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Paralytic shellfish poisoning: a short account of an outbreak occurring on the north-east coast of Britain in May 1968

by

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At the end of May 1968, there occurred in north-east England an outbreak of paralytic shellfish poisoning which affected 85 persons who had consumed mussels (Mytilus edulis) taken from the Budle Bay-Holy Island area (Figure 1). Such outbreaks, whilst relatively common in North America, are rare in Europe, and intensive investigations were therefore made by a number of groups to establish the circumstances of the outbreak. This account sets out only the main features of the incident which will be described in greater detail elsewhere.

The first unusual observation was the sudden death of sea birds, mainly shags (Phalacrocorax aristotelis), on and around the Farne Islands between 14 and 23 May. Post mortem observations failed to reveal the cause of death, although intestinal haemorrhage was commonly observed. Before death, birds were seen to lose equilibrium and stagger, and many vomited sand-eels (Ammodytes spp.), which are their normal diet. Large quantities of dead sand-eels were caught in nets and washed up on the shore just south of the Farne Islands, between 24 and 27 May. In addition, dead sand-eels were reported in the catch of a seine-net boat much further north, off Rosehearty, on 30 May.

The main outbreak of paralytic shellfish poisoning in humans occurred on 30-31 May, when 85 persons became ill after eating mussels, most of which had been purchased from a shellfish shop in the city of Newcastle-upon-Tyne. The mussels were gathered on 28-29 May from commercial mussel layings in the Holy Island-Budle Bay area, which is the centre of the only commercial mussel

fishery in north-east England. These mussels are normally gathered at weekly or twice weekly intervals throughout the year, and those taken during the previous week were apparently harmless. Several other cases of illness occurred among those who gathered mussels from the same area for themselves from 19 to 26 May. Most of the illnesses were caused by mussels which had been steamed in the shop for 20 minutes and the liquors discarded before consumption, although some patients cooked the mussels only for 5 minutes; none ate the mussels raw. The symptoms were typical of P.S.P. cases reported in North America, with a short incubation period (at times as little as 20 minutes), loss of sensation of the hands, tingling of the mouth and tongue, a sensation of floating, and weakness of the limbs. In the worst cases there was difficulty of respiration; there were no fatalities, although several patients were taken to hospital.

When the outbreak was identified, the local health authorities stopped the sale of mussels, and on the advice of the Ministry of Agriculture, Fisheries and Food closed the whole of the Northumberland coast for the taking of bivalves. This area was subsequently extended to include the whole of the coast between Fife and the Humber. By 31 May, the presence of P.S.P. toxin in the mussels was confirmed by the Newcastle Public Health Laboratory using the standard mouse toxicity technique employed in North America. Mussels causing the illness contained, before cooking, between 10 062 and 20 800 mouse units of toxin per 100 g of meat, which is greatly in excess of the value of 400 units considered in North America to be the maximum safe level. After cooking for 20 minutes, 60.5 per cent of this toxin was still present, with 32 per cent in the liquor and 28.5 per cent in the meat. Fortunately, the liquor was discarded and not consumed. Patients who were ill received doses of toxin ranging between 3 000 and 30 000 mouse units; some became ill after eating only 3 000 units, whilst others escaped illness after taking 30 000 units.

Having established that the mussels were toxic, a survey was made to determine the geographical extent of the toxicity. Initially mussels, escallops (Pecten maximus) and queens (Chlamys opercularis) were taken from places between Musselburgh and the River Humber, but sampling was later extended to include mussels from stations north of the Firth of Forth and on the west coast of Scotland, and mussels, cockles (Cardium edule) and oysters (Crassostrea angulata) from the east coast of England as far south as the Thames Estuary. The results of tests on samples collected between 29 May and 7 June south of the Firth of Forth are shown in Figure 1 and from other Scottish stations between 10 and 14 June in Figure 2. South of the

Firth of Forth the toxic area extended without break over 200 miles (320 km) of coast and at least 8 miles (13 km) offshore in the region of the Farnes and Flamborough Head. The highest concentrations (> 20 000 units/100 g) occurred in mussels collected between Eyemouth and Blyth. On the east coast of Scotland, toxicity reached 3 867 units at Burntisland, on the Fife coast, was absent at Montrose, but present at Aberdeen, the Ythan, and Sandhaven near Rosehearty, where sand-eel mortalities had earlier occurred. None of the samples taken from the west coast of Scotland contained detectable toxin. Tests have continued at intervals and there has been a steady decline of toxicity at all stations (Table 1).

On average a 50 per cent reduction of the concentration of toxin took place in about one week. Thus the time taken for raw shellfish to become safe for human consumption (< 400 units/100 g) depended upon the initial concentration of toxin present. Mussels from Eyemouth and Blyth with an initial concentration of 20 800-27 000 units/100 g took eight weeks to reach the safe concentration, whilst those from Dunbar (initial concentration 3 200 units) took only two weeks. All shellfish from the toxic area were safe for human consumption on 23 August, eleven weeks after the initial detection of toxicity. Tests for toxicity have continued with shellfish from a number of stations around the United Kingdom, but at the time of writing no toxicity has been detected at any other point.

The concentration of toxin in single samples of other shellfish collected off the Northumberland coast was as follows: escallops (Pecten maximus) 7 840 units, cockles (Cardium edule) 3 136 units, queens (Chlamys opercularis) 1 280 units, soft clams (Mya arenaria) 668 units. The adductor muscle of the escallop contained only 216 units/100 g.

Apparently normal specimens of several species of fish and other shellfish taken from the Northumberland coast contained no detectable toxin: plaice (Pleuronectes platessa), flounders (Platichthys flesus), haddock (Melanogrammus aeglefinus), herring (Clupea harengus), winkles (Littorina littorea), whelks (Buccinum undatum), lobsters (Homarus vulgaris) and crabs (Cancer pagurus). However, laboratory tests have shown that whelks when fed exclusively on highly toxic mussels for 12 days accumulated up to 1 112 units/100 g of tissue.

Plankton observations were started soon after the report of dead birds and sand-eels and again when toxin was detected in mussels. At no time were bloom concentrations of toxic dinoflagellates found in the vicinity of toxic molluscs, but it is well established that the toxin may be retained by

Table 1 Toxicity of raw mussels expressed as mouse units/100 g tissue

	June					July			August	
	27-2	3-9	10-16	17-23	24-30	1-7	8-14	15-21	5-11	12-18
	Weeks after mussel toxicity									
	0	1	2	3	4	5	6	7	10	11
Rosehearty			547		243		<200+			nil
River Ythan			218		nil					nil
Aberdeen			243		nil		nil			nil
Montrose			<200		nil		nil			nil
River Eden			3333		302		<200+	nil	nil	
Lower Largo			2833		1545		315	<200+	nil	
Burntisland			3867		<200+		<200+	nil	nil	
Musselburgh		106		nil	nil			nil		nil
Dunbar		3200		362	360					nil
Eyemouth		20080		17400	5995			732		278
Holy Island	20800		3880		3740			525		nil
*Farne Bank			7840		2080					382
Budle Bay	18480	9480			2800			260		nil
Blyth		27000	24780	13300		5496		865		<200+
Hartlepool		5920	3880		1126			183		nil
Scarborough		12800	5600		1374			nil		nil
Bridlington		190	nil		nil			nil		nil
/Cleethorpes-Grainthorpe		nil	nil		nil			nil		

+Some toxin present

*Escallops (whole meat)

/Cockles

bivalves long after the bloom has disappeared. However, exceptional phosphorescence was seen on the 14 May around the Farne Islands and on 22 May off Staithes; water samples from the latter area were found to contain Gonyaulax tamarensis at a concentration of 74 000/litre. On 24 May, Dr J. B. Buchanan of the Dove Marine Laboratory, Cullercoats observed a discoloured patch of water 4 miles off Blyth, which contained a dinoflagellate subsequently identified as G. tamarensis. Other patches of discoloured water were observed 10 miles (16 km) ENE of the mouth of the River Tyne between 27 and 31 May and 2½ miles (4 km) off St. Abbs Head on 31 May. On and after 3 June small numbers of G. tamarensis were widely distributed off the north-east coast of England and off the Firth of Forth and Rosehearty, as far as 15 miles (24 km) offshore, but bloom concentrations were not observed, although Peridinium depressum was occasionally abundant. However, samples taken by continuous plankton recorder, and analysed by Mr G. A. Robinson of the Oceanographic Laboratory of the Scottish Marine Biological Association at Edinburgh, showed that G. tamarensis first appeared in samples east of the Firth of Forth between 19 and 21 April. Numbers appeared to increase and spread southwards until the middle of May, reaching a maximum concentration 10-15 miles (16-24 km) off the coast between Eyemouth and the Farne Islands between 11 and 19 May. No observations were made within 5 miles (8 km) of the coast and only a few south of the Farnes, but it is probable that high concentrations were present in the coastal areas at the same time. Detectable concentrations were present up to 60 miles off the coast, but by the end of May these, together with the high concentrations, had virtually disappeared. Thus G. tamarensis was widely distributed off the north-east coast both immediately before and during the bird and sand-eel mortality and during the first cases of mussel toxicity. In the absence of any other toxic dinoflagellates in comparable numbers, it would seem reasonable to conclude that G. tamarensis was the source of the toxicity.

The presence of large numbers of dead Ammodytes off Northumberland between 24 and 27 May and off Rosehearty on 30 May would suggest that these fish are particularly sensitive to Gonyaulax toxin for no other dead fish were observed, except for a few plaice which may have died from other causes. A few dead or weak invertebrates have been found within the toxic area (Venus striatula, Macoma baltica, Cardium edule, Lucinoma borealis), but, apart from these and the dead birds, no other major biological damage has been reported.

A limited series of hydrographic observations was made off the north-east coast during the first half of June. Neither salinity nor water temperature

appeared to be abnormal. There was a well developed thermocline with surface water temperatures within the range 9.3-12.8°C. Nutrient concentrations were low when compared with those made in January but this was not unexpected after the spring phytoplankton bloom had taken place. Very low dissolved oxygen values (5-57 per cent saturation) were found at two stations 5 and 8 miles off Scarborough. It is possible that these may have resulted from oxygen depletion following the decay of an exceptionally heavy phytoplankton bloom.

Analysis of meteorological observations made off the north-east coast during the month of May shows that the frequency of onshore winds was higher in 1968 than in all years since 1957, although winds were stronger in 1967. During the first 11 days of the month there was no protracted sunshine but 12, 13 and 14 May were fairly sunny. Rainfall off the north-east coast during May was in no way unusual.

At present we have no explanation of why a bloom of toxic dinoflagellates should have occurred during 1968. It is likely that an unusual combination of hydrographic and climatic conditions occurred at a time when adequate mineral nutrients were present in the sea and this allowed a massive proliferation of Gonyaulax tamarensis to occur. During the last 40 years, only one incident of shellfish toxicity has been reported in Britain. The feasibility and need for routine surveys of shellfish toxicity are now under consideration.

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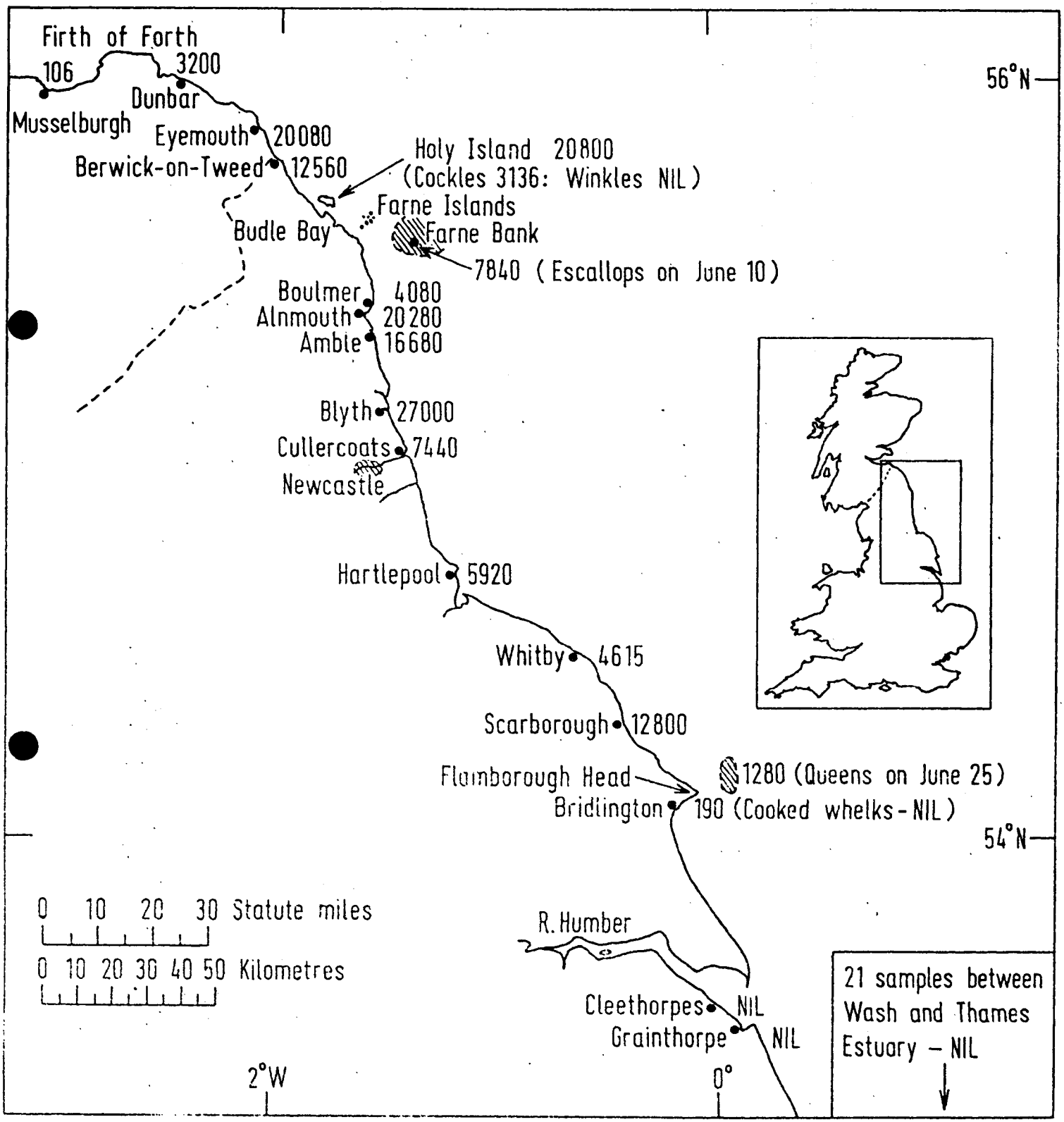

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Figure 1 Distribution of toxic mussels, 29 May to 7 June 1968 (mouse units per 100 grammes)

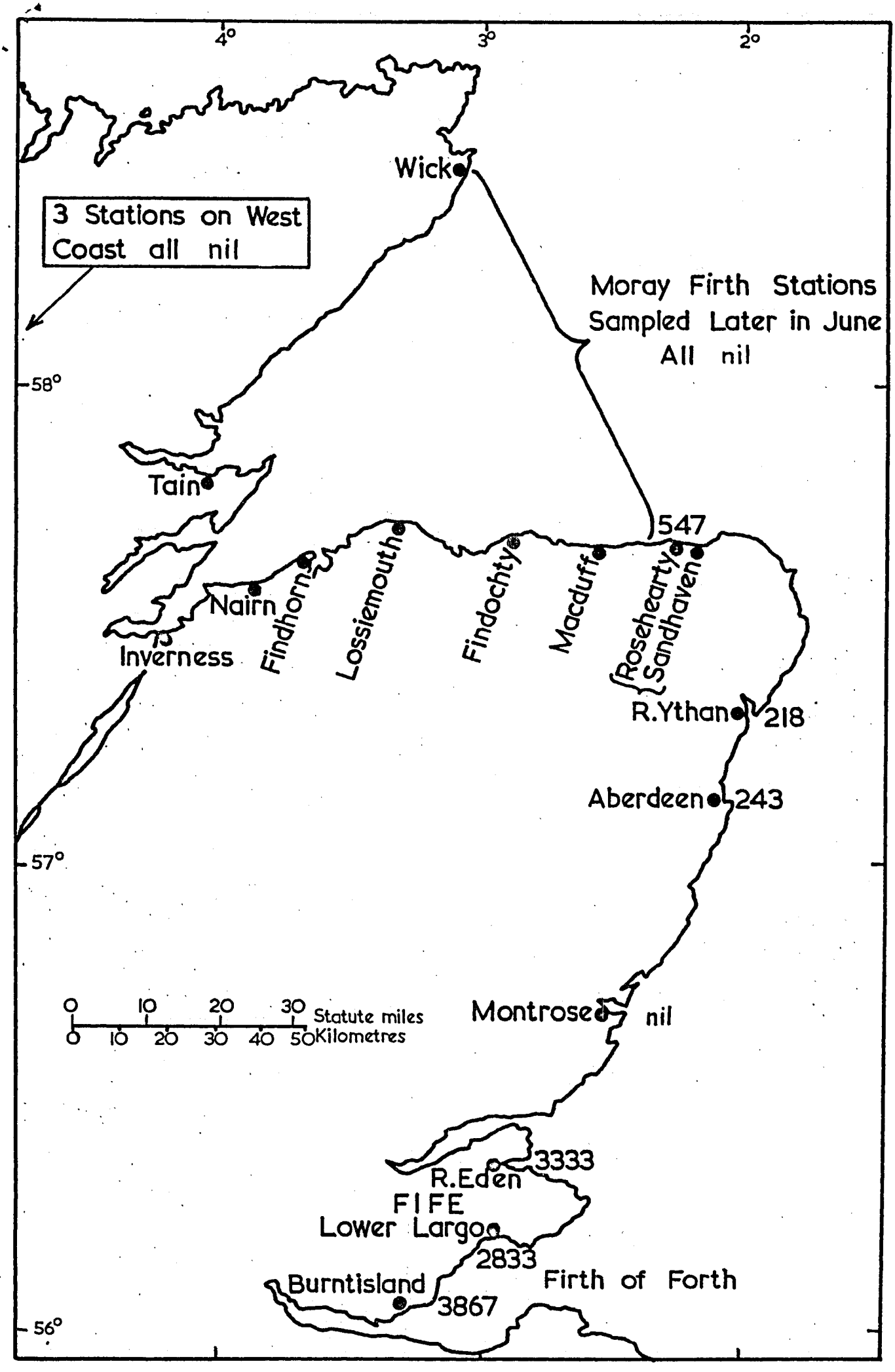

Figure 2. Samples taken 10–14 June.