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Technical Reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report will be abstracted in *Aquatic Sciences and Fisheries Abstracts* and will be indexed annually in the Service's index to scientific and technical publications.

Numbers 1-456 in this series were issued as Technical Reports of the Fisheries Research Board of Canada. Numbers 457-714 were issued as Department of the Environment, Fisheries and Marine Service, Research and Development Directorate Technical Reports. The series name was changed with report number 715.

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Les numéros 1-456 de cette série ont été publiés à titre de Rapports techniques de l'Office des recherches sur les pêcheries du Canada. Les numéros 457-700, à titre de Rapports techniques de la Direction générale de la recherche et du développement, Service des pêches et de la mer, ministère de l'Environnement. Le nom de la série a été modifié à partir du numéro 701.

La page couverture porte le nom de l'établissement auteur où l'on peut se procurer les rapports sous couverture cartonnée.

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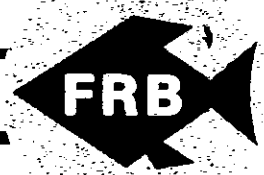
**Toxicity Tests with Oil Dispersants
in Connection with Oil Spill at
Chedabucto Bay, Nova Scotia**

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FISHERIES RESEARCH BOARD OF CANADA

TECHNICAL REPORT NO. 201

1970



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Technical Reports

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TECHNICAL REPORT NO. 201

TOXICITY TESTS WITH OIL DISPERSANTS
IN CONNECTION WITH OIL SPILL AT
CHEDABUCTO BAY, NOVA SCOTIA

by

John B. Sprague and William G. Carson

This is the Thirty-Fifth FRB Technical Report from the
Fisheries Research Board of Canada
Biological Station, St. Andrews, N. B.

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Fisheries Research Board of Canada
Biological Station, St. Andrews, N. B.

SUMMARY

Ten oil dispersing agents were screened for acute toxicity. The agents were selected by "Project Oil", the group concerned with cleaning up Bunker C oil in Chedabucto Bay following the wreck of the "ARROW".

Most tests were done in fresh water at 15°C with Atlantic salmon (Salmo salar L.). A uniform stock of this fish was available and salmon proved more sensitive than the most suitable marine fish, winter flounders. American lobsters were extremely resistant and were used in only a few tests. Stirred static tests were used. The dispersant or oil-and-dispersant was initially emulsified in water using a blender.

Acute toxicity to salmon of the dispersants without oil, could be described as follows:

Practically non-toxic (4-day LC50 \geq 10,000 mg/l), Corexit 8666;
Slightly toxic (1,000-10,000 mg/l), None;
Moderately toxic (100-1,000 mg/l), A sample of "new" BP 1100B;
Toxic (1-100 mg/l), BP 1100B, BP 1100, Gulf Agent 1009,
Naphtha gas, Dispersant 88, Dispersol SD, BP 1002,
and XZIT x-1-11.

Bunker C oil by itself could be considered "practically non-toxic" on the basis of 4-day tests, or "slightly toxic" in 7-day tests.

In equal-weight mixtures of oil and dispersant, Corexit 8666 could be termed "moderately toxic". BP 1100 and Dispersol SD were "toxic", being lethal at somewhat less than 10 mg/l of each component.

Some results with low concentrations (about 100 mg/l) of Corexit 8666, suggested that a relatively strong delayed toxicity was caused either by toxic degradation products of Corexit, or by the bacteria bringing about degradation.

These tests cover only acute effects. Sublethal or long-term effects might be important under some field conditions and should always be considered.

INTRODUCTION

A great deal of scientific and technical work was stimulated by the spill of Bunker C oil which occurred following the wreck of the tanker "ARROW" in Chedabucto Bay, Nova Scotia, on February 4, 1970. A task force was formed to investigate and clean up the oil pollution, and operate under the name "Project Oil". Apparently this group was under considerable pressure from commercial firms and others, to use special oil dispersing agents for cleaning up the pollution. This pressure was resisted because of the excessive toxicity previously noted for dispersants used after the "TORREY CANYON" wreck (Smith, 1968). Nevertheless, some information on toxicity was needed in case it became desirable to use a dispersant. Accordingly, Project Oil selected certain dispersing agents and requested that their toxicity be tested at St. Andrews, New Brunswick.

This report gives the results of preliminary screening of 10 oil dispersants for acute toxicity to aquatic life. The most complete tests were with small salmon at 15°C. Although these were in fresh water at a fairly high temperature, some comparisons indicate that this gives a valid reflection of toxicity to marine fish in cold water. The dispersants of highest interest were tested in combination with oil. Some others of lesser interest were tested by themselves, without oil.

METHODS

Species Used

Atlantic salmon (Salmo salar L.) in the freshwater parr stage were the primary fish used in this work. They were obtained from a federal fish culture station, their lengths were mostly 6 to 9 cm and they were acclimated to either 5° or 15°C (see Appendix B).

Winter flounders (Pseudopleuronectes americanus (Walbaum)) were used as the most suitable marine fish for laboratory testing. They were obtained by trawl in Passamaquoddy Bay near St. Andrews. Different batches of flounders varied in adaptability to laboratory conditions, some batches having high mortality. Probably this was related to amount of damage they suffered in the net during catching. Punctures and other injuries were sometimes quite noticeable.

American lobsters (Homarus americanus Milne-Edwards) were used in some tests. They were small specimens which had been held under semi-natural conditions over the winter at St. Andrews, in running sea water at ambient temperature, about 3°C at the time of tests.

Soft-shelled clams (Mya arenaria L.) were used in a couple of tests. They were dug on beaches at the Biological Station a few days before the test.

Average lengths and weights of animals are given for each test in Table 2 of Appendix A. The average is representative of the groups in most cases, although a few tests with flounders involved extreme size-ranges.

Dispersants Used

Bunker C Oil was provided by Imperial Oil Limited, Dartmouth, N. S., and came from another tanker which carried the same type of Venezuelan oil as did the "ARROW".

Corexit 8666 was provided through Project Oil, supplied by Imperial Oil Limited. One ml weighed 0.8111 gm.

BP 1100B came through Project Oil. It is supplied by BP Oil Limited, Montreal 109, and originates with British Petroleum Co., Ltd. A second sample, here called New BP 1100B, arrived May 29, a few days after the sample from Halifax, and had apparently been shipped directly from BP in Montreal. The second sample was somewhat less toxic than the first. BP 1100B is supposed to be a low-toxicity version of BP 1100.

BP 1100 was also sent by Project Oil, and is a product of BP Oil Limited. One ml weighed 0.8111 gm. When it proved to be more toxic than expected, a second sample was sent by Project Oil; we call it New BP 1100 and found it was not greatly different in toxicity from the first sample.

BP 1002 was supplied by BP Oil Limited of Montreal. It was the dispersant used in large quantities after the "TORREY CANYON" spill. It was known to be toxic, but was included in the present tests as a "yardstick" with which to evaluate the other dispersants.

Gulf Agent 1009 came from the Gulf Research and Development Co., Pittsburgh, through Project Oil. Our sample had a code number LS-3040 on the label.

Naphtha Gas was purchased from the Imperial Oil distributor in St. Stephen, New Brunswick. It is the "white gas" commonly used in camping stoves, lanterns, etc. For use on oil spills, naphtha was to be mixed with talc to make a slurry, and this would be put on the oil in hope of forming small globules which would sink. There was considerable uncertainty what kind of "talc" was to be used, so we could not simulate the mixture at St. Andrews. A very small amount (65 gm) talc-naphtha-oil mixture was finally sent by Project Oil. This had been reportedly scraped off rocks after a small field trial. The sample appeared to be somewhat dried, apparently contained some beach sand and large particles of talc, and was a somewhat plastic, sticky, solid. It was blended with some difficulty

into water and tested for toxicity, although the significance of the test is questionable.

Dispersant 88 is also called "Oil Dispersant 88" and "Colloid 88". It is a product of Colloid Chemical Company, Brockton, Mass., and is handled by R. N. G. Equipment Ltd., Halifax. It was supplied by Project Oil. It is described as a "suspension of inert mineral granules in water with the aid of a biodegradable non-ionic emulsifier".

Dispersol SD comes from Imperial Chemical Industries, through Project Oil. One ml weighed 0.8367 gm.

XZIT x-1-11 was handled by Grant Associates, Saint John, New Brunswick. The manufacturer is not known to us.

Test Procedures and Conditions

Static tests were used, i.e. a given concentration of test-mixture was made up and was not renewed during the test. Exposures were usually continued for seven days, with frequent observations of fish mortality for the first few days, decreasing to twice-a-day observations at the last. Some tests were continued for two weeks and a very few were stopped at four days. In quite a few tests with oil or oil-dispersant, fish were removed at 7 days and held in clean running water for a further seven days to check for delayed mortality.

Tanks (Figs. 1 to 5). All tests were done in fiberglas tanks, newly-lined with polyethylene sheet before each test, to prevent carryover of toxicant from one test to another. The volume of test water was always 60 l, which filled the tank to a depth of 21 cm. The tanks were immersed in constant-temperature baths.

Five salmon were used in each test. They were held in a cage made of white nylon netting with openings .64 x .32 cm covering a frame of iron rod, about 30 cm by 46 cm. In tests with flounders, five individuals were also used in each test, held in a similar cage except covered with 3.8 cm mesh polypropylene netting. In each test with lobsters, three individuals were used, in a cage like that for flounders except divided into three compartments. Netting on a cage was always renewed if it was to be used in a different kind of toxicant, with a few exceptions noted later. Netting was not necessarily renewed if the cage was to be used in the same toxicant (e.g. Corexit-and-oil) a second time.

A laboratory-stirrer with a 4 cm propellor blade operated at about 3/4 speed outside the cage in each tank (Fig. 1-5). This kept the toxicant fairly well dispersed in the water in most cases, and also moved the water through the cages, making the fish swim, and aerating the water.



Fig. 1. General view of a row of test tanks set in constant temperature troughs.

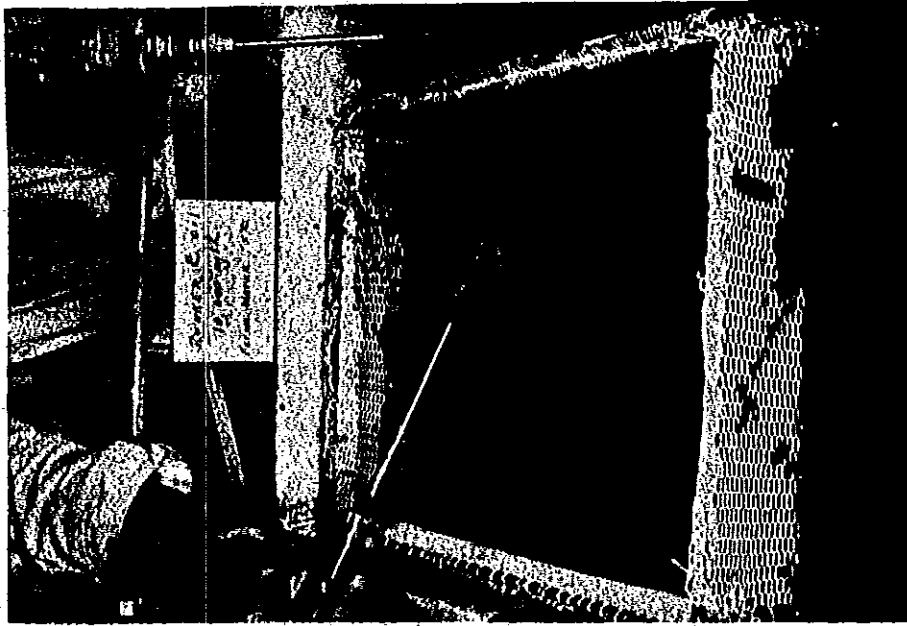


Fig. 2. Appearance of a tank with 10,000 mg/l of Bunker C oil in fresh water. The fish are within the cage under the layer of oil. This concentration did not kill salmon, flounder, or lobsters in 4 days although there were longer term effects.

Preparation of test-mixture. The same procedure was always followed. A 3-litre Erlenmeyer was partly filled with water from the test tank. The required amount of oil (if any) was weighed out and added to the water. The required amount of dispersant was weighed and added. A high-speed blender with a 2.5 cm blade was turned on for 2 or 3 minutes. This made a successful emulsion except with very high concentrations of oil alone, which tended to clog the blender. The emulsion was then poured into the tank. The stirrer in the tank usually maintained the dispersion (e.g. Figs. 4, 5) except that oil with no dispersant reformed fairly quickly into globs or layers (Fig. 2).

Ancillary conditions of water. Average temperature is indicated for each test in Table 2 of Appendix A. Individual temperature readings were almost always within 0.5°C of this average, and usually closer than that. Dissolved oxygen was periodically measured polarographically with an E.I.L. Model 15A oxygen meter. Values were usually near saturation and always above 80% saturation except for a few cases noted in Appendix A. Hydrogen ion concentration in freshwater tests was between pH 6.6 and 7.2 except in one case (naphtha) noted in Appendix A, in which pH was raised. In seawater tests, pH was between 7.5 and 7.9, the lower values occurring in some of the stronger concentrations of toxicant.

Critique of Bioassays

These tests give an indication of the acute (short-term) lethal effects only. This limitation must be firmly kept in mind. There are quite likely to be long-term or sublethal effects at concentrations of oil/dispersant which are lower than those discussed here.

One limitation of the bioassays was that they were static tests, that is, the test-water was not changed. Because of the difficulties in working with the thick and sticky test-mixtures, it was impossible to make daily changes within limitations of time and effort. In high quality research, the test-mixtures should have been changed daily to maintain approximately constant conditions of the toxicants. The whole approach to such bioassays with aquatic organisms is to keep constant conditions in each tank so that one may interpolate between concentrations to draw conclusions on thresholds of effect.

Test-volumes were initially adequate for salmon. Preferred bioassay conditions would be at least 2 litres of test-solution per gram of fish (Sprague, 1969). If total weight of the five salmon were 30 litres, as was often the case, the initial 60 litres was adequate. This should, of course, have been changed

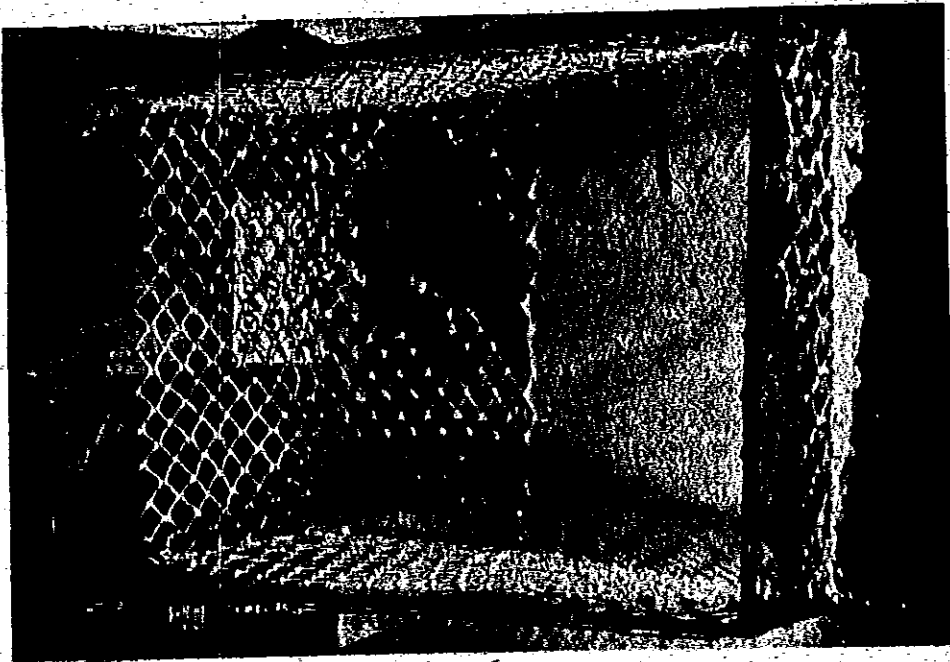


Fig. 3. Appearance of 10,000 mg/l of Corexit 8666 in sea water. The flounders shown, and other test organisms, survived this concentration.

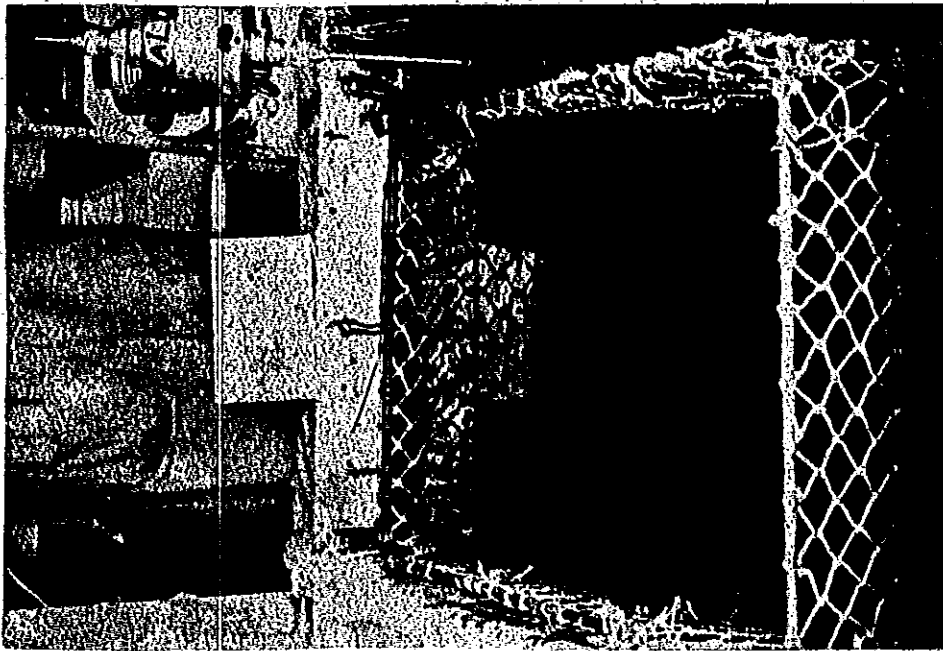


Fig. 4. Appearance of 1000 mg/l of Bunker C oil dispersed in sea water with an equal amount of Corexit 8666. Lethal to flounders in about a week, but not to lobsters.