THE SCOTTISH NATURALIST
Founded 1871
A Journal of Scottish Natural History

Editorial Committee:
J.A. Gibson
John Hamilton
John C. Smyth
A. Rodger Waterston

THE SCOTTISH NATURAL HISTORY LIBRARY
Foremount House, Kilbarchan, Renfrewshire PA10 2EZ

The Scottish Naturalist is an independent journal, published by the Scottish Natural History Library, primarily devoted to the study of Scottish natural history. Although its main interests have always centred on fauna and flora, it is prepared to publish articles on the many aspects of Scottish natural science embraced by its title, including Zoology, Botany, History, Environment, Geology, Archaeology, Geography, etc.

All articles and notes for publication, books for review, etc, should be sent to the Editors at the Scottish Natural History Library, Foremount House, Kilbarchan, Renfrewshire PA10 2EZ.

Contributions should be clearly written; whenever possible they should be typed, double-spaced, on one side of the paper, with adequate margins, and should try to conform to the general style and arrangement of articles and notes in the current number of the journal. Maps, diagrams and graphs should be drawn in black ink on white unlined paper. Photographs should be on glossy paper. Proofs of all articles will be sent to authors and should be returned without delay.

Authors of articles, but not of short notes, will receive thirty reprints in covers free of charge. Additional copies may be ordered, at cost, when the proofs are returned.

The Scottish Naturalist will be published annually, and more often as required. The annual subscription is £7.50, which should be sent to the Editors at the Library address. Members of recognised natural history organisations may receive the Scottish Naturalist at a greatly reduced subscription; for details apply to the Editors.
THE SCOTTISH NATURALIST

A Journal of Scottish Natural History

With which is incorporated The Annals of Scottish Natural History and The Western Naturalist

96th Year 1984

CONTENTS

The Birds of the Endrick Mouth, Loch Lomond
   An annotated check-list up to 1st January 1980
   Mr. John Mitchell 3

The Status of the Wild Cat in Kintyre
   Dr. Eric Bignal and Dr. Nigel Easterbee 49

Comparative Observations on the Invertebrate Fauna of
   Two Orkney Streams
   Dr. P.B. Heppleston 53

Open-Water Zooplankton from Five Tayside Freshwater Lochs
   Mr. David H. Jones 65

The Minnow on the Island of Arran
   Dr. Peter S. Maitland 93
EDITORS

J.A. Gibson
John Hamilton
John C. Smyth
A. Rodger Waterston

All items for publication should be sent to the Editors at
The Scottish Natural History Library
Foremount House, Kilbarchan, Renfrewshire PA10 2EZ

ISSN 0268-3385

Published by
THE SCOTTISH NATURAL HISTORY LIBRARY
The Birds of the Endrick Mouth, Loch Lomond

An Annotated Check-List up to 1st January 1980

By John Mitchell
Nature Conservancy Council

Introduction

The annotated species list for counties and selected localities once formed the mainstay of ornithological journals. Over the years such lists have gradually lost favour with some editorial boards, yet the need for descriptive accounts of the best ornithological sites in the country remains, both for conservation bodies and the casual birdwatcher alike. In many instances much of the required information has already been gathered, but has not been collated into a readily accessible form. To date, this has been the case for one of the most rewarding birdwatching spots in the west of Scotland - the Endrick Mouth in the south-east corner of Loch Lomond.

To birdwatchers, the term Endrick Mouth encompasses an area much wider than just the point where the river discharges into the loch. Ornithological records have regularly appeared under this name from the entire south-east corner of Loch Lomond extending from Portnellan to Balmaha, and the flood plain of the river right up to Drymen Bridge. It was the need for a clearly defined boundary which eventually led to the present author delineating the Endrick Mouth recording area by its peripheral roads, thereby establishing limits that could easily be identified both on the Ordnance Survey map and on the ground.

The landward part of the recording area is bounded on the west by the unnumbered eastern road to Townhead of Aber and a private road leading to Portnellan Farm; to the south and east lies the A811 road from Gartocharn to Drymen; to the north the B837 road between Drymen and Balmaha; also included is the Aber Isle, the only permanent island within observable range. In this account these boundaries have been strictly adhered to even to the exclusion of several interesting records, which in some cases are outwith the recording area by only a few hundred yards.

This paper brings together and summarises the recorded ornithological observations made at the Endrick Mouth from the mid-19th century up to 1st January 1980. Every effort possible has been made to trace all available published and unpublished records for the area, yet almost certainly some will have been missed, and the compiler would be grateful if any omissions or
ENDRICK MOUTH, LOCH LOMOND.
Mouth of the River Endrick
in the south-east corner of Loch Lomond

Map: Neil Mitchell
Photographs: John Mitchell
errors noted in the annotated list could be brought to his attention.

Physical Description and Historical Notes

With the retreat of the penultimate glacier about 12,500 years ago, what is now the flood plain of the River Endrick became an arm of the sea. The present hinterland upstream from today's river mouth then consisted of a raised delta with estuarine flats formed from large deposits of water-borne silt, before Loch Lomond was effectively sealed off from the Clyde following the final resurgence of glacial ice (Dickson et al 1978). Draining the sandstones and basaltic lavas of the Blane and Endrick valleys, the river is still carrying downstream an estimated 13 to 14 thousand tons of silt and fine sand each year. Much of this mineral-rich sediment is accreting in a fan-shaped sand bar at the river mouth (Poodle 1970).

Early accounts of the Endrick Mouth area are few, the first from the pen of Richard Frank who visited Loch Lomondside in 1656 or 1657. Looking down from high ground near Drymen, Frank described the low-lying country below as "besieged with bogs". Tradition has it that in 1742 the bride of the 2nd Duke of Montrose burst into tears when she first set eyes on this same tree-less expanse around Buchanan House which was to be her future home. The establishment of the first plantations from this date gives a ring of authenticity to the story that the Duke was much affected by his young wife's distress. The winning of the rich alluvial soils by extensive drainage was already in hand by this period. From the first detailed survey of Buchanan Estate, made by William Edgar about 1743-45, successive maps record the gradual transformation of the landscape by drainage, enclosure and tree planting. Similar land management was carried out on the south side of the River Endrick by the Ross Priory Estate. Maintenance by hand of miles of essential ditches, however, required a great deal of labour, and by the turn of this century the O.S. maps show clearly that some drainage channels were showing the first signs of falling into disrepair. The decaying process of the drainage system, followed by the re-establishment of marsh, has continued right up to the present day.

Apart from the changes brought about by agriculture and forestry, other developments have been proposed for the Endrick Mouth corner of Loch Lomond from time to time. During the railway boom of the 19th century a line was planned to run right through the area en route for the Pass of Balmaha. The Glasgow and North Western Railway bill was presented to Parliament in 1882, but was turned down in the following year. Six years later in 1889 the Dumbarton, Jamestown and Loch Lomond Railway was
promoted, the aim being to link the River Leven with a steamer pier to be constructed at the 'Port' of Aber. This, too, failed through lack of support (Thomas 1971 and 1976). Routes for a Mid-Scotland Ship Canal were surveyed as early as 1763, one plan proposing to canalise the Endrick's lower reaches (Pratt 1922). With the emergence of Germany as a maritime power in the early 1900s, proponents of the scheme lost little time in stressing the strategic advantage of quickly being able to switch a defensive naval force from one side of Britain to the other. However, the cost of building a canal of sufficient width and depth to accommodate the largest warships was to prove prohibitive. In the late 1940s and early 1950s a survey was made of the upper catchment area of the Mar Burn (a feeder stream of the lower Endrick) with a view to building a high-level reservoir for a pumped storage or conventional hydro-electric station on the lochside below. Concern over the plan was expressed by local naturalists because of a press statement which conveyed the impression that the power station would be sited right by the river mouth. This turned out to be incorrect, however, and in the event the whole scheme was dropped on account of its uneconomic small size.

Developments on a large scale have been carried out or proposed for Loch Lomond as a whole. In 1966, the Central Scotland Water Development Board was given the authority to impound and abstract water for domestic and industrial use (Cuthbertson et al 1977). The Board originally planned to establish a range of water control on the loch between 22 and 27 feet Ordnance Datum, but following a number of objections on environmental grounds the maximum height of the barrage to be constructed across the loch's only outlet was lowered to 26 feet. The barrage became operational in 1972. Since then the modal (most frequent) level of the loch has risen from roughly 25 feet O.D. to 26 feet O.D., the spring and early summer months being the most affected (Poodle 1979). This increase in water level is most noticeable at low-lying areas like the Endrick Mouth, where there is only a minimal rise in height from loch bed to shore. Hard on the heels of the Loch Lomond Water Scheme came a second proposal to establish a pumped storage hydro-electric station on Loch Lomondside, this one to be sited at Craigroyston, above Rowardennan. If this should ever become operational, then even higher loch levels could be expected, for in order to provide storage in the loch for water released from an upper reservoir it will apparently be necessary to increase the present range of control at least by another one foot three inches. At the time of writing, however, a decision on the Craigroyston scheme has been indefinitely deferred.

Despite the feel of the developer's hand, the Endrick Mouth has survived better than some of the other wetland sites in the
general Glasgow area. Several well known localities, noted particularly for wading birds and/or wildfowl, have all but disappeared in the last few years: e.g. Robroyston (Hilda) Marshes - infilled with rubble in 1963/64 to create playing fields; the network of pools at Hamilton Low Park and Merryton - most of them infilled in 1966 for the M74 motorway built right through the middle of this once extensive site; and Paisley Moss - much of the last ornithologically good remnant infilled in 1969 for an extension to the main runaway to Glasgow Airport. Fortunately, the conservation interest of the Endrick Mouth and its surrounds was recognised at an early date, and most of its best wetland areas now form part of the Loch Lomond National Nature Reserve administered by the Nature Conservancy Council.

Bird Habitat at the Endrick Mouth

For birds, the Endrick Mouth area offers a wide range of nesting and feeding habitat, including the shallow loch, exposed sand banks during low water, a slow meandering river with ox-bow pools, reed beds and marshes, wet meadows, arable land, deciduous and conifer woodlands, plus the policy plantings and gardens around Buchanan Castle and Ross Priory. Up to 85 different species nest each spring and early summer. For non-breeding species, the geographical position of the Endrick Mouth is very important, the area being well placed at the confluence of several migration routes used by birds, - the Loch Lomond valley, the upper Forth valley, Strathendrick, Strathblane and Strathleven (a direct link with the Inner Clyde estuary).

The river mouth itself, the Ring Point and Wards Low Ground have consistently proved the most productive places for observing migrants. Mention has already been made of the continuous deposition of silt at the river mouth, but little of this is available to feeding birds until the level of the loch falls to about 25 feet O.D. following a dry spell. With the loch level below 24 feet O.D. a vast, almost continuous, sand bank is exposed right from Net Bay to Balmaha. To one side of the river mouth lies the Ring Point, a narrow promontory about a mile long (Williamson et al 1973). Between the sandy ridges of the Point lie a number of lagoons, probably all former positions of the river mouth before being displaced by accreting silt. In contrast, Wards Low Ground is an artificial site, consisting, up to the early 1930s, of arable fields protected from river floods by an earthen dyke. As the drainage system broke down, the arable land gradually reverted to marsh and sedge fringed pools, frequently becoming one continuous stretch of water at times of flood. Studies by Glasgow University Department of Zoology on the muds and silts of Wards Low Ground and the river mouth have shown that both sites are particularly rich in aquatic inverte-
The Endrick Bank exposed during low water in late summer
brates (Maitland 1966, Tippet 1975), thus demonstrating the high food potential for waders and wildfowl.

Completing the best of the wetland habitats for birds are the Crom Mhin (Shaw 1975), another one-time arable area steadily turning to wet meadow and marsh, and the Aber Bogs (Waltho 1979 and 1980). The Bogs are made up of large stands of reeds and fen vegetation formerly cut over for 'bog-hay'. Since regular harvesting of bog-hay ceased in the 1930s, there has been considerable colonisation by willow.

Compared with the islands of Loch Lomond, the woodland bird habitat at the Endrick Mouth is not exceptional, the most favoured localities being the water-logged woods of Gartfairn (Shaw 1974) and Ring Wood East (Williamson et al 1973), and the policy plantings in the vicinity of the two former country seats.

Bird Recording at the Endrick Mouth

It is now over 200 years since the first ornithological observation from the Endrick Mouth was committed to print. During Thomas Pennant's first tour of Scotland, undertaken in 1769, he was informed by "persons of credit" in Dumbarton that torpid Swallows had been taken in mid-winter out of a sand-bank over the River Endrick near Loch Lomond. It is easy to be amused by this statement today, but it should be remembered that the early naturalists had still to solve the great mystery of where many of the birds vanished to at the end of the summer.

Every good birdwatching spot produces at least one outstanding personality or character, and in the Endrick Mouth's case it must surely be George Leith, later to become Sir George Leith Buchanan. In 1848, at the age of only 14, he began well by finding the first Shoveler's nest to be recorded in the Clyde Faunal Area. Before his 17th birthday he had shot Scotland's first ever Bonaparte's Gull, a north American species, thus attracting the attention of William Yarrell and other ornithological pundits of his day. He was a first-rate marksman, on one occasion bringing down twelve Snipe with twelve successive shots. Over the years his prowess with a gun was not only to show that some of the less common waders occurred in the Clyde area more regularly than had hitherto been supposed, but was also responsible for establishing a permanent place for the Endrick Mouth on Scotland's ornithological map. Most of Sir George Leith Buchanan's more interesting field records were reported in a short series of papers on Loch Lomondside's birds written by local recorder James Lumsden. As far as can be ascertained, Lumsden was the first ornithological historian to describe the lower lying parts of the Ross Priory and Buchanan Castle estates as the 'Mouth of the Endrick', later to be shortened to the more familiar Endrick Mouth.
After the death of Sir George Leith Buchanan in 1903, the Endrick Mouth slipped into almost total ornithological obscurity for over forty years. Because of the lack of information for this period, the compilers of a report on 'The Natural History Features of the West of Scotland in relation to Regional Planning' produced in 1946 (Cameron et al 1946) were only able to repeat the old 19th century records when presenting their case for the conservation of this part of Loch Lomondside. The renaissance of interest began with the setting-up of a national scheme for counting wintering ducks, geese and swans, organised by the Wildfowl Inquiry Committee of the British Section of the International Council for Bird Preservation. The Endrick Mouth was regularly counted for eleven out of the first fourteen seasons used as a basis for the Nature Conservancy's monograph *Wildfowl in Great Britain* (Atkinson-Willes 1963), the area being shown to harbour wintering wildfowl in numbers of regional importance.

From the early 1950s, records of other species observed at the Endrick Mouth began to appear with increasing frequency in articles in the *Scottish Naturalist* and the *Glasgow and West of Scotland Bird Bulletin*, before the general collation of ornithological reporting passed to *Scottish Birds*, the journal of the Scottish Ornithologists' Club, in 1959. Up to and including 1967, most of the Endrick Mouth records are to be found scattered throughout the journal's regular feature 'Current Notes'. In 1968 this quarterly national report was replaced by a comprehensive annual summary - the 'Scottish Bird Report', produced as a separate publication from 1978. Because of the growing volume of material submitted at the end of each year, it was inevitable that the choice of records for inclusion in the national report became more selective. This undoubtedly contributed to the launching of several local and regional reports in Scotland, including the *Loch Lomond Bird Report* produced annually from 1972. This privately circulated report (complete sets deposited in the Scottish Natural History Library and in the Waterston Library of the Scottish Ornithologists' Club) functions as a repository for ornithological matters for the whole of the Loch Lomond catchment area, but from its inception has incorporated a special section for records from the Endrick Mouth.

As will be seen from the species list which follows, the Endrick Mouth's reputation as a premier *inland* birdwatching spot is justly earned. Well over 200 different species have been reliably reported, including four vagrants from North America and three 'firsts' for Scotland. The list of waders recorded is particularly impressive, and the area is close enough to the Inner Clyde estuary to attract the occasional wind-blown seabird sheltering from the autumn storms. Wildfowl form the main
interest in winter, the annual population between 1975 and 1979 averaging just over 2,000 birds, with a peak of 4,244 counted in November 1978. For the rarity seeker, however, the Endrick Mouth is almost totally unpredictable, although the pleasure derived from seeing an unfamiliar bird after numerous unfruitful visits serves to make all the effort seem worthwhile. In describing both the joys and despair in pursuing the elusive Salmon which lurk just off the Endrick Bank, the late Ian Wood in his book *Out from Balmaha* (1947) quotes an expression often used by Loch Lomond anglers to buoy-up flagging spirits on the dull days .... "You never know the minute". The same unwavering optimisim is shared by the birdwatching regulars who haunt the Endrick Mouth just on the off-chance of spotting a pulse-quickening vagrant once in a while.

**Systematic List**

With only minor alterations, in accordance with local usage, the annotated species list below follows the *List of Recent Holarctic Bird Species* by Professor Karel H. Voous (1977). The use of square brackets indicates (a) the species has not been unre-ervedly accepted on to the British and Irish list; (b) the description of the bird submitted to the 'British Birds' rarities committee was considered insufficient for complete acceptance of the record; or (c) the record was initially accepted, but later withdrawn by the observer.

With over 200 full species recorded at the Endrick Mouth on one or more occasions, there are not enough descriptive terms to define precisely the status of every bird. The following generalised descriptions must therefore suffice:

- **Present throughout the year:**
  - can occur in every month of the year.

- **Present for much of the year:**
  - can occur most months of the year.

- **Summer Visitor:**
  - seasonally present during the middle months of the year.

- **Winter Visitor:**
  - seasonally present during the early and late months of the year.

- **Passage Migrant:**
  - occurs with some regularity on spring and/or autumn passage, but not necessarily annually.

- **Occasional Visitor:**
  - occurs with some regularity, but most have no definite pattern as to season.
Irregular Visitor:
- occurs only intermittently, but there are more than five modern records.

The number of occurrences is stated for any species recorded on only five or less occasions.

Wherever the information is available, an indication is given of the numbers in which each species has occurred. As a result of systematic counts, any wildfowl which occur regularly in winter have been treated as special cases and an analysis undertaken for the previous five years' figures (1975-1979) inclusive:

Peak Population (Swans & Geese):
- figure derived from the average of the highest single count in each of the five seasons.

Regular Population (Ducks):
- figure derived from the average of the three highest counts in each of the five seasons.

A number of past records have been extracted from the game books of Ross Priory and Buchanan Castle estates. The surviving books cover the periods 1868-1898 and 1879-1925 respectively.

Mention of feral wildfowl breeding in the area refers in almost every instance to birds which have originated from a private collection kept at Wards from 1959 to 1980 inclusive.

Almost all the individual records are referenced. In cases where the record has apparently not previously appeared in print, the name of the observer or the source of the record is given. The following abbreviations are used throughout:

BB - British Birds.
CWGR - The Clyde Wader Group Report.
LLBR - Loch Lomond Bird Report.
PNHSG - Proceedings of the Natural History Society of Glasgow.
SBR - Scottish Bird Report (produced as a separate from 1978).
SN - The Scottish Naturalist.
RED-THROATED DIVER *Gavia stellata*
   Irregular Visitor. All singles. Mainly winter records, but birds in summer plumage occurred in 1976/77/78.

BLACK-THROATED DIVER *Gavia arctica*
   One record. Single, first seen on 21 Jan 1966, and found dead eight days later (E.T. Idle).

GREAT NORTHERN DIVER *Gavia immer*

LITTLE GREBE *Tachybaptus ruficollis*

GREAT CRESTED GREBE *Podiceps cristatus*

RED-NECKED GREBE *Podiceps grisegena*

SLAVONIAN GREBE *Podiceps auritus*

BLACK-NECKED GREBE *Podiceps nigricollis*
   [Record of a single bird on 16 April 1961 (SB 1: 436) was subsequently withdrawn (SB 2: 57).]

FULMAR *Fulmarus glacialis*
   Irregular Visitor. All singles, most found dead Mar - Aug.

STORM PETREL *Hydrobates pelagicus*
   One recent record. Single bird, early 1946 following gales, was seen for about 10 days (A.J. Macfarlane). The Storm Petrel appears to have been recorded more regularly in the mid-19th century (Leith 1852).
LEACH'S PETREL *Oceanodroma leucorhoa*

One recent record. Single, found dead 9 Nov 1952 following 'wreck' of Leach's Petrels throughout Scotland (Wynne-Edwards 1953). The bird was picked up on the Dunbartonshire side of the river, not Stirlingshire as stated in the report. Also appears to have been recorded more regularly in the mid-19th century (Leith 1852).

GANNET *Sula bassana*

Irregular Visitor. Mainly singles, but five immatures 15 Sept 1968 (SB 5: 310). One record of a bird diving for fish (Anderson 1944). Loch Lomond would appear to be one of the most regularly frequented fresh-water bodies in Scotland, the Gannets probably attracted by the presence of large shoals of the herring-like Powan.

CORMORANT *Phalacrocorax carbo*

Present throughout the year. No breeding records. Maximum population on the occasions when low water in late summer and autumn exposes the rocky reef around the Aber Isle. Highest recorded number - 88, 14 Oct 1972 (SB 7: 334). Ringing recoveries elsewhere on Loch Lomond show that the birds originate from widely scattered colonies in Scotland, the most frequent records being from the fresh-water breeding colony at Loch Mochrum, Wigtownshire.

SHAG *Phalacrocorax aristotelis*

One record. Single, 22 Sept 1969 following gales (T. Weir). Two ringing recoveries elsewhere on Loch Lomond suggest the bird may have originated from the Farne Islands, Northumberland.

BITTERN *Botaurus stellaris*

Four recent records. All singles - Sept 1933 (Pennant 1933), heard 'booming' 1937 (SB 1: 5), 23 Jan 1977 (SB 10: 120) and 7-21 Jan 1979 (SBR 1979: 13). A comment by Wade (1822) that the Bittern was occasionally seen about lower Loch Lomond may well have referred to the Endrick Mouth.

GREY HERON *Ardea cinerea*

Present throughout the year. Breeds. Heronry first reported at Rushypark Plantation near Woodend Lodge in the late 1890s, transferring to Gartfairn Wood in the early 1930s. One pair unsuccessfully attempted to nest on the Aber Isle 1958 or 1959. After being reduced to only six pairs following the severe winter of 1962/63, a gradual build up of the colony to 39 pairs by 1974, this maximum number being equalled in 1978 (Mitchell 1978b).
SPOONBILL *Platalea leucorodia*


FLAMINGO *Phoenicopterus* sp.


MUTE SWAN *Cygnus olor*


BEWICK'S SWAN *Cygnus columbianus*

Occasional (winter) Visitor. Usually 1-5 birds, but has become decidedly scarce in recent years. Highest recorded number - 26, Oct 1968 (R. Shaw).

WHOOPER SWAN *Cygnus cygnus*

Winter Visitor (occasional summering birds). Regular, but declining in numbers. Peak population - 42, Jan-March. Highest recorded number - 92, 17 March 1963 (E.T. Idle). In 1950 and 1951 a male Whooper Swan paired with a female Mute Swan, the first year's nest being harried and the following year the pair producing infertile eggs (Woods 1954). In 1978 a wild male Whooper Swan held territory with an escaped pinioned female, but it was not until the following year that breeding was proved (Mitchell 1981a).

BEAN GOOSE *Anser fabalis*

Formerly regular Winter Visitor. Apparently the most common of the 'grey geese' occurring in the Loch Lomond area during the last century (Gray 1864, Harvie-Brown 1867). Up to the mid-1960s, the Endrick Mouth was one of only three localities in Britain where Bean Geese occurred annually, although greatly reduced in numbers (Boyd 1963). Highest recorded post-war number - 30, 22 Feb 1953 (SN 66: 67). Last flock, of 16 birds, 4-8 Jan 1972 (SB 7: 342). A pair of feral full-winged Western Bean Goose *Anser f. fabalis* nested in 1978 and 1979 (LLBR 7: 4; 8: 3).

PINK-FOOTED GOOSE *Anser brachyrhynchus*

Passage Migrant (occasional winter visitor). Regular.
Large skeins pass over the area in autumn, only the occasional flock briefly stopping-off. Highest recorded flock stopping-off - 300, 27 Sept 1976 (LLBR 5: 3).

**WHITE-FRONTED GOOSE** *Anser albifrons*


**GREYLAG GOOSE** *Anser anser*

Winter Visitor (feral birds present throughout the year). Regular. Peak population - 1,730. Highest recorded number - 3,000, Feb and Nov/Dec 1978 (SBR 1978: 15). The Greylag Goose is the only species of wildfowl wintering at the Endrick Mouth which regularly occurs in numbers of international importance (Salmon 1981). Only an irregular visitor to Loch Lomondside up to the late 1930s (Berry 1939), but over 600 birds present at the Endrick Mouth when the first goose count was undertaken in Oct 1948 (I.C. Christie). Feral breeding of full-winged Greylags first recorded in 1973 (SB 8: 228), with three nests found in 1975 (LLBR 4: 2).

**BAR-HEADED GOOSE** *Anser indicus*

[One record. Single male, in company with Greylag Geese, 15 Jan 1978 (Mitchell 1979c)].

**SNOW GOOSE** *Anser caerulescens*


**CANADA GOOSE** *Branta canadensis*

Present for much of the year (usually absent during the period of summer moult). Peak population - 32. Highest recorded number - 57, 17 Sept 1972 (SB 7: 343). First record of a pair 30 April 1955 (SN 68: 158) pre-dates the wildfowl collection built-up at Wards, but the majority of the present feral flock
probably originate from this source. One or two feral pairs nesting annually from 1968.

**BARNACLE GOOSE Branta leucopsis**

Passage Migrant (occasional winter visitor). Irregular. Usually very small numbers mixed-in with Greylag Geese during the autumn arrival, but separate flocks have occurred. Highest recorded number - 59, 27 Sept 1977 (SB 10: 126).

**BRENT GOOSE Branta bernicla**


**RUDDY SHELDUCK Tadorna ferruginea**

One record. Single male, in company with Shelducks, 11 April 1979 (SBR 1979: 16). Almost certainly the same pinioned bird which escaped from Cameron House Wildlife Park two months earlier.

**SHELDUCK Tadorna tadorna**

Summer Visitor (occasional birds at other times of the year). Regular. Breeds. Most pairs which hold territory at the Endrick Mouth nest just outwith the boundaries. Prior to the first outbreak of myxomatosis in 1955, Shelducks apparently occasionally nested in rabbit holes on the Ring Point and in the earthen embankment around Wards Low Ground. Territorial population appears stable at about 20 pairs, with varying numbers of non-territorial birds present. Highest recorded number of adults - 124, 4 June 1978 (Bignal 1980). First recorded nesting at the Endrick Mouth in 1877 (Lumsden 1881).

**WOOD DUCK Aix sponsa**

[Following the escape of a full-winged pair of Wood Ducks from Wards, nest and eggs reported beside the Mill Burn, Drymen, in 1962 (R. Shaw).]

**MANDARIN Aix galericulata**

Four records of full-winged birds. All singles - female on 13 Dec 1974 (SB 8: 410), female on 23 Nov 1975 (SB 9: 185), male on 18 Feb and male on 17 April 1977 (SB 10: 121). The first record at least suggests the possibility of feral breeding as the result of ten pinioned Mandarins (6 males and 4 females) escaping from Wards collection in the spring of 1974 (LLBR 3: 2).
Shallow sedge-fringed pools at Wards Low Ground
Old drainage channel through the reed beds of the Aber Bogs
WIGEON *Anas penelope*

Present throughout the year. Breeds only occasionally; most of the summering males appear not to have mates. Autumn and winter influx. Regular population - 463. Highest recorded number - 647, 16 Dec 1973 (SB 8: 223).

GADWALL *Anas strepera*


TEAL *Anas crecca*


MALLARD *Anas platyrhynchos*


PINTAIL *Anas acuta*


GARGANEY *Anas querquedula*

Passage Migrant (summer visitor). Regular in recent years. Singles and pairs. Nesting suspected in 1979, but not proved (SBR 1979: 17).

SHOVELER *Anas clypeata*

Present for much of the year (absent in winter during severe weather). Breeds. Autumn influx. Regular population - 36. Highest recorded number - 100, 13 Oct 1963 (R. Shaw) and late Oct 1978 (SBR 1979: 17). A nest and eggs found in April 1848 (Leith 1852) was the first recorded breeding record for the Clyde Faunal Area.

POCHARD *Aythya ferina*

Winter Visitor (occasional males in summer). Regular. May have bred on one occasion - adult with juvenile, 25 July 1977 (LLBR 6: 2). Regular population - 10. Highest recorded number
The wintering population has greatly declined in numbers, for in the mid-19th century the Pochard was described as the most abundant wildfowl species on the loch (Gray 1864).

**TUFTED DUCK Aythya fuligula**


**SCAUP Aythya marila**


**LONG-TAILED DUCK Clangula hyemalis**


**COMMON SCOTER Melanitta nigra**


**VELVET SCOTER Melanitta fusca**


**GOLDENEYE Bucephala clangula**

Winter Visitor (summer records in recent years). Regular population - 18. Highest recorded number - 50, 30 Nov 1979 (LLBR 8: 4). May have bred on one occasion - female with one young, 8 Sept 1979 (LLBR 8: 4). Appears to have greatly declined in numbers since the end of the 19th century, when wintering Goldeneye were described as occurring 'in hosts' (Lumsden 1887).

**SMEW Mergus albellus**

Winter Visitor. Irregular. Usually single redheads (fe-
males & immatures). Highest recorded number - three, 17 March 1963 (J. Campbell) and 1 Dec 1973 (LLBR 2: 2).

RED-BREASTED MERGANSER Mergus serrator

Present for much of the year (only the occasional birds in winter). Breeds. Influx of broods from elsewhere on the loch sometimes results in large creches being formed; 90 young in one party, 12 July 1968 (J. Mitchell).

GOOSANDER Mergus merganser

Present for much of the year. (Summer records becoming more regular as Loch Lomond population continues to expand). Highest recorded number - 17 10 Dec 1977 (LLBR 6: 2) to 26/27 Feb 1978 (SBR 1978: 19). Female with nine young, only 2/3 days old, 25th June 1977 (Brock 1978) probably nested elsewhere on the loch.

MARSH HARRIER Circus aeruginosus

Irregular Visitor. All singles. Almost all the records were reported in the periods 1959/60 (Richmond 1959) and 1966/67.

HEN HARRIER Circus cyaneus

Winter Visitor (occasional summer records). Regular. Usually singles, but two sometimes seen hunting in close proximity. First began to appear about 1952, when it was consolidating itself as a breeding species in a neighbouring area.

GOSHAWK Accipiter gentilis


SPARROWHAWK Accipiter nisus

Present throughout the year. Breeds. Maximum of two pairs recorded in any one year.

BUZZARD Buteo buteo

Present throughout the year. Breeds. Minimum of four pairs in any one year.

ROUGH-LEGGED BUZZARD Buteo lagopus

One record. Single, 3 Jan 1960 (LLBR 9: 3).
GOLDEN EAGLE *Aquila chrysaetos*


OSPREY *Pandion haliaetus*

Passage migrant (summer visitor). Annual from about 1964. Mainly single birds, but two together (？ pairs) not uncommon.

KESTREL *Falco tinnunculus*

Present throughout the year. At least one breeding site. Other birds seen appear to be from nesting sites just outwith the recording area.

MERLIN *Falco columbarius*

Occasional Visitor. All singles between August and January.

GYRFALCON *Falco rusticolus*

Two records. Both singles - Greenland race *Falco rusticolus candicans* 3 April 1955 (Forrester 1957), and nominate European race 5 Nov 1960 (Richmond 1961).

PEREGRINE *Falco peregrinus*

Occasional Visitor (recorded all months of the year). Almost all singles, but 'pairs' present on two occasions.

RED GROUSE *Lagopus lagopus*

No recent records. The Buchanan Castle game books list 39 Red Grouse shot on the Low Mains between 1882 and 1890. On the south side of the river the Ross Priory game books record five Red Grouse shot in 1887. These birds, probably feeding on stubble, reflect the high stocking rate on the surrounding moors during this period.

BLACK GROUSE *Tetrao tetrix*

Two recent records. Both singles - 26 June 1960 (M. Forrester), and female 25 Sept 1979 (LLBR 8: 5). Formerly regular entries in the Buchanan Castle game books for the Gartfain area.

CAPERCAILLIE *Tetrao urogallus*

Irregular Visitor (mainly winter records). All singles. Formerly bred. Following re-introduction of the Capercaillie into Scotland from about 1837, the first bird was shot at Ross Priory during winter 1867/68, which pre-dates an introduction into the Duke of Montrose's woods about 1870-1875. Controlled
stock maintained on Ross Priory estate, nesting up to the 1930s (Harvie-Brown 1888, Pennie 1951).

RED-LEGGED PARTRIDGE *Alectoris rufa*


GREY PARTRIDGE *Perdix perdix*

Occasional Visitor. Formerly bred. Highest recorded number in recent years - six, 2 Jan 1978 (J. Mitchell). Frequently mentioned in both the Buchanan Castle and Ross Priory game books.

QUAIL *Coturnix coturnix*

One recent record, single, 7 June 1975 (SB 9: 195). Three past records. All singles - 1868, 24 Sept 1898 (Buchanan Castle game books), and about 1910 (D. Stewart).

PHEASANT *Phasianus colchicus*

Present throughout the year. Breeds. Highest recorded number in a flock - 50, 22 Jan 1978 (F. Moore). First introduced into the area by the Third Duke of Montrose around the turn of the 19th century (Freeland 1845).

WATER RAIL *Rallus aquaticus*

Present throughout the year. Breeds. Elusive and often overlooked, but four records of nests or young (Cassidy 1948, SB 1: 65, Shaw 1975, LLBR 7: 4).

SPOTTED CRAKE *Porzana porzana*


CORNCRAKE *Crex crex*

Irregular Visitor. Formerly regular summer visitor and breeding. The last good year for Corncrakes was 1965, when at least four separate birds calling.

MOORHEN *Gallinula chloropus*

Present throughout the year. Breeds. Winter influx.
Numbers formerly controlled at Wards, with 90 and 84 killed in the winters of 1969/70 and 1970/71 respectively (R. Shaw). Decrease in breeding birds in last few years attributed to predation by Mink.

COOT Fulica atra

Present throughout the year. Breeds. Autumn and winter influx. Highest recorded number - 500, 27 Jan 1963 (A.G. Gordon). Decrease in breeding birds in last few years attributed to predation by Mink.

OYSTERCATCHER Haematopus ostralegus

Summer Visitor / Passage Migrant (only the occasional bird in mid-winter). Breeds. Most noticeable passage in late Feb - early March. Size of flocks very variable. Highest recorded number - 300, 12 March 1977 (LLBR 6: 3).

AVOCET Recurvirostra avosetta


LITTLE RINGED PLOVER Charadrius dubius


RINGED PLOVER Charadrius hiaticula


GOLDEN PLOVER Pluvialis apricaria


GREY PLOVER Pluvialis squatarola


LAPWING Vanellus vanellus

Present for much of the year. Breeds. Spring and autumn passage, plus 'hard-weather' westward movements during severe winter conditions. Size of passage flocks very variable. Highest recorded number - up to 600 on several occasions (CWGR 2: 19).
KNOT *Calidris canutus*


SANDERLING *Calidris alba*


LITTLE STINT *Calidris minutia*


TEMMINCK'S STINT *Calidris temminckii*


PECTORAL SANDPIPER *Calidris melanotos*

One recent record. Single, 18 Oct 1959 (Forester 1960). One past record. Single, 24 Nov 1882 (Harting 1883); second Scottish record, being incorrectly placed in Perthshire when first published (see *Field* 2 Dec 1882).

CURLEW SANDPIPER *Calidris ferruginea*


PURPLE SANDPIPER *Calidris maritima*

One record. Single in full breeding plumage, 7 May 1972 (*LLBR* 1: 2). Note: the date of 7 Jan 1972 given in *SB* 7: 357 is incorrect.

DUNLIN *Calidris alpina*

RUFF *Philomachus pugnax*


JACK SNIPE *Lymnocryptes minimus*


SNIPE *Gallinago gallinago*


LONG-BILLED DOWITCHER *Limnodromus scolopaceus*


WOODCOCK *Scolopax rusticola*

Present throughout the year. Breeds. On Loch Lomondside, the winter population is occasionally augmented as a result of 'hard-weather' movement from the east of Scotland. More usual passage occurs in Oct-Nov and again in Feb. Should the latter migration be stopped by severe weather, abnormal numbers may stay to breed. This was particularly noticeable at Ross Priory in 1903 (K. & R.M. Buchanan's unpublished Clyde Woodcock Enquiry schedules per McWilliam 1936; Alexander 1947).

BLACK-TAILED GODWIT *Limosa limosa*


BAR-TAILED GODWIT *Limosa lapponica*

Passage Migrant. Irregular. Usually singles. Highest recorded number - seven, 4 May 1974 (*SB* 8: 428). Note: A record of ten Bar-tailed Godwits on 8 May 1954 (*SN* 67: 69) is a misprint (see *SB* 1: 6) and should refer to the previous species.

WHIMBREL *Numenius phaeopus*

Passage Migrant. Regular. Mainly spring (May). Usually
singles and small groups. Highest recorded number - 21, 8 May 1966 (SB 4: 244).

**CURLEW Numenius arquata**


**SPOTTED REDSHANK Tringa erythropus**


**REDSHANK Tringa totanus**

Summer Visitor / Passage Migrant (one winter record). Regular. Breeds. As a migrant, recorded in small numbers in spring and only odd birds in autumn.

**GREENSHANK Tringa nebularia**

Passage Migrant (two winter records). Regular. Singles and very small groups. Highest recorded number - ten, 14 Aug 1968 (CWGR 2: 21).

**GREEN SANDPIPER Tringa ochropus**


**WOOD SANDPIPER Tringa glareola**

Passage Migrant. Irregular. All singles.

**COMMON SANDPIPER Actitis hypoleucos**


**SPOTTED SANDPIPER Actitis macularia**

[Record of a single bird on 8-9 Aug 1977 (BB 72: 524; SBR 1978: 47) was subsequently withdrawn (BB 74: 472).]

**TURNSTONE Arenaria interpres**

Passage Migrant. Irregular. Singles and very small groups. Highest recorded number - five, 30 July 1978 (LLBR 7: 5).
RED-NECKED PHALAROPE *Phalaropus lobatus*


ARCTIC SKUA *Stercorarius parasiticus*


GREAT SKUA *Stercorarius skua*


LAUGHING GULL *Larus atricilla*

One record. Single, 2 April 1968 (Mitchell 1980a). First record for Scotland. The record was initially rejected by the 'British Birds' rarities committee (*BB* 62: 491), but was subsequently reconsidered and accepted (*BB* 72: 526).

LITTLE GULL *Larus minutus*


BONAPARTE'S GULL *Larus philadelphia*

One record. Single, shot end of April 1850 (Leith 1851). First record for Scotland. Specimen exhibited at a meeting of the Zoological Society of London in 1884 (Saunders 1889).

BLACK-HEADED GULL *Larus ridibundus*

Summer Visitor (occasional birds at other times of the year). Regular. Breeds. No more than 25 pairs nesting by the late 1970s, but in the mid-1930s to early 1940s the colony was estimated at up to 5000 pairs. Decline began with excessive egg-gathering during the war and immediate post-war years (Mitchel 1980b and 1981b).

COMMON GULL *Larus canus*

Present throughout the year. Breeds. Pair first recorded nesting in 1972. Since then a few pairs have nested or attempted to nest each year. Autumn/winter influx. Up to 400 birds gather on fields. Large numbers pass over the area to roost on the loch (Jardine 1979).
LESSER BLACK-BACKED GULL *Larus fuscus*

Summer Visitor (occasional records in mild winters). Regular. Small numbers of non-breeding birds, but one pair attempted to nest in 1972 (Williamson et al 1973).

HERRING GULL *Larus argentatus*

Present throughout the year. Small numbers of non-breeding birds in summer. In winter, large numbers pass over the area to roost in the loch (Jardine 1979).

ICELAND GULL *Larus glauoides*

One record. Single adult, 13 May 1973 (LLBR 2: 3).

GLAUCOUS GULL *Larus hyperboreus*


GREAT BLACK-BACKED GULL *Larus marinus*

Present throughout the year. Small numbers of non-breeding birds in summer. Origin of a past breeding record (Huxley 1964) has not been traced. Winter influx. Wintering flock exceeding 100 birds in last few years.

KITTIWAKE *Rissa tridactyla*

Two records. Both singles - 4 Jan 1978 (found dead) and 4 Sept 1978 (SBR 1978: 31).

CASPIAN TERN *Sterna caspia*

Two records. Both singles - 7 Aug 1968, the first record for Scotland (Forrester 1969), and 4 July 1976 (SB 10: 99).

SANDWICH TERN *Sterna sandvicensis*

Irregular Visitor. Most records refer to birds passing between the Firths of Clyde and Forth. Highest recorded number - seven, 16 July 1978 (LLBR 7: 6).

COMMON TERN *Sterna hirundo*

ARCTIC TERN *Sterna paradisaea*


LITTLE TERN *Sterna albifrons*

Two records. Both singles - 5th June 1960 (*SB* 1: 280) and 10 July 1971 (*SB* 7: 143).

BLACK TERN *Chlidonias niger*

Passage Migrant. Irregular. Mainly singles. Highest recorded number - three, 11 Sept 1968 (*SB* 5: 333) and 8 May 1971, in full breeding plumage (*SB* 7: 142). An abnormally plumaged bird on 20 May 1979 may have been a hybrid between a Black Tern and the closely allied White-winged Black Tern (*LLBR* 9: 8).

GUILLEMOT *Uria aalge*

Two recent records. Following 104 mph gale in the Firth of Clyde several sightings of birds (maximum of three together) 22 Sept - early Oct 1969 (*SB* 6: 98). Two birds (one found dead) 19-21 Sept 1971, others being reported elsewhere on the loch; no apparent connection with stormy weather (Placido 1972). One past dated record of two freshly dead on 27 Sept 1893, but remains of others had been noted earlier (Sir G.H. Leith Buchanan correspondence).

LITTLE AUK *Alle alle*

One record. Single, found dead about 1935 (I.C. Christie).

STOCK DOVE *Columba oenas*

Present for much of the year. Suspected breeding. Very small numbers reported, but probably overlooked.

WOODPIGEON *Columba palumbus*

Present throughout the year. Breeds. Autumn/winter influx. Many birds gather in the oak woods in good acorn years, and flocks of several hundred in cereal fields after harvesting.

COLLARED DOVE *Streptopelia decaocto*

Present throughout the year. Breeds. Compared with many other parts of Scotland, the Collared Dove was very slow in colonising the Endrick Mouth area. Pair first recorded in 1968, but it was not until 1974-1975 that the species became firmly
established. Highest recorded number - 20 at one farm, Dec 1979 (LLBR 9: 8).

**Cuckoo Cuculus canorus**


**Barn Owl Tyto alba**

Present throughout the year. Breeds. Three birds hunting together on two occasions - 31 Jan 1976 (K. Ritchie) and 29 Jan 1978 (LLBR 7: 6).

**Scops Owl Otus scops**

One record. Two, 2 Nov 1968, with a possible sighting of a single bird on the following day (Mitchell 1979d).

**Tawny Owl Strix aluco**

Present throughout the year. Breeds. One pair regularly utilises open nest sites.

**Long-eared Owl Asio otus**

Irregular Visitor. Reported to have bred in at least two localities up to the early 1960s. Sightings very infrequent since then.

**Short-eared Owl Asio flammeus**

Winter Visitor (occasional birds at other times of the year). Regular. Almost all singles, two being recorded on only one occasion - 9 to 16 Oct 1977 (LLBR 6: 2). Lumsden (1895) described the Endrick Mouth as a regular haunt of Short-eared Owls.

**Nightjar Caprimulgus europaeus**

No records for 30 years. Formerly regular in the Gartfairn area up to the 1930s (W. McLean) and still occasionally heard about Balmaha in the late 1940s (Wood 1954). An undated specimen in the Ross Priory collection.

**Swift Apus apus**

Summer Visitor/Passage Migrant. Regular. Nests at Ross Priory. In early May and again in late July, up to 200 migrants gather near the mouth of the river.
KINGFISHER *Alcedo atthis*

Occasional Visitor. All singles. Formerly bred. The River Endrick has long been known as a haunt of Kingfishers (Harvie-Brown 1867), nesting in the lower reaches of the river up to the early 1940s (A. MacFadyen).

BEE-EATER *Merops apiaster*

[One probable record. Single bird answering to the description of this species, 9-11 Oct 1978, but insufficient detail recorded for complete acceptance by the 'British Birds' rarities committee (Mitchell 1981c).]

HOOPOE *Upupa epops*


GREEN WOODPECKER *Picus viridis*

Occasional Visitor. All singles. Recorded annually since 1970.

GREAT SPOTTED WOODPECKER *Dendrocopos major*

Present throughout the year. Breeds. At least two nesting pairs present each year. First recorded nesting in the Endrick Mouth area in 1921 (Baxter and Rintoul 1953).

SKYLARK *Alauda arvensis*

Present throughout the year. Breeds. Flocks exceeding 60 birds recorded on stubble during winter months.

SAND MARTIN *Riparia riparia*

Summer Visitor/Passage Migrant. Regular. Breeds occasionally, most recently about 50 pairs in stretch of the river below Drymen Bridge. Noticeable build-up to several hundred birds in August prior to departing south in late summer.

SWALLOW *Hirundo rustica*

Summer Visitor/Passage Migrant. Regular. Breeds. Hundreds of migrant Swallows sometimes present around the mouth of the river from late April - mid May, particularly if northwards movement temporarily held back by cold weather.

HOUSE MARTIN *Delichon urbica*

Summer Visitor/Passage Migrant. Regular. Breeds. A former large indoor colony was dispersed when a barn at Claddochside Farm was badly damaged during the great gale of Jan 1968 (J.
Nisbet). Build-up in numbers of migratory birds not so noticeable as last two species, but in excess of 100 birds recorded on several occasions.

**TREE PIPIT Anthus trivialis**

Summer Visitor/Passage Migrant. Regular. Breeds. Highest recorded number on passage - 80, 17 April 1977 (LLBR 6: 5).

**MEADOW PIPIT Anthus pratensis**


**ROCK PIPIT Anthus spinola**

Four records. All singles - 5-9 March 1970 (erroneously reported as May in SB 6: 395), 30 Jan 1977 identified as a Water Pipit, the central and southern European sub-species Anthus spinola spinoletta (SB 10: 148), 12 Feb 1978 (G.J. Brock) and 21 Sept 1978 (SBR 1978: 35).

**YELLOW WAGTAIL Motacilla flava**

Passage Migrant. Irregular. Mainly spring. Almost all singles, two being recorded on only one occasion - 7 May 1977 (LLBR 6: 5).

**GREY WAGTAIL Motacilla cinerea**

Present for much of the year. Breeds. One pair nests annually beside the Mar Burn, with an occasional second pair elsewhere.

**PIED WAGTAIL Motacilla alba**

Present for much of the year. Breeds. Two roosts on record - the Aber Bogs, with up to 34 birds present on 12 May 1978 (LLBR 7: 7), and the Aber Isle, with about 70 birds present on 21 Sept 1979 (LLBR 8: 6). Highest recorded number on passage - 100, 20 July and 12 Sept 1978 (LLBR 7: 7).

The White Wagtail M.a. alba is a passage migrant. Regular. Movement is particularly well marked in spring. In excess of 100 birds trickling through the area during the course of a few hours noted on several occasions.

**WAXWING Bombycilla garrulus**

Winter Visitor. Irregular. Subject to periodic irrupt-
ions into Scotland. Highest recorded number - 17, 30-31 Oct 1965 (E.T. Idle and R. Shaw) and 8 March 1971 (R.K. Pollock).

DIPPER *Cinclus cinclus*

Present for much of the year. Breeds. One pair nests annually beside the Mar Burn. Formerly a second pair on the Mill Burn just below Drymen (J.B. Mason).

WREN *Troglohytes troglodytes*

Present throughout the year. Breeds.

DUNNOCK *Prunella modularis*

Present throughout the year. Breeds.

ROBIN *Erithacus rubecula*

Present throughout the year. Breeds.

REDSTART *Phoenicurus phoenicurus*

Summer Visitor/Passage Migrant. Regular. Breeds. Sparingly distributed in the older wooded areas. Late migrants recorded up to mid-Oct.

WHINCHAT *Saxicola rubetra*


STONECHAT *Saxicola torquata*

Irregular Visitor. Breeds some years. Usually only one pair, but formerly much commoner. Subject to periods of absence for several years following severe winters.

WHEATEAR *Oenanthe oenanthe*

Passage Migrant. Regular. Formerly bred. Passage of the nominate European race in late March - early April and August. Usually 1-5 birds. Highest recorded number - 50, 20 Aug 1971 (I.T. Draper). The occasional bird in late April - May would appear to be the Greenland race *Oenanthe o. leucorrhoa*.

RING OZEL *Turdus torquatus*

No recent record. A single undated specimen in the Ross Priory collection.
BLACKBIRD Turdus merula
Present throughout the year. Breeds. Autumn and winter influx.

FIELDFARE Turdus pilaris
Winter Visitor/Passage Migrant. Regular. Although many hundreds pass through in late autumn, perhaps no more than 200-300 winter in the area.

SONG THRUSH Turdus philomelos
Present for much of the year (absent during severe weather). Breeds.

REDWING Turdus iliacus
Winter Visitor/Passage Migrant. Regular. Thousands pass through in late autumn, with up to 500 wintering in the area.

MISTLE THRUSH Turdus viscivorus
Present throughout the year. Breeds. Mainly confined to gardens and open wooded areas.

GRASSHOPPER WARBLER Locustella naevia
Summer Visitor/Passage Migrant. Regular. Breeds. Numbers fluctuate from one year to the next, many more males recorded singing in spring than actually stay to breed.

SEDGE WARBLER Acrocephalus schoenobaenus
Summer Visitor/Passage Migrant. Regular. Breeds. Assumes quite high densities in fen areas being colonised by willow.

WHITETHROAT Sylvia communis
Summer Visitor/Passage Migrant. Regular. Breeds. Formerly common. Totally absent in 1969 following national 'crash' in numbers, but slow recovery has been taking place since 1970.

GARDEN WARBLER Sylvia borin
Summer Visitor. Regular. Breeds. Pairs thinly distributed in woodlands with well developed undergrowth.

BLACKCAP Sylvia atricapilla
Summer Visitor. Regular. Breeds. Similar habitat to Garden Warbler, but less common.
WOOD WARBLER *Phylloscopus sibilatrix*

Summer Visitor. Irregular. Has bred. Nest found in Gart- 
 farn Wood in 1960 (M. Forrester) and the occasional singing bird 
 noted in the same locality since then.

CHIFFCHAFF *Phylloscopus collybita*

Summer Visitor/Passage Migrant. Regular. Breeds. Nest 
 ing pairs mainly confined to areas of rhododendron overhung by trees 
 (Meiklejohn 1952), but the occasional pair will utilise young 
 conifer plantations bordered by tall trees. Usually more males 
 recorded singing in early spring than actually stay to breed.

WILLOW WARBLER *Phylloscopus trochilus*

Summer Visitor/Passage Migrant. Regular. Breeds. The 
 commonest warbler. Noticeable passage of 'autumn' migrants in 
 the second half of July and early August.

GOLDCREST *Regulus regulus*

Present throughout the year. Breeds. A characteristic 
 species of conifer woodlands, but one pair found nesting in gorse 

SPOTTED FLYCATCHER *Muscicapa striata*

Summer Visitor. Regular. Breeds. Sparingly distributed in 
 woods and gardens.

PIED FLYCATCHER *Ficedula hypoleuca*

Two records. Both singles - 30 July 1963 (SB 2: 492-493) 
 and 3 June 1975 (LLBR 4: 3).

LONG-TAILED TIT *Aegithalos caudatus*

Present throughout the year. Breeds. Winter influx. 

WILLOW TIT *Parus montanus*


COAL TIT *Parus ater*

Present throughout the year. Breeds. Winter influx.

BLUE TIT *Parus caeruleus*

Present throughout the year. Breeds. Winter influx.
Wet birch woodland of the Ring Wood East
GREAT TIT *Parus major*

Present throughout the year. Breeds. Winter influx.

TREECREEPER *Certhia familiaris*

Present throughout the year. Breeds.

GREAT GREY SHRIKE *Lanius excubitor*

Winter Visitor. Single bird almost annual. Usually stays only a few days, but in winter of 1963/64 a bird was present 25 Nov to end of March (SB 2: 323, E.T. Idle).

JAY *Garrulus glandarius*

Present throughout the year. Breeds. Thinly distributed in wooded areas. Autumn influx in good acorn years, when small flocks of six or more birds may be present.

MAGPIE *Pica pica*

Occasional Visitor. Has bred. After a long period of absence following persecution, the Magpie returned to the area in the 1950s. Nests recorded from 1970 to 1973, but not since.

JACKDAW *Corvus monedula*

Present throughout the year. Breeds. Main colonies at Ross Priory and Buchanan Castle.

ROOK *Corvus frugilegus*

Present throughout the year. Breeds. Seven separate colonies totalling 228 nests in 1979 (LLBR 8: 2). Nest counts during two national censuses showed 408 pairs in 1945/46 and 252 pairs in 1975 (Mitchell 1976). A large winter roost at Buchanan Castle (*Glasgow Herald* 15/1/1955 p.3; Fforde 1982) has been abandoned, and a smaller one formed in the Ring Woods.

CROW *Corvus corone*


RAVEN *Corvus corax*

Occasional Visitor. One or two birds may occur at any time of the year outwith the breeding season. An exceptional record of 14 Ravens rising in a thermal over a sandbar at the river mouth, 12 Aug 1962 (SB 2: 261).

STARLING *Sturnus vulgaris*

Present throughout the year. Breeds. Assemblies of juvenile birds on the marshes are a particular feature of the summer months. Winter influx.

HOUSE SPARROW *Passer domesticus*

Present throughout the year. Breeds. Usually confined to the vicinity of human habitation, particularly farms.

TREE SPARROW *Passer montanus*

Occasional Visitor. Usually one or two birds, but 'several' recorded mobbing a Sparrowhawk with prey, 7 Dec 1974 (LLBR 3: 5).

CHAFFINCH *Fringilla coelebs*

Present throughout the year. Breeds. Winter influx, some flocks totalling hundreds of birds.

BRAMBLING *Fringilla montifringilla*

Occasional (winter) Visitor. Usually one or two birds. Highest recorded number - 30+, Jan 1954 (SN 67: 71).

GREENFINCH *Carduelis chloris*

Present throughout the year. Breeds. Thinly distributed around Ross Priory and Buchanan Castle.

GOLDFINCH *Carduelis carduelis*

Present for much of the year. Breeds occasionally. Late summer influx, flocks of up to 50 birds feeding on thistles recorded on several occasions.

SISKIN *Carduelis spinus*

LINNET Carduelis cannabina

Present throughout the year. Breeds. Late summer influx to feed on thistles. Highest recorded number - 60, 31 Aug 1977 (LLBR 6: 5).

TWITE Carduelis flavirostris

Occasional Visitor. Records over the last few years show that August is the most regular month for appearance, but the largest groups occur later in the year. Highest recorded number - 40, 6 Oct 1973 (LLBR 2: 3) and 29 Dec 1975 (LLBR 4: 3).

REDPOLL Carduelis flammea

Present throughout the year. Breeds. Winter influx. No accurate counts available, but flocks in excess of 50 birds occasionally seen. A single Mealy Redpoll, the nominate northern race Carduelis f. flammea, recorded 24 Jan 1976 (LLBR 5: 4).

CROSSBILL Loxia curvirostra

Three records. Two, 9 Oct 1975 (SB 9: 233); "small party"; 17 Oct 1978 (LLBR 7: 7); two, 30 Jan 1979 (LLBR 8: 6).

BULLFINCH Pyrrhula pyrrhula

Present throughout the year. Breeds. Pairs thinly distributed in wooded areas.

HAWFINCH Coccothraustes coccothraustes


LAPLAND BUNTING Calcarius lapponicus

One record. Single male, amongst large flock of mixed finches and buntings, 26 Jan 1968 (SB 5: 355).

SNOW BUNTING Plectrophenax nivalis


YELLOWHAMMER Emberiza citrinella

Present throughout the year. Breeds. Pairs very thinly distributed in areas of gorse. Winter influx.

REED BUNTING Emberiza schoeniculus

Present throughout the year. Breeds. Winter influx.
Acknowledgements

The preparation of an account of the birds of the Endrick Mouth would have been impossible had it not been for the diligent recording of observations by many ornithologists over the years. It would not be practicable to mention them all by name, but their individual contributions are gratefully acknowledged. My thanks are also due to all those who assisted in tracing unpublished sources of information - correspondence, personal notes and reminiscences, wildfowl count schedules, estate game records, and private and institutional skin collections.

Bibliography

Topographical and Historical


TIPPET, R. (1975). A Preliminary Survey of Invertebrates inhab-
iting the Mud Flats at Wards Low Ground, Kilmaronock. (Un-
published Glasgow University Zoology Department Report).
WADE, W.M. (1822). Delineations, Historical, Topographical and
Descriptive of the Watering and Sea-bathing Places of Sco-
tland. Paisley.
WALTHO, C.M. (1980). The establishment of Fen Carr in the Aber
Bogs, Dunbartonshire. West Dunbartonshire Naturalist Re-
port, 5: 14-23.

Ornithological

Conservancy Monograph). HMSO. London.
Edinburgh.
BELMAN, P.J. (1980). Sightings of colour-ringed Greenland
BERRY, J. (1939). The Status and Distribution of Wild Geese and
of the Loch Lomond National Nature Reserve. (Unpublished
BOYD, H. (1963). The numbers of wild geese in Great Britain:
53.
Birds, 41: 191.
GIBSON, J.A. (1958). A list of the breeding birds of Loch
GIBSON, J.A. and McWILLIAM, J.M. (1959). A Supplement to 'The
Birds of the Firth of Clyde'. Glasgow.


Mr. John Mitchell, 22 Muirpark Way, DRYMEN, Glasgow G63 ODX.
THE STATUS OF THE WILD CAT IN KINTYRE

By ERIC BIGNAL and NIGEL EASTERBEE
Nature Conservancy Council

Introduction

Although the Wild Cat Felis silvestris is now found throughout Knapdale (Arnold 1984, Gibson and Rainier 1983, N.C.C. Survey), the last fully documented record of an authentic Wild Cat from Kintyre was one shot near Loch Garasdale, north of Tayinloan, in 1910 (Harvie-Brown 1910). The specimen was mounted by Charles Kirk, the well-known Glasgow taxidermist, and was preserved in Largie Castle for many years, but unfortunately was lost when Largie Castle was demolished (Gibson and Colville 1975). Recently, however, we have been able to examine a cat recovered from the A83 road near Clachan in February 1982, which we consider is probably genuine F. silvestris on the basis of its pelage and gut length.

An unconfirmed record of a true Wild Cat came from Clachan in May 1974 (Campbeltown Courier, 16th May 1974; Gibson and Colville 1975) and in the course of our investigations we have been able to trace the skull of this animal, and can confirm that it was genuine F. silvestris.

Other recent Kintyre records which have been reported to us are given below:

October 1983: One shot south of Cnoc Reamhar NR7746.
October 1983: One found dead by roadside (A83) between Clachan and Tayinloan NR74.
Spring 1984: One shot near Clachaig NR7141.

Two older records which may be authentic are:

1958: One gin trapped at Largie Castle (killing chickens) NR7046.
1973: One snared at Ballochroy Glen NR7451.

Measurements

1974 specimen: Male, skull only available. Checked using a morphometric technique (Corbet and French, in prep.), and by measuring cranial volume (Schauenberg 1969). This specimen proved to be a Wild Cat with both methods; there were no signs of any interbreeding with domestic cats.
1982 specimen: Male, weight 5.5kg; head and body length (animal on its back) 54.3cm, tail 30.7cm. A typical Wild Cat in appearance: the tail was thick with 4/5 black rings, the last three of which were quite distinct, and a blunt black tip. There was some white hair in the umbilical region and on the chest and throat. The whiskers were mostly white and the underside of every paw was black. It was not possible to measure the animal's skull, which had been badly damaged. The gut length, however, measured 152cm, within the range given for Wild Cats (117-165cm) by Schauenberg (1977), which is shorter than that for domestic cats (168-216cm).

Summary

We can therefore confirm that Wild Cats have been present in Kintyre since at least the mid-1970s, although their distribution appears to be restricted. It is always difficult to establish the precise date when an animal becomes extinct in an area, but Langley and Yalden (1977) suggested that the Wild Cat had disappeared from south Argyll by 1864. The report by Harvie-Brown of the Wild Cat from Loch Garasdale in 1910 shows that this earlier date was incorrect.

Whether or not any true Wild Cats survived in Kintyre after 1910 is not genuinely known, since the first specimen actually available for examination was the skull of the 1974 cat. The possible 1958 record, however, does shed doubt on whether the Wild Cat ever really became extinct in Kintyre. Having survived into the early part of the twentieth century, it seems feasible that Wild Cats may have been present in small numbers right through to the early 1950s, a period when gamekeeping pressure would have been low, and when rural depopulation and, latterly, expansion of conifer afforestation was taking place. If any Wild Cats did survive, then the remote hill country along the spine of Kintyre must have been their stronghold. Alternatively, the recent reappearance of the Wild Cat in Kintyre could be the result of a natural recolonisation of range from Knapdale.

Acknowledgements

We would like to thank Mr. Alex Dale for the loan of the skull of the 1974 specimen; Mr. Peter Strang, Mr. Derek Farah, Mr. Chris Gabriel and Mr. Neilson Hunter for other information and records. We particularly thank Mr. Ian McDonald of Clachan for providing us with the 1982 specimen, and also for interviewing Mr. John McMillan, of Tayinloan, the former gamekeeper for Largie Estate.
References


Dr. Eric M. Bignal, Nature Conservancy Council, Quinhill, CLACHAN, By Tarbert, Argyll PA29 6XN.
Dr. Nigel Easterbee, Nature Conservancy Council, 12 Hope Terrace, EDINBURGH EH9 2AS.
COMPARATIVE OBSERVATIONS ON THE INVERTEBRATE FAUNA OF TWO ORKNEY STREAMS

By P.B. HEPPLESTON
Kirkwall Grammar School, Orkney

Introduction

This preliminary study serves two purposes:

(i) to present some data on the invertebrate fauna of an Orkney moorland stream in a manner comparable with studies on other British hill streams (e.g. Arnold and Macan 1969, Armitage et al 1975, Minshall and Kuehne 1969, Morgan and Egglishaw 1965, Sutcliffe 1972).

(ii) to investigate the effect of agricultural influence on the fauna thus described.

At one time Orkney was a moorland county with sheep as the main stock product. Land reclamation proceeded gradually over the centuries and Orkney became a predominantly agricultural county; this reclamation continues today as farming methods improve and gives rise not only to increased production and income for the farming community, but also to some concern that the ancient moorland habitats are becoming scarcer. Bird populations and communities are particularly vulnerable (Lea and Bourne 1975) as the more varied habitats make way for a more uniform type of environment.

This increase in agricultural land reclamation and its associated drainage, fertilising effect and farm effluent is bound to have an influence on the freshwater habitats of the county. Hence there are plans to survey the major freshwater lochs of Orkney over the next few years - and this present study gives some preliminary indication of the effect on streams.

In order to obtain some reasonable idea of the extent of this effect, two streams were selected for study, one with no apparent agricultural influence (a moorland stream) - the other running through farmland for most of its length.

Study Areas (Figure 1)

1. Burn of Swartaback - a moorland stream arising in the low hills west of Kirkwall and running through parts of the R.S.P.B. Hobbister reserve where heather predominates and where sheep occasionally wander; it pours its normally small flow into the
Loch of Kirbister at G.R. 374073. The mean width of the stream is about 2m or less and the depth is around 20cm, save for deeper pools beneath small waterfalls. There are no farmsteads along its length.

2. Toab Burn - in contrast, whilst arising in the peat moorland of the Holm hills east of Kirkwall, runs through land used intensively for cattle and sheep grazing and some crop production (grass and oats). It enters the sea direct (G.R. 517046); thus the terminal 50m or so can come under saline influence at very high tides.

The streams were selected on the basis of similarity in length, depth, and speed of water flow; the only difference was the nature of the land through which they flowed - the one an archetypal Orkney moorland stream, the other presumably influenced by being bounded for most of its length by good agricultural land and bordered by a number of farmsteads.

Geologically, the streams' catchment areas were similar, running over Old Red Sandstone rocks overlaid with peat or boulder clay; these conditions give rise to acidic land and oligotrophic freshwater systems.

The vegetation of Swartaback was typical of a hill stream - few rooted plants, and moss-covered stones. Toab Station 1 was similar, but Toab 2 and 3 showed a marked increase in algal growth and a reduction in species diversity.

Methods

Water Chemistry

Analyses were carried out by Dr. A.J. Cassells-Smith (Pathology Dept, Newcastle-on-Tyne General Hospital). Samples were stored in the dark in plastic containers and analysed for anions and cations on a Vickers M300 multichannel analyser.

Salinity determinations were made by PBH using the method described by Barnes (1974).

Microbiology

Standardised samples of water from each station were inoculated on to standard nutrient-agar plates and the gross percentage coverage of eventual bacterial growth after two days at 25°C was estimated.

Invertebrate Collections

At each of the three stations on each stream a net 25cm x 25cm (mesh 10/cm) was held upright against the stream-bed and the substrate immediately adjacent to the net-mouth was disturbed.
Table 1: Water Chemistry. Analysis of Ions.

<table>
<thead>
<tr>
<th>Ion m mol/l</th>
<th>T 1</th>
<th>T 2</th>
<th>T 3</th>
<th>S 1</th>
<th>S 2</th>
<th>S 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na⁺</td>
<td>2.20</td>
<td>2.20</td>
<td>2.20</td>
<td>1.80</td>
<td>1.80</td>
<td>1.80</td>
</tr>
<tr>
<td>K⁺</td>
<td>0.10</td>
<td>0.28</td>
<td>0.13</td>
<td>0.05</td>
<td>0.05</td>
<td>0.05</td>
</tr>
<tr>
<td>Cl⁻</td>
<td>0.10</td>
<td>0.80</td>
<td>0.10</td>
<td>1.10</td>
<td>0.10</td>
<td>0.80</td>
</tr>
<tr>
<td>Ca²⁺</td>
<td>0.91</td>
<td>1.40</td>
<td>1.08</td>
<td>0.16</td>
<td>0.35</td>
<td>0.44</td>
</tr>
<tr>
<td>PO₄</td>
<td>0.03</td>
<td>0.00</td>
<td>0.08</td>
<td>0.01</td>
<td>0.05</td>
<td>0.07</td>
</tr>
<tr>
<td>Mg²⁺</td>
<td>0.60</td>
<td>0.70</td>
<td>0.60</td>
<td>0.30</td>
<td>0.45</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Notes:  
(a) Toab consistently higher in Na⁺ K⁺ Ca²⁺ Mg²⁺ (i.e. cations).  
(b) Cl, PO₄ show no major (sign.) differences between the two streams.  
(c) No suggestion of any intra-stream differences at these sample sites.  
(These figures are comparable with those for two other streams in Orkney).
in a uniform manner (as described by Macan 1958) whilst moving slowly upstream. This was repeated three times at each station for one minute on each occasion. The results presented show the number of animals found per 60 second sample. Both streams were sampled in late October 1976.

Results

Water Chemistry

Six major ions were included in the analysis (Table 1). Phosphate ions should give some indication of organic matter from farms and fields but it was not possible to analyse for nitrate ions - which would have improved the assessment of organic influence. The major conclusions to be drawn are:-

(a) The two anions showed no significant difference between the two streams.

(b) There was no indication of any within-stream variation at the sample stations.

(c) The Toab stream was consistently higher in total measured cations, and also in individual cations, particularly Ca++ and Na+.

These results are similar to data from other Orkney fresh-water sites which I have studied and can thus be considered representative of the habitat type. Table 2 shows how these Orkney values compare with data from other British localities. The Orkney concentrations for Ca++, Mg++ and K+ fall within the range of quoted values for other regions; but Na+ concentration is consistently higher, as might be expected in habitats so close to the sea, from which a fine saline spray frequently travels some distance inland in gale-force winds. Similarly high Na+ values have also been reported from Shetland (Britton 1974).

Bacterial content of the water

No quantitative estimates were attempted, rather an index of abundance. Table 3 shows the raised bacterial content at Toab stations 2 and 3, confirming that this station did indeed receive a higher loading of organic matter (almost certainly from farm run-off) than in the Burn of Swartaback.

Invertebrates

A broad comparison of the two streams showed a marked difference in total individual animals, with Toab Burn being the richer stream (Table 4).

Swartaback - no significant variations from station to station
<table>
<thead>
<tr>
<th>Source of water sample</th>
<th>Authority</th>
<th>SODIUM m mol/1</th>
<th>MAGNESIUM m mol/1</th>
<th>CALCIUM m mol/1</th>
<th>POTASSIUM m mol/1</th>
<th>Total Na Mg Ca m mol/1</th>
<th>Total μ-equiv. Na Mg Ca K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shropshire</td>
<td>) Arnold &amp; Macan (1969)</td>
<td>0.250</td>
<td>0.105</td>
<td>0.260</td>
<td>0.013</td>
<td>0.615</td>
<td>993</td>
</tr>
<tr>
<td>Malham, Yorks</td>
<td>) Macan (1969)</td>
<td>0.160</td>
<td>0.120</td>
<td>2.000</td>
<td>0.018</td>
<td>2.280</td>
<td>4418</td>
</tr>
<tr>
<td>Cumbrian rain</td>
<td></td>
<td>0.083</td>
<td>0.008</td>
<td>0.008</td>
<td>0.050</td>
<td>0.099</td>
<td>165</td>
</tr>
<tr>
<td>Duddon valley</td>
<td>Minshall &amp; Kuehne (1969)</td>
<td>0.187</td>
<td>0.037</td>
<td>0.088</td>
<td>0.012</td>
<td>0.312</td>
<td>324</td>
</tr>
<tr>
<td>Northumberland</td>
<td>Sutcliffe (1972)</td>
<td>0.20-0.30</td>
<td>0.25-0.40</td>
<td>0.10-1.00</td>
<td>n.d.</td>
<td>0.65-1.70</td>
<td>-</td>
</tr>
<tr>
<td>Scotland sandstone</td>
<td>Egglishaw &amp; Morgan (1965)</td>
<td>0.54-1.00</td>
<td>0.10-0.40</td>
<td>0.33-0.50</td>
<td>n.d.</td>
<td>0.97-1.90</td>
<td>-</td>
</tr>
<tr>
<td>Scotland granite-basalt</td>
<td></td>
<td>0.10-0.30</td>
<td>0.050</td>
<td>0.02-0.20</td>
<td>n.d.</td>
<td>0.17-0.55</td>
<td>-</td>
</tr>
<tr>
<td>Toab 1</td>
<td>This study</td>
<td>2.200</td>
<td>0.600</td>
<td>0.910</td>
<td>0.100</td>
<td>3.710</td>
<td>5320</td>
</tr>
<tr>
<td>Toab 2</td>
<td></td>
<td>2.200</td>
<td>0.700</td>
<td>1.400</td>
<td>0.280</td>
<td>4.300</td>
<td>6680</td>
</tr>
<tr>
<td>Toab 3</td>
<td></td>
<td>2.200</td>
<td>0.600</td>
<td>1.080</td>
<td>0.130</td>
<td>3.880</td>
<td>5690</td>
</tr>
<tr>
<td>Swartaback (Mean)</td>
<td></td>
<td>1.800</td>
<td>0.400</td>
<td>0.320</td>
<td>0.050</td>
<td>2.520</td>
<td>3290</td>
</tr>
</tbody>
</table>

**Notes:**
(1) The figures obtained in the Orkney study were assessed in m-mol per litre. Hence other source figures were converted from a variety of units to enable comparisons.
(2) Conversion example: 400 μ-equiv./l Calcium ions = 0.2 m mol/l Calcium ions (2+)
(3) n.d. - no data.
although there was a tendency towards a greater general abundance lower downstream. Almost half the animals caught at Station 1 (highest upstream) were of one species *Isoperla grammatica*. The presence of *Gammarus pulex* (present further downstream) is the first record for Orkney (Heppleston 1984).

Toab - within-stream variation was very evident here; station 1 had a fauna quite distinct from the other two stations, richer in taxa (x 2) and in numbers (x 5). There were no taxa common to Stations 2/3 and 1.

Individual species results of note include the high number of *Baetis vernus/tenax* in Toab 1. At the same station there was an abundance of Chironomids in the moss covering of stones and extremely high numbers of *Potamopyrgus jenkinsi*. Swartaback data show a variety of taxa of which few showed any tendency towards dominance save Plecoptera/Ephemeroptera which accounted for almost a third of the total animals in this stream.

Only eight of the 31 taxa categorised were found in both streams, the common link being Swartaback samples and Toab 1. This further points to a basic similarity between these four sampling sites.

A further method of comparison was also made between sample sites using a biotic index of water pollution (Woodiwiss 1964). Thus Toab 1 is classified as 'clean', Toab 2 as 'bad' and Toab 3 as 'doubtful' (or 'bad' if the estuarine *G. zaddachi* is excluded). Swartaback samples combined gave a 'very clean' index.

Discussion

**Swartaback samples**

As stated above there were no differences of significance between the three stream samples.

Toab 1 and Swartaback 1-3.

This comparison enables an assessment of the two natural stream sectors, both running through moorland. The three Swartaback samples were pooled and are compared below with the Toab 1 sample numbers multiplied by three (thus equating the samples) but omitting the *P. jenkinsi* figures:

Toab 1: 13 taxa, 1500 individual animals.

Swartaback: 19 taxa, 228 individual animals.

Thus Toab appears richer, having over five times as many individuals though fewer taxa; separate Swartaback samples show 11, 13, and 7 taxa at Stations 1, 2 and 3 respectively. The evident overall similarity between the four 'natural' stations is
supported by the chemical analyses, which showed little variation (Tables 1, 2), and the taxa common to them.

Toab 1 and Toab 2/3.

A marked difference was apparent here:

Toab 1: 14 taxa, 500 individuals (+860 *P. jenkinsi*)
Toab 2: 5 taxa, 220 individuals
Toab 3: 5 taxa, 304 individuals

There were no taxa common to all three stations, but particularly evident were the concentrations of Tubificidae and Oligochaeta in Toab 2 and 3, taxa typical of water polluted with organic matter (Hynes 1963). Neither group was represented in the clean (Table 3) waters of Toab 1. The large number of *Gammarus zaddachi* in Toab 3 was due to the proximity of the sample point to the sea; this species is commonly found in euryhaline conditions (Gledhill et al 1976).

Conclusions

Toab 1 seems representative of a natural Orkney stream fauna; Swartaback stations also have a natural (undisturbed) fauna, but, being less rich in fauna, are perhaps more typical of the more acid conditions prevailing in Orkney. Similar regions of northern Scotland are likely to be similar in their freshwater species spectrum.

Toab 2 and 3, together with the bacterial analyses, show the influence of organic farm pollution on an Orkney stream, for chemical analyses do not support the idea that fertiliser run-off contributes to the chemical burden of the water; rather the data suggest that direct farm run-off is more significant in directly affecting the fauna of this stream. Similar instances can be found throughout other agricultural regions in Britain and can be of considerable importance with regard to specific freshwater habitats such as trout spawning streams. Until farmers are offered sufficient encouragement in the expensive matter of treatment of farm effluent, it is likely that this kind of effect will be perpetuated.

Future Work

This study was only able to scratch the surface of Orkney stream biology; to date, however, there has been almost no survey work published on these habitats except those by Maitland and Kellock (1971), Sutcliffe (1974) and Kellock and Maitland (1969). For this reason a more extensive sampling programme is planned for the future; using this present work as a preliminary set of
### Table 3: Percentage Bacterial Growth Cover on Agar Plates
(Means of three plates per station)

<table>
<thead>
<tr>
<th></th>
<th>Station 1</th>
<th>Station 2</th>
<th>Station 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toab</td>
<td>0.0</td>
<td>98.0</td>
<td>80.0</td>
</tr>
<tr>
<td>Swartaback</td>
<td>5.0</td>
<td>7.5</td>
<td>0.0</td>
</tr>
</tbody>
</table>
Table 4: Invertebrate Collections - Results

<table>
<thead>
<tr>
<th>Species/Taxon</th>
<th>Numbers per minute</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T 1</td>
</tr>
<tr>
<td>Polycealis nigra</td>
<td>-</td>
</tr>
<tr>
<td>Oligochaeta (Naididae)</td>
<td>-</td>
</tr>
<tr>
<td>Tubificidae</td>
<td>-</td>
</tr>
<tr>
<td>Helobdella stagnalis</td>
<td>10</td>
</tr>
<tr>
<td>Ostracoda</td>
<td>56</td>
</tr>
<tr>
<td>Gammarus pulex</td>
<td>-</td>
</tr>
<tr>
<td>Gammarus zaddachi</td>
<td>-</td>
</tr>
<tr>
<td>Amphineumura sulcicollis</td>
<td>-</td>
</tr>
<tr>
<td>Diura bicaudata</td>
<td>49</td>
</tr>
<tr>
<td>Isoperla grammatica</td>
<td>-</td>
</tr>
<tr>
<td>Baetis vernus/tenax</td>
<td>185</td>
</tr>
<tr>
<td>Rheithrogena semicolorata</td>
<td>-</td>
</tr>
<tr>
<td>Heptagenia lateralis</td>
<td>-</td>
</tr>
<tr>
<td>Limnephilidae</td>
<td>26</td>
</tr>
<tr>
<td>Hydropsyche sp.</td>
<td>-</td>
</tr>
<tr>
<td>Electrocnemia sp.</td>
<td>-</td>
</tr>
<tr>
<td>Polycenopus sp.</td>
<td>-</td>
</tr>
<tr>
<td>Rhyacophila sp.</td>
<td>2</td>
</tr>
<tr>
<td>Sericostomatidae</td>
<td>3</td>
</tr>
<tr>
<td>Dytiscidae</td>
<td>-</td>
</tr>
<tr>
<td>Oulimnius tuberculata</td>
<td>-</td>
</tr>
<tr>
<td>Elmis aenea</td>
<td>20</td>
</tr>
<tr>
<td>Tipulidae (Dicranota)</td>
<td>-</td>
</tr>
<tr>
<td>Chironomidae</td>
<td>102</td>
</tr>
<tr>
<td>Simulium sp.</td>
<td>29</td>
</tr>
<tr>
<td>Hydracarina</td>
<td>8</td>
</tr>
<tr>
<td>Potamopyrgus jenkinsi</td>
<td>860</td>
</tr>
<tr>
<td>Lymnaea pereger</td>
<td>-</td>
</tr>
<tr>
<td>Ancylus sp.</td>
<td>8</td>
</tr>
<tr>
<td>Pisidium sp.</td>
<td>2</td>
</tr>
<tr>
<td>(Anguilla anguilla)</td>
<td>-</td>
</tr>
</tbody>
</table>

Ca Na Mg cations                     | 3.71 | 4.30 | 3.88 | 2.26 | 2.60 | 2.69 |

Numbers                               | 1360 | 220  | 304  | 61   | 93   | 74   |

Taxa per station sample               | 14   | 5    | 5    | 11   | 11   | 7    |

Total taxa per stream                 | 21   |      |      |      |      |      |

Total animals per stream              | 1884 | 228  |      |      |      |      |
data it is hoped to develop a comprehensive survey of Orkney streams and to attempt a deeper analysis of species and taxa. By this means it is anticipated that the great paucity of freshwater survey work in Orkney will be redressed, for wetland habitats are of great importance in the county as well as providing opportunities for the examination of island stream communities for comparison with neighbouring island groups and areas of the Scottish mainland.

Summary

This preliminary survey described the basic invertebrate fauna of natural Orkney hill stream habitats and indicated that farming influence in the form of farm effluent run-off is likely to result in significant alteration of the fauna. These effects, if widespread, could have far-reaching implications for Orcadian wetland habitats.

Acknowledgements

This study was carried out as a spare-time activity whenever I could find time from my teaching duties and other commitments. Only basic facilities were available to me in Orkney and thus I am very grateful to Dr. A.J. Cassells-Smith for carrying out the water analyses. Dr. D.W. Sutcliffe kindly confirmed the identification of Gammarus pulex.

References


Dr. P.B. Heppleston, Fairleigh, Old Scapa Road, KIRKWALL, Orkney KW15 1BB.
OPEN-WATER ZOOPLANKTON FROM FIVE TAYSIDE FRESHWATER LOCHS

By DAVID H. JONES
Institute of Terrestrial Ecology

Introduction

Standing-water zooplankton communities in Scotland have been studied over a period of almost 100 years, although between the early 1900s and recent years no extensive surveys were reported. Scott, in the Annual Reports of the Fisheries Board for Scotland (1890-99), gave detailed results of samples from a wide geographical range of sites and this information was augmented by the Bathymetrical Survey of Scottish Fresh-Water Lochs (Murray and Pullar 1910). Murray, in a separate paper (1905), summarised much of this information. More recently Maitland, Smith and Dennis (1981) reported on the zooplankton communities of Scotland's five largest lochs (Lomond, Awe, Ness, Morar and Shiel) and noted that despite many of the species being present in most of the lochs, their proportional representation in the samples and the presence of a few uncommon species characterised each loch quite distinctly.

The freshwaters of Tayside have been the subject of a recent ecological survey, the purpose and methodology of which were described by Maitland, Morris and Lyle (1981). Each of the 74 standing waters studied was sampled in a similar manner, irrespective of size. Zooplankton sampling was carried out from the shore or shallow water (see Jones 1981, for details of method) and samples were obtained from a distance no greater than 20 m out into open water. To supplement the information obtained by this method a more extensive sampling programme on five of the largest lochs within the survey (Earn, Lyon, Laidon, Lintrathen and Leven) was carried out from a small boat, in an endeavour to obtain samples more truly representative of open-water zooplankton (see Figure 1).

The brief sampling programme of the present survey did not permit changes in seasonal abundance to be taken into consideration, so the differences which are apparent between the five communities are based on differences in species composition and relative abundance at the time of sampling. Since the sampling programme was completed in the course of a few days of extremely calm summer weather, however, the results may be taken as fully comparable and should be representative of the populations at this particular stage of the season. As
Figure 1. Map to show the Tayside Region, its major urban areas and the five lochs chosen for this survey
<table>
<thead>
<tr>
<th>LOCH</th>
<th>Date sampled</th>
<th>Time (BST)</th>
<th>Vertical hauls</th>
<th>Horizontal tows</th>
<th>Weather</th>
</tr>
</thead>
<tbody>
<tr>
<td>EARN</td>
<td>10.8.77</td>
<td>1215-1515</td>
<td>7</td>
<td>6</td>
<td>Calm, light breeze, generally sunny, occasional cloud.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1300-1500</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEVEN</td>
<td>17.8.77</td>
<td>1300-1500</td>
<td></td>
<td></td>
<td>Light breeze, Sun and occasional cloud.</td>
</tr>
<tr>
<td>LINBOTHEN</td>
<td>12.8.77</td>
<td>1115-1215</td>
<td></td>
<td></td>
<td>Calm. Bright sunshine.</td>
</tr>
<tr>
<td>LAIDON</td>
<td>11.8.77</td>
<td>1900-2040</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LYON</td>
<td>11.8.77</td>
<td></td>
<td>5</td>
<td>3</td>
<td>Calm, Sun and occasional cloud.</td>
</tr>
</tbody>
</table>

Table 1: Sampling Information
Maitland, Smith and Dennis pointed out (1981), this may well be adequate to characterise the loch communities.

Sampling Methods

The objective of this survey was to obtain adequate material from each loch so as to ensure the collection of not only the common species, but also those which were comparatively uncommon. An additional consideration in choosing the sampling strategy was an attempt to counteract the possibility of uneven distribution (see George 1981) resulting from the physical characteristics of the lochs. Consequently, a dual sampling programme was chosen. Vertical hauls were made from 10 m to the surface, with three exceptions where adequate depth could not be achieved. On these occasions duplicate hauls were taken, the results summed and then converted to a value equivalent to a standard 10 m haul. The vertical hauls were linked by 1.6 km (one mile) horizontal tows made at a depth of 0.5 m to 1.0 m, and exceptions were made only in the case of Loch of Lintrathen, where distances had to be reduced (1 at 0.80 km, 2 and 3 at 1.07 km) because of the relatively small size of the loch. The vertical hauls were made using a small zooplankton net (diameter of opening = 25 cm) of nylon gauze (24 meshes per cm). This was lowered with adequate weight attached, and then hauled back to the surface at an approximate rate of 0.5 m per second. The horizontal tows were made with a Hardy Small Plankton Indicator (Glover 1953). The diameter of the nose-cone aperture was 12.7 mm and the replaceable discs in the rear of the sampler were made of nylon gauze (40 meshes per cm). The Indicator was towed well clear of the wash created by the boat's propellor, at a speed of four to five knots.

The positions of the tows and the vertical hauls are shown on the maps (Figure 2) and the sampling information is given in Table I. Distances through the water were estimated from readings of a small impellor log, and stations for vertical hauls were found by compass bearing from predetermined map positions. Conditions for small boat work were excellent, and even light breezes were only occasionally encountered.

Physical and Chemical Environment of the Plankton

In the Tayside synoptic survey information on the physical environment was obtained from 1 : 50,000 Ordnance Survey maps and from geological maps (Maitland 1979; Maitland, Morris and Lyle 1981). The data from the five lochs sampled in this present survey are incorporated in Tables 2 and 3. Chemical data was obtained from analyses of water samples collected during the fieldwork periods of the Tayside survey in April and July 1977 (Maitland and Morris 1981). Selected parameters are
listed in Table 4 and the values for the Chemical Index given in this table were calculated according to the method described by Jones (1981).

An examination of the loch outlines shown in Figure 2 and the data in Table 2 indicate that the lochs are of two distinct morphometric types. Lochs Laidon, Lyon and Earn are typical flooded valleys, long, narrow and deep, whereas Loch of Lintrathen and Loch Leven are more or less circular in outline and are relatively shallow. Loch Leven lies in a rock depression which is covered by glacial deposits (Kirby 1974) and is a typical drift-basin loch, although Loch of Lintrathen, despite its shape and relatively shallow depth is, like the other three, a rock-basin loch (Murray and Pullar 1910).

Because of the differences in their morphometry, and factors such as altitude, the physical environment provided by these lochs varies. For example, they differ to varying degrees in total volume and retention time, seasonal temperature range, thermal stratification, and the presence or absence of winter ice-cover. One major factor influencing total productivity of a loch, however, may be the fluctuation of water-level, since this may be sufficiently severe or frequent to prevent the development of a normal and productive littoral zone. Such fluctuations and their effects are seen clearly in Loch Lyon, a reservoir formed to provide water for hydro-electric power, where the water level may vary by many metres and where the exposed shore is virtually lifeless. Loch of Lintrathen, formed in order to provide water for domestic and industrial supply, undergoes lesser variations in level, and there is some relatively minor control in the outflows of both Loch Earn and Loch Leven. Loch Laidon is the only entirely natural loch in the survey.

Taking all the physical and chemical parameters into consideration, an attempt has been made to assess subjectively the potential trophic status of each loch. The suggested series is as follows:

- Loch Lyon - Oligotrophic
- Loch Laidon - Oligotrophic
- Loch Earn - Oligo-mesotrophic
- Loch of Lintrathen - Mesotrophic
- Loch Leven - Eutrophic

The relationships of the results to the biological data are considered in the following sections.

Biological Data

Each sample, either vertical haul or horizontal tow, was analysed individually. Whole samples were counted, with the
Figure 2
(Folded sheet - facing page 70)

Maps of the selected lochs
showing the track of the horizontal tows
and the positions (●) of the vertical hauls

Note: Loch of Lintrathen is drawn to
twice the scale of the other lochs
Table 2: Physical Data

<table>
<thead>
<tr>
<th>LOCH</th>
<th>LYNN</th>
<th>LAIDON</th>
<th>LEVEN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grid Ref. (Outflow)</td>
<td>27695241</td>
<td>2745317</td>
<td>36170995</td>
</tr>
<tr>
<td>Altitude (m.a.s.l.)</td>
<td>97</td>
<td>344</td>
<td>107</td>
</tr>
<tr>
<td>Longest axis (km)</td>
<td>10.3</td>
<td>8.5</td>
<td>5.9</td>
</tr>
<tr>
<td>Surface area (ha.)</td>
<td>991</td>
<td>505</td>
<td>1330</td>
</tr>
<tr>
<td>Mean depth (m)</td>
<td>42.0</td>
<td>16.7</td>
<td>4.0</td>
</tr>
<tr>
<td>Maximum depth (m)</td>
<td>87.0</td>
<td>54.0</td>
<td>21.3</td>
</tr>
<tr>
<td>Status</td>
<td>Nat(u)</td>
<td>R</td>
<td>Nat(c)</td>
</tr>
</tbody>
</table>

N = Natural loch
R = Reservoir
(u) = uncontrolled outflow
(c) = controlled outflow
<table>
<thead>
<tr>
<th>LOCH</th>
<th>EARN</th>
<th>LYON</th>
<th>LAIDON</th>
<th>LINTRATHEN</th>
<th>LEVEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (km²)</td>
<td>159</td>
<td>73</td>
<td>134</td>
<td>76</td>
<td>166</td>
</tr>
<tr>
<td>Mean Altitude (m.a.s.l.)</td>
<td>409</td>
<td>596</td>
<td>383</td>
<td>389</td>
<td>182</td>
</tr>
<tr>
<td>% Base-richness</td>
<td>6</td>
<td>2.3</td>
<td>0</td>
<td>13.6</td>
<td>100</td>
</tr>
<tr>
<td>Land use -</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Rough grazing</td>
<td>83</td>
<td>93</td>
<td>91</td>
<td>66</td>
<td>-19</td>
</tr>
<tr>
<td>% Forestry</td>
<td>6</td>
<td>0</td>
<td>1</td>
<td>17</td>
<td>9</td>
</tr>
<tr>
<td>% Arable</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>13</td>
<td>63</td>
</tr>
<tr>
<td>LOCH</td>
<td>LEVEN</td>
<td>LINLATHEN</td>
<td>LAIDON</td>
<td>EARN</td>
<td>LYN</td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>-----------</td>
<td>--------</td>
<td>------</td>
<td>-----</td>
</tr>
<tr>
<td>pH</td>
<td>7.75(5)</td>
<td>7.70(4)</td>
<td>5.40(1)</td>
<td>6.65(2)</td>
<td>7.20(3)</td>
</tr>
<tr>
<td>Conductivity (µS)</td>
<td>195.00(5)</td>
<td>50.50(4)</td>
<td>3.10(1)</td>
<td>2.30(1)</td>
<td>3.05(3)</td>
</tr>
<tr>
<td>Alkalinity (mg/L)</td>
<td>62.00(5)</td>
<td>17.00(4)</td>
<td>3.10(1)</td>
<td>2.85(2)</td>
<td>3.05(3)</td>
</tr>
<tr>
<td>Na</td>
<td>9.75(5)</td>
<td>4.45(4)</td>
<td>2.85(2)</td>
<td>2.30(1)</td>
<td>2.85(2)</td>
</tr>
<tr>
<td>K</td>
<td>1.85(5)</td>
<td>0.68(4)</td>
<td>0.43(2)</td>
<td>0.43(2)</td>
<td>0.43(2)</td>
</tr>
<tr>
<td>Ca</td>
<td>26.50(5)</td>
<td>5.50(4)</td>
<td>1.05(1)</td>
<td>1.05(1)</td>
<td>1.05(1)</td>
</tr>
<tr>
<td>Mg</td>
<td>2.00(4)</td>
<td>2.00(4)</td>
<td>tr.</td>
<td>tr.</td>
<td>tr.</td>
</tr>
<tr>
<td>P</td>
<td>0.26(5)</td>
<td>0.26(5)</td>
<td>0.48(1)</td>
<td>0.48(1)</td>
<td>0.48(1)</td>
</tr>
<tr>
<td>Nitrate N (mg/L)</td>
<td>0.980(5)</td>
<td>0.980(5)</td>
<td>0.280(4)</td>
<td>0.280(4)</td>
<td>0.280(4)</td>
</tr>
<tr>
<td>Mean</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
</tr>
</tbody>
</table>

Table 4: Water Chemistry (Mean of April & July values, with ranks in brackets)
Figure 3.

Diagram to show the species of Cladocera and Copepoda found in each loch

The numbers in brackets are the total number of species in each loch
exception of those from Loch Leven. The latter were sub-sampled, with either 5% or 10% by volume being removed by Stempel pipette from each well-mixed sample. The results of all these counts were expressed as the number of each species per 10 m vertical haul or 1.6 km horizontal tow. A summary of these values is given in Table 5, as a mean value per vertical or horizontal sample for each species in each loch. Table 6 combines these two values and expresses their sum as a percentage of the total number of organisms in all samples from each loch. In addition, in Table 8, the relationship between these estimated populations is expressed as a ratio of the lowest value.

Species Composition

Figure 3 shows the distribution of species according to lochs (after Maitland, Smith and Dennis 1981). The basic and almost ubiquitous species forming the zooplankton communities in Scottish Highland lochs, especially the larger ones, are Diaptomus gracilis, Cyclops strenuus abyssorum and Daphnia hyalina. They occurred in all five lochs in this small survey and, in the remaining 68 lochs sampled for zooplankton in the survey of Tayside freshwaters (Jones 1981), they were present in samples from 32, 33 and 32 sites respectively. Maitland, Smith and Dennis (1981) found that in the five largest Scottish lochs the two copepods were present in all lochs, but that Daphnia was present only in Loch Lomond, Loch Awe and Loch Ness. However, Jones (unpublished data) indicates that this species is also present in Loch Shiel and Loch Morar, although with a restricted distribution and at a low level of abundance. Murray (1905), referring to his own records and to those of Scott (1890-99), said that D. gracilis was "found in almost every loch on the mainland". He also reported that D. hyalina was "common over nearly the whole of Scotland" and although he did not refer to Cyclops sp., Scott (1890-99) recorded C.s. abyssorum in numerous other lochs both in the Central Highlands and in parts of the Lowlands. The large predatory Cladocera, Bythotrephes longimanus and Leptodora kindtii, also occurred in all five lochs and they, too, seem to be common in the majority of large water bodies in Scotland.

Diaphanosoma brachyurum and Sida crystallina were uncommon in this survey and the former was found only in Loch Laidon, although there it was relatively abundant. It was also found at eleven other sites in the main Tayside survey and, of these, six sites had environmental characteristics which, apart from size, were similar to Loch Laidon. The other five sites all seemed to provide a very different environment from that of Loch Laidon. They were mostly small and shallow, at lower
Table 5: Mean Numbers of Zooplankton Species per Sample

<table>
<thead>
<tr>
<th>LOCH</th>
<th>EARN</th>
<th>LYON</th>
<th>LAIDON</th>
<th>LINTRATHEN</th>
<th>LEVEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Samples</td>
<td>V H</td>
<td>V H</td>
<td>V H</td>
<td>V H</td>
<td>V H</td>
</tr>
<tr>
<td></td>
<td>(7)</td>
<td>(6)</td>
<td>(6)</td>
<td>(5)</td>
<td>(3)</td>
</tr>
<tr>
<td>Species</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diaptomus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>gracilis</td>
<td>59</td>
<td>14</td>
<td>137</td>
<td>275</td>
<td>160</td>
</tr>
<tr>
<td>Cyclops s.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>abyssorum</td>
<td>46</td>
<td>16</td>
<td>15</td>
<td>23</td>
<td>86</td>
</tr>
<tr>
<td>Daphnia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>hyalina</td>
<td>111</td>
<td>116</td>
<td>38</td>
<td>178</td>
<td>15</td>
</tr>
<tr>
<td>Diaphanosoma</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>brachyurum</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>82</td>
</tr>
<tr>
<td>Bosmina</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>coregoni</td>
<td>1.3</td>
<td>1.7</td>
<td>2.7</td>
<td>7.7</td>
<td>1.4</td>
</tr>
<tr>
<td>Polyphemus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pediculus</td>
<td>0.3</td>
<td>5.8</td>
<td>-</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Sida</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>crystallina</td>
<td>-</td>
<td>0.2</td>
<td>-</td>
<td>-</td>
<td>0.5</td>
</tr>
<tr>
<td>Holopedium</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>gibberum</td>
<td>0.1</td>
<td>-</td>
<td>19.7</td>
<td>4.2</td>
<td>-</td>
</tr>
<tr>
<td>Bythotrephes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>longimanus</td>
<td>1.2</td>
<td>0.8</td>
<td>1.0</td>
<td>2.0</td>
<td>1.6</td>
</tr>
<tr>
<td>Leptodora</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>kindti</td>
<td>0.6</td>
<td>-</td>
<td>3.2</td>
<td>2.8</td>
<td>2.4</td>
</tr>
<tr>
<td>TOTALS</td>
<td>220</td>
<td>155</td>
<td>217</td>
<td>493</td>
<td>349</td>
</tr>
<tr>
<td></td>
<td>743</td>
<td>656</td>
<td>1503</td>
<td>7252</td>
<td>2399</td>
</tr>
</tbody>
</table>
Table 6
Percentage Species Composition of Zooplankton in each Loch

<table>
<thead>
<tr>
<th>SPECIES</th>
<th>EARN</th>
<th>LYN</th>
<th>LAIDON</th>
<th>LINTRATHEN</th>
<th>LEVEN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diaptomus gracilis</td>
<td>19.5</td>
<td>58.1</td>
<td>63.6</td>
<td>42.3</td>
<td>9.5</td>
</tr>
<tr>
<td>Cyclops s. abyssorum</td>
<td>16.6</td>
<td>5.4</td>
<td>12.3</td>
<td>5.4</td>
<td>44.1</td>
</tr>
<tr>
<td>Daphnia hyalina</td>
<td>60.7</td>
<td>30.4</td>
<td>4.3</td>
<td>47.3</td>
<td>44.6</td>
</tr>
<tr>
<td>Diaphanosoma brachyurum</td>
<td>-</td>
<td>-</td>
<td>18.4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Bosmina coregoni</td>
<td>0.8</td>
<td>1.5</td>
<td>0.4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Polyphemus pediculus</td>
<td>1.6</td>
<td>+</td>
<td>0.2</td>
<td>0.2</td>
<td>-</td>
</tr>
<tr>
<td>Sida crystallina</td>
<td>0.1</td>
<td>-</td>
<td>-</td>
<td>2.8</td>
<td>-</td>
</tr>
<tr>
<td>Holopedium gibberum</td>
<td>+</td>
<td>3.4</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Bythotrephes longimanus</td>
<td>0.5</td>
<td>0.4</td>
<td>0.3</td>
<td>1.2</td>
<td>0.6</td>
</tr>
<tr>
<td>Leptodora kindti</td>
<td>0.2</td>
<td>0.8</td>
<td>0.2</td>
<td>0.8</td>
<td>1.4</td>
</tr>
<tr>
<td>Totals</td>
<td>374</td>
<td>710</td>
<td>1092</td>
<td>2158</td>
<td>9651</td>
</tr>
</tbody>
</table>
altitudes, and had a significant forestry component in the land use of the catchment area. *Sida* was present in Loch of Lintrathen, especially in the shallower water at the north end of the loch, and also occurred, as a single specimen, in the sample nearest to the west, or inflow, end of Loch Earn. This species was also found at a number of sites in the main Tayside survey (Jones 1981). Typically, these sites were environmentally similar to Loch of Lintrathen, i.e. chemically intermediate, of an 'upland' character, and possessed a moderately diverse species complex.

Another uncommon species was the copepod *Diaptomus laticeps*, found only in Loch Lyon, where in each sample a small number of adult specimens was noted amongst the commoner *D. gracilis*. The separation of the two species in the copepodite stages was not attempted in detail, and although the adults of *D. laticeps* generally outnumbered the adults of *D. gracilis*, it seemed probable that, according to the size of the copepodite stages, the population was predominantly (i.e. greater than 50%) *D. gracilis*. *D. laticeps* was only found at one other site in the Tayside zooplankton survey, namely Loch Garry (Jones 1981). Murray (1905), however, recorded it from four lochs out of the 44 which he examined in Perthshire and west Aberdeenshire. He considered it to be a 'western' species, with its boundary in the north-east part of Perthshire and only common to the west and north of the county. A recent paper by Fryer and Joyce (1981) reviews the distribution of some species of *Diaptomus* and shows that the boundary of the distribution of *(Arcto) - Diaptomus laticeps* coincides with the mean maximum summer isotherm of 23°C in the northern half of Scotland.

*Holopedium gibberum* was found in only two lochs, Lyon and Earn. According to Hamilton (1958) the commonest occurrences of this species are in waters with a pH of between 6.0 and 6.8 and in which the concentration of calcium ions is less than 20 mg per litre. Both lochs have calcium ion values below this level and Loch Lyon has a mean and range for pH which are within the given limits, but the pH values recorded for Loch Earn are higher. Hamilton (1958) states, however, that *Holopedium* has been recorded at pH 4.0 and 7.5. This being so, there seems to be no reason why both Loch Laidon and Loch of Lintrathen should not also support a population of *Holopedium*, since both lochs are within the chemical limits given. The absence of a species, however, is sometimes as unaccountable as its presence, and it may be that this species fluctuates in numbers from year to year, as indicated by Maitland, Smith and Dennis (1981) who, despite a previous report of its presence by Tippett (1978), failed to find it in Loch Awe in 1978, but took it in samples the following year.
Somewhat surprisingly, *Bosmina coregoni* was only present in three lochs and was not abundant in any. It is typically found as a very abundant species in large oligotrophic waters; for example, Maitland, Smith and Dennis (1981) found more than 1,000 per cubic metre in Loch Awe. The scarcity of this species in these five lochs, therefore, may possibly be due to seasonal variations in abundance.

*Polyphemus pediculus* was present in four of the five lochs, but was not a dominant constituent of the population in any of them. It appears, however, to show some preference for an inshore habitat, and this may account for the low numbers collected.

Relative Abundance

While the information given in Figure 3 shows how the species composition can distinguish one loch from another, because of their different assemblages of species or by the presence of uncommon species, the relative abundance of all the crustacean zooplankton and the relative proportions of the different species can add further dimensions to the characterisation of each loch.

The data in Tables 5 and 6 show the numerical dominance in all five lochs of the three species, *Diaptomus gracilis*, *Cyclops s. abyssorum* and *Daphnia hyalina*. In four lochs they total well over 90% of the sample populations by numbers, and if *Diaphanosoma brachyurum* replaces *Daphnia* in Loch Laidon, the same level is reached there too. However, there is a considerable difference between lochs as to how these species are proportionally divided. In Loch Laidon and Loch Lyon *Diaptomus gracilis* is the dominant species, whereas in Loch Earn and Loch of Lintrathen *Daphnia* is dominant. *Cyclops s. abyssorum* is of comparatively little importance in four of the lochs, but in Loch Leven it forms 44% of the population and is the species co-dominant with *Daphnia hyalina*.

In broad terms it appears that percentage species composition is related to trophic status, and that the richer and more productive the water the greater is the dominance of *Cyclops* and *Daphnia*. From being only minor constituents of the population in Loch Laidon, they become co-dominants and form nearly 90% of population by numbers in Loch Leven. Conversely, the poorer the waters, especially in chemical terms, the greater is the dominance of *Diaptomus*. Such a trend is apparent in all these five lochs and was also seen in the overall Tayside survey (Jones 1981).
Figure 4

(Page 81 - opposite)

Selected species from Loch Lyon and Loch Laidon

Numbers per sample, expressed as a percentage of the total number in all samples from each loch

\[ V = \text{Vertical samples} \]
\[ H = \text{Horizontal samples} \]
LOCH LYON

V

H

Cyclops s. abyssorum

Diaptomus gracilis

Daphnia hyalina

Diaphanosoma brachyurum

All species

Sample number

Sample number

LOCH LAIDON

V

H
Spatial Distribution

All sampling, except for Loch Laidon, was carried out in the middle of the day, between late morning and mid-afternoon in bright, sometimes sunny, weather and with no more than rippled water surface. The conditions of light penetration and surface temperature are therefore considered to be comparable. Sampling of Loch Laidon took place in the early evening of a clear day, and although the angle of light striking the surface would be lower than at all other sites, the absence of wind left the water surface undisturbed. The only exceptional factor which may have influenced vertical distribution was in Loch Leven, where at the time of sampling there was a heavy bloom of blue-green algae. It is likely that this will have been avoided by the species normally occurring in the surface waters.

To compare relative numbers of individuals in vertical samples with those in horizontal samples it was necessary to estimate the relationship between the volume of water filtered by each sampling method. The ratio used to calculate the relative values was $V : H = 2.4 : 1$, so to make a direct comparison the figures given in Table 5 under the columns headed H should be multiplied by a factor of 2.4.

Vertical Distribution

The herbivore *Daphnia hyalina* was, on average, more abundant in the horizontal than in the vertical samples. *Diaptomus* showed a preference for the surface waters in Loch Lyon, Loch Laidon and Loch of Lintrathen, but for the deeper waters in Loch Earn and Loch Leven. *Cyclops s. abyssorum* showed less positive preferences, although in Loch Leven it was more abundant in the vertical samples than in the horizontal. This distribution could be due to the algal bloom.

Numbers of the three small planktonic Crustacea, *Bosmina*, *Polyphemus*, and *Sida crystallina* were low, but despite this there was a tendency for them to be associated with the surface waters. The majority of *Holopedium* taken were from deep water, although this species is not confined by any means to deep or large lochs (Hamilton 1958, Jones 1981). The predatory Cladocera may well occupy different levels as part of their feeding strategy, because on the occasions when they were common, *Bythotrephes* was more abundant in the horizontal samples and *Leptodora* was more abundant in the vertical samples.
Horizontal Distribution

Examination of the data obtained for individual samples suggests that in some instances one or more species show a non-random distribution pattern. The data presented in Figure 4 have not been analysed statistically, but are presented graphically for visual interpretation and comment.

Non-random distribution patterns are the result of interactions between a variety of physical, chemical and biological factors. Even with the synchronous recording of many parameters by a detailed and accurate method (George 1976) interpretation of the results may be difficult. In most instances, however, the problem is to prove non-randomness, whereas in this survey the problem is to account for what appear to be clear cases of non-random distributions. The form these take (Figure 4) is a decline in abundance from one end of a loch to the other.

Two lochs show examples of this phenomenon, Loch Laidon and Loch Lyon, and it is manifested to different extents by three species, quite strongly by *Cyclops s. abyssorum* and *Daphnia hyalina*, and to a lesser extent by *Diaptomus gracilis*. In Loch Laidon and Loch Lyon *Cyclops s. abyssorum* is comparatively abundant at the inflow and declines sharply towards the outflow. In the horizontal samples from Loch Lyon and the vertical samples from Loch Laidon, a similar trend is apparent for *Diaptomus gracilis*. The reverse happens to the population of *Daphnia hyalina* in Loch Laidon, the numbers increasing towards the outflow end of the Loch. In Loch Lyon, however, *Daphnia* declines in abundance from the mid-way point towards the outflow end. *Diaphanosoma* shows no clear-cut pattern or trend, although on the whole there is a decrease in abundance from inflow to outflow rather than the reverse. In Loch Laidon the sum of these patterns, shown in 'all species', produces a definite decline in numbers throughout the loch for vertical samples, and in the horizontal samples there is a marked drop in the last stage of the transect. In Loch Lyon the general trend for 'all species' is not so clearly defined but here, too, there is a very distinct decline just before the end of the sampling transect.

A variety of physical and biological factors could account for these results, and many have been given consideration. It must be noted, however, that Loch Earn, with a relatively similar morphometry, showed no obvious non-random distributions either of individual species or of the total population. Physical factors such as heavy rainfall, wind-induced circulation currents, convection currents and seiches all seem unlikely to have caused these distributions, since conditions
Table 7
Comparative 'Richness' and 'Diversity' of Littoral and Open-Water Species in the Five Lochs

<table>
<thead>
<tr>
<th>LOCH</th>
<th>EARL</th>
<th>LYON</th>
<th>LAIDON</th>
<th>LINTRATHEN</th>
<th>LEVEN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Littoral</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population density</td>
<td>944</td>
<td>9</td>
<td>726</td>
<td>524</td>
<td>417</td>
</tr>
<tr>
<td>Number of species</td>
<td>23</td>
<td>13</td>
<td>23</td>
<td>29</td>
<td>19</td>
</tr>
<tr>
<td><strong>Open-water</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population density</td>
<td>374</td>
<td>710</td>
<td>1092</td>
<td>2158</td>
<td>9651</td>
</tr>
<tr>
<td>Number of species</td>
<td>9</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>5</td>
</tr>
</tbody>
</table>
### Table 8
Comparison of Mean Density of Crustacean Zooplankton in Tayside Lochs and Scotland's Largest Lochs

<table>
<thead>
<tr>
<th>LOCH</th>
<th>MEAN DENSITY PER CUBIC METRE</th>
<th>RATIO TO LOWEST MEAN DENSITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEVEN</td>
<td>13,897</td>
<td>25.90</td>
</tr>
<tr>
<td>LOMOND</td>
<td>3,698</td>
<td>6.90</td>
</tr>
<tr>
<td>(South basin)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LINTRATHEN</td>
<td>3,108</td>
<td>5.80</td>
</tr>
<tr>
<td>SHIEL</td>
<td>2,980</td>
<td>5.56</td>
</tr>
<tr>
<td>AWE</td>
<td>2,825</td>
<td>5.27</td>
</tr>
<tr>
<td>LAIDON</td>
<td>1,573</td>
<td>2.93</td>
</tr>
<tr>
<td>LOMOND</td>
<td>1,439</td>
<td>2.68</td>
</tr>
<tr>
<td>(North basin)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LYON</td>
<td>1,022</td>
<td>1.91</td>
</tr>
<tr>
<td>EARN</td>
<td>539</td>
<td>1.01</td>
</tr>
<tr>
<td>MORAR</td>
<td>536</td>
<td>1.00</td>
</tr>
</tbody>
</table>
had been fine and calm during the preceding few days. Feeding inter-relationships represent another possible cause of variations in relative abundance in a non-random manner, but their effects are unlikely to produce such an extensive pattern or to be detectable on the sampling scale used in this survey. The influence of outflow currents was also considered and losses in this manner have been discussed by various authors (Brook and Woodward 1956, Larsson 1972, Smith 1980), who have compared swimming rates of Crustacea with current speeds. From the evidence of their findings it is clear that some losses must occur, but if animals are passively carried in the flow their density will remain constant at all times. Conversely, if they are able to react to a current and swim against it there should be, as pointed out by Smith (1980), an apparent increase of numbers near the boundary region where swimming speed overcomes current speed. In the present examples neither of these patterns occurs. Furthermore, in both instances, the samples showing the decline in numbers were taken at a distance which seems to be beyond the possible influence of the outflow currents.

There is, of course, always the possibility that the patterns of decline seen in these two lochs may have arisen by pure coincidence, so in any further surveys of this type similar distribution patterns will be looked for very carefully. At present this remains a question to which there is no satisfactory answer.

Discussion

The danger of trying to obtain too much information from too few data is an obvious risk when comparing the biological characterisation of sites on the basis of one set of samples. Within the limits of the method, however, the information obtained, especially when taken in the context of the results from the Tayside synoptic survey, indicates that in general terms the lochs fall into a series based on the relative abundance and diversity of the crustacean zooplankton. This is related in broad terms to the trophic status of the lochs, which results from the interaction of a complex of parameters including surface geology, rainfall, altitude, land use in the catchment area, and the physical parameters mentioned in an earlier section.

The biological data are briefly summarised in Table 7 and show that where abundance (representing a measure of productivity) is high, diversity (a measure of the number of species) is low, and conversely when abundance ('richness') is low, diversity is high. Looking at the differences between the oligotrophic lochs, Loch Lyon and Loch Laidon differ
principally in the presence or absence of a biologically active littoral region. The absence of any productive capacity in this region in Loch Lyon must affect the open-water community to some extent. Loch Laidon, whose chemistry suggests that it may be a poorer productive environment, benefits by having a comparatively rich littoral region, and this may well be the compensating factor in making it an apparently more productive loch for zooplankton. Some data giving comparisons of the littoral samples from these lochs are given in Table 7. The situation of Loch Earn is rather a problem, since according to the open-water sampling it has the lowest abundance and shares the highest diversity. However, the results of sampling the littoral region, and the chemical results, suggest that it should be richer and less varied than the above two lochs, and this is not so. It is possible that Murray and Pullar (1910) offer a reason for this, although not a full explanation, by their comment to the effect that the main algal 'bloom' in Loch Earn is in the winter, and that in summer algae are scarce and the water is clear.

Loch of Lintrathen is distinguished by being 'richer', i.e. having a higher population density than the above three lochs, and in conjunction with this it has a slightly less diverse population, although Diaptomus is still an important constituent of the main group of dominant Crustacea. The triangular coordinate plot (Figure 5) has been drawn on the basis of the percentage contribution made by measurements of 'richness', 'diversity' and 'trophic status' from the data on open-water plankton for each loch, the sum of the contributions equalling 100%. The relative contribution made by each parameter determines the loch's position on the plot, and therefore the degree of proximity gives a measurement of similarity. Loch of Lintrathen is further from the three 'long' lochs than they are from each other, but it is still nearer to them than it is to Loch Leven. The latter is outstanding in the context of these five lochs, because of its abundant crustacean zooplankton and because of the low level of species diversity demonstrated. It is situated in relatively low-lying, geologically base-rich, arable farming country and has a distinct and extensively shallow form. It is not therefore unexpected for its biology to be so distinct. It is satisfying to know, however, that by the comparatively coarse methods of estimation used in this survey it can easily be picked out as a biologically distinct loch.

In conclusion, it is of interest to consider these five lochs, representative of the largest in Tayside, in relation to the five lochs studied by Maitland, Smith and Dennis (1981), the largest in Scotland. Mean densities per cubic metre,
Figure 5.

Triangular coordinate diagram of the percentage 'Richness', 'Diversity', and Trophic Status for the five lochs.
calculated from the results of the August zooplankton samples (Maitland, Smith and Dennis 1981) are compared with mean densities per cubic metre of zooplankton from lochs in the Tayside survey (Table 8). The results for the ten lochs are ordered by calculated mean density, and the ratio of each value in relation to the lowest value (Loch Morar) is also given. The results for Loch Lomond are divided into north and south basins, to permit direct comparison with Maitland, Smith and Dennis (1981) who sampled only the north basin. Unpublished data have provided comparative figures for the north and south basins and the relationship between these values has been used to estimate a value for the south basin.

Apart from restating the comments regarding Loch Earn and Loch Laidon being apparently poorer and richer respectively than might have been anticipated, nothing unexpected can be found in the ordering of Table 8. Loch Leven remains an outstandingly different site, being about four times as 'rich' in zooplankton as its nearest neighbours, the south basin of Loch Lomond and Loch of Lintrathen.

Summary

Samples of open-water zooplankton were collected from five of the largest lochs in the Tayside Region of Scotland (surface areas ranging from 185 to 1330 hectares). In each loch a set of collections was made, by towing a Hardy Small Plankton Indicator at a depth of 0.5 m to 1.0 m; these horizontal hauls were interspersed with vertical net hauls from 10 m, generally at intervals of 1.6 km (one mile).

All Crustacea in the samples were identified and counted, and the results were examined in conjunction with physical and chemical parameters characterising the lochs. Differences in species composition were apparent, although a nucleus of species was common to all lochs. Estimates of relative abundance showed that there was a considerable variation not only in the total numbers but also in the proportions of each species. The five sites were of varied trophic status, and an association between this parameter and the biological results was evident. However, the absence of some species and the reduced number of others in apparently suitable environments cannot easily be explained. A further biological observation, as yet unexplained, was the distribution pattern, especially of two species in two of the lochs.

Acknowledgements

My especial thanks go first and foremost to my colleague Mr. A.A. Lyle, who acted as boatman, guide and adviser during
the sampling programme, and secondly to him and to other colleagues, particularly Dr. P.S. Maitland, the leader of the synoptic survey, for their efforts in extracting map and field data of which I have availed myself in this paper. I have had many useful discussions with these two colleagues and with Mr. I.R. Smith, and I am very grateful to them all. Mrs S.M. Adair has kindly used her drawing skills on my behalf in Figures 1, 3 and 4.

I should also like to express my thanks to those in authority over the various waters, for their help and for permission to carry out the sampling programme.

References


Mr. David H. Jones, Institute of Terrestrial Ecology,
78 Craighall Road, EDINBURGH EH6 4RQ.
THE MINNOW ON THE ISLAND OF ARRAN

By PETER S. MAITLAND
Institute of Terrestrial Ecology, Edinburgh

The Minnow *Phoxinus phoxinus* is a member of the carp family (Cyprinidae) which is widely distributed throughout the British Isles, except in the north and west of Scotland (Maitland, 1972). There is some evidence that its limit of distribution has moved north in recent years (R.N. Campbell, personal communication), but its status along the west coast of Scotland, especially on several of the islands, is in some doubt. It is very common on the mainland of the Clyde area (Maitland, 1980) but not on the islands of the Clyde estuary.

On the Island of Arran in the Firth of Clyde the Minnow was originally thought to be (and probably was) absent, but was said to have been introduced to the island during the 1830s. Paterson (1837) said "There were no minnows in Arran until lately, when they were brought from Ayrshire, it being expected that they will help to raise the trouts to a greater size". The introduction was also recorded by McNaughton (1840), who stated that Minnows had been introduced to "several rivers and lakes of Arran", but cautiously concluded that the "result of the experiment cannot for some time yet be ascertained". Later Wilson (1842), commenting on the introduction, noted that Minnows were "not indigenous to the island". It appears, however, that the 1830s introduction did not ultimately succeed, since no later records could eventually be traced (Gibson, 1975b). Within recent years there have been rumours of further introductions, none of them substantiated, however, and additional information was needed (Gibson, 1975a).

In August 1977, during a fishing trip to Loch Garbad (National Grid reference: NS 019 238) several small fish, thought to be Minnows, were seen in the shallows. No specimens were caught, however, and their identity remained uncertain. The loch was visited again in August 1982. This time several Minnows were caught - both 0+ specimens (young of the year) and mature individuals. The species was exceedingly common, and enormous shoals occurred all round the edge of the loch and in its outflow. The only other fish species known to occur regularly in the loch is the Trout *Salmo trutta*, but it is likely that the Eel *Anguilla anguilla* occurs there too.
In the meantime, it must be assumed that the origin of the Minnows in Loch Garbad is a recent introduction, and enquiries are continuing.

References

THE SCOTTISH NATURALIST
Founded 1871
A Journal of Scottish Natural History
With which is incorporated The Annals of Scottish Natural History and The Western Naturalist

Record of Publication

The Scottish Naturalist and Journal of the Perthshire Society of Natural Science
1871

The Scottish Naturalist
1872-1891

The Annals of Scottish Natural History
1892-1911

The Scottish Naturalist

The Western Naturalist
1972-1982

The Scottish Naturalist
1983-date

Published by The Scottish Natural History Library
CONTENTS

The Birds of the Endrick Mouth, Loch Lomond
   An annotated check-list up to 1st January 1980
   Mr. John Mitchell

The Status of the Wild Cat in Kintyre
   Dr. Eric Bignal and Dr. Nigel Easterbee

Comparative Observations on the Invertebrate Fauna of
   Two Orkney Streams
   Dr. P.B. Heppleston

Open-Water Zooplankton from Five Tayside Freshwater Lochs
   Mr. David H. Jones

The Minnow on the Island of Arran
   Dr. Peter S. Maitland

Published by The Scottish Natural History Library