Oil Pollution: Damage Observed in Tropical Communities along the Atlantic Seaboard of Panama
Author(s): Klaus Rützler and Wolfgang Sterrer
Source: *BioScience*, Vol. 20, No. 4 (Feb. 15, 1970), pp. 222-224
Published by: American Institute of Biological Sciences
Stable URL: http://www.jstor.org/stable/1295129
Accessed: 17/04/2009 12:18

Oil Pollution

Damage observed in tropical communities along the Atlantic seaboard of Panama

Klaus Rützler and Wolfgang Sterrer

From 18 to 22 February 1969, approximately 2 months after the wreck of the oil tanker *Witwater* (13 December 1968), we had the opportunity to visit the site of the event to make a preliminary study of the effects of oil pollution on marine habitats.

The incident occurred approximately 2 nautical miles northeast of Galeta Island, Canal Zone, where the marine facility of the Smithsonian Tropical Research Institute is located (Fig. 1). The 3400-ton tanker S. S. *Witwater* ruptured on its way to the Atlantic entrance of the Panama Canal.

Close to 20 thousand barrels of diesel oil and Bunker C were released during and after the accident and driven toward the Galeta Island shoreline by the strong onshore seasonal winds (Fig. 2).

By avoiding the use of detergents, which proved to be fatal to marine life during the well known Torrey Canyon wreckage (Scilly Isles) and by burning and pumping off the oil which had accumulated under the force of onshore winds in a small bay adjacent to the Galeta Laboratory, the Smithsonian Tropical Research Institute staff, in collaboration with members of the local military forces had considerably reduced the threat of severe damage to marine life.

Dr. Rützler is with the department of invertebrate zoology, Smithsonian Institution, Washington, D.C. 20560. Dr. Sterrer is with the Bermuda Biological Station for Research, St. George's West, Bermuda.

Fig. 1. Aerial view of the Smithsonian Tropical Research Institute Marine Laboratory, Galeta Island.

Fig. 2. Oil drifting toward the Galeta Island shore near the Marine Laboratory.

Unfortunately, because of the very recent initiation of research on invertebrate groups at the Galeta Laboratory, information available about the composition of the nearby biota in the unpolluted state is incomplete and concentrates on vertebrate populations only. However, by comparing our observations with data from other better known areas in the tropical Atlantic, we obtained a good impression of the actual and potential damage to the flora and fauna of the various habitats caused by the oil spillage.

Rocky Shores

Since oil untreated with detergents is floating on the surface, it is the intertidal biota which suffer most from a spill. A great percentage of the affected shore consists of exposed rocky coast, mainly the Fort Randolph area and the causeway leading to the Galeta Laboratory. High winds caused a spray of mixed seawater and oil to cover trees and shrubs in the supralittoral zone to a height of 2 m above mean tide level; the oil has already killed many of these plants. Supralittoral spray pools and upper mesolittoral tide pools are still covered with a layer of oil up to 2 cm deep and are devoid of life (Fig. 3). Thanks to the strong water agitation producing water-in-oil emulsions, the lower mesolittoral and the infralittoral zones were only temporarily affected by oil. The waves, as soon as they had discharged their oil, already started to erode it again. Also, the rapid action of the emergency crew, who by pumping and burning eliminated large quantities of oil (Fig. 4) before the tide had withdrawn, helped to lessen the effects in these zones. Nevertheless, damage to the gastropod and barnacle populations has to be assumed.

Wherever rocks and driftwood are fully exposed to the sun at low tide, the oil layer is slowly being reduced to a thin crust of tar and the substrates are being repopulated by the usual variety of intertidal organisms.

Coral Reefs

Although the water was very agitated and turbid during our visit, we were able to dive in shallow water. The reefs seemed to be the least affected communities of all. Shallow coral patches, consisting mainly of *Porites furcata, P. asteroides, Siderastrea radians, Millepora Complanata* (a hydrocoral), and associated organisms showed no ill effects at the time of the survey. This can be explained

Fig. 3. Oil-covered supralittoral spray pool near Fort Randolph.

by the fact that these corals were subtidal and did not come into direct contact with the oil, which is mainly confined to the air-water interface. Further, due to high winds, water level at low tide was higher than usual; some of the corals observed would probably be partly exposed during very low tides, but they were not exposed or affected by oil during this period.

Sandy Beaches

Below a blackish oil-stained supralittoral zone, the sandy beaches of the affected area looked clean, at first glance. However, below a recently accumulated clean layer (2-5 mm), the sand was permeated completely with oil. In contrast to the rocky shore, sandy beaches as well as mangrove swamps have a rather horizontal than vertical extension (flat angle of exposure), and a large "internal" surface. They act as huge natural filters for the water masses brought in by waves and tides.

In the case of the sandy beach, still another phenomenon has to be considered, that of the subterranean backflow of water. With every wave breaking and running dead, a considerable amount of water is transported up the beach. Whereas most of the lower portion of this water body flows back on top of the sand, most of the upper portion filters vertically into the sand (Sterrer, 1965). Rough observations showed that, taking a wave

Fig. 4. Burning of oil which was trapped in a small bay next to the Galeta Marine Laboratory.

period of 10 sec, and a water layer 1 mm thick as a basis, this means that 86,400 liters of water are filtered through 1 m of surfaces and per 24 hr. This considerable amount of water, then, together with the fresh groundwater, creates a continuous stream which—depending on local conditions—may continue for hundreds of meters underneath the sea bottom.

In the case of an oil spill, this means that the surface oil film brought ashore is deposited on top of the sand when the water soaks in and is pressed down by the

TABLE 1.

	Oil sand	Unaffected sand	
	Panama	Florida [a]	Morehead City, N.C.
Ciliata	45	-	32
Turbellaria	3 [b]	38	243
Nematoda	6	22	8.000
Archiannelida	-	100	-
Other Annelida	6	4	40
Copepoda	-	18	45
Others	-	2	430
Total	60	194	8.790

[a]Average of cores d-1, top 35 mm (Bush, 1966, p. 64)
[b]*Macrostomum* sp.

following wave. The subterranean current, therefore, will mix more and more with oil which will invade biotopes far from the contaminated surface. On the positive side, the large surface area of the interstitial oil droplets will facilitate bacterial degradation.

Some quantitative samples of sand which we collected came from a small beach in the mangrove, approximately 2 km southeast from the Galeta Station. The sand (medium grain size, with a high amount of detritus), taken at midwater level, was heavily contaminated with oil to at least 30 cm sediment depth. An analysis[1] showed that 100 cm of sand (average wet weight = 121.9 g) held 31.8 g of water and 6.2 g oil. One fresh sample was brought back to the laboratory and studied alive, using the magnesium chloride technique described by Sterrer (1968).

Data for comparison with unaffected beach sediments of similar characters come from Bush (1966), who did her study on Florida beaches, and from unpublished samples collected in Morehead City, North Carolina, during a recent student excursion with Dr. R. Riedl (Chapel Hill). Whereas the Florida data seem to refer to a medium sheltered beach, the North Carolina material was collected on a very sheltered tidal sand flat. For better comparison, the number of specimens given in Table 1 have been calculated for 100 cm^3 of sediment.

[1]To determine the oil content of the samples, the sand was dried at 37 C over silica gel until no more weight loss occurred. Then it was repeatedly washed in benzene. The blackish stained benzene was then evaporated in large Petri dishes at 37 C and the residue weighed.

Fig. 5. Intertidal stilt roots of *Rhizophora* in a badly affected mangrove area.

The considerable difference in the nematode figures of the Florida and the North Carolina samples can be explained partly by the much more sheltered position of the latter collecting locality. This invariably means, on sandy beaches, that the absolute numbers as well as the dominance of nematodes increase. Another factor is that of the method—our samples from both Panama and North Carolina were washed with about 8 liters of magnesium chloride solution and then filtered through a plankton netting of 65 micron mesh width, whereas the Florida samples were treated with much less fluid and simply decanted.

Summarizing these few and very preliminary data, it seems that the oil inflow into the sand beach ecosystem results in a dramatic reduction of the meiofauna population. Obviously, animals with a relatively large (limbs) and inert (cuticula) body surface, such as crustaceans, are the first to disappear. The occurrence of comparatively large amounts of small ciliates might indicate the presence of oil-degrading bacteria on which they prey.

Mangroves

As could have been expected, the mangroves, being a predominantly intertidal community, suffered the most under the oil spillage. All the oil that could not settle along the exposed rocky shores was finally driven into the protected mangrove area (Fig. 5). The wide intertidal mud flats were all more or less thickly covered with oil. So was the surface of the tide channels distant from the open sea. Every footstep on the mud at low tide released large quantities of oil from the substrate. The pneumatophores of black mangrove trees (*Avicennia*) were all covered with a mixture of oil and mud. The stilt roots of the red mangrove (*Rhizophora*) had a thick

Fig. 6. Dead oil-covered seedlings of *Rhizophora*.

layer of pure oil on their mesolittoral sections. It is still too early to judge damage on the fully grown trees, but it is to be expected that *Avicennia* in particular will suffer, since their pneumatophores are of vital importance for the ventilation of the remainder of the root system, which is buried in the anaerobic mud. The majority of young seedlings of *Rhizophora* were found to be killed, covered by oil (Fig. 6).

We did not obtain any data on the microfauna of the mud which could not be studied alive. A strong reduction of the fiddler crab population (*Uca* sp.) could be observed in comparison to other mangrove areas. This is not surprising if we compare the oil content values of four mud samples taken in a mangrove swamp 1 km southeast of Galeta Marine Station, 500 m distant from the open water. The samples (5 cm surface layer) were selected from intertidal localities which appeared to be affected by a various degree (I-III):

Sample	Wet weight (g/100 cm³) (saturated with water)	Water (g/100 cm³)	Oil (g/100 cm³)
I	170.3	56.1	9.3
II	143.1	53.4	17.0
III	119.2	50.9	21.4

Fig. 7. Oil-smeared *bostrychietum* on *Rhizophora* roots.

The characteristic intertidal algal community "*bostrychietum*" on the *Rhizophora* stilt roots and its inhabiting microfauna were practically eliminated in all oil exposed areas (Fig. 7); as were the sedentary animals of this zone, such as oysters (*Crassostrea* sp., Fig. 8), mussels (*Brachidontes* sp.), barnacles (*Balanus* sp.), sponges, tunicates, and bryozoans (compare: Rützler, 1969).

The infralittoral horizon in the mangroves consists of numerous tide channels and lagoons. There the wickerwork of *Rhizophora* stilt roots provides protec-

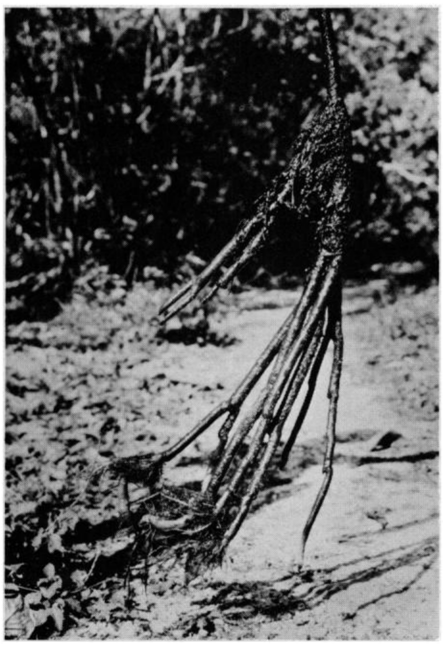

Fig. 8. Dead oil-covered oysters on *Rhizophora* stilt roots.

tion for many juvenile and adult fishes and various crustaceans, many of which are of commercial importance. All of these are directly or indirectly (via the food chain) endangered by oil pollution. Obviously affected are those species which, for respiration, or for obtaining food, have to penetrate the air-water interface. We have observed dead and dying young sea turtles (*Caretta* sp.) on mangrove beaches; mass mortality of seabirds had been reported by the Torrey Canyon Report; a number of oil-smeared herons and one dying commorant were observed by a staff member of the Smithsonian Tropical Research Institute, near Galeta.

Conclusions

This fragmentary survey taught us the importance of immediate research on the effects of oil pollution in the sea, so that we may be ready for possible future oil spills; with increasing use of larger tankers, wrecks in the future could be catastrophic.

Even some of the long-term effects of the fortunately moderate accident off Galeta have yet to be investigated. We should take advantage of this warning and concentrate on research at places, such as Galeta, where the conditions of the natural environment can be studied, as well as the effect upon those conditions of experimentally introduced oil spills. Physical and chemical as well as biological phenomena must be studied in this connection. STRI has already proposed one such effort.

Acknowledgment

We are grateful to Dr. P. Glynn, Mr. E. Kohn, and Dr. I. Rubinoff of the Smithsonian Tropical Research Institute for their hospitality and valuable advice. Dr. Rubinoff provided Figures 1, 2, and 4.

References

Bush, L. 1966. Distribution of sand fauna in beaches at Miami, Florida. *Bull. Mar. Sci.*, **16:** 58-75.

Rützler, K. 1969. The Mangrove Community, Aspects of its Structure, Faunistics and Ecology. Proc. International Symposium on Coastal Lagoons, Mexico City, 1967 (in press).

Sterrer, W. 1965. Zur Oekologie der Turbellarien eines suedfinnischen Sandstrandes. *Botanica Gothoburgensia*, **3:** 211-219.

______. 1968. Beitraege zur Kenntnis der Gnathostomulida. I. Anatomie und Morphologie des Genus *Pterognathia* Sterrer. *Arch. Zool.*, **22:** 1-125.