

# The Torrey Canyon Disaster and Intertidal Marine Life

by

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On March 18, 1967, the tanker Torrey Canyon ran aground on the Seven Stones reef off Land's End. At least 60,000 tons of crude oil has since been released. In mopping up, large quantities of detergent have been used to emulsify the oil. The effects of the oil and detergent on the intertidal marine life have been examined at two areas of the Cornish coast. The report paints a dismal picture.

## Sennen Cove, April 6

THIS beach on the southern end of Whitesand Bay is one of the worst hit beaches on the Cornish coast. According to local information the oil must have been more than a foot thick in places. Many of the boulders on the upper part of the beach were almost completely hidden. The area was the subject of one of the most intense oil-clearing efforts. Roughly 22,500 gallons of detergent are said to have been used each day.

The following procedures were being used to remove the oil. On the rocky part of the shore detergent was first sprayed at high pressure to emulsify the oil, and the resulting mixture washed off with water from fire hoses. On the sandy beach the sand was ploughed up with bulldozers and then sprayed with detergent. It was hoped that the churning action of the surf as the tide rose would then wash the emulsified oil out of the sand.

No fauna, dead or alive, was found in the sandy area, even in those parts in which bulldozing was not carried out. A transect from high to low water mark was marked out on the beach and 1/16 square metre areas were examined at intervals of 10 metres along it. In the absence of any living or dead material, however, it is impossible to estimate the effects of the oil or detergent on the sand. The rocky shore, however, presented a completely different picture. Many of the pools and hollows between boulders contained dead fish and invertebrates. The findings are shown in Table 1. Some polychaete worms were still showing signs of life, but most of them had perished. Species found included ragworms (*Nereis diversicolor*) and lugworm (*Arenicola marina*). An almost complete absence of gastropod snails was also noticed.

The whole of this shore had been sprayed several times with detergent, but in many areas quantities of oil still adhered to the rocks. Above high water mark some pools of pure oil, black in colour, still remained, but on the lower shore and on the sand all the oil had formed an emulsion with sea water and resembled melted chocolate in appearance and consistency. Where the process of emulsification had been carried further by using detergent, a milky liquid was formed which flowed down the shore as spraying proceeded. This liquid is apparently an emulsion of the oil in sea-water, whereas the brown substance is an emulsion of water within the oil.

The northern end of the beach, which had been affected by oil, but had not received direct spraying with detergent, was also briefly examined. The shore here is also rocky, but is much more exposed than the southern end. No dead fish or invertebrates were found. As in the southern part of the shore, limpets (*Patella vulgata*) were easily pulled from the rocks, but not so many had actually become detached or been washed off. Anemones (*Anemonia sulcata*) were still attached to the rocks, but were strongly contracted, even under water. A few small

Table 1. SPECIES FOUND DEAD AT SENNEN COVE OR PORTHWARRA AFTER MOPPING-UP OPERATIONS

FISH		Location	Comments
Eel	<i>Anguilla anguilla</i>	P.	Many dead eelers in pools of fresh water stream
Rocklings		S.	Specimens up to 85 cm long
Three-bearded rockling		P.	
Sand-eel	<i>Ammodytes</i> sp.	S.	Specimens up to 80 cm long
Lesser weever	<i>Trachinus vipera</i>	S.	
Montagus blenny	<i>Blennius montagui</i>	S. and P.	
Common blenny	<i>Blennius pholis</i>	S. and P.	
Long-spined sea scorpion	<i>Cottus bubalis</i>	P.	
Dab	<i>Pleuronectes limanda</i>	S.	
Flounder	<i>Pleuronectes flesus</i>	S.	Many young
Cornish sucker	<i>Lepadogaster gouvani</i>	S.	
INVERTEBRATES			
Sea anemone	<i>Actinia equina</i> <i>Anemonia sulcata</i>	S. and P. S. and P.	} Either detached from rocks or showing signs of injury. The tentacles of <i>Actinia</i> were frequently withdrawn tightly even under water. <i>Anemonia</i> species seemed to have lost their power to react to external stimulus
Ragworm	<i>Nereis diversicolor</i> <i>Nereis cultrifera</i>	S. P.	
Lugworm	<i>Arenicola marina</i>	S.	
Barnacle	<i>Balanus balanoides</i>	S.	Many have lost their opercular plates
Isopod	<i>Eurydice pulchra</i> <i>Idotea emarginata</i> <i>Idotea pelagica</i>	S. S. and P. S.	One live specimen found
Amphipod	<i>Merinogammarus</i> sp. <i>Amphihoe rubricata</i>	P. P.	
Prawn	<i>Leander serratus</i>	S.	
Common shrimp	<i>Crangon vulgaris</i>	S.	
Edible crab	<i>Cancer pagurus</i>	S. and P.	} More than 50 per cent of crabs were berried females
Shore crab	<i>Carcinus maenas</i>	S. and P.	
Chiton			
Limpet	<i>Patella vulgata</i>	S. and P.	Fallen from rocks or now loose
Periwinkle	<i>Littorina littoralis</i>	S. and P.	Live specimens present on the fronds of <i>Fucus</i>
ALGAE			
	<i>Enteromorpha</i>	P.	Growing in and around the fresh-water stream, but now bleached to a pale fawn colour
	<i>Rhodochorton</i>	S.	Greasy velvet in appearance.

S., Sennen Cove, April 6. P., Porthwarra, April 8 (after detergent spraying operations).

periwinkles (*Littorina littoralis*) were found on oil-covered fronds of *Fucus*.

## Porthwarra, April 7

Porthwarra is a small rocky creek about 3 miles south-east of Land's End. The shore here consists of rock and boulders, between which a small fresh-water

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dent set of genes for V. (i) If V sections are derived from a common ancestor set, then conservative residues should have been selectively preserved; but such conservative stretches are not common to different species or to  $\kappa$  and  $\lambda$  chains of a single species. (ii) The doubling of an ancestral C to produce the second type of light chain would presumably have had the best chance of survival if it recognized the pre-existing set of V peptides. Variable sections of light chain should therefore be common to  $\kappa$  and  $\lambda$  chains, but this is not the case. The following facts are also relevant to any theory involving two genes per chain: (iii) Pulse labelling experiments have, as yet, provided no direct evidence for separate synthesis of C and V halves of chains. (iv) Polysomes involved in the synthesis of immunoglobulin are of appropriate size for heavy and light chains and not smaller units<sup>32,33</sup> (but compare ref 34). (v) Certain Gm specificities located on different halves of  $\gamma$  chains are invariably paired<sup>35</sup>; if the specificities on the N-terminal half (Gm(z) and Gm(f)) are in fact in V, then any mechanism involving gene fusion seems to be excluded. (vi) If rabbit allotypes (A1-A3) are in the variable region of the heavy chain controlled by multiple genes, then the explanation of their Mendelian inheritance becomes problematical.

Because only a limited number of genes must control C and because two gene models of chain synthesis appear unsatisfactory at least for the light chain, it seems likely that:

(3) Variability arises from a small number of genes by somatic hypermutation of the stretch coding for V. Several mechanisms have been proposed: (i) Somatic rearrangements, involving inverted duplications<sup>36</sup>, do not easily explain the nature and distribution of residue differences along the entire length of V. (ii) Specialized messenger translation mechanisms, involving the use of unusual triplets<sup>37</sup>, appear to be excluded by observed variations in chain length and also by other features such as the predominance of substitutions involving single base changes. (iii) A somatic mutation mechanism involving a defective repair enzyme which becomes operative after stretches of DNA coding for V have been split off<sup>38</sup> would generate a far larger number of variants than appears necessary<sup>31</sup>. (iv) Crossing-over between a single (functional) gene coding for the whole chain and a set of v genes (modifiers) present, for example, on an episome, would also account for the separate evolution of chain types because each has a separate functional gene<sup>44</sup>. An enzyme which promotes crossing-over could become active at a specific stage of differentiation. Conservative sections of V could provide the requirements for correct pairing. The problems raised in 2(v) and (vi) remain applicable to this model.

For the sake of simplicity, possibilities involving more than one of the mentioned mechanisms, or different mechanisms for distinct chain types<sup>41</sup>, are not discussed. Although it seems likely that variability of immunoglobulin chains is generated by a somatic mechanism, available sequence data provide no positive evidence for any of the model systems that have been advanced. A more critical assessment of the genetic mechanisms involved may come from an understanding of the evolutionary pattern of immunoglobulin and from studies on the inheritance of well characterized variants.

This review of recent work on the structure of the immunoglobulin molecules is in part based on a symposium organized by the Royal Society in 1966<sup>42</sup>. More detailed bibliographies can be found in other reviews soon to be published<sup>41,43</sup>.

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## THE TORREY CANYON DISASTER

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stream runs down to the sea. According to local information quantities of oil had come ashore there 8 or 9 days previously. Examination of the rocks showed that the oil was lying in two distinct bands—one at extreme high water springs, the other at the level of high water neaps around the lower limit of the pelvetia zone. Pure oil, black in colour, lodged only in the upper pools, on the rest of the shore it resembled melted chocolate. No detergent had been used here, and the object of examining this shore was to compare the effects of oil alone (Porthgwarra) with those of oil and detergent (Sennen Cove).

At Porthgwarra animal life appeared to be perfectly normal and healthy. The only unusual feature noticed was that limpets (*Patella vulgata*) could be pulled off the rock surface quite easily by hand. Gastropod snails (*Littorina* species) were seen crawling on the fronds of *Fucus*, even though the fronds were covered with oil, and it seemed doubtful whether the plants would survive. As at Sennen, fronds of algae seemed to have a particular attraction for the oil, and very few plants escaped a covering of it.

While we were examining the shore, equipment for spraying the area with detergent arrived and it was learned that the operation would be carried out during that day. Accordingly a second visit to Porthgwarra was planned for the following day, as this would offer an excellent chance of observing the effects of the detergent on marine life.

### Porthgwarra, April 8

On examining the shore the next morning (low water about 11.20 a.m.) the effects of spraying with detergent were immediately obvious (see Table 1). In the pools and hollows between the boulders on the lower shore there were many dead fish, and many dead invertebrates were

found in the rock pools. It was noticed that limpets (*Patella vulgata*) had become much looser in their attachment to the rocks, and some had fallen or been washed off. Most of them, however, were still alive. Far fewer gastropod snails were seen than on the previous day, and only a few specimens of *Littorina littoralis* were found. Other molluscs seen included dead specimens of a chiton and a sea-snail.

According to local information, spraying had been carried out on the previous day from about 10 a.m. to 3 p.m., that is from half an hour before low water to an hour and a half before high water. Some traces of oil still remained on the rocks, and on the upper shore some thick deposits of oil still existed in clefts between rocks.

### Comments

It is apparent from these findings that the mixture of emulsified oil and detergent is far more toxic than the oil itself. Two theoretical considerations would seem to lend support to this view. First, all or nearly all detergents are themselves toxic; second, once the oil is emulsified it ceases to become merely a surface layer and becomes instead an actual part of the aqueous environment where it may be taken into the gills of fish or ingested by filter-feeding organisms, etc. Thus where littoral marine life is concerned, the use of detergents constitutes a "cure" worse than the "disease" itself.

In offshore waters, the effects of spraying oil patches with detergents are as yet unknown. It is hoped that the immense capacity for dilution available in the sea may alleviate or nullify any toxic effects. Much of the emulsified mixture, however, is likely to remain near the surface and, while pelagic fish may not suffer harm from it, it is possible that large numbers of planktonic organisms may be destroyed.

Much work needs to be carried out before the most effective way can be found of solving such oil problems—taking into consideration all interests including marine life, fisheries, sea-birds and amenity value of beaches. It is hoped that the Torrey Canyon affair, disastrous though it has been in many respects, will act as a spur to such efforts.

We thank Mr. G. Wollaston, M.A.F.F. Fisheries Officer at Newlyn, and Mr. B. T. Hepper of the Fisheries Experiment Station at Conway for advice and encouragement, Mr. B. W. D. Richardson for encouragement and invaluable help during the survey of Sennen Cove, Miss Monica Gaiger for putting her car at our disposal, and the military and civil personnel engaged on operations at Sennen who allowed us unrestricted access to the area where detergent spraying was being carried out.

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### University News:

### The City University

DR. M. A. JASWON, at present a reader in mathematics at the Imperial College of Science and Technology, has been appointed professor and head of the Department of Mathematics, and Dr. V. E. Price, reader in mathematics at the university, has been appointed professor of computer science. Mr. P. K. M'Pherson, at present a lecturer at St. John's College, Oxford, has been appointed first professor of instrument and control engineering at the university, an appointment which is unique in Great Britain.

### London

PROFESSOR A. P. WATERSON, professor of medical microbiology at St. Thomas's Hospital Medical School, has been appointed to the chair of virology tenable at the Royal Postgraduate Medical School.

### Appointments

MR. D. W. WRIGHT, at present deputy director of the National Vegetable Research Station, has been appointed director of the station in succession to Dr. James Philp.

DR. W. A. SIMMONDS, at present director of industrial research at Solihull, has been appointed director of the Gas Council's Midlands Research Station at Solihull, Warwickshire, in succession to Dr. F. J. Dent.

### Announcements

THE Deutsche Akademie der Naturforscher Leopoldina, Halle, recently elected the following new members in the sections indicated: *Physics*, Professor H. Schopper (Karlsruhe); *Chemistry*, Prof. D. H. R. Barton (London); *Geology*, Professor D. Andrusov (Bratislava); Professor P. F. J. Macar (Liège); Professor T. F. W. Barth (Oslo); *Botany*, Professor A. E. Pop (Cluj); *Anatomy*, Professor G. Wolf-Heidegger (Basle); Professor G. Romhányi (Pécs); *Physiology*, Professor K. Lissák (Pécs); *General Pathology*, Professor W. E. Griesbach (New Zealand); Professor G. Holle (Leipzig); *Hygiene*, Professor H. Meisel (Warsaw); *Pediatrics*, Professor H. Asperger (Vienna); *Internal Medicine*, Professor R. Schmid (Chicago).

CORRIGENDUM. On page 157 of the article entitled "An Early Miocene Member of Hominidae" by L. S. B. Leakey (*Nature*, 213, 155; 1967) the height of the incisor of *Kenyapithecus wickeri* is given as 10.25 mm (labial and lingual). This should read 9.25 mm.

## THE NIGHT SKY IN MAY

All times are in Universal Time

MOON		CONJUNCTIONS WITH THE MOON	
New Moon	9d 15h	Venus	13d 07h, 2° S.
Full Moon	23d 20h	Mars	20d 16h, 2° S.
		Jupiter	15d 04h, 5° S.
		Saturn	6d 04h, 0.5° N.

### PLANETS

Name	R/S	Times of rising (R) and setting (S) during the month			Mag.	$D_p$ (10 <sup>6</sup> miles)	Zodiacal position
		Beginning	Middle	End			
Mercury	S	Unfavourable	20h 15m	22h 00m	-1.7	121	Taurus
Venus	S	23h 20m	23h 30m	23h 35m	-3.6	98	Gemini
Mars	S	4h 10m	3h 00m	2h 00m	-0.9	60	Virgo
Jupiter	S	1h 30m	0h 35m	23h 40m	-1.6	524	Gemini
Saturn	R	Unfavourable	2h 50m	1h 55m	+1.1	946	Cetus

$D_p$  is the distance of planet from the Earth on the 15th of the month.

### OTHER PHENOMENA

6d 04h Saturn occulted by the Moon, visible in S.E. Asia, Indonesia, W. and N. Australia.  
9d 15h Partial eclipse of the Sun, visible in N. America and N. Europe (not in British Isles).

Eclipse begins	12h 37m
Greatest eclipse	14h 42m
Eclipse ends	16h 47m

21d 01h Mercury 7° N. of Aldebaran.  
31d 13h Venus 4° S. of Pollux.