

## THE MONTAGU'S HARRIER BREEDING IN SCOTLAND

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### INTRODUCTION

In recent years, the Montagu's Harrier *Circus pygargus* has become one of the rarest breeding animals in the British Isles. Following a peak in the mid-1950's, a noticeable decline set in, until by 1974, there was no confirmed nesting (Sharrock, 1976). In 1975, there was not even a report of a pair in residence, while 1976 saw little change, with two successful nests in separate localities in southern England (M. J. Everett, pers. comm.).

It is a sad fact that this exceptionally graceful and attractive bird of prey, must now be regarded as virtually extinct as a breeding species. At best, it is at present extremely rare, and in view of this, it is worth while to reflect on the only recorded successful nesting of the Montagu's Harrier in Scotland, the more appropriate for this journal, as the event took place within the Forth basin. The paper is intended as a sequel to 'The Return of the Hen Harrier' in the previous issue, which related the success of the other species of harrier nesting in Scotland. While the Hen Harrier *Circus cyaneus*, continues to increase and spread in the British Isles and is now fairly numerous in Scotland, the converse is true of Montagu's Harrier in Britain as a whole. Because of the threats to rare raptors in particular, it was deemed wise to maintain strict secrecy in the past, as indeed today, thus resulting in unfortunate shelving of knowledge gleaned. This account is therefore the first detailed documentation of the bird breeding in Scotland.

First, let us consider the most likely main causes that have brought about this alarming decline in the Montagu's Harrier. In the past, it largely bred in the southern counties of Britain, and somewhat of an opportunist, it proved very catholic in its choice of nest-site and food, birds being frequent in the diet. For the latter reason and because the decrease had started by the early sixties, pesticide-contamination has probably played a significant part in the decline aggravating direct persecution—frequent and persistent enough at the nest. Even more so, gunning-down on migration must almost certainly account for a high toll, as this species, along with the Hobby *Falco subbuteo*, shares the distinction among British birds of prey, of being a purposeful, long distance migrant, both Africa

bound, the Montagu's Harrier wintering within the tropics and beyond, reaching even as far as the Cape. A high mortality, especially among birds of the year, is to be expected due to the increased hazards incurred by migration through France and the Iberian peninsula, where an annual senseless destruction is wrought by gunmen lying in wait - the low flying harrier, particularly susceptible, for as the owl's facial-disc suggests, birds of this genus use hearing in addition to sight in their detection of prey, and in the case of Montagu's Harrier, are easily lured to the imitation call of the Quail *Coturnix coturnix* (Bannerman, 1956). Even more ominous is the note sounded by Brown, (1970), in which the suggestion is made that since c. 1950, there has been a marked diminution in the numbers of Montagu's and Pallid Harriers *Circus macrourus* wintering in East Africa — birds that co-exist in their Eurasian breeding grounds, as well as in their widespread wintering haunts in the grassland-savanna of west, east and southern Africa, where the ratio is always in favour of the Pallid Harrier (Roberts et al, 1970; Brown, 1970; Elgood et al, 1966). If it is in fact the case that there is a decline in the general population of these somewhat similar harriers, then the cause, with regard to the Eurasian range, is almost certainly attributable to the widespread use of toxics used in cultivation, and increased mechanisation of arable land.

## CHARACTERISTICS AND PLUMAGES

Like the Hen and Pallid Harriers, Montagu's Harrier is a dimorphic species, the plumages of adult male and female being strikingly different in each case, however, unlike most harrier species, there is no great disparity, indeed an overlap in the dimensions of the sexes (which by way of contrast is marked in the Hen Harrier). Also, whereas the female in the Hen Harrier has a much thicker tarsus in comparison with that of the male, the legs of both sexes in Montagu's Harrier are of identical width and very slender in proportion — differences in the species, reflected in the size of their prey i.e. a much smaller prey-range in the Montagu's Harrier.

By comparison with the robust Hen Harrier, the Montagu's species is one of very slender proportions and lighter build, with the body noticeably thinner, although perhaps slightly stouter in the female than in the still lighter male. The tail is proportionally longer and the wings of a much narrower chord, while more pointed due to a shortening of the 4th, 5th and 6th primaries. Where soaring or gliding, the flight feathers (primaries) are widely splayed in the Hen Harrier, whereas there is often no noticeable spacing between those of either sex in Montagu's

Harrier. In gliding or soaring, the wings of the Montagu's Harrier are more pronouncedly angled upwards from the shoulder, than in the case of the Hen Harrier. A certain cleaving of the primaries occurs in flapping of the wings during hunting, and then, a cock Montagu's Harrier is a study in grace and poise, as low to ground, he alternately glides and flaps; so light in weight, that he rises and falls in undulating flight with each strong beat of the long, unflexed wings, curved back from the carpal joint. Although the opposite is generally believed, and may indeed be the case, when the males of Hen and Montagu's species were disputing territory in 1954, the greater wing-span was that of the Montagu's Harrier.

The following descriptions are from notes taken of the adult pair in 1955, and the juveniles in every year. Typical abrasion of the ash-grey upper parts of the male, revealed an admixture of brownish colouring, the primaries black and with their pale-grey coverts contrasting with the darker grey of the other wing-coverts and back. While lacking the broad white rump of the male Hen Harrier, having instead a grey barred, white rump, he was handsomely distinguished by the broad rufous flecks on flanks and feathers of the tibia. His iris was bright-yellow, and in flight, the secondaries showed the distinctive, if narrow, single black bar that traverses them. The under-wing coverts, off-white, featured a series of very narrow black bars. By contrast, the female had a general brown colouration above, similar to the female Hen Harrier, but with a distinctly narrower white rump, and while the under-wing was similarly barred, the outer tail feathers were more contrastingly banded with yellowish-buff and alternating dark-brown bars. The juveniles are distinguished from the adult female of both species and juvenile Hen Harrier by the uniform rufous under parts and rufous edging to the dark-chocolate upper parts. They also have a rounded crown to the head, whereas that of the young of the Hen Harrier is angular.

## HISTORY AND BREEDING LOCALITY

There have been few sightings of the Montagu's Harrier in Scotland. Witherby, (1952), in regarding it as a rare vagrant, included among some 7 records in southern Scotland, one on the 15th June, 1881, that might have bred in the Solway area (shot in Kirkcudbrightshire). It has occurred as far north as Fair Isle (Waterson, 1937), and Orkney (Bannerman, 1956); at Arbroath on the east coast (Baxter and Rintoul, 1953). In recent years, one female, if not two birds, was seen in the Spey marshes on the 21st and 23rd May, 1970 (Douglas Weir) pers.comm.

The 1940-45 war years evidently gave the Montagu's Harrier a short respite. A relaxation in shooting and other human disturbances, resulted in a hitherto unknown build-up of population. In the early fifties, their breeding strength was probably in excess of double that in the thirties, with c. 20 pairs nesting in 1950 in Devon-Cornwall alone i.e. nearly the equivalent for the whole of England, pre-war. It was during this peak population period, when the species was nesting widespread in England, including the northern counties, that it began to make its appearance as a breeding bird in north Wales, Ireland and Scotland.

At that time a conservative estimate of nesting-pairs in Britain would be of the order of 45-50, but possibly well in excess of this figure. In this post-war era of resurgence, to begin with, Scotland had a pair of early arrivals reported from East Lothian in April, 1947, one of which was shot (Bannerman, 1956), while a pair that had been shot and preserved were claimed to have nested in the Loch Coire area of central Sutherland in 1946 or 1947 (D. Weir, pers. comm.). Next, a bird was reported killed in April, 1951, near Perth (Mackenzie, 1951). In the following year, 1952, nesting in Kirkcudbright was confirmed — an Anglesey ringed bird (when young) was found dead near its nest with 4 eggs, which later disappeared (P. Sandeman, pers. comm.).

It was in this same year (1952), that I found the first successful nest — in south Perthshire. Subsequently, the Montagu's Harrier bred in 1953 and 1955, with young reared in all three years — a total of 5 reaching the stage that they were able to vacate their nest locality. A solitary male was the only bird present in 1954.

In 1952-53, the nest sites were 40 m (45 yds) apart; that of 1955, was located fully 4½ km (3 miles) to the S.W. The habitat was 'grouse-moor', and all 3 nests were located in marginal, ling *Calluna vulgaris* dominant, moorland, at 274 m (900 ft) and 230 m (750 ft) above sea-level, respectively. With a generally southerly aspect, the nest-sites were situated well below the peaty Slymaback-Cromlet Hill northern watershed of Strathallan, and clearly visible from Dunblane. A line due north of this town, exactly bisects the two nesting localities - the more distant, 4.6 km (barely 3 mls), (and the nearer, 4.9 km (mls)) N.W. of the Great North Road. Cast an eye to the gently swelling moor above Braco, and on the horizon, is the lone sentinel of a windswept larch — a few hundred metres to the S.E. of this, and some 15 m (50 ft) below it, were the first two nests (1952-53). The 1955 nest was 500m (550 yds) S.E. of the High Wood (Hill House) on Cromlix moor.



## NESTING - 1952

Montagu's Harrier made its first appearance on Braco moor in 1952. The previous summer, only a pair of Hen Harriers were present. It was, in fact, the discovery of the Hen Harrier nesting on the Callamlor-Glen Artney end of the moorland in 1951, that led me to search as far afield as this eastern extremity of a vast expanse of more or less hilly, undulating and flat heather-moor, largely on peaty soils overlying the Old Red Sandstone.

The spring and summer of 1952 was inclement with changeable temperatures and weather, from early April until late July. After a raw-cold morning with persistent low cloud, frequent showers followed by thunder, hail and sleet, the 10th May saw the female Montagu's Harrier rise in pouring rain from a ling not far from where, exactly a month hence, the first egg was laid. On the following forenoon of a misty, rainy day, the male was first seen. He was hunting low, up-hill, the heathery slopes of Cromlet Hill (where most of his foraging was done in 1952-53), when, flushing the adult male Hen Harrier from a strip of rank ling, they careered around, accepting each other, before going their separate ways. That same evening, the air now clear and crisp, the two males of both species of harrier (the cock Hen Harrier pale-grey in contrast to the darker grey and slender built Montagu's) were active on the wing among the ancient pines that cover many hectares of open woodland-heath at 245 m (800 ft) on the fringe of the moor — near to where the hen Montagu's Harrier had risen the day before. Not far apart, the harriers would hunt low over the *Calluna* (ling) glades, between times, sailing just over the broad dark-green umbrella canopies of the pines.

On the 24th May, while I saw no sign of the female, the male Montagu's Harrier and male Hen Harrier were both active on a day of warmth. As the latter mounted high in circles, before setting course for the hill, 3½ km (2½ miles) to the N.E., the Montagu's slowly wheeled upwards, beneath him.

It was not until the 10th June that the female was found with her first egg, probably laid that morning and already being incubated. She lifted off the same at only 6 m (20 ft) distance, and similarly, later that day. The nest was an apology for such — a mere slight depression in a deep carpet of green mosses within the narrow confines of encircling rank ling. The only lining material could well have been added after the

laying, comprised as it was of only some six 5 cm (2 inch) long broken-off pieces of the rush *Juncus effusus* and two short twigs of burnt ling. On returning after the first disturbance, she had 'embroidered' the periphery with a brief rhizome of *J. effusus*. The egg, white with a few red-brown flecks. The most interesting fact was that the nest in which the Hen Harrier reared young the previous year, was only 9 m (30 ft) removed from the Montagu's nest, and in the same strip of rank Calluna! Just as remarkable were the 3 cock-nests of the then un-mated male Hen Harrier, in the same heather tract also! One had been used as a former roost too, for, as with the ling surrounding the 1951 nest, old excreta of the harrier sprinkled his nest.

The clutch was complete with the second egg (pure white), found on the 13th, and the lining, still scanty, was of like short pieces of rush, thinly laid in the nest hollow. This time, the hen rose when I was still a good way off, remaining silent and flying a good distance before circling. Only on my stooping over the nest, did she reiterate a 'chatter' (weak compared with most Hen Harriers) becoming as suddenly quiet the moment I left it.

A week later the female was flushed to reveal the lining as scanty as previously; some small twigs of ling, simply decoration around the nest, while the eggs now were slightly stained. On this same day, the 20th June, the female Hen Harrier (when her sole nest occupant was c.12 days old, in a nest, this year 365 m (400 yds) from her 1951 nest and that of the Montagu's Harrier), was seen to attract her mate by circling and calling over the nest area. On his approach, the male performed a complete loop, turning over on his back, and on circling his spouse, she executed a quick "somersault", thereby attracting the male Montagu's Harrier, who joined them in flight, with no antagonism on the part of any; shortly after, they all separated.

Only one egg hatched in the Montagu's Harrier nest (estimated incubation period 29-30 days); the other proved addled. When the diick was 3-4 days on the 12th July, the female again on leaving the nest, circled at a distance and dropped into the heather out of sight. It was indeed the male Hen Harrier who created a noise. After flying around me calling, at the Montagu's nest, he perched close by on top of long ling and continued to "natter" away in a state of great anxiety — his own young now fully fledged, and a male at least 34 days old, was some 365 m (about a quarter mile) away.

When some 24 days old (on 1st August) the young Montagu's Harrier was well feathered and more handsome than any juvenile Hen Harrier. Traces of down adhered to the centre of the breast, throat, forehead, upper and under coverts, and under-parts generally, and the tail, as yet, only two contrasting blackish-brown and pale rufous bars. The upper plumage was dark chocolate-brown to blackish-brown, with contrasting rufous tips to most feathers while underparts from breast to tail-coverts and underwing-coverts, were an immaculate, uniform rich-rufous. While these features distinguish (lie juvenile Montagu's from that of the Hen Harrier, so also does the dark chocolate-brown ear-coverts which contrast with the otherwise plumbeous-brown of the head. Upper tail coverts had pale-rufous tips; the iris, chocolate-brown - indicative of female sex (Lazlo, 1941), as in the juvenile Hen Harrier. The 3<sup>1</sup>/<sub>2</sub> week old youngster was sitting on the addled egg, and the feather remains of Pipit *Anthus pratensis* prey lay on the nest.

All the evidence was that the female was a first year bird (i.e. late nesting, 17 days later than she laid in the following year, and in the case of the 1955 female); the scanty nest compared with 1953; the small clutch (c/2) and her general behaviour — retiring in nature.

#### NESTING - 1953

If anything, the weather, April-late July, was even more changeable than in 1952, with cold spells and a very rainy July. On the 10th May there was no sign of either Montagu's Harrier, but on the 17th of the month (dull and cold), the male was seen rising from burnt ground, soaring into a high wind. The 24th May, showery again and a day of low cloud, saw first the male pitch in short flight and preen in the rain, and just afterwards the female dropped into her nest nearby, and shortly left. The time, 11.00 am. and her first egg laid. No sooner had she risen, calling excitedly in response to the ecstatic 'switchback' advertisement display of the male Hen Harrier (this year, mateless) high-up and a distance off, than the hen Montagu's Harrier flew in wild abandon. Having executed a quick succession of several complete side-rolls low over the heather, she continued for some time to toss around in a seemingly irrational manner. The male Hen Harrier either never saw her, or ignored her, for he came no closer, but the cock Montagu's was quick to come on the scene, and he had to stoop twice, almost coming in contact with her, before the wild antics, at all times low to ground, were curbed. She then

made two visits to the nest, carrying in the bill, short pieces of rush from nearby, and, just afterwards, the male in the company of the female, circled the nest before dropping in on the same. No doubt, his first inspection of the egg, he rose shortly, when the hen bird descended on the nest, where she sat until raised 2 hours later.

The 'nest' was as last year at this stage, a mere hollow, barely lined, in a deep carpet of mosses that underlay the whole strip of rank ling (and still does 24 years later!). It was 40 m (45 yds) from last year! nest, in the centre of an adjacent level tract, footing a heathery slope of shorter growth, and like the 1952 nest, only 110 m (120 yds) from a thin strip of tall planted pine (now felled). At 1.00 p.m, the single egg reposed on a few short white rhizomes of mat-grass *Nardus stricta*, 2 few-inches long stems of rush *Juncus effusus* pulled at the root, and a few small twigs of ling. That evening, there was only the addition of a few short rushes under the grass roots.

At 2-3 day intervals, a further 3 eggs were laid — a clutch of four. On the 30th May, when the nest held 3 eggs, the lining was still scanty i.e. barely lined with white nardus rhizomes, and some short lengths of rush.

As on both occasions when flushed on the 24th, she gave only a short, shrill yelp on rising from the nest (silent otherwise) and as each time on the day of the first egg, rose at only several meters distance. The same distance again, she rose from her nest on the 25th June, when 32 days since the laying of the first egg, none were as yet chipping, while the nest was now well lined — 5 cm (2 ins) in depth, 30 cm (1 ft) in diameter and comprised largely of nardus rhizomes, also short stems of rush *Juncus effusus*, and a small number of short and lengthy branches of ling. The female was apparently that of 1952, identically plumaged and the nest similar initially. Now probably a two-year-old her clutch was doubled, while as also to be expected, she had commenced laying 2½ weeks earlier and more in. keeping with the normal average (Witherby, 1952).

On the 28th June, the first chick was a day old, and a second egg was chipped with the chick inside, cheeping and cheetering, two distinctly different sounds produced by the chick, the cheetering being a continuous sound (like that hatched) and tapping with its "egg-tooth" at

the same time! Again, the hen had risen several metres ahead, and while the male flew around the territory for some time, pitching on the adjacent burnt-slope twice, he then came low over the nest and in that instant, dropped on to the same (no prey visible), leaving 10 seconds later. A cloth-hide, placed 5.5 m (18 ft) on the 25th June, was now moved to 3.5 m (12 ft) from the nest.

The second chick had hatched by early morning on the 29th; shell fragments broken up into the nest-lining. The hen sat as tight as before. A shrill yelp on rising off the nest, (always the case), she silently flew in circles, perching on several nearby pines. At other times, it was her habit to circle awhile a distance-off, then pitch somewhere out of sight. Two eggs were added and assuming that they were the first laid, then the incubation period of 29 days would agree well with 1952.

From the nest centre, the front of the hide was positioned 2.4 m (barely 8 ft) on the 1st July. A plucked Pipit lay on the nest and the hen rose and circled silently as usual. She was shot by the local gamekeeper the following afternoon, when the chicks were only 3 and 5 days old, small, chattering mites in their sparse, white 1st down.

At fairly close range, the male rose from the nest on the late-morning of the 3rd July. Several hours later, and again at 9.00 pm, he was put up from the nest. The cock-bird was actually brooding the chicks on each occasion. While keeping afar off, he kept 'chattering' anxiously, as long as I remained at the nest — the call more punctuated than that of the Hen Harrier male, higher-pitched, but weaker.

Four hours were spent in the hide the following day - from 9.00 am-1.00 pm, when the male brought in 2 Pipits, but made no attempt to feed the chicks, whose crops were deflated. Nor did he make any move to brood them, both miserable with a cold S. wind blowing and in the 20 minutes he sat on the nest, trying to bury beneath him, but only managing to get their rear-ends nestled under his body feathers. It was on his second prey-call, that he settled down, only to rise up on long, slender yellow leg and talon when, having heard keeper and dog a long way off, the dog now ran nearby. On its closer approach, he took wing. Both Pipits were torn up by hand and thus fed to the chicks, they devoured everything edible, until their crops bulged.

The morning after, at 10.00 am on the 5th July, the male rose 2 from the nest and flew around calling. Both chicks, now 6 and 8 days old, were well fed, their crops fully distended (a plucked Pipit lying on the nest) and very warm, had been brooded subsequently. Following a heavy shower, earlier that morning, it rained heavily for the rest of the day and especially so that night. Single handed, the cock continued to regularly feed, as well as brood, both young, successfully rearing them until fully fledged by the end of the month, and continuing to attend their needs for a further month i.e. until the end of August.

The male, the provider, had taken over the role of the female, in addition to his own! Not just remarkable on account of July being a particularly wet month, with frequent rain-showers throughout, and cold initially, but because this was a hitherto unrecorded happening — a male Montagu's Harrier has, apart from this instance, never been known to brood, let alone rear young. Furthermore, I know of no other case of a male bird of prey attempting to, far less brooding or rearing young. At the same stage of development, I have known (again within the Forth basin) of the hen Golden Eagle *Aquila chrysaetos* to be shot and the male continue to bring in Red Grouse, whilst the chicks starved in the midst of plenty.

After bringing in a Pipit at 6.15 pm on the 9th July, he laid the capture on the rim of the nest, both young well fed, and after cleaning his talons with the bill, strode over and poked gently both downy nest-mates with his bill. Every movement slow and deliberate, he then straddled the eldest occupant, now 12 days old and sprouting contour quills. Breast feathers puffed-out, he tolerated the heaving (to begin with) of the young, but apparently suffering some discomfort, he shortly rose and turning around, immediately brooded again the same bird, but this time, facing the hide. Where prior to settling and brooding, he had continued to look this way and that with a cold, suspicious stare in his yellow eyes, now his expression softened, and was apparently one of composure. At 6.55 pm, after some 35 minutes steady brooding, he rose to rend apart the Pipit, feeding first himself, then most of the kill to the elder young, now risen-up; the youngest receiving a tiny portion. Previously, the younger had tried, mostly in vain, to get under the cock; thus briefly covered. The meal over, for another 20 minutes, the male brooded both simultaneously now, the young occasionally uttering a cheep. At 7.15 pm, he rose and took wing. Earlier, he had arrived with a Pipit at 9.30 am, and another 6 hours later. While in the hide 3½ hours from 4.00 pm,

another 2 Pipits were brought in with an interval of 1 hr 10 mins — the first at 5.05 pm. Four Pipits in all, in the space of nearly 9 hours. The first three had been apportioned, and in the manner adopted by female harriers and other raptores accustomed to feeding young, he tilted his head in offering each morsel of food. After his third food-call and an 8 minute stay on the nest, both young had cheeped and cheetered incessantly for quite some time, especially the youngest, and by huddling together, derived some warmth.

A total of 37½ hours were spent in the hide between the 4th -31st July, during which time a total of 29 prey items were brought in i.e. an average of one kill per 1 hour 17 minutes. These comprised 21 Pipits, 1 Skylark *Alauda arvensis*, 2 unidentified small passerines, 2 Red Grouse cheepers and 3 infant Rabbits *Oryctolagus cuniculus*. Between the 1st - 31st July, the total number of food items accounted for was 45 i.e. 35 of feather and 10 of fur (a bird to mammal ratio of 3.5:1) - in all, 28 Pipits, 1 Skylark; 2 unidentified passerines, 2 Snipe fledglings *Capella gallinaga* 2 Red Grouse cheepers, and 10 Rabbit infants (of c.3 wks). As the young grew apace, their food requirements increased, being fairly consistent throughout the latter feathering stage i.e. c. 2½ weeks until fully fledged (31-35 days), when, based on my observations in 1953 and 1955, food requirements were the equivalent of 4-5 Pipits a day per individual. During the next 4 weeks free-flying stage i.e. until independent, they were provided with about the same quantity of food, although in the latter fortnight or so, their needs are probably somewhat less. On the 16th July, (the young 2½ weeks old), the cock arrived with 7 kills between 11.35 am - 6.15 pm; an average interval of 66 minutes, and 57 minutes between departing the nest-site and returning with prey. On the 28th July (young aged 4 weeks) he brought in 8 kills in the period 10.35 am — 6.15 pm; an average interval of 73 minutes, and 50 minutes between leaving the nest-site and bringing in prey.

Most foraging and procurement of prey was done a good distance from the nest area; generally he would rest a short while on the burnt slope near to and overlooking the nest, after feeding the young, and having done so, more often than not, set-off due north. On the 22nd August, he was hunting the steep northern slopes of Cromlet Hill - 2.4 km (1¼ ml) removed from the juveniles. In the later feathering stage, the bird-prey was not so well plucked before returning to the nest, however, the flight and tail feathers invariably were, that is with the one exception, when the victim was brought back alive! There was no doubt that

while he completely ignored Pipits flying about the nest, and also Whinchats *Saxicola rubetra* feeding their fledglings around his nest, he would make a kill at no great distance away. As in 1955 he returned with a kill in as brief a time as 7, 10 and 15 minutes, so in 1953 he arrived twice in 10 minutes with a Pipit and unidentified perching-bird (Pipit?) and once within 13 minutes — again a Pipit.

Because of the heather closely encircling the nest, the harrier had to drop vertically, wings fully raised, on to the same, having first flown low over the nest. At 1.15 pm on the 28th, he did so as usual, landing with the customary thump. It was 13 minutes since his last call — a grouse cheeper. The prey, as always, grasped in his talons, he had alighted on the rim of the nest with a live Pipit, fully feathered and held down on its back by one foot, calling in despair while the young harriers looked on in silence. The cock hesitated awhile, then stepped back across the nest and immediately began to pluck the wing-feathers, the wings now pinned by both talons. The helpless bird continued to look up, a deliberate pause between each wrench, and was shortly without voice, but still alive, while next, the throat-feathers were plucked. It died when the hawk now pulled the tailfeathers. The young, practically fledged, were then fed before the parent flew to his burnt stance.

Unlike any Hen Harrier young I have known, when 2½ weeks old, one of the offspring lay on its back as do some young Merlins *Falco columbarius* and similarly, with talons drawn-in and ready to strike-out, at the intruders close approach. It did so again on the 28th, when 29 days old, and the eldest, a female, after flying some 36 m (120 ft) and then 30 m (100 ft) on its 34th day, employed the same tactics in the heather; ready to flail-out with needle-sharp claws. In the later feathering stage, it was more usual for them to adopt a similar attitude of defiance to that exhibited by young Hen Harriers — rising up and arching the wings, and likewise, silent.

As with young Hen Harriers, there was a strong attachment to the nest — for fully 4½ weeks in the case of both young in 1953. The nest is solidly trampled and odourous latterly, but never fouled with food-remains, while white excreta clings to the heather fringe, and particles of white down. While the adult male preferred to rest during heavy rain, the young (in the nest) were made most uncomfortable if not miserably soaked, flattening themselves as it pounded heavier and heavier on the 16th, while a shower was enough to send the eldest young, at 4½ weeks old, scampering under the heather fringe, just as the cock had started feeding



it! The same fully-feathered young, during the mid-day heat a few hours earlier, sunned herself, flattened, with wing spread full-out across the nest, and again two days later (30th July) in the brief spell of hot sun - the nest and surrounds now covered with down. When 2½ weeks old the young will pull at prey on the nest or held in the foot of the parent, but are incapable of tearing skin or flesh, their voice having within a fortnight, changed to a "whee" audible at a distance and used when hungry. At 3 weeks, they gaze up on the passing of any sizeable bird such as a gull, shuffle around at times, frequently stretch a wing and lie in various positions. The young were never known to feed themselves or seen to tear at a carcass until the 28th, when the young male, aged exactly 4 weeks and a day, tore up and ate in 5 minutes a Pipit, immediately after the cock had deposited it and flown off. Evidently, although the parent was in the habit of feeding the young, they were for perhaps a week, capable of rending prey. On the latter date, while the young male seldom flapped his wings bouncing as he did so, his sister, now 31 days old, frequently exercised hers, could fly-hop and thus, perch on top of the heather fringing the nest. And, at this stage, both pulled out their remaining down, swallowing some of it; the youngest even pulling the others down.

Until obliged to on the 31st July by the author, the juvenile female was content to fly several metres and even less on that date. Replaced in the nest, two days later they were together among the ling beside the nest — female and male aged respectively 36 and 34 days, i.e. 5 weeks. On being approached, both flew well, the eldest afar and the other, a good distance.

In the late evening of the 10th August, the eldest (now 44 days old) rose from the nest, where a fresh, part-eaten Pipit lay and when later disturbed it twice used a weaker version of the adult chatter. This latter day frequenting of the nest, the more interesting as the well fledged bird, now strong on the wing, had been able to fly increasingly far over the past ten days. Since the 2nd August or thereabouts, the two juveniles had lived apart, although both in the vicinity of the nest. The eldest (female) was in the habit of resting on the burnt slope from early to late August, where formerly the adult male had habitually rested, while the juvenile male preferred the cover of long heather some 90 m (100 yds) from the nest, roosting on a 1951 cock Hen Harriers nest 67 m (75 yds) from the same, as also among rank ling — this rudimentary structure, covered with its white excreta. The male continued to provide for the juveniles up until at least the 30th August - a Pipit, the last prey item

seen delivered, when the eldest retrieved it from the ground. On the 6th September, there were no harriers on this stretch of moor.

On the 22nd August the young male harrier having first made passes at a Buzzard *Buteo buteo* on the ground, narrowly missed it several times in aerial chase and later that day, saw a Kestrel *Falco tinnunculus* off the moor, and after the small falcon had settled on a pine top, made some low passes at it before perching alongside, each one appearing to ignore the other. The harrier perched on several more conifers while a Jay *Garullus glandarius* scolded harshly, the young Montagu's Harrier on the pine canopy above it! The attitude of the old male towards a large falcon was quite different from his heedless regard for a Kestrel resting on his burnt stance, as witnessed on the 25th July. Just after sundown on the 15th August, he came on a young male Peregrine Falcon *F. peregrinus* in the heather by the solitary larch, some 200 metres from and overlooking the nest-site of the harrier. Having risen up, he stooped on the falcon and "on its tail" pursued it low to ground, circling the tree. The Peregrine then perched on the limb of an adjacent small larch, while for a considerable time, the harrier continued to circle round, repeatedly diving close on this recent arrival, chattering continuously and louder than had it been a human. The call, "kik-kik-kik-kik", was kept up after the harrier had given up feigning and the cloudy sunset had turned to gathering gloom during this protracted incident. The cock Montagu's Harrier eventually settled in the near vicinity of the nest, sometime after the falcon had flown far enough away.

#### UNMATED MALE - 1954

The weather pattern for the spring-summer (early April to late July) of 1954, was as unsettled as it had been the previous year, with cold and wet spells alternating with warmer conditions, the third week of June being notably rainy in central Scotland. There was no male Montagu's Harrier on Braco moor on the 9th May (as in 1953), but my next visit found him back on the 13th (first seen on 17th May, 1953) of the month, when, 1 km S.S.W. of his former nests, he was seen hunting low over Feddal Hill at 8.00 a.m.

On the next day, he was to be found occupying the territory held for 3 consecutive years by a male Hen Harrier who had remained unmated throughout this long period. This was on Cromlix moor, 4½ km (barely 3 miles) S.W. of the Montagu's previous territory. Still in dispute, the males of both species of harrier, laid claim to the same territory - a flat expanse of ling, several hectares in extent, quite closely flanking the

High Wood (an old stand of pines that enclose a shepherd's house). A strip of 60cm (2 ft.) long ling, held 5 Hen Harrier cock-nests spaced 6 m (7 yds) to 18 m (20 yds) apart. Three of these were substantial, and dated from 1952-53-54, while two small structures were built in 1954 and an attempt of the previous years, was 55 m (60 yds) removed.

The late afternoon of the 14th saw the male Montagu's Harrier pitch twice on burnt ground within this territory, and above it, he once performed his advertisement-display. No sooner had he gone off hunting, than the male Hen Harrier was circling above me, in the disputed territory, chattering in his state of agitation. Suddenly his attention was switched to the male Montagu's as the latter appeared above me. The Hen Harrier swooped on him and proceeded to rout the new claimant. Pursuing the much darker grey, more slender harrier to the far corner of the wood, the Hen Harrier repeatedly swooped on the other, only chattering to begin with, but calling out, when once the Montagu's Harrier retaliated. It was a dogged chase, with both harriers turning over on their sides on closing-in, once, almost brushing each other with extended talons. Just beyond the limit of the territory, they went off in opposite directions.

In spite of the incident on the previous day, the 15th May saw the male Montagu's Harrier well established in the Hen Harriers territory of yesterday and former years. He always rested in one small area of the heather, and upon returning from hunting, he had no sooner pitched than he gave chase to the male Hen Harrier, now dispossessed and keeping to the outer fringe of the territory. It was 4.00 p.m., and swooping on the other harrier, pursued it a good distance before returning to pitch in the same spot. Dispossessed, nevertheless, the male Hen Harrier couldn't resist returning at 8.00 a.m. the next morning on seeing me in the territory during the Montagu's absence. Circling round me, chattering loudly and coming close, and shortly afterwards repeating the same, he then rested on a molinia tussock for 20 minutes, gaping at intervals, before finally taking leave. It was on the 23rd May that I discovered the male Hen Harrier had established a new territory c. 1.6 km (1 ml) N.E., on Cambushinnie Hill.

For the next month, the cock Montagu's remained in complete possession of the territory, the only other encounter with the Hen Harrier that I observed, was on the night of the 25th May, when at 10.10 p.m., upon his return, the new owner circled low a patch of rank ling that concealed the other male within the territory. Then one stoop, and the

Hen Harrier straightway departed, leaving the Montagu's circling.

From the 14th May - 11th June, the Montagu's Harrier announced his presence with daily regularity. This took the form of an advertisement-display of varying degrees of intensity, but never as vigorous as that of the male Hen Harrier. On 10 out of 11 day-visits throughout this period and between 7.15 a.m. — 9.30 p.m., this displaying was witnessed at altitudes from fairly low — c.600 m (2,000 ft) above the territory, occasionally adjacent moorland — the latter height twice on the 16th May, when barely visible to the naked eye. The display, accompanied by a call resembling that of disturbance or aggression, but with a very distinct pause between each utterance "kik — kik — kik — kik", repeated after a much longer interval. At its mildest, the display would comprise a number of shallow dives and ascents, with wings curved back and flapped. The same more often, incorporated a side-to-side swerving and canting; once tilting side-to-side in quick succession, in level flight. While on six occasions, displaying took place at a fairly low height, more often it was in conjunction with high soaring — on 17 occasions, this was the case. In June, these displays were as described — shallow "switchbacks" with swerving and canting — and confined to high-up, interspersed with spells of gliding and afterwards, continuing to glide on high. The 2nd June was an exception, when returning at 9.30 p.m. with a kill grasped in his talons, after a brief display, he descended to pitch in the territory. From the 16th — 30th May, the advertisement-displays involving soaring, were on six out of nine occasions, of a more spectacular kind, i.e. commencing at a great height and finishing low to ground. The following description, whilst conforming to the others of the 6, in descent and finish, represents the advertisement-display at its most exaggerated. On a day of heat and stillness (16th May) at 11.15 a.m., the male spirals upward on a thermal, and is soon c.600 m (2,000 ft) overhead. Levelling out at this altitude with a few "switchbacks" performed, he begins a rapid descent whilst swerving, canting, rolling and side-slipping. Meanwhile, direction is sharply changed from time to time, wings flapped throughout and the call, reiterated at intervals, far carrying. Finally, he almost brushes the heather in a side-slipping swerve, shooting-up and repeating the same several times alternatively to left and right, before flattening out to alight among the ling in the middle of his territory. From leaving the territory until his return, the time taken was 12 minutes and after 20 minutes rest, he repeated the very same performance, in the same time.

Hunting was very largely done over heather-moor, as in other years; occasionally over hill-pasture and, lower still, ploughed field. Roosting was within the territory as witnessed at dusk, and at 5.30 a.m. on the 30th May when he rose from the ling as the sun came through the mist and dew lay heavy on the ground. One of the cock nests built by the Hen Harrier, had several of his white splashes (excreta) and a recently killed Pipit on the 29th May.

Territorial adult Red Grouse (well outside the prey-range of the species) were little perturbed by him, and if they rose at all, would fly but a short distance. Twice within half an hour, he made for the distant stance of a certain cock Red Grouse, each time coming down on it with extended talons, the grouse only rising in the last instant on the first occasion, and narrowly missed, flew a brief circuit to return to almost the same spot; its reaction the second time, much as before. A dog Fox *Vulpes vulpes* making its appearance within the harrier's territory, he completely ignored, having once flown low over it. More surprising, a pair of Short-eared Owls *Asio flammeus* nesting in the centre of the harriers territory, were quite accepted. Only once was the harrier seen to stoop at the sitting owl, i.e. several times in succession, on the 31st May, when the 3 owl chicks had newly emerged. Last seen on the 11th June, the male Montagu's Harrier had deserted the area by the 15th of the month, with rainy weather having set in over the past few days.

#### NESTING - 1955

An exceptional summer was that of 1955, notable for its prolonged drought, lasting several months in England, while Scotland fared little different in respect of warmth, drought and high sunshine totals. Late March ushered in an early spring, in central Scotland, however a very cold N.W. wind persisted from 10th - 22nd May, with air and ground frosts on some nights, and snow-covered high peaks, such as Stobinian-Ben More. There followed the first spell of drought, lasting a month, from the 23rd May - 22nd June in south Perthshire, with a persistent E. wind and combination of sun, retarding growth and drying the ground, throughout the first fortnight of June. After 11 days of changeable weather, with some rain and showers, this region was subjected to further drought, with very warm, sunny weather lasting 5 weeks, i.e. 4th July - 8th August. The next three weeks of August and into September, were very variable, mainly mild and warm, with some rain and showers, while the temperature soared to 86°F on

25th August - as recorded in nearby Crieff. From the time of arrival of the first Montagu's Harrier until the departure of the last of them on Cromlix moor, rain had fallen on only 16 days (including at least 7 days with one or more showers) - a ratio of 14 : 1 in favour of dry days, with no measurable rainfall. The total precipitation was small, with June, July and August each having only one wet day.

On the 15th May, the male was back, and occupying the same triangle of heather-moor, the centre of his new territory, 500 m (550 yds) from that of 1954. It was the middle of the very cold period of N.W. airstream, when the bird was first heard, as he displayed at a great height. That was mid-morning, and on my return three hours later, he was rising with slack wing-beats until a good height reached, the advertisement-display was repeated. Finishing low to ground, 15 minutes after take-off, the display pattern agreed with that of the previous year. Following a brief rest after each performance he would then hunt.

The effectiveness of such displays was evident when my next visit, on the 21st May, 6 days later, found that a new female Montagu's Harrier had not only recently arrived, but accepted the male's territory, and was mated to him, whilst it still continued a cold N.W. wind, with occasional heavy showers. This chance encounter, the more astonishing when one considers that males and females migrate separately, and here, the Montagu's Harrier is on the very periphery of its breeding range. In Hungary, males precede the females by 4-5 days on return migration in spring (Laszlo, 1941); the males are soon followed by the females on arrival in Jutland — Denmark (Weis, 1923), and locally in Cornwall, the males, arriving on the 27th — 28th April, were a week to a fortnight in advance of the females (Robinson, 1950).

Within, at the most, several days of her arrival, the female was already depending on the male for food, receiving prey at 11.15 a.m., 4.00 p.m. and 7.30 p.m. by both aerial and ground-pass on the 21st May, and spending rest periods within the territory, and adjacently (if disturbed), whilst roosting in the strip of ling in which she eventually nested. Her attachment was such, that she would utter the drawn-out chatter upon human invasion of the territory — reiterated a number of times, as she circled upwards, on seeing me for the first time (21st May). The male's presence would at times cause her to solicitate him, with the "whistle" that serves this purpose, used in the air and on the ground. Twice that day, the repeated whistling from molinia tussocks, resulting in mating — once

successful, and once frustrated when a cock Red Grouse rose from closeby, and launched itself straight at them with a whirl of wings, narrowly missing the male harrier and causing him to rise at that instant.

Although now mated, on the 21st May, the male was twice seen to display in the typical manner, on high, both times. The female responded by sailing around low over the territory on the first occasion and uttering the solicitating "whee", the male coming down, swerving, to meet her. That was late-morning. At 5.15 p.m., while high overhead, the male's voice exclaiming, she soared just beneath him, venting an occasional "whistle" while the display ended as before, with the hen-bird following him down in a long glide, talons lowered and finally swooping at the grounded cock, causing him to take wing. On the 22nd May, the display was seen for the last time. After 45 minutes distant flight together, far out over Cambushinnie-Feddal Hill, with the male at regular intervals swooping down on his spouse at the outset, on their return, the male displayed at a great height, while she flew fairly low. Unlike the 1952-53 female, the exuberant "switchback" of the 4 years unmated Cromlix male Hen Harrier, did not elicit any response from the new Montagu's female.

Coition was seen on 5 occasions, between the 21st - 30th May, by which latter date, the fourth egg had been laid. Of brief duration (4 — 5 seconds), this was usually in response to the reiterated "whistling" of the hen (up to several minutes on end), and took place independently of food offering, or more often, following exchange of prey, i.e. several minutes afterwards and prior to or after consumption of the food.

During the nuptial-laying period, of 11 kills delivered to the female, six exchanges took place on the ground; five in the air. Of the aerial passes, at least two were foot to foot, i.e. not dropped. And, at rest, at least two were transferred from talon to talon, with the female more often (five out of six times) pitching close alongside her mate, he, usually rising in that instant — once briefly hesitating. Prior to nesting, on at least some occasions, the male brought food to a molinia tussock 8 m (10 yds) from where the nest eventually was -on the 21st May, here were the fragments of a Lapwing's *Vanellus vanellus* egg, as well as remains of a Pipit brought in that day. Feathered or furred prey is carried in the talon, tucked up under the tail-coverts, but the male arrived with a Lizard *Lacerta vivipara* held in the bill, on the 22nd May (similarly, the female in 1953, carried a Lizard caught by herself).

The Montagu's Harrier, like the hen Harrier, is given to soaring not infrequently when circumstances allow, and both sexes will attain a great height. Apart from soaring incorporated with displaying, in 1955 the adult birds were seen to soar on forty-five occasions at various times during the period of their stay on Cromlix. On eight occasions, male and female together; the male alone on twenty-one occasions, and the female fourteen times solitary, while, with the juveniles, male and female were associated in high wheeling on one occasion each.

Coinciding with the date of the first egg laid in 1953, the 24th May saw the first laid of a clutch of five eggs by the new female. Disturbed in the early dusk (10.20 p.m.), the hen rose from the 'nest', silent and at several metres (thus agreeing with the findings for older females in the similar latitude of Jutland (Weis, 1923)). The single egg, white with a rusty-yellow streak, had (as suspected with the 1952-53 bird) almost certainly been laid on the moss carpet underlying the heather, as only one or two beakfuls of bleached molinia, i.e. mere wisps of grass, underlay the egg, while by the following evening (25th) a thin wad of molinia 22cm (9 ins.) in diameter, covered the moss. The laying of the first egg in each case, had seemingly initiated the addition of the first lining material. In the centre of a strip of rank ling 50cm (20 ins.) tall, the nest was closely fringed by the same — enough space to accommodate the sitting bird - and on slightly sloping ground, was only some 200 metres from the edge of the moor (fringed by grass pasture). Gradual addition to the lining was made throughout the laying-incubation period, until by hatching time, there was a molinia pad, 25 cm diameter/25mm depth (10 x 1 inch), circularly arranged, with few short pieces of ling (stick and with leaf) decorating the periphery of the nest. As late as the 9th July (a week after the last hatching), there were some fresh stems of rush *Juncus effusus* added to the lining.

Laid at two day intervals, the clutch of five was complete on the 1st June, each egg was indelibly marked in order of laying by the author. The fourth proved addled, while the remaining four hatched on the 24th 26th, 27th and 30th June, giving an incubation period of 29 - 31 days, i.e. 31 days the first two; 30 days the third and 29 days the fifth. Typical of the ground-nesting harriers, the eggs were white, each having one to several, small pigment smears.

While the male had proved the exception to the rule in 1953 in adopting the role of the female and rearing the young single-handed, now it was the turn of the second adult female to demonstrate



behaviour which, again, has apparently created a precedent. Exceptional among birds of prey, Hen Harriers frequently are audacious in their attacks upon human intruders at the nest. Montagu's Harriers are retiring by nature in the same circumstances, but here was the bird with a difference, although by comparison with the other species, her passes and strikes were timid. On the occasion of the first egg laid, in the twilight, the hen in slow flight, hung overhead some 15 m (50 ft) up, calling several times. Four subsequent daylight visits to the nest during the laying period, met with a similar reaction - remaining above although gaining more height (to 30 m) and continuously chattering, whilst once, slowly circling upwards in still air, and at other times, moving slowly into the *breeze*, shifting from side to side. Three days after the clutch was complete, the first feints were made — frequently well above me, but five times to within a metre of my head, with two such, on successive approaches. As on future occasions, these were shallow swoops with little impetus behind them, and always into wind. The sustained chatter with brief intervals on this occasion, gave way to more sporadic calling after an initial outburst, when the eggs were on the point of hatching, and afterwards. It was not until the second chick was due to hatch, that the talons were even part-lowered, when as usual, several low feints were made. On the 9th July, with the eldest young now 15 days old, the female struck me for the first time — four times on the bare head with her talons, whilst many swoops included some that just missed. A week later, she made the last feints — low and with talons slightly lowered. It had also been her custom to shadow me silently, when away from the nest, and would do so to the not distant edge of the moor.

When the offspring were scattered, and the youngest, 24 days old, the female's response to my presence in their vicinity, had waned markedly. No longer did she, if necessary, beat her wings strongly to maintain position overhead, but would soar on high and seldom call, eventually disappearing, and in another week (31st July), kept afar off, and called twice at long intervals, before perching out of sight. The male's reaction to my nest-visits was in extreme contrast to that of the opposite sex — he kept far away, or would continue soaring higher even to a great height, and drift across the sky in a wide arc, never chattering more than a few times on any occasion, not even when the young were newly hatched.

The third chick succumbed in the day of rain that followed its hatching. For the remaining three, the male, as prior to and during 'ncubation, continued to provide all sustenance until an advanced

stage of feathering, as well as supplying at least part of the female's needs, when the last of the three had recently fledged, i.e. until the 2nd August. In 14½ weeks (21.5 - 29.8), 60 of the large number of prey items procured by the male, were witnessed brought in - 28 delivered to the female (until the youngest was fledged) and a like number to the young; 4 were carried off, due to human presence. Transference of food, male to female, with young to feed, was now by drop-catch. This was enacted both at height and fairly low to ground, with the female rolling over on her side to grasp the falling prey in an outstretched foot, after either up to several metres free-fall, or in near contact. When the young were 15, 13 and 9 days old, and the food-call of the eldest, carried 400 metres, the cock arrived with 5 kills during a 9% hour watch; an average interval of 1 hour 42 minutes between departure and return. A week later, when the eldest of the three (two males/one female), a male was fully 2 metres (7 ft) from the nest and regularly wing exercising, the male's day was largely spent hunting. Now, the food supply stepped up, 9.55 a.m. -- 5.25 p.m. inclusive, saw 10 prey items brought in, with an average interval of 50 minutes, and 44 minutes departure-arrival. Of the 10 kills, 4 were taken direct to the nest, 3 of them consecutively, when the male spent up to 30 seconds on the nest, or left unhesitating. No sooner had he gone in each case, than the female left her rest-place to apportion the food to the young, leaving the nest a few minutes later. Even during the heat of midday, when the temperatures soared into the eighties, the male would keep bringing in prey. After the food-pass, while the hen briefly rested at a distance, it was his habit to circle low the nest, or its vicinity. On the 26th July, with the young 26 - 32 days old and scattered 7-20 odd metres from the nest, 10.50 a.m. — 2.15 p.m. inclusive, saw 5 kills arrive, with an average interval of 51 minutes, while daily it continued hot.

The strong sun necessitated that the female brooded the two youngest until they were at least 9 and 13 days old. Other than this, her time was mostly spent resting on a grassy rise, some 90 metres from the nest, facing the direction the male most often appeared from. She remained restricted to the territory while the young were flightless, with rare exception latterly. Prior to the fledging of the young, the female was only seen to hunt four times — up to only several minutes duration on the first three occasions, and in the vicinity of the nest, without capture. When the third egg was laid, she disturbed a full-grown Mountain Hare from its form, near to the nest, alighting briefly on its back. Again, late in the day, several days after completion of the clutch, when a Snipe was flushed and during a 10-hour watch, when the eldest

young were 3 weeks old and she hunted but once. On the fourth occasion, when the young were near Hedged, she also returned prey less.

At 31 days, the youngest (a male), on the 13th July, was capable of short, circuitous flights in the company of the other two juveniles, all three indulging in such activity at intervals during the latter cooler hours, having shared a rushy-hollow some distance from the nest most of the day. The male appeared to be instructing or encouraging the juveniles to hunt, when at 4.55 p.m., 5.45 p.m., 6.45 p.m. and 8.10 p.m. on that same day, he worked the vicinity of their concealment, once systematically quartering a strip of ling in which the young were present. Indeed, soon after the third apparent demonstration, one of the eldest juveniles (35/37 days) made its own kill — an animal the size of a small vole or shrew. That evening, the male, was particularly active, when between 7.45 p.m. — 9.08 p.m. he delivered 5 kills, with an average interval of only 21 minutes — two of these were drop-passes (first and last), caught and ate by the adult female; the others, taken to the juveniles.

The female, too, was hunting with some frequency, now that all three juveniles were fledged, and on the 31st July, she was seen to hunt briefly within range of the young or just out of sight of them — 6 times in all, between 11.00 a.m. and 8.00 p.m. Her prey items included 2 Pipits, both unplucked (in contrast to that of the male) on the 11th August. While the male continued to be the main provider, she met the needs of the equivalent of one fledged youngster, foraging to at least 2% km (1% mis) beyond the territory, over heather and rough-pasture. A week before the male and the last juvenile vacated the nesting-locality, the female deserted the area, i.e. by the 22nd August, having been last seen two days previously, when she dropped a kill for a juvenile to catch low down, and several metres below her, at 8.55 p.m. In Jutland, with a corresponding latitude, Weis (1923) did not see females much after mid-August.

During the post-fledging period of one month, the male was seen to bring in 25 kills for the juveniles, all of them delivered direct. Among his prey, were identified: 5 Pipits, 1 Skylark, 1 adult male Wheatear *Oenanthe oenanthe*, 1 Song Thrush *Turdus ericetorum* and 2 juvenile Snipe (as in 1953). While, as in previous years, he largely worked heather-moor, in the first fortnight of August, he devoted much time to hunting over pasture and occasionally fields. At first, the food was dropped lowdown for the juveniles, they, either on the ground or in pursuit of the male (as with the female). From mid-August, no longer entirely retrieving their meals, the

juveniles proved adept at catching falling prey — at first, released low, and latterly high-up as well, as for example when the male, turning over on his back, threw up the Pipit for the juvenile to catch in one foot as it fell. He continued to provide the requirements of the juveniles until the last day of their stay on Cromlix, when two kills were released on high, in the more usual upright manner.

Rarely, and then very briefly, did the juveniles ever attempt to forage in their first fortnight on the wing. During this period, they were given to playful flight, invariably, making shallow swoops at each other. On the 2nd August, already one of the eldest (37/39 days old and flying barely a week) was winging over the peripheral pasture, some 200 meters from the nest site. Two days later, they spent about half an hour flying in the late morning, and in the heat of the day, one ventured as far as the cultivated ground below the pasture. The 7th August saw all three soar, wheeling to a good height, and the following day, one of them having risen to a considerable height in this way, descended in a long glide, on the conifer stand that footed the pasture. For c.10 minutes the juvenile harrier weaved back and forth, from end to end of the wood, scattering all the tree-top inhabitants - Wood Pigeon, etc. This was to become a regular daily practice with the juveniles, the third having found its way to join the other two over the wood by the 10th August, and what with their carefree abandon above the plantation and their flying over the adjacent lower fields, the attention of estate workers was soon drawn to them. They now, and for several or more days past, used fence-stobs for perching.

The next day found 2 pole-traps set out for them, both of which I sprung, and ironically, one was shot on the 12th August ("the glorious twelfth"). However, the lives of the other two were spared, once I had words with the gamekeeper concerned. The remaining juveniles continued to soar for lengthy periods indulging in playful exchanges with each other, and making similar mock attacks on other birds of prey - Kestrel, Merlin, Peregrine and Buzzard, while the adult male joined both juveniles in a long session with a juvenile Hen Harrier, all four towering to a great height. Human invasion of their play-area could occasion a weak chatter, as on the 8th August. Between times soaring, the 23rd August, saw both juveniles perching on the uppermost, slender, dead branches of tall spruces (see also p.15), in the high stand that lay adjacent to their nest site. Sometimes they had difficulty in maintaining their balance, while later that day, one bird remained a quarter of an hour on the top-most branch of a lofty spruce, well within the wood. Weis (1923) found that unlike their parents, the juveniles shunned trees.

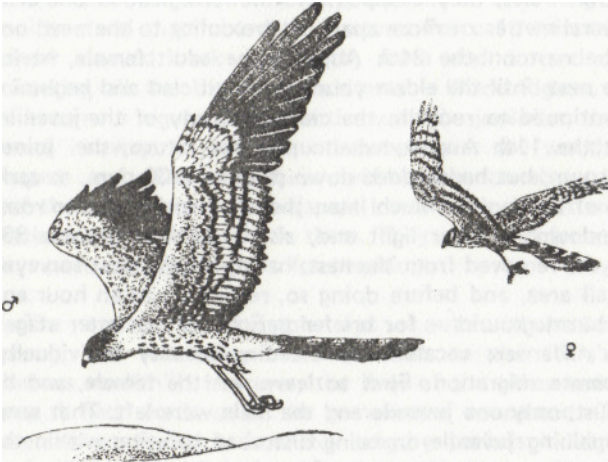
From mid-August, the juveniles increasingly turned to hunting, infrequent and for short periods to begin with; more frequently and up to quarter of an hour on end, by the beginning of their last week. On its final day on Cromlix, the remaining juvenile hunting at intervals, spent 1 hour 10 minutes, foraging out of 2 hours (8.55 a.m.-10.55 a.m.), and for up to 25 minutes in duration. It had acquired the technique of quartering certain areas on occasion, but all attempts at hunting witnessed, were futile, and as far as moorland habitat was concerned, it was dependent on the parent bird.

The juveniles were habitually early roosters, and regular in timing—in good light, between 9.00 p.m.—9.05 p.m., the last ringtail, had gone to roost on the several occasions witnessed between 8th - 16th August, and by 8.30 p.m. on the 24th August. After a few preliminary low circles, they dropped into the rank heather one after the other, several metres or more apart, in proximity to the nest, one roosting in the nest on the 24th August. The adult female, having roosted in the nest until the eldest young was well clad and beginning to feather, continued to roost in the close company of the juveniles until as least the 11th August, when upon her return, she joined them at 9.15 p.m., but had bedded down prior to 9.00 p.m., as early on as the 8th of the month. Much later, the adult male went to roost long after sundown, in poor light and, also in rank ling, some 500 metres (600 yds) removed from the nest, having always first surveyed the nest/ringtail area, and before doing so, resting up to an hour and more on old burnt ground — for briefer periods in the latter stages. The Montagu's Harriers vacated the breeding locality individually, indicating separate migration. First to leave was the female, and by the 29th August, only one juvenile and the male were left. That same night, the remaining juvenile on being disturbed roosting within the territory flew off west, and on the 31st August, the locality was deserted,

The only sighting in 1956, an unseasonable wet summer (June to August), if ever there was one, was of an adult male on the 6th May, at first hunting the heather above the pine wood on Braco moor, at 2.00 p.m., and then quartering the lower slopes of Cromlet Hill — this on a grey, overcast day of very strong S.W. wind and threatening rain.

## SUMMARY

The serious decline of the Montagu's Harrier in Britain is examined and reference made to an apparent reduction in numbers elsewhere. Events leading to the nesting of the species in Scotland are described, and there follows a detailed account of the breeding of the bird in each year - 1952-53 and 1955; also the activities of the non-breeding male in 1954. Unusual behaviour is dealt with, such as the unique rearing of the young by the male in 1953, when he adopted the role of the female in addition to his own, as provider. The female attacking a human and tree-perching by juveniles is also described. One way and another, a fascinating series of events unfolds and a remarkably successful breeding history is related. A section is devoted to features of the species, including a number of new observations resulting from the nesting of Montagu's Harrier in Scotland.



REFERENCES

- BANNERMAN, DA.. 1956. The Birds of the British Isles. Edinburgh.
- BAXTER, E.V., and RINTOUL, L.J., 1953. The Birds of Scotland, Edinburgh. BROWN, L., 1970. African Birds of Prey. London : Collins.
- ELGOOD, J. H., SHARLAND, R. E., and WARD, P. 1966. Palearctic migrants in Nigeria. *Ibis*, 108 : 84 - 116.
- LASZLO, S., 1941. The Habits and Plumages of Montagu's Harrier. *Aquila*, 46 - 51 : 247-268.
- MACKENZIE, J. M. D., 1951. *Scottish Naturalist*, 63 : 132.
- ROBERTS, A., McLACHLAN, G.R. and LIVERSIDGE, R., 1970. Birds of South Africa. Capetown.
- ROBINSON, W., 1950. Montagu's Harriers. *Bird Notes*, 24 : 3 : 103-114.
- SHARROCK, J. T. R., 1976. The Atlas of Breeding Birds in Britain and Ireland. Berkhamstead : Poyser.
- WATERSTON, G., 1937. *British Birds*, 38 : 250.
- WEIS, H., 1923. Life of the Harrier in Denmark. London : Wheldon & Wesley & Copenhagen : G.E.C.
- WITHERBY, H. F., JOURDAIN, F.C.R., TICCHURST, N.F. and TUCKER, B.W., 1952. The Handbook of British Birds (Vol. 3). London Witherby.

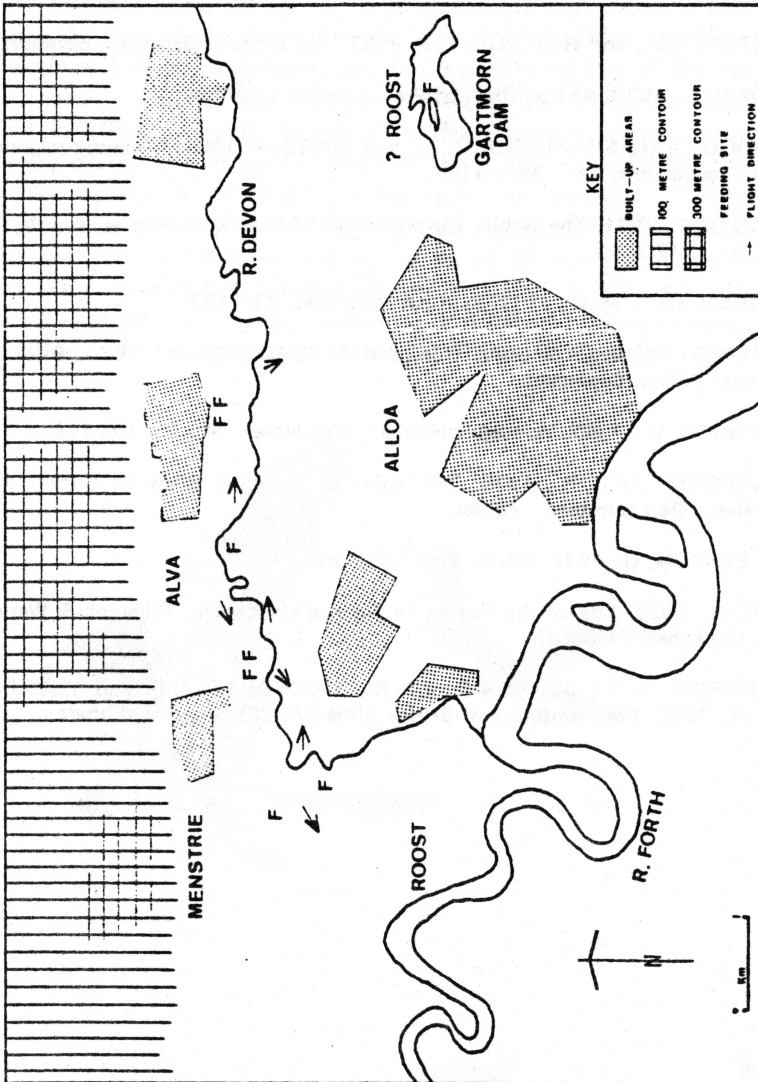


Fig. 1 The main feeding areas (F), roost sites and evening flight lines, the flight direction arrows are schematic, not exact compass bearings.



## THE ROOST-FLIGHTS OF WHOOPER SWANS IN THE DEVON VALLEY (CENTRAL SCOTLAND)

C. J. Henty

### INTRODUCTION

Whooper Swans (*Cygnus cygnus*) are traditionally associated with romantic landscapes. Thus Charles St. John (1878, Ch 24) graphically describes their life and death on the Moray Firth whilst several recent studies are based on herds that are semi-resident on lochs surrounded by mountains (Hewson 1964, Airey 1955). In contrast many of the Whooper Swans spending the winter in Central Scotland get their living from farmland, their priorities being with food rather than aesthetics. I know wild swans best in the carseland of the Devon-Forth Valley and from some viewpoints they feed and flight against a background of the Ochil scarp. However for most of the day they graze amongst sheep on pasture or stubble or grub for potato fragments on muddy fields which are set on the smoky outskirts of small towns and are traversed by lines of pylons and by roads whose traffic noise blurs out the swan's bugling. Even their evening roost flights finish on a town reservoir or on a tidal stretch of the Forth close by an abandoned coal tip.

Nevertheless, the artificial and unromantic situation in which these Whooper Swans operate does give a convenient opportunity for various types of detailed study and the aspect I chose was their behaviour immediately before and during their evening roost flight from a feeding area to a night-time roost, between 2 and 7 km away. The herds of swans were located during the day and the area visited about sunset since there is a good chance that the birds will still be in the same spot. Observations were almost invariably made from a car and in the cases analysed here there were no indications that the swans were at all affected by my presence.

As so often happens the study turned out to be a pale shadow of that originally planned since I had hoped to get detailed records of behaviour for up to half an hour before departure and see whether feeding, resting, grooming and social interactions altered in a regular manner before the roost flight. It rapidly became apparent that the swans usually left so long after sunset that poor visibility in the last twenty minutes meant that little could be recorded except the numbers that flew off and whether any birds remained on the ground. Hence systematic data

was reduced to the times at which birds left and whether different sub-groups vanished toward the same or different directions.

#### TIME OF DEPARTURE TO ROOST

On most evenings a herd of swans that are present at sunset do not all fly off to roost at the same time although the majority leave within about ten minutes of each other. The best measure of departure is to take the time by which 50% of the original herd has left since this can be found unambiguously by analysing the field notes and also corresponds well to the period when the departure rate is highest. I have 17 records of herds totalling between 11 and 111 (median 42) where all or most of the birds left and without any interference from disturbance. These records cover the dates 24 November 1974 to 12 January 1975 and 30 October 1976 to 29 December 1976. For unknown reasons there was no regular herd present in the autumn of 1975 and swans always become difficult to find in late winter when most are probably feeding to the west of Stirling.

The median departure time was 44 minutes after sunset, 2/3 of the evenings lying between 37 and 57 minutes and with extreme values of 24 and 69 minutes after sunset. I expected to find that the swans would leave earlier under poor light conditions but in fact there was a total overlap for the departure times under complete overcast and those when much of the sky was clear. There was also no noticeable effect of frost during the preceding 24 hours although continued hard weather disrupted the whole commuting system. The length of daylight available for feeding does seem to have a small effect on roost flights. For autumn, with day length greater than 7% hours, the median roost departure time was 39.5 minutes after sunset whereas in winter, when day length was less than 7% hours, many departures were later with a median of 50 minutes after sunset. This difference is almost statistically significant. (Spearman rank correlation - 0.35,  $p$  approx. 0.08.)

#### FLOCK INTEGRATION AND DESTINATION

Fig. 1 shows the main feeding sites, roosts and flight directions noted in this study. The largest group of swans that leaves at one time in a given direction comprises on average about 2/3 of the total herd and this proportion varies only slightly between large and small herds. There is considerable overall variability in the timing and direction of flight of subgroups from a given herd and even if birds take off at the same time it is quite likely that they will split with different parties vanishing in each of the two main directions. 75% of all birds leave toward a stretch of

the Forth which is tidal, relatively undisturbed and about 150 m wide. I have some direct observations of Whoopers arriving there at dusk or present after dark whilst many herds feed only 2 km distant and, given reasonable visibility, an observer at the departure point can see them fly toward and then lose height and vanish over this part of the river; occasionally small groups continue upriver toward Stirling. Departures toward this main site can be seen regularly from feeding areas about 5 km away. The destination of birds that leave in the second (easterly) direction is not proven but is almost certainly to be Gartmorn Darn which is between 4 to 7 km from the feeding fields and is a known day and night time haunt of Whooper Swans.

Occasionally small parties of Whoopers fly past a herd under observation. They move in the standard directions of roost flight and may land beside the birds on the ground.

#### GENERAL OBSERVATIONS

Reliable data on pre-flight behaviour are difficult to collect due to the varying distances and visibility conditions of different observations. Quite often a scattered feeding herd would close up in the quarter hour before departure whilst immediately before take-off some groups walked steadily away from the main herd. Feeding at times continued until it was too dark to be seen but many groups apparently stopped feeding sometime before departure. The swans were sometimes wary of passing sheep or Brown Hares (*Lepus capensis*) but I have never seen them fly in direct response to such disturbance.

Given an observation distance of less than 500 metres and the absence of traffic noise it is normal to hear trumpeting immediately before a group takes flight and the calling continues as long as the birds are in view. The swans fly fairly low, not more than 30 metres high, and are unlikely to be in the air for more than ten minutes even if they go to Gartmorn Dam.

During the continued hard spell of December 1976 and January 1977 it became apparent on some evenings that many and sometimes all of a herd would take a short flight or even walk from a field onto the narrow River Devon and stay there at least until well after normal roosting times. By mid January there were no herds on the usual fields but one chance observation suggested that some Whoopers were

spending much of the day out of sight on the Devon.

## DISCUSSION

The roost flights of these Whooper Swans take place in the half dark, at a time when most motorists put on headlights, and this raises two functional problems. First, the late departure from the fields would tend to make the birds vulnerable to ground predators such as Foxes (*Vulpes vulpes*). Secondly, the whole area is crossed by power lines at the swan's commuting height and dead birds can indeed be found under them. Why should swans delay departure and increase the risk of predation or accident? A potential benefit of late departure could be the extra time available for feeding, and although direct evidence for this is equivocal (e.g. there is no clear response to frost which would be expected to increase the need to feed) the relation of flight time to day length does support this hypothesis. Another possibility is that roost flights in the half dark are a protective tactic against aerial predators. Although eagles are a negligible risk to the Devon Valley swans at present this need not be the case either for the breeding grounds or for migration since in the Cairngorms some Golden Eagles (*Aquila chrysaetos*) pursue migrant geese (Nethersole-Thompson and Watson 1974). Information on the timing of migration flights through the Scottish Highlands could test this point since the eagle theory would predict that the swans tended to migrate after dusk.

The nature of these roost flights clearly implies that the composition of at least the larger herds of Whooper Swans is constantly changing. Boyd and Eltringham (1962) remark that the social structure of this species is much less stable than that of flocks of geese and I have noted with the Devon Valley Whooper Swans that a large herd may during the day break up into small groups or split into two subunits, one almost entirely composed of family parties and the other of adult plumaged birds. It is possible to invent ecological explanations for this flexible social structure, for the regular differences between behaviour in autumn and in late winter, and also for year to year differences but at the moment there is not enough evidence to test such extra speculation.

## SUMMARY

Whooper Swans in the Devon Valley commute between feeding areas and several night roosts. Although the majority of birds in a herd may

leave together at dusk and in the same direction, a substantial minority leave at other times and/or in other directions. The main departure times are well after sunset (median 44 minutes) when visibility is very poor and this does not vary with immediate cloud cover or frost conditions during the previous day. Departures more than 50 minutes after sunset only occur during the period of shortest day length. Other observations are unsystematic but suggest that feeding and flock dispersion change sometime before take-off and calling is noticeable immediately before and during flight. The costs and benefits of late roosting are discussed. In prolonged hard frost the whole feeding and flighting system can break down.

#### REFERENCES

- AIREY, A. F., 1955. Whooper Swans in southern Lakeland. *Bird Study* 2, 143-150.
- BOYD, H. and ELTRINGHAM, S. K., 1962. The Whooper Swan in Great Britain. *Bird Study* 9; 217-241.
- HEWSON, R., 1964. Herd composition and dispersion in the Whooper Swan. *British Birds* 57, 26-31.
- NETHERSOLE-THOMPSON, D. and WATSON, A., 1974. *The Cairngorms, their natural history and scenery*. London, Collins.
- ST. JOHN, C., 1878. *Sketches of wild sports and natural history of the Highlands*. London, Murray.

## STIRLING AND CLACKMANNAN BIRD REPORT (1976)

C. J. Henty

## INTRODUCTION

The effects of the great British drought of 1976 were not so noticeable in central Scotland since the winter and spring rainfall had been normal and the remarkable spell of dry and sunny weather did not start till the end of June. No reports have been received of changes in the habits or distribution of birds during the hot weather, a marked contrast to the situation in the Lepidoptera. For example, at the height of the dry spell in August I could find no evidence that in the Abbey Craig area the birds were making any special use of the small burn that formed the only surface water close at hand. Pied Flycatchers attempted to breed near Bridge of Allan but, as the additional notes show, they had also done so in 1975.

The autumn was wet and stormy and marked by a spectacular October influx of Redwings with associated Ring Ousels, Redwings and many other species could be seen flying steadily to the south and west, notably at Stronend near the west end of the Gargunnock scarp which seems to act as a leading line for visible migration during the day. Stronend also produced a large scale movement of Woodpigeons and is probably the best site in the Central Region for observing visible migration in autumn.

December was continuously very cold and snowy and diving duck were forced to leave lochs and reservoirs. There was however no evidence of unusual numbers of Tufted Duck appearing on the Forth at Kennetpans, the traditional hard weather refuge, although hundreds appeared on the freshwater stretch of the Forth above Stirling Bridge. In spite of the bitter weather and the attractions of suburban bird tables resident passerines stayed in deciduous woods in large numbers and were joined by Redwings. A most impressive sight occurred in December just outside of our area on the Carse of Lecropt where some 4000 finches, including Chaffinches, Greenfinches, Bramblings and Linnets, frequented a field of linseed and were continually put to flight by two Hen Harriers.

SYSTEMATIC LIST 1976

RED-THROATED DIVER	S/C Upper Forth (mainly Culross area) 2 on 15th February and 7th March, 1 on 19th and 21st December	(DMB)
LITTLE GREBE	S Saltwater records, 2 at Grangemouth Docks on 28th December (DMB). At Culross ash pans (W. Fife), 1 on 1st January and 3 on 27th January	(DMB)
GREAT CRESTED GREBE	S Kinneil, 125 in February, 123 on 26th August and 180 on 26th September	(DMB)
FULMAR	S 3 flying to E off Crombie Point on 22nd August, 1 at Kinneil on 26th August, 2 flying to E off Grangemouth on 28th August	(DMB)
	S On 15th August 1 flying to NW over Alloa, watched until out of sight inland	(DMB)
GANNET	S 3 at Bo'ness on 22nd August and 6 on 19th September, 1 injured imm. at Kinneil on 26th August	(DMB)
CORMORANT	S/C 127 on Upper Forth on 18th January	(DMB)
	2 on Airthrey Loch through autumn	(CJH)
SHAG	S 1 at Kinneil on 3rd October	(DMB)
	2 at Culross (W. Fife) on 9th October and 1 on 14th November	(DMB)
	C 1 at Alloa on 2nd October	(DMB)
HERON	C max. 12 at Black Devon mouth on 28th August (DMB), 1 on Glenwhinnel Burn at 470m (hard frost) on 27th December	(CJH)
MALLARD	S/C 1017 on Upper Forth on 15th February	(DMB).
	400 at Kennetpans on 15th January	(GSh)
	630 at Tullibody Inch on 3rd March	(GSh)
	585 at Skinflats on 12th December	(DMB)
TEAL	C 135 at Marchglen Pool on 11th January	(CJH)
	140 on 14th October	(DMB)
GADWALL	S 1 at Grangemouth on 15th February	(DT)
	1 at Skinflats on 28th August	(DMB)
WIGEON	S/C Upper Forth 238 on 18th January and 350 on 11th November	(DMB)
	max. above Kincardine Bridge and 60 at Kennetpans on 4th December	(CJH)

PINTAIL	S	150 at Skinflats on 13th January	(DMB)
	C	1 at Tullibody Inch on 15th August	(DMB)
SHOVELER	S	3 at Grangemouth on 8th August and 14 on 18th August	(DMB)
	C	1 at Tullibody Inch on 15th August	(DMB)
SCAUP	S	max. 16 at Grangemouth on 13th February and 11 at Kinneil on 6th March	(DMB)
TUFTED DUCK	S	4 pairs, 4 males and 1 female at Airthrey Loch on 24th June	(CJH)
		360 at Airthrey on 2nd February	(DMB)
		165 on Forth at Cornton on 8th December (start of hard weather)	(DMB)
GOLDENEYE	S	15 on Forth at Cornton on 8th December	(DMB)
	C	58 at Kennetpans on 13th January	(DMB)
RED BREASTED	S	60 at Grangemouth Docks 28th December	(DMB)
MERGANSE	S/C	550 on Upper Forth on 14th November	(DMB)
GOOSANDER	S	21 on Forth at Cambuskenneth on 23rd January	(GSh)
SHELDUCK	S/C	on Upper Forth, 1680 on 15th February and 1938 on 21 December	(DMB)
		123 at Tullibody Inch on 7th March	(GSh)
		30 at Kennetpans on 8th December	(CJH)
		Kinneil moult flock, 536 on 8th August and 400 on 13th August	(DMB)
GREYLAG GOOSE	C	1st of autumn heard at Muckhart on 28th September, flying towards Loch Leven	(DMB)
	S	90 flying to NW at Stirling on 4th May	(DT)
	C	rarely feed in Devon Valley, but 160 on grass near Dollar on 26th December	(CJH)
PINK FOOTED GOOSE	C	1st of autumn heard at Muckhart on 28th September	(DMB)
	S	29 at Skinflats on 18th September	(AMcl)
	C	Hillfoots, 8 flew to E on 29th September. Heard after dark flying to E on 29th September and 9th November.	
		120 to E on 8th October	(CJH)
		24 (+25 Anser sp.) to W on 2nd December (frost)	(CJH)



BARNACLE GOOSE	S	23 at Skinflats on 11th September 45 to S at Grangemouth on 26th September and 24 at Skinflats on 3rd October	(AMcl) (DMB) (DMB)
MUTE SWAN	S	15 at Cornton on 8th December	(DMB)
	C	25 at Cambus on 12th December	(DMB)
WHOPER SWAN	C	1st of autumn, 11 at Menstrie on 30th October max. 55 at Alva on 28th November During hard weather in late December flocks sometimes did not make the usual dusk departure but roosted on the feeding fields or walked down to the R. Devon	(CJH) (CJH)
BUZZARD	S	2 at Bridge of Allan/Sheriffmuir in March and May 1 at Stronend on 5th October 1 at Sheriffmuir on 7th, 13th and 21st October	(DMB) (CJH) (DMB, CJH)
	C	1 at Muckhart 4th July and 1 at Wood Hill on 30th October	(DMB) (CJH)
SPARROWHAWK	S/C	records mainly in autumn and winter.	
HEN HARRIER	S	1 at Kippenmuir on 20th March and 31st October 1 at Stronend on 25th October	(DT) (CJH)
PEREGRINE	S	1 at Airthrey on 11th February 2 territories in west of area	(DMB) (JM)
	C	no Hillfoots records	
MERLIN	S	1 overwinter at Skinflats/Grangemouth up to 14th March 2 at Fallin on 25th January and 1 at Gargunnock on 4th October	(GSh, DT, DMB) (DT) (CJH)
	C	1 near Alloa, 15th August, 27th and 28th December	(DMB, CJH, AMcl)
KESTREL	S/C	max. 4 over Dumyat on 31st August	(DMB)
RED GROUSE	S	numerous on Sheriffmuir in autumn few on high mosses in summer	(CJH) (CJH)
PARTRIDGE	C	31 at Alva (stubble) on 3rd October, 30 at Gogar (grass) on 30th October	(CJH)
CORNCRAKE	S	1 calling in young cereal at Airthrey on 21st May	(CJH)

COOT	S 40 stayed on Airthrey Loch during the December freeze, on small pools or grazing on grass (CJH)
OYSTERCATCHER	S/C Upper Forth, max. 1142 on 18th January (DMB) Heard at night from 16th February (CJH, GSh)
TURNSTONE	S/C 5 at Kinneil on 8th August (DMB)
LAPWING	S/C 1680 on Upper Forth on 23rd February (GSh)  S 205 flying to SW in 4 groups at Gargunnock on 3rd December, hard frost (CJH)  C 2200 at Tullibody Inch on 15th August (DMB)
RINGED PLOVER	S/C winter max. on Upper Forth 69 on 18th January (DMB)  S 130 at Skinflats on 31st May (DMB)
GREY PLOVER	S/C Upper Forth max. 500 in early October (DMB)  S Winter max. 14 at Skinflats on 13th January (GSh) 40 at Black Devon mouth on 2nd October (DMB)
GOLDEN PLOVER	S at Skinflats, 375 on 1st July (DT) and 1000 on 18th September (DMB)  C 365 at Gogar (ley grass, + Lapwing) on 3rd November (CJH)
SNIPE	S max. 25 at Skinflats on 10th October (DMB)  C up to 17 on a marshy spring at Alva During severe frost in December (CJH)
WOODCOCK	S 1st roding at Bridge of Allan on 15th March (GSh)
CURLEW	S/C abundant on Ochils in summer (CJH) 1590 on Upper Forth on 18th January (DMB) Numbers smaller above Kincardine Bridge 61 at Black Devon mouth on 12th January (GSh) and 70 at Kennetpans on 4th December (CJH)
WHIMBREL	S at Grangemouth, 2 on 10th July, 3 on 8th August and 22nd August (DMB).
BLACK-TAILED GODWIT	S Kinneil, 3 on 1st February and 3 on 26th September (DMB) Skinflats, 1 on 20th September (AGG)

BAR-TAILED GODWIT	S	231 at Kinneil on 1st February	(DMB)
	C	1 at Black Devon mouth on 2nd October As usual very scarce above Kincardine Bridge.	(DMB)
COMMON SNADPIPER	S	1st of summer, 1 at Bridge of Allan 19th April	(GSh)
		Grangemouth/Kinneil, 1st of autumn, 10th July, max. 4 on 8th August	(DMB)
		max. on Upper Forth 2300 on 15th February and 3100 on 3rd October	(DMB)
SPOTTED REDSHANK	S	1 at Grangemouth on 16th September and 24th October	(DMB)
		and 1 at Skinflats on 20th September	(AGG)
	C	1 at Black Devon mouth on 15th August and 29th August	(DMB)
GREENSHANK	S	10 at Skinflats on 28th August	(DMB)
	C	5 at Black Devon mouth on 15th August	(DMB)
KNOT	S/C	Upper Forth, 7531 on 15th February and 6020 on 19th December	(DMB)
	S	1st of autumn, 2 at Kinneil on 8th August	(DMB)
	C	1 at Black Devon mouth on 2nd October as usual very scarce above Kincardine Bridge.	(DMB)
LITTLE STINT	S	Grangemouth/Kinneil, 1st 4 on 18th September, max. 21 on 3rd October, last 1 on 24th October	(DMB)
	C	18 at Black Devon mouth on 2nd October	(DMB)
DUNLIN	S/C	Upper Forth, 8245 on 18th January and 8520 on 21st December	(DMB)
CURLEW SANDPIPER	S	2 at Skinflats on 20th September	(AGG)
		11 at Kinneil on 3rd October and 4 on 10th October	(DMB)
SANDERLING	S	3 at Skinflats on 22nd August, 8 on 28th August at Grangemouth	(DMB)
RUFF	S	Skinflats/Kinneil, 9 between 8th August and 26th September, max. 4 on 20th September	(DMB, AGG)
	C	Black Devon mouth, 12 between 15th August and 2nd October, max. 5 on 15th August	(DMB)

GREAT SKUA	S	Skinflats/Kinneil, 1 on 18th August, 22nd August, 26th September, 3rd October (DMB)	
POMARINE SKUA	S	2 at Kinneil on 26th September and 3 on 9th October (DMB)	
ARTIC SKUA	S	Skinflats/Kinneil, 30 between 18th August and 24th October, max. 6 on 18th August and 9th October (DMB, AMcl). 2 at Skinflats on 18th September flew to W out of sight possibly left inland (DMB)	
LESSER BLACK-BACKED GULL		1 at Stirling in Jan/Feb (GSh, CJH)	
COMMON GULL	C	30 at Upper Glendevon Reservoir on 5th June (DMB)	
KITTIWAKE	S	40 flying to W at Grangemouth on 9th May (DMB) and 3 flying to E at Skinflats on 28th August (DMB)	
BLACK TERN	S	1 at Kinneil on 13th August and at Grangemouth on 22nd August (DMB)	
COMMON TERN	S	50 at Grangemouth on 9th May (DMB)	
	C	2 at Upper Glendevon Reservoir on 5th June (OMB)	
ARCTIC TERN	S	2 at Kinneil 13th August, 5 at Skinflats on 28th August (DMB)	
COMMON/ARCTIC TERN	S/C	Upper Forth, 1120 on 18th August (DMB)	
ROSEATE TERN	S	5 Kinneil on 13th August (DMB)	
SANDWICH TERN	S/C	Upper Forth, 1590 on 18th August (DMB)	
STOCK DOVE	S	7 flying to W at Stronend on 25th October during large movement of Woodpigeons (CJH)	
WOODPIGEON	S	1080 flying to W in 2 hours at Stronend on 25th October, most parties very high (nb. not a roost movement since none seen on 4th, 5th, or 24th October). (CJH)	
COLLARED DOVE	C	colonised Alva, 2 seen in E end on 21st June and 7th September (CJH) Build up in Tillicoultry, 10 on 26th December (CJH)	
SHORT-EARED OWL	S	very few records, 1 at Stronend on 4th October (CJH)	

BARN OWL	S	1 on 20th January at Blairlogie	(DMB)
SWIFT	S	1st of summer at Bridge of Allan on 6th May	(GSh)
KINGFISHER	S	1 at Bridge of Allan in early May and 18th November	(RN Campbell) (S. Proctor)
	C	1 on Black Devon at Lynn Mill in July and 11th August	(A. Chamove)
GREEN WOODPECKER	C	1 at Vicars Bridge on 3rd October	(DMB)
SKYLARK	S	Sheriffmuir, singing on 24th February party of 75 on 14th March 50 at Kinneil on 1st February	(GSh) (CJH) (DMB)
SWALLOW	S	5 at Airthrey on 22nd April	(DMB)
HOUSE MARTIN	S	1st of summer at Bridge of Allan on 6th May	GSh)
SAND MARTIN	S	1st of summer at Airthrey on 31st March	(DMB)
RAVEN	C	2 at large nest, Craig Leith in March and April	(CJH)
CARRION CROW	C	100 by R. Devon at Dollar on 11th January	(CJH)
ROOK	S	500 at 400m on rough grass at Sheriffmuir on 24th June Flocks taking acorns at Airthrey on 1st-17th October	(CJH) (DMB)
	C	new rookery, 4 nests in park at Alva	(CJH)
JAY	C	scarce, 1 at Sheardale 26th December 1 at Forestmill 24th October	(CJH) (DMB)
GREAT TIT	C	frequent in Red Carr Wood on 25th December in spite of hard weather	(CJH)
BLUE TIT	C	frequent in Red Carr Wood on 25th December in spite of hard weather	(CJH)
LONG-TAILED TIT	S	8 at Airthrey on 24 December.	
	C	parties: 12 at 200m on Wood Hill on 25th January (hard weather) 15 on Wood Hill on 30 October, 11 at Alva 27 December.	

WREN	C	abundant in Red Carr Wood on 25th December during hard weather 2 at 350m in thick snow in Balquharn Glen on 19th December	(CJH) (CJH)
DIPPER	S	at Bridge of Allan, early building on 1st February but 1st eggs at usual dates, no 2nd broods	(GSh)
MISTLE THRUSH	S	song at Bridge of Allan from 13th January	(GSh)
FIELD FARE	S	5 singles at Stronend on 25th October 700 on 7th November	(CJH) (CJH)
	C	250 at Kincardine on 15th January, last big number 400 at Silver Glen (Alva) on 30th October	(GSh) (CJH)
SONG THRUSH	S	1st song of spring at Bridge of Allan on 21st February, influx in mid-February 5 together at Stronend on 4th October	(GSh) (CJH)
	C	4 together in open field at Brucefield on 7 March	(CJH)
REDWING	S	60 at Airthrey on 13th March; last spring flock 657 flying to W and 54 flying to E at Stronend on 25th October 700 at Cambusbarron on 24th October	(CJH) (CJH) (CJH)
	C	500 at Silver Glen (Alva) on 30th October During hard weather in December one in garden at Alva, 1st for 7 years also during this period, very numerous in Hillfoots valley and on slopes which cleared of snow and frost very quickly. Also unusually numerous within deciduous woods.	(CJH) (CJH)
RING OUZEL	C	5 in Silver Glen (Alva) with Fieldfares on 30th October	(CJH)
BLACKBIRD	S	34 in pasture at Bridge of Allan on 21st February	(GSh)
	C	numerous in woods during December hard weather, turning the leaf litter	(CJH)
WHEATEAR	S	pair at North Third Reservoir on 9th April	(AM)

STONECHAT	S/C 5 pairs on Sheriffmuir, 3 returned by 24th February (GSh) 2 pairs in gorse above Alva, several there in February and early March and 1 on 21st November but none in December (CJH)  3 more pairs in west Ochils; 2 at Glensherup 13th November (CJH) 1 at Kinneil 18th September (DMB) but no other reports from east or south-central Stirling.
WHINCHAT	S 1 at North Third Reservoir on 7th May (GSh) In W Ochils numerous in bracken or rushes 155-330m (CJH)
REDSTART	S/C only 1 record in Hillfoots, singing on Wood Hill at 300m on 5th June (CJH)
ROBIN	C at Alva, the habit of hovering under a suspended container and pecking up at fat was noted only during hard weather in December (CJH)
WHITETHROAT	S at Grangemouth on 9th May (DMB) Bred at Airthrey but still decidedly scarce.
CHIFFCHAFF	S 1 at Bridge of Allan on 5th February (GSh)
WOOD WARBLER	S 1 at Bridge of Allan 21st April (GSh)  C 2 on Wood Hill at 200m in early summer (CJH)
SPOTTED FLYCATCHER	S 1 at Bridge of Allan on 21st April (GSh)
PIED FLYCATCHER	S Pair building at Bridge of Allan on 27th May (GSh)
MEADOW PIPIT	S/C winter: 20 at Kincardine on 26th January (GSh) 36 at Balquharn Dam (Alva) on 14th February, flew up glen (mild) (CJH) 65 above Alva at 240m on 13th March (CJH) Autumn: 20 flying to S at Auchenbowie (Dunipace) on 3rd October and 30 to SW in 10 min. at Stronend on 4th October, 28 to WSW on 5th October. Large parties at Earl's Hill (Gargunnock) on 4th October and at Sheriffmuir on 5th October (CJH)

PIED WAGTAIL	S	13 at Airthrey on 20th February, 1st flock since previous autumn This could possibly be a change in flocking habit rather than an influx since in the mid and late autumn up to 50 roosted in a University courtyard(MD) although the large feeding parties of early autumn had disappeared. 25 at Kinneil on 26th September	(CJH)       (OMB)
	C	during the December hard weather there were the usual scattered individuals along the Hillfoots	  (CJH)
WHITE WAGTAIL	S	12 at Grangemouth on 5th May	(DMB)
GREY WAGTAIL	S	at Bridge of Allan, 3 nests away from water, two in Hermitage Wood	(GSh)
	C	very scarce in winter, e.g. 1 at Black Devon mouth on 14th February	(AM)
YELLOW WAGTAIL	S	Grangemouth, 1 on 9th May and 2 on 18th and 22nd August Pair on 10th July male with pale grey head, white eye stripe and light throat.	 (DMB) (DMB, DRW)
WAXWING	C	2 at Pool of Muckhart on 24th April	(DMB)
STARLING	C	none nesting this year on Wood Hill at 300m 450, all juveniles, at 540m on Ochil scarp on 1st July 2000 roosting on Kincardine Bridge on 28th December Singing and visiting nest holes within Red Carr Wood on 25th December.	 (CJH) (CJH) (CJH)
HAWFINCH	S	2 feeding on attached elm seeds at Bridge of Allan on 23rd May	(CJH)
GOLD FINCH	S	13 above Bridge of Allan on 12th August and 2 flying to W at Stronend on 25th October	(CJH) (CJH)
	C	35 by old railway at Fishcross on 19th September	(CJH)
SIASKIN	S	100 at Dunmore Moss on 21st March Pair in garden at Bridge of Allan on 19th April	(DMB) (GSh)
LINNET	S	100 at Grangemouth on 1st February and 100 at Kinneil on 3rd October 5 flying to S near North Third Reservoir on 4 October, 5 flying to W, 1 to E at Stronend on 25th October	 (DMB) (CJH)



TWITE	S	70 at Skinflats and 140 at Kincardine Bridge on 13 January 21 W at Stronend on 25 October	(DMB, GSh) (CJH)
	C	30 at Black Devon mouth on 7th March	(GSh)
REDPOLL	S	50 at Dunmore Moss on 21 March 4 W at Stronend on 25th October	(DMB) (CJH)
	C	20 at Dollar on 29th March	(DMB)
BULLFINCH	S	max. 14 at Stronend on 5th October	(CJH)
CHAFFINCH	S	420 at Kincardine Bridge on 26th January 400 wintered at Airthrey, up to 1st February 60 flying to W and 11 to E at Stronend on 25th October	(GSh) (GSh) (CJH)
BRAMBLING	S	42 at Airthrey on 1st February	(GSh)
	C	7 at Alva on 12th December hard weather, 1st seen there in 8 years.	(CJH)
CROSSBILL	S	20 in Loch Ard Forest on 26th December	(JM)
CORN BUNTING	S	scarce, singing at Skinflats on 25th April and 31st October	(DT) (AMcl)
	C	scarce, 2 at Kennetpans on 22nd January	(GSh)
YELLOW HAMMER	S	25 at Airthrey on 2nd January and 30 at Kincardine Bridge on 15th January	(GSh) (GSh)
	C	20 at Kennetpans on 26th January Appeared on waste ground in Alva, 10 on 21st February and 13 on 28th February; also during hard weather, 17 on 4th December	(GSh) (CJH)
REED BUNTING	S/C	in summer, widespread in W. Ochils, in bracken and rushes up to 370m (not in rush beds at 520m) 50 at waste grain, Airthrey, on 8th February 25 at Grangemouth on 18th April 35 at Kennetpans on 26th October	(CJH) (GSh) (DMB) (CJH)
HOUSE SPARROW	C	often 30 in garden at Alva in autumn included a partial albino, female with head offwhite, except for brown flecking on ear coverts and above eye, rump whitish, rest normal	(CJH)

TREE SPARROW	S	at Airthrey to 22 February	(GSh)
		1 flying W at Stronend on 25th October	(CJH)
	C	7 at sheep trough on 11th December, at Alva during hard weather	(CJH)

Additions to 1975 Report.

PIED FLYCATCHER	S	bred Bridge of Allan, male seen 24th May, 6 eggs laid subsequently but deserted	(PWS)
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The following species were also recorded but no notes of special interest were received during 1976 by the local recorder.

Black Grouse, Moorhen, Great Black-Backed Gull, Herring Gull, Black-Headed Gull, Cuckoo, Tawny Owl, Great-Spotted Woodpecker, Magpie, Coal Tit, Treecreeper, Blackcap, Sedge Warbler, Tree Pipit, Greenfinch, Snow Bunting.

RECORDERS:

D. M. Bryant, M. Davies, A. G. Gordon, C. J. Henty, A. MacIver, A. Mitchell, J. Mitchell, P. W. Sandeman, G. Shaw, D. Thorogood.

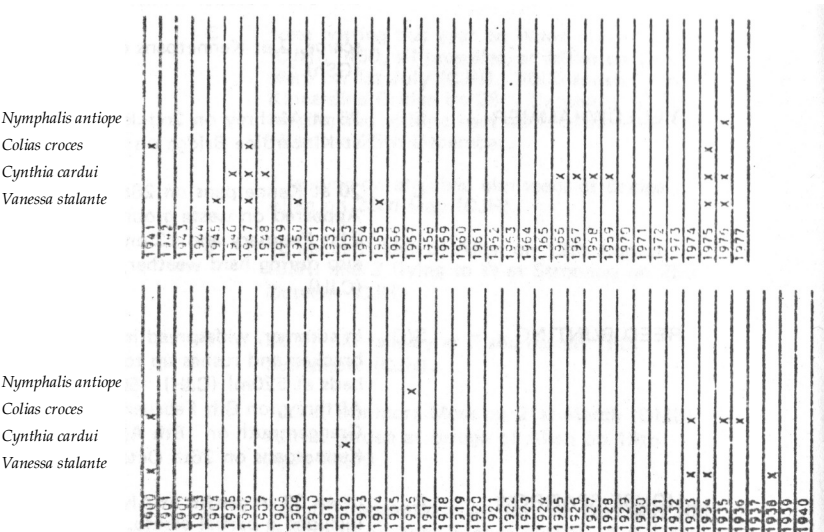


Figure 1 Migrant butterflies in Central Scotland—years in which exceptional numbers have been recorded.

TREE SPARROW	S	at Airthrey to 22 February	(GSh)
		1 flying W at Stronend on 25th October	(CJH)
	C	7 at sheep trough on 11th December, at Alva during hard weather	(CJH)

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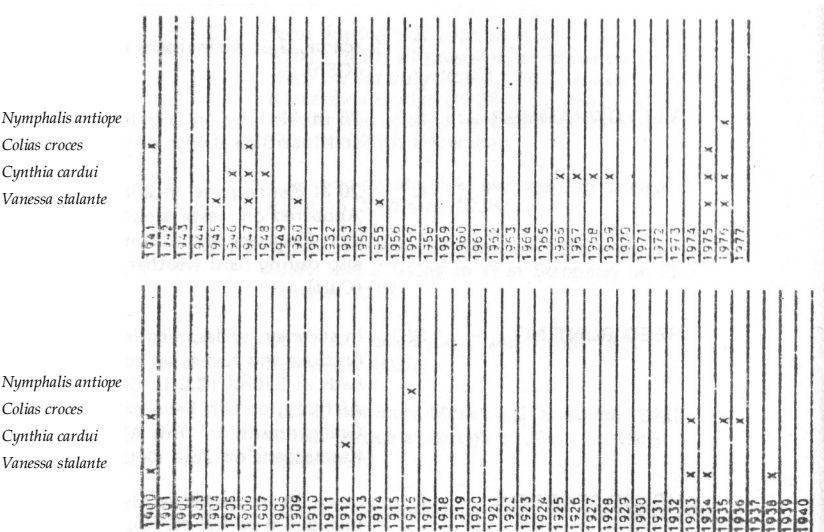


Figure 1 Migrant butterflies in Central Scotland—years in which exceptional numbers have been recorded.

## MIGRANT BUTTERFLIES OF CENTRAL SCOTLAND

by George Thomson

### INTRODUCTION

There have been a few years in the last decade or so when some of our migrant butterflies have been seen in greater numbers than they were in 1975 and 1976, but none when the overall impression was of a massive influx of migrant species, so spectacular that it resulted in a proliferation of notes and articles in the national press. Two events contributed to the situation. Firstly, the large numbers of the Vanessid butterflies which were to be seen in the summer and autumn (Red Admirals and Painted Ladies in particular) were not the consequence of direct migration, but they were the result of the hot, dry weather conditions and related breeding success of the parent butterflies which had arrived in moderate numbers in the spring and early summer. Secondly, there was the largest migration of the Camberwell Beauty to this country since 1872.

There are nine butterfly species in Central Scotland which are migratory or which display migratory tendencies. These can be grouped as follows:-

1. Resident species which sometimes migrate on a local scale.  
These include —  
The Green-veined White (*Pieris napi* L.) The  
Small Tortoiseshell (*Aglia urticae* L.)
2. Resident species whose populations are regularly reinforced by migration.  
These include -  
The Large White (*Pieris brassicae* L.) The  
Small White (*P. rapae* L.)  
The Peacock (*Inachis io* L.)
3. Migrant species which normally cannot establish themselves in central Scotland.  
These include —  
The Clouded Yellow (*Colias crocea* Fourcroy)  
The Red Admiral (*Vanessa atalanta* L.)  
The Painted Lady (*Cynthia cardui* L.)  
The Camberwell Beauty (*Nymphalis antiopa* L.)

Other migrant species which have been recorded elsewhere in the north of Britain could conceivably be found in central Scotland but as yet they have remained unrecorded. These include -

The Pale Clouded Yellow (*Colias hyale* L.)  
 Berger's Clouded Yellow (*C. australis* Verity)  
 The Long-tailed Blue (*Lampides boeticus* L.)  
 The Queen of Spain Pritillary (*Issoria Lathonia* L.)  
 The Monarch (*Danaus plexippus* L.)

While this paper is primarily concerned with the species in group one, some notes on the species in the other two groups would not be out of place here. The species least prone to migration is the Green-veined White. The fact that it has produced a number of well-defined geographical races is indicative of its sedentary nature. However, it has been observed in company with other migrating 'whites'. Furthermore, the species can often be seen flying quite purposefully in one direction over a considerable distance, a behaviour pattern quite alien to more colonial species. The Small Tortoiseshell can be found many miles from what could be considered to be a suitable habitat. It is frequently seen at the top of our highest mountains and also well out at sea, but no unidirectional movements of a number of individuals has been recorded. On the other hand, the Peacock is a well-established resident only in the south and west of Scotland, at least as far north as northern Argyll. In eastern, central and northern Scotland, it is, almost certainly, a migrant with very little breeding being reported in these areas. Its occurrence is fairly regular in central Scotland. Both Large and Small Whites are resident almost throughout the country, although the Small White is rare in the far north and in Orkney it is absent from Shetland. These species are reinforced by migration from the south and, in the case of the Large White, also from the north-east. Neither species depends on migration for its survival here.

### The Red Admiral

The four species listed in group three are the well-known migrant butterflies whose numbers here depend upon numbers arriving in this country from abroad. The best known of these is the Red Admiral, a name which is so frequently and quite erroneously applied to the Small Tortoiseshell in central Scotland. *Vanessa atalanta* is known to over-winter in

Britain occasionally. This uncommon event has been interpreted differently by Williams (1958) and Baker (1972) giving rise to different suggestions about the extent, origins and frequency of the butterfly's migrations. It may also over-winter in Scotland, as the butterfly has been found on the Isle of May on April 10th, 1914, possibly too early to be anything other than a hibernating imago. However, this must happen but rarely. The best years in central Scotland for the Red Admiral were probably 1900, 1933, 1934, 1938, 1945, 1947, 1950, 1955, 1975 and 1976. The year 1974 was a particularly bad one for this species.

### The Painted Lady

The Painted Lady has a definite tendency to migrate northwards along the coast in the east and throughout the Western Isles in the west. For this reason, in inland central Scotland it is found less commonly than elsewhere except the central Highlands, where the species is a rare vagrant. The spring migrants are generally believed to have come from North Africa (Baker loc.cit.), although the summer migrants probably originate from further north in central Europe, possibly also southern England. The butterfly has never been known to survive the winter in Scotland: it is unlikely that it can do so in England either. In the south of Britain the spring migrants lay their eggs on thistles (*Carduus* species) and more rarely on some other plants, to produce a brood in late summer and autumn, but in Scotland this probably is an uncommon event. The years 1969 and 1975 appear to have been the best '*cardui* years' of the last decade. There have been four periods of particular abundance this century, *circa* 1912, 1945-47, 1966-1969 and 1975-1976.

### The Clouded Yellow

Although the Clouded Yellow may be found in any part of Scotland in exceptional years, it is more often recorded in Galloway than elsewhere. In some years most of the records are from the eastern part of the country, while in others they are more often found in the west. The insects which are found in central Scotland in June have migrated from central or southern Europe and North Africa, sometimes producing a 'home-grown' brood in August. This happened in 1877. In years when the reports have been in July, August and September, the butterflies will usually be the result of summer migrations from England, or perhaps further migrations from central or southern Europe. In 1877 probably more *crocea* reached Scotland than any year since. This

particular year the butterfly spread as far north as Harray, Orkney. Specific records from central Scotland are sparse. Ian B. Crockart reported several in the Stirling area in 1933 and 1947 (pers. cofnm.), there is a report from Muckhart, Clackmannanshire on the 12th September, 1935 (Smith 1936) and another from near Comrie, Perthshire on the 28th July, 1941 (Harrison 1941). Other good years were 1900, 1936 and 1975.

### The Camberwell Beauty

On account of its size, the Camberwell Beauty is without doubt the most spectacular of our migrants. Most specimens in Scotland have been seen in the east of the country, although the reports extend to the western mainland. It is almost certain that the individuals which arrive in this country in the autumn have come from Scandinavia. The presence of a sizeable number of Scottish reports in the early part of the year indicates that the species sometimes over-winters here. However, there are no known cases of these hibernating butterflies producing offspring the following year. There are very few documented records of *antiopa* in central Scotland. The earliest of these is a report of the Camberwell Beauty near Doune, Perthshire in August, 1878 (Evans 1897), and another was seen at Bearsden on the 29th April, 1916 by Long (Clarke et al 1917). Other records are more recent. Chalmers-Hunt (1977) lists specimens from Edinburgh (September 18th, 1976) and near Blackford, Perthshire (September 4th, 1976). The author saw one near Aberfoyle on the 24th July, 1976 and another in Dunblane on the 5th July, 1977.

The comparative table (figure 1) shows quite clearly that the 1975—1976 period was by far the best years for migrant butterflies since the 1930—1950 period, a fact borne out by the reaction of the general public to the situation and the increased awareness of at least some elements of our local fauna.

## REFERENCES

- BAKER, R. R., 1972. The geographical origin of the British spring individuals of the butterflies *Vanessa atalanta* (L.) and *V. cardui* (L.). *J. Ent.* (A), 46, number 2, 185-196.
- CHALMERS-HUNT, W. M., 1977. The 1976 Invasion of the Camberwell Beauty (*Nymphalis antiopa* L.). *Ent. Rec. J. Var.* 89, 89-105.
- CLARKE, W. E., Evans, W., Grimshaw, P.H. (Eds.), 1917. *Vanessa antiopa* in Scotland. *Scottish Naturalist* (1917), 12.
- EVANS, W., 1897. Notes on lepidoptera collected in the Edinburgh district. *Scottish Naturalist* (1897), 89-110.
- EVANS, W., 1914. Lepidoptera (moths) and other insects at Scottish lighthouses, chiefly in the Forth area. *Scottish Naturalist* (1914), 225-233.
- HARRISON, J. W. Heslop, 1941. *Colias croceus*. Fourc., in Perthshire. *Ent. Rec. J. Var.*, 51, 120.
- SMITH, F. W., 1936. Clouded Yellow (*Colias croceus*). *Scottish Naturalist* (1936), 78.
- WILLIAMS, C. B., 1958. *Insect Migration*, Edinburgh and London: Collins.



**Figure 2** Directional patterns in migrant butterflies of central Scotland: 1 Large White, 2 Small White, 3 Peacock, 4 Clouded Yellow, 5 Red Admiral, 6 Painted Lady and 7 Camberwell Beauty.



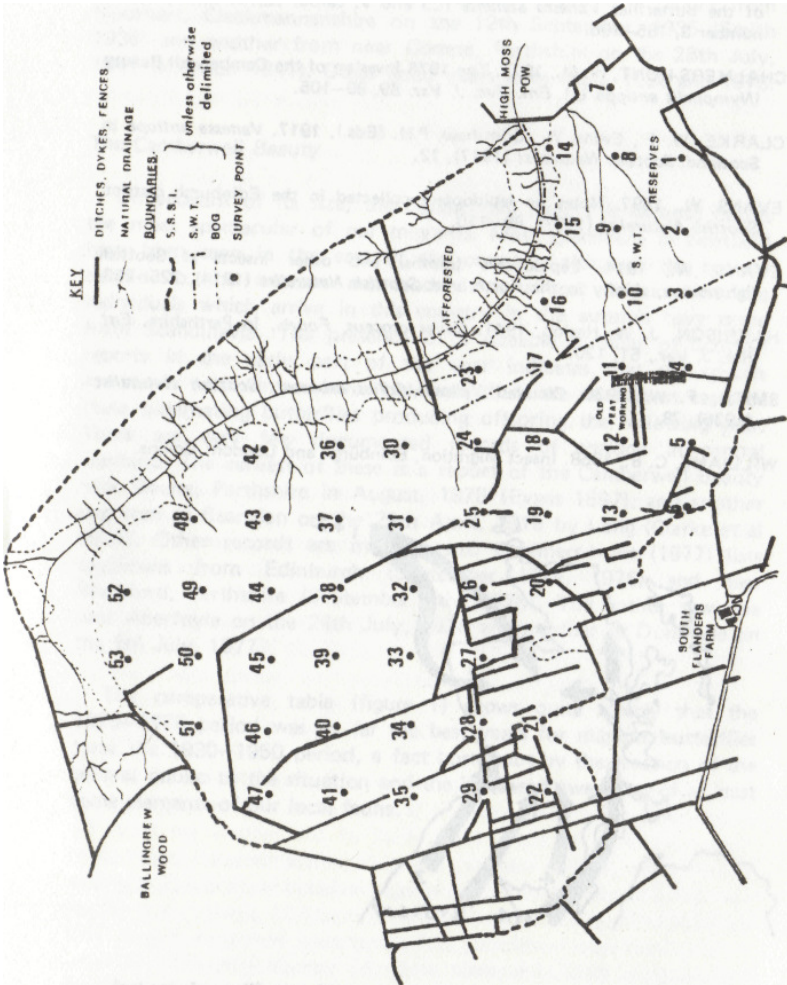


Fig.1 Map of East Flanders Moss S.S.I.

## A VEGETATION SURVEY OF EAST FLANDERS MOSS S.S.S.I.

**Peter Bannister**

### INTRODUCTION

East Flanders Moss, an extensive lowland raised bog, is one of the most noteworthy natural features of the Central Region. Raised bogs are composed of a characteristic assemblage of plants tolerant of both wet conditions and poor nutrient regimes. *Sphagnum* moss is the most important species, its water-holding capacity, coupled with the accumulation of *Sphagnum*-derived peat, allows the bog to grow above the influence of ground water and become entirely dependent upon rainwater for its supply of both moisture and nutrients. Pearsall (1950) and Ratcliffe (1964) give general accounts of the characteristics of various types of bog including raised bogs, while Ratcliffe also includes Flanders Moss amongst his examples.

Flanders Moss developed from the marshy estuarine deposits that are now represented by the carse clays. The main marine transgression began about 8500 years ago and ended about 6500 years ago (Sissons 1976) and the oldest parts of the Moss usually date from this later time; however there are older peats buried below the carse clay and in some places there may be no intervention of carse clay (Sissons and Smith 1966). Pollen analyses of both types of peat have been made (Durno 1956, Newey 1966).

The Moss represents the northern limit in Britain for the Bog Rosemary (*Andromeda polifolia*) and is notable for the presence of two North American bog plants, Labrador Tea (*Ledum groenlandicum*) and Bog Laurel (*Kalmia polifolia*) although both occur in only small quantities and *Ledum* is found in greater abundance elsewhere (Proctor and Bannister 1974). Animal interest is provided by the population of Blue Hares that contrast with the Brown Hares of the adjacent farmland. Adders are frequently encountered in summer. The Moss is also an important roost for Pink-footed Geese and supports a large inland colony of breeding Lesser Black-backed Gulls, while the butterflies and moths are also of interest (MacLaurin, 1974).

The raised appearance of the bog has been accentuated by the clearance of the former surrounding peat down to the carse clay during the conversion of the land to agriculture (Cadell 1913). As a result the remaining bog has become better drained and drier. Interference with

the bog surface is probably much older, the pollen record indicates that extensive clearing of adjacent forest occurred in the Iron Age/Roman Period (100-200 AD) with localised spasmodic clearing intervening until the advent of large-scale clearances that have taken place from the 18th century until the present day (Turner 1965). Modern interference with the remaining Moss ranges from draining through to afforestation and proposed large-scale peat extraction. Gartrenich Moss, West Flanders Moss and several smaller mosses are already lost by drainage and afforestation: against this background the conservation of at least some areas of the remaining bog is desirable.

In 1971 an area of East Flanders Moss to the north and east of South Flanders Farm (Grid reference NS 625969) and in 1973 two bogs to the south of the survey area, Shirgarton Moss (NS 647963) and Killorn Moss (NS 621962) were designated as Sites of Special Scientific Interest (S.S.S.I's). Also in 1973 the south-eastern extremity of the East Flanders Moss S.S.S.I. was acquired by the Scottish Wildlife Trust (S.W.T.) as a Nature Reserve (fig. 1). The survey deals with the whole of East Flanders Moss S.S.S.I.

## METHODS

A grid, oriented from North to South and East to West, was superimposed upon a map of the area. The intersects of the grid were 200m apart and the area surveyed was limited to the Moss surface to the west of High Moss Row. The intersects were located by map and compass in the field and were used as survey points. A record was made of the plant species within a 2 x 2 m quadrat at every point surveyed; notes were also made of other features of the site such as relative wetness, evidence of grazing, vegetation and hummock-hollow height. (Hummocks and hollows are characteristic of well-developed raised bog, although there is considerable controversy over their development and significance (Ratcliffe 1964). Because each survey point is restricted to 4 m<sup>2</sup> in an area of 4 ha the absence of a species record does not mean that the particular species is absent from the adjacent area of the Moss, nevertheless the distribution of records does give a guide to the relative abundance of species in different parts of the Moss.

The initial survey provided some of the basic data for mapping. The final vegetation map was compiled from aerial photographs that were related to ground surveys.

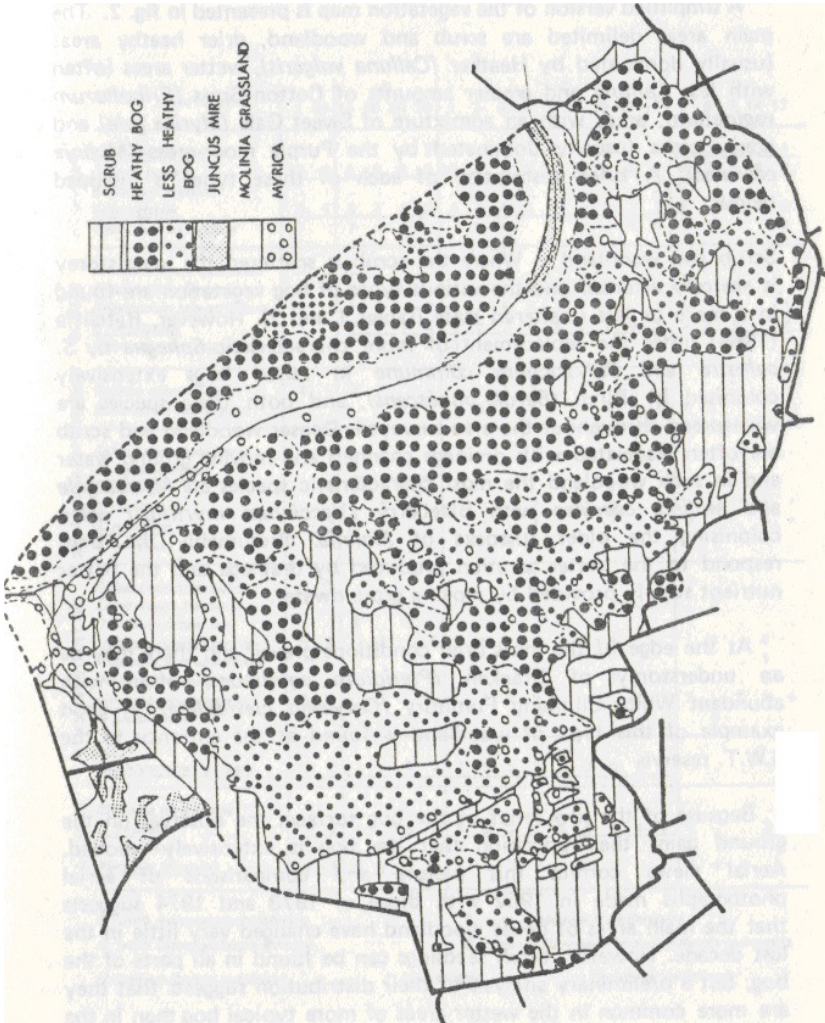


Fig 2 Vegetation map of East Flanders Moss S.S.S.I.

## RESULTS

### 1. Vegetation

A simplified version of the vegetation map is presented in fig. 2. The main areas delimited are scrub and woodland, drier heathy areas (usually dominated by Heather (*Calluna vulgaris*), wetter areas (often with less *Calluna* and greater amounts of Cotton-Grass (*Eriophorum vaginatum*), areas with an admixture of Sweet Gale (*Myrica gale*) and grassy areas (usually dominated by the Purple moor-grass (*Molinia caerulea*). A brief description of each of these types is included below.

Scrub and woodland — Where the scrub is scattered the understorey is scarcely affected and the various types of bog vegetation are found in a more or less unaltered state (tables 1 and 2). However, Ratcliffe (1964) notes the replacement of more characteristic *Sphagna* by *S. palustre* and *Polytrichum commune* in raised bogs extensively colonised by Birch (*Betula pubescens*), and both these species are widespread throughout the area surveyed. Denser woodland and scrub are often associated with drainage channels and moving ground water and in such woodland the most characteristic species are *Myrica gale* and *Molinia caerulea* with Blaeberry (*Vaccinium myrtillus*) often colonising the older tussocks of *Molinia*. Presumably the trees respond to the better aeration produced by drainage and the better nutrient supply provided by moving groundwater.

At the edge of the moss drier conditions prevail and there may be an understorey of Bracken (*Pteridium aquilinum*) often with abundant White Climbing Fumitory (*Corydalis claviculata*). A good example of this type of woodland is found at the entrance to the S.W.T. reserve.

Because of the low relief of the bog surface, the observer on the ground gains the impression that the bog is extensively wooded. Aerial views correct this picture and comparisons of aerial photographs made in 1962 with those of 1973 and 1974 suggests that the main areas of dense woodland have changed very little in the last decade. However, Birch seedlings can be found in all parts of the bog, but a preliminary analysis of their distribution suggests that they are more common in the wetter areas of more typical bog than in the drier areas with dominant heather. One is drawn to the conclusion that Birch may be characteristic species of this lowland bog rather than an invader taking advantage of the drying surfaces, as is usually suggested (e.g. Ratcliffe 1964).

	Stand Number	A				B				C										D				
		1	36	11	19	24	25	1	2	8	10	15	16	23	42	43	4	6	7	14	17			
WOODY SPP.	<i>Betula pubescens</i>	2	.	+	.	.	3	.	.	.	.	.	.	.	.	.	5	10	5	2	+			
	<i>Calluna vulgaris</i>	7	8	8	9	8	9	10	9	7	8	10	8	8	8	8	4	2	8	8	8			
	<i>Empetrum nigrum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	8	.	.	.	.			
	<i>Erica tetralix</i>	5	4	5	3	4	5	4	3	4	5	1	3	2	2	2	6	.	5	5	2			
	<i>Vaccinium oxycoccus</i>	7	.	7	.	.	.	.	2	1	.	.	.	.	.	4	5	7	.	.	.	2		
GRASSES AND SEDGES	<i>Anthoxanthum odoratum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.			
	<i>Deschampsia flexuosa</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	.	.	.			
	<i>Eriophorum angustifolium</i>	4	.	1	.	.	3	.	3	4	3	.	1	.	.	1	5	.	3	+	1			
	<i>E. vaginatum</i>	7	.	7	5	7	5	5	5	7	8	5	5	7	5	5	6	4	5	7	6			
	<i>Trichophorum cespitosum</i>	.	.	.	2	3	3	.	.	.	.	.	.	.	2	.	.	.	4	.	.			
OTHERS	<i>Drosera rotundifolia</i>	2	.	2	2	.	4	.	.	1	3	.	3	.	.	.	.	.	.	.	1			
	<i>Narthecium ossifragum</i>	.	.	.	2	5	.	3	.	.	.	.	2	2	5	4	4	5	.	.	.			
SPHAGNUM SPP.	<i>Sphagnum cuspidatum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.			
	<i>S. magellanicum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.			
	<i>S. palustre</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.			
	<i>S. papillosum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.			
	<i>S. rubellum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.			
	<i>S. recurvum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.			
OTHER BRYOPHYTES	<i>Aulacomnium palustre</i>	+	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.			
	<i>Campylopus flexuosus</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.			
	<i>Dicranum scoparium</i>	.	.	5	.	6	.	.	7	.	.	5	1	.	.	.	.	.	.	.	.			
	<i>Hypnum cupressiforme</i>	+	8	.	3	.	5	2	5	1	.	7	3	3	.	.	.	4	.	4	.			
	<i>Plagiothecium undulatum</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1			
	<i>Pleurozium schreberi</i>	.	.	.	.	.	.	.	.	.	.	.	.	5	.	6	9	.	.	3	.			
	<i>Polytrichum commune</i>	8	5	.	2	.	.	.	7	8	5	.	.	.	.	2	7	.	8	4	4			
	<i>P. juniperinum</i>	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.			
LICHENS	<i>Odontoschisma sphagni</i>	5	8	7	8	6	7	7	5	5	2	7	3	6	7	7	.	.	.	.	.			
	<i>Cladonia floekeriana</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.			
	<i>C. impexa</i>	4	5	4	.	8	5	6	6	2	1	5	5	8	4	2	4	.	.	.	2			
	<i>C. pyxidata</i>	.	.	.	2	.	.	2	2	.	.	2	.	.	.	.	.	.	.	.	.			
	<i>Parmelia physodes</i>	4	2	5	2	2	2	1	4	2	2	.	.	.	.	+	4	4	.	.	.			

A with *Aulacomnium palustre*B with *Sphagnum magellanicum*C with *Odontoschisma sphagni*D without *O. sphagni* and with *Betula pubescens*

Values are Domin numbers

\* Unevaluated

Constants underlined

Table 1. Species composition of vegetation samples classified as "healthy bog" (lacking *Andromeda polifolia*)

Apart from Birch, scattered Scots Pine (*Pinus sylvestris*) occurs, particularly in the northern part of the survey area. Some pine seedlings were observed in the western part of the bog. There are also vigorous stands of *Myrica* in the northern part of the Row which merge into willow carr along the western tributary.

Heathy bog (table 1) - This is typical of the drier areas and is most prevalent in the eastern part of the S.S.S.I. *Calluna* is dominant and the most typical species of the well developed bog surface (e.g. *Andromeda polifolia*). Cranberry (*Vaccinium oxycoccus*) are infrequent. The *Sphagna* found tend to be associated with drier areas (e.g. *S. rubelleum*, *S. papillosum*) and other associated species such as Deer Sedge (*Trichophorum cespitosum*) and Wavy Hair-Grass (*Deschampsia flexuosa*) may also be associated with the drier conditions and disturbance.

Less heathy bog (table 2) - In these areas the importance of *Calluna* is reduced and species characteristic of well-developed raised bog occur in greater abundance. Such species include *Andromeda polifolia*, *Vaccinium oxycoccus* and a greater variety of *Sphagnum* species including *S. magellanicum* and *S. palustre*.

*Myrica* and *Molinia*-*Myrica* bog (table 3) - These areas are often associated with moving ground water. They are typical of much of the well-developed scrub on the bog surface and also of the upper reaches of the High Moss Row. Much of the northern area of the bog has *Myrica* scattered through it and extensive stands of *Myrica* occur in the vicinity of old peat workings in the southern part of the bog.

Although most areas with *Myrica* contain some *Molinia*, the most extensive areas of *Molinia* grassland occur alongside the High Moss Pow and in the area to the north of the bog surface. These areas were not included in the floristic survey. *Molinia* is also typical of some partially reclaimed areas at the edges of the bog. Typically associated species include *Deschampsia flexuosa* in the drier areas and Tufted Hair-Grass (*D. cespitosa*) in the wetter areas. In the southern part of High Moss Pow there are areas with extensive Wood Horsetail (*Equisetum sylvaticum*). The wettest areas, often associated with running water, merge into rushy mires with Soft Rush *Juncus effusus*, being the prevalent species in the southern part of the burn and Sharp-flowered Rush (*J. acutiflorus*) in the north-western tributaries. In some of the driest areas at the edge of the Moss on the lower reaches of the Pow the grassland is replaced by stands of Bracken.

	Stand Number	with <u>Polytrichum commune</u>												without <u>P. commune</u>											
		22	38	48	28	26	33	20	41	49	45	34	39	40	47	32	29	46	30	31	35	27	44	51	
WOODY SPP.	<u>Andromeda polifolia</u>	2	4	4	4	4	3	5	3	2	4	3	3	3	5	2	4	4	5	3	3	4	2	2	
	<u>Betula pubescens</u>	.	3	4	.	.	4	4	5	3	1	.	2	4	3	.	5	.	.	4	.	.	.	.	
	<u>Calluna vulgaris</u>	8	2	7	7	7	7	7	4	7	9	7	8	8	8	8	7	4	8	8	6	7	9	7	
	<u>Empetrum nigrum</u>	4	.	3	4	.	4	5	5	.	6	4	4	5	5	.	.	.	.	.	6	5	.	.	
	<u>Erica tetralix</u>	5	5	4	4	4	3	4	5	4	4	3	4	2	4	2	3	6	5	4	3	4	5	4	
	<u>Myrica gale</u>	.	.	4	4	.	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	<u>Vaccinium oxycoccus</u>	5	6	5	7	7	7	5	4	4	4	4	5	4	5	8	5	9	.	8	4	6	5	3	
	<u>Pinus sylvestris</u>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	6	.	.	
GRASSES AND SEDGES	<u>Deschampsia flexuosa</u>	.	+	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	<u>Eriophorum vaginatum</u>	6	8	8	7	7	8	6	8	8	6	6	6	6	7	6	6	5	7	8	7	8	5	5	
	<u>Eriophorum angustifolium</u>	3	.	.	.	2	2	5	.	1	.	.	.	+	+	.	.	.	4	.	.	.	.	3	
	<u>Trichophorum cespitosum</u>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	
	<u>Rhynchospora alba</u>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	
OTHERS	<u>Drosera rotundifolia</u>	4	.	3	.	.	2	3	4	3	.	.	.	.	.	.	.	.	.	.	.	3	.	4	
	<u>Narthecium ossifragum</u>	4	.	5	.	.	4	.	.	.	.	.	.	3	.	.	4	2	.	4	.	3	5	7	
SPHAGNUM SPP.	<u>Sphagnum capillaceum</u>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	<u>S. compactum</u>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	<u>S. cuspidatum</u>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	<u>S. magellanicum</u>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	<u>S. palustre</u>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	<u>S. papillosum</u>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	<u>S. plumulosum</u>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	<u>S. recurvum</u>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	<u>S. rubellum</u>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
OTHER BRYOPHYTES	<u>Aulacomnium palustre</u>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	
	<u>Campylopus atrovirens</u>	.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	<u>Dicranum scoparium</u>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	<u>Hypnum cupressiforme</u>	.	.	.	.	.	3	.	.	.	4	6	3	5	+	.	.	.	.	.	4	.	.	.	
	<u>Pleurozium schreberi</u>	.	.	.	.	.	3	.	.	.	+	5	4	7	.	7	.	5	.	8	7	.	4	.	
	<u>Polytrichum commune</u>	3	8	6	5	3	4	5	8	5	7	6	7	4	7	7	.	.	.	.	.	.	.	.	
	<u>P. juniperinum</u>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	<u>Odontoschisma sphagni</u>	8	6	8	7	8	6	8	7	6	8	8	7	6	7	6	8	8	7	6	8	8	7	5	
		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
LICHENS	<u>Cladonia furcata</u>	.	.	.	2	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	<u>C. impexa</u>	6	.	2	6	6	2	6	3	2	6	4	4	7	3	5	7	.	8	5	5	.	4	3	
	<u>C. pyxidata</u>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	
	<u>C. squamosa</u>	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
	<u>Parmelia physodes</u>	5	2	5	4	5	7	4	2	5	2	4	6	4	5	5	3	.	4	1	4	4	2	3	

Values on Domin Scale

\* Unevaluated

Constants underlined

Table 2. Species composition of vegetation samples classified as "healthy bog" (with *Andromeda polifolia*)



Table 3. Species composition of vegetation containing *Myrica gale* and/or *Molinia caerulea*

		A		B			C				D
		37	13	9	12	5	53	18	50	52	21
WOODY SPP.	<i>Andromeda polifolia</i>	5	4	.	.	.	.	.	.	.	.
	<i>Betula pubescens</i>	C	C	3	8	4	4	.	.	4	.
	<i>Calluna vulgaris</i>	7	5	5	1	4	9	6	8	9	.
	<i>Empetrum nigrum</i>	5	.	.	.	.	.	.	.	.	.
	<i>Myrica gale</i>	.	5	1	6	5	7	6	6	5	7
	<i>Vaccinium myrtillus</i>	.	.	5	.	4	.	.	.	.	.
	<i>V. oxycoccus</i>	8	5	.	7	6	3	.	3	.	.
	<i>V. vitis-idaea</i>	.	2	.	.	.	.	.	.	.	.
	<i>Erica tetralix</i>	.	5	4	4	5	2	4	4	4	.
GRASSES AND SEDGES	<i>Deschampsia flexuosa</i>	5	.	.	.	.	.	3	.	.	.
	<i>Eriophorum angustifolium</i>	.	.	4	1	.	.	.	.	.	.
	<i>E. vaginatum</i>	6	5	5	7	7	5	8	3	5	.
	<i>Molinia caerulea</i>	2	6	5	.	.	.	.	.	.	9
OTHERS	<i>Drosera rotundifolia</i>	.	.	1	.	.	.	.	2	.	.
	<i>Narthecium ossifragum</i>	.	5	.	.	3	.	.	.	.	.
SPHAGNUM SPP. (PRESENT ONLY)	<i>Sphagnum cuspidatum</i>	*	.	.	.	.	.	*	.	.	.
	<i>S. magellanicum</i>	.	.	.	.	.	*	*	*	.	.
	<i>S. palustre</i>	.	*	.	*	.	*	*	*	*	.
	<i>S. rubellum</i>	.	.	*	.	.	.	.	.	.	.
OTHER BRYOPHYTES	<i>Aulacomnium palustre</i>	.	.	.	.	.	.	4	.	.	.
	<i>Leucobryum glaucum</i>	.	.	.	.	.	.	.	.	3	.
	<i>Hypnum cupressiforme</i>	*	.	.	.	.	.	.	4	.	.
	<i>Pleurozium schreberi</i>	6	.	.	7	.	.	5	.	2	.
	<i>Polytrichum commune</i>	8	.	.	.	.	2	7	.	3	.
	<i>P. juniperinum</i>	.	4	8	7	.	.	.	.	.	.
	<i>Odontoschisma sphagni</i>	.	.	3	4	4	6	8	8	6	.
	<i>Cladonia impexa</i>	2	.	.	.	.	2	.	4	.	.
LICHENS	<i>Parmelia physodes</i>	5	4	2	6	4	4	3	3	3	.

A with *Andromeda polifolia*

B bog with reduced heather cover (more Birch)

C bog with good heather cover

D *Molinia/Myrica* only

Values are Domin numbers \*Unevaluated constants underlined

N.B. Table 1 contains two stands with *Myrica* (but with strong 'Bog' component)

TABLE 4. Species with significantly different frequencies in the Scottish Wildlife Trust (S.W.T.) Reserve and elsewhere in the S.S.S.I.

Species more frequent within the S.W.T. Reserve.

% frequency

	S.W.T.	elsewhere
<i>Eriophorum angustifolium</i>	75	39
<i>Sphagnum papillosum</i>	67	34
<i>S. rubellum</i>	67	12
<i>Cladonia pyxidata</i>	25	5

Species more frequent elsewhere in the S.S.S.I.

<i>Andromeda polifolia</i>	0	61
<i>Vaccinium oxycoccus</i>	25	85
<i>Empetrum nigrum</i>	0	39
<i>Sphagnum pafustre</i>	17	78
<i>S. magellanicum</i>	8	44
<i>Parmelia physodes</i>	50	93

The frequency records are based on quadrat records from the sites surveyed (Fig. 1), a larger sample would have produced more species with significantly different distributions.

## 2. Species Distributions

These are shown in figs. 3-5. Some species, such as *Calluna vulgaris*. Cross-leaved Heath (*Erica tetralix*). *Eriophorum vaginatum*, *Odontoschisma sphagni*, *Parmelia physodes* and *Cladonia impexa* are ubiquitous. The first four species are common in raised bogs; the lichens, and *Cladonia impexa* in particular, may be widespread because of the relatively dry conditions that exist on this site (Ratcliffe 1964). With this widespread group may be included other species that are less frequent but are nevertheless scattered throughout the Moss. These include species of wet areas such as Common Cotton-grass (*Eriophorum angustifolium*). Sundew (*Drosera rotundifolia*), Bog Asphodel (*Narthecium ossifragum*), *Polytrichum commune* and possibly *Sphagnum magellanicum*; and species of drier areas such as the mosses *Pleurozium schreberi* and *Hypnum cupressiforme* which colonise *Calluna* hummocks. *Betula pubescens* is also frequent in most areas of the bog.

Other species, often considered to be more typical of well-developed raised bog (e.g. *Andromeda polifolia*, *Vaccinium oxycoccus*, Crowberry (*Empetrum nigrum*), *S. cuspidatum* and various other <sup>1</sup> *Sphagna*, and the one record of White beak-sedge (*Rhynchospora alba*) all tend to be more frequent in the north and west of the area. In contrast to these, species often considered typical of hummocks or drier areas of bogs (i.e. *Sphagnum rubellum*, *S. papillosum*, *Deschampsia flexuosa*, *Trichophorum cespitosum*, *Vaccinium myrtillus* and *Dicranum scoparium*), are found mainly in the south and east.

The number of records of other species is often too small to make a reliable assessment of their distribution. Exceptions can perhaps be made for *Myrica* and *Molinia*, their distribution tends to be somewhat peripheral, which fits in with their association with drainage.

## 3. Other factors

The subjective assessments of wetness that were made suggest that the driest areas are peripheral and eastern although there is a drier area in the centre of the north-western area. This latter correlates with the highest point of the bog. An analysis of the distribution of some of the more important species shows that the presence of large amounts of *Eriophorum vaginatum* or the presence of *Andromeda* is positively associated with wetness.

Hummock-hollow heights tend to be greatest near the centre of the bog, some large values near the edge seem to be associated with erosion rather than well developed hummocks and hollows. The areas with well developed hummocks and hollows generally have a greater presence of tree seedlings. Vegetation height is largely a function of vegetation cover. The tallest heights are in scrub and *Myrica* stands; seedlings are less frequent in areas of tall vegetation.

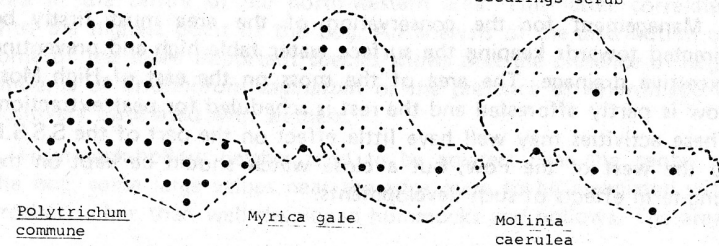
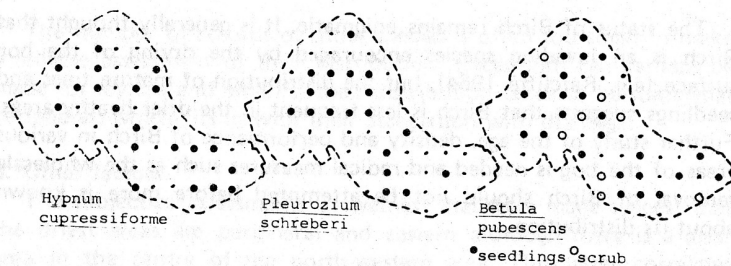
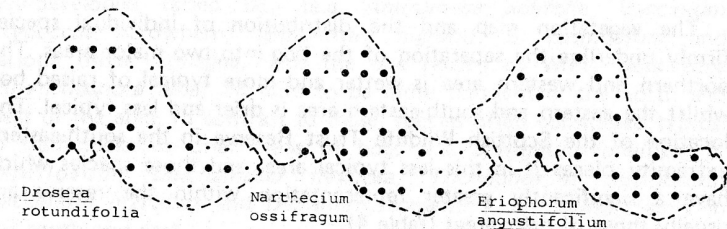
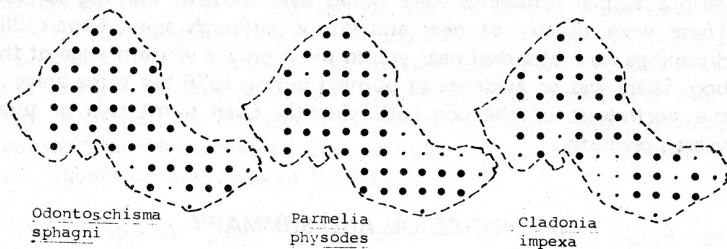
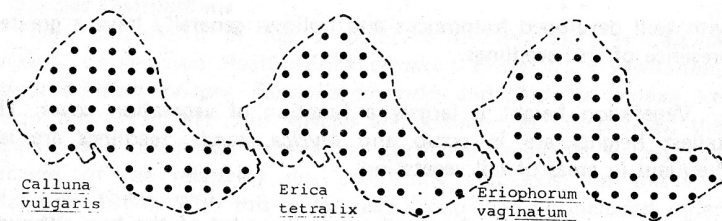
Evidence of grazing is usually near the edge of the bog although various animal droppings were noted over most of the bog surface. These were usually of deer and grouse although some Capercaillie droppings were observed near grazed pines on the western edge of the bog. There was no evidence of burning during 1976 but some areas in the north-west of the bog had evidently been burnt two or three years previously.

## DISCUSSION AND SUMMARY

The vegetation map and the distribution of individual species firmly underline the separation of the bog into two major areas. The northern and western area is wetter and more typical of raised bog whilst the eastern and south-eastern area is drier and less typical. The location of the Scottish Wildlife Trust Reserve in the south-eastern extremity places it in this less typical area, and those species which have a significantly greater representation within the reserve are usually those of drier areas (table 4).

The status of Birch remains enigmatic. It is generally thought that Birch is an invading species encouraged by the drying of the bog surface (e.g. Ratcliffe 1964), but the distribution of mature trees and seedlings suggests that Birch is less frequent in the drier heathy areas. Further study of the age, density and performance of Birch in various areas of the bog is needed and radical measures such as the wholesale removal of Birch should not be attempted before more is known about its distribution.

Management for the conservation of the area must firstly be directed towards keeping the surface water table high and preventing excessive drainage. The area of the moss on the east of High Moss Row is partly afforested and the rest is scheduled for peat extraction. These activities may well have little effect on the part of the S.S.S.I. to the west of the Pow, but a close watch should be kept on the long-term effects of such developments.



The only active management to the west of the Pow consists of burning in the northern part of the moss. This does not appear to have many damaging effects, indeed the abundance of *Andromeda* seems to be greater in areas that have been burnt than in areas of rank Heather. The old peatworkings to the south represent past management and it is interesting to note that the depressions have extensive *Sphagnum* carpets of *S. magellanicum* with much *Vaccinium oxycoccus*. These observations suggest that radical measures, such as burning or clearing and digging out areas in the drier part of the bog may encourage some of the more typical species. Control led experiments would be needed before such extreme measures were made on a large scale. In conclusion therefore, the S.S.S.I. does include areas of considerable botanical interest and further research followed by controlled management could possibly bring other areas up to a comparable standard.

#### ACKNOWLEDGEMENT

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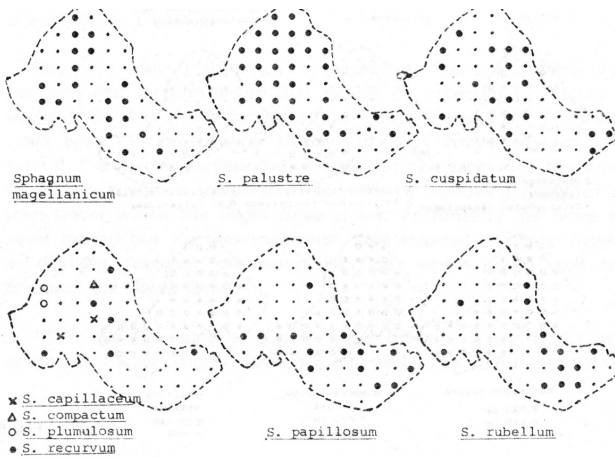
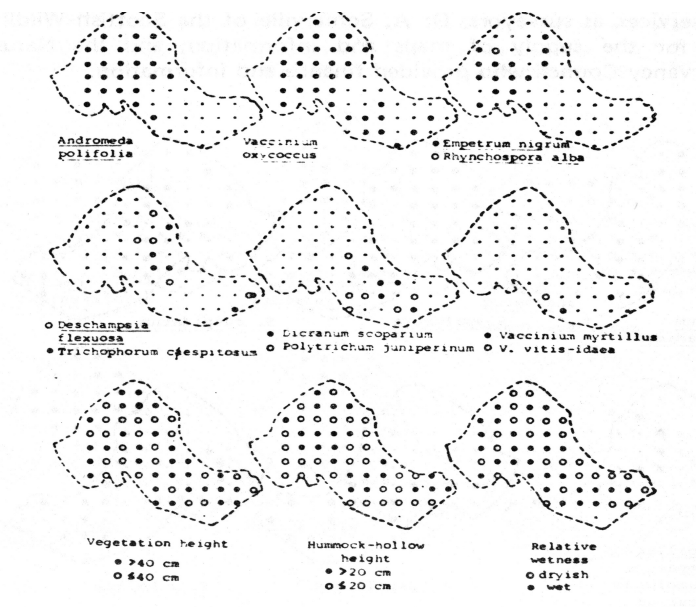


Fig. 4.

## REFERENCES

- CADELL, H.M. 1913. The Story of the Forth, Glasgow: Maclehose.
- DURNO, S.E. 1956. Pollen analysis of peat deposits in Scotland, *Scottish Geographical Magazine*, 72, 178-187.
- MacLAURIN A.M. 1974. Butterflies and moths from Flanders Moss, *The Glasgow Naturalist*, 19, 85-90.
- NEWAY, W. W. 1966. Pollen analyses of sub-carse peats of the Forth Valley, *Transactions of the Institute of British Geography*, 39, 53-59
- PEARSALL, W.H. 1950. *Mountains and Moorlands*, London: Collins
- PROCTOR, J. and BANNISTER, P. 1974. Vegetation and flora. In: *The Stirling Region* (ed. D.W.G. Timms), pp. 87-114. Stirling University.
- RATCLIFFE, D.A. 1964. Mires and Bogs. In: *The Vegetation of Scotland* (ed. J.H. Burnett), pp. 426-478. Edinburgh: Oliver and Boyd.
- SISSONS, J.B. 1976. The geomorphology of the Upper Forth Valley. *Fon Naturalist and Historian*, 1, 5-20.
- SISSONS, J.B. and SMITH, D.E. 1965. Peat bogs in a post-glacial sea and a buried raised beach in the western part of the Carse of Stirling, *Scottish Journal of Geology*, 1, 247-255.
- TURNER J. 1965. A contribution to the history of forest clearance *Proceedings of the Royal Society*, 8161, 343-354.



## A NOTE ON THE YELLOW STAR-OF-BETHLEHEM

Ian B. Crockart

The rare plant Yellow Star-of-Bethlehem (*Gagea lutea*) was listed by Croall (1880) in his compilation of plants found within 30 km of Stirling. It is pleasing to note that there is at least one local site where the species is still abundant. In mid-April, 1977, I revisited for the first time since 1949 or 1950 a Stirlingshire locality of this woodland rarity, which had been shown to me by the late Mr James Chisholm, a former science master at the High School of Stirling. The population is now apparently much more luxuriant than the recollections of my first visit suggested and its profusion of flowers this year reminded me of Wordsworth's Daffodils; there must have been hundreds of inflorescences. 1977 may have been a good year for the flowering of this species since Mr R. Cook (pers. comm) had evidence for the plant in flower from near Dollar in a previously unrecorded locality.

The flowering of *Gagea lutea* is undoubtedly sporadic. This was commented upon by Morris (1920) who was moved to write a paper on the exceptional flowering of that year when he noted about 150 plants in full flower in two closely situated localities. It is not known if either of the localities visited by Morris correspond to the one known to me. It is possible that the differences in the number of individuals in flower at the times of my first and my most recent visit have given an erroneous impression of the size of the total population of plants.

However, some inadvertent 'management' over the last few years has provided circumstances that would be expected to favour the *Gagea lutea*. The site is part of a flush adjacent to a field. Eight or so years ago the farmer (with whom I recently conversed) wished to extend the fence bordering the field further back into the wood. Work was begun in preparation for this by removing many of the trees under which the *Gagea lutea* grows. Fortunately the fence was never moved but the clearance must have resulted in a great increase in daylight reaching the woodland floor which could well have favoured the *Gagea lutea*.

After the flowering of *Gagea lutea* the site is overgrown with dominant Sweet Cicely (*Myrrhis odorata*). The luxuriance of the rarity in the



midst of the taller *Myrrhis odorata* must reflect the ability of the *Gagea lutea* to complete its growth early in Spring before the other species has reached its maximum extent.

#### REFERENCES

- CROALL, A. 1880. List of plants found within a radius of 20 miles round Stirling. Transactions of the Stirling Field Club, 2, Appendix 1-11.
- MORRIS, D. 8. 1920. The Yellow Star-of-Bethlehem. Transactions of the Stirling Natural History and Archaeological Society, 42, 85-87.

### **BREEDING OF THE COMMON CROSSBILL *LOXIA* *CURVIROSTRA* IN THE STIRLING REGION**

John Mitchell

Following an irruption of Common Crossbills into Scotland during the latter part of 1976, feeding parties were reported from a number of large conifer plantations in the western half of the Stirling Region. On 9th March 1977, Mr. and Mrs. J. Proctor watched a scarlet male 'courtship-feeding' a responsive female in a wind-blown clearing in the Loch Achray Forest near Brig o' Turk. Personal observations a few days later indicated that the pair were almost certainly holding a breeding territory, although I was unsuccessful in finding a nest. However, on 14th April Mr. C. Preston noted a female Common Crossbill with three newly fledged young in attendance at this same locality. Other possible breeding occurrences recorded in 1977 include a female observed carrying nesting material on 5th February at Cainoch in the Carron Valley Forest (Dr. J. T. Knowler) and a mixed group of female and juvenile birds seen feeding near Drymen Road Cottage in the Loch Ard Forest on 1st May (D. L. Clugston).

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## DUTCH ELM DISEASE IN CENTRAL SCOTLAND

E. N. Greenshill

### INTRODUCTION

Dutch Elm Disease was first identified in south east Britain in 1927, although most certainly present earlier; it was recorded in several European countries shortly before World War 1. It is thought that the disease originated in Asia, despite the name "Dutch" Elm Disease, given to it because of the research the Dutch have carried out. It is notable that amongst the species of elm native in Asia, a high degree of resistance to the disease is found. A good example is *Ulmus pumila*; the Dwarf or Siberian Elm which unfortunately is of a different appearance from our native elms and cannot be considered as a replacement tree.

After the first outbreaks of the disease, it continued to extend its range and was recorded from Edinburgh, for example, in 1938. About this time it went into the first of many declines, although by then considerable numbers of elm trees had been killed. Deaths from the disease continued and in the thirty year period ending in the 1960's approximately 10% of the British elm population were killed. Most deaths occurred in occasional severe flare-ups of the disease. It was then considered that Dutch Elm Disease was endemic but of no particular importance.

In 1969 it became apparent that a flare-up in southern England was not going to be short lived. In 1971 a survey was carried out by the Forestry Commission which showed that the outbreak would continue until substantial numbers of elms had been killed, so reducing the numbers of the Elm Bark Beetles, the vectors of the disease. In 1971 the Dutch Elm Disease Order was enacted by the Forestry Commission, conferring on eligible Local Authorities powers to order the felling of diseased trees, and to carry out further sanitation felling. In spite of these measures the disease continued and it was gradually realised that it was killing trees much more quickly than ever before. It was discovered that the dramatic and lethal spread was due to a new virulent strain of the disease which could kill a mature English Elm (*Ulmus procera*) in about two or three weeks. The emergence of this strain of the disease, to be called the aggressive strain, was linked with

a consignment of elm logs from Canada which had been landed at a port on the south coast of England.

A further effort in the struggle against the disease was the Dutch Elm Disease (Restriction on Movement of Diseased Elms) Order of 1974. This restricted the movement of elm timber from areas of high infection to areas of low infection. By this time it was estimated that as many as 3.5 million trees had died out of a total of 23 millions. In 1975 the first outbreak of the present epidemic was recorded in the Scottish Central Region, on private land near Clackmannan. This was quickly dealt with by the Forestry Commission, who destroyed the timber by burning.

The disease is caused by an ascomycete fungus *Ceratocystis ulmi* (also known as *ceratostomella ulmi* and *ophiostoma ulmi*) which is composed of yeast-like bodies which reproduce by budding and which are moved in the plants' sap. The English Elm (*Ulmus procera*) which predominates in many oarts of England has extremely low resistance to the aggressive strain of the disease, whilst the other two native species, the Wych Elm '*Ulmus glabra*) and the Smooth Leaved Elm (*Ulmus carpinifolia*) show slightly more resistance.

The fungus produces a toxin which poisons the tree and causes the vessel walls in which it travels to produce tyloses, which grow and olock the water supply. The mass of fungus and tyloses can clearly be seen by cutting through an infected branch and observing dark spots or rings. If bark is stripped from a branch or twig dark streaks can be seen running laterally along it.

It is not until July that symptoms of the disease become apparent. Occasionally in very hot spells, such as those experienced in the Stirling area in 1976, symptoms become noticeable as early as June. The most obvious sign is the yellowing of the leaves over the whole or part of the tree. The young fleshy twigs in which secondary thickening has not started wilt at the tips giving a characteristic symptom often likened to the bend in a shepherd's crook. This "Shepherd's Crook" effect occurs at the same time as the leaves begin to turn yellow.

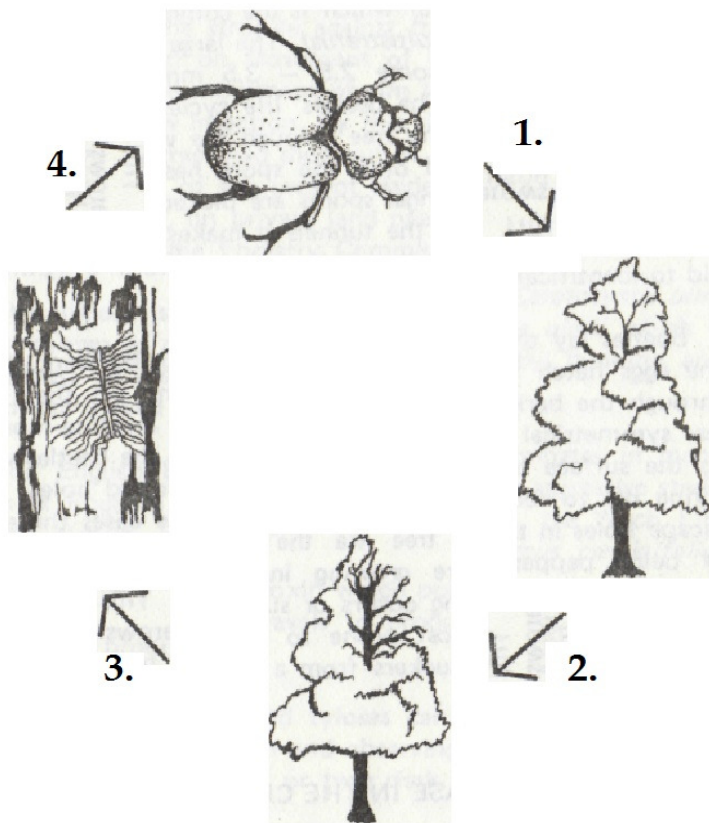
Dutch Elm Disease is transmitted mainly by Elm Bark Beetles, two species of which are present in Great Britain, the large Elm Bark Beetle (*Scolytus scolytus*) which is the commoner and the Small Elm Bark Beetle (*Scolytus multistratus*). The large insect measures 5-6 mm in length, the lesser some 2.5 -- 3.5 mm. Both are black with red-brown wing cases. The beetles' life cycles are similar (Fig.1). The disease gains entry to the tree through the wound the feeding beetle makes in the twigs and once the spore has germinated the fungus spreads quickly. The fungal spores are picked up by the adult beetle when it travels through the tunnels it makes in the bark for it is in these sheltered sites that the fungus produces its delicate *fructifications*. These are inconspicuous and do not form a significant aid to identification of the disease.

Beetles lay their eggs in chambers they excavate in the bark. When the eggs hatch the larvae begin feeding at once and eat their way through the bark at right angles to the egg chamber creating more or less symmetrical systems of galleries. After pupating the beetles work to the surface of the bark emerging through neat round holes, then flying off to feed in the crowns of elms. In severe cases the adult escape holes in the trunk or branch of a tree can have the appearance of being peppered by a shotgun blast. The disease can also be transmitted from tree to tree via the roots. This occurs most commonly where trees are growing in hedgerows or in other situations where root grafting occurs or suckered trees exist. English Elm (*Ulmus procera*) is most prone to this as many of the trees growing in hedgerows are suckers from a common parent and exist on a mutual root system.

## DUTCH ELM DISEASE IN THE CENTRAL REGION

The history of Dutch Elm Disease in the central belt of Scotland goes back many years. A piece of ground on Abbey Craig, Stirling was designated as a site of special scientific interest (S.S.S.I.), because it was one of the most northerly colonies of Elm Bark Beetle in Britain. It is worth noting that the second tree to be felled in the Central Region during the current outbreak of Dutch Elm Disease was in the S.S.S.I. area.

Concern about the possibility of large scale Dutch Elm Disease in the Central Region came about when the District Officers of the Forestry Commission carried out a survey of timber yards after isolated outbreaks of the disease had been reported in Dundee and Glasgow.



1. Adult beetle feeds on twigs of healthy trees.
2. Fungus spreads through transpiration vessels causing partial death of tree.
3. Dying tree provides breeding ground for beetle.
4. Larvae develop and fungus fructifies in galleries. Spores are carried away on bodies of beetles to infect other trees.

Fig. 1. Life cycle of the beetle

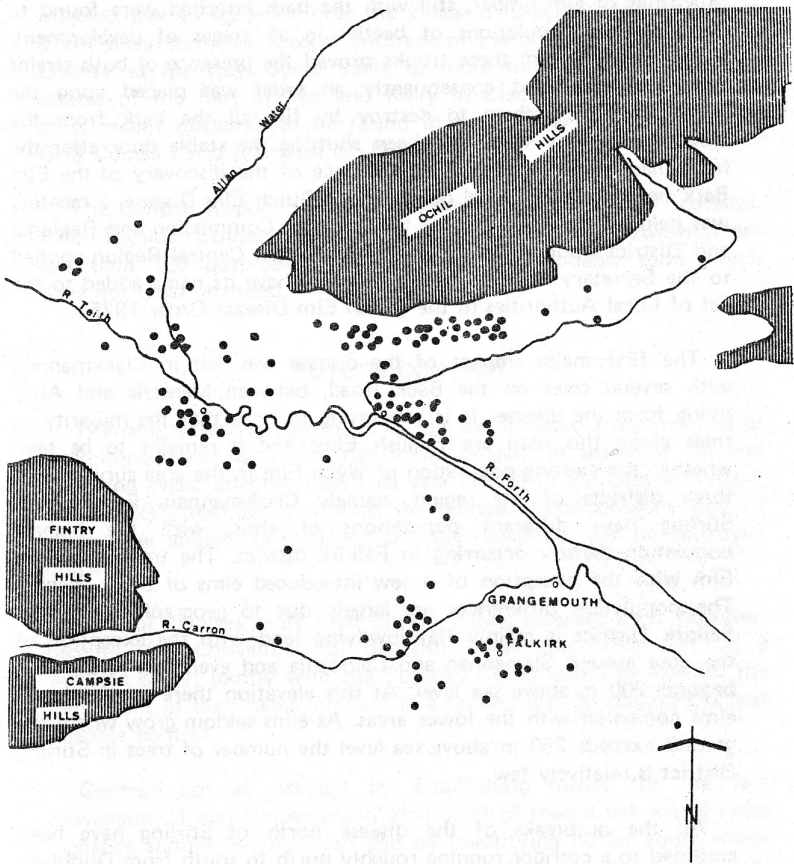


Fig. 2. Incidences of the disease, 1977



Glasgow. (These came from consignments of diseased English Elms which had arrived in Scotland). At a timber yard near Falkirk large quantities of elm timber, still with the bark attached were found to contain huge populations of beetles in all stages of development. Samples taken from these trunks proved the presence of both strains of the disease, and consequently an order was placed upon the owners requiring them to destroy by fire all the bark from the timber. This may well have been shutting the stable door after the horse had bolted, and as a consequence of the discovery of the Elm Bark beetles and the local outbreaks of Dutch Elm Disease, a meeting was held in January 1976 by the Forestry Commission and Regional and District Council Officials. As a result, the Central Region applied to the Secretary of State for Scotland to have its name added to the list of Local Authorities in the Dutch Elm Disease Order 1975.

The first major impact of the disease was felt in Clackmannan with several trees on the Back Road, between Menstrie and Alva, dying from the disease. It is interesting to note that the majority of trees along this road are English Elms and it remains to be seen whether the existing population of Wych Elm in the area survive. The three districts of the region, namely Clackmannan, Falkirk and Stirling have different populations of elms, with the highest population density occurring in Falkirk district. The trees are Wych Elm with the exception of a few introduced elms of other species. The population differences are largely due to geographical factors. Falkirk District is mainly flat low-lying land with the exception of the area around Slamannan and California and even this rarely rises beyond 200 m above sea level. At this elevation there are far fewer elms compared with the lower areas. As elms seldom grow where the ground exceeds 250 m above sea level the number of trees in Stirling District is relatively few.

All the outbreaks of the disease north of Stirling have been confined to a corridor running roughly north to south from Dunblane to Stirling (Fig.2). From Stirling the corridor goes off in two directions, one branch along the Hillfoots and into Clackmannan county and the other along the southern bank of the Forth and through Plean towards Larbert, from where the disease is thought to have originated.

An outlying incidence of the disease was just north of Doune and this

outbreak has been the most northerly discovered in the Central Region. Whereas the disease has been largely confined to fairly clearly defined areas around Falkirk and Stirling, outbreaks in Clackmannan have been occurring in a much more haphazard way. The first infected tree to be felled near the village of Clackmannan was about 9 km away from the second outbreak of the disease in Clackmannan County at Menstrie. Some thirty or more trees were felled in the estates of the Earl of Mar and Kelly in Clackmannanshire and the most recent outbreak to be found in the county was on Braehead Golf Course (Grid reference NS 866940).

The Central Region is the most heavily infected part of Scotland. Fife, Tayside, Strathclyde and the Lothians have had between them less than 100 outbreaks, although there are probably some which have not been recorded.

### FUTURE CONTROL

The only effective control is to fell the infected trees and it is of vital importance for authorities to be diligent in searching for and removing every infected tree. Last year (1976) in the Central Region, about 1000 trees fell victim to the disease. Approximately half of these have already been felled, and the remainder will be destroyed quickly.

Control involves more than merely felling diseased trees, however, recently the Convention of Scottish Local Authorities set up a working party, jointly with the Forestry Commission, to monitor the movement of the disease, and act in a unified way to achieve the best possible control.

Control can be assisted by establishing routes for the safe movement of elm timber identifying areas of special risk where extra vigilance should be employed and by identifying buffer zones where elm populations are low. To avoid the possibility of root transmission, barriers between the trees can be made by digging trenches or chemically sterilising the soil, other measures such as sanitation felling, injecting specimen trees with chemicals and involving volunteer organisations to assist with the non-specialised aspects of tree removal are additional weapons with which to combat the disease. A vital need is for a publicity campaign to bring to local attention the fact that a quarter of a million trees in the Central Region are at risk. All the measures against Dutch Elm Disease must be used as an overall coordinated strategy which is developed from experiences in England.

The Elm population in the Scottish Lowland is the link between the hedgerow and woodland trees and as such an important role in the Scottish countryside. If Elms are to remain in substantial numbers and maintain their present impact then all the measures discussed above must be rigorously carried out to control Dutch Elm Disease.

## REFERENCES

BURDEKIN, D.A., (1972) Forestry and Home Grown Timber February 1972; Dutch Elm Disease; how to control it. Benn Publications Ltd.

GIBBS, J. N., & HOWEL, R. S., (1972) Dutch Elm Disease Survey 1971. F.C. Record No. 82 H.M.S.O.

GIBBS, J. N., (1974) Biology of Dutch Elm Disease. F.C. Record 94 H.M.S.O.

BURDEKIN, D. A. & GIBBS, J. N., (1974) The Control of Dutch Elm Disease. F.C. Leaflet No. 54 H.M.S.O.

## Addenda 1977

In October 1977 a team of four was appointed operating under the job creation scheme who undertook to survey all elm trees in the Region. This has proved to be invaluable as not only the number of elms and their location is known, but the 'spin-off' information will prove useful in the future.

The up-to-date figures for populations and infections are as follows:-

Falkirk District	21,825
Stirling District	14,085
Clackmannan District	19,090
No- of trees suspected to be diseased	920
No. of trees actually infected	742
No. of trees felled to date	361

The 742 trees came under 98 felling notices.

The disease now extends westwards to Loch Achray. Map ref. NS 509069.

## HISTORICAL SOURCES FOR CENTRAL SCOTLAND

B. J. Elliott

Under the auspices of the Government's job creation scheme, two graduate assistants, Susan Hobbs and Lynda Wright began work in February 1977 researching historical source material for a series of pamphlets of the above title. The publication is a joint venture of the Central Regional Council and the University of Stirling. The Council is carrying out the actual tasks of publishing and selling the pamphlets. The University provides the working space, supervision and employer-role for the assistants who in addition to researching documents and illustrations carried out the tasks of writing introductions, proof-checking and design lay-out.

The title of the first pamphlet being published in September 1977 is *World War I* and is concerned with social and economic life in Central Scotland during 1914-18. Aspects such as recruitment, industry, the role of women, rationing and education are illustrated through extracts from about 50 largely original historical sources. The second pamphlet is a detailed survey of the *Coal Industry* from the 17th to the 20th centuries and includes extracts from the statistical accounts, travellers' journals, industrial surveys, Royal Commissions, Parliamentary papers and more recently from National Coal Board publications. The third pamphlet is on *World War II* and covers many of the same topics as *World War I* but includes a number of previously unpublished Government papers from the Scottish Records Office. The fourth publication is *Transport 18th - 20th Centuries* with appropriate space being given to local road, rail, water and air facilities. Before the end of the project in August work had been completed on numbers 5 and 6, *Law, Crime and Punishment* and *Housing, Health and Welfare*.

No difficulty has yet been encountered with materials still in copyright. With the exception of one national newspaper all copyright holders have given permission to reproduce free of charge. Her Majesty's Stationery Office has given a comprehensive permissions right to the scheme. It is hoped to sell the pamphlets at 30p per copy, each of which will have eight illustrations and, where appropriate, a map