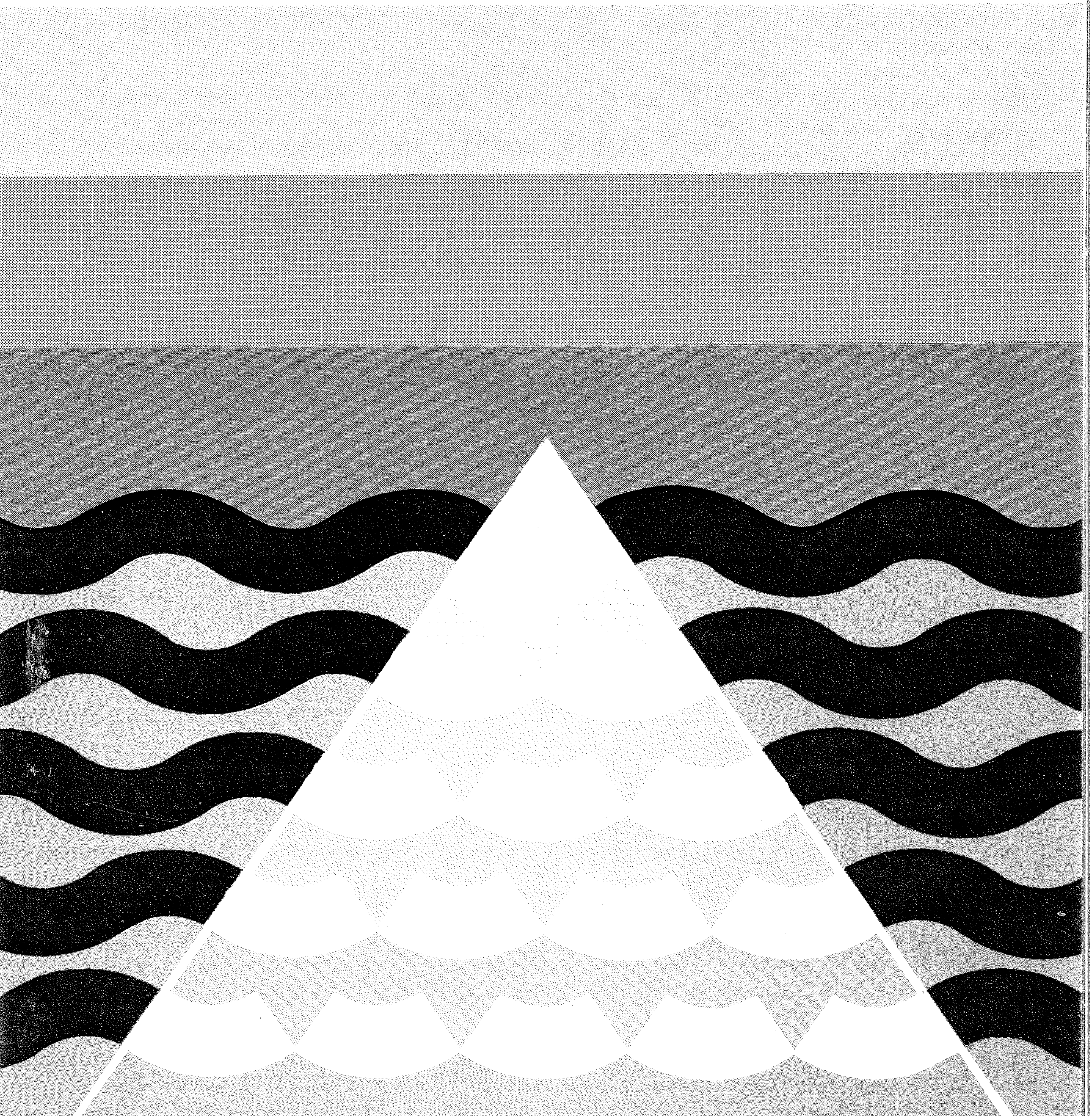
SERIE B
1976 Nr. 17

FISKEN og HAVET

RAPPORTER OG MELDINGER
FRA FISKERIDIREKTORATETS HAVFORSKNINGSINSTITUTT - BERGEN



SERIE B
1976 Nr. 17

REPORT OF THE TAR BALL SAMPLING DURING THE TRANS ATLANTIC POLLUTION SURVEY 1976

By

THOR HEYERDAHL JR.
Fiskeridirektoratets Havforskningsinstitutt
Postboks 1870-72, N-5011 Bergen

Editor
Erling Bratberg

PREFACE

In connection with the 1976 Trans-Atlantic Sailing Race, organized by the Sail Training Association (STA), a pollution survey was undertaken by some of the larger sailing vessels. This survey, the Trans-Atlantic Pollution Survey (TAPS-76), proposed by the Norwegian Council member of the Sail Training Association, Mr. Alf R. Bjercke, was concerned with surface pollution of oil, tar balls and solids (marine litter) by visual observations en route from Plymouth via Tenerife to Bermuda and Newport during June-July 1976.

The Intergovernmental Oceanographic Commission (IOC) agreed to assist with the preparations for the pollution survey. To guide and supervise preparation for and follow-up of TAPS-76, the IOC appointed a small international committee with the following composition:

Colonel R. G. F. Scholfield, Race Director, STA, U.K.
Mr. B. Warburton, STA, USA
Capt. W. Rogala, STA, Poland
Conseil General A. R. Bjercke, STA, Norway
Dr. T. Heyerdahl, Italy
Mr. R. Junghans, Chairman IOC Working Committee for IGOSS, USA
Mr. O. J. Østvedt, Fourth Vice-Chairman IOC, Norway

The Secretary IOC, Mr. Desmond P. D. Scott, also explored the possibilities for co-ordinating sampling of tar balls using neuston nets from naval ships crossing the Atlantic before the Bicentennial Celebrations in USA. It was decided that sampling of tar balls along approximately the same route as that of the sailing vessels making visual observations would be of considerable value.

Following this proposal the Norwegian members of the Committee for TAPS-76 made arrangements for sampling of tar balls from the Norwegian naval frigate KNM "Trondheim" through Commander

R.P. Breivik, and through Dr. J.O. Strømberg, Kristineberg, similar arrangements were made with the Swedish naval ship HMS "Älvsnabben".

The IOC wishes to express its sincere thanks to officers and crew on board KNM "Trondheim" and HMS "Älvsnabben", and especially to captain I. Poppe and captain L. Andersson in charge of the sampling programme, for their excellent work. The survey has shown that a large amount of high quality data can be obtained by using ships of opportunity.

Finally the IOC expresses its thanks to the Institute of Marine Research, Bergen for supplying the equipment and to Mr. T. Heyerdahl jr. who prepared the present report.

Ole J. Østvedt
Fourth Vice-Chairman IOC

INTRODUCTION

Floating oil residues, also known as oil lumps, pelagic tar or tar balls, are semisolid globules which float at the surface. They are a product of evaporation and solution combined with other processes of oxidation and degradation of petroleum at sea.

Further degradation of these tar particles leads to the formation of smaller, denser forms that may eventually sink to the sea bottom (MORRIS and BUTLER 1973). Tar particles in the water column, although derived from the surface tar lumps, may exceed the quantity of lumps floating on the surface at any given time simply by being more resistant to degradation, and thus having a longer residence time in the water column than the residence time of the parent lumps on the surface (MORRIS, BUTLER, SLEETER and CADWALLADER 1975). The longevity of particulate oil in the sea may consequently be in the order of years.

It is generally accepted that shipping and land runoff are the two predominant sources of petroleum in the sea, sharing about equal amounts and leaving smaller contributions to other sources such as natural seeps, atmospheric fallout and offshore exploitation. As runoff from land is least likely to result in tar, the transportation of crude oil is the prevailing origin of pelagic tar. The tar flux to a given area is assumed to represent 35 per cent of the oil spilled (ANON. 1975).

Sampling of tar balls by neuston nets is an important part of the Marine Pollution (Petroleum) Monitoring Pilot Project of IOC's Integrated Global Ocean Station System (IGOSS) supported by several UN Agencies and in which a number of their member states are participating.

Neuston nets and instructions for the sampling were supplied by the Institute of Marine Research to the naval ships participating in the present survey. KNM "Trondheim" sampled on the way to the USA where HMS "Älvsnabben" took over the equipment and worked on the return cruise.

All samples were delivered to the Institute in good condition together with complete logsheets giving relevant observations.

MATERIALS AND METHODS

Tar balls were collected with a modified neuston net (SAMEOTO and JAROSZYNSKI 1969). This is a surface sampler with a square opening (40 x 40 cm) to a nylon plankton net (mesh size 243 um) which scavenges the sea surface. Towed over a distance of 1 nautical mile (using standard procedures, 5 knots for 12 minutes accordingly, about 740 m^2 of sea surface is filtered to a depth of approximately 20 cm.

Surface sampling was made once or twice daily by the two naval vessels on their respective crossings of the North Atlantic, KNM "Trondheim" following a course south of the Azores en route from the Channel to the US east coast, and HMS "Älvsnabben" a more northerly route on the return transect (Fig. 1). Between 21 June and 1 July 13 sampling stations were taken going west and 20 stations taken eastbound between 15 and 25 July (Table 1).

Immediately upon retrieval the total contents of the sampler were flushed into plastic bottles or jars and stored frozen until analysis in the laboratory. After thawing, the tarry particles were separated from the plankton under a binucular microscope and dried at maximum 40°C until constant weight was obtained.

The sampling as well as the analytical methods have been in accordance with the procedures recommended for the IGOSS Marine Pollution (Petroleum) Monitoring Pilot Project (ANON. 1974). Finally, the biomass of the plankton in each sample was determined as displacement volumes.

RESULTS

Oil particulates were found in all samples collected (Fig. 1). Using a chategorization applied by WONG, GREEN and GRETNEY (1976), the frequency distribution was as follows:

< 0.1	mg tar per m^2 sea surface,	trace	: 18.2 %
0.1 - 1	" " " " " "	, medium	: 48.5 "
1 - 5	" " " " " "	, heavy	: 27.3 "
> 5	" " " " " "	, extra heavy	: 6.1 "

I. e. 82 % of the sampling stations may be regarded as medium to extra heavily polluted by particulate oil.

The lower values are, with one exception, from coastal waters including the Channel. The higher values are from the oceanic waters of the Gulf Stream or the northern sector of the North Atlantic gyre. The one low value from high seas was obtained in a branch of the Labrador current, carrying water south from the Arctic (Fig.1).

The amount of tar as related to the planktonic biomass of the samples was highly variable, ranging from traces to nearly the total content (Table 1). Regarding the material as a whole, however, roughly one third of the matter collected was oil, the rest being mainly planktonic organisms.

CONCLUDING REMARKS

Whilst observing the data obtained from this survey, attention should be payed to the scanty sampling scattered across the wide expanses of the North Atlantic Ocean. Nevertheless, the observations of the TAPS-76 survey are in good agreement with those of other investigators. Comparable observations to the present study are, when averaged over the corresponding areas, as follows: US east coast 0.2 mg/m^2, northwest Atlantic 1.0, Gulf Stream 2.2

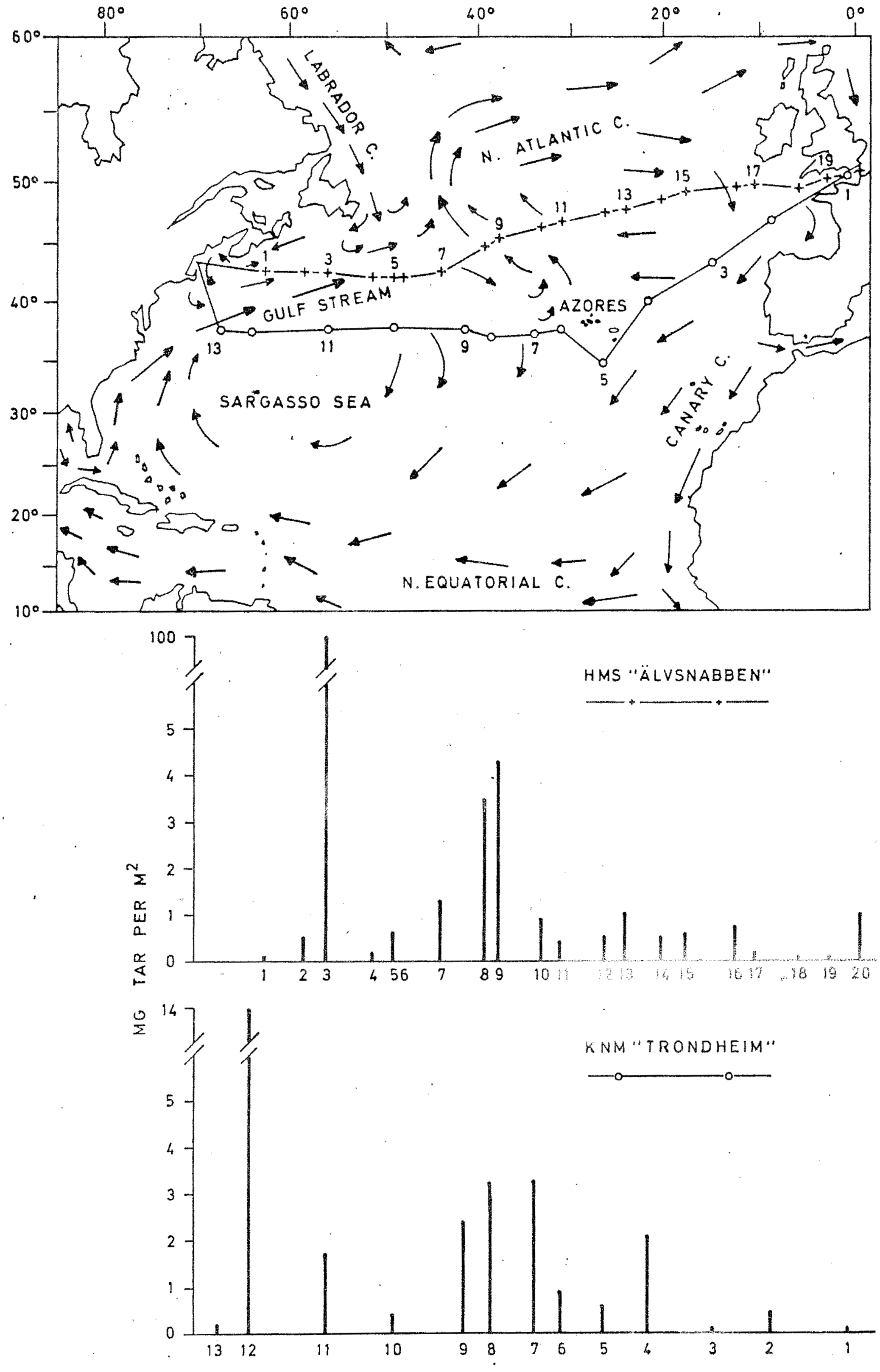


Fig. 1. Upper part:

Positions of the tar ball sampling stations, and an indication of the main current systems. The upper course followed by HMS "Alvsnabben" and the lower by KNM "Trondheim"

Lower part:

Concentration of tar at the corresponding stations, in mg per m^2 sea surface.

and the Azores 2.8 mg/m^2. Higher values, on the average 10 mg/m^2 or more, are reported from the eastern and southern sectors of the current system encircling the North Atlantic and from the Sargasso Sea in the center of the anticyclonic gyre (HEYERDAHL 1971, MORRIS 1971, LEVY and WALTON 1973, MORRIS and BUTLER 1973, McGOWAN _et al._ 1974, SHERMAN _et al._ 1974, BUTLER 1975, EHRHARDT and DERENBACH 1975, LEVY 1975, DIAS, OLSEN and ØSTVEDT 1976).

All these observations display that the clockwise circulation system of the North Atlantic is a trap for much of the waste dumped into it, including the various oil discharges from shipping. This is all the more conspicuous as practically all oil cargoes are transported along the coasts on either side of the Atlantic and not across it.

Very high values were discovered in November 1975 in the Canary Current on a cruise with the R. V. "G. O. Sars" to the Ampere and Josephine Banks, averaging 13.0 mg/m^2 with maxima 35.8 - 38.8 (DIAS, OLSEN and ØSTVEDT 1976). This is a major influx area of oil discharges to the North Atlantic as it coincides with the tanker routes between the Middle East and western Europe where petroleum pollutants become entrained in the current system of the North Atlantic gyre.

The relatively less polluted coastal waters of this survey may reflect the heavy restrictions imposed upon tankers and other ships when passing these areas, the data from the densely trafficked Channel being the most striking.

When the amount of tar is viewed against the biomass of plankton collected, it must be noted that no account has been taken of season, diurnal migration, patchiness, mesh size etc. Nevertheless, with a ratio of about 2 : 1 between plankton and oil for the total material, these values do serve to demonstrate that particulate oil has indeed become a major ecological factor in the marine environment of the North Atlantic, if only by its mere physical presence and the accommodation it offers to epiflora and epifauna.

Studies beyond registering and monitoring their existence should be implemented to clarify the impact of these oil residues on marine life.

ACKNOWLEDGEMENT

The author is indebted to Mr. Grim Berge for reviewing the manuscript. I also wish to thank Jan de Lange who performed most of the analysis of the samples and Karsten Hansen who undertook the biomass measurements.

SAMMENDRAG

Et norsk og et svensk marinefartøy, KNM "Trondheim" og HMS "Älvsnabben", samlet sommeren 1976 inn overflateprøver med hovtrekk på sine respektive overfarter mellom Kanalen og USA's østkyst. Prøvene ble analysert ved Havforskningsinstituttet i Bergen.

Samtlige prøver inneholdt oljeklumper, og 82 % av prøvene kan karakteriseres som middels til meget sterkt forurenset av oljeklumper. Sammenholdt med prøver tatt i andre atlantiske farvann viser dette at det sirkulære strømsystemet i det nordlige Atlanterhav virker som en oppsamlende bakevje for oljeutslipp fra skipsfarten. De relativt renere kystfarvann kan sees i sammenheng med utslippsrestriksjonene som gjelder der.

Oljeinnholdet i hele materialet utgjorde omlag halvparten så mye som planktonmengden. Det må imidlertid tas sterke forbehold på grunn av innsamlingsmetodikken. Likevel viser dette at oljeklumper er blitt en betydelig økologisk faktor i det marine miljø i det nordlige Atlanterhav. Konsekvensene av dette burde gjøres til gjenstand for nærmere studier.

REFERENCES

ANON. 1974. Operational plan for the pilot project on marine pollution monitoring under the framework of IGOSS. Task Team II Report modified by the Joint IOC/WMO Task Team II on Marine Pollution Monitoring. DOC. IOC-WMO/MPMSW-I, Appendix II.

ANON. 1975. Petroleum in the marine environment. Workshop on Inputs, Fates and the Effects of Petroleum in the Marine Environment, 21-25 May 1973. National Academy of Science. Wash. D.C. 107 p.

BUTLER, J.N., 1975. Pelagic tar. Scient.Am. 232 (6): 90-97.

DIAS, M.L., OLSEN, K. and ØSTVEDT, O.J., 1976. Report on a cruise by the R.V. "G.O.Sars" to the Acores and the coast of Portugal November/December 1975. Coun.Meet.int.Coun.Explor.Sea, 1976 (J:12): 1-17, 8 tab., 17 fig. [Mimeo] .

EHRHARDT, M. and DERENBACH, J., 1975. Composition and weight per area of pelagic tar collected between Portugal and south of the Canary Islands. In McINTYRE, A.D. and WHITTLE, K. ed. Petroleum Hydrocarbons in the Marine Environment. Rapp. P.-v.Reun. Cons. int.Explor.Mer. (In press).

HEYERDAHL, T., 1971. Atlantic Ocean pollution and biota observed by the "Ra-Expeditions". Biol.Conserv. 3 (3): 164-167.

LEVY, E.M. and WALTON, A., 1973. Dispersed and particulate petroleum residues in the Gulf of St. Lawrence. J.Fish.Res.Bd.Can. 30 (2): 261-267.

LEVY, E.M., 1975. The geographic distribution of tar in the North Atlantic. In McINTYRE, A.D. and WHITTLE, K. ed. Petroleum Hydrocarbons in the Marine Environment. Rapp. P.-v. Reun. Cons. int. Explor. Mer. (In press).

McGOWAN, W.E., SANER, W.A. and HUFFORD, G.L., 1974. Tar ball sampling in the western North Atlantic. Natn. Bur. Stand. Spec. Publ. 409: 83-84.

MORRIS, B.F., 1971. Petroleum: tar quantities floating in the Northwestern Atlantic taken with a new quantitative neuston net. Science, N.Y. 173: 430-432.

MORRIS, B.F. and BUTLER, J.N., 1973. Petroleum residues in the Sargasso Sea and on Bermuda beaches. Proceedings of Joint Conference on Prevention and Control of Oil Spills. American Petroleum Institute, Wash. D.C. 1973: 521-529.

MORRIS, B.F., BUTLER, J.N., SLEETER, T.D. and CADWALLADER, J, 1975. Particulate Hydrocarbon Material in Oceanic Waters. In McINTYRE, A.D. and WHITTLE, K. ed. Petreoleum Hydrocarbons in the Marine Environment. Rapp. P.-v. Reun. Cons. int. Explor. Mer. (In press).

SAMEOTO, D.D. and JAROSZYNSKI, L.O., 1969. Otter surface sampler: a new neuston net. J. Fish. Res. Bd. Can. 26: 2240-2244.

SHERMAN, K., COLTON, J.B., DRYFOOS, R.L., KNAPP, K.D. and KINNEAR, B.S., 1974. Distribution of tar balls and neuston sampling in the Gulf Stream system. Natn. Bur. Stand. Spec. Publ. 409: 243-244.

WONG, C.S., GREEN, D.R. and CRETNEY, W.J., 1976. Distribution and Source of Tar on the Pacific Ocean. Mar. Poll. Bull. 7 (6): 102-105.

Table 1. Data appendix.

Ship & Station	Date	Time GMT	Position North	Position West	ml plankton biomass	mg of tar pr. m^2 sea surface
T 1	21. June	1015	50°27'	00°05'	4.7	<0.01
T 2	22. "	1130	46°53'	08°44'	0.1	0.4
T 3	23. "	1015	43°27'	15°00'	5.0	0.01
T 4	24. "	1030	40°00'	21°30'	6.5	2.1
T 5	25. "	2045	34°42'	26°34'	60.0	0.6
T 6	26. "	1045	37°53'	30°59'	ca. 0.3	0.9
T 7	26. "	1930	37°43'	33°58'	11.2	3.3
T 8	27. "	1115	37°41'	38°33'	0.8	3.2
T 9	27. "	1930	37°57'	41°28'	7.3	2.4
T 10	28. "	1830	38°00'	49°04'	0.1	0.4
T 11	29. "	1730	37°54'	56°11'	0.1	1.7
T 12	30. "	2100	37°55'	64°00'	–	14.0
T 13	1. July	1145	37°59'	67°16'	0.1	0.2
Ä 1	15. "	1830	42°45'	62°48'	0.5	<0.01
Ä 2	16. "	1200	42°50'	58°20'	1.1	0.5
Ä 3	16. "	2030	42°45'	56°08'	0.1	>100 x)
Ä 4	17. "	1215	42°18'	51°19'	2.0	0.2
Ä 5	17. "	2130	42°10'	48°50'	0.2	0.6
Ä 6	17. "	2300	42°09'	48°18'	4.8	0.04
Ä 7	18. "	1415	42°56'	44°00'	1.0	1.3
Ä 8	19. "	1130	44°52'	39°10'	1.8	3.5
Ä 9	19. "	1930	45°25'	37°30'	2.0	4.3
Ä 10	20. "	1015	46°15'	33°10'	0.5	0.9
Ä 11	20. "	1900	46°43'	31°08'	0.1	0.4
Ä 12	21. "	1045	47°34'	26°30'	0.6	0.5
Ä 13	21. "	1915	47°48'	24°29'	0.4	0.1
Ä 14	22. "	1000	48°47'	20°10'	0.3	0.5
Ä 15	22. "	1800	49°12'	17°55'	0.5	0.6
Ä 16	23. "	1015	49°33'	12°41'	0.4	0.7
Ä 17	23. "	1800	49°43'	10°24'	4.0	0.1
Ä 18	24. "	0930	49°39'	05°38'	3.2	0.03
Ä 19	24. "	1915	50°05'	02°28'	43.7	0.04
Ä 20	25. "	0900	50°39'	01°14' E	1.0	1.0

x) Approx. 2/3 of sample analyzed

FISKEN OG HAVET, SERIE B

Oversikt over tidligere artikler finnes i tidligere nr.

1976 Nr. 1 Svein Sundby: Oseanografiske forhold i området Malangsgrunnen-Fugløybanken-Tromsøflaket. En oversikt.

1976 Nr. 2 Anon.: Fiskeressurser og oseanografiske forhold utenfor kysten mellom Stad og Stord

1976 Nr. 3 O. Grahl-Nielsen, T. Neppelberg, K.H. Palmork, K. Westrheim og S. Wilhelmsen: Om kontrollerte utslipp av oljehydrokarboner fra produksjonsplattformen på Ekofisk.

1976 Nr. 4 Didrik S. Danielsen og Svein Arnholt Iversen: Innvirkning av små overtemperaturer på dødelighet og vekst hos I-gruppe rødspette (Pleuronectes platessa L.).

1976 Nr. 5 Didrik S. Danielsen og Svein Arnholt Iversen: Temperaturens innvirkning på hummerens (Homarus gammarus L.) dødelighet og vekst i første leveår.

1976 Nr. 6 Einar Dahl, Else Ellingsen og Stein Tveite: Fiskeribiologiske undersøkelser i Langesundområdet august 1974 - oktober 1975.

1976 Nr. 7 Bjørn Bøhle: Dødelighet av sei (Gadus virens), hvitting (Gadus merlangus) og brisling (Clupea sprattus) i oppvarmet sjøvann og dødelighet av torsk (Gadus morhua L.) ved korttidseksponering i oppvarmet sjøvann.

1976 Nr. 8 Bjørn Bøhle: Temperatureffekt på embryonalutvikling og klekking av egg hos dypvannsreke (Pandalus borealis KRØYER)

1976 Nr. 9 Bjørn Bøhle: Eksperimenter med temperaturpreferanse i horisontale gradienter hos marine fisk - en midlertidig rapport.

1976 Nr. 10 Svein Sundby: Akvakultur i Vest-Finnmark. Lokalisering av velegnede steder.

1976 Nr. 11 Kr. Fr. Wiborg: Undersøkelser i dyreplankton i området Malangsgrunnen-Fugløybanken-Tromsøflåket i mai - oktober 1975.

1976 Nr. 12 Otto Grahl-Nielsen, Tore Neppelberg, Karsten H. Palmork, Kjell Westrheim og Svein Wilhelmsen: Oljespillet fra T/T "Drupa": Undersøkelser vedrørende olje, vann og fisk.

1976 Nr. 13 Olav Hansen, Per Dag Iversen og Ole Dag Østhus: Ukontrollert svinn ved fiskeoppdrett.

1976 Nr. 14 Einar Dahl, Else Ellingsen og Stein Tveite: Fiskeribiologiske undersøkelser i Oslofjorden, august 1974 - oktober 1975.

1976 Nr. 15 Dag Møller og Øyvind Bjerk: Sammenlignende vekstforsøk hos laksefisk.

1976 Nr. 16 Dag Møller, Marianne Holm, Rita Lerøy og Gunnar Nævdal: Variasjoner i veksthastighet og alder ved kjønnsmodning hos regnbueaure.