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Effect of trawling on animals of the sea bed

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Summary—Damage to fish food species trawled over in the main area of the North Sea plaice, cannot be serious; otherwise there would be a noticeable difference where trawling is impossible, as close to light vessels or among the under-water sand dunes.

Direct attack, covering the ground some five or six times over on the average, did break full-grown Heart Urchins, *Echinocardium cordatum*, and possibly swimming or paddler crabs (*Portunus depurator*), but appeared not to damage *Ophiura albida*, nor any of the fragile-shelled plaice food animals: razor shells, *Mactra* or *Tellina*. Those forms were not very abundant, but all the 15 specimens taken of fragile animals (other than urchins and paddlers) were undamaged. Such large urchins as were damaged were not plaice food.

Doubtless *Sabellaria* habitations (ross) would be broken and laid low, but they would probably soon be reconstructed.

Trawling, even with a tickler chain, seems again to escape the so viable indictment.

INTRODUCTION

Many trawlermen are sure that their work alters the bed of the sea. Some say that it improves it, increasing the growth of animal forms growing up from the sea bed by clearing out old structures. Others say that trawling, especially with tickler chains, harms the food of fishes by breaking protective shells and structures.

The complaint of damage is an old one. In 1376 the Commons petitioned the King of England " that the great and long iron of the wondyrchoun runs so heavily and hardly over the ground when fishing that it destroys the flowers of the land below water there ". In the 19th century the beam trawl came in for similar criticism, which Dr. W. C. MacIntosh, acting for the Royal Commission of 1863, disposed of. However, trawls have become heavier and tickler chains more common, in certain fisheries almost universal. One such fishery is the English one for plaice in the southern North Sea; and in 1938 it seemed worth while to devote a little research-vessel time to finding out whether tickler chains had any marked effect.

Doubtless trawling with heavy tickler chains breaks up and flattens structures made of sand-tubes by *Sabellaria*, and similar comparatively fragile highly projecting structures, when these are not so strong as to prevent trawling because of the frequency of tearing. But *Sabellaria* tenements seem to be annual growths, run up fairly quickly, so that it may not be assumed that much permanent damage is done.

The fishing skipper of the *George Bligh* advised that it would be foolish and not really relevant to experiment on Sabellaria grounds, which he thought to be limited compared with the whole plaice area; so the decision was made to confine the enquiry to the usual clean, sandy ground frequented by plaice.

METHODS

The first line of approach was to assume that there exists a small sanctuary about three-quarters of a mile in radius centred on each light vessel, within which trawling would be very rare, for fear of fouling the lightship's moorings. If trawling had made

an appreciable effect on the benthos of the plaice area, the community within that sanctuary should be appreciably different from the community outside. The sanctuaries of two light vessels, the *Haaks* and the *Terschelling*, were examined with the following gear: Petersen's grab; Naturalist's dredge; Agassiz trawl; otter trawl with shrimp-

Table I.—Dredging before and after trawling

BEFORE

George Bligh, Cruise K (1938), Sta. 16, 10th July, 1938, Naturalist's dredge (6 foot) lined shrimp-netting, Egmont SE'ly 15 miles, Dhan on 90 fms. wire in Lat. 52° 44½′ N. Long. 4° 16′ E., 13 fathoms, sand, 1015 to 2010 hours, tides various, sea 4, wind SW'ly 4, sky cloudy, 14 hauls driving with wind and tide except where otherwise noted.

Haul	*Time* (assumed 10 mins. duration)	*Dhan bearing and distance*
1	1038–1048	N to NxW ¼ mile (magnetic variation 9° W)
2	1110–1120	S to S¼E ¼ mile
3	1145–1155	S 1¼ miles
4	1235–1245	E to SE½E ½ mile
5	1314–1324	W to SWxW ½ mile
6	1356–1406	NE 200 yds. to ½ mile (? direction reversed)
7	1440–1450	NE x E to SxW½W ¼ mile
8	1519–1529	NExE ½ mile to ESE ⅛ mile
9	1551–1601	NExE ¼ mile to 200 yards
10	1623–1633	NExE ¼ mile " tide getting less "
11	1654–1704	NExE ¼ mile to ENE ⅛ mile
12	1725–1755	NExE to SW ¼ mile
13	10 minutes	NExE to SW ¼ mile " with help of engines "
14	10 minutes	buoy to NE'ward no distance

AFTER

42 traverses with the trawl as nearly as possible to the tracks of Sta. 16, Hauls 7–13; Cruise K 1938, Sta. 20, 13th July, 1938, otherwise as for Sta. 16 but time 1415 to 1920 hours, tide " 1400, Buffs and Dhan NNW, so proceeded to buoy ", sea 2, wind variable 2, sky cloudy, 7 hauls driving with wind and tide.

Haul	*Time* (assumed 10 mins. duration)	*Dhan bearing and distance*
1	1418–1428	NExN to ESE ¼ mile
2	1447–1505	NNE to S ¼ mile
3	1524–1538	NExE to S ¼ mile
4	1599–1612	NExE to S½E ¼ mile
6	no record—" foul haul "	
6	1704–1712	ENE 300 yards to SSW 200 yards
7	1730–1745	NExE to SxE ¼ mile
8	1810–1826	ENE ¼ mile to SSE 200 yards
9	1842–1900	" ? washed it all out "

net cover on the codend. Control hauls were made 5 miles away from the *Haaks* only. That work was done on the 6th, 7th, 8th and 9th of July, 1938. (*George Bligh* K 1938, Stas. 2–10, 11–12, 13–14).

Another sanctuary is provided by the under-water sand dunes of the extreme south-eastern North Sea. These are dangerous to otter trawls, because of the trawl doors getting down into the small valleys between the ridges and the net then fouling

the intervening crest. The beam trawls formerly used could generally get along safely, presumably because the beam took the blow of the sand-crest. By 1939, beam trawls were almost extinct, so the " bank " area provided another sanctuary. Had trawling had an appreciable effect, the benthos should be different as one left the bank area. On July 23rd and 24th, 1939, this was investigated near the northern boundary, as located by echo-sounding, using Petersen's grab and the Naturalists' dredge. Two lines of stations were completed (*George Bligh* L 1939, Sta. 14, Hauls 0–9, Sta. 15, Hauls 0–6).

Another line of approach was to try to damage animals of the sea-bed with a trawl armed with a heavy tickler-chain. The idea was to choose a bed of some animal with a fragile shell, as fragile as possible, and then tow over it as precisely as possible.

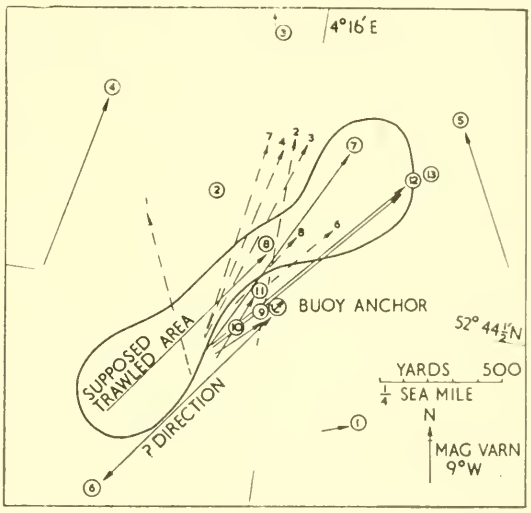

Fig. 1. Dredge hauls before and after trawling

Tracks of hauls before using trawl and tickler chain are shown as whole arrows with the serial number in a circle; hauls after, as broken arrows with unringed serial numbers, related to the position of a buoy's anchor. " Before " hauls 7 to 10 showed a bed of Heart Urchins, which was also sampled by " after " hauls 2 to 8 with moderate success, the wind having changed. The swinging positions of the buoy have been taken into account. Its area of 180 yards radius limited trawling, probably to something like the shaped area indicated. In the waist, the area would be trawled over on the average, about 5 times. Heart Urchins were broken, but not Mactra.

Range judged visually was perhaps accurate to within 20 per cent; but the buoy's position (on 90 fms. wire in 13 fms.) would alter with the tide. A trawl, which probably fished at something over 20 yards width, was furnished with half-inch chain extending for 100 feet between the otter-boards, shorter and therefore mostly ahead of the 120 foot ground-rope. This was towed up and down on the 11th, 12th, and 13th July, 1938, crossing the ground 42 times; but owing to the error in the buoy's position due to tide and the imprecision of trawling, these cannot be thought of as 42 exactly superimposed hauls 20 yards wide. Instead we must think of an area like that shown in Fig. 1, representing fishing as close to the buoy's moorings as the ship dare go. The waist of the constricted area is 150 yards wide, which allows for 7 to 8 strips side by

side; so, on the average, the ground would be swept about 5–6 times. It was possible to be more precise about the examination of the benthos bed before and after the trawling, by choosing the same phase of the tide. The animal tested was *Echinocardium cordatum*, the Heart Urchin, which was the most vulnerable animal we encountered—certainly not a plaice food at the size (from memory, about an inch and one-half in diameter), but no better animal was found. It had the further disadvantage that dredge catches would fall from 39 in a 10 minute haul to 3 when the tide slackened. This leads to an investigation of where exactly the dredge hauls lay (Table I).

The dredging ground (52° 44½′ N., 4° 16′ E.) was some 13 miles southerly of the *Haaks* Light Vessel, and because many of the hauls were made while the *George Bligh* was driving with wind and tide it is possible to plot the approximate tidal pattern (Sta. 16, Hauls 1–13, but discarding No. 6, for which the record is suspect). Assuming as a first approximation that the Dhan buoy did not swing during a 10 minute dredge haul, the course of the haul can be plotted out from the bearing and distance at the beginning and end of the haul, taking an arbitrary position for the buoy. Then, as a second approximation, the buoy is assumed to be on that bearing and at a distance of 180 yards (90 fms of wire in 13 fms of depth) from its anchor. The position of dredge haul is then replotted from the assumed true position of the buoy. Most positions of the buoy were found to lie near a N.E. and S.W. zone (magnetic), not very different from that derived from tidal information on admiralty chart 2182A for a position 52° 36′ N., 4° 10′ E.

The information given in Table I has been plotted on Fig. 1, from which it is seen that there is reasonable overlap of Sta. 16, Hauls 7–13 with Sta. 20, Hauls 2–8. Neither set lay perfectly in the trawlable area; but both lay partly within it. Sta. 16, Hauls 7–13, and Sta. 20, Hauls 1–8, may be said to do so.

Some benthos material was preserved from these investigations; but none is to be found 17 years later. It is thought that the jars were buried for safety of staff in 1940, and discarded as not in good order in 1945. Data are therefore in the form of incomplete identifications written in the log-books at the time. They are so given here.

During the attempt to break *Echinocardium* it was found possible to distinguish whole, broken or even fragmentary specimens, as " dead ", meaning " long dead " (having no spines), " recently dead " (having lost some spines), and " broken " (having all the proper spines). By counting fragments containing apical pores, it was possible to estimate the number of whole urchins.

RESULTS

The sanctuaries from trawling showed no marked difference in benthos from outside, so there seems no reason to burden this paper with details of the results. The only point of interest was a bed of *Echinocardium* within three-quarters of a mile of the *Haaks* Light Vessel, but because this did not extend around the Light Vessel, we can hardly attribute significance to it, especially because later on we found a localized bed 13 miles away in the fishing area. The fauna also included " flat stars " (*Astropecten*), *Asterias rubens*, *Portunus depurator*, *Eupagurus*, and a few *Mactra*, *Venus*, and razor-shells. These showed no marked differences three-quarters of a mile and 5 miles from the *Haaks* Light Vessel, and the species and quantities three-quarters of a mile from the *Terschelling* Light Vessel seemed similar to those close to the *Haaks*.

Similarly, there was no appreciable change in fauna taken in grab and dredge on stations 3 miles apart running out of the protected " banks " area and in to it again. The fauna was similar to that noted above.

On the other approach—the direct attack with the tickler chain and trawl—the results are shown in Table II. It will be remembered that Hauls 7–13 of the first

Table II.—Dredge catches before and after trawling

	*Heart Urchins**						*Paddlers†*						*Other fragile forms*
	Live		*Recently Dead*		*Dead*		*Live*		*Recently Dead*		*Dead*		
	whole	‡broken	whole	‡broken	whole	‡broken	whole	broken	whole	broken	whole	broken	
Sta. 16					*Preliminary hauls*								
Haul													
1		1											1 Ophiura
2	1												
3	2												
4	6						3						4 Ophiura, 2 Tellina
5	3						3						1 Tellina
6	4						3						3 Ophiura
					Before trawling								
7	17	24					3						3 Ophiura, 2 Mactra
8	10	27					4						2 Ophiura, 1 Razor, 2 Mactra (1 broken)
9	17	21					4						2 Ophiura, ** 2 Mactra, 2 Tellina
10	12	27					2						1 Mactra, 2 Tellina
11		1					1						1 Razor
12	3		9				2						4 Ophiura, 1 Mactra
13			1				3						2 Ophiura
14	1												
Sta. 20					*After trawling*								
Haul													
1	4	5	1				3						2 Ophiura, 1 Mactra, 1 Razor, 1 Tellina
2	1	1	1	7			5						1 Ophiura, 1 Razor
3		Foul haul											
4				2						3			4 Ophiura
5		Foul haul											
6		1	1	3			4				1		1 Ophiura
7		1		1		1	3				1		
8	4	3		2			2						2 Ophiura, 1 Mactra
9					nil, possibly washed out								

* *Echinocardium cordatum*
‡ including fragments equivalent to one, by apical pores and 1 very small
† *Portunus depurator*
** 5 cms.

station and Hauls 1–8 of the second, were more or less in the trawled area. It is clear that after trawling there was a new phenomenon in the catches, namely Heart Urchins recently dead and broken. Possibly there is a similar phenomenon in Paddlers (*Portunus depurator*); but in no other form is there any sign of damage.

It may be noted that the 9 dead whole urchins taken in Haul 12 of Station 16 constitute one of those observations that one so frequently wishes one had not made.

They do not upset the remainder of the results (not being broken), but they are intrinsically difficult to account for. In the cruise report I noted them as " presumably thrown overboard after previous hauls ". I can do no better now; but only regret the long chance that delivered them on board again, if indeed that is the explanation.

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