

BUTTERFLY MONITORING

SCHEME

Report to recorders 2003









The Butterfly Monitoring Scheme

Report to Recorders

2003

J NICK GREATOREX-DAVIES & DAVID B ROY

CEH Monks Wood Abbots Ripton Huntingdon Cambs PE28 2LS

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SUMMARY

- 1. This report reviews the national Butterfly Monitoring Scheme (BMS) for the 2003 season and marks the twenty-eighth year of monitoring since the scheme started in 1976.
- 2. The year 2003 was a relatively good year for butterflies, ranking 10^{th} highest of the series (1976-2003) and the best year since 1997. Of the 50 species and generations for which overall indices of abundance were calculated, 30 increased from 2002 to 2003 and for 12 of these the index more than doubled.
- 3. There were four *highest indices ever* Adonis blue second generation, Red admiral, Comma and Ringlet. In general, migrant species did well with Painted Lady having its second highest index of the series, only bettered by 1996. The summer broods of bivoltine species also fared well as did univoltine species with summer flight periods. Numbers of Small Heath and Speckled Wood also increased at the majority of sites.
- 4. No species produced its *lowest collated index* in 2003. Species which fared less well were those flying in the spring, including first generations of bivoltine species such as **Small White** and **Large White**, counts of **Peacock** and **Brimstone** after over-winter survival and univoltine species emerging at that time of the year such as **Green Hairstreak**.
- 5. The day-to-day operation of the scheme is run by Mr Nick Greatorex-Davies at the Centre for Ecology and Hydrology (CEH, formerly ITE), Monks Wood. Mr David Roy (CEH Monks Wood) has overall responsibility for management of the BMS. He is also responsible for the technical aspects of the scheme, and co-ordination of research using the BMS. The BMS is jointly funded by the Joint Nature Conservation Committee (JNCC) and by CEH.
- 6. Data were received from 130 transects (including 14 Environmental Change Network (ECN) transects) for the 2003 season, and for only 4 transects were data insufficient for any annual indices to be calculated. Data from 3 transects were collected but were not submitted in time to be included in this report. Only one transect produced no data, but is expected to produce data again in 2004. The total number of transects in the BMS in 2003 was 134.
- 7. Data were received electronically from Transect Walker software from 54 transects, an increase of 22 (32 in 2002) from 2002. A new version of the Transect Walker software is currently being developed and should be available for entering 2004 transect data.
- 8. The partnership agreement for joint working on butterfly monitoring has been signed by CEH, JNCC and BC.
- 9. Recent and forthcoming publications using data from the BMS are listed.
- 10. Appendix I contains graphs showing annual fluctuations in the all-sites collated indices from 1976-2003.
- 11. Appendix II examines the voltinism and flight periods of **Common Blue**.

INTRODUCTION

The purpose of this report is to review the Butterfly Monitoring Scheme (BMS) and to summarise the results of the scheme for the year 2003, with the particular aim of providing feedback to the many transect recorders, site managers and site owners involved with the scheme, on long and short term changes and trends in butterfly abundance and other features of interest.

Origins, organisation and aims of the BMS

The BMS was launched in 1976 by Dr Ernie Pollard based at the Institute of Terrestrial Ecology (ITE) at Monks Wood. The scheme was initially financed jointly by the Nature Conservancy Council (NCC) and ITE. Since 1991 it has been jointly financed by the Joint Nature Conservation Committee (JNCC) (acting on behalf of the statutory conservation agencies (successors to NCC): English Nature, Countryside Council for Wales, Scottish Natural Heritage and the Environment and Heritage Service Northern Ireland), and ITE (now the Centre for Ecology and Hydrology (CEH)).

The day-to-day operation of the BMS continues to be run by Mr Nick Greatorex-Davies and Mr David Roy has overall responsibility for the management of the scheme. Dr Ernie Pollard retired from active involvement in the scheme in 1998 (apart from walking a transect as part of the scheme) but is still available for advice when required.

The primary aims of the scheme are to provide information at regional and national levels on changes in the abundance of butterfly species, to detect trends which may indicate changes in their status and to provide a reliable long-term reference against which population changes in species studied elsewhere on individual sites, or in other countries, can be monitored. It also aims to monitor changes at individual sites and, by comparison with results elsewhere, to assess the impact of local factors such as habitat change caused by management. The scheme also provides information on aspects of the population ecology and phenology of individual species, both in relation to the effect of environmental changes (including climate change) and as a contribution to butterfly ecology.

Sites from which the BMS receives data

The year 2003 was the 28th year of the BMS. Currently 134 transects at sites throughout the United Kingdom contribute to, or are part of, the BMS. At least some data were received from 133 transects (including 14 Environmental Change Network (ECN) transects¹). However data from three of these transects arrived too late to be included in the analysis. Only four transects failed to provide sufficient data to produce annual site index values for at least one species. These 126 site producing indices is by far the highest number since the BMS began, and is, in part, due to the improved method of calculating indices enabling indices to be calculated in cases where they could not previously. Compared with 33 sites in 2002, 63 transects produced sufficient data for annual indices to be calculated for all the species recorded in 2003 and a further 10 transects for all but one index, reflecting the good summer weather.

¹ The ECN was set up in 1993 with funding from the Department of the Environment (now Department for Environment, Food and Rural Affairs) in conjunction with a number of research organisations (including CEH) to monitor changes in the environment, particularly in relation to climate change. Butterfly monitoring is just one part of this programme. ECN transects are not managed as part of the BMS, but data from most of the ECN sites are now used together with the BMS data to calculate the annual all-sites collated indices. Two of the BMS transects are now also ECN transects, making a total of 14 ECN transects. Within the rest of this report BMS and ECN transects will simply be referred to as BMS transects because all potentially contribute to the scheme in providing data for the calculation of the collated annual indices.

Sites gained

Sites gained

Three transects were added to the BMS in 2003. **Sandwell Valley** in West Bromwich in the West Midlands, **Cavenham Heath NNR** in the Suffolk Brecklands, and **Allt Mharcaidh -** an ECN site in the Cairngorms.

The **Sandwell Valley** transect began in 2002. The site is a 105 hectare Local Nature Reserve owned and largely managed by the Sandwell Metropolitan Burough Council. A small part of the site is leased to, and managed by, the RSPB. The site is mostly an old coal mining area and habitats include flower-rich hay meadows, scrub and hedgerows with lines of trees. The transect route is mainly on the RSPB reserve and the goes round a 14-hectare lake. A range of common butterflies are recorded on the transect including the Brown Argus.

The **Cavenham Heath** transect began in 2002 and is walked by the same team who record the Chippenham Fen transect, which has been in the BMS since 1976. The site is largely dry heathland, a biotope poorly represented in the BMS, and also has some derelict fen. This adds a second BMS transect to the county of Suffolk and, since the loss of the Weeting Heath transect in 1998, is the only BMS transect in Breckland. The site supports good populations of Brown Argus and Grayling as well as many of our commoner butterfly species.

Allt Mharcaidh is an upland transect on the north-west edge of the Cairngorm Mountains and was recorded for the first time in 2003. The transect route climbs a steep hillside from about 300 to 700m. Habitats include naturally regenerating pine woodland, blanket bog, upland grass and lichen heath. The Large Heath and Scotch Argus are both recorded on the transect. The transect is being recorded as part of the data being collected by the Environmental Change Network.

Sites lost

Six transects were lost from the BMS in 2002 and 2003. These were Loch Fleet in Highland, St. Margaret's Bay in Kent, two farmland transects at Loddington in Leicestershire (Loddington (arable) and Loddington (embankment)), Denmark Farm in West Wales and Whixall (C) on the Shropshire-Clywd border. Table 1 lists, and shows some details of, these six transects and other transects that have been lost from the BMS over the past 10 years. Efforts continue to be made at some of these sites to find new recorders. We draw attention to these sites in the hope that BMS recorders moving to an area where one of these transects is located may be willing to assist with recording it. Generally those with the longest runs of data are given the greatest priority.

Loch Fleet in Highland is a coastal site on the east coast of Scotland, north of the Moray Firth. It produced data for the BMS from 1996 to 2001, recorded by Scottish Wildlife Trust summer wardens under the auspices of Scottish Natural Heritage who own the site. Unfortunately these wardens are no longer available. Efforts are still being made to find a new recorder in this relatively sparsely populated part of Scotland. The site has good populations of Dark Green Fritillary and Grayling.

St. Margaret's Bay is a chalk grassland site on the east coast of Kent. The transect joined the BMS in 1989 and transect counts continued until 2001. The site is rich in butterflies, and includes Dingy Skipper, Small Blue, Adonis Blue and Chalkhill Blue. Silver-spotted Skipper has also been recorded on the transect.

The **Loddington (arable)** and **Loddington (embankment)** transects are on an experimental farm owned by the Allerton Trust. The transect submitted data to the BMS for just two years,

2000 and 2001. It has not been recorded since. However it is hoped that transects will continue in one out of five years.

Denmark Farm near Lampeter in West Wales joined the BMS in 1993 and transect counts ceased after the 2002 season. Dwindling numbers of Small Pearl-bordered Fritillary have been recorded on the transect. The transect on this restored pasture site was walked by staff of the Shared Earth Trust who own the site but are no longer able to commit time to continuing the transect.

Whixall (C) was one of two transects on the Fenn's, Whixall & Bettisfield Mosses NNR which straddles the Clywd-Shropshire border near Whitchurch. The habitat on the site is lowland blanket bog and the site supports populations of Large Heath. The transect joined the BMS in 1994 and recording continued until the end of the 2002 season. The Countryside Council for Wales feel unable to continue two transects on the same site.

Table 1. Transects lost from the BMS over the past 10 years

Anyone wishing to take on, or assist with, one of these transects should contact the BMS at CEH Monks Wood.

Site number	Site name	County	Owner/recorder	Years of data in BMS	Main habitat(s)
13	Craig y Cilau	Powys	Countryside Council for Wales	1976-1997	Upland grass
44	Radipole Lake	Dorset	RSPB	1977-1996	Coastal gravel pits
53	Avon Gorge	Somerset	National Trust	1983-1999	Deciduous woodland & grassland
59	Weeting Heath	Norfolk	Wildlife Trust	1978-1998	Grass heath & pine woodland
66	Tentsmuir Point	Fife	Scottish Natural Heritage	1978-1996	Coastal dunes
73	Wart Barrow	Cumbria	Private	1978-1996	Pasture
77	Morton Lochs	Fife	Scottish Natural Heritage	1979-1996	Coniferous woodland
78	Morrone Birkwood	Highland	Scottish Natural Heritage	1979-1999	Upland heath & deciduous woodland
96	Coombes Valley	Shropshire	RSPB	1979-2000	Deciduous woodland & grassland
120	Cors y Llyn	Powys	Countryside Council for Wales	1992-2000	Deciduous woodland & grassland
132	St. Margaret's Bay	Kent	Private	1989-2001	Coastal chalk grassland
143	Loch Fleet	Highland	Scottish Natural Heritage	1996-2001	Dune heath
148	Denmark Farm	Ceredigion	Shared Earth Trust	1993-2002	Restored pasture

Site number	Site name	County	Owner/recorder	Years of data in BMS	Main habitat(s)
152	Pengelli	Ceredigion	Countryside Council for Wales	1994-1997	Coniferous woodland
157	Whixall [C]	Shropshire	Countryside Council for Wales	1994-2002	Lowland raised bog
168	Loddington (Arable)	Leicestershire	Allerton Trust	2000-2001	Arable & pasture farmland
169	Loddington (embankment)	Leicestershire	Allerton Trust	2000-2001	Arable & pasture farmland

UPDATES ON THE CONTINUED DEVELOPMENT OF THE BMS

Reporting of annual indices

The data collected by the butterfly transects have proved invaluable for a wide range of applications, including conservation management, butterfly ecological studies and climate change research. We are continually aiming to increase the uses of the invaluable data collected as part of the BMS. In particular, we are trying to expand the ways in which results from the scheme are presented. As part of this process we present collated indices for a wider range of species for the first time and include figures for first broods of bivoltine species, and spring emergence of species which overwinter as adults.

Partnership agreement & collaboration with Butterfly Conservation

We are delighted to report that the partnership agreement between CEH, Butterfly Conservation and Joint Nature Conservation Committee has now been completed and finalised. All three organisations are now striving to attract additional resources to take forward the expansion of the current scheme and explore new ways of monitoring butterflies. Our long-term aim is to produce improved **national**, **regional** and **major habitats collated indices**. We aim to cover the majority of the UKs butterfly species for which the BMS method is a suitable monitoring method, including species for which it has not been possible to provide collated indices in the past. In addition, improved data will be provided for more in depth scientific research into butterfly ecology and for investigating the impacts of climate change.

An update on butterfly monitoring in Scotland

In 2003 there were 26 BMS transects in Scotland which submitted at least some data to the scheme. Two of these transects are single species transects, that is weeks are only recorded during the flight period of the target species.

Following the highly successful one-day workshop on butterfly monitoring organised by Butterfly Conservation that was held in Perth in December 2002, Julie Stoneman from Butterfly Conservation Scotland office carried out an audit of butterfly transects that were being carried out independently of the BMS in Scotland (Stoneman *et al* 2003). The Perth meeting had highlighted some of the problems surrounding butterfly monitoring in Scotland (see page 6 of 2002 report) but also encouraged recorders to start new transects and to record more weeks on existing sites. The result was an improvement in the number of annual indices that could be calculated from Scotlish sites in 2003. Although this may have been partly due to the good summer weather, it is nevertheless encouraging.

The audit (and work subsequent to it) revealed that in 2003 there were 28 independent transects, which together with the BMS transects provide a reasonably good geographic spread of sites (Map 1). The most poorly covered areas are the north and north west of Scotland and Southern Argyll to Galloway. Six of the 28 independent transects were started in 2003. Three transects have been operating for more than a decade, but the majority have been established since 1993. Well over half of BMS transects were started before this period. In 2003 twenty-two of the 28 independent transects submitted data to Butterfly Conservation, four were not walked in 2003 (but are expected to continue) and data are still to be submitted from the other two. Eight transects are for single species. As in the BMS, most transects are on nature reserves or other areas of semi-natural vegetation. Where data exists from years prior to 2003, these are currently being entered into Transect Walker at Butterfly

Conservation Scotland in Stirling, or in some cases are being inputted by current walkers themselves.

Map 1. The distribution of BMS and independent transects in Scotland in 2003

(a second single species transect for the Mountain Ringlet at Creag Meagaidh is not shown). Updated from Stoneman *et al.* (2003).



On February 28th 2004 BC held another meeting for butterfly recorders in Scotland. The venue was Stirling and CEH BMS was again represented. The remit of the meeting was wider than transect monitoring and included general butterfly recording. One hundred and five people booked into the meeting and despite heavy snow falls in parts of Scotland, 92 people attended. It was clear from the response of audience at the meeting that there was considerable interest in, and enthusiasm for, transect monitoring among at least some of those present.

Of the transects that contribute to the BMS in Scotland, six are not currently operating. Two of these, **Tentsmuir** and **Morton Lochs**, were extremely well recorded in the past. Both are part of the same NNR but with very different habitats and were recorded from 1978 and 1979 until 1996 by Pete Kinnear (then of SNH) for 19 and 18 years repectively. Almost all indices could be calculated from the data collected over these years. Prior to the Stirling meeting, three people (including the current site manager of the NNR) had shown an interest in reviving these two transects. Four further volunteers have come forward as a result of an appeal for recorders at the Stirling meeting, giving a team of seven potential recorders to revive these two important Scottish transects. Recording is expected to restart this coming season.

The additional transects significantly increase the number of transects recorded for several scarce or rare butterfly species (Table 2).

Species	Independent Transects	BMS Transects	Total
Chequered Skipper	6	3	9
Marsh Fritillary	1	1	2
Northern Brown Argus	0	2	2
Pearl-bordered Fritillary	9	4	13
Large Heath	3	8	11
Mountain Ringlet	2	2	4
Small Blue	2	1	3
Small Pearl-bordered Fritillary	11	14	25
Dingy Skipper	1	3	4

Table 2. Coverage of UKBAP butterfly species by BMS and independent transects in

 Scotland

Reference

Stoneman, J., Greatorex-Davies, N. & Stewart, K. (2003). A provisional audit of butterfly transects in Scotland. Unpublished report, Butterfly Conservation Scotland, Stirling. 24pp. http://www.butterfly-conservation.org/bcuk/scotland/transect_audit

Transect Walker

Transect data entered into Transect Walker in 2003

There was a large increase in the number of sites submitting data electronically from Transect Walker software in 2003. 54 transects provided data using this method, an increase of 22 from the previous year (32 in 2002). This significant increase in uptake is very encouraging, but curiously did not include seven sites where data had been entered into TW the previous year.

Use of Transect Walker and Field Recording Forms

We continue to recommend Transect Walker (TW) to recorders for electronic submission of data. We also require the Field Recording Forms (FRFs) to check for errors made in transcribing data from the paper forms to TW. A number of important errors are corrected in this way. We supply Field Recording Forms each Spring (or the similar ones produced by Butterfly Conservation) and they are preferable to the use of other forms or field notebooks. They are laid out in a way that makes subsequent data entry into TW easier and help to avoid transcription errors, as well as making it more likely that other details (e.g. weather conditions) are recorded. The use of field notebooks with susequent transfer to FRFs is not recommended as this can introduce additional transcription errors. We do make the use of FRFs obligatory – but would much prefer that you use them! Most important is that the transect is walked and the information is recorded as accurately as possible.

Spring 2004 release of a new version of Transect Walker

To encourage the wider use of Transect Walker, a new version is currently being developed, and should be available in time for entering transect data collected in 2004. Some of the areas of improvement include:

- Easier data entry, e.g. improved input screens
- Extended data input options, e.g. extra species and recording weeks
- Easier data transfer
- New reporting functions
- New import function to provide all past BMS data in Transect Walker format.

SUMMARY OF THE 2003 SEASON

Fuller details of the results summarised here can be found in Table 3, Table 8. Graphs showing the collated indices are given in Appendix I.

Review of changes in indices

A good year for butterflies

The year 2003 was a good year for butterflies, ranking 10th highest of the series (1976-2003) and the best year since 1997. Of the 50 species and generations for which indices of abundance were calculated. 30 increased from 2002 to 2003 and for 12 of these the index more than doubled. There were *four* highest indices ever – the second generation of Adonis Blue, Red Admiral, Comma and Ringlet – but no species had its worst index. Species which fared less well in 2003 were those flying in the spring. Numbers for first generations of bivoltine species were lower than in the previous year, as were counts of **Peacock** and Brimstone after over-winter survival and univoltine species emerging in the spring.



Large influx of migrants

2003 was a very good year for migrant species, with Red Admiral, Painted Lady and Clouded Yellow all seen in large numbers. In particular, the annual total of Red Admirals



was the highest ever for the series with 4909 recorded from 101 sites where an annual index of abundance could be calculated. This markedly exceeds the previous highest value of 3863 in 1996 (from 87 sites).

Although 2003 was also a good year for **Painted Lady** numbers, totals were only around a third those seen in 1996 when a major influx took place. In total, 5799 Painted Lady individuals were counted from 102 transects in 2003 (average of 57 per transect), compared to 13884 individuals counted from 91 transects in 1996

(average of 152 per transect). For sites where an index for **Painted Lady** was available in both 1996 and 2003, the ratio of numbers between the two years was also similar (10442 in 1996 compared to 3594 in 2003).

Recovery of the small heath

The sharp decline in Small Heath numbers seen since 1997 was reversed in 2003. The national index of abundance more than doubled (124% increase) between 2002 and 2003 returning to an average value for the series (1976-2003). Good numbers were recorded on many transects with an index of over 100 being recorded at 28 sites. In particular, counts across southern England returned to levels last seen in the mid 1990s e.g. Fontmell Down, Dorset (830); Castle Hill, East Sussex (704) and Martin Down, Wiltshire (685). Small Heath increased at over 70% of sites producing an annual index in both 2002 and 2003.



Species expanding in distribution also continued to increase in abundance

The Butterflies for the New Millenium (BNM) atlas (Asher et al. 2001) demonstrated expansion in the distribution of a number of species since the previous atlas period of 1970-82 (Heath, Pollard & Thomas, 1984). This spread north continued in 2003 with the **Comma** being seen in Fife for the first time in almost 200 years and the speckled wood reaching the Outer Hebrides. For both species, these sightings were considerably beyond the currently recorded range boundary. Trends at monitored sites also reflect the success of these expanding species with Peacock, Speckled Wood, Comma, Ringlet and Marbled White all





showing significant increases in their national index since 1976. Not surprisingly, a number of these species also had a very good year in 2003. Comma and Ringlet both recorded their highest ever index of abundance, and Speckled wood had its second highest index. Numbers of other expanding species also increased during the year - Small skipper, Large Skipper, Brown Argus, White Admiral, Peacock (summer generation), Marbled White and Gatekeeper.

Increases in second generation counts of whites, but poor numbers in spring

Spring counts of whites (Pieridae) were lower in 2003 than in the previous year. The national index for Orange Tip was 19% lower, but still an average value for this species over the whole BMS series. The drop in first generation indices for Large, Small and Green-veined

White were more marked however showing 48%, 46% and 25% declines from 2002 levels. For each species, the index in 2003 was one of the worst for the whole series, ranking 22nd, 24th and 22nd worst since 1976. The first generation count for all three species declined between 2002 and 2003 at approximately 65% of sites. In contrast, the second generation counts for these three whites were all good. For example, numbers of 2nd generation Large White increased at 65% of sites monitored in both 2002 and 2003, Greenveined White increased at 55% of sites and a remarkable 85% of sites increased for Small White.



Mixed fortunes for fritillaries



Fritillary species had mixed fortunes in 2003. The recent recoveries in Small Pearl-Bordered Fritillary and Pearlbordered Fritillary (yearly increases since 1999) did not continue into 2003. The national index of abundance for Small Pearl-bordered fritillary declined by 14% and **Pearl-bordered Fritillary** by 20%. In contrast, both Silver-washed fritillary and Dark Green Fritillary continued their increases since 2001, showing respectively, a 59% and 85% increase in their national collated index from 2002 to 2003.

Details of the changes outlined on the preceding pages are summarised in Table 2, with further details in Table 8.

In the last column of Table 2 (Trend in all-sites [collated] index), significant trends are identified using simple regressions of \log_{10} all-sites collated index on years (for method see Pollard *et al.* 1995). The figure gives the degree of slope (trend) of the regression line, positive or negative. Asterisks indicate the degree of statistical significance of trend: * P <0.05, ** P<0.01; *** P< 0.001. It should be noted that simple regression results may give rather too many significant results with population data (Diggle, 1990), so these figures should be treated with caution. Nevertheless they do give an indication as to how the different species are faring on monitored sites.

Table 3. Summary of changes 2002/2003.

Species	2002	2003	%	%	rank	rank	Lowest / highest index and other comments	Trend in
	index	index	Down	Up	2002	2003		index
Small Skipper	71	91		28	21	17		0.005
Silver-spotted Skipper	201	664		230	11	2	Highest index since 1997	0.61 ***
Large Skipper	79	92		17	21	15		0.020
Dingy Skipper	83	78	6		19	23		-0.088 **
Grizzled Skipper	110	63	43		10	24		-0.11 *
Brimstone 1 (spring)	96	90	6		17	19		0.03
Brimstone 2 (autumn)	87	76	13		18	24		-0.058 *
Large White 1 (1 st generation)	106	55	48		13	22		-0.20 **
Large White 2 (2 nd generation)	71	106		49	23	10		-0.048
Small White 1	117	63	46		12	24		-0.14 **
Small White 2	50	153		206	26	7		0.006
Green-veined White	111	83	25		11	22		-0.037
Green-veined White	94	118		26	16	9		0.016
Orange Tip	124	101	19		5	13		0.027
Green Hairstreak	95	54	43		17	26	3 rd worst index	-0.057
Purple Hairstreak	152	54	64		7	25		-0.034
Small Copper 1	106	69	35		12	23		0.036
Small Copper 2	74	160		117	21	5		0.004
Small Blue	57	129		127	22	9		-0.040
Silver-studded Blue	198	147	26		6	9		0.24 **
Brown Argus 2	70	157		124	21	9		0.090
Northern Brown Argus	82	78	5		18	20		0.090
Common Blue 1	62	124		101	26	9		-0.055
Common Blue 2	109	160		47	15	5		0.051
Chalkhill Blue	55	74		35	26	22		-0.016
Adonis Blue 1	213	210	1		5	6		0.12
Adonis Blue 2	176	642		265	7	1	Highest index ever	0.28 *
Holly Blue 1	519	166	68		5	11	<u> </u>	0.20
Holly Blue 2	93	73	22		15	17		0.094
White Admiral	40	67		68	27	20		-0.19 ***
Red Admiral	124	365		195	12	1	Highest index ever	0.26 ***

Species	2002	2003	%	%	rank	rank	Lowest / highest index and other comments	Trend in
_	index	index	Down	Up	2002	2003	-	index
Painted Lady	282	2005		611	7	2	2 nd highest index, only 1996 higher	0.27
Small Tortoiseshell	78	169		116	18	6		-0.026
Peacock 1	175	112	36		3	14		0.13 ***
Peacock 2	73	102		40	23	13		0.080 *
Comma	159	267		68	9	1	Highest index ever	0.21 ***
Small Pearl-bordered Fritillary	65	56	14		22	24		-0.19 ***
Pearl-bordered Fritillary	64	51	20		20	25		-0.20 **
High Brown Fritillary	53	122		130	25	11		0.006
Dark Green Fritillary	83	153		85	18	5		-0.017
Silver-washed Fritillary	82	131		59	19	6		0.010
Speckled Wood	141	172		22	7	2	2 nd highest index	0.16 ***
Wall Brown 1	83	87		4	22	18		-0.088
Scotch Argus	164	162	1		5	7		0.21 ***
Marbled White	94	122		30	17	13		0.14 **
Grayling	51	67		31	28	22		-0.16 ***
Hedge Brown (gatekeeper)	83	104		25	18	11		-0.061
Meadow Brown	85	111		30	20	10		0.042
Small Heath	47	105		124	28	14	Good increase in 2003, counter to recent	-0.13 ***
							declines	
Ringlet	143	201		41	9	1	Highest index ever	0.25 ***

Summary of the weather in 2002 / 2003

Table 2 shows a summary of UK weather in 2002/2003. Weather summaries are provided by Weatherquest (<u>http://www.uea.ac.uk/~e870/guardian.htm</u>). The summary is for the UK as a whole and so will not necessarily describe weather in particular regions precisely. Anomalies are with respect to the 1951-80 average.

2003 was generally warm, dry and sunny. Spring and late summer were particularly favourable, with February, March and August having 40-67% less rain and 28-48% more sunshine than average.

2002	Daytime temp	Rainfall (%)	Sunshine(%)	Brief description	
January	+1.6	0	-12	Cloudy and mild	
February	+2.0	+98	+8	Mild and very wet	
March	+1.6	-13	+3	Mild	
April	+1.3	-8	+13	Mild and quite sunny	
May	+0.6	+51	-7	Rather wet	
June	0	+17	-14	Quite wet	
July	-0.3	+25	-10	Quite cool and wet	
August	+1.1	-26	-8	Warm and dry	
September	+1.0	-51	+13	Warm, dry and sunny	
October	-0.9	+80	+4	Cool and very wet	
November	+1.4	+52	-5	Wet and very mild	
December	-0.3	+2	-21	Cloudy	
Annual	+0.7	+14	-2	Warmer and wetter than average	
2003	Daytime temp	Rainfall (%)	Sunshine(%)	Brief description	
2003 January	Daytime temp +0.6	Rainfall (%) +10	Sunshine(%) +39	Brief description Mild and sunny	
2003 January February	Daytime temp +0.6 +0.4	Rainfall (%) +10 -47	Sunshine(%) +39 +48	Brief description Mild and sunny Mild, dry and sunny	
2003 January February March	Daytime temp +0.6 +0.4 +2.4	Rainfall (%) +10 -47 -40	Sunshine(%) +39 +48 +38	Brief description Mild and sunny Mild, dry and sunny Warm, dry and sunny	
2003 January February March April	Daytime temp +0.6 +0.4 +2.4 +2.2	Rainfall (%) +10 -47 -40 -23	Sunshine(%) +39 +48 +38 +25	Brief description Mild and sunny Mild, dry and sunny Warm, dry and sunny Warm, dry and sunny	
2003 January February March April May	Daytime temp +0.6 +0.4 +2.4 +2.2 +0.6	Rainfall (%) +10 -47 -40 -23 +33	Sunshine(%) +39 +48 +38 +25 -9	Brief description Mild and sunny Mild, dry and sunny Warm, dry and sunny Warm, dry and sunny Warm, dry and sunny Wet	
2003 January February March April May June	Daytime temp +0.6 +0.4 +2.4 +2.2 +0.6 +1.6	Rainfall (%) +10 -47 -40 -23 +33 +8	Sunshine(%) +39 +48 +38 +25 -9 +2	Brief description Mild and sunny Mild, dry and sunny Warm, dry and sunny Warm, dry and sunny Wet Warm	
2003 January February March April May June July	Daytime temp +0.6 +0.4 +2.4 +2.2 +0.6 +1.6 +1.5	Rainfall (%) +10 -47 -40 -23 +33 +8 -8	Sunshine(%) +39 +48 +38 +25 -9 +2 -5	Brief description Mild and sunny Mild, dry and sunny Warm, dry and sunny Warm, dry and sunny Warm Warm Warm	
2003JanuaryFebruaryMarchAprilMayJuneJulyAugust	Daytime temp +0.6 +0.4 +2.4 +2.2 +0.6 +1.5 +2.4	Rainfall (%) +10 -47 -40 -23 +33 +8 -8 -67	Sunshine(%) +39 +48 +38 +25 -9 +2 -5 +28	Brief descriptionMild and sunnyMild, dry and sunnyWarm, dry and sunnyWarm, dry and sunnyWetWarmWarmWarmVery warm, dry and sunny	
2003 January February March April May June July August September	Daytime temp +0.6 +0.4 +2.4 +2.2 +0.6 +1.5 +2.4 +1.5	Rainfall (%) +10 -47 -40 -23 +33 +8 -8 -67 -39	Sunshine(%) +39 +48 +38 +25 -9 +2 -5 +28 +17	Brief description Mild and sunny Mild, dry and sunny Warm, dry and sunny Warm, dry and sunny Wet Warm Warm Very warm, dry and sunny Warm Warm, dry and sunny	
2003 January February March April May June July August September October	Daytime temp +0.6 +0.4 +2.4 +2.2 +0.6 +1.6 +1.5 +2.4 +1.5 -1.1	Rainfall (%) +10 -47 -40 -23 +33 +8 -8 -67 -39 -15	Sunshine(%) +39 +48 +38 +25 -9 +2 -5 +28 +17 +30	Brief description Mild and sunny Mild, dry and sunny Warm, dry and sunny Warm, dry and sunny Wet Warm Warm Very warm, dry and sunny Warm Cool, dry and sunny	
2003 January February March April May June July August September October November	Daytime temp +0.6 +0.4 +2.4 +2.2 +0.6 +1.5 +2.4 +1.5 -1.1 +1.5	Rainfall (%) +10 -47 -40 -23 +33 +8 -8 -67 -39 -15 +11	Sunshine(%) +39 +48 +38 +25 -9 +2 -5 +28 +17 +30 +7	Brief description Mild and sunny Mild, dry and sunny Warm, dry and sunny Warm, dry and sunny Wet Warm Warm Very warm, dry and sunny Warm Cool, dry and sunny Mild	
2003 January February March April May June July August September October November December	$\begin{array}{c} \textbf{Daytime} \\ \textbf{temp} \\ +0.6 \\ +0.4 \\ +2.4 \\ +2.2 \\ +0.6 \\ +1.6 \\ +1.5 \\ +2.4 \\ +1.5 \\ -1.1 \\ +1.5 \\ +0.2 \\ \end{array}$	Rainfall (%) +10 -47 -40 -23 +33 +8 -8 -67 -39 -15 +11 +1	Sunshine(%) +39 +48 +38 +25 -9 +2 -5 +28 +17 +30 +7 +25	Brief description Mild and sunny Mild, dry and sunny Warm, dry and sunny Warm, dry and sunny Wet Warm Very warm, dry and sunny Warm Very warm, dry and sunny Warm Vory warm, dry and sunny Warm, dry and sunny Warm, dry and sunny Sunny	

Table 4. Summary of UK weather in 2002/2003.

SITES CONTRIBUTING DATA TO THE BMS IN 2003

The number of sites contributing data to the BMS in 2003

The BMS was officially launched in 1976 with just 36 sites contributing to the scheme. However three years of trials preceded this when data were being gathered to test the method. Seven sites still in the BMS, which were monitored during this period as part of this process, have data going back to 1974. The number of sites contributing to the BMS (Figure 1) has gradually increased over the years with at least one site being added to the scheme in most years. Three new sites were brought into the BMS in 2003, but six were lost.

In 2003, 130 of the 134 transects part of the BMS submitted at least some data to the scheme. Only one transect produced no data at all in 2003, data for two further transects were not received in time to contribute to this report. The distribution of the transects currently part of, or contributing to, the BMS is shown on Map 1.



Figure 1. Number of sites contributing data to the scheme

Distribution of sites

Map 2. BMS and ECN sites in 2003. Symbols are as follows: BMS = dark blue; ECN = light blue; New sites in 2003 = red; Non-current sites = grey. Boundaries are Watsonian Vice-Counties.



Percentage of counts completed

The overall percentage of counts completed in 2003 was 78%, an improved level compared to recent years (Table 3), and a similar level to other sunny summers (e.g. 1982, 1984, 1990, 1992, 1995 and 1997). All sites submitting at least some data have been included in the analysis.

Year	% of weeks	Number of	Number of weekly
	completed	sites	counts
1976	68%	36	639
1977	62%	62	996
1978	69%	68	1219
1979	74%	83	1587
1980	76%	82	1610
1981	74%	84	1607
1982	79%	83	1714
1983	72%	88	1649
1984	79%	86	1761
1985	73%	88	1659
1986	72%	86	1621
1987	73%	88	1680
1988	75%	89	1732
1989	78%	99	2012
1990	80%	96	2002
1991	75%	98	1920
1992	78%	103	2098
1993	73%	109	2076
1994	72%	112	2089
1995	75%	121	2370
1996	73%	126	2388
1997	76%	121	2380
1998	68%	119	2109
1999	74%	125	2406
2000	74%	133	2552
2001	68%	118	2090
2002	74%	125	2413
2003	78%	130	2633

Table 5. Percentage of counts completed 1976-2003.

With good summer weather, the level of recording was good through most of the season in 2003. For details of regions see previous reports.



Figure 2. The number of sites with completed transects in each recording week 2002

Figure 3. The number of sites with completed transects in each recording week 2003



The number of weeks recorded for each transect

The number of weeks recorded for each transect in 2002 and 2003 are shown in Figures 4 and 5 respectively. For details of regions see previous reports.



Figure 4. Number of weeks recorded for each transect in 2002



Figure 5. Number of weeks recorded for each transect in 2003

Annual indices and the proportion that could be calculated

Site annual indices are calculated for each species for each transect where the species occurs and where data are sufficient. An annual index for a species is simply the total mean weekly count on a transect for the year including estimates (see section on estimates below). Where a species is double-brooded or, in the case of the hibernating species Peacock and Brimstone where there is a separate spring and summer flight, two separate indices are calculated. Where species produce a third brood (notably Small Copper and Wall Brown) third brood figures are combined with those of the second brood. In some cases the divisions between the broods are indistinct and a single index is given for the year. These species are Red Admiral, Painted Lady, Small Tortoiseshell, Comma, Speckled Wood and Small Heath.

Table 6. The number of transects for which different proportions of annual indices could be calculated for all years (1976 – 2003) for all transects recorded in each year.

Year	0%	>0-20%	20-40%	40-60%	60-80%	80-<100%	100%	Number of
								transects
1976	2	0	1	1	2	22	8	36
1977	11	1	1	2	3	15	29	62
1978	9	2	2	4	5	17	29	68
1979	5	2	2	2	5	12	55	83
1980	3	0	2	2	9	14	52	82
1981	4	1	2	1	2	13	61	84
1982	4	1	0	1	5	18	54	83
1983	2	0	1	1	6	20	58	88
1984	2	0	1	3	11	12	57	86
1985	5	3	2	3	7	16	52	88
1986	2	3	3	5	13	7	53	86
1987	6	2	2	2	18	22	36	88
1988	6	1	5	8	9	10	50	89
1989	6	2	2	4	10	16	59	99
1990	3	2	2	3	8	16	62	96
1991	5	4	2	5	17	25	40	98
1992	5	5	2	7	3	20	61	103
1993	17	6	2	1	6	20	57	109
1994	13	2	3	5	18	19	52	112
1995	9	3	8	11	17	23	50	121
1996	20	2	7	10	9	32	46	126
1997	16	9	7	10	11	26	42	121
1998	20	5	7	12	20	40	15	119
1999	17	5	12	12	20	32	27	125
2000	13	10	9	12	20	34	35	133
2001	17	7	11	19	15	30	19	118
2002	24	5	6	7	14	36	33	125
2003	4	8	10	7	16	22	63	130

Numbers of butterflies recorded

The number of sightings of butterfly species recorded on BMS transects in 2003 are listed in Table 7. Numbers included in this analysis are only those where sufficient data were provided in either 2002 or 2003 for site annual indices to be calculated.

Species	2002	2003	2002	2003
-F			order	order
Meadow Brown	39120	54224	1	1
Gatekeeper	13280	18597	2	2
Ringlet	12324	17810	3	3
Common Blue	6413	12608	6	4
Green-veined White	10475	11746	4	5
Small Heath	3968	10580	10	6
Speckled Wood	7765	9614	5	7
Small White	3475	8832	12	8
Small Tortoiseshell	3628	7223	11	9
Small Skipper	5174	6583	8	10
Adonis Blue	2065	6052	19	11
Painted Lady	779	5799	24	12
Peacock	5538	5766	7	13
Red Admiral	1471	4909	21	14
Marbled White	3158	4498	13	15
Scotch Argus	2861	3949	15	16
Large White	2934	3824	14	17
Chalk-hill Blue	2757	3625	16	18
Small Copper	1397	3201	22	19
Large Skipper	2469	2874	18	20
Brimstone	2516	2025	17	21
Comma	1197	1916	23	22
Dark Green Fritillary	678	1610	27	23
Grayling	737	1191	26	24
Wall Brown	778	1152	25	25
Orange Tip	1637	1102	20	26
Brown Argus	491	1004	30	27
Silver-washed Fritillary	331	792	33	28
Dingy Skipper	597	515	29	29
Heath Fritillary	439	511	32	30
Small Pearl-bordered Fritillary	270	498	36	31
Silver-studded Blue	4304	468	9	32
Northern Brown Argus	278	412	35	33
Silver-spotted Skipper	197	383	40	34
Large Heath	118	286	44	35
Small Blue	120	244	43	36
Pearl-bordered Fritillary	269	212	37	37
Clouded Yellow	187	196	41	38
High Brown Fritillary	81	195	47	39
Holly Blue	450	195	31	40

 Table 7. Sum of site indices and order of abundance for 2002 and 2003

Species	2002	2003	2002	2003
•			order	order
Green Hairstreak	249	190	38	41
White Admiral	85	183	46	42
Grizzled Skipper	280	182	34	43
Chequered Skipper	19	145	52	44
Marsh Fritillary	214	142	39	45
Mountain Ringlet	34	68	49	46
Wood White	95	67	42	47
Purple Hairstreak	138	48	45	48
Swallowtail	23	38	51	49
Duke of Burgundy Fritillary	54	36	48	50
Brown Hairstreak	12	31	54	51
Lulworth Skipper	30	16	50	52
Purple Emperor	3	5	56	53
White-letter Hairstreak	4	4	55	54
Black Hairstreak	13	2	53	55

Summary of changes at site level 2002/2003

The changes in the site indices for all species from 2002 to 2003 are summarised for sites where annual indices could be calculated (Table 8). Collated indices for 2002 and 2003 are shown where these are calculated. Some species do not have collated indices because they are recorded on too few BMS transects for a meaningful index to be calculated. Collated indices should be treated with caution where they have been calculated using relatively few transects, e.g. Chalkhill Blue, Small Pearl-bordered and Pearl-bordered Fritillaries and Silver-washed Fritillary.

Table 8. Summary of changes at site level 2002/2003

(No. of sites with index in 2002 or 2003', includes transects where the index was zero in both years)

Species - brood		No. of sites with indices 1976-2003	Average no. of sites with indices per year	No. of sites with index in 2002 or 2003	No. of sites with index in 2002 and 2003	Increase	Decrease	No change	Zero index in 2002 and 2003	2002 only	2003 only	Collated index 2002	Collated index 2003
Chequered Skipper	1	2	1	2	2	1		1					
Small Skipper	1	121	65	90	71	36	26	5	4	8	11	72	92
Lulworth Skipper	1	1	1	1	1		1						
Silver-spotted Skipper	1	12	6	9	5	5				2	2	202	665
Large Skipper	1	135	69	97	72	42	26	1	3	9	16	80	93
Dingy Skipper	1	55	30	38	23	6	10		7	8	7	84	79
Dingy Skipper	2	1	1	1	1				1				
Grizzled Skipper	1	44	27	35	27	5	8	1	13	4	4	111	64
Swallowtail	1	3	2	2	1	1					1		
Wood White	1	11	8	9	9		1		8				
Wood White	2	1	1	1	1				1				
Pale Clouded Yellow	1	8	6	7	7				7				
Clouded Yellow	1	117	67	81	50	15	11	2	22	12	19		
Brimstone	1	114	59	82	58	22	28	3	5	15	9	97	91
Brimstone	2	116	63	84	64	25	26	3	10	10	10	88	77
Large White	1	165	73	106	74	16	47	2	9	22	10	107	56
Large White	2	168	79	114	83	54	23	5	1	11	20	72	107
Small White	1	157	70	101	76	11	50	6	9	15	10	118	64
Small White	2	163	75	113	81	69	9		3	12	20	51	154
Green-veined White	1	169	73	111	80	21	55	1	3	15	16	112	84
Green-veined White	2	172	79	118	91	50	35	3	3	10	17	95	119
Orange Tip	1	146	69	97	64	21	36	3	4	16	17	125	102
Green Hairstreak	1	72	38	46	29	7	15	1	6	7	10	96	55
Brown Hairstreak	1	12	8	10	9	4	2		3		1		
Purple Hairstreak	1	62	40	51	39	6	18	2	13	6	6	153	55
White-letter Hairstreak	1	28	21	24	17	2	2		13	3	4		
Black Hairstreak	1	5	4	4	4		2		2				
Small Copper	1	155	73	97	66	12	16	3	35	15	16	107	70
Small Copper	2	159	76	106	71	46	15	1	9	13	22	75	161
Large Copper	1	1	1	1	1				1				
Small Blue	1	25	14	16	12	5	1		6	1	3	58	130
Small Blue	2	15	7	13	7	3	3		1	2	4		

Species - brood		No. of sites with indices 1976-2003	Average no. of sites with indices per year	No. of sites with index in 2002 or 2003	No. of sites with index in 2002 and 2003	Increase	Decrease	No change	Zero index in 2002 and 2003	2002 only	2003 only	Collated index 2002	Collated index 2003
Silver-studded Blue	1	11	5	8	4	1	1		2	1	3	199	148
Brown Argus	1	69	41	58	43	7	10	1	25	5	10		
Brown Argus	2	72	42	60	41	21	6	3	11	7	12	71	158
Northern Brown Argus	1	12	5	9	4	1	3			1	4	83	79
Common Blue	1	166	81	108	73	38	20	4	11	13	22	63	125
Common Blue	2	165	77	110	80	51	11	3	15	13	17	110	161
Chalk-hill Blue	1	28	19	23	19	9	2		8	2	2	56	75
Adonis Blue	1	14	8	11	10	5	3		2		1	214	211
Adonis Blue	2	15	9	12	12	9	1		2			177	643
Holly Blue	1	111	57	83	55	5	35	4	11	18	10	520	167
Holly Blue	2	112	62	85	63	13	18	3	29	9	13	94	74
Duke of Burgundy	1	19	11	15	11	1	2		8	2	2		
Fritillary		•				- 10							
White Admiral	1	39	25	34	25	13	4	1	1	3	6	41	68
Purple Emperor	1	9	6	8	8	2	10		6				
Red Admiral	1	168	78	116	86	72	10	4		14	16	125	366
Painted Lady	1	162	76	114	80	78	10	2		12	22	283	2006
Small Tortoiseshell	1	167	72	110	82	68	13	1		17	11	79	170
Camberwell Beauty	1	2	2	2	2				2				
Camberwell Beauty	2	2	2	2	2		(0)		2	24	1.7	176	110
Peacock	1	154	68	109	/0	10	62	-	1	24	15	1/6	113
Peacock	2	161	77	118	83	48	30	2	3	10	24	1.0	103
Comma	1	122	62	91	64	45	18	1		18	12	160	268
Small Pearl-bordered	I	56	23	34	19	2	10	1	6	2	13	66	57
Printing Poor bondoned Eritillary	1	40	10	26	15	1	2		0	5	6	65	50
Iliah Drown Eritillary	1	40	19	20	15	4	<u></u>		9	3	2	54	$\frac{32}{122}$
Derly Croop Emitillary	1	<u> </u>	/ 10	0 55	20	16	0	2	12	6	11	<u> </u>	123
Silver weeked Eritillery	1	<u> </u>	40	26	20	10	2	2	12	2	2	04	134
Marsh Fritillary	1	17	20	11	- 30	11	1	2	6	1	3	05	152
Glanville Fritillary	1	1/	<u> </u>	11	<u> </u>		1		0	1			
Heath Fritillary	1	<u> </u>	3	1 	3	1	2			1	1		
Speckled Wood	1	131	67	ہ 96	80	52	23	3	2	9	7	142	173
Wall Brown	1	127	64	85	53	5	18	3	27	16	16	84	88
Wall Brown	2	127	68	89	65	17	18	1	29	7	17	04	
Mountain Ringlet	1	2	1	2	1	1	10	-		,	1		
Scotch Argus	1	14	6	13	7	3	2		2	1	5	165	163
Marbled White	1	67	42	55	42	27	7		8	6	7	95	123
Gravling	1	58	30	39	30	13	7	1	9	2	7	52	68
Gatekeeper	1	128	68	97	76	52	22		2	8	13	84	105
Meadow Brown	1	172	82	126	92	70	22			10	24	86	112
Small Heath	1	156	75	97	66	37	14	2	13	8	23	48	106
Large Heath	1	14	4	8	2	2		-	10	1	5		
Ringlet	1	133	63	98	65	53	10	1	1	13	20	144	202

Comparison of the 28 years of the BMS

The following method has been used to assess the overall relative abundance of butterflies in each of the 28 years of the BMS (1976-2003). For the 32 species for which all-sites collated indices have historically been calculated, the years have been ranked 1 to 28 according to the collated index value for the species. The score 1 was given to the year with the highest value (best year), and 28 to the year with the lowest value. For each year, the 32 ranks were summed, to give an overall indication of the year's quality for butterflies compared with the other years in the series. Figure 6 shows these sums of ranks. The overall ranking of years is shown above the columns in the histogram. 1981 emerges as the worst butterfly year of the series overall, and 1982 as the best. 2003 comes out as the 10th best year of the scheme using this method.

Figure 6. Histogram showing the sum of the ranks of each species for which a collated index is calculated for each year of the BMS, 1976-2003.



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APPENDIX I. Collated indices graphs, 1976-2003

Figure 7. Log collated indices, 1976-2003.

The graphs on the following pages show fluctuations in the all-sites collated indices. These include all species for which sufficient site annual indices can be calculated. Where species are bi- or multivoltine (two or more generations per year) or have a separate spring and summer-autumn flight (i.e. Brimstone and Peacock) both broods/flight are given although the second brood/flight is generally the most abundant and used to assess change. In the case of species which have a partial third brood, such as the Small Copper and Wall Brown, third brood figures are included with the second brood figures. For some bivoltine species it is difficult to separate the generations due to significant overlap in the broods. These are Painted Lady, Red Admiral, Comma, Small Tortoiseshell, Speckled Wood and Small Heath. In these cases a single all-season index is calculated.

Graphs should be interpreted with caution for species and broods which produce, or have produced, collated index values with large associated standard errors. In these cases, indices are based on relatively few sites and include Silver-spotted Skipper, Scotch Argus, Small Blue, Sliver-studded Blue, Northern Brown Argus, High Brown Fritillary and Adonis Blue. All figures are of logged values and, where practical, are shown to the same scale so that visual comparisons between graphs can be made. However, note the extended scale for the species listed above which have large standard error bars or species with large annual variations in numbers, e.g. Holly Blue and Painted Lady.



Figure 7. Log collated indices, 1976-2003





Figure 7. Log collated indices, 1976-2003



Figure 7. Log collated indices, 1976-2003



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Figure 7. Log collated indices, 1976-2003



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Appendix II: Voltinism and flight-periods of the Common Blue

Background

The Common Blue is notable for geographic differences in its life cycle. This species is bivoltine in southern and central England but typically has one generation per year in northern England and Scotland. There is some flexibility in this general pattern however. The Butterfly Monitoring Scheme (BMS) data show clearly that there are some sites where it generally has one generation, but, in warm summers, may have two. We review data from these and other BMS sites to examine how warm summers such as 2003 may affect voltinism and flight-periods of this species in northern England and Scotland.



Introduction

The Common Blue is widespread throughout Britain and Europe except at high altitude. In Britain, it can be found from the south coast of England to the north of Scotland (Asher *et al.*, 2001) and is present in almost all countries throughout Europe (Tolman and Lewington, 1997). The Common Blue has also been found on most Butterfly Monitoring Scheme sites (166 in total) (Figure 1).

There are clear geographical differences in the life cycle of the Common Blue, with bivoltine populations occurring through most of England and univoltine populations occurring Scotland. In the south of Britain, adults of the first generation usually emerge in May. Eggs are laid on a range of leguminous plants, with Birdsfoot Trefoil (*Lotus corniculatus*) and Black Medic (*Medicago lupulina*)

commonly used. The second generation adults fly in late summer and Dennis (1985) recorded a switch in major food plants, dependent on seasonal availability, in the two generations. Frohawk (1934) considered that only a small proportion of larvae from the first generation of the Common Blue develop rapidly and emerge as adults in the same summer, the rest overwinter and emerge in the following spring. However, evidence from the BMS suggests that a high proportion of larvae develop quickly, at least in the south of Britain, as the second generation index is usually larger (around twice as big) than the first (Figure 2).



Figure 1. The abundance of Common Blue on Butterfly Monitoring Scheme (BMS) sites. Symbols represent the mean annual index on each site in five categories: 1-15; 16-50; 51-100; 101-175; 175-225.



Figure 2. The flight period of Common Blue at BMS sites in England and Wales (1976-2002), south of the Ordinance Survey 365km north grid line.



The flight periods of univoltine populations in the north of Britain typically begin in June and at some sites lasts into September. These single flight-periods are usually longer than either of the two in the south. Based on analyses of data from the BMS, Pollard and Yates (1993) suggest that the Common Blue is one of the very few British species in which voltinism appears to be disjunct, i.e. the usual number of flight-periods switches from two to one, with a clear, although not mapped, geographical boundary. They suggest that there is some intermediate voltinism at the boundary itself, but had been little studied. With a further ten years of data, we can now examine the voltinism and flight periods of the Common Blue in greater detail.

Evidence from Butterfly Monitoring Scheme

We have examined fifteen sites in northern England and Scotland that support good numbers of Common Blue. At each site we compare the flight period in 2003 with the typical flight period seen in previous years that were monitored. Five sites occur at the suggested geographic boundary between univoltine northern populations of Common Blue and bivoltine southern populations. Two of these, Rostherne Mere and Saltfleetby, have produced two generations in each year since they began monitoring in the late 1970s (Figure 3a), but at both sites the second generation count in 2003 was markedly larger than the first. This suggests a greater proportion of individuals developed within the season in 2003 than has been typical in previous years.

Figure 3. The flight period of Common Blue. a) Saltfleetby and Rostherne Mere



Although slightly further south of these two sites, populations of Common Blue at Derbyshire Dales have typically been univoltine since monitoring began there in 1979, possibly due to its higher altitude (around 235m compared to around sea level). Although, variable counts at this site make flight periods difficult to interpret, two generations have been apparent in recent years, including 2003 (Figure 3b).

b) Derbyshire Dales



There have generally been two generations each year for Common Blue populations at both Thorne Moors and Leighton Moss; monitoring began in 1990 and 1977 respectively at these two sites. There is a clear separation between the May and July/August broods in 2003 that is not apparent in previous years (Figure 3c). The flight period of Common Blue at these sites in 2003 is also characterised by a relatively large second brood, whereas the size of the two generations is approximately even in previous years.

c) Thorne Moors and Leighton Moss



Sites further north from Leighton Moss and the southern lake district are characterised by having univoltine populations that tend to produce a few second generation individuals in warm years. Smardale Gill, Bishop Middleham Quarry, Mabie Forest are characteristic of this pattern, with each having a small emergence of adults in September 2003. It was also notable in 2003 that the flight period of the main emergence was around a month earlier at Bishop Middleham Quarry and Mabie Forest than in previous years (Figure 3d).

d) Smardale Gill, Bishop Middleham Quarry and Mabie Forest



Three sites on the east coast of Britain near the Scotland/England border (Lindisfarne, Newton Links and St. Abbs Head) all have univoltine populations of Common Blue. Each had a relatively early summer emergence in June/July 2003. St. Abbs Head also had a partial emergence in early September (Figure 3e).

e) Newton Links, Lindisfarne and St. Abbs Head



Common Blue populations at Creag Meagaidh, St. Cyrus, Sands of Forvie are also typically univoltine, as are those at Loch Fleet even though it has not been monitored since 2001. The three sites monitored in 2003 had a relatively early flight period compared to previous years (Figure 3f).

f) Greag Meagaidh, St. Cyrus, Sands of Forvie and Loch Fleet Greag Meagaidh



Conclusions

Differences in the flight period of Common Blue between 2003 and previous years were apparent at most sites examined. In particular, two aspects were notable:

- 1. The flight periods at sites near the geographic boundary between univoltine and bivoltine populations were typical of those seen at sites further south. The second generation was around twice the size of the first, whereas both generations were almost equal in most previous years. Also, the separation between the two broods in 2003 was more noticable than in previous years.
- 2. Populations of Common Blue in Scotland remain predominantly univoltine. However, flight periods at these sites were generally around a month earlier in 2003 than previous years and many also have produced a small partial second brood in September.



Although this is a limited examination of the voltinism and flight period of Common Blue, it does suggest a degree of flexibility in the life cycle of this species. What remains to be tested is how far we can predict these and other aspects of this species' ecology, particularly in relation to climate change. However, it seems apparent that the geographic boundary between univoltine and bivoltine populations is likely to progress northwards under warmer conditions.

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