as seen on the monitor,
2) UTV-camera in an aluminium frame,
4) 8" plastic floats, 5) Trap, 6) Indicator of current direction, 7) Bottom frame with contrast net, 8) Cable and 9) Cable drum.

as I. Fish butting against the funnel part were recorded as B1, and fish butting against the posterior half of the trap were recorded as B2. The direction of the current is designated as α, β and γ, referring to whether the current is directed opposite to the entrance direction, at right angles

to it or in the same direction as the entrance direction. Directions of the current in between those mentioned were pooled as belonging to one of the nearest main groups (α, β or γ).

RESULTS.

Some basic data from the experiment are given in Table 1. In the Varangerfjord haddock and cod dominated the catches. The overall catch was small. The mean number of fish in the traps was 1.33 with a mean fishing time of 20.0 hours. Apart from the relatively low probability for fish to enter the trap, discussed in more detail later on, this was probably due to the small size of many fish leading to escape through the meshes.

Table 1. Data from the tests in the Skogsvåg (S1-S4) and in the Varangerfjord (V1-V8).

Test	Bait	Depth (meters)	Fishing time (hrs)	Observation time (hrs)	Catch
S1	Mackerel	25	19	7.0	Whiting 1 Cod 1
S2	Crab	35	25	11.0	Whiting 4 Haddock 1
S3	Mackerel	35	23	10.0	Whiting 1
S4	Herring	30	43	8.3	Cod 1
V1	Cod	35	13	12.3	-
V2	Mackerel	30	23	11.0	-
V3	-	30	16	4.5	-
V4	Mackerel	35	13	10.0	-
V5	Mackerel	25	32	19.0	Haddock 3 Cod 1
V6	Mackerel	25	3.5	3.5	Cod 1
V7	Mackerel	25	8	8.0	Haddock 1
V8	Mackerel	25	22	10.8	-

When observing the behaviour of the fish it was usually not possible to determine the exact species; consequently whiting, cod and haddock were regarded together. The number of fish observed during the different tests varied considerably (Table 2),

even if the different times of observation are taken into account. The percentage of fish showing further interest in the trap was on the other hand relatively constant in most of the tests. The ratio I/A was between 70.3% and 91.2% in eight experiments using mackerel as bait, while the ratio B/A was between 10.9% and 68.4%. Bait of cod seems to be less effective (I/A = 46.4%; B/A = 2.9%). When using no bait, few fish were interested (28.8%) and no fish butted against the net. This test (V3) is best compared with the test V2 with bait of mackerel as these tests were carried out under similar conditions on successive days. The striking difference between these tests clearly demonstrates the importance of the bait.

Table 2. General activity (A), number of fish showing interest in the trap (I) and number of fish butting against the net (B) in the different tests.

Test	S1	S2	S3	S4	V1	V2	V3	V4	V5	V6	V7	V8
A	19	73	38	30	207	295	52	91	31	13	120	64
I	17	57	34	18	96	269	15	66	25	13	89	
B	13	37	17	10	6	160	-	56	20	5	45	7

The most critical event in trapping fish is the passing through the entrance funnel. Due to difficulties in observing fish within a trap and also due to the small size of some fish enabling them to pass through the meshes, it was not possible to obtain quantitative data for each test here. It is, however, clear that most fish butted against the net without coming into closer contact with the first funnel. On the other side, if a fish swam into the funnel, the probability of entering the trap was relatively high. In one test 6 out of 14 attempts to pass the first funnel were successful.

Fish could sometimes pass through the second funnel directly after having passed the first one. If the fish did not pass on directly it often swam relatively slowly for a period of 1 - 2 minutes, then becoming more active for a period of 10 - 30 minutes. No special interest was directed towards the bait. Usually the fish swam through the second funnel during this

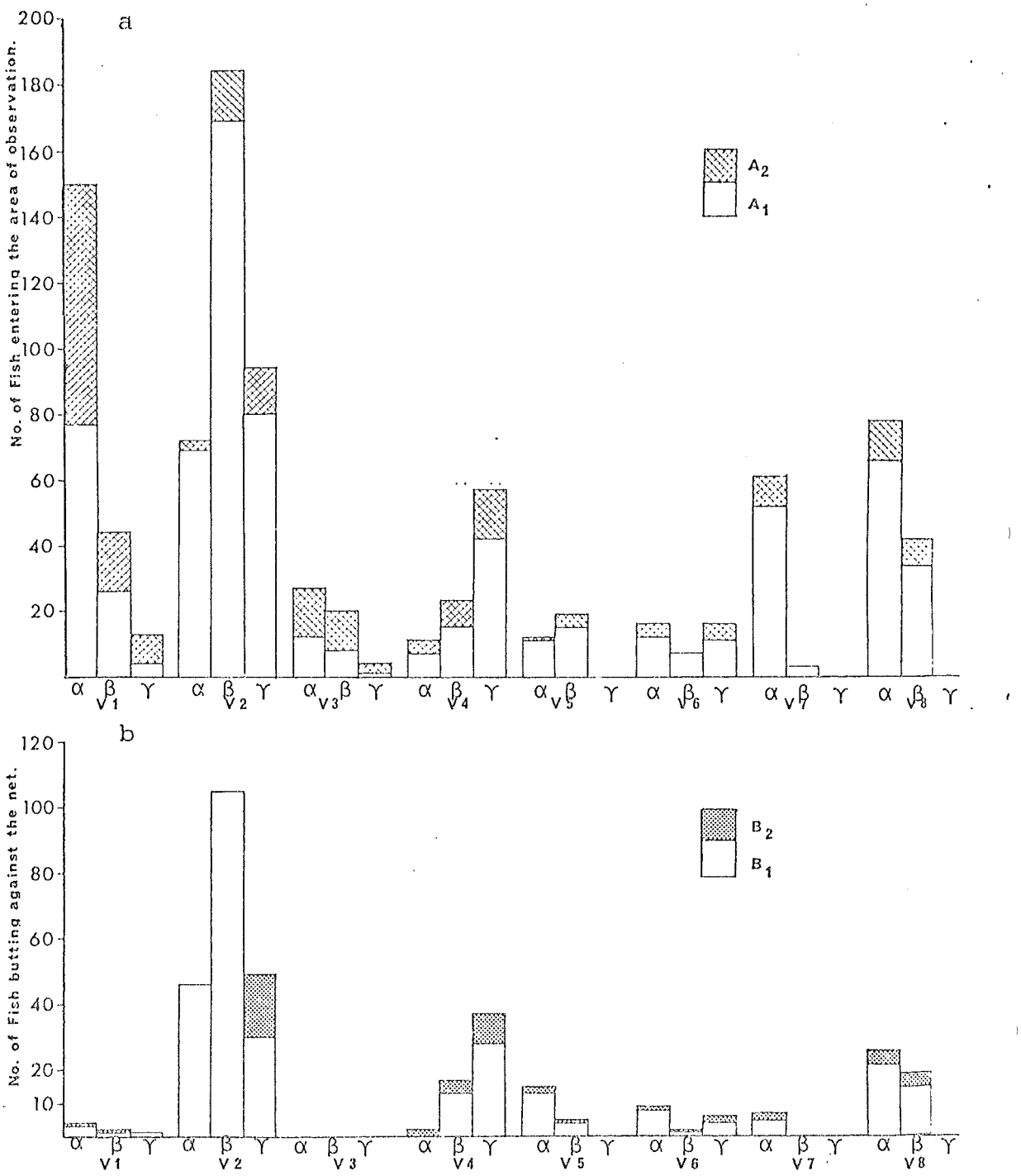

Fig. 2a. Number of fish entering the area of observation in the same (A2) or in the opposite of the direction of the current (A1) for each test.

b. Number of fish butting against the funnel part (B1) or the end part (B2) of the trap relative to the direction of the current. α, β and γ refer to the direction of the current relative to the trap, defined on page 3. V1, V2...V8 refer to the test number.

active period. The stay in the first room lasted from 5 seconds to 4 hours. Fish were seldom observed to leave the trap through the first funnel and were never observed to escape through the narrow second funnel.

The majority of fish entered the area of observation opposite to the direction of the current, regardless of the position of the trap (Fig. 2a). The attraction of fish to a trap baited with fresh cod (test V1), or an unbaited trap (V3) seems to be random relative to the direction of the current.

The number of fish butting against the net was greater to leeward of the bait independent upon the position of the trap relative to the direction of the current (Fig. 2b). The greater B1 frequency during most of the tests can be explained by the position of the bait in the funnel part of the trap. The lack of interest of fish to an unbaited trap is indicated in Fig. 2b (V3).

DISCUSSION.

The purpose of these observations were to achieve continuous recordings of movements of the fish in relation to the entrance funnel of the trap and the direction of the current.

The advantages of this kind of observation method compared to the direct observations made by scuba divers, like that described by HIGH & BEARDSLEY (1970) and HIGH & ELLIS (1973) for similar studies, are more continuous recordings of fish movements and no scuba diver effects on the fish.

The obvious weakness of this method is that closely related species are difficult to separate from their dorsal side, and that single fish are impossible to follow outside the area of observation. A fish can for instance leave and enter the area of observation leaving the observer in doubt whether or not he observes the same fish.

The results suggest that traps only catch a small part of the fish coming into contact with the gear. This is also indicated by the relatively small catches of cod, haddock and whiting in

comparative fishing experiments (VALDEMARSEN 1976).

One critical factor is obviously the direction of the current. Fish were principally observed to butt against the net in a place were olfactory stimuli from the bait were brought by the current. A fish was never observed to enter the first funnel downstream. Consequently, in practical fishing traps should ideally be placed with the funnel end pointing in the direction of the current. The relatively few attempts to enter a funnel is apart from the influence of the current, presumably due to some kind of inhibition to enter a narrow opening. In a strongly motivated fish this inhibition may be overcome. The strength of the inhibition is certainly dependent on the species and also probably on the habitat of the fish. In two trap experiments in Vadsø harbour bassin, 40 and 35 cod were caught during 1.5 and 3 hours of fishing. These fish were probably adapted to structures in their environment.

The present study clearly demonstrates the significance of the bait. With no bait present, few fish were interested in the trap and no fish attempted to enter. This is not consistent with findings by HIGH & BEARDSLEY (1970), HIGH & ELLIS (1973) and MUNRO et al. (1971). The disagreement probably reflects species differences. HIGH & BEARDSLEY (1970) has speculated on alternative motivations causing fish to enter traps, among them predator-prey interrelationships and social attraction. The latter explanation could also be applied to gadoid fish. In one trap the bait was removed when one cod had been caught. Two weeks later the trap contained eight cod. However, even if social attraction may play a role when one fish has already passed into the trap, the bait seems to be important during the initial phase.

Fish showed a definite tendency to approach the bait against the direction of the current in the presence of bait. This is in agreement with findings by HOBSON (1963) and SUTTERLIN (1970). With no bait present the direction of swimming was, however, random in relation to the direction of the current, i.e. no positive rheotaxis occurred.

REFERENCES.

FERNØ, A., A. JOHANNESSEN, K.L. OLSEN, P. SOLEMDAL, S. TILSETH & J.W. VALDEMARSEN. 1976. Fish behaviour in relation to long lines observed by TV. Coun.Meet.int.Coun. Explor.Sea, 1976 (B:38): 1-7. [mimeo].

HIGH, W.L. & A.J. BEARDSLEY. 1970. Fish behaviour studies from an undersea habitat. Comml.Fish.Rev. 32(10): 31-37.

HIGH, W.L. & J.E. ELLIS. 1973. Underwater observation of fish behaviour in traps. Helgoländer wiss.Meeres-unders. 24: 341-347.

HOBSON, E.S. 1963. Feeding behaviour in three species of sharks. Pacif.Sci. 17: 171-194.

MUNRO, J.L., P.H. REESON & V.C. GAUT. 1971. Dynamic factors affecting the performance of the Antillian fish trap. Proc.Gulf.Caribb.Fish.Inst. 23: 184-194.

SUTTERLIN, A.M. 1975. Chemical attraction of some marine fish in their natural habitat. J.Fish.Res.Bd.Can. 32(6): 729-737.

VALDEMARSEN, J.W. 1976. Norwegian experiments with deep sea traps. Coun.Meet.int.Coun.Explor.Sea, 1976 (B:7): 57-59. [mimeo].