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Investigations with herring trawl nets

by

J. Schärfe

The object of the present measurements was to examine the influence of two alterations in the design of the German herring bottom trawl net. These alterations consisted of

1) "Süberkrüb" wing doors used instead of the usual otter-boards, and
2) a net bag made of particularly thin Perlon twine instead of a bag made of usual Manila net twines.

For the purpose of comparative measurements four different types of fishing gear were designed:

A. Usual other boards with the usual net bag made of Manila net twine.
B. Usual other boards with net bag made of thin Perlon twine.
C. "Süberkrüb"-wing doors with the usual net bag made of Manila net twine.
D. "süberkrüb"-wing doors with net bag made of thin Perlon net twine.

The adjustment of the gear, i.e. the lengths of the bridles (20 fathoms), legs (12 fathoms), auxiliary headlines and connective legs as well as the size and adjustment of the kites (0,8 x 1,2 m), was the same for the four types of fishing gear.

The two net bags made of Manila and Perlon with ground rope of 160 feet in length had been made by the same firm in exactly the same way and differed only by the material and diameters of the net twines. Only the diameter is of interest here. The following table shows the differences.

Net section	Manila net twine Ø mm	Perlon net twine Ø mm
Herring wing	3,4	1,8
Herring square	3,4	2,0
I + II Pint	3,4	1,8
Herring Belly	3,3	1,8
"Maschenstück" (piece between belly and funnel)	3,7	2,0
Herring funnel	3,5	2,0
Herring cod end	3,4; double	2,6; single

Table 1: Diameter of the net twines used for the comparative nets.

A smaller diameter of the net twine effects a more favourable relation between the mesh-opening on the one side and the net twine and knots on the other side and thus a reduction of the drag.

The usual otter boards used for the experiments were plain boards in the size of 1,33 x 3,30 m = 4,4 squ.mtrs. The "Süberkrüb"-wing doors, however, were convex boards (radius of the curvature 1350 mm) in the size of 1,30 x 3,00 m = 3,9 squ.mtrs.

Whereas the usual otter boards run along the bottom of the sea with their long edge finding there considerable resistance and even guidance, the "Süberkrüb"-wing doors run over the ground with their short edge and encounter there a much smaller resistance. Owing to their design, they perform with equal lift a smaller drag than the usual wing doors.

It should be examined by the measurements, how far these alterations take effect.

The existing 27 series of measurements were obtained during the third voyage of the fisheries research vessel ANTON DOHRN in September 1955 in the North Sea. The following measuring instruments were used:

a) Dynamometer for measuring the load of the warp aboard immediately behind the towing hook. These measurements refer to the drag of the whole fishing gear.

b) Dynamometers for measuring the load on the bridles immediately behind the otter boards. These measurements measure the drag of the net bag including the kites, bridles, legs, auxiliary head lines, connective legs and Danlenos.

c) Special log for measuring the speed of the vessel.

d) Attack-angle meter for measuring the angle of attack of the otter boards.

e) Echo sounder for measuring the opening-height of the fishing gear.

Moreover, the revolution figure of the propeller and the steam-content of the cylinders with constant pressure of the boiler were measured.

As the existing measurements were only a secondary subject of the voyage which was principally dealing with herring research it was scarcely possible to carry out comparative measurements under

uniform exterior conditions. In place of that the measurements were mainly made at the fishing stations which interrupted the voyage anyhow. Therefore, the changing exterior conditions as depths of water, wind, motion of the sea, possible currents in the depths, and course of the vessel are the reasons for the comparatively varying measured values. The combined effect of those reasons cannot be analyzed here. In place of that, average values shall be promulgated and discussed.

I. Angle of attack of the otter boards.

The angles of attack mentioned in the following table were found during the measurements made with the four types of fishing gear in question. The variations are not only caused by the influence of the varying net bags, but there exists also a difference in the adjustment of the otter boards between Type A and B. More details are of no importance for further discussion.

Type of fishing	Angle of attack degree	For one trawl board Lift t	Drag t
A. Usual otter boards; Manila net bag	25-28	o,84-o,91	o,41-o,51
B. Usual otter boards; Perlon net bag	19-22	o,65-o,75	o,24-o,32
C. "Süberkrüb"-wing door; Manila net bag	22-28	o,87-o,85	o,31-o,4o
D. "Süberkrüb"-wing door; Perlon net bag	23-28	o,87-o,85	o,32-o,4o

Table 2: Measured angles of attack and theoretical values of lift and drag of the trawl boards at a towing speed of 3,7 knots.

The figures for the lift and drag at a towing speed of 3,7 knots are inserted into the table beside the corresponding figures of the measured angles of attack. These computed values do not include the additional forces of lift and drag which develop particularly with the usual wing doors (A and B) when they rush over the bottom of the sea. They refer only to the influence of the water. Therefore they are smaller than they should be according to the actual conditions. Among the figures of the lifts, only Type B strikes as being somewhat smaller. The drags referred to the water are of equal order of size for all four types of fishing gear. However, it may not be concluded, that the reduction in the

drag intended by the use of Süberkrüb-wing doors cannot be reached. The actually found differences in the drags of the two investigated types of wing doors (see Table 5), as will still be shown, are in the present case only due to the varying friction at the bottom of the sea.

As indicated by the following table, the optimum of the angle of attack for the two types of boards is to be found in varying ranges.

"Süberkrüb"-wing door			Usual otter board		
angle of attack degree	lift t	drag t	angle of attack degree	lift t	drag t
9,5	o,96	o,o7	24,6	o,83	o,39
12,6	1,o6	o,11	34,7	1,o6	o,74
14,4	1,11	o,17	37,7	1,o9	o,84
16,6	1,o6	o,22	39,7	1,o8	o,9o
19,6	o,86	o,27	37,9	o,73	o,58
			39,9	o,69	o,58

Table 3: Area of the optimum angles of attack for the two different types of trawl boards including the theoretical values for lift and drag at a towing speed of 3,7 knots.

The usual otter boards were in case A within the optimum range, where there exists at first a great lift as compared with a drag that is not yet so great. In case B the lift did not reach the actual maximum value, but the drag was then still smaller.

The "Süberkrüb"-wing doors, however, had in the above mentioned measurements too great angles of attack, at which the lift decreases already, whereas the drag continuously increases. Since it was impossible to re-arrange the deficient adjustment of the wing doors, which was responsible for that, aboard the vessel, one had to renounce to an optimum utilization of the smaller drag characteristic for that type of boards.

II. Opening-height of the gear.

The following table shows the average values of the height of the opening ascertained for the four varying types of fishing gear.

Type of fishing gear	Headleine m	1. kite m	2. kite m
A. Usual otter boards; Manila net bag	4,o	8,5	14,o
B. Usual otter boards; Perlon net bag	4,o	8,o	12,5
C. "Süberkrüb"-wing doors; Manila net bag	3,5	8,o	13,5
D. "Süberkrüb"-wing doors; Perlon net bag	4,5	8,5	13,5

Table 4: Average values of the heights of apertures measured for the four types of fishing gear.

The table shows no striking differences between the types of fishing gear to be compared. The existing differences can be explained by the varying exterior conditions. As it was not desired to change the trim of the fishing gear for the purpose of the intended comparisons, the result meets fairly the intentions the experiment.

III. Drag of the fishing gears and their parts.

As mentioned above, the drag of the whole fishing gear was measured immediately behind the towing hook and simultaneously the particular drag of the net bag including bridles, Danlenos, legs, auxiliary headlines and kites immediately behind the trawl boards below water. By computing the difference between the two values it is possible to investigate up to what degree the two sections of the fishing gear participate in the drag of the whole fishing gear. As the lengths of the warps did not considerably differ and the bridles, legs, Danlenos, auxiliary headlines and kites were always kept in equal sizes and adjustment, the obtained differences in the drag resulted from the trawl boards or net bags, which are under discussion here. The following table gives below the average values measured for slightly varying towing speeds comparative values (underlined), which were converted to a uniform towing speed of 3,7 knots.

(Table 5, see page 6)

In spite of the mentioned varying exterior conditions and the limited exactness of the measuring methods the above survey of average values indicates clearly the expected tendency. When using the newly to be tried parts of fishing gear (Perlon net or "Süberkrüb"-wing doors) the drag of the fishing gear decreases at equal towing speed and thus, of course, also the required performance of the engine. Moreover, the share of the two discussed sections of the fishing gear in the total drag is varying.

Type of fishing gear	towing speed knots	Revolution of propeller per minute	Contents of Cylinder %	Total t	Drag Trawl-board plus warp t	Net bag plus lines, Danlenos plus kite t
A. Usual otter boards; Manila net	3,6	86	6o	6,4	1,8	4,6
	3,7	--	--	6,8	1,9	4,9
B. Usual otter boards; Perlon net	3,7	84	55	6,4	2,4	4,o
	"	""	""	"	"	"
C. "Süberkrüb" wing doors; Manila net	3,6	83	57	6,1	(o,9)	(4,6)
	3,7	--	--	6,4	(1,1)	(5,3)
D. "Süberkrüb" wing doors; Perlon net	3,7	8o	52	5,7	1,2	4,5
	"	""	""	"	"	"

Table 5: Average values and comparative values of the drags found for the four varying types of fishing gear. The values put into () are single measurements at a total drag of 5,5 t.

Type of fishing gear	drag at 3,7 knots t	Difference t	%	Difference t	%	Difference t	%
A. Usual otter boards; Manila net	6,8	- o,4	- 6				
B. Usual otter boards; Perlon net	6,4			- o,4	- 6		
		o,o	o			- 1,1	-16
C. "Süberkrüb" wing doors; Manila net	6,4			- o,7	- 11		
D. "Süberkrüb" wing doors; Perlon net	5,7	- o,7	- 11				

Table 6: Differences in the drag of the several types of fishing gear basing on the taken measurements.

When comparing the two extreme Types A and D an average saving of 16 % of the drag was reached. That would mean, for instance, that by using the same engine power the fishing gear Type C would be

towed at a speed of 4,o knots instead of fishing gear type A performing a speed of 3,7 knots. Thus the towing speed could be increased by about 8 % without any additional expenses, although in the case in question the saving of drag is not yet the optimum attainable result because of the unfavourable angle of attack of the "Süberkrüb"-wing doors.

The following average values indicate the share of the whole drag for the two seperately measured sections of the fishing gear:

Type of fishing gear	Warps and trawl boards	Bridles, Danlenos, legs, auxiliary headlines, kites and net bag
A	28 %	72 %
B	38 %	62 %
C	(16)%	(84)%
D	21 %	79 %

Table 7: Percentage share in the total drag of the mentioned sections of the gear. ( ) separate measurements.

It is no doubt desirable that the lifting device has the most possible small share as compared with the net bag which is indispensable for the fishing operation. Also in the above comparison the fishing gear Type D is obviously more efficient than the types A and B.

IV. Catching ability.

No difference in the catching ability of the several types of fishing gear could be proved by the measurements under discussion. According to the general opinion among fishery circles, the finer Perlon net is by no means supposed to be less efficient, but owing to its smaller swell it should operate even better than the usual Manila net. A judgement as to whetherthat suggestion is right, can not yet be made, because the existing material is insufficient.

By using the investigated methods for decreasing the drag (hydrodynamically favourably designed trawl boards and finer net twines) it might be possible to increase the fishing power and profitableness of a specific trawler by increasing the towing speed or by employing a larger fishing gear with the same engine power.