

4. Fauna

Invertebrate animals were collected from the plant beds, open water and from the substratum. A standard FBA net (aperture 0.96mm) was used for a 5 minute period in the plants and open water, and bottom samples were taken from 1/10/m² area to a depth of 2cm.

B. Streams

The discharge (volume of water passing a given point), water temperature, pH and oxygen content of the water were measured. Plant species, together with their relative abundance were listed, and in addition plant species occurring in the marshy pool through which the Old Light stream was flowing, were noted. No attempt was made to quantify the fauna — boulders, stones, plants and pools were thoroughly searched for invertebrate life.

RESULTS

A. Ponds

1. Physical and Chemical

Table 1 shows the physical and chemical characteristics of the ponds.

TABLE 1

Parameter	Pondsbury	Quarry	Rocket Pole	Quarter-Wall 1	Quarter-Wall 2
Maximum depth m	1.2	1.7	2.2	0.8	0.4
Air temperature °C	15.0	17.0	15.0	18.0	18.0
Water Temp-Surface °C	15.0	17.0	17.0	18.0	18.0
Water Temp-Bottom °C	14.5	16.0	12.0	17.0	**
pH	4.8	5.8	5.4	5.9	5.9
Oxygen-surface mg ^l -1	8.8	7.6	7.2	9.6	10.0
% age saturation	90.0	81.0	77.0	104.0	109.0
Oxygen-bottom mg ^l -1	8.0	6.4	6.8	9.2	**
% age saturation	81.0	67.0	65.0	98.0	**

All of the ponds are acidic and apart from the Rocket Pole pond, their water temperatures are similar in both shallow and deep areas, relating to the ambient air temperature. Temperature stratification occurred in the deepest part of the Rocket Pole pond. The surface waters of all the ponds are well oxygenated (77-109% age saturation) and Pondsbury and the larger Quarter-wall pond have good oxygen levels at depth. There is less oxygen in the Rocket Pole and Quarry ponds as was recorded in August 1979.

2. Flora (Table 2)

TABLE 2
Relative abundance of species of plants at the five ponds

Species	Pondsbury	Quarry	Rocket Pole	QW1	QW2
<i>Sphagnum cuspidatum</i> Ehrh.	5 S	—	—	—	—
<i>Hypericum elodes</i> L.	5 ES	—	—	—	—
<i>Hydrocotyle vulgaris</i> L.	5 S	—	2 FS	3 FS	2 FS
<i>Myosotis scorpioides</i> L.	4 E	—	—	—	2 E
<i>Juncus effusus</i> L.	5 E	2 E	2 E	3 E	5 E
<i>Juncus articulatus</i> L.	2 E	—	—	—	—
<i>Eleocharis palustris</i> L.	3 E	2 E	1 E	3 E	—
<i>Peplis portula</i> L.	3 S	—	—	2 S	3 FS
<i>Ranunculus flammula</i> L.	1 E	2 FE	—	—	—
<i>Ranunculus omniophyllus</i> Ten.	1 F	—	—	—	—
<i>Elatine hexandra</i> (Lapierre)	1 S	—	—	—	—
<i>Potamogeton polygonifolius</i> (Pourret)	3 SF	3 SF	—	2 SF	5 SF
<i>Callitriche</i> sp.	2 SF	—	—	2 SF	—
<i>Lemna minor</i> L.	1 F	—	—	—	—
No. of Species	14	4	3	6	5

E = Emergent, S = Submerged, F = Floating

N.B. The insectivorous Sundew, *Drosera rotundifolia* L. was again found on the SE bank a short distance from the water.

The greatest species diversity of plants occurred at Pondsbury where 14 species were identified. As in 1979, five species were dominant — *Sphagnum cuspidatum*, *Hypericum elodes* (Marsh St. Johns' Wort), *Hydrocotyle vulgaris* (Marsh Pennywort), and *Myosotis scorpioides* (Water Forget-me-not) in the water and *Juncus effusus* (Soft Rush) at the edges of the pond. Fewer species were found in the smaller Quarterwall Pond, but the dominant plant there, the bog pondweed, *Potamogeton polygonifolius*, covered over 90% of the water area. *Potamogeton* also occurred in the shallower areas of the Quarry pool and was also found this year in small patches on the east and west sides of the larger Quarterwall pond. In Quarry pool as in 1979, plants occurred mainly at the edges e.g. *Juncus effusus*, *Eleocharis palustris* (Common Spike Rush) and *Ranunculus flammula* (Lesser Spearwort). A similar situation was observed at the larger Quarterwall pond, but this year several small patches of *Callitriche* (Starwort) were noticed in the shallower areas of the pond. As before macrophytic life was extremely sparse in the Rocket Pole pond with a few patches of *Hydrocotyle vulgaris* at the edges and stands of *Juncus effusus* and *Eleocharis palustris* at the eastern side of the pond.

3. Plankton (Table 3)

No plankton was collected from the smaller Quarterwall pond due to absence of open water. The plankton from the other four ponds varied both in numbers of species and in composition. Phytoplankton was only obvious in the Rocket Pole pond where the plankton was completely dominated by the blue green algae, *Microcystis* and *Arthrospira* and the green alga, *Pediastrum*, giving the pond a "pea-soup" appearance.

In Pondsbury, the water flea, *Daphnia obtusa* dominated and the smaller cladoceran, *Chydorus sphaericus* was also common. In the larger Quarterwall pond, various stages of the cyclopoid copepod, *Cyclops* sp. were the most abundant organisms, with many nauplii larvae, immature copepodid stages and mature males and females (with egg sacs) all being found. The plankton of Quarry pool although not as prolific as in the previous two ponds carried the greatest number of species — no one species was dominant, but the rotifers (5 spp) formed an important element of the plankton.

TABLE 3
Organisms in the plankton of the ponds

Species	Relative Abundance			
	Pondsbury	Quarry	Rocket Pole	QW1
<i>Algae:</i>				
Filamentous green	—	1	—	—
<i>Pediastrum</i> sp.	—	—	4	—
<i>Microcystis</i> sp.	—	—	5	—
<i>Arthrospira</i> sp.	—	—	3	—
<i>Rotifera:</i>				
<i>Brachionus calyciflorus</i> Pallas	—	—	2	1
<i>Brachionus rubens</i> (Ehrb)	—	2	3	—
<i>Keratella vulga</i> (Ehrb)	—	1	—	—
<i>Keratella quadrata</i> (Muller)	—	—	2	—
<i>Filinia longiseta</i> (Ehrb)	—	1	—	—
<i>Squatinella tridentata</i> (Fresenius)	—	3	—	—
<i>Pompholyx sulcata</i> (Hudson)	—	1	—	—
<i>Cladocera:</i>				
<i>Daphnia obtusa</i> (Kurz)	5	—	2	4
<i>Chydorus sphaericus</i> (Muller)	3	2	2	—
<i>Copepoda:</i>				
<i>Cyclops</i> sp.	2	3	—	4
Imm. cyclopids	2	—	—	5
Cyclopid nauplii	2	—	—	5
Harpacticoids	2	2	—	—
<i>Ostracoda:</i>				
Cypridid	—	—	—	1
<i>Diptera:</i>				
Chironomid L.	2	2	—	—
Total No. of species	5	10	8	4

4. Macroinvertebrate fauna

The species present and numbers of the invertebrate fauna found in the vegetation and open water are given in Table 4 and species and numbers in the bottom mud of each pond in Table 5.

Pondsbury possessed the greatest numbers of species and organisms in the vegetation and open water, followed by the smaller Quarterwall pond. Rocket Pole pond contained three species only with just 41 animals being found in the 5 min sampling period.

Two species occurred in all five ponds, Chironomid midge larvae and *Asellus meridianus*, the water slater, which formed very large populations in Pondsbury and the smaller Quarterwall pond where there was much decaying organic matter from the extensive plant beds. The presence of plants is an important factor for many of the invertebrates who use them as a refuge and a substratum as well as for food.

Corixids, the lesser water boatmen, occurred in four of the ponds (not Rocket Pole) and *Corixa panzeri*, a species which prefers waters with little organic matter and few weed beds (Southwood and Leston, 1959) was typically present in the larger Quarterwall pond. The predatory water boatman *Notonecta obliqua* dominated both Quarterwall ponds and Pondsbury.

Some species were restricted entirely to one pond and they included the flatworm *Polycelis nigra*, which was very abundant in Pondsbury. Here also occurred red Limnocharid mites and the water spider, *Argyroneta aquatica*, which is a long standing member of the Lundy fauna (George and Stone 1979). A few of the insects had restricted distributions. The damselfly *Ischnura elegans* only occurred in Quarry pool and the mayfly larva *Cloeon dipterum* in

the weedy Quarterwall pond. A notable find this year was the gastropod mollusc, *Lymnaea truncatula*, two specimens of which were found on the *Potamogeton* of the small pond at Quarterwall.

TABLE 4
Species and numbers of Macroinvertebrates in the plant beds and open water
(5 min. sampling time).

Species (* on surface. l. = larva)	Pondsbury	Quarry	Rocket Pole	QW1	QW2
<i>Platyhelminthes:</i>					
<i>Polycelis nigra</i> (Muller)	800	—	—	—	—
<i>Annelida:</i>					
<i>Lumbriculus variegatus</i> (Muller)	11	—	—	8	—
<i>Crustacea:</i>					
<i>Daphnia obtusa</i> Kurz	105	—	30	—	—
<i>Simocephalus vetulus</i> (Muller)	—	—	—	—	30
<i>Cyclops</i> sp.	30	—	—	—	—
<i>Asellus meridianus</i> Racovitza	738	12	1	54	250
<i>Uniramia — Chelicerata:</i>					
<i>Argyroneta aquatica</i> L.	6	—	—	—	—
Hygrobatid mite	4	—	—	—	22
Limnocharid mite	30	—	—	—	—
<i>Insecta:</i>					
<i>Cloëon dipterum</i> (L) l.	—	—	—	—	8
<i>Ischnura elegans</i> (Van de Linden) l.	—	4	—	—	—
<i>Gerris gibbifer</i> Schum *	—	4	—	5	—
<i>Notonecta obliqua</i> Thunb.	13	—	—	40	25
<i>Corixa punctata</i> (Illiger)	7	—	—	—	—
<i>Corixa panzeri</i> (Fieb)	—	—	—	15	—
Immature corixids	70	4	—	20	22
<i>Gyrinus substriatus</i> Stephens *	5	—	—	—	—
<i>Hydroporus pubescens</i> (Gyllenhal)	4	—	—	—	—
<i>Ilybius quadriguttatus</i> L.	—	1	—	4	6
<i>Helophorus grandis</i> Illiger	—	—	—	—	4
Dytiscid l.	—	11	—	10	4
<i>Limnephilus cases</i> (empty)	2	—	—	6	—
Chironomid larvae/pupae	15l	3l	10l	30l	15l
		+		+	+
		2p		45p	21p
<i>Mollusca:</i>					
<i>Lymnaea truncatula</i> (Muller)	—	—	—	—	2
Total No. of species	14	7	3	9	11
Total No. of organisms	1835	42	41	231	409

As in the 1979 survey, the bottom mud of all the ponds supported few species, with the red oligochaete *Lumbriculus variegatus* occurring in all samples taken. Two specimens of a small burrowing bivalve mollusc, the pea mussel *Pisidium subtruncatum*, not previously recorded on Lundy, was found in the bottom mud of the larger Quarterwall pond.

No attempt was made to estimate fish populations of the ponds, but as previously noted (George, 1981) a very large population of mirror carp still occurs in the Rocket Pole pond. Crucian carp can be found in Pondsbury; the Quarry pool supports both Crucian and Golden carp and large numbers (over 100) of small Golden carp were seen swimming in the surface waters.

TABLE 5
Invertebrates (nos/m²) in bottom mud

Species	Pondbury Quarry	Rocket Pole	QW1	QW2
<i>Protista:</i>				
<i>Paramecium</i> sp.	—	—	VA	—
<i>Annelida:</i>				
<i>Lumbriculus variegatus</i> (Muller)	200	180	30	180 60
<i>Crustacea:</i>				
<i>Asellus meridianus</i> Racovitza	400	—	—	140 100
<i>Insecta:</i>				
Red Chironomid Larvae	100	40	10	40 —
<i>Mollusca:</i>				
<i>Pisidium subtruncatum</i> Malm	—	—	—	2 —
Total No. of species	3	2	3	4 2
Total No. of organisms	700	220	40	262 160

VA = Very abundant

B. Streams

1. Physical and Chemical Characteristics

The Old Light stream and the Punchbowl Valley stream were acid, pH 4.9, and well oxygenated (over 90% saturation). On the day sampled when the ambient air temperature was 15°C, both recorded temperatures of 14°C. The discharge (volume of water passing a given point) was measured halfway down the cliff and was ½ litre/sec. for the smaller Old Light stream and 1 litre/sec. for the larger Punchbowl Valley stream. Both streams consisted of alternating areas of rapids, pools and small waterfalls interspersed with larger boulders and smaller rocks.

2. Flora

The species present and relative abundance are given in Table 6. Plants were recorded also in the Old Light marshy pool through which the stream was flowing.

With the exception of three species, *Fontinalis*, *Pellia* and the filamentous green alga, all of the plants recorded were found in the other freshwater habitats on the island. The Willow moss, *Fontinalis antipyretica*, which was found in the near vertical areas of the Punchbowl stream is known to occur in a wide range of habitats, both acidic and calcareous (Hynes, 1972). In 1979, it also occurred in small patches on the South side of the Quarry pool. The liverwort, *Pellia epiphylla*, which has previously been recorded on Lundy (Paton, 1975), was found under overhangs in the 'waterfall areas' of the Punchbowl stream. Only two species occurred in the Old Light stream, *Hydrocotyle* and the filamentous green alga, both of which occurred also in the marshy pool.

TABLE 6
Relative abundance of plants in the streams

Species	Punchbowl Stream	Old Light Pool	Old Light Stream
<i>Sphagnum cuspidatum</i> Ehrh	2	—	—
<i>Fontinalis antipyretica</i> (in vertical areas)	4	—	—
<i>Pellia epiphylla</i> (L.) (under overhangs)	2	—	—
Filamentous green alga	—	2	3
<i>Juncus effusus</i> L. (at edges)	—	3	—
<i>Carex</i> sp. (at edges)	2	—	—
<i>Potamogeton polygonifolius</i> (Pourret) (in pools)	3	4	—
<i>Hydrocotyle vulgaris</i> L.	3	4	2
<i>Callitriche</i> sp.	—	2	—
<i>Peplis portula</i> L.	—	3	—
<i>Myosotis scorpioides</i> L.	1	—	—
<i>Ranunculus flammula</i> L.	2	3	—
Total No. of species	8	7	2

3. Fauna

Very few invertebrates were found in the two streams.

Punchbowl stream

Old Light stream

Insecta:

Oligochaeta:

Plectrocnemia conspersa
(Curtis) l.

Lumbriculus variegatus
(Muller)

Dicranota sp. l.

Insecta:

Helophorus grandis Illiger

In the Old Light stream the two animals, the red worm, *Lumbriculus* and the adult beetle, *Helophorus*, also occurred in the pool at the top of the cliff, where several *Asellus meridianus* were also found.

Two insect larva occurred in the Punchbowl stream, the caseless caddis, *Plectrocnemia conspersa* and the tipulid larva, *Dicranota*. *Plectrocnemia* is normally found in small headwater streams, particularly in pool areas (Edington, 1968), and this was certainly the case in the Punchbowl stream. This caddis constructs a net that varies in form according to flow rate and water depth to catch living prey (Townsend and Hildrew, 1979). There appears to be little food for the caddis larva in this stream, but *Plectrocnemia* is known to take appreciable quantities of terrestrial prey, e.g. insects that fall into the water, so this is probably its main food source on Lundy. In its one-year life cycle (Edington and Hildrew 1981) this caddis has five larval stages, with the 5th stage building a stoney pupal case which is attached firmly to stones. One such case, containing a 5th stage larva was found in September 1986 as well as younger larvae. The tipulid larva, *Dicranota* is also another carnivore, and like the caddis, probably uses insects that fall into the stream, as its major food source.

DISCUSSION

There appear to have been no major changes in the flora and fauna of the Lundy ponds during the last seven years, with the pond communities remaining remarkably stable over this period. At first sight this is a little surprising as small ponds are noted for their instability when compared with larger bodies of standing water such as lakes, (Macan, 1973). Heavy rains can change water quality in a few hours, deoxygenation can easily occur particularly at night if there is a large phytoplankton bloom, and small water bodies are subject to vagaries of the season often experiencing drought conditions in the summer and severe cold and freezing during the winter. The Lundy freshwater habitats have encountered extremes of weather in the last seven years e.g. the dry July of 1984 caused water levels to drop significantly in Pondsby and the Quarterwall ponds, and in February 1986, the ponds were subject to severe freezing conditions for a long period.

The stability over the last seven years indicates that many of the organisms have good powers of survival and also that there has been a consistent recruitment of species from the mainland. It is well known that freshwater organisms, particularly those inhabiting small water bodies, have a remarkable capacity for surviving extreme conditions e.g. some species e.g. Cladocera, Rotifera, have resistant eggs; some e.g. Oligochaeta, Platyhelminthes, form cysts and aestivate in the bottom mud. Many insects overwinter as larvae which can lie dormant under ice and in the summer, adult insects can move from a pond that is drying up, especially the good fliers, such as beetles and water boatmen. On Lundy, the Quarry pool and the Rocket Pole pond always retain some water even in the most severe drought periods (c.f. 1976).

Notable this year, was the discovery of two species of mollusc in the Quarterwall ponds which were not found in the 1979 survey. The small pea-mussel, *Pisidium subtruncatum* which as far as we know, has not been recorded on the island before, occurred in the bottom mud of the larger Quarterwall pond. It appears to be a common species of *Pisidium* on the mainland occurring in all types of flowing and static water habitats (Ellis, 1978). A small population may have been present in 1979, but missed in the sampling procedures, or it could easily have been transported to Lundy in the last seven years. Lansbury (1955) has shown that *Pisidium* occasionally attaches to large insects such as Hemiptera (e.g. water boatmen) and may be carried from one water body to another in this way.

The other mollusc found, *Lymnaea truncatula* has been previously recorded on the island (Anon, 1950). Two specimens of this small snail which is regarded as a semi-aquatic as it can live also in damp situations on land, were found on the *Potamogeton* of the smaller Quarterwall pond. Thirty-six years ago, the snail was not found north of the Old Light, occurring mainly around Millcombe. It is interesting that the Quarterwall ponds are less acid than the other ponds and can provide a tolerable habitat for these snails.

Plankton in small ponds in the summer and autumn is very variable with often one species dominating for a short period. Therefore it was not unusual to find that in early September 1986 the plankton in Pondsby was dominated by a cladoceran, *Daphnia obtusa*, that was not found in the pond in August 1979. However, examination of the plankton of the other ponds again demonstrates their stability. As in 1979, the Rocket Pole pond was again dominated by the same species of blue-green algae, *Microcystis* and *Arthrospira*, and the larger Quarterwall pond by cyclopoid copepods, both immature and mature forms. As before there was a range of species in the Quarry pool with no one species dominating.

Although some 23 species of macroinvertebrates were found in the vegetation and open water of the ponds, there were relatively few species and numbers of organisms in the Rocket Pole pond and Quarry pool. An obvious reason for this is the presence of large populations of fish in their waters. It is difficult to see how these two ponds, particularly Rocket Pole, which have comparatively little plant and macroinvertebrate life can support such apparently thriving fish populations. Cannibalism of the younger fish by adults appears likely in these two ponds.

Although several of the small streams on the eastern side of the island had some water flowing in them no animal life was found. The three streams, shown on the OS map at Gannets Combe, were mainly just boggy areas with *Sphagnum* moss, *Juncus*

effusus and *Hydrocotyle vulgaris* growing there. The flora and few faunal species present in the Old Light stream obviously came from the marshy pool at the top of the cliff through which the stream was flowing. The larger Punchbowl stream, which probably rarely dries up, contained eight species of plants, six of which occur at Pondsbury. The other two species were the willow moss, *Fontinalis* which was abundant throughout the length of the stream, and the liverwort, *Pellia*, which grew under overhangs in the waterfall areas. The two invertebrates found, the larvae of *Plectrocnemia* and *Dicranota* are characteristic of flowing waters, occurring in upland streams on mainland Britain. The caddis, *Plectrocnemia*, has been recorded in Dartmoor streams by Elliott (1968) and adults could reach Lundy from North Devon fairly easily.

The apparent stability of the Lundy freshwater habitats during the past seven years, which after all are fairly small shallow bodies of water, has been the most interesting aspect of the 1986 survey. Less research has been carried out on ponds by freshwater biologists than on lakes, and very little is known about small island freshwater habitats. It will be useful to return to Lundy in a few years time for further surveys of the pond and stream communities, to see if this stability is maintained.

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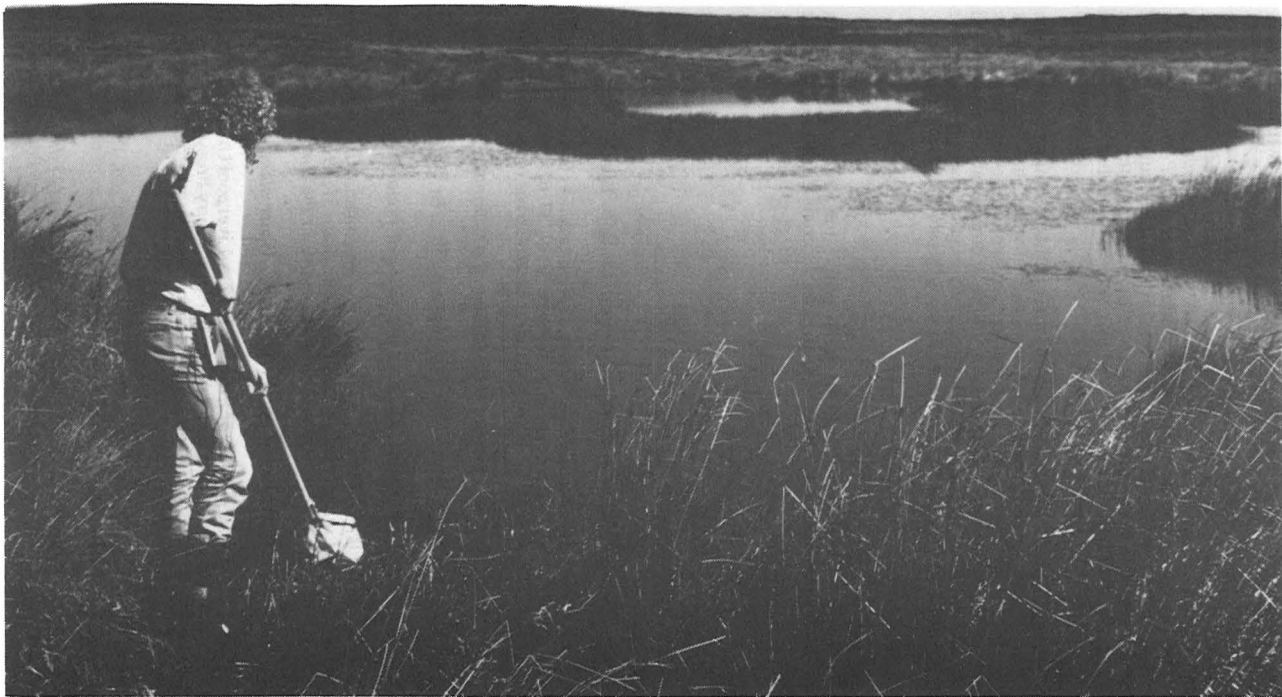


Plate 1

View of Pondsbury, with one of the authors (S.S.) sampling the submerged *Hypericum* beds for invertebrates.

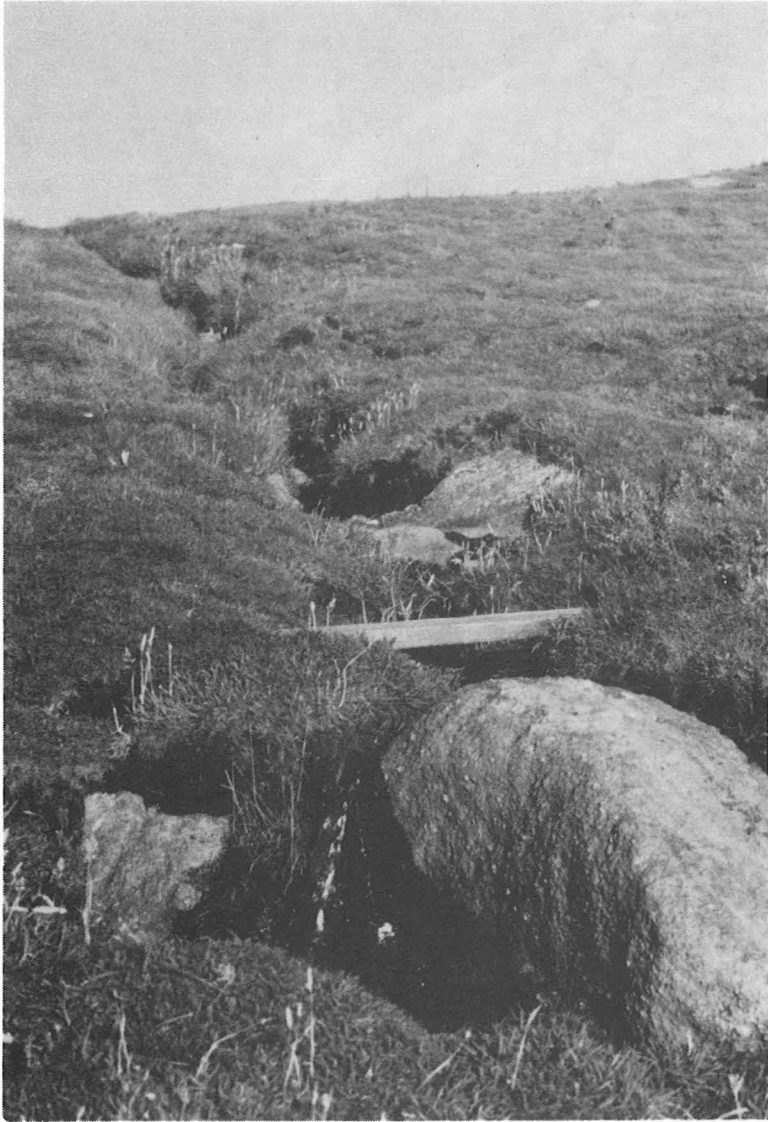


Plate 2

Stream flowing from the marshy pool, north of the Old Light, down the cliffs on the west side of the island.



Plate 3
View of Pondsbury stream, halfway down the cliffs in Punchbowl valley, showing the large boulders and a *Potamogeton* pool at the bottom of the photograph.