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FURTHER OBSERVATIONS ON THE DISTRIBUTION OF MYTILICOLA INTESTINALIS
AROUND SCOTLAND.

by

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Summary

A further survey was carried out in 1971 of the distribution and abundance of Mytilicola intestinalis Steuer in Scottish waters to find out what changes have taken place since the survey of 1966.

As Mytilicola was found, initially in 1970, in Linne Mhuirich (Loch Sween), where mussel cultivation has been started, the survey was extended to include other west coast lochs where such activities have taken place or are contemplated.

The outbreak in Linne Mhuirich has not spread to other parts of Loch Sween, and none of the other west coast lochs is affected. In most parts of the Clyde the decline reported in 1966 has continued, while in the Firth of Forth Mytilicola is now present only in small numbers over a limited area.

Introduction

During the summer of 1971 a further survey was carried out of the distribution and abundance in Scottish waters of Mytilicola intestinalis Steuer, the gut parasite of the mussel (Mytilus edulis), in order to find out what changes had taken place since the previous survey in 1966 (Mason, 1966).

There is now considerable interest in Scotland in the culture of both mussels and oysters, which are an alternative host for Mytilicola. The Molluscan Shellfish (Control of Deposit) (Scotland) Order 1965 was introduced in order to prevent the spread of pests from other countries or from infested to uninfested areas. In 1970 an outbreak of Mytilicola was discovered in Linne Mhuirich (Loch Sween), the site of experiments on mussels and oysters, where mussel cultivation on a commercial scale had been started. The new survey was therefore extended to include other areas where such activities had taken place or were contemplated as well as other areas where Brittany oysters were known to have been laid.

In 1951, 1953 (Thomas, 1954) and 1961 (Mason, 1961) there were apparently independent, heavy infestations in several parts of the Clyde sea area and in the Firth of Forth. A light infestation in the upper Solway Firth was also recorded. In 1966 (Mason, 1966) no parasites were found in the Solway. In the Forth and Clyde areas the distribution was largely similar to that in 1961, but in most places there was a striking reduction in abundance.

Material and Methods

In 1970 (January-March, September) samples from Loch Sween were examined at the Marine Laboratory, Aberdeen, for the presence of Mytilicola.

Samples from a number of places around Scotland in the period May-August 1971 were also sent to the Marine Laboratory. Field surveys were carried

cut in the Clyde, Solway and Forth areas, and in several west coast sea lochs, in May 1971. Mussels were examined in the fresh state as soon as possible after collection. Samples were of 50 or 100 adult mussels, except in some of the known areas of infestation, where closely spaced samples of 25 were taken.

Results

The distribution and abundance of Mytilicola are shown in Figures 1-5. Table 1 shows the percentages of mussels infested and the average number of parasites per mussel at each station. The corresponding results obtained in 1961 and 1966 are also indicated.

(a) General distribution (Fig. 1)

Most of the Scottish coastline remains free from Mytilicola, which occurs only in the Forth and Clyde areas and in Loch Sween.

(b) Firth of Forth (Fig. 2)

There has been a further reduction of the incidence of Mytilicola in the Firth of Forth. From the dense and widespread infestation of 1961 the parasite has now declined to such an extent that it was found in only three places: Leith (Station 6) with 2% of the mussels examined infested; Granton (Station 8) with 4%; and Dalgety Bay (Station 23) with 4%. In no case was there more than one parasite per mussel. It should be noted that at Granton (Station 8) no parasites were recorded in 1966. With the small samples taken in these areas, a "clean" sample indicates at most a very low level of infestation, but not necessarily that Mytilicola is completely absent from that place.

(c) The Clyde sea area (Figs. 3 and 4)

There has been a further decrease in the Gareloch area since 1966, no parasite being found at several stations. A new occurrence was recorded in Loch Long (Station 90). In the Holy Loch Mytilicola has reappeared in moderate concentration at Station 83. The Loch Striven area shows a further decline, but in Loch Riddon (Station 77) the level of infestation remains fairly high. Colintrave (Station 78) in the Kyles of Bute, and Rothesay (Station 115) both show an increase in the level of infestation, and also in the average numbers of Mytilicola per mussel.

On most of the east side of the Clyde, Mytilicola is scarce or absent. The 2% infestation at Skelmorlie (Station 110) is another new record. Loch Ryan remains heavily infested (Stations 124 and 125) though a decrease was recorded at Stranraer (Station 125) which was by far the most heavily infested place in 1966. It is now similar to Cairnryan (Station 124).

(d) West coast lochs (Figs. 1 and 2)

During the course of experiments on mussel cultivation in Linne Mhuirich (Loch Sween) from 1967 to 1969, many samples of mussels were opened in order to determine their condition, but no Mytilicola was found. In January 1970 a sample of rope-grown mussels was found to have an infestation of 14%. A survey of the whole of Loch Sween was undertaken in February 1970, and showed that this infestation was confined to Linne Mhuirich. Rope-grown mussels had an infestation of 59%, with a mean of 1.9 Mytilicola per mussel. Shore samples had from 32 to 99% infestation, and mean numbers

of parasites per mussel ranging from 0.5 to 7.3. One mussel contained 33 Mytilicola. In September 1970 mussels from an anchor rope of a raft in Linne Mhuirich showed an infestation of 84%, with a mean of 3.14 parasites per mussel.

Further samples were taken as part of the 1971 survey. Again, no Mytilicola was found in any part of Loch Sween except Linne Mhuirich (Station 58), where shore mussels had a moderate infestation of 14%. No suspended mussels were available for examination. The parasite seems to have spread rapidly through the mussels on the shore and through those being cultivated by the suspended rope method. The 1971 sampling showed a lower level of infestation, but there are insufficient data to suggest a real decline.

Experiments on mussel culture are now in progress in the Loch Beag area of Sutherland (see Fig. 1). A careful watch is being kept but no Mytilicola has been found.

In Loch Creran (Fig. 5), experiments on mussels and oysters are in progress, and there is a thriving natural population of mussels. These were examined in some detail, but were found to be free from infestation. Many of the other west coast lochs as far south as West Loch Tarbert were also sampled, and found to be free from Mytilicola.

Discussion

The most important change which has taken place since the 1966 survey is the appearance of Mytilicola in Linne Mhuirich, a small arm of Loch Sween cut off from the main loch by a narrow entrance with a shallow sill. The parasite can be introduced by infestation by larvae from elsewhere, infested animals brought in attached to ships, and introduction of shellfish already infested. The first method is extremely unlikely here as there are no infested areas nearby and the pelagic stage is short (Hockley, 1951). The second is not likely to apply to Linne Mhuirich, since only small boats can enter, and even such traffic is rare.

Oysters from France have been relaid in Loch Sween at various times up to 1966. It is quite feasible that Mytilicola was introduced with them, and conditions in Linne Mhuirich would be ideal for the spread of the pest. Despite frequent sampling, no infestation was found prior to January 1970. From 1966 to 1970 the mussel population was increased by rope cultivation and by 1970 was very concentrated. There is little tidal flushing and in summer the temperature is high. Korringa (1968) stresses the importance in the spread of Mytilicola of a large number of hosts, and water movements of such a nature that the larvae remain present in large numbers. Korringa (1968) states that mussels can be cultivated in the presence of a moderate infestation without serious loss of condition.

Mason (1966) suggested that the cold winter of 1962-3 may have caused a reduction in the level of infestation in the Forth and Clyde, though Korringa (1968) says that, in Holland, severe winters have had no such effect. Whatever the reason for the decline, the lower numbers of Mytilicola, producing fewer larvae, will tend to decline further. This is what seems to be happening in most parts of the Clyde, but there are still centres from which the parasite could spread again if conditions were favourable. In the case of the Forth, the level of infestation is nowhere high, so that the decline may continue.

Acknowledgements

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Table 1

The incidence of infestation of mussels by adult *Mytilicola intestinalis* at various places in Scottish waters, May-August 1971, together with the corresponding figures for 1966 and 1961

Station	Size Range (mm)	No. examined	% of Mussels infested			Mean no. of <i>Mytilicola</i> per mussel		
			1971	1966	1961	1971	1966	1961
1 Berwick	34-43	50	0	0	0	0	0	0
2 Cockenzie	50-71	50	0	0	-	0	0	-
3 Prestonpans	44-54	50	0	0	0	0	0	0
4 Musselburgh	53-80	50	0	4	0	0	0.04	0
5 Joppa	49-63	50	0	0	6	0	0	0.08
6 Leith	34-45	50	2	2	2	0.02	0.02	0.02
7 Newhaven	52-74	50	0	0	4	0	0	0.04
8 Granton Pt	55-71	50	4	0	8	0.04	0	0.10
9 Snab Pt	53-71	50	0	4	36	0	0.04	0.54
10 Barnbougle Castle	55-76	50	0	0	56	0	0	0.94
11 Hound Pt	-	-	-	2	63	-	0.02	0.83
12 Long Craig Pier	53-71	50	0	0	70	0	0	1.26
13 South Queensferry	-	-	-	2	76	-	0.02	1.30
14 Hopetoun	50-72	50	0	2	54	0	0.02	0.94
15 Blackness	50-68	50	0	0	46	0	0	0.66
16 Kincardine Bridge	-	-	-	0	53	-	0	0.93
17 Culross	45-60	50	0	0	56	0	0	1.00
18 Crombie Pt	54-74	50	0	0	76	0	0	1.50
19 Charlestown	55-71	50	0	2	72	0	0.02	1.36
20 North Queensferry	50-75	50	0	0	48	0	0	0.58
21 Inverkeithing	-	-	-	8	68	-	0.08	1.33
22 St David's Bay	-	-	-	-	45	-	-	0.55
23 Dalgety Bay	59-78	50	4	2	34	0.04	0.02	0.58
24 Aberdour	55-70	50	0	4	42	0	0.04	0.80
25 Burntisland	53-71	50	0	0	2	0	0	0.02
26 Kinghorn	-	-	-	-	0	-	-	0
27 Kirkcaldy	50-72	50	0	0	0	0	0	0
28 Methil	56-73	50	0	0	0	0	0	0
29 Lower Largo	41-58	50	0	0	0	0	0	0
30 River Eden Estuary	52-72	50	0	0	0	0	0	0
31 Montrose	64-86	50	0	0	0	0	0	0
32 Aberdeen	55-89	50	0	0	0	0	0	0
33 Newburgh	50-82	50	0	0	0	0	0	0
34 Peterhead	-	-	-	-	0	-	-	0
35 Findhorn	43-62	100	0	0	-	0	0	-
36 Nigg (Cromarty Firth)	-	-	-	0	0	-	0	0
37 Tain (Dornoch Firth)	56-78	50	0	0	0	0	0	0
38 St Margaret's Hope (Orkney)	45-68	100	0	0	0	0	0	0
39 W. Quarff (Shetland)	40-76	100	0	0	0	0	0	0
40 Stornoway	51-72	50	0	0	0	0	0	0
41 North Bay (Barra)	48-75	50	0	0	-	0	0	-
42 Durness	68-95	100	0	0	0	0	0	0
43 Loch Ewe	-	-	-	0	-	-	0	-
44 Plockton	68-79	50	0	0	0	0	0	0
45 South Ballachulish	44-67	50	0	0	0	0	0	0
46 North Shian	50-67	50	0	-	-	0	-	-
47 Inver	52-67	50	0	-	-	0	-	-
48 Balliveolan	46-64	50	0	-	-	0	-	-
49 South Creagan	48-71	50	0	-	-	0	-	-
50 South Shian	37-51	50	0	-	-	0	-	-
51 Bonawe Ferry	42-55	50	0	-	-	0	-	-
52 Oban	-	-	-	0	-	-	0	-
53 Loch Feochan (Head)	50-82	50	0	-	-	0	-	-
54 Loch Feochan (South)	51-70	25	0	-	-	0	-	-
55 Loch Craignish	40-53	50	0	-	-	0	-	-
56 Keils	28-45	50	0	-	-	0	-	-
57 Danna	40-60	50	0	-	-	0	-	-

Station	Size range (mm)	No. examined	% of Mussels infested			Mean no. of <i>Nytilicola</i> per mussel		
			1971	1966	1961	1971	1966	1961
58 Linne Mhuirich	35-80	50	14	-	-	0.16	-	-
59 Tayvallich	44-77	50	0	-	-	0	-	-
60 Eilean Mhartan	42-66	60	0	-	-	0	-	-
61 Rudh'an Tasaair	45-70	50	0	-	-	0	-	-
62 Corran Buidhe	30-51	50	0	-	-	0	-	-
63 Castle Sween	30-62	50	0	-	-	0	-	-
64 Loch Killisport	49-69	50	0	-	-	0	-	-
65 West Loch Tarbert	45-56	50	0	-	-	0	-	-
66 Campbeltown	45-57	50	0	0	0	0	0	0
67 Tarbert	49-79	50	0	0	0	0	0	0
68 Ardrishaig	45-60	50	0	0	-	0	0	-
69 Loch Gair	50-64	50	0	-	-	0	-	-
70 Inveraray	48-62	50	0	0	0	0	0	0
71 Clachan	47-68	25	0	0	0	0	0	0
72 Strachur	-	-	-	0	-	-	0	-
73 Stralachlan	47-70	50	-	0	0	-	0	0
74 Otter Spit	48-61	25	0	0	-	0	0	-
75 Kilfinan Bay	48-65	50	0	0	-	0	0	-
76 Carry Pt	55-67	50	6	24	64	0.08	0.28	0.96
77 Ard a' Chapuill	49-63	25	32	24	80	0.18	0.32	2.24
78 Colintrave	50-61	50	12	6	-	0.20	0.12	-
79 Ardtarig (Loch Striven)	48-65	25	0	4	64	0	0.04	1.80
80 Inverchaolain (Loch Striven)	-	-	-	4	-	-	0.06	-
81 Knockdow (Loch Striven)	33-43	25	4	48	84	0.04	0.64	5.48
82 Innellan	48-60	25	0	24	40	0	0.28	0.84
83 Sandbank	55-77	25	12	0	72	0.16	0	2.60
84 Strone	40-52	25	0	0	84	0	0	3.36
85 Gairletter	-	-	-	0	12	-	0	0.12
86 Ardentinny	47-54	25	0	0	8	0	0	0.10
87 Carrick	-	-	-	0	-	-	0	-
88 Lochgoilhead	53-59	25	0	0	0	0	0	0
89 Arrochar	48-68	50	0	0	0	0	0	0
90 Arddarroch	51-66	50	2	0	0	0.02	0	0
91 Coulport	45-57	50	0	8	8	0	0.08	0.08
92 Kilcreggan	34-60	50	2	4	60	0.02	0.04	1.28
93 Rosneath Bay	51-66	50	0	8	44	0	0.08	0.88
94 Stroul Bay	-	-	-	11	72	-	0.11	1.76
95 Barremman Pier	47-65	50	4	4	92	0.04	0.04	3.80
96 Meikle Rahaen	-	-	-	8	92	-	0.10	3.48
97 Rowmore	40-58	50	0	12	88	0	0.12	3.72
98 Garelochhead	42-69	50	2	3	18	0.02	0.03	0.52
99 Faslane	50-62	25	4	5	88	0.04	0.07	2.52
100 Shandon	-	-	-	12	88	-	0.12	2.20
101 Croy	-	-	-	8	72	-	0.09	3.92
102 Rhu	42-67	25	0	2	8	0	0.02	0.10
103 Helensburgh	43-62	25	0	1	76	0	0.01	1.24
104 Ardmore	46-52	25	4	3	80	0.04	0.03	1.92
105 Newark Castle	35-57	50	0	0	-	0	0	-
106 Greenock	52-67	50	2	0	5	0.02	0	0.05
107 Gourock	42-57	50	0	2	2	0	0.02	0.02
108 Cloch Pt	40-50	50	2	-	-	0.02	-	-
109 Inverkip	46-59	50	0	0	6	0	0	0.08
110 Skelmorlie	32-44	50	2	0	0	0.02	0	0
111 Largs	43-59	50	0	0	4	0	0	0.04
112 Fairlie	51-65	50	0	0	-	0	0	-
113 Millport	-	-	-	0	0	-	0	0
114 Kilchattan	50-74	25	0	0	2	0	0	0.02
115 Rothesay	40-50	50	20	2	5	0.30	0.04	0.08
116 Lochranza	-	-	-	0	-	-	0	-
117 Brodick	-	-	-	0	-	-	0	-

Station	Size range (mm)	No. examined	% of Mussels infested			Mean no. of <i>Mytilicola</i> per mussel		
			1971	1966	1961	1971	1966	1961
118 Portencross	31-46	50	0	0	-	0	0	-
119 Ardrossan	34-45	50	0	0	4	0	0	0.04
120 Troon	31-48	50	0	0	-	0	0	-
121 Ayr	41-70	82	9	6	68	0.10	0.06	2.00
122 Turnberry	30-43	50	0	0	-	0	0	-
123 Girvan	34-50	50	0	0	0	0	0	0
124 Cairnryan	49-66	50	50	40	56	0.72	0.60	1.23
125 Stranraer	54-64	100	42	88	86	0.90	2.80	3.32
126 Luce Bay	60-76	50	0	0	0	0	0	0
127 Isle of Whithorn	41-50	50	0	0	-	0	0	-
128 Heston Island	59-75	100	0	0	0	0	0	0
129 Southerness	43-59	50	0	0	-	0	0	-
130 Powfoot	40-57	50	0	0	8	0	0	0.08

FIG. 1. DISTRIBUTION OF MYTILICOLA INTESTINALIS IN SCOTLAND

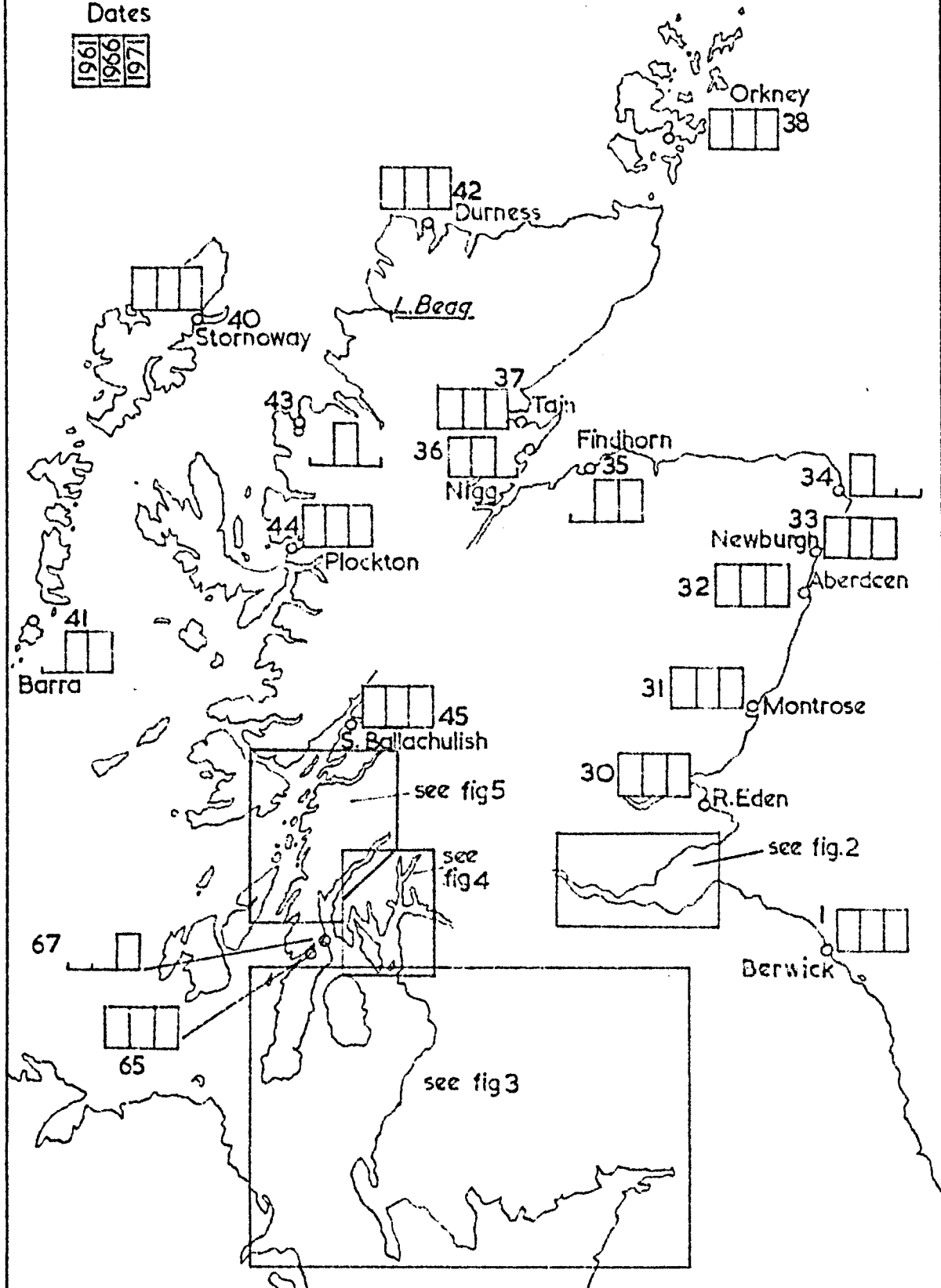
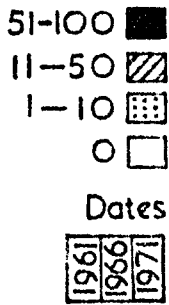
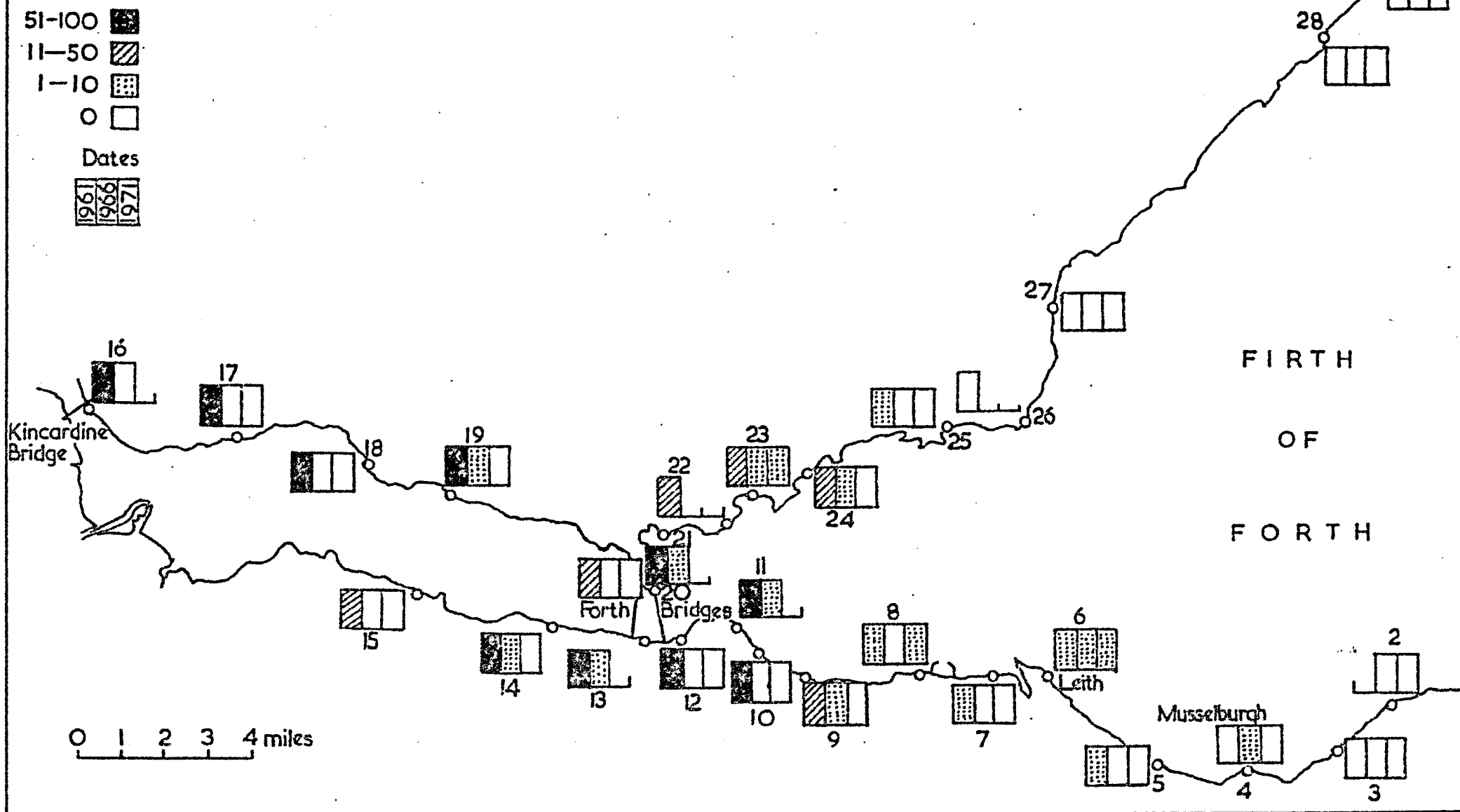


FIG. 2. DISTRIBUTION OF MYTILICOLA INTESTINALIS IN THE FIRTH OF FORTH



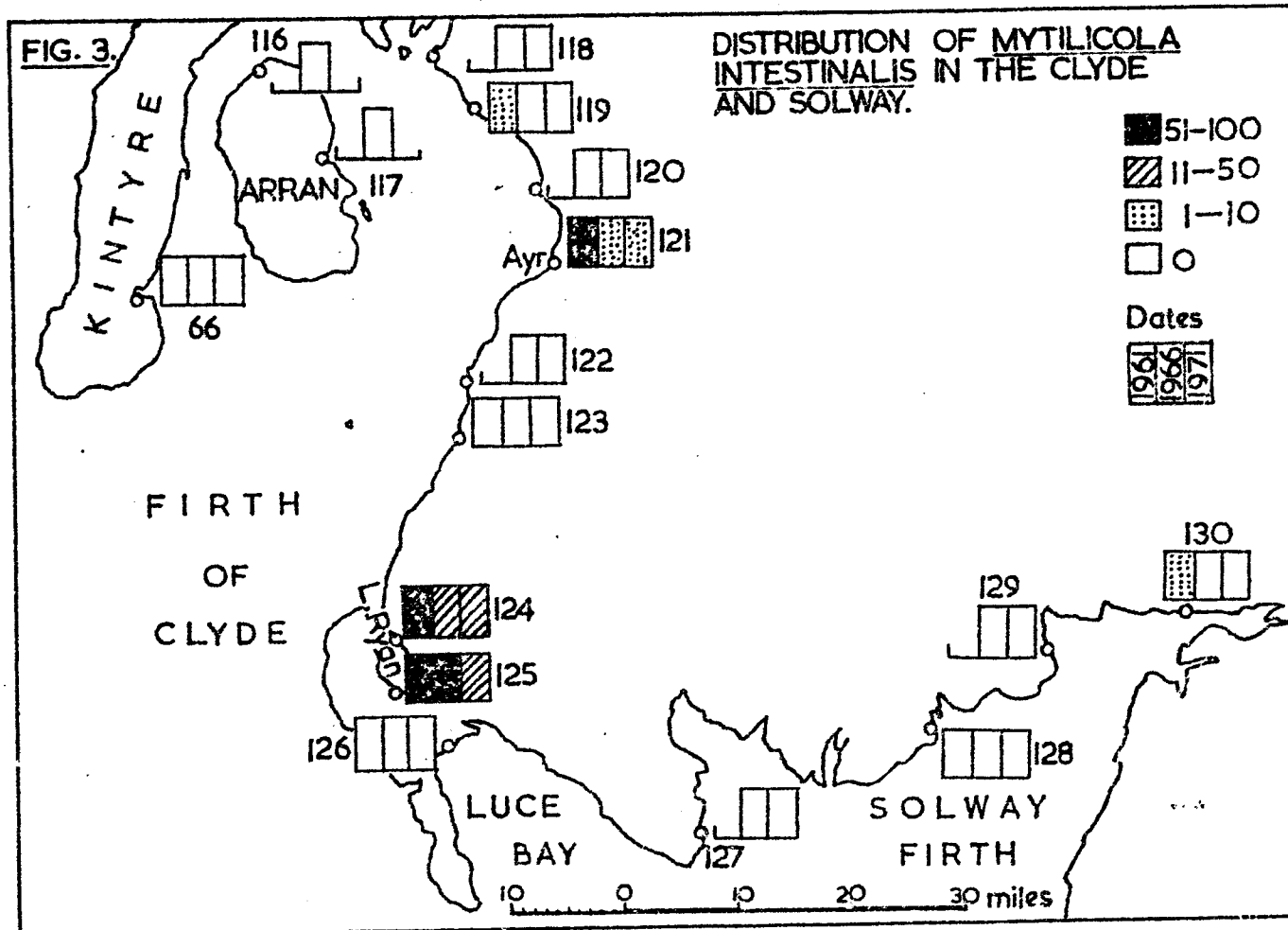
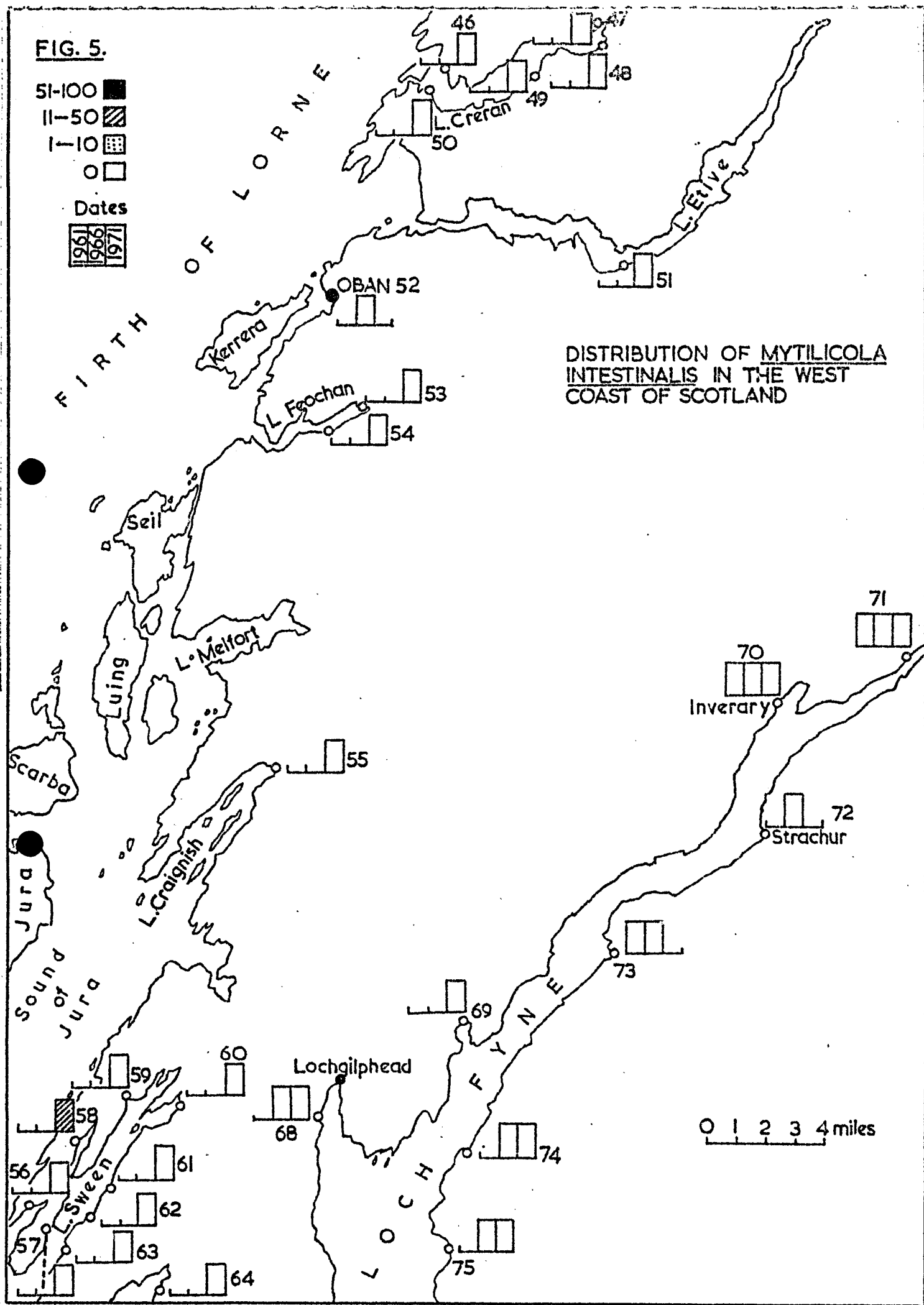
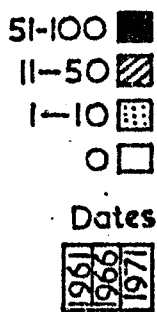


FIG. 5.



DISTRIBUTION OF MYTILICOLA
INTESTINALIS IN THE WEST
 COAST OF SCOTLAND

