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Seal Deaths in Cornwall

Autumn 1969

DSW 038131

Foreword

The occurrence of deaths amongst seal pups in Cornwall in the autumn of 1969 was investigated by the Seals Research Unit of N.E.R.C. The Officer in Charge of the Seals Research Unit gave interviews to the press and informed them of the progress of these investigations. Now that these are complete, we thought it would be in the best interests of everyone if an extensive account were produced. The following report is not in the strict form of a scientific paper and is somewhat more discursive; it is hoped that those receiving it will bear this in mind. Nevertheless, the investigations reported and the conclusions reached have been pursued with the utmost scientific rigour.

Acknowledgements

The Natural Environment Research Council (N E R C.) and the Seals Research Unit are much indebted for the help they received from people mentioned in the report, and in particular, for the co-operation they received from Mr. Jones, who runs a seal sanctuary at St. Agnes in Cornwall, and the Royal Society for the Prevention of Cruelty to Animals (R S P C A). The facilities accorded by the Ministry of Agriculture, Fisheries and Food (M A F F) locally were of great assistance and we are particularly indebted to Mr. A.V. Holden of the Department of Agriculture and Fisheries for Scotland Fisheries Laboratory at Pitlochry, and to Mr. S.E. Allen of the Nature Conservancy's Merlewood Research Station for the chemical analyses.

Introduction

Considerable public concern was expressed in the autumn of 1969 following reports of dead and dying seals being washed up on Cornwall shores. The reports referred mainly to young seals but also to adult seals suffering from lesions which were described as "burn marks". These reports followed closely on the reported deaths of around ten thousand guillemots and other birds of the auk family in the region of the Northern Irish Sea in September and October. Some of these birds were found on examination to have higher levels of some organochlorine compounds in their livers than are normally detected in routine monitoring, and this lead to suggestions that the seal deaths might be similarly connected with pollution.

The NERC Seals Research Unit investigated the event with the help of various other organisations and people. Most reports of seals were received through Mr. K. Jones, who for the past nine years has run a seal sanctuary at St. Agnes, and from Mr. G. Griffiths, RSPCA Inspector at Penzance. The MAFF Veterinary Investigation Centre at Truro carried out some of the post-mortem examinations, was responsible for all the bacteriological findings and provided laboratory and office facilities. Other organisations assisted with analyses of organs and tissues.

The pups

It has been stated that more than 50 pup seals have been found dead or dying on the Cornish coast. Mr. Jones has given details of 21 reports of seal pups in difficulties, of which he has personally confirmed 18. Four pups are still alive in his care. Mr. Griffiths has recorded 18 seals, plus 4 passed to Mr. Jones. One such pup, which subsequently died, was received from the Isles of Scilly. There is thus a total of 40 reports concerning 36 seals which were either found dead or died soon afterwards.

There were two reports from September, five from October and the remainder from November and the early part of December. Figure 1 shows the distribution of the dead and dying pups.

Mr. Jones says that ordinarily there are reports of 8 or 9 pups in difficulties each year and Mr. Griffiths suggests a similar figure; thus reports for 1969 are more numerous than usual. It is not certain to what extent these reports indicate a true increase in the number of dead pups. The publicity in the local and national press, and on television, had the additional effect of causing a greater proportion of dead seals to be reported. Dead seals are not usually reported to the RSPCA or Mr. Jones because they are past human aid.

Of the seals which died, 9 were subjected to a full post-mortem examination and 2 others were professionally examined. Four living pups were examined at Mr. Jones' seal sanctuary. One of these, collected at Portreath on 4 December, was a fat and healthy pup with an estimated weight of about 60 lbs; it appeared well able to fend for itself.

A second pup (7789), captured the same day at Godrevy, was in poorer condition. It weighed 42 lbs and had several bite-marks on its body, similar to those inflicted by adult seals on pups not their own which solicit feeding. There were no signs of gross infection. This seal would have had small chance of surviving in the wild. It died from accidental causes on 5 December.

A third pup was captured at Newquay on 26 November and the fourth at St. Agnes on 16 November. These were fed on a milk/margarine diet with mackerel. Both were very much undersized for weaned pups and probably weighed about 30 lbs. each. Mr Jones thought they were not putting on weight properly considering how much they ate. One had some superficial eye infection from which the organisms Corynebacterium pyogenes and Pseudomonas aeruginosa were isolated. Both pups produced a thick nasal mucus (as did two older seals at the sanctuary). This mucus yielded on culture an organism of the genus Proteus and Escherichia coli. It is unlikely that any of these organisms was directly responsible for the poor condition of the pups. C. pyogenes is often present normally on mucous membranes and skin; E. coli and Proteus, both enterobacteria, are widely distributed as non-pathogenic organisms, but may cause infections, as can Pseudomonas.

The remains of a pup carcass found at St. Agnes on 4 December were examined. The animal had been dead about six weeks and the head and the anterior part of the body were missing. Its weight at death was estimated at about 20 lbs. It was probably either a still-birth or a starveling which had received no milk from its mother.

The findings of the post-mortem examination of ten other seals are summarised in Table I. One seal (7789) died from accidental asphyxia. One (6822) was found to be suffering from pneumonia, but only the lungs were available for examination. Two (6887 and 7620) were recorded as dying from septicaemia. The cause of death of the remainder was diagnosed as starvation.

With the exception of 7789, which died from accidental causes, and 7620, the body weights of the remaining seven animals were all 35 lbs. or less. The average weight of a Grey seal pup at birth is about 31 lbs. and, under normal feeding, it reaches a weight of between 90 and 100 lbs. by its seventeenth day of life, when it is weaned (Coulson & Hickling, 1964).

Most Grey seal pups in Cornwall and the south-west generally are born in late September and October (Davies, 1957) so that it is highly probable all the pups examined were well past the age of normal weaning. Thus all pups weighed (except 7620) were grossly underfed. 7397, which weighed only 12 lbs, had the lowest weight ever recorded for a Grey seal pup. 7620 was estimated to be 65 lbs, but the post-mortem report said there was "some degree of starvation". Probably this estimate was much too high; a pup weighing 65 lbs is plump and fat with a well-developed blubber layer and would show no signs of starvation.

Various organisms were cultured from the seals examined. Escherichia coli was recovered from five of the specimens, Proteus sp. from one and streptococci from two. These organisms are probably normally present as non-pathogens, but they can lead to septicaemia (as in 6887) in an animal in poor condition. Pasturella multocida (= P. septica) is pathogenic for a large number of different animals. "Probably the most important role that Pasturella multocida plays in disease is that of a secondary invader when the resistance of the animal has been reduced by various stresses" (Merchant & Packer, 1967 pp. 339-340). Pasturella haemolytica is also an important secondary invader. As with P. multocida environmental factors are thought to be important in leading to infection.

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From four of the animals examined no organisms could be cultured. This was probably due to the antibiotic therapy they had received while in Mr Jones' care.

Samples of tissues from specimens 7843, 7847 and 7852 were subjected to a virological examination by the Veterinary Investigation Centre, Bristol. Results were all negative.

The bacteriological findings show that seal deaths were not due to any epidemic disease. The pneumonia and septicaemia diagnosed probably represented the terminal stages of a decline due to lack of food, rather than the infection of an otherwise healthy animal. Diagnoses, weights and bacteriological examinations indicate that the primary cause of death was malnutrition. As the animals examined represent 25 per cent of the total reliably reported dead (a very high percentage for an episode of this kind) it is justifiable to extend this conclusion to the mortality as a whole. Possible causes of this starvation are discussed later.

The adult seals at the Lizard

Reports were received of sick adult seals at the Lizard. The Seals Research Officer visited the Lizard and interviewed two people who had seen these seals; the following is a synopsis of their account.

A member of the crew of the Lizard lifeboat saw a large seal, about 6 feet in length, on the old slip on the afternoon of 26 November. It appeared to be gasping through its mouth and its nostrils were opening and closing. There was some white mucus around the nostrils and mouth and the seal wiped at its face with its flippers. Patches of fuel-oil were present on the body (this is usually seen on seals in this area) but on the sides of the neck was what was described as a "burnt patch" where the fur had gone. This was not the sort of mark that could have been caused by entanglement with a rope.

The following day a pup was seen on the slip. The pup appeared to have a sore eye surrounded by mattery grease but it was lively and snapped at the lifeboatman's boots. It is not usual to see seal pups at the Lizard but Lynance Cove and Soapy Cove usually produce a few pups each year.

On 28 November a big seal was seen with a raw band around its neck. This seal was gasping and its back jerked in a convulsive way.

On the afternoon of 29 November a very big seal was seen on the slip and was approached to within two yards. Its upper lip was rolling back and its eyes had a glazed appearance. It wiped its face with its flippers. The animal gave off steam from its skin.

On Sunday 30 November, throughout the low water in the middle of the day, a very large seal was ashore on a rock. This was approached to within three yards. The seal was lively and aggressive and barked at the lifeboatman. On the right side of its neck was a patch about five or six inches in diameter, from which the hair had gone. The skin was 'rising up' and though it was not bleeding there was an ooze from it. It was possible to see the flesh and white fibres. A companion of the lifeboatman, present at the time and who had been corroborating this account, said that the lesion resembled an overgrown cattle ring-worm. On the left side of the neck was a patch of about the same size. Here the hair was present but was matted by a greasy and mattery discharge. The seal rubbed at these patches with its flippers from time to time.

The lifeboatman thought that the lesions described were not ordinary bite wounds. He said the skin had not been torn. He was sure that the adult seals sighted on these four occasions were all separate animals.

A local fisherman gave a similar, but less extensive, account and suggested that the seal seen on Sunday might have caught its neck in a lobster pot or a wreck when hunting for bream or conger.

None of these seals was seen after Sunday 30 November.

A report of seals with "burn marks" round their necks at Land's End was made to the RSPCA Inspector at Penzance, but the animals could not be located.

The description given of these lesions tallies with lesions observed by members of the Seals Research Unit on both Grey and Common seals off East Anglia and in the Wash. Their aetiology is unknown but their appearance corresponds with a long-standing ulcerative condition of the skin with bacterial and possibly fungal infection.

It is not possible to make a diagnosis of the condition reported in Cornwall as no specimens have been secured and no qualified persons have seen these seals. A similar ulcerative lesion with necrotic areas has been described from the dolphin Lagenorhynchus obliquidens (Johnson & Ridgway, 1969). Pseudomonas aeruginosa was isolated from this lesion; the same organism was identified from the infected eye of a seal in the present investigation. It seems most likely that these lesions are due to secondary infection of a minor wound on a seal that is in poor condition. Superficial wounds in seals take a long time to heal as the lowered skin temperature caused by immersion in water hinders tissue repair. If the seals seen at the Lizard were bulls, which seems likely as all were described as large, then the neck lesions were on the area most often wounded during fighting in the breeding season.

The significance of the gasping reported in two of the seals is not known. Seals sometimes suffer from lung-worms, but this would cause them to cough, not gasp. If the seals were suffering from pneumonia, as a result of loss of condition and subsequent infection, they might show respiratory distress. Seals never normally inhale through the mouth.

Some adult seals might be expected to be in poor condition at the end of the breeding season, but there is nothing to connect the described condition of the adult seals at the Lizard with the reports of dead and dying pups.

The question of pollution

Mention has been made of public fears of environmental poisoning, aroused by the deaths of sea birds in the Northern Irish Sea earlier in the autumn of 1969. The existence of a Ministry of Defence (MOD) experimental establishment near Portreath naturally added to this speculation about pollution.

With this in mind, signs of poisoning were especially looked for. No evidence has come to light that either the deaths of the pups or the condition of the sick adult seals were caused by pollution or poisoning, either chronic or acute.

There were no signs of gastritis or enteritis (apart from that associated with septicaemia in two cases) in any of the pups examined post-mortem. The description of the sick adult seals does not allow diagnosis but it is very unlikely that the lesions observed could have resulted in chronic poisoning. It could be speculated that they were caused by acute contact with a corrosive substance, but it is impossible to substantiate or even investigate such a suggestion with no specimens available, and it is thought probable that these lesions resulted from infection of wounds.

Tissue samples from 7 of the Cornish seal pups were analysed for organophosphorus and organochlorine residues. No organophosphorus compounds were detected. Organochlorine compounds looked for were the pesticides dieldrin and DDT, the breakdown products DDE and TDE, and a group of substances commonly know as polychlorinated biphenyls or PCBs. These compounds are all highly lipophilic and hence found dissolved in the body fat. Previous assay for these substances in seals has been by analysis of blubber samples, but the emaciated state of the Cornish seals allowed only liver to be routinely used, though three blubber samples were also examined. Results for liver and blubber agree when corrected for fat content (See Table II).

A suckling seal pup may become contaminated with organochlorines from residues present in its mother's fat. Such residues might pass through the placenta to contaminate the foetus before birth or the pup might become contaminated by drinking milk with organochlorine-contaminated milk fat. The possibility of contamination through the skin exists, but the quantity which could be involved in the course of the pup's life would be minute. Although quantitative data are lacking it is believed that the great majority of the organochlorines found in seal pups that have not begun to feed for themselves have been ingested with the milk and that the contamination found in the pups therefore reflects the general contamination of the seal stock.

It follows from this that the amount of contamination present in a suckling seal pup depends both on the degree of contamination of its mother's milk and the amount of milk it has received. If for any reason less than the normal amount of milk is taken, the total dose of organochlorines obtained from the mother will be smaller than if the pup had taken a full ration of milk. However, if the deprived pup then subsequently starves it will use up what little fat it has but not the dissolved organochlorines. The result of this is a rise in the concentration of organochlorines in the fat.

The situation is thus extremely complicated. True comparisons between organochlorine concentrations can only be made if the nutritional status of the animals compared is similar. As all the Cornish material originated from starving pups, a class of animals not

investigated in earlier work, it was decided to compare the Cornish samples with material obtained from 5 seal pups, 3 well nourished and 2 starving, taken in January 1970 from another colony.

The results obtained (see Table II)are not easy to interpret. A comparison of values from the well nourished and starving seals from the Northern colony shows that the concentration of organochlorines found is higher in the starving pups. As explained earlier this does not imply that the starving seals have received a greater quantity of organochlorines than the well nourished seals. In fact the opposite is the case, because the utilisation of fat by the starving animals has concentrated the organochlorines into the small amount of fat remaining. As neither of the starving animals from the Northern sample was as emaciated as any of the Cornish seals examined (except for 7739), the concentration effect is more marked in the Cornish seals. On the other hand, the well nourished animals from the Northern colony, having received more milk fat containing dissolved organochlorine compounds from their mothers' milk, have therefore received a higher total dose of organochlorines.

When the concentrations of the various compounds in the tissues are compared it is found that dieldrin, DDT and its derivatives DDE and TDE are found in similar concentrations in seal pups from both Cornwall and the Northern colony. Because of the concentration effect caused by starvation it seems likely that dieldrin and DDT pollution in Cornwall is not as heavy as in the area from which the Northern seals were obtained.

The case appears different for PCBs, and Cornish seals contain 3 to 10 times more than the seals from the North but considerably less than seals from East Anglia, where Grey and Common seals have been found to contain between 350 and 520 p.p.m. PCB in their blubber. The difference found in Cornish seals is in the proportion of PCBs to other organochlorines, but it should be emphasised that the sample is small and the material (starved pups) unusual so no definite conclusion can be drawn.

The toxicity of organochlorines generally is very imperfectly known. It is believed that when an animal is well nourished, with ample fat reserves, considerable concentrations can be tolerated. If the animal's nutritional status declines, fat is metabolised and the dissolved organochlorines are released into the blood; such deleterious effects as are known concern DDT and dieldrin in birds. PCBs appear to be less toxic to birds than DDT. No information at all is available about the toxicity of organochlorines to seals but even the most heavily contaminated animals studied, those from East Anglia which contained 350-520 p.p.m. PCB, 30-36 p.p.m. DDT and 0.8-1.0 p.p.m. dieldrin in their blubber, did not appear to be suffering from any symptoms that could be ascribed to poisoning.

The Ministry of Agriculture, Fisheries and Food is currently carrying out a monitoring programme to determine the level of organochlorine compounds in marine organisms and fish in the South-west. So far no exceptionally high levels have been reported.

Other contaminants

Other tissue samples from the Cornish seals were analysed for traces of the heavy metals, arsenic, lead and mercury. The results, together with those from the control sample of seals from the second colony are set out in Table III. The levels recorded are of the same order as has been recorded from similar organs from other mammals, though the mercury values appear higher, but there are no data for normal levels in seals. Besides the three elements listed in the table, a qualitative scan was made for other possible toxic elements, but nothing exceptional was detected.

It had been suggested that the MOD research establishment at Nancekuke, on the cliffs above Portreath, might be the source of poisonous effluents, but all effluent from the laboratories at Nancekuke is chemically treated to render it innocuous, and it is held in tanks prior to discharge into the sea. The effluent is monitored both chemically and biologically, using marine organisms, before it is discharged. The suggestion is thus quite unfounded.

"What," asked one national newspaper, "is the mysterious red froth in the sea beneath Nancekuke?" These red waters, seen beneath Nancekuke, at Godrevy and elsewhere on the north Cornish coast, are caused by water running from the adits of the tin mines after rain. The phenomenon is well known to Cornishmen and the Red River, which discharges into St. Ives Bay about a mile south of Godrevy Point, has received its name from this.

Reports of shoals of dead fish were circulated. These all appear to relate to a shoal of young pilchard, found ashore just to the west of Pendeen by the keeper of the Pendeen light-house on 29 October. These fish were examined by the District Inspector of Fisheries at Newlyn, who sent specimens to the MAFF laboratory at Burnham-on-Crouch. These were analysed for organochlorine compounds, including PCBs, but no significant concentrations were found. It was concluded that this shoal had stranded and subsequently dried out.

A report of undersized pollack being caught suffering from lesions described as 'burns', both internal and external, has also been widely circulated. The Inspector of Fisheries could not substantiate this report and no specimens were found. Cod and other gadoid fishes like pollack are not infrequently found suffering from ulcerative lesions.

In the course of the whole seal investigation only three dead sea birds were found, and although birds were not especially looked for, this seems a very low figure for the time of the year. The lack of reports of dead birds in the area suggests there was no gross environmental pollution.

Later observations at sea

To check whether the mortality at Cornwall in 1969 approached totality, a fishing vessel was chartered on 11 December to look for surviving pups at known breeding localities (Figure 2).

The Carrack rocks, about 3 miles west of St. Ives, were first visited. This is a regular hauling place for Grey seals in the summer, but is not a breeding site. No seals, either adult or pup, were seen at the Carracks but a very heavy ground swell which broke over the landing places would have made it impossible for the seals to haul out.

At the eastern limit of St. Ives Bay a young seal was seen in the water about 100 yards to the north of Fishing Cove; although stained with fuel-oil and rather thin about the neck it was not obviously sick. Another young seal was seen swimming vigorously in the surf to the west of Hell's Mouth.

At Crane Island a young seal was seen close to the rocks, and another was seen off Samphire Island and two more sightings were made at Ralph's Cupboard. It is possible that these were of the same animal. Another young seal was seen just to the west of Gull Rock.

At Gull Rock the tide forms an eddy where flotsam and the bodies of dead animals accumulate, according to fishermen with local knowledge. No dead seals were seen here, but two oiled guillemots were picked out of the sea.

The sighting of six or more, probably seven, young seals off the coast between Godrevy Point and Portreath indicates a fair survival of pups, on the basis of summer sightings of adults. Only one of the animals seen (the first sighted) did not appear to be in a perfectly healthy condition, but some further mortality of young might be expected in the course of the winter. No adult seals were seen during the trip; they were probably lying up in the caves.

Discussion

The primary cause of death of the seal pups found on the Cornish coast was starvation, thought to have been caused by the pups becoming separated from their mothers before normal weaning time.

The lactation period in Grey seals is very short, lasting less than 3 weeks. The mother then deserts her pup which fasts and loses weight, before beginning to feed for itself. While it suckles the pup puts on weight at an astonishing rate, as much as 5.1 lbs/day being recorded (Coulson & Hickling, 1964) though probably around 3-4 lbs/day is more usual. The link between the pup and its mother, its only source of food for the first three weeks of its life, is a delicate one and should it be broken early the pup's chances of survival are greatly decreased. It is believed that a pup which has not reached a weight of around 65 lbs by its last milk feed is unlikely to survive the winter following its birth.

Cow seals are known to lose contact with their pups as a result of bad weather or disturbance through crowding effects or human interference. Crowding does not necessarily involve large numbers of seals; even a small number of seals in a confined space may constitute a crowd and disturbance to normal behaviour may follow, so that mortality through cows losing contact with their offspring is by far the commonest cause of pup death on Grey seal breeding grounds. Starveling pups wander about trying to feed indiscriminately from cows, or even bulls and other pups, and are frequently savagely bitten. Infection of these wounds may occur as the pup's condition falls and eventually death may result through septicaemia.

The localities on the North Cornish coast where seals are found are all exposed to northerly or westerly weather and most, if not all, the pups produced in this area are born in the sea-caves. Although the caves offer some protection from the weather, the space inside may be limited, particularly at high tide, and crowding of the type mentioned above may occur when even only half a dozen seals use a cave. A pup which strays outside its cave may well have great difficulty in finding its way back again, particularly if the entrance to the cave is beneath the water.

It is probably the lack of good breeding sites which has limited the Grey seal population in Cornwall. Grey seals occur most abundantly where the breeding females have access to sheltered beaches or low grasslands behind a beach. By far the largest concentration of Grey seals in the South-west is that centered on the tip of Pembrokeshire, from Strumble Head to Caldey Island. This area, together with part of the Cardiganshire coast, supports a population of about 300 pups, of which rather more than half are born on the islands of Ramsey and Skomer. About 200 Grey seals live on the Scilly Isles, mainly on the rocky islets to the west of the inhabited islands and about 60 pups are produced each year. The numbers inhabiting Cornwall are less certain. The seals are considerably more dispersed than at either the Scillies or Pembroke and it seems likely that their numbers are added to in the summer by animals from the Pembrokeshire colonies. However, a figure of 200-250 seals for the Cornish coast from Hartland Point round Land's End to the Lizard seems reasonable. Such a population would produce about 60-75 pups each year.

As it was concluded that about 40 pups were reliably reported dead, and there were probably some dead animals which were not found (though it is thought that these were very few) this would represent a high mortality if all the pups came from the Cornish stock.

Grey seals are long-lived animals, life spans of up to 40 years being recorded. They have few predators other than man and the adult mortality rate, in the absence of human interference, is thus very low. High juvenile mortality rates, on the other hand, are the rule at Grey seal breeding colonies.

On the basis of existing life table data (Hewer 1964) it has been assumed that on average 60% of all pups die in their first year, mostly soon after birth and weaning. There is, of course, year to year variation and populations breeding at the foot of cliffs are very liable to total mortality of the pups in bad weather. A spell of heavy westerly weather is believed to have killed nearly all the pups born at a breeding site under the cliffs of Ronas Hill in Shetland in 1969.

In Cornwall, seals are very little, if at all, molested by man. Killer whales, virtually the only seal predator in English waters, are rarely seen off Cornish coasts. As the Cornish seal stocks do not show a rate of increase comparable to that observed in the past quarter-century at other Grey seal colonies at, for example, the Farne Islands or the Orkneys, it is concluded that the juvenile mortality rates in Cornwall must, on average, be high. The probable reason for this is the lack of suitable breeding sites on the inhospitable Cornish coast.

There is a possibility that not all the pups found dead originated from Cornwall, and the much larger Pembrokeshire population seems a likely source. Many young seals in Pembrokeshire were marked between 1952 and 1969 by the West Wales Naturalists' Trust and of the 62 marked animals recovered outside the marking area 20 have been recovered on the South-west Peninsula: one from the Scilly Isles, 15 from Cornwall and 4 from Devon. Of the 25 animals marked in 1969 one has already been recovered from Cornwall.

Table IV shows the incidence of winds of over 20 knots (corresponding to slightly more than Force 6 on the Beaufort scale) as recorded at Milford Haven and St. Mawgan in September, October and November 1969. Winds of this speed could create sea conditions bad enough to cause some pups in unfavourable situations to become separated from their mothers.

Between 7 and 9 November strong winds blew from between west and north (Table V) with speeds of up to 41 knots. All but 7 of the 40 reports of dead and dying pups follow this period of bad weather, so it seem likely that some of the animals reported could have been driven by the wind from Pembrokeshire to the Cornish coast.

It may be noted here that there was no similar reported mortality of seals from the Pembrokeshire coast. Only two sickly pups had been noted at Dale Fort Field Centre by 10 December and a representative of the West Wales Naturalists' Trust considers that there are only five reliable records of dead or dying pups, four from around Manorbier and one from Tenby (Fig. 1). It is highly likely that other deaths occurred which were not reported but it is certain that there was no exceptional mortality in Pembrokeshire.

Summary and Conclusion

About 40 reports of dead or dying Grey seal pups on the Cornish coast between Newquay and Fowey were received in the autumn of 1969. Eleven of the dead seals were examined, of which 9 were subjects of full post-mortems. The cause of death was determined to be starvation; no evidence was found of an epidemic.

Four adult seals seen at the Lizard at the end of November had lesions on their necks. These lesions are believed to be the result of wounds, received in fighting during the breeding season, becoming infected.

Analyses of tissue samples of the dead seals show that the Cornish seal stocks, like those from elsewhere in the British Isles, are contaminated with organochlorine residues. The level of pesticide (DDT and dieldrin) contamination is relatively low but PCB contamination is relatively high, though much lower than in seals from East Anglia. The concentration of lead and arsenic in the Cornish seal pups is of the same order as that found in other mammals. Mercury levels are higher.

The seal pups which were found dead or dying had become separated from their mothers before the normal weaning time which is about three weeks after birth, and had been insufficiently developed to start feeding for themselves. The separation was probably caused either by disturbance or bad weather. Healthy pups were still to be found on the Cornish coast after the last of the reports was received.

Some of the pups reported from Cornwall may have originated from Pembrokeshire. A spell of high winds in early November might have caused pups to drift from Pembrokeshire to Cornwall.

It is concluded that the deaths were part of the normal juvenile mortality of the seals, always likely to be high in Cornwall, and that extraneous factors such as epidemics or pollution, were not involved.

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Table I

Summary of post-mortem reports on ten Grey seal pups

Ref.No.	Date examined	Sex	Weight	Diagnosis	Organisms cultured
6822	27.10.69	F.	lungs only	Pneumonia	Pasturella multocida
6887	27.10.69	M.	30 lbs.	Septicaemia	Pasturella multocida Escherichia coli
7397	19.11.69	F.	12 lbs.	Starvation	-
7620	28.11.69	F.	(65 lbs)*	Septicaemia; some degree of starvation	Escherichia coli
7634	29.11.69	-	25 lbs.	Starvation (pneumonia)	-
7717	3.12.69	F.	22 lbs.	Starvation	Pasteurella haemolytica Escherichia coli Streptococci
7789	8.12.69	F.	42 lbs.	Asphyxia	-
7843	9.12.69	F.	22 lbs.	Starvation	Escherichia coli Proteus sp
7847	9.12.69	M.	35 lbs.	Starvation	Escherichia coli Streptococci
7852	9.12.69	M.	33 lbs.	Starvation	-

* estimated weight

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Tissue	Origin	Fat content per cent	Concentration in tissue, ppm wet weight					
			Dieldrin	DDE	TDE	DDT	Total insecticide organochlorine	PCB
Liver	Cornish	5.2	0.08	1.9	0.31	0.22	2.51	46
	Northern (well nourished)	9.0	0.07	0.5	0.09	0.5	1.16	3.7
	Northern (starving)	7.6	0.07	1.0	0.15	0.9	2.12	6.2
Blubber	Cornish	16.7	0.25	6.7	0.69	3.7	11.34	160
	Northern (well nourished)	86.2	0.38	4.7	0.66	4.4	10.14	34.
	Northern (starving)	73.3	0.57	9.5	1.16	7.4	18.63	48

Table II Synopsis of concentrations of organochlorine compounds in seal tissue.
(For full details, see Appendix).

TABLE III

Concentrations of Arsenic, Lead & Mercury in Seal tissues, expressed as micrograms per gram dry weight of tissue. (Analyses by D.E. Allen, Merlewood Research Station, Nature Conservancy, Grange-over-Sands, Lancashire).

Concentration, $\mu g/g$ dry weight

	Specimen No.	Tissue	Arsenic	Lead	Mercury
Cornish Seal Pups	(7843	Liver	20	1	5
	(7847	"	54	< 1	5
	7852	Liver	3	1	13
		Kidney	15	< 1	12
	7620	Liver	8	5	8
	7634	"	1	4	9
	7789	"	10	3	7
	(1)	"	29	2	11
Northern sample	HG63	Liver	17	2.6	3
		Kidney	42	4.9	5
	HG66	Liver	< 1	3.5	6
		Kidney	1	2.2	< 0.5
	HG67	Liver	3.5	0.6	4
		Kidney	3.5	1.4	5
	HG64	Liver	20	4.1	1
		Kidney	< 1	2.1	6
	HG65	Liver	15	4.3	3
		Kidney	< 1	1.4	3

Table IV

Number of hours in the month with recorded wind-speeds of 20 knots or over at St. Mawgan and Milford Haven. (Data from Meteorological Office)

	September	October	November
St. Mawgan	3	31	171
Milford Haven	30	20	78

Table V

Average wind speed and direction for three days in November, 1969, at St. Mawgan and Milford Haven. (Data from Meteorological Office)

		November: 7	8	9	
St.Mawgan:	Speed	19.3	24.7	28.2	knots
	Direction	343	288	272	degrees
Milford Haven:	Speed	12.0	15.8	17.9	knots
	Direction	330	286	271	degrees

List of Figures

Fig.1. Map to show distribution of reports of dead and dying seals on the Cornish coast. Five similar reports from Pembrokeshire are also shown.

Fig.2. The coast searched for young seals.

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APPENDIX

Concentrations of organochlorine compounds in seal tissues, expressed as parts per million, wet weight of tissue. (Analyses by A.V. Holden, Freshwater Fisheries Laboratory, Department of Agriculture & Fisheries for Scotland, Pitlochry, Perthshire.)

	Specimen No.	Tissue	Fat Content per cent	Concentration in tissue, p.p.m. wet weight				
				Dieldrin	DDE	TDE	DDT	PCB
Orkney seal pups	7843	Liver	4.3	< 0.01	0.9	0.15	0.4	17
	7847	"	2.3	0.07	1.8	1.3	0.1	36
	7852	"	4.5	0.11	1.2	0.57	0.8	77
	7830	"	4.1	0.05	1.0	< 0.04	< 0.08	31
	7834	"	11.1	0.15	1.6	< 0.02	< 0.04	43
	7789	"	2.6	0.04	1.0	< 0.02	< 0.04	26
	(1)	"	6.7	0.11	5.1	< 0.04	< 0.08	90
	Average		5.2	0.08	1.9	0.31	0.22	46
	7843	Blubber	37.5	0.44	8.7	1.1	4.5	173
	7847	"	8.2	0.23	8.1	0.69	5.0	187
	7852	"	4.4	0.08	3.2	0.27	1.7	118
	Average		16.7	0.25	6.7	0.69	3.7	160
Northern sample	HG63	Liver	10.0	0.04	0.7	0.09	0.7	5.2
	HG66	"	9.2	0.11	0.5	0.09	0.4	3.8
	HG67	"	7.9	0.07	0.3	0.09	0.3	2.2
	Average		9.0	0.07	0.5	0.09	0.5	3.7
	HG63	Blubber	84.7	0.37	6.0	0.86	6.5	44
	HG66	"	87.4	0.58	4.9	0.65	4.1	34
	HG67	"	86.6	0.20	3.3	0.46	2.6	25
	Average		86.2	0.38	4.7	0.66	4.4	34
	HG64	Liver	7.4	0.05	0.7	0.09	0.6	3.9
	HG65	"	7.8	0.08	1.3	0.21	1.2	8.4
	Average		7.6	0.07	1.0	0.15	0.9	6.2
	HG64	Blubber	80.4	0.54	10.3	1.17	7.6	50
	HG65	"	67.1	0.59	8.6	1.15	7.2	46
	Average		73.8	0.57	9.5	1.16	7.4	48

Well nourished

Starving

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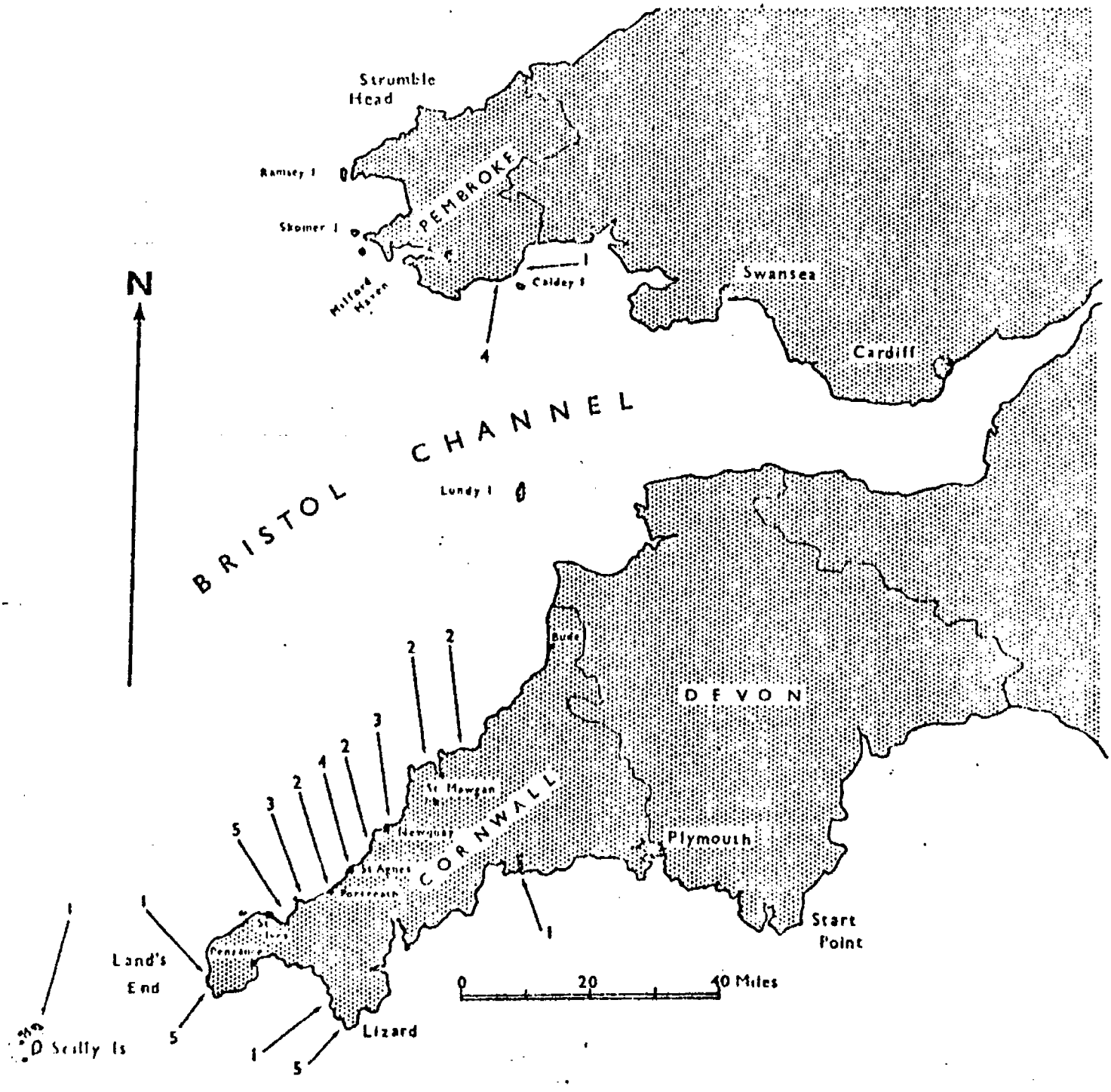

Fig 1. Map to show distribution of reports of dead & dying seals on the Cornish coast. Five similar reports from Pembrokeshire are also shown.

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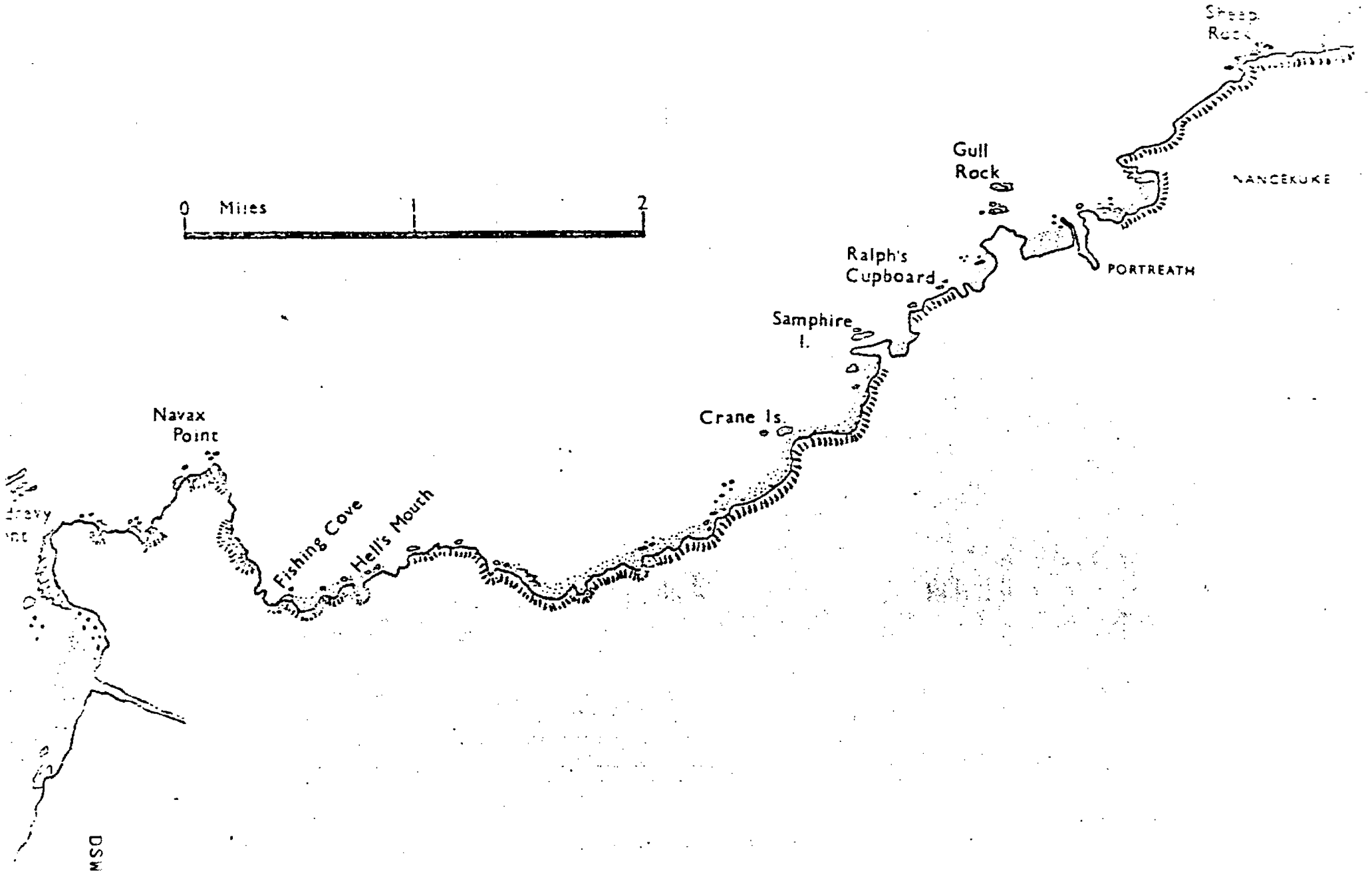

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Fig 2. The coast searched for young seals.