

EPIHEMEROPTERA AND PLECOPTERA FROM ORKNEY

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Orkney lies off the extreme north-east tip of the mainland of Scotland and the group comprises some 49 islands. These are likely to be interesting faunistically for a variety of reasons, mainly geographical in nature. There is very little published information concerning the aquatic fauna of Orkney; that available consists mainly of short notes on various organisms or groups (e.g. Poppius, 1905). Prior to the present study, there appear to have been no records of any species of Ephemeroptera or Plecoptera from Orkney (vice-county 111).

Several other islands off the Scottish coast have been surveyed ecologically over the last century, and there are now a number of studies available, which are in most cases concerned with only one section of the flora or fauna (e.g. Browne, 1952; Hunter, 1953; Jackson, 1954, etc.). Though often of potential interest, the inland waters of these islands have been rather neglected by ecologists, though a few comprehensive surveys have been carried out (e.g. Bertram, 1939; Hamilton, 1963; Maitland, 1968). The present account represents part of a survey of the freshwater invertebrate fauna of Orkney recently carried out by the authors.

The Area

Geologically, Orkney consists of a group of islands separated by sounds—interpreted as a drowned valley system. Typically, Orkney landscape consists of rounded hills rising to some 250 m., flanked by broad stretches of farmland. The rocks underlying this are mostly calcareous flagstones (Middle Old Red Sandstone), but overlying sandstones of the Eday series cover considerable parts of Eday, the east mainland and the land surrounding Scapa Flow. Small inliers of earlier rocks, broadly granitic in composition, occur around Stromness and intermittently for some 6 km. to the north. In Hoy, massive sandstones of the Upper Old Red Sandstone form the infertile mountainous western part of the island, rising at several points to about 500 m. Much of the Middle Old Red Sandstone has a cover of boulder clay which has also been piled on some rock terraces to form the present rounded hills. Areas of peat and heather cover much of the uncultivated upland region: near exposed coasts blown sand forms dunes and links.

A great variety of aquatic habitats is found on Orkney. Water draining from the peat covered uplands is naturally soft and, in wet weather particularly, heavily stained by organic matter. In contrast to such ditrophic waters, the numerous springs of the flagstone districts are very clear and hard, so much so that spreads of tufa around springs and in flushes are common.

The pH and alkalinity of water bodies originating from a mixture of surface and spring waters vary seasonally, being much softer in wet weather when surface runoff predominates, than in dry spells when the main supply is ground water. In the granite and other sandstone areas water is invariably soft. In most areas a certain amount of salt from blown spray is present and this becomes an important factor in waters near exposed coasts during stormy weather. In general, the average chloride content of the waters on Orkney is much higher than would be found in most places on the mainland of Scotland (Table 1). The variety of Orkney

TABLE 1.

Chemical analyses (in p.p.m.) of the water from two Orkney lochs.

	Loch of Kirbister		Loch of Boardhouse	
Date	26.7.65	11.1.56	25.3.59	11.3.59
pH	8.9	7.2	7.9	7.7
Suspended Solids	2.3	10.5	3.8	10.0
Total Solids	184	216	158	446
Chloride (as Cl)	44	42	48	44
Alkalinity	114	60	74	72
Iron (as Fe)	0.2	0.3	0.3	4.4

waters, some of them extremely rich chemically (Table 1), would indicate that a wide range of habitats is available, and that a corresponding range of aquatic species could be expected there.

Methods

Systematic collections of Orkney freshwater fauna were made from July 1964 to October 1965: a number of specimens were also supplied by members of the Orkney Field Club during this period. Collections were made using methods appropriate to the substrate in question, for Ephemeroptera and Plecoptera these consisted mainly of the hand-picking of animals from stones and the use of a small hand net (10 meshes per cm) in softer substrates and among weed. Animals were sorted alive and then preserved in 4% Formaldehyde in labelled tubes. The contents of these tubes were later identified and counted in the laboratory (Table 2).

A large number of freshwater habitats of different types were examined during this survey. However, for various reasons, it was not possible to visit several important waters, notably the hill lochs of Hoy and Rousay and waters in the sand dune areas of the North Isles. No systematic collecting was carried out in waters which were obviously very brackish. In spite of this, the survey is considered to have included most of the common species of freshwater invertebrates and to indicate some of the ecological relationships relevant to these animals in Orkney. The present account is concerned only with the Ephemeroptera and Plecoptera of the area.

TABLE 2a. Numbers of Ephemeroptera in collections of freshwater fauna from Orkney (positive localities only)

Station	5	10	12	13	16c	17	20	21	23	25	27	29	31	32	34a	41a	46	47	55
<i>Caenis horaria</i>										2									
<i>Caenis moesta</i>	1																		
<i>Ephemerella ignita</i>										3									
<i>Rhithrogena semicolorata</i>					1	10	11	8											1
<i>Hepptagenia lateralis</i>					3														
<i>Leptophlebia marginata</i>																1			
<i>Centroptilum luteolum</i>	1								20	12	23								
<i>Centroptilum pennulatum</i>				2											2				
<i>Proclonon pseudorufulum</i>																			
<i>Cloeon simile</i>																			
<i>Baetis pumilus</i>			4		1			3											
<i>Baetis rhodani</i>						22	9	5	20	5									
<i>Baetis tenax</i>	18																11	2	31

Station	56	57	59	60	61	63a	65a	66	68	71	72a	72b	73a	78	79	83	Total
<i>Caenis horaria</i>																	2
<i>Caenis moesta</i>																	1
<i>Ephemerella ignita</i>																	3
<i>Rhithrogena semicolorata</i>	1				15	4											51
<i>Hepptagenia lateralis</i>																	3
<i>Leptophlebia marginata</i>	5																6
<i>Centroptilum luteolum</i>														1	4		61
<i>Centroptilum pennulatum</i>																	2
<i>Proclonon pseudorufulum</i>																	2
<i>Cloeon simile</i>											2						2
<i>Baetis pumilus</i>	5	14	1	36	1	14	12	28									69
<i>Baetis rhodani</i>	1			61	1		2		9		22	2				4	257
<i>Baetis tenax</i>																	18

TABLE 2a—Continued

TABLE 2b. Numbers of Plecoptera in collections of freshwater fauna from Orkney (positive localities only)

Station	9a	10	11	12	13	14a	14b	16c	20	21	22	23	27	28a	29	34a	36	41a	41b
<i>Amphinemura sulciollis</i>								6		4							1	33	4
<i>Nemoura cinerea</i>	2																		
<i>Nemoura avicularis</i>							4		4	1	1	1	3	5					
<i>Leuctra inermis</i>			1																
<i>Leuctra hippopus</i>							3												
<i>Leuctra fusca</i>													1						
<i>Perlodes microcephala</i>																			
<i>Diura bicaudata</i>		1		5	4	4													
<i>Isoperla grammatica</i>		5					3	1	3	1	3	3	1						
<i>Chloroperla torrentium</i>		1	1																

Station	48a	48b	53b	56	57	59	60	61	63a	63c	65a	66	71	73a	74a	77	80	83	Total
<i>Amphinemura sulciollis</i>				1			2	1				1							5
<i>Nemoura cinerea</i>	6	1									1			27					85
<i>Nemoura avicularis</i>			1	1													1		5
<i>Leuctra inermis</i>												3							8
<i>Leuctra hippopus</i>			2		1	6	7							7		3			36
<i>Leuctra fusca</i>																			3
<i>Perlodes microcephala</i>																			2
<i>Diura bicaudata</i>															1				16
<i>Isoperla grammatica</i>				2	2	4	4	1										1	20
<i>Chloroperla torrentium</i>					1	2	1												8

TABLE 2b—Continued

Ephemeroptera

Thirteen different species of Ephemeroptera were recorded from Orkney during the present survey. This compares with the total Scottish list of thirty-six (none from Orkney, two from Caithness) and the complete list for the British Isles of forty-seven recorded by Macan (1961). A further seven species were added to the Caithness list by Morgan & Egglshaw. The Orkney species are listed in Table 2 together with data concerning all stations at which Ephemeroptera were collected, and the numbers collected there. Short notes on the ecology of these species in Orkney are given below.

Caenis horaria (Linnaeus) was recorded from a single locality—the Loch of Bosquoy—where it was collected among mud and stones in shallow water. Macan (1961) notes that its characteristic habitat is soft mud in still and flowing water.

Caenis moesta (Bengtsson) was also recorded from a single locality—the Loch of Boardhouse—where it was collected near the outlet among mud and stones in shallow water.

Ephemerella ignita (Poda) was collected with *Caenis horaria* among mud and stones in shallow water in the Loch of Bosquoy. This species occurs among vegetation and stones, mainly in running water, in other parts of the British Isles; it is known, however, to occur in lakes in northern areas (Macan, 1961). The Orkney specimens were collected in June—well within the short period of occurrence known for nymphs elsewhere in the country (Maitland, 1965).

Rhithrogena semicolorata (Curtis) occurred in eight of the habitats sampled during the present survey—all stony burns, the characteristic habitat of this species. Nymphs were recorded from October to July; emerging adults in July only. These data agrees with the life cycle for this species outlined by Macan (1960).

Heptagenia lateralis (Curtis) was recorded from a single locality—Woodwick Burn—a fast-flowing stony burn, characteristic of the habitat described for this species by Macan (1961).

Leptophlebia marginata (Linnaeus) was recorded from two localities in Orkney, both standing waters; one a clear stony reservoir, the other a stony loch. The specimens at both places were collected among stones in shallow water.

Centroptilum luteolum (Müller) occurred at six of the localities examined: two of these were lochs, one a weedy pool and three were rather stony burns. Macan (1961) records the species as being found mainly in slow-flowing sections of rivers and streams; while this is undoubtedly a common type of water for the species (Maitland, 1966), it does also occur in many standing waters (e.g. Loch Lomond).

Centroptilum pennulatum (Eaton) was less common than *C. luteolum*, and specimens were collected at only one station—the Loch of Hundland—where they occurred among flat stones in weed and silt. The species is thought to favour a similar habitat to that of *C. luteolum* (Macan, 1961).

Procloeon pseudorufulum (Kimmins), a species with similar requirements to those of the two preceding forms, was also recorded from only one locality—a small pond. Specimens were collected here among sparse weed growth in shallow water.

Cloeon simile (Eaton) was again found at only one location—Graemeshall Loch—where specimens were collected among weed growing in silt with a few stones.

Baetis pumilus (Burmeister) was collected from six different localities—five of them stony burns, the other a small mossy pool. The normal habitat for this species is moss or stones in running water (Maitland, 1966).

Baetis rhodani (Pictet), the commonest species of Ephemeroptera found during this survey, was recorded from twenty-one localities—all of them running water. Emerging adults were found at several places in October 1964, just within the emergence period noted for the English Lake District (May-October) by Macan (1957).

Baetis tenax (Eaton) was recorded at only one locality—a stony stream on Rousay. The species is thought to be characteristic of stony streams in mountainous areas (see Maitland, 1966).

Plecoptera

Ten different species of Plecoptera were recorded from Orkney during the present survey. This compares with the total Scottish list of twenty-nine and the complete list for the British Isles of thirty-four (Hynes, 1958). Though twelve species have been recorded from Caithness (Morgan & Egglisshaw) and three from Shetland, none appears to have been recorded previously from Orkney. The present list is included in Table 2, together with data concerning all stations at which Plecoptera were collected and the numbers of each species collected there. Short notes relevant to these collections are given below.

Amphinemoura sulcicollis (Stephens) was recorded from four localities—one loch and three burns—in all of which it was found in shallow water among stones. Hynes (1958) and Maitland (1966) both note that it is common among stones in running water.

Nemoura cinerea (Retzius) was the commonest species of Plecoptera found on Orkney. It was recorded from ten localities, all sluggish streams, ditches or ponds, typical of the characteristic localities mentioned by Hynes (1958).

Nemoura avicularis Morton was found at four localities—all standing waters—of differing natures. The first was a weedy pool, the second a rather muddy dam, the third a small stony loch and the fourth a quarry pool. Hynes (1958) records the species as common on some lake shores and among emergent vegetation in rivers.

Leuctra inermis (Kempny) was recorded from three localities, all stony burns. This appears to be the characteristic habitat for this species (see Maitland, 1966).

Leuctra hippopus (Kempny) is a common species on Orkney

and was recorded at ten different places, two of them lochs, the others all burns. All specimens were collected among stones in shallow water. Hynes (1958) notes that this species is often abundant in stony rivers and streams.

Leuctra fusca (Linnaeus) was found only in a small weedy pool on Evie. Emerging adults were collected here at the end of August in 1964, well within the emergence period of July-September mentioned by Hynes (1941).

Perlodes microcephala (Pictet) was recorded at two stations only: both of them were small stony burns, the type of habitat mentioned by Hynes (1958).

Diura bicaudata (Linnaeus) occurred at six different stations, four of them lochs, the other two burns. All specimens were collected among stones in shallow water at these places. Emerging adults were found in June 1965, agreeing well with the April-July period of emergence noted by Hynes (1941).

Isoperla grammatica (Poda) was recorded at eight different localities, seven of them stony burns the other a stony loch shore. Hynes (1958) notes that, though this species occurs only in stony streams and rivers in the English Lake District it can be found in stony lakes further north.

Chloroperla torrentium (Pictet), another species characteristic of stony substrates (Hynes, 1958), was recorded at six localities in Orkney. One of these was a stony loch shore, the others were all stony burns.

Discussion

The variety and number of waters which were examined during this study (a full list of these will be lodged with the Orkney Museum) make it probable that the present list of Ephemeroptera and Plecoptera, though possibly not a complete one, will include all the common species there. In contrast to the two other Scottish islands whose freshwater fauna has been studied in greatest detail—St. Kilda (Hamilton, 1963) and the Isle of May (Maitland, 1968)—the aquatic fauna of Orkney is not notably impoverished compared with that of mainland communities. Thus, though no aquatic stages of either Ephemeroptera or Plecoptera have been recorded from either St. Kilda or the Isle of May, the majority of the common Scottish species of both these groups are now known to occur on Orkney.

Caithness is the nearest area of the mainland of Scotland to Orkney. Many of the nine species of Ephemeroptera and twelve of Plecoptera so far recorded from Caithness were found on Orkney during the present study, in addition to several other species. The low species lists recorded from Caithness for both groups are more likely to be due to inadequate collecting in that area than anything else, for twenty-two species of Ephemeroptera (Macan, 1961) and twenty-six species of Plecoptera (Hynes, 1958) have been recorded from the Scottish mainland, north of the Caledonian Canal. It is likely that many of these species occur in Caithness and quite possible that some of those not recorded in the present account may occur on Orkney too (e.g. *Ecdyonurus venosus* Fabricius; *Brachyptera risi* (Morton)).

A general paucity of freshwater species on an island or group of islands is a common feature of some of the islands round Scotland in relation to the mainland. In the Orkney islands, however, the situation is less extreme than in some others. It has been suggested that the low number of freshwater species found on the island of St. Kilda is partly due to isolation (Hamilton, 1963). Maitland (1963) notes that the number of freshwater species recorded from the Isle of May is less than from St. Kilda, but the cause here is more likely to be the temporary nature of the waters rather than isolation. The proximity of the Orkney islands to the mainland of Scotland and the extremely varied nature of its freshwater habitats mean that both these factors are less likely to be important than on many other Scottish islands. The variety and number of invertebrate species recorded during the present survey is in agreement with this.

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Appendix

The fresh waters sampled on Orkney

1a, Pond at north end of North Fara; HY/528378, (6.9.64). 1b, Ditch at cemetery, North Fara; HY/528367, (6.9.64). 2a, Pond at Carrick, Eday; HY/567384, (25.7.65). 2b, Quarry pond, Vinguoy Hill, Eday; HY/560385, (25.7.65). 2c, Mill Loch, Eday; HY/564368, (25.7.65). 3a, Pond on hillside behind Loch of Doomy, Eday; HY/559347, (25.7.65). 3b, Loch of Doomy, Eday; HY/559344, (25.7.65). 4, Quarry pond at school, Eday; HY/563308, (25.7.65). 5, Stream at Sinians of Cutlaws, Rousay; HY/366319, (8.8.65). 6, Loch of Scockness, Rousay; HY/450440, (15.8.64). 7a, Loch of North Tofts, Egilsay; HY/467305, (15.8.64). 7b, Ditch between Kirbist and schoolhouse, Egilsay; HY/470295, (30.4.64). 8a, Pond at Langskaill, Gairsay; HY/435219, (25.6.65). 8b, Stream at north-west corner of Gairsay; HY/436229, (25.6.65). 8c, Pond on isthmus leading to 'Hen of Gairsay', Gairsay; HY/451219, (25.6.65). 9a, Stream in former mill dam, Shapinsay; HY/485172, (20.6.65). 9b, Ornamental pond, Balfour Castle, Shapinsay; HY/473165, (20.6.65). 10, Outlet of Loch of Boardhouse; HY/256271, (10.6.65).

11, Loch of Boardhouse; HY/273249, (9.6.64). 12, Burn of Kirbister; HY/285254, (13.10.64). 13, Loch of Hundland; HY/291269, (19.6.65). 14a, Loch of Swanney at Lochside; HY/304283, (13.10.64). 14b, Loch of Swanney at Southend; HY/319273, (11.6.65). 15, Peerie Water, Evie; HY/335272, (5.10.65). 16a, Pond north of Lowries Water, Evie; HY/343259, (15.4.66). 16b, Lowries Water, Evie; HY/345257, (2.2.65; 5.10.65). 16c, Pond at top of the Wards', Evie; HY/349252, (2.2.65). 17, Stream 150 m. from sea at Marwick, Birsay; HY/232243, (4.10.64). 18, Pond near summit of Vishall Hill, Evie; HY/285250, (25.1.65). 19, Loch of Vastray, Evie; HY/399254, (24.7.64). 20, Woodwick Burn 200 m. above A966, Evie; HY/382237, (25.1.65).

21, Woodwick Burn below Cott of Dale, Evie; HY/379234, (25.1.65). 22, Quarry pond beside A966 near Crowrar, Evie; HY/394227, (25.1.65). 23, Burn of Rusht; HY/326225, (2.2.65). 24, Loch of Sabiston; HY/293225, (10.10.65). 25, Loch of Bosquoy; HY/304187, (15.6.64). 26, Pond at Nisthouse, Dounby; HY/310197, (26.10.65). 27, Ditch at bridge below Nether House, Firth; HY/376184, (6.10.64). 28a, Loch of Brockan, Rendall; HY/393189, (6.10.64). 28b, Oyce of Isbister, Rendall; HY/392183, (15.5.64). 29, Burn at Sowa Dee at Langa Dee; HY/232145, (22.6.65). 30, Burn at Cruland, Sandwick; HY/237151, (22.6.65).

31, Loch of Harray; HY/284169, (19.10.65). 32, Quarry Pond (Ness), near B9055, 800 m. north of Lyking, Sandwick; HY/274159, (19.10.65). 33, Quarry pond (Brecks), Bookan, Sandwick; HY/284144, (25.4.65). 34a, Pond, 600 m. north-west of Ring of Brodger, Sandwick; HY/290138, (25.4.65). 34b, Loch of Harray at Ring of Brodger; HY/294137, (25.4.65). 36, Loch of Harray at Stoneybrae Camp, Stenness; HY/310139, (5.6.64). 37a, Marsh east of Horraquoy, Harray; HY/330147, (27.9.64). 37b, Pond in field near Rickla, Harray; HY/326143, (27.9.64). 38, Quarry pond, Hillview, Harray; HY/337140, (15.7.64). 39, Loch of Wasdale, Firth; HY/342150, (1.9.64). 40, Burn north of Black Craig, Stromness; HY/219121, (11.5.65).

41a, Stromness Reservoir; HY/240107, (2.5.65). 41b, Ditch north-west of Stromness Reservoir; HY/237107, (2.5.65). 42, Ponds in 'the Loons', Stromness; HY/246104, (2.5.65). 43, Seepage at shore at Skatelan Skerry, Bay of Ireland; HY/273099, (15.6.64). 45, Quarry pond, Heddle Road, Firth; HY/356128, (27.8.64). 46, Burn, 300 m. south-east of Breck Heddle.

Firth; HY/348,118, (27.8.64). 47, Burn at road end, 500 m. south of Kings' dale, Firth; HY/375111, (23.2.65). 48a, Pond on saddle between Lyradale and Keelylang Hills, Firth/Orphir boundary; HY/367107, (23.2.65). 48b, Pond on west flank of Keelylang Hill, Firth; HY/370104, (23.2.65). 49, Burn at Hardhill; HY/395117, (27.8.64). 50, Tributaries of Burn of Ireland, Mid Moss, Stennes; HY/315085, (29.8.64).

51, Trickle in valley behind Fea, Orphir; HY/323045, (1.12.64). 52, Ditch to west corner of Bay of Myre, Orphir; HY/324040, (26.4.65). 53a, Quarry pond 400 m. north of Gyre, Orphir; HY/340052, (15.9.64). 53b, Dam at Gyre, Orphir; HY/341047, (24.4.65). 55, Burn at Newhouse, Orphir; HY/362084, (17.11.64). 56, Loch of Kirbister; HY/370080, (28.2.65; 21.6.65). 57, Burn at Swartaback, Orphir; HY/380075, (15.7.64). 58, Burn, 300 m. east of Hobbister, Orphir; HY/389071, (16.6.64). 59, Greenigo Burn, near mouth; HY/413067, (26.1.65). 60, Cotland Burn, near mouth; HY/428083, (8.6.64).

61, Orquill Burn near Longhouse, St. Ola; HY/416097, (27.4.65). 62, Quarry pond (Chinglebraes), St. Ola; HY/428090, (5.7.64). 63a, Orquill Burn, 300 m. west of Orquill House, St. Ola; HY/425095, (15.6.64). 63b, Orquill Burn above bridge at A964; HY/431093, (15.6.64). 63c, Orquill Burn between bridge and Scapa Distillery, St. Ola; HY/432091, (15.7.64). 63d, Rainwater butt, Scapa House, St. Ola; HY/434091, (1.9.65). 65a, Burn at Craigiefield Farm, St. Ola; HY/462121, (29.4.65). 65b, Quarry pond, Craigiefield Farm, St. Ola; HY/462122, (29.4.65). 66, Burn entering Bay of Deepdale, Holm; HY/452045, (28.4.64). 67, Burn 300 m. east of Tongue of Gangsta, Holm; HY/457035, (28.4.64). 68, Burn at reservoir near bridge on A960; HY/468083, (20.12.64). 69a, Looma Chun, 1200 m. north-east of Hunclett, Holm; HY/483060, (9.3.65). 69b, Black Loch, 1200 m. east-north-east of Hunclett, Holm; HY/484056, (9.3.65).

71, Graemeshall Burn, 600 m. east of Lynnfield, Holm; HY/476046, (21.11.64). 72a, Graemeshall Loch, Holm; HY/489020, (8.9.64). 72b, Graemeshall Burn: just above outfall to loch; HY/489022, (8.9.64). 73a, Burn, 1200 m. north-north-west of Hamly Hill, Holm; HY/490053, (10.11.64). 73b, Peat pond, 1200 m. north-north-west of Hamly Hill, Holm; HY/490053, (10.11.64). 74a, Loch of Tankerness; HY/514097, (7.2.65). 74b, Ditch entering north-west corner of Loch of Tankerness; HY/513098, (7.2.65). 75, Pond Clifftop, 300 m. south of Rerwick Head, Tankerness; HY/542115, (15.4.64). 76, Trickle on top of cliff east of Muckle Castle, Deerness; HY/563032, (20.12.64). 77, Pegal Burn, 2 km. above mouth, Hoy; ND/280982, (27.7.65). 78, Burn of Ore, below bridge on B9047, Hoy; ND/304939, (12.7.64). 79, Burn of Ore, middle reach, Hoy; ND/290935, (12.7.64). 80, Quarry ponds, Kirk Point, Lamb Holm; HY/485000, (26.10.64; 29.6.65).

81, Ditch, Bu Sands, Burray; ND/487968, (16.2.65). 82, Echnaloch, Burray; ND/473967, (6.7.65). 83, Burn, near mouth, Sandwick, South Ronaldsay; ND/437892, (26.10.64). 84, Trickle, clifftop, 1100 m. south of Sandwick, South Ronaldsay; ND/434881, (26.10.64). 85a, Trena Loch, South Ronaldsay; ND/465853, (1.11.64). 85b, Field pond, 300 m. south of Trena Loch, South Ronaldsay; ND/465849, (1.11.64). 86a, Ditch, roadside, east shore of Bur Wick, South Ronaldsay; ND/443838, (24.1.65). 86b, Field pond, east of road to Brough, South Ronaldsay; ND/445836, (24.1.65). 87, Pond, clifftop at Rami Geo, Halcro Head, South Ronaldsay; ND/470850, (1.11.64). 88, Ponds, 400m. west of Old Head, South Ronaldsay; ND/466835, (7.7.65).