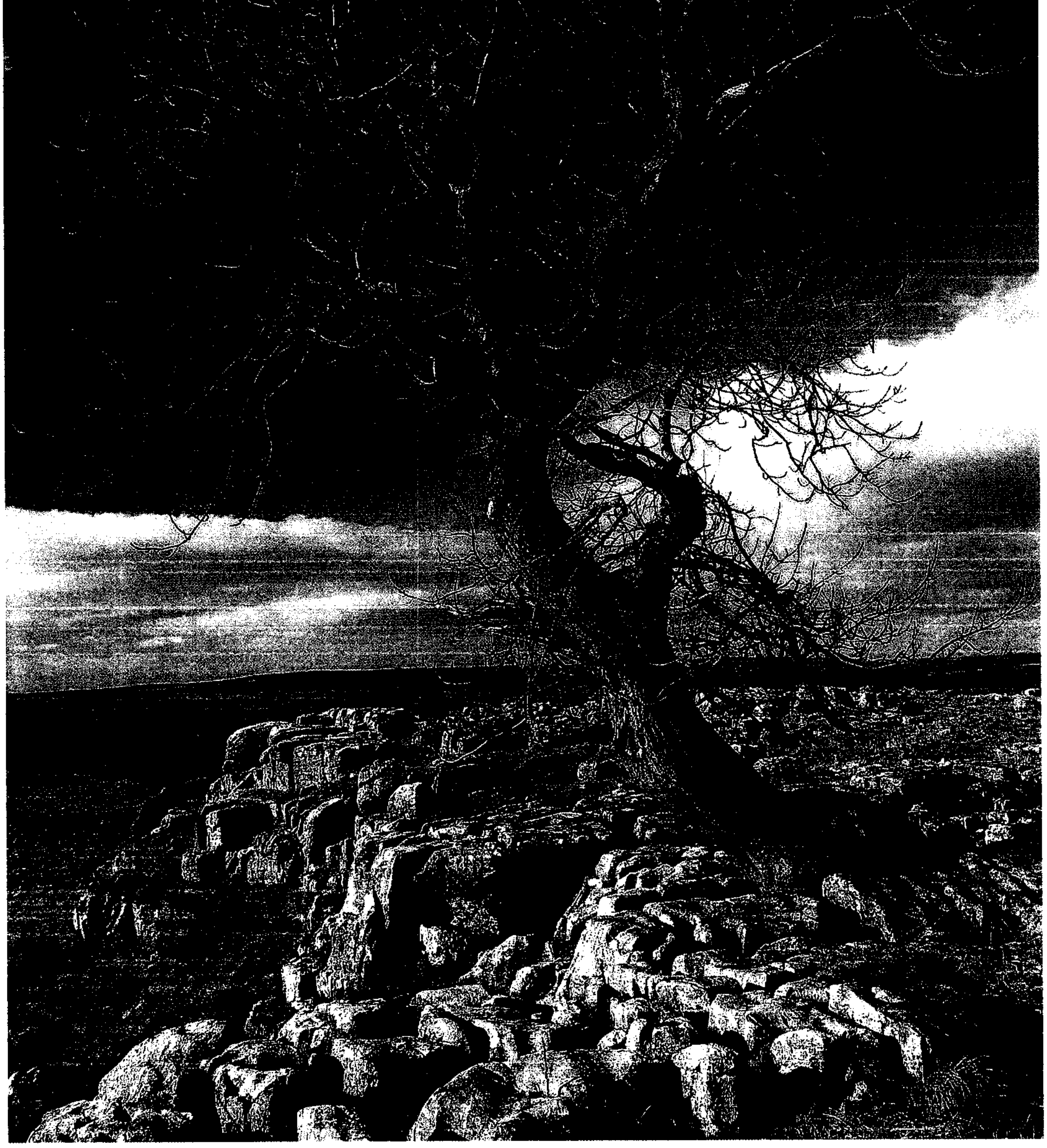
BRINGING
ENVIRONMENTAL
UNDERSTANDING TO ALL

Life in a Limestone Landscape

The Malham Tarn Research Seminar

14th – 16th November 2003



CONTENTS

		Page
Foreword		3
Acknowledgements		3
Rationale		4
Programme		5
Proceedings: Abstracts		
Life		
▪ Grassland monitoring at Malham Tarn Close 1956-2001	J Allinson	6
▪ Variation in Malham population of large yellow sedge(*Carex flava*) and its implications		P
Ashton	10	
▪ A future for White-clawed crayfish in the Dales?	P Bradley	12
▪ Aquatic macrophyte ecology of Malham Tarn: 1994 to 2003	G Hinton	14
▪ The Mollusca of Malham	A Norris	17
▪ Butterflies of Malham Tarn: Fifty years of change	T Whittaker	19
Landscape		
▪ Changes in the Malham Tarn carbon cycle	P Coletta	21
▪ Erratic judgements, re-assessment of landform-based limestone	H Goldie	
22erosion rates		
▪ Preliminary observations on small to medium scale mature surface karst landforms in NW England	H Goldie	24
▪ The evidence for palaeokarst in the Malham high country	M Marker	26
▪ Re-thinking the origin of limestone pavements	P Vincent	28
Cowside Beck reports		
▪ Cowside Beck Introduction	A Pickles	29
▪ Geomorphology	H Goldie & M Marker	31
▪ Cowside Beck caves	D Hodgson	33
▪ Water chemistry	D Richardson	36
▪ Lichen Survey	O Gilbert	38
▪ Freshwater invertebrates	D Richardson	42
▪ Bryophytes	M Proctor	43
▪ Diatoms	D Richardson	45
▪ Algae	A Pentecost	46
Wider dissemination of information and the Amateur/Academic interface	S Gill & M Samworth	48
Authors and Contacts		49
Attendees		50

FOREWORD

The 2003 Seminar title *"Life in a Limestone Landscape"* emerged following the previous seminar as an all embracing heading that would provide space for the potential range of topics.

The range of papers covered topics from palaeo-karst land surfaces to changing butterfly populations around Malham Tarn. Also presented were the findings of the Cowside Beck Research Group established following the 2001 Seminar. The proceedings have been grouped under the headings of Life, Landscape, Cowside Beck and Information Flow.

Each presentation was of interest in its own right, collectively the works are a step forward in our understanding of the environment of Malham Tarn. A common theme for the weekend was change; change in occurrence, change in interpretation or changing roles. For the Cowside Beck Group this was the first opportunity to present and share the results of their work. The Cowside Beck work crosses the amateur-professional divide raised by Steve Gill and Mike Samworth and discussed informally over the weekend.

The dates of the Fourth Malham Tarn Research Seminar are Friday 18th – Sunday 20th November 2005. This will provide us with an opportunity to consider research priorities for the future as well as sharing results from ongoing work. Ideas and suggestions about topics, speakers or other issues will be gratefully received.

Adrian Pickles

Head of Centre
Malham Tarn Field Centre
September 2004

ACKNOWLEDGEMENTS

All contributors and attendees

Keith Orrell for chairing the sessions

Helen Goldie and Margaret Marker for compiling proceedings

Malham Tarn Field Centre Staff for looking after us so well

Elizabeth Judson for co-ordinating and facilitating the weekend

Robin Sutton for the cover photograph

The Third Malham Tarn Research Seminar

LIFE IN A LIMESTONE LANDSCAPE

Friday 14 – Sunday 16th November 2003

A series of talks, displays and discussions about landscape, conservation and the future, hosted and supported by the Field Studies Council at Malham Tarn Field Centre.

Malham Tarn and the surrounding area has an extensive history of research work often based at the Field Centre. At a time of changing pressures on the rural landscape arising from CROW and other changes in rural-agricultural policy research findings should be central to the way that we respond. Life in a Limestone Landscape offered those involved in agriculture, conservation and research the opportunity to share experience and information.

The 2001 Seminar considered historical and current research and began to explore two distinct themes. Those themes were:

a) the relationship between cultural and conservation values

b) the role of the amateur naturalist in nature conservation.

Two aims to be considered in the 2003 seminar were:

a) the role of designated sites and research in nature conservation

b) co-ordination and dissemination of multi-stranded research.

Original objectives

- A review of research based on Malham Tarn
- Sharing the Cowside Beck research findings
- Establishing priorities and opportunities for future research and monitoring based at Malham Tarn

PROGRAMME

Friday 14th

The Limestone Country Project	*Paul Evans*

Saturday 15th

The Mollusca of Malham Tarn	*Adrian Norris*
Variation in *Carex flava* at Malham and its possible consequences	*Paul Ashton*
Butterflies of Malham: fifty years of change	*Terrence Whittaker*
Ten years of submerged macrophyte surveys at Malham Tarn	*George Hinton*
Investigation to establish the conservation status of white-clawed crayfish at Craven Limestone Complex SAC	*Paul Bradley*
Dynamics of carbon in Malham Tarn	*Pietro Coletta*
Monitoring grassland	*Judith Allinson*
The Cowside Beck Project	
Introduction	*Oliver Gilbert*
Geomorphology of the watercourse	*Helen Goldie & Margaret Marker*
Water chemistry	*Douglas Richardson*
Algae	*Allan Pentecost*
Lichens	*Oliver Gilbert*
Bryophytes	*Michael Proctor*
Freshwater invertebrates & diatoms	*Douglas Richardson*
Cave studies	*David Hodgson*
Summary	*Oliver Gilbert*
Re-thinking the origin of limestone pavements	*Peter Vincent*
The evidence for paleokarst in the Malham area	*Margaret Marker*
Mature small to medium scale surface limestone landforms of NW England	*Helen Goldie*
Eratic judgements: a new interpretation of the Norber erratics and re-assessment of landform-based limestone erosion rates	*Helen Goldie*
Early dry stone walls in the limestone landscape	*Tom Lord*
Wider dissemination of information and the amateur-academic interface	*Steve Gill & Mike Samworth*
Building the biological identification pyramid	*Steve Tilling*

Sunday 16th

Conservation issues, BAPS, EU initiatives, updates on recording	*Adrian Pickles*
The work of the National Trust in the Malham area	*Julian Clark*
The role of Malham Tarn Field Centre	*Adrian Pickles*

GRASSLAND MONITORING AT MALHAM TARN CLOSE: 1956 – 2001

Five sets of records (DAFOR values), recorded between 1956 and 2001 on 1.6 ha upland limestone pasture-meadow at Malham Tarn Close SD 894622 from which sheep and cattle had been excluded since 1948, showed that:

- Malham Tarn Close is very species rich
- It is difficult at times to distinguish whether differences in results between two sets of records are due to the fact that the field was not surveyed thoroughly enough in the first place, or because there is a true change.
- Some changes and patterns were present. These included an increase in wetland species over time; no increase in the total number of "hay meadow indicators" after the third recording; and a dip n the number of species recorded in the year that had very high rabbit grazing.

Charles Sinker collected the first set (Sinker, 1960). Anne Burn collected the second set (Disney, 1975). The author, who first worked at the centre in 1979, collected the last three sets. All three recorders were botanists. The lawn was searched thoroughly and DAFOR (dominant, abundant, frequent, occasional and rare) values were recorded. The author visited the lawn between one and three times each year and spent between six and eight hours each year surveying. Initially it was suspected that removal of sheep would have an effect. But other grazing changes not foreseen have occurred and will occur. (See Fig 3) The results are available for use in considering future management. NVC types include M26b (the majority), CG9, CG2, U4 MG3, and on the thicker soil, U4.

What did the results show?

1) The lawn is very species rich. Its "hay meadow indicator" (Allinson, 1995) scores are similar to the very best sites inside and outside the YDNP (32 total, including 4 species of *Alchemilla* or 25 species average).
2) New species continued to be recorded each monitoring: 93 species were recorded by 1956 and 113 species in 2001 but a total of 151 species were recorded over the 5 monitorings. (At the fourth monitoring there were only four new species, so the situation appeared to be stabilising, but at the fifth monitoring a further 11 were found). This gave rise to the question: is this due to under-recording or to real changes in vegetation?

   It is possible that it could be due to under recording. However, evidence that at least part of the change in results at Tarn Close is due to a change in species composition can be obtained in two ways: (i) by looking at the pattern of species change between recordings (See Fig 1) and (ii) by noting that some species change fits in with environment change. By considering groups of plants together, e.g. all wetland loving plants, then the "noise" generated by missing a species one year due to under-recording only has a small effect. Also under recording will, to some extent reflect the abundance of a species.

i) Fig.1 Gains and Losses of species between monitorings

	<1956	1974	1986	1993	2001
Incr between adj monitorings		16	33	17	29
Incr between adj but 1 monitorings			43	31	27
Incr between adj but 2 monitorings				34	37
Incr between adj but 3 monitorings					41

	<1956	1974	1986	1993	2001
Decr between adj monitorings		19	18	14	20
Decr between adj but 1 monitorings			31	19	21
Decr between adj but 2 monitorings				25	14
Decr between adj but 3 monitorings					21

Sets of results close to each other in time have (on the whole) fewer different species than sets separated by a larger time. Here are two examples to help understand the table: Comparing 1986 and 1993 adjacent monitorings, there were 17 gains and 14 losses. Between 1956 and 1993 (separated by two other monitorings) there were 34 gains and 25 losses.

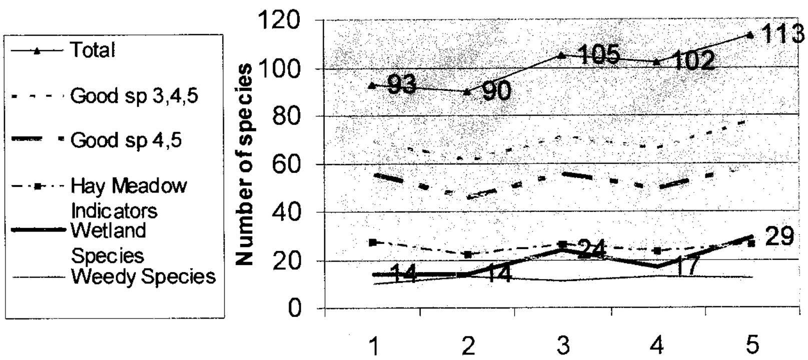
ii) Some changes can be linked to environmental factors as described in 3 - 6 below.

The following groupings of species were considered:

- Plants of interest and medium and high conservation value (given ratings of 3,4,5 by the author)
- Plants of medium and high conservation value (given ratings of 4,5 by the author)
- Hay Meadow Indicator Species - HMI - (a set list of 47 species used in English Nature Yorkshire Dales unimproved neutral grassland surveys (Allinson, 1995).
- Wetland species
- Weedy species: unwanted species. Here weedy species are defined as plants that a conservationist would prefer not to have. At this site they tend to be competitors rather than ruderals. (Competitors are plants that grow well when there are a lot of nutrients, (e.g. *Urtica dioica, Lolium perenne)* and thus block out slower growing plants. Ruderals are plants that invade open spaces)

Fig. 2 Total numbers of species present in different categories over the five monitorings.

Year	<1956	1974	1986	1993	2001	Total
Total	93	90	105	102	113	151
Good sp 3,4,5	69	61	71	66	77	104
Good sp 4,5	55	45	55	49	58	78
Hay Meadow Indicators	27	22	26	23	26	32
Wetland Species	14	14	24	17	29	34
Weedy Species	10	13	11	13	12	16



1) Stability of "Hay meadow indicators": Five extra HMIs appeared at the third monitoring, but no more after that. Grime has classified plants as choosing one of three strategies (plus intermediate strategies): competitors, stress tolerators and ruderals. An analysis of the list of the 22 HMIs which Grime has classified, shows that with the exception of *Filipendula ulmaria* which is a competitor, all the species are either stress tolerators or have a more intermediate neutral strategy - i.e. they are species which need a stable habitat (Grime et al 1988; Allinson, 1995). Two of the five which appeared were wetland plants – *Trollius europaeus* and *Caltha palustris.* (If HMIs had been missed by under recording, then they would have continued to "appear" right up to the last recording.)
2) Wetland species are increasing. The graphs show that the number of wetland species is increasing. The majority of them are found near the Tarn shore, and include the rare *Carex appropinquata.*
3) There is no evidence of shrub colonisation, with the one possible exception of the young *Alnus glutinosa* tree at the Tarn shore edge.
4) At the period of high rabbit grazing in 1993 there was a dip in the number of species recorded.

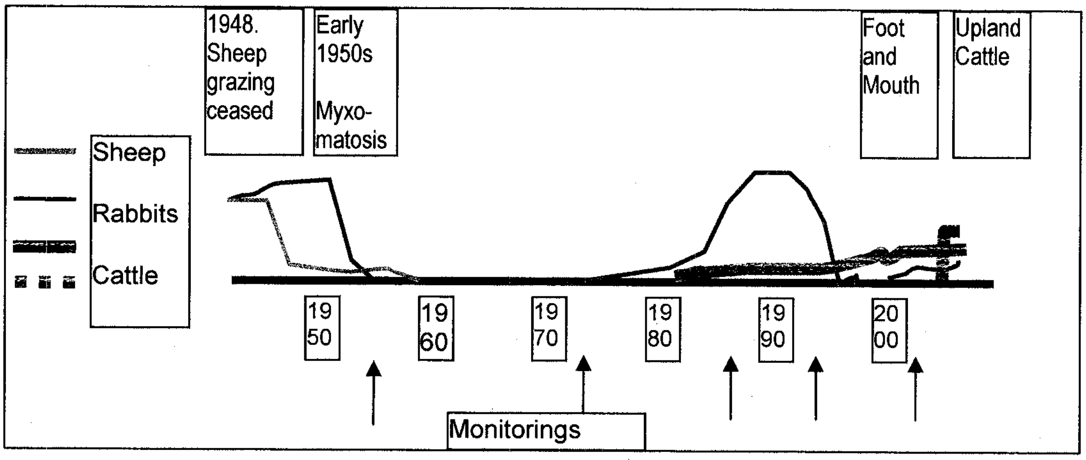
Summary of grazing and management changes

The following are some observations made by the author about grazing and management. Observations from other people who knew the Close would be welcome.

The level of the Tarn was raised by about 1m in 1791 and possibly altered to some extent in 1910.

The Close was ungrazed since 1948 and the vegetation was recorded as long and rank in 1960 (Sinker, 1960) and in 1974 (Disney, 1975), but it was very short by 1993 due to intensive rabbit grazing. Roe deer were a rare sight up to the mid 1980s but have increased in number since then. Trees were planted in the west area in the 1950s (which was not surveyed) and were cut down in about 2000. Metal railings were put up around the Close in about 1987. Some large cattle came in from Great Close in 2002 in autumn. In 2003 about 20 small Dexter cattle were put on for several weeks in October. The septic tank to the west of the Paul Holmes seat stopped being used before 1978. There were many nettles there from 1978 to 1993, but they are decreasing in intensity now. The met. pen was moved from the upper lawn onto the Close in the mid eighties, and it was partially protected from rabbit grazing by a netting fence until 2003, when the netting was removed.

Fig 3 Illustrative chart show the general pattern of grazing influences on Tarn Close



What next?

The author holds the data on Excel worksheets. The data show patterns for individual species and for other groups of species. The abundance ratings have not yet been used in the analysis. In future recordings, target notes and G.P.S. records could be made for the rarer species.

References

Allinson, J.M. (1995) Status of Species Rich Neutral Grassland in Western North Yorkshire. *Naturalist* **120**: 125-141.

Disney, R.H.L. (1975) Review of Management Policy for the Malham Tarn Estate. *Field Studies* **4 (2)**

Grime, J.P., Hodgson, J.G. and Hunt, R. (1988) *Comparative Plant Ecology*. Oxford University Press/Unwin Hyman, London.

Leach, S.J. (1988) *The Rogate Plots.* Internal England Field Unit Report N.C.C.

Sinker, C.A. (1960) The Vegetation of the Malham Tarn Area. *Proc. Leeds Phil. Lit. Soc. (Sci.),* **8** 139-175.

Author: Judith Allinson

VARIATION IN THE MALHAM POPULATION OF LARGE YELLOW SEDGE (*CAREX FLAVA*) AND ITS IMPLICATIONS

Introduction

Carex flava is a rare plant in Britain, known only from two populations; at Roudsea Wood in Cumbria (vc 69) and Malham Tarn in Yorkshire (vc 64). By comparison, it is much more common in Europe and in North America. The population at Malham Tarn is small, with only 10 presumed genets. Small population sizes, such as those of *Carex flava* at Malham, are considered to be at a higher risk of extinction than larger ones. A contributory factor to this risk is the smaller levels of genetic variation potentially found when populations comprise low numbers of individuals. This study aims to record the level of variation found in the Malham population using both morphometric and genetic (isozyme) approaches and to compare this with the Roudsea population (which numbers approximately 1500 – 2000 presumed genets) and populations found elsewhere.

Methods

Specimens of *C flava* were collected in the field as ramets or seed from clumps at least 3 m apart from each other. Plants were cultivated at Edge Hill until they were mature. In addition to Malham Tarn and Roudsea Wood, plants were collected from 12 other populations, comprising material from Sweden (three populations), Canada (four), Finland (two), Norway (two) and France (one), the number of samples collected per population ranging from 6 to 47 individuals. Genetic analysis was carried out using 14 isozyme systems yielding 16 loci. The within population variation (HS) was calculated for each site. In the morphometric study 10 characters, predominantly of the flowering parts, were recorded from the same 12 populations. Precise details of these methods are given in Blackstock and Ashton (2001). For each of the 10 characters the mean and standard deviation were recorded. From these values the co-efficients of variation (standard deviation/mean x 100) were calculated.

Table 1 Sample size and levels of genetic variation (H_s) in populations of *C.flava* at Malham Tarn, Roudsea and across all populations.

	No pops.	Sample size		H_S
		Range	**Mean**	
Malham Tarn	1		10	0
Roudsea	1		24	0.17
All populations	14	6-48	17	0.001

Malham population of C flava showed no isozyme variation ($H_S = 0$). This was lower than that found at Roudsea ($H_S = 0.17$) but similar to many other populations of the species (Table 1).

Table 2: Coefficients of variation for 10 morphological characters in *Carex flava* for Malham Tarn, Roudsea and all populations

	Malham	Roudsea	All populations
Sample size	n=10	n= 6	n=40
Vegetative leaf length / width ratio	15	26	34
Vegetative leaf width at base	24	35	27
Ligule length	42	43	42
Male spikelet length	19	50	37
Male spikelet peduncle length	117	75	114
Beak length	12	5	14
Perigynium length	13	15	14
Male glume, length/width ratio	15.5	16	14
Number of bristles on one side of perigynium	20	13	28
Nutlet length excluding beak	6	5	8

In the morphometric study, Malham had a notably higher level of variation than the Roudsea population in three of the 10 characters, a lower level in three characters and a similar level in four characters (Table 2). Thus the Malham Tarn population may be considered to be as variable as the Roudsea population when morphology is considered.

Conclusion

There is no evidence to suggest that the Malham Tarn population of *C flava* shows significantly lower levels of variation than other populations of the same species. The low level of isozyme variation in the population coupled with high levels of morphometric variation is typical of the pattern recorded elsewhere in the species (Schmid 1986, Hedren, 2004). Given the similarity in levels of variation within the Malham population, compared to other populations of the species, it seems unlikely that this population will suffer decline due to genetic factors. It is thus argued that the continued success of the species at Malham will be determined by management and habitat availability.

References

Blackstock, N and Ashton, P A (2001) A re-assessment of the putative Carex flava agg (Cyperaceae) hybrids at Malham Tarn (vc 64): A morphometric analysis Watsonia 23 505-516
Hedren, M (2004) Species delimitation and the partitioning of genetic diversity - an example from the Carex flava complex (Cyperaceae) Biodiversity and Conservation 13 293-316
Schmid, B (1986) Patterns of variation and population structure in the Carex flava group. In Jonsell, B and
Jonsell, L. (eds), Biosystematics in the Nordic Flora. Symb. Bot. Ups. 27: 2, pp. 113-126

Acknowledgements

The practical work for this paper was undertaken by Nigel Blackstock as part of a PhD project funded by Edge Hill College of Higher Education.

Author: Paul A. Ashton

A FUTURE FOR WHITE-CLAWED CRAYFISH IN THE DALES?

Introduction

This extended abstract introduces some key elements of a five-year research project (1999-2004) investigating mechanisms of population change in white-clawed crayfish *(Austropotamobius pallipes)* in Northwest England, and also highlights the threatened status of this species.

Population status

Nationally, many populations of white-clawed crayfish have suffered severe declines over the last 30 years. Much of this decline has been attributed to the spread of the American signal crayfish (*Pacifastacus leniusculus*), and the crayfish plague (*Aphanomyces astaci*) that it carries. Catchments in the South and East have been particularly affected, and populations in the Midlands have also suffered dramatic declines.

The current distribution map shows that the species remains widespread throughout much of the country. But in fact only fragments of former populations now exist in most of its former range, and plague outbreaks and/or non-native crayfish species have been recorded or suspected in many catchments. White-clawed crayfish are undoubtedly experiencing one of the most rapid declines of any species in this country, and could conceivably be heading for near extinction in some regions over the next decade.

Despite the observed decline of white-clawed crayfish, mass mortality has been recorded at only a relatively small number of the sites from where they have 'disappeared'. Local extinctions are suspected to have occurred, and many are thought to have resulted from *A. astaci* infection. However, there have been relatively few confirmed cases of crayfish plague in this country and, before the current study, this devastating disease had been little studied in the field. A few remaining catchments in Northwest England support some of the country's last strongholds for white-clawed crayfish.

Current research project

In July 1999, my then employer, the Environmental Consultancy University of Sheffield (ECUS) was commissioned to investigate the possible effects of quarrying discharges and dewatering on selected watercourses in the Yorkshire Dales. One element of the fieldwork was a baseline survey of white-clawed crayfish. Fascinated by the intriguing results of this fieldwork, and concerned by the lack of previous field-based research, I resigned from my position, to investigate mechanisms of population change in white-clawed crayfish in upland areas of Northwest England.

The study has since benefited from the results of an evolving series of field investigations, and has made progress in furthering our understanding of key mechanisms of population change in white-clawed crayfish, particularly involving crayfish plague. Over the last four years, I have witnessed a dramatic decline of white-clawed crayfish throughout much of Upper Ribblesdale. The species was widespread and abundant in that area <10 years ago, but only fragments of the former population now remain. Isolated headwaters and offstream sites (particularly in the Northwest) might provide the best chance for the long-term survival of white-clawed crayfish in this country.

Malham Tarn, its feeder streams and outfall stream, together comprise the major wetland component of the Craven Limestone Complex candidate Special Area of Conservation. The cSAC citation (1998) considered the site to be of "*European Interest*" for white-clawed crayfish, and claimed this to be "*one of the best areas in the United Kingdom*" for this species. The site is relatively isolated from potential sources of crayfish plague and non-native crayfish species, and its small headwater catchment is largely controlled by English Nature and the National Trust.

An historical review carried out for the current research found that white-clawed crayfish were apparently abundant at Malham Tarn until the 1970s. Holmes (1965) commented that crayfish, "*...are plentiful on the stony exposed shores. They attain a good size... Large numbers of crayfish remains have been noted around the edges of the Tarn when otter have been recorded in the area.*" However, there have been very few records of white-clawed crayfish at Malham Tarn over the last 20 years.

A substantial population decline has occurred at Malham Tarn, but the mechanisms of this decline are only now being investigated. Detailed surveys carried out during 2000-03 have located only a small remnant population of white-clawed crayfish at this site. The loss of such an internationally important refuge population of this critically threatened species would be a serious conservation concern.

Conservation and training

Interim results of this research are enabling additional conservation measures to be developed and implemented. Fish stocking practices have been revised at several key sites, and both English Nature and the Environment Agency have reviewed procedures aimed at reducing the spread of crayfish plague between catchments. In addition, the study has discovered previously unknown populations of white-clawed crayfish, which might be conserved, and has also assisted with the establishment of an experimental captive rearing facility for white-clawed crayfish in the Dales.

To help promote standards amongst practitioners, we have also been running IEEM training workshops 'Working with Crayfish' for the last three years at Malham Tarn Field Centre.

Acknowledgements

This research has been supported by essential expenses from English Nature and the Environment Agency, and has also received logistical support from the Field Studies Council, the National Trust and a number of local bodies and individuals.

Author: Paul Bradley

AQUATIC MACROPHYTE ECOLOGY OF MALHAM TARN: 1994 TO 2003

Malham Tarn is the highest marl lake in Britain and perhaps the best example of an upland charophyte (stonewort-dominated) lake. It has been the subject of intermittent surveys since the 1930s, which show that at least a third of the lake is covered by luxuriant stonewort growth. The current project was prompted by concerns over catchment impacts and increased trophic status of the Tarn (nitrate levels are relatively low but have increased threefold since 1949). Given the known sensitivity of charophytes to water quality, annual surveys were started in 1994 to provide semi-quantitative data on macrophyte cover and abundance. The methodology is based on cumulative presence or absence data for each species (from 10 grapnel drops) at each sampling station.

The present study provides new evidence for the dynamic nature of the submerged macrophyte assemblage and changes in productivity. The ecosystem appears to be influenced more by water levels than any measured water quality impacts. The full 10 year cycle (Figure 1) shows a dramatic change in species composition following the 1995 drought and subsequent decline in the abundance of all submerged macrophytes. Figure 2 shows that the in-lake uptake of $CaCO_3$ is lowest when macrophytes are least abundant. A full recovery to favourable condition has now taken place with *Chara globularis* var *virgata* again dominating the plant assemblage.

Cumulative contour maps for the three main macrophyte species (Figure 3) show that *Elodea Canadensis* and *Potamogeton berchtoldii* prefer water less than 2.5 metres deep. *Chara* thrives across the tarn bottom, but shows a preference for deeper water (2.5 to 3 metres).

The study has identified a series of issues to be addressed by relevant bodies:

- Reduced water quality sampling frequency by Environment Agency at the Tarn inflow and outflow
- Malham Tarn as a possible (Marl Lake) Intercalibration site for the Water Framework Directive. This will require the collection of a wider range of data on the biota and water quality
- The collation of data and access to long term data sets
- Role of Field Studies Council\National Trust\English Nature in data collection and long monitoring

Author: George C. F. Hinton

Figure 1: Long term changes in macrophyte abundance (cover) in Malham Tarn

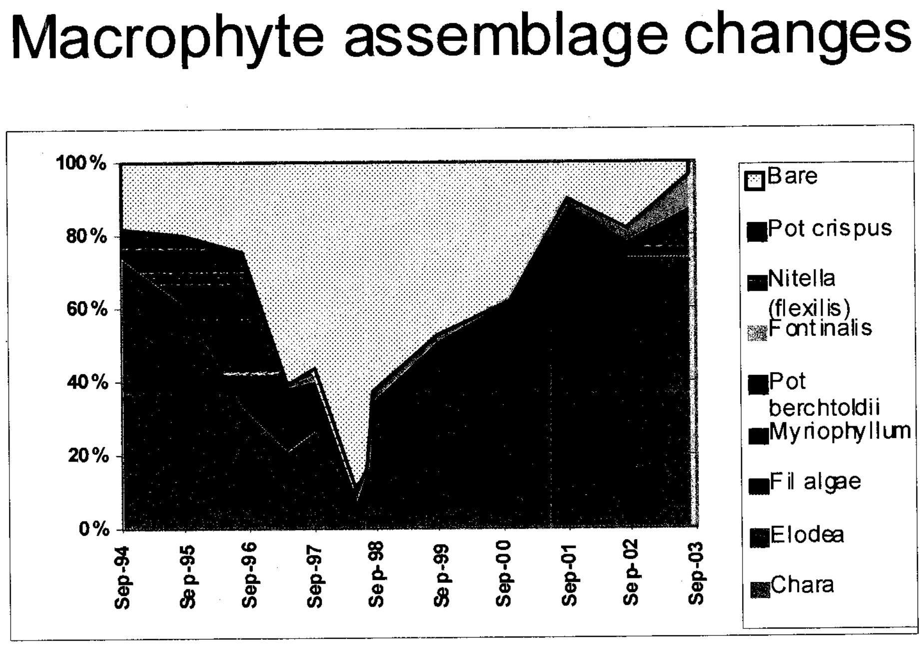


Figure 2: Uptake of calcium carbonate by biota in Malham Tarn (data from Environment Agency)

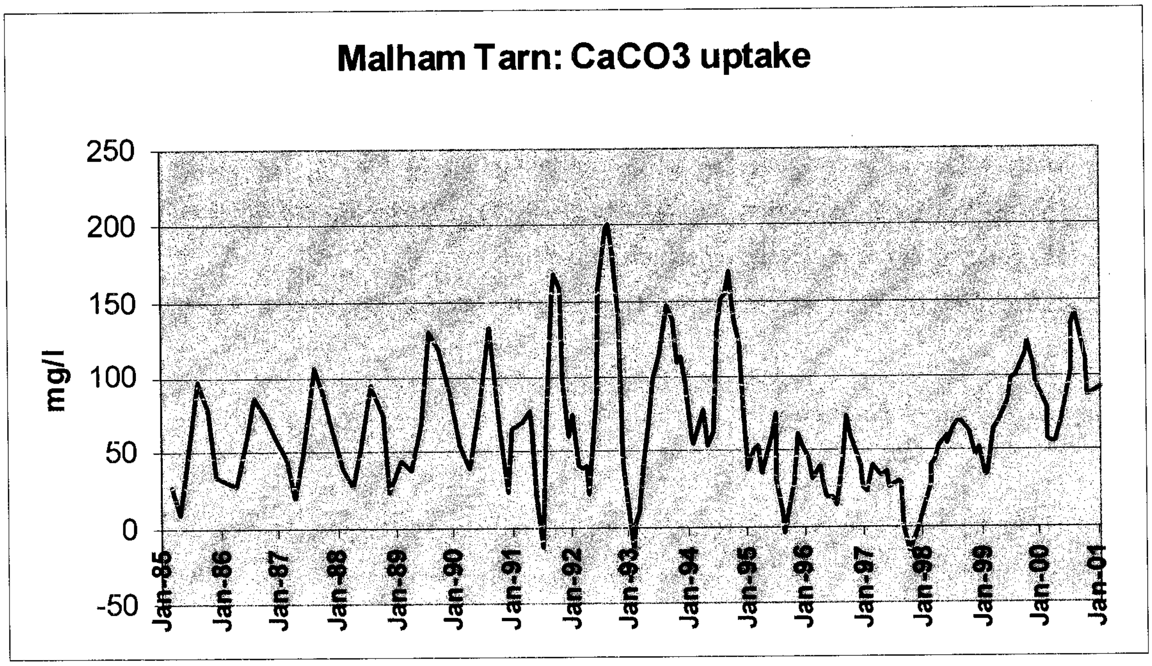
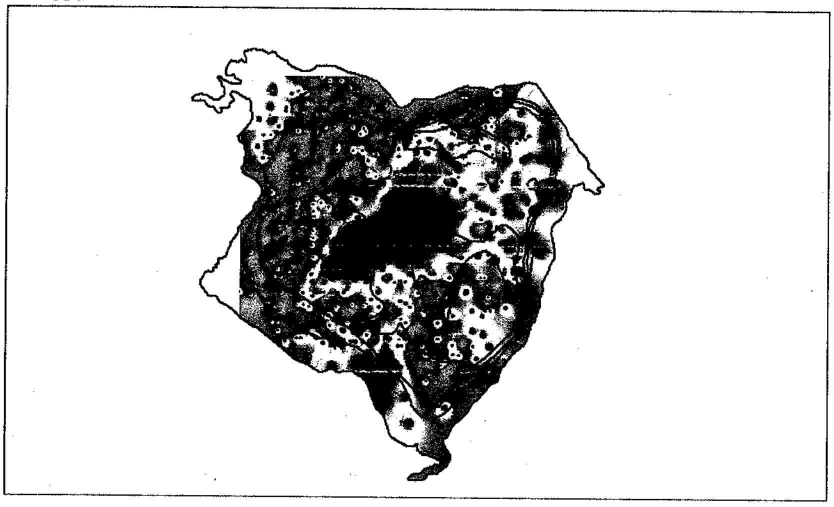


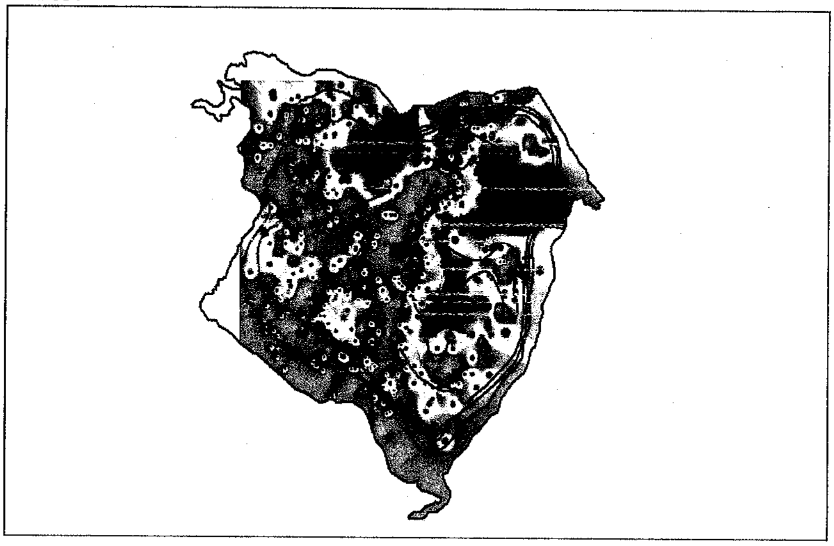
Figure 3: Cumulative distribution maps for major macrophytes based on 10 years data
Blue/green = highest cover, Red/yellow = lowest cover

Error!



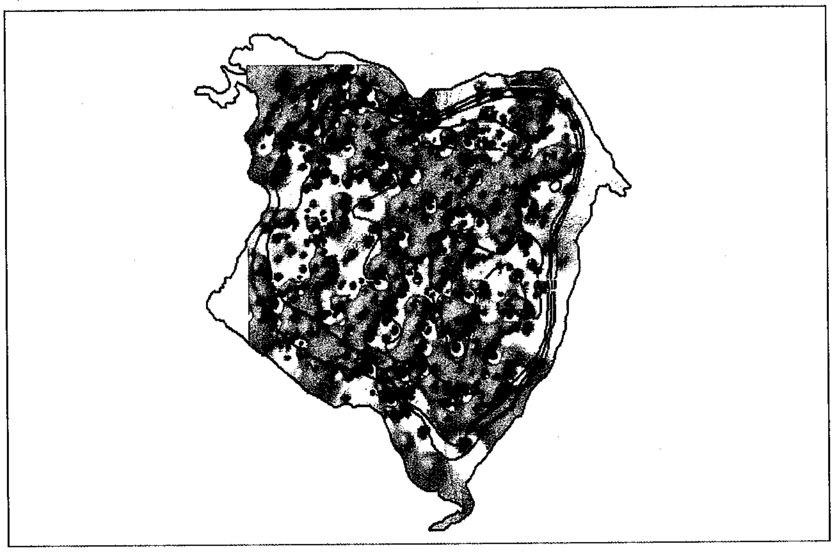
3a) Elodea Canadensis

Error!



3b) Potamogeton berchtoldii

Error!



3c) Chara globularis v virgata

THE MOLLUSCA OF MALHAM

For many years the Malham Tarn area had been considered as one of the best-recorded areas of Yorkshire. However, a great deal of work has been undertaken in the rest of the county over recent years, which highlights the molluscan fauna of the Malham area as being under-recorded.

The total Molluscan list for the combined traditional recording area of the field centre with the National Trust Estate, now stands at a total of 87: 62 land-snails and 25 freshwater, approximately 50% of the total Yorkshire Molluscan Fauna. The traditional recording area covered parts of two ten-kilometre squares and 28 one-kilometre squares; combine this with the larger National Trust Estate which covers parts of four ten-kilometre squares, you get a total of approximately 60 one-kilometre squares. Of these 60 squares, we have modern records for only 16.

Only 6 species, (four land and two freshwater, *Vertigo* (Vertigo) *pusilla* Muller, 1774, *Vitrea* (Vitrea) *subrimata* (Reinhardt, 1871), *Deroceras* (Agriolimax) *agreste* (L., 1758), *Helicella* (Helicella) *itala* (L., 1758), *Pisidium lilljeborgii* (Clessin, 1886) and *P. pulchellum* (Jenyns, 1832), of the 37 species listed in the Yorkshire Red Data Book, are recorded from the Malham Tarn area. A number of species are recorded from only one location and several more have not been recorded for nearly 50 years, or, in the case of *Vertigo pusilla,* over 100 years. One species, *Truncatellina cylindrica* (Ferussac, 1807), re-identified as *Columella edentula* was recorded from High Folds Scar during the 1955 molluscan field course and has since been removed from the list.

A full systematic survey of the mollusca of the combined areas of the Malham and National Trust Estates is now seriously required if we are to understand the molluscan fauna of the area.

Author: Adrian Norris

CHECK LIST OF THE MOLLUSCAN SPECIES RECORDED FROM THE MALHAM AREA

Freshwater Mollusca

Valvata (Valvata) cristata Muller, 1774
Valvata (Cincinna) piscinalis (Muller, 1774)
Potamopyrgus antipodarum (Grey, 1843)
Bithynia tentaculata (L., 1758)
Physa fontinalis (L., 1758)
Lymnaea (Galba) truncatula (Muller, 1774)
Lymnaea (Galba) palustris (Muller, 1774)
Lymnaea (Lymnaea) stagnalis (L., 1758)
Lymnaea (Radix) peregra (Muller, 1774)
Anisus (Anisus) leucostoma (Millet, 1813)
Bathyomphalus contortus (L., 1758)
Gyraulus albus (Muller, 1774)
Armiger crista (L., 1758)
Ancylus fluviatilis Muller, 1774
Sphaerium (Sphaerium) corneum (L., 1758)
Pisidium amnicum (Muller, 1774)
Pisidium casertanum (Poli, 1791)
Pisidium personatum Malm, 1855
Pisidium obtusale (Lamarck, 1818)
Pisidium milium Held, 1836
Pisidium subtruncatum Malm, 1855
Pisidium lilljeborgii Clessin, 1886
Pisidium hibernicum Westerlund, 1894
Pisidium nitidum Jenyns, 1832
Pisidium pulchellum Jenyns, 1832

Land Snails

Carychium minimum Muller, 1774
Carychium tridentatum (Risso, 1826)
Succinea (Succinea) putris (L.,1758)
Oxyloma elegans (Risso, 1826)
Azeca goodalli (Fer., 1821)
Cochlicopa lubrica (Muller, 1774)
Cochlicopa lubricella (Porro, 1838)
Pyramidula rupestris (Drap., 1801)
Columella edentula (Drap., 1805
Vertigo (Vertigo) pusilla Muller, 1774
Vertigo (Vertigo) antivertigo (Drap., 1801)
Vertigo (Vertigo) substriata (Jeffreys, 1833)
Vertigo (Vertigo) pygmaea (Drap., 1801)
Abida secale (Drap., 1801)
Pupilla (Pupilla) muscorum (L., 1758)
Lauria (Lauria) cylindracea (Da Costa, 1778
Vallonia costata (Muller, 1774)
Vallonia pulchella (Muller, 1774)
Vallonia excentrica Sterki, 1892
Acanthinula aculeata (Muller, 1774)
Ena (Ena) obscura (Muller, 1774)
Discus (Discus) rotundatus (Fer., 1774)
Punctum (Punctum) pygmaeum (Drap., 1801)
Arion (Arion) ater (L., 1758)
Arion (Mesarion) subfuscus (Drap., 1805)
Arion (Kobeltia) distinctus Mabille, 1868
Arion (Carinarion) circumscriptus Johnston, 1828
Arion (Carinarion) fasciatus (Nilsson, 1822)
Arion (Microarion) intermedius Normand, 1852
Vitrina (Vitrina) pellucida (Muller, 1774)
Vitrea (Vitrea) subrimata (Reinhardt, 1871)
Vitrea (Crystallus) crystallina (Muller, 1774)
Vitrea (Crystallus) contracta (Westerlund, 1871)
Aegopinella pura (Alder, 1830)
Aegopinella nitidula (Drap., 1805)
Nesovitrea hammonis (Strom, 1765)
Oxychilus (Ortizius) alliarius (Miller, 1822)
Oxychilus (Ortizius) helveticus (Blum, 1881
Oxychilus (Oxychilus) cellarius (Muller, 1774)
Tandonia budapestensis (Hazay, 1881)
Limax (Limax) maximus L., 1758
Lehmannia marginata (Muller, 1774)
Deroceras (Deroceras) laeve (Muller, 1774)
Deroceras (Agriolimax) agreste (L., 1758)
Deroceras (Agriolimax) reticulatum (Muller, 1774)
Boettgerilla pallens Simroth, 1912
Euconulus (Euconulus) fulvus (Muller, 1774)
Euconulus (Eucolulus) alderi (Gray, 1840)
Cecilioides (Cecilioides) acicula (Muller, 1774)
Cochlodina (Cochlodina) laminata (Mont., 1803)
Clausilia (Clausilia) bidentata (Strom, 1765)
Clausilia (Clausilia) dubia Drap., 1805
Balea (Balea) perversa (L., 1758)
Helicella (Helicella) itala (L., 1758)
Monacha (Ashfordia) granulata (Alder, 1830)
Trichia (Trichia) hispida (L., 1758)
Trichia (Trichia) plebeia (Draparnaud, 1805)
Trichia (Trichia) striolata (Pfe., 1828)
Arianta arbustorum (L., 1758)
Helicigona lapicida (L., 1758)
Cepaea (Cepaea) nemoralis (L., 1758)
Cepaea (Cepaea) hortensis (Muller, 1774)

BUTTERFLIES OF MALHAM TARN: FIFTY YEARS OF CHANGE

There is little information about the occurrence of most butterfly species in the Yorkshire Dales until the middle part of the last century. A research study on the Insects of the Malham Tarn Area (1954-58) by the Entomological Section of the YNU included the first catalogue of the lepidoptera (YNU 1963). Eight resident species of butterfly (plus 2 migrant) were recorded. The collation of records 1967-82 by John Heath culminated in the publication of the first national distribution maps and added two species missed by the YNU (Emmett & Heath 1989 1999-2003) for the two 10km squares that include Malham Tarn. Records selected from these grid-squares (SD86 & SD87) 1999-2003 using the Butterfly Conservation database (Asher *et al.* 2001) were used to produce an up to date species list (Table 1). This comprises 17 resident plus 2 migrant and 2 vagrant species. All the habitat specialist species, now classed as species of conservation concern, were missed for a variety of causes during the YNU study; Green Hairstreak - no visits before mid June; Dark Green Fritillary - local, low population density; Northern Brown Argus - local, low population density, inactive in poor weather.

Table 1 Butterflies at Malham Tarn, 1950-1958 and 1999-2003

Butterfly Species	**Type**	**1950-8**	**1999-2003**	**Locations**	**Abundance**		**First rept.**
Peacock	Wider	Present	Present	**W**, TF, TC	651	22.5%	1948
Green-veined white	Wider	Present	Present	**TF,TM,HM**,W, HMP	539	18.7%	1948
Small Tortoiseshell	Wider	Present	Present	**W**,TF, TC	470	16.3%	1948
Red Admiral	Migrant	Migrant	Migrant		315	10.9%	pre 1950
Common Blue	Wider	Present	Present	**HF**,TF,TC	217	7.5%	1948
Painted Lady	Migrant	Migrant	Migrant		208	7.2%	pre 1950
Green Hairstreak	Hab. Spec.	*	Present	**TM, TF**	135	4.7	-
Small Heath	Wider	Present	Present	**HF**, ML	135	4.7%	1948
Meadow Brown	Wider	Absent	Present	**HF,TC**,TF, HM	74	2.6%	1999
Large White	Wider	Present	Present	**G**	43	1.5%	1948
N.Brown Argus	Wider	*	Present	**HF**	40	1.4%	-
Comma	Wider	Absent	Present	**TF**, W, TC, TM	13	0.5%	ca. 1995
Small Skipper	Wider	Absent	Present	**HF**, TC	12	0.4	2002
Small White	Wider	Present	Present	**G**	12	0.4	Pre 1950
Dk. Green Fritallary	Hab. Spec.	1-1950*	Present	**HF**, TC, HMP, HM	7	0.2%	1950
Large Skipper	Wider	Absent?	Present	**HF, TF**, TC	6	0.2%	Pre 1996?
Orange Tip	Wider	Absent	Present	**TF**	4	0.1%	c1996
Small Copper	Wider	Absent?	Present	**TM**	3	0.1%	Pre 1997
Ringlet	Wider	Absent	Vagrant?	TC, TF	2	0.1%	2003?
Brimstone	Wider	Absent	Vagrant	TF	1	<0.1%	Not Res.
Gatekeeper	Wider	Absent	Vagrant	TF	1	<0.1%	Not Res.
Holly Blue	Wider	Present	Absent	Woodland edges			1948
TOTAL SPECIES		**13?**	**21**	N=	**288**		

KEY: Wider = wider countryside, Ha Mire (HM), Ha Mire Plantation (HMP), High Folds Scar (HF), Malham Lings (ML), Tarn Moss (TM), Gardens (G), Widespread (W), * Not recorded by YNU.
Bold type indicates main habitat.

There are six recent coloniser species and in all cases these are species which have also been spreading or increasing their densities in wider Yorkshire. To account for this spread, the available habitat is relevant or more likely an improvement of climate. There is ample evidence that summers are now much warmer but also drier and hence sunnier, a marked amelioration for the Central Pennines which is one of the cloudiest areas of England.

In contrast to the wider Dales area, the habitats around Malham Tarn appear largely unchanged since Sinker's (1963) survey, with the grassland rather better managed although part of High Folds is threatened by recent tree planting. Woodland has generally been managed rather badly with inappropriate planting at Ha Mire Plantation (HMP) and neglect promoting a dense canopy in Tarn House Plantation and tree death at HMP. This led to a more open woodland and a ground flora, including *Viola riviniana* and other forbes, which paradoxically is more suitable for butterflies including the Dark Green Fritillary. Although Sinker (1960) referred to Tarn Close as 'Improved' this is now florally enriched especially with flowering plants and is one of the key habitats providing nectar for the butterflies. The key conservation habitats are the warm, stony calcareous grassland below High Close Scar for the Northern Brown Argus. Tarn Moss (TM) and Tarn Fen (TF) which supports bilberry and provides territorial markers and nectar plants for the Green Hairstreak. High Folds (HF), Tarn Close (TC) and HMP support violets and nectar plants for the Dark Green Fritillary. It is important to retain a sunny aspect with an open vegetation structure on these sites. In the future it is suggested that Malham Tarn will see the Ringlet as a resident species and the populations of Small Skipper and Orange Tip will increase and the Gatekeeper will become a more common vagrant. Another spreading species the Speckled Wood may be seen for the first time.

Key references

Asher, J., Warren, M., Fox, R., Harding, P., Jeffcoate, G. and Jeffcoate, S. (2001) The Millennium Atlas of Butterflies in Britain and Ireland, Oxford University Press, Oxford.

Emmett, A.M. and Heath, J. (eds.) (1989) The Moths and Butterflies of Great Britain and Ireland, 7 (1). Harley Books, Colchester.

Sinker C.A. (1960) The vegetation of the Malham Tarn area. Proc. Leeds Phil. & Lit. Soc., Scientific Section Vol. VIII, Part V, 1-37.

YNU (1963) The Insects of the Malham Tarn area. Proc. Leeds Phil. & Lit. Soc., Scientific Section Vol. IX, Part II, 15-91.

Author: Terence M. Whitaker

CHANGES IN THE MALHAM TARN CARBON CYCLE

This study investigated changes in the carbon cycle of Malham Tarn between Jan 1996 and May 1999. Phytoplankton samples and a ^{14}C-fixation method to assess phytoplankton productivity showed Malham Tarn to be weakly mesotrophic. Supply of carbon comes principally from groundwater dissolved inorganic carbon (DIC), which accounts for about 380 tonnes of carbon per year. Stable carbon isotope values of inflowing groundwater DIC ($?^{13}C_{DIC}$) varied seasonally (from around -12.7‰ (VPDB) in September to around -15.1‰ in winter/early spring). This indicates seasonal variation in the contribution of soil respired CO_2 and aquifer carbonate. A 55 days aquifer flow-through time was estimated using correlations between $?^{13}C_{DIC}$ and antecedent mean air temperatures. Photosynthesis and degassing results in outflow water from Malham Tarn being depleted in DIC and $^{13}C_{DIC}$-enriched relative to inflow water (by 1.16mM/l and 7.1‰ respectively). DIC degassing was estimated at 39 tonnes of carbon per year. Annual carbon retention in Malham Tarn was estimated to be 35 tonnes of carbon per year. Malham Tarn outflow $?^{13}C_{DIC}$ values and DIC concentration varied seasonally and interannually reflecting the growth and abundance of phytobenthos. 51 tonnes of carbon was estimated to be contained in the summer 1997 macrophyte phytobenthos, almost a third of this was carbon in the calcium carbonate of stem encrustations of the biomineralising charophyte *Chara globularis* var. *virgata.*

A 6.7m sedimentary core was retrieved from Malham Tarn, and pollen and isotope records have been produced. Similarities between the isotope records of the Malham Tarn core and the Greenland Ice Sheet Project 2 (GISP2) core indicate that some climatic events are identifiable in the Malham Tarn isotope record. Others aspects of the Malham Tarn isotope record are associated with local hydrological changes. Artificial deepening in 1791 is represented by a change in sediment type from charophyte marl to peaty carbonate mud. A delayed response of the $?^{18}O$ (carbonate) record to this event suggests deepening occurred after an initial period of lake area enlargement. Interpretation of the sedimentary record is, however, currently hindered by the lack of an absolute chronology. This study will therefore provide the basis for further palaeo-environmental interpretation once dates are obtained.

Author: Pietro Coletta

ERRATIC JUDGMENTS: A NEW INTERPRETATION OF THE NORBER ERRATICS AND A RE-ASSESSMENT OF LANDFORM-BASED LIMESTONE EROSION RATES

Introduction

The work aims to re-examine interpretations of pedestals beneath glacial erratics on Carboniferous Limestone areas of NW England, paying particular attention to the Norber pedestals on the SE flank of Ingleborough in Yorkshire. Recent field observations of mature surface limestone landforms in NW England have stimulated a re-examination of limestone denudation rates derived from landform evidence. The Norber pedestals have provided one of these sources (Sweeting, 1966). Similar features elsewhere in Northern England, such as Cunswick Tarn near Kendal, Scar Close and Scales Moor in Yorkshire, Gaitbarrows and Farleton Knott in Cumbria, have also been re-assessed in the field. Literature on sites elsewhere has also been examined.

Field sites

Local site characteristics at Norber imply that the oft-quoted denudation rates are very restricted in relevance to other limestone areas. The Norber pedestals only indicate how much a limestone surface will change after erratic boulder deposition, where that surface is composed of well-fractured, stepped limestones, across a sloping topography. In these circumstances mechanical weathering is heavily involved in eroding back limestone steps, and whilst solution will aid, this process it is not dominant. An underlying stepped surface structure explains many of the so-called pedestals at Norber, which stand on small cliffs. The surface is not the continuous limestone pavement as implied in the literature and was probably already unevenly weathered, and certainly unevenly glacially plucked, before the boulders were deposited by ice. The most well known pedestals at Norber are also not typical of the whole array of these features, and all are accounted for by the explanation involving local characteristics. Bed thickness is the main influence on pedestal height. Mechanical erosion has included human and animal activities.

Pedestals on weak limestones at Cunswick Scar, Cumbria; Leean in Co. Leitrim, Eire; and in South Wales, have also been misinterpreted, with the emphasis on solutional rather than mechanical erosion. Pedestals on stronger limestone at other sites have also been misinterpreted where solution of the lower parts of pedestals from surrounding soil and vegetation has not been carefully assessed.

Implications

Overall this work establishes that limestone surface lowering by solution in drier, interfluve locations in Northern England since the glacial erratics were deposited is of the order of 15 cm at maximum, thus about one third of the 40 to 50 cm figures cited in the literature (Gunn, 1985; Ford and Williams, 1988). Even this lower figure poses problems and some sites indicate only about 5 to 10 cm. Further work needs to be carried out. It can also be questioned as to when the boulders were emplaced on the limestones beneath. If the boulders were not deposited during the Late Devensian Glaciation but during an earlier glacial episode this would further reduce the calculated solution rates. Many sites are accounted for by geological factors and, for such reasons, Norber in particular cannot be used as a general case for widely applicable solution rates.

This work has considerable implications for interpretation of the age and development of small and medium-scale surface landforms in the limestone areas of NW England.

Author: Helen S. Goldie

References:

Ford, D.C. & Williams, P.W., 1989, Karst Geomorphology and Hydrology. Chapman & Hall, London.
Gunn, J., 1985, Pennine karst areas and their Quaternary history. Ch. 14 in (ed.) Johnston, R.H., The geomorphology of North-west England. Manchester University Press.
Sweeting, M.M., 1966, The Weathering of Limestones. In (ed.) Dury, G.H. Essays in Geomorphology, Heinemann, London. 177-210.

PRELIMINARY OBSERVATIONS ON SMALL TO MEDIUM SCALE MATURE SURFACE KARST LANDFORMS IN NW ENGLAND

Introduction

Field observations in Carboniferous Limestone areas of NW England have identified landforms whose characteristics provoke serious questions regarding their formation entirely since the Late Devensian, c. 15 ka ago. The scale and type of feature under discussion here have been neglected in British karst studies. Comparison with limestone landscapes in unglaciated areas such as Northern Hungary and Southern Spain also stimulated questions about the NW England features.

The features include: rounded boulders; large grikes and weathering flares; deeply runnelled bevelled edges; large grike-holes; well-rounded bed and scar edges; isolated in situ 'boulder' outcrops; tor-like features; and pinnacle-like clints. These are often found near or around limestone pavements, and in thick, massive beds. The view that they have all formed in the 15 ka since the end of the last glaciation from a closed-joint rock surface is hard to support. Topographic relationships, including proximity to more scoured surfaces, suggest that the high solution rates needed to form the features in that time would have been impossibly localised for sufficient time.

Discussion

A modified Goldie and Cox (2000) model of limestone pavement development is presented which demonstrates the major factors influencing survival of these landforms from glaciation. Survival is related to factors such as thick, massive rock, and locations sheltered from the main ice flow scour during the late Devensian glaciation. Such locations may be at high altitude between main valleys, sheltered from ice flow, or where ice streams could lose power. Identification of similar features within apparently glacially-scoured pavement areas may indicate greater age of those pavement features, ie that their form partly results from earlier karstification. In some cases it may be demonstrable that these forms have never been glaciated and are exposed by the erosion back of overlying beds along strong limestones, that is, that they are palaeokarst. This idea is in the literature (and see Vincent, this abstract series). Surface features may in part be extremely old, Late Carboniferous for example, as demonstrated by the interstratal karst at Trowbarrow Quarry near Morecambe Bay.

Assumed post-Devensian solution rates were questioned during this work. Rates based on pedestal work have been exaggerated. Figures of 40 to 50 cm in the literature for surface solutional lowering in 15 ka can be reduced in dry interfluve areas with calcareous soils to c.15 cm maximum for that period and probably considerably less.

Implications

Many of the small-medium scale features of limestone outcrops in Northern England may therefore be considerably older than previously thought. It is possible that some forms were never glacially scoured or that others have developed since earlier glaciations than the Late Devensian. Thus these areas have older and more complex small and medium scale surface karst landforms than has been appreciated until recently.

Author: Helen S. Goldie

References:

Goldie H.S. & Cox, N.J., 2000, Comparative morphometry of limestone pavements in Switzerland, Britain and Ireland. Z.Geomorph. N.F. Suppl.-Bd. 122, 85-112

Vincent, P.J., 1995, Limestone pavements in the British Isles: a review. Geogr. J., 161, 265-274

Vincent, P.J., 2004, In this abstract collection.

THE EVIDENCE FOR PALAEOKARST IN THE MALHAM HIGH COUNTRY

Introduction

Since karst areas are considered to have 'karstic immunity' because surface flow is minimal, ancient landforms and deposits survive longer. The possibility exists that the large karstic depressions (dolines or uvalas) may be palaeokarstic in origin. The paper focuses on the Malham high country, a triangular area of 22 km^2 lying between Arncliffe, Kilnsey and Malham Tarn, reaching altitudes above 500m. Large karstic depressions have been reported from this area since at least 1955. There is also consensus first presented by Dr Marjorie Sweeting (1974, 1980) that this area has the most evolved karst.

Over 100 depressions are known from the Malham high country and some exceed 10m in depth. Reports of depths exceeding 100m should now be refuted; confusion in conversion from feet to metres! The deepest recorded is 35m depth. Detailed mapping has established that the number of depressions far exceeds the number reported in the literature. Comparison of their altitude distribution with a histogram from cumulative intercontour distance analysis for the area establishes that they are disproportionately located above 450m altitude. All the depressions are located close to the contact of the upper Asbian beds and the overlying Wensleydale Group sediments. It is probable that interstratal palaeo surfaces (interruptions in deposition) may have facilitated their location.

The evidence for palaeokarst.

The depressions are too large to have formed since the end of the Late Devensian glaciation. The glacio-karst, within which they are located, is itself considered to be palaeokarstic since the climatic conditions under which it developed no longer obtains. The depressions preceded the last glacial so it must be accepted that they too are palaeokarstic.

SOME EXAMPLES OF BRITISH PALAEOKARST

Area	Feature	Age	Reference
Cumbria	Furness sops (haemetite deposits)	Post Triassic	Rose & Dunham 1977
	Deepdale	? Tertiary	Gale 1981
White Peak	Brassington Formation	Tertiary	Ford 1977
Cresswell Crags	Exhumed karst	Pre-glacial	Hunt 1994
North Wales	Red clays (?terra rossa)	Pre Glacial	Wright 1983
South Wales	Collapse features	Interstratal	Thomas 1954:1974

Athough palaeokarst is usually associated with ancient 'shield' continents, such as Africa or America, some relics remain in Britain, despite glacial modification (Table 1). It is relevant to recognise that it is ice streams (such as eroded the Dales) that altered the landscape, leaving little modified uplands between. The evidence for palaeokarst in Britain is scattered but direct dating is scarce. The best evidence comes from Ireland. There much ancient karst is at low elevation and is buried under later sediments or peat. The Polnahallia site

(Galway) has provided dates ranging from Late Pliocene to early Pleistocene thereby indicating a Tertiary origin for the karst. So far dating for the Yorkshire depressions is absent but they may contain periglacial sediments at the base with loess above, overlain by peat which commenced formation about 9ka years ago.

Author: Margaret E Marker

RE-THINKING THE ORIGIN OF LIMESTONE PAVEMENTS

Limestone pavements form one of the most characteristic landforms on the Carboniferous Limestones of northern England. Most are now legally protected and they provide important habitats for many rare plants. Most descriptions of pavements refer to clints and grikes and generations of students have spent endless hours measuring these features.

The evidence

In order to understand these landforms, it is necessary to link process with geology. It is now recognised that the Asbian and Brigantian stage limestones which make up the Great Scar Limestone are not just cyclically bedded but that the cycles also involved repeated emergenceas sea levels fell during periods of Carboniferous glaciation. The emergence surfaces were covered with volcanic dusts (wayboard clays) and paleokarstic, calcreted, surfaces developed under the rich Carboniferous soil. The calcreted surfaces are hard and poorly jointed as compared with the limestone sequences above the volcanic dust layer – the so-called wayboard clay. These terrestrial clays are not to be confused with marine shale bands that may have been deposited over the exposed land surface as the sea flooded back during the end of an emission cycle.

Calcreted horizons have only been abraded by Devensian ice scour whereas beds above the wayboard clays have been severely plucked. In interpreting the limestone pavements of northern England we should think in terms of the links between pavement form and these Asbian cyclic sequences. Thus for example, massive, poorly jointed pavements, such as those at Scar Close and Gait Barrows NNR are developed in the glacially exhumed paleokarstic surfaces under the wayboard clays, whereas heavily jointed pavements are developed on beds above the wayboard clays.

Not only does the calcrete/non-calcrete development account for variation in the limestone pavements themselves but it also accounts for the stepped hillside profiles in the Dales karst. Calcreted exhumed paleokarstic surfaces are visible in many places and a good example can be seen in the floor of the Ribbleshead Quarry. Wayboard clays are also visible at several exposures and in cave tunnels in Chapel Le Dale and at Great Asby Scar NNR.

The significance

Why is all this important? First, the karst landscape is actually not simply the product of recent glacial scour; much of it has been exhumed and is very old. Second, we can now more easily explain the morphological variations between pavements. In conserving the landscape we should not just think in terms of floristic richness and diversity but also the geomorphological diversity, too. A limestone pavement is not just simply a pavement is it?

Author: Peter Vincent

COWSIDE BECK INTRODUCTION

Location

Upper part of the River Wharfe catchment with drainage basin to the north of Malham Tarn (SD895665).

Description

The river flows northeast from SD888692 for approximately 5km into the River Skirfare at SD934720 which then joins the River Wharfe south of Kettlewell at SD977693. The catchment is approximately $8km^2$, mainly on Great Scar Limestone with subsurface water flow dominant, particularly on the south side. Downstream and inter-tributary changes in processes, morphology and chemistry due to land use and lithology are evident.

The upper reaches show steep V-shaped valley profiles with well developed terracettes and some meandering in the channel. The middle reaches contain a straightened section after the confluence of Darnbrook Beck. A glaciated lower section has resulted in steep scars supplying considerable bedload to the channel.

The main stream is fed by springs close to the channel. Those higher up the valley and on the valley slopes are only active after heavy storms have raised the water table. Others are present at the surface at all times suggesting the Horton formation basement beds are not far below the present valley floor.

Three longer tributaries feed the main stream from the Northwest. Darnbrook Beck flows mainly on glacial drift, which overlies the variably permeable Wensleydale(Yoredales) and Grassington Grit formations. The western headwaters rise as several springs near the base of the Grassigton Grit, the acidic nature of the soil is reflected in the chemistry of the water. As the stream flows over the limestone, the pH of the water shows a significant increase. Towards Darnbrook Farm, a series of sinks leave the channel dry during periods of baseflow.

Tennant Gill rises on Wensleydale Formation shales below the grit. Along the lower section it crosses drift on top of Goredale Limestone it has been channelised to prevent flooding of the meadows. In 1982 a sink developed above Tennant Gill Farm leaving the lower part dry. Thoragill Beck rises from springs in the Goredale Limestone and flows in an old meltwater channel for 750 metres to the confluence with Cowside.

Land Use

The catchment is dominated by extensive upland pasture including unimproved rough grazing on the steeper slopes and improved pasture with limited chemical fertilizer application and manuring on the more sheltered fields. The tops of Fountains Fell and Darnbrook Fell have areas of heather moorland and blanket bog. There are mature conifer plantations on the small valleys feeding Darnbrook Beck.

Nature Conservation

Cowside Beck is a nationally important upland stream which lies within the Craven Limestone Complex Special Area of Conservation. Habitats include calcareous and acid grasslands and flushes (wet areas at springs), limestone pavement and scattered trees. Various rare plants occur including bird's eye primrose, blue moor grass, limestone fern, baneberry and downy currant. Dipper, grey wagtail and common sandpiper all breed close to the beck.

Darnbrook Farm falls within the Craven Limestone Grassland Wildlife Enhancement Scheme implemented by English Nature.

Reference

Woof, C. and Jackson, E. (1998) *Some aspects of the water chemistry in the area around Malham Tarn, North Yorkshire.* Field Studies, 7, 159-187.

Author: Adrian Pickles

COWSIDE BECK: GEOMORPHOLOGY

Cowside Beck,Yorkshire, U.K. a tributary of the River Skirfare, flows into the River Wharfe. The catchment has an area of c.20 km^2 with contrasting conditions. On Fountain's Fell (668 m) and Darnbrook Fell(624 m) peat-covered, glacial drift overlies Millstone Grit and Wensleydale (Yoredale) Series rocks. In the west and south the limestone of the Malham Formation rises to 538 m in the Malham high country with dry valleys and few surface streams. The karstic nature of much of the catchment makes it difficult to precisely define the actual catchment boundaries. As a result of these varied conditions there is a wide habitat range with the emphasis on varied calcareous habitats depending on amounts of limestone, forms of outcrop, overlying sediment, altitude, exposure and moisture levels.

Cowside Beck has been investigated because it is a characteristic high quality calcareous stream. The Cowside valley heads at 400 m in a dry valley sector 875 m in length. Intermittent springs occur down valley. The general alignment is northeast for 2 km. Permanent risings appear at 360-375 m altitude. About 500 m upstream of the confluence of the Darnbrook Beck the major north bank tributary, the Cowside Beck swings to align west-east for 1.5 km. Below the Darnbrook Beck confluence the Cowside Beck enters its 'gorge' section. Downstream of the gorge the valley again trends northeast, for 3 km to the confluence with the Skirfare. In this sector there is a clear valley-in-valley cross section. The overall long-profile is well adjusted to the Skirfare River at Arncliffe where it is incised into a large depositional gravel fan. A stream ordering exercise identified the importance of the Darnbrook catchment, which is a fourth order stream. Cowside Beck remains fourth order after the Darnbrook Beck confluence since Upper Cowside (above the CB/DB confluence) is a third order thus not changing the order when it joins Darnbrook.

The entire catchment of Cowside Beck is known to have highly variable discharge; the Darnbrook side is regarded as 'flashy', even though it has peat-cover, which should act as a sponge. However, the boulder clay here is not particularly absorbent and the peat is thin in places, favouring flashiness. This is exacerbated by underground drainage around and above Darnbrook House. [Ref: Hodgson elsewhere in these abstracts].

The system can be divided into several segments, each with a distinctive, although not unvarying, character. Cross profiles from some segments highlight asymmetry, and it is worth emphasizing the valley-in-valley profile of Lower Cowside with impressive limestone scars at Yew Cogar Scar. There is no evidence of glacial drift on the limestone on the southern side although scree is characteristic. On the north side of the valley there is drift above the break of slope, and areas of cemented scree that locally support steeper slopes. It is possible that the scree was derived from erosion of the limestone on the south side, under periglacial conditions and the stream has cut into this scree. Forms of the valley cross profiles and adjustment of the long profile to the Skirfare favour the idea that Cowside Beck did not contain active ice-flow during the most recent glaciation, c. 20 ka ago. Although the area may have been ice-covered, the modern thinking considers that most active ice flow was in the dales, and possibly not in the smaller side valleys such as

Cowside Beck. Thus the high areas between main valley ice flows may have been fairly inactive in terms of glacial erosion and Cowside Beck could have had inactive ice in it.

Upper Cowside has limestone outcrops in the dry valley floors, and there is loess and drift fill in these courses, which are eroding to form steps. The valleys flood after heavy rain, with flow from intermittent resurgences. Piping from the steps is then active. (Such an event was observed by D.Hodgson in Nov 2003 after c. 80 mm of rain fell in the previous eight days). In Upper Darnbrook the lithology of the streambed changes from the acid Millstone Grit at highest levels to stepped limestones and sandstones (Wensleydale Series), then to stepped limestones, in a relatively steep course. Loose material derived from the drift is also important. Increasingly, as the course levels out downstream, there is more gravel but the streambed contains many boulders with occasional bedrock outcrop. Below Darnbrook House the bed is often dry and boulder strewn downstream of the sinking of water. There are many shallow step waterfalls over limestone layers across the width of the stream in the upper courses, which become less distinct as the watercourse enlarges, but which can still be seen as lines of rapids in the water.

The stream network includes karst resurgences: seepages and springs, including tufa streams; dry valleys; gorge sections and varied scar features. There are seepages on both sides of several of the component streams (see map). In Lower Cowside seepages enter the river bed from the south side, but from the north side they rise at about 10 to 20 m above the river and have incised small valleys. There is also much seepage in to the east side of Darnbrook Beck where there is peat over drift. Some springs rise direct from bedrock, such as in the Upper Cowside headwaters, others are stony, or completely in bedrock. There are large input springs particularly below the CB/DB confluence, in the gorge immediately below this confluence and at Yew Cogar Cave. Much of this flow is from the Malham high country. The gorge below the confluence is narrow, shaded and well vegetated with trees. There is significantly less visible bedrock on Lower Cowside except at very low water levels. Other inputs include seepages with vegetational flushes.

One noteworthy point concerning waterflow in the whole catchment concerns the southern side, a large area from which inputs to Cowside are far less than from the northern tributaries (see Hodgson this volume). A stream tracing exercise would be needed to confirm where the water goes but various possibilities include underground flow taking water to the Skirfare via Cote Gill, or direct springs, exploiting fractures and faults in the limestone.

Altogether the various parts of Cowside Beck provide a surprisingly wide range of habitats, largely but not exclusively calcareous, in a considerable range of geomorphic situations.

Authors: Helen S. Goldie & Margaret E. Marker

THE COWSIDE BECK CAVES

Introduction

The caves reported resurge into Cowside Beck or contain water that connects to the resurgences. Few cavers visit these systems, the largest being restricted by the position of its entrance. It is possible that more caves will be found and missing links discovered in the present known systems. Upstream of the Robinson Pot sumps, there is a depth gap of 60m before the base of Darnbrook Pot, however a fault crosses the moor at the Cockpits and bisects Darnbrook Pot in the area of the Main Chamber. This causes problems for further exploration underground. A similar gap exists between the sump and rising for Cherry Tree Hole, so potential exists for more passages to be found.

The caves

CHERRY TREE HOLE - explored 1960: Length 1.25km.

This system has two streamways that were initially thought to unite and make their way to a downstream sump. However temperature recordings suggest that the North Passage finds a different route and possibly a different rising from the South Passage stream. A possibility is that South Passage water goes direct to Cowside Beck and the North Passage water goes to Thoragill Cave.

<u>Fauna</u>

Flies were trapped on two trips into the cave and first identified as *Heliomiza serrata* but later were confirmed as *Heliomiza captiosa* (Natural History Museum). Fungus found on rotting wood was identified as Candle Snuff fungus, *Xylaria hypoxylon* (OG). At the end of January 2003 evidence of bats was found. (DH, JA & AG). A bat detector was placed in the North Passage and bat movements were recorded over a few weeks during the winter hibernation period. A detector was placed beside the entrance in August to record late summer swarming. This proved that bats were using Cherry Tree Hole on a regular basis. Three species were caught: Brown Long Eared, Daubenton's and Natterers.

DARNBROOK POT - explored 1957: Depth 71m.

The cave is an active meandering stream passage with excellent calcite formations. Evidence of fault crossing the system, can be seen in the large chamber (18m x 12m x15m) and in the lower section of the cave. The water sinking at the end appears to mix with waters from the nearby surface stream and from Darnbrook Beck (when sinking). This water reappears in the main stream-way in Robinson's Pot.

<u>Fauna</u>

Searching for an alternative site to Cherry Tree Hole for a bat detector, Darnbrook Pot was visited on 3:11:2003. Large quantities of bat droppings were found especially in the Main Chamber.

ROBINSON'S POT -explored 1862 and 1867; 1975 rediscovered and extended: Length 2.5km

This is a very varied system with potential for extension; small passages connect active and fossil passages. The main stream passage is the main drain for Darnbrook Fell. There are excellent calcite formations in the main streamway and some unusual mud formations in the fossil passage. A fossil band extends around the chamber, the same band is also found in Cowside Beck flood rising.

History: In the 1862 Chamber the names of explorers marked onto the rock with candle soot were:
J. Metcalfe 1862 - James, Farmer, Darnbrook Farm
John Gill 1862 - John, Farmer, East Garth, Litton
J. Coulthard 1862 - John, Gamekeeper at Malham Tarn Estate
T. Coulthard 1862 - Thomas, Head Gardener, Malham Tarn Estate
J. Lee 1867 - ? , farmed at Stonelands, Litton
W. Morrison 1867 - Owner Malham Tarn Estate
W. Ward 1867 - William, Gamekeeper, Malham Tarn Estate

Fauna

The streams in the system were examined for invertebrates in 1975, 2002 and 2003. All recorded species were troglophiles. Larval and adult stonefly, *Dinocras cephalotes,* including one adult female caught just after it emerged, was found to extend through the whole system. *Gammarus pulex* and *crenobia alpina* were recorded at the same position in each survey. In 1975 a red deer antler tine was found in McColl's Rift and in 2003 a bone thought to be a match to part of a cow tibia was found. A fish was seen at the start of Sump 1 on 13:9:2003.

A sample of foam from the Main Streamway contained the spores of the following *Hypomycetes* (aquatic fungi) *Articulospora and Tetracladium marchalianum.* In 2002-2003 one caddis larvae, *Plectroneinia conspersa,* was found compared to seven in 1975. In the recent survey 12 species were recorded, this is significantly less than the 30 species recorded in 1975.

A crawl to the right at the start of Sump 1 gives access to the Worm Series. This emerges into a large phreatic passage, the mud on both sides showing large quantities of worm casts from *Allolobophora chlorotica* (the green worm). Eight worms were removed for examination, of these some were clitellate - mature and in breeding condition, others were juvenile or recently hatched from cocoons. This indicates a viable population. The species can survive long periods submerged in water. Records exist of *Allolobophora chlorotica* surviving for 50 weeks in soil totally submerged below aerated water. Cocoons can hatch under water and the young worms can feed and grow although totally immersed.

YEW COGAR CAVE -extended 1968-1974: Length 1.1km

This was once the resurgence for some of the Darnbrook Fell caves. The cave now contains two streams, the first from Darnbrook Fell and the second from Parson's Pulpit area. It is quite possible that the water ends in a phreas zone below Cowside Beck before emerging at the rising; this may extend back to Darnbrook Beck, Shaft No.1 which may be connected to the downstream sump in Robinson's Pot.

LOOP CAVE

This is a small resurgence cave in the scar on the south bank of Cowside Beck 400m downstream of the Darnbrook Beck confluence.

History:
On 26th October 2001 two carved names and a date were observed in the cave wall:
J.W.Myers R.Metcalfe 1842

Fauna
The cave is home to a breeding colony of *Meta merianae* (a troglophile spider) first recorded November 1956 (DH). *Scoliopteryx libatrix* (Herald moth) uses the cave as an overwintering site.

COWSIDE BECK: MAIN RISING AND FLOOD RISING

In September 2002 an attempt to enter these risings was made. A dead trout approximately 200mm in length and a living one were found. These are the only trout recorded in two years work on Cowside Beck.

Author: Dave Hodgson

Other initials in text refer to the following people. JA: John Altringham, OG: Oliver Gilbert

COWSIDE BECK - WATER CHEMISTRY

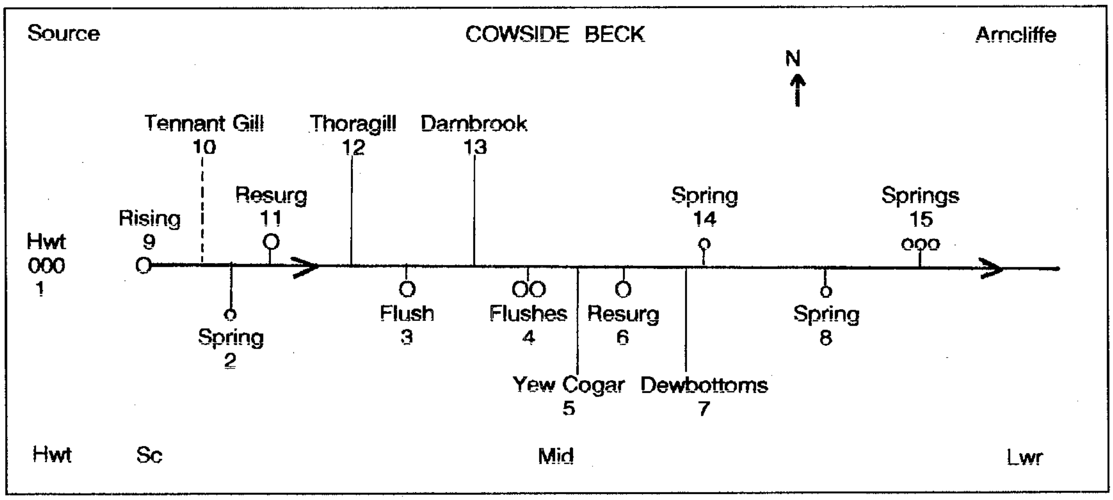
The total hardness of the water of Cowside Beck, expressed as mgs $CaCO_3\ l^{-1}$, varies between 122 and 202 and its composition is relatively constant throughout its 4 km length, with differences between source and confluence with the River Skirfare at any one time, varying by as little as 10-30 mgs $CaCO_3\ l^{-1}$ (Table 1)

The headwaters (Fig.1) consist of a number of springs which only become apparent in times of heavy rain; here the hardness is constantly higher (192 -266) which, when taken into account with temperatures of 7-9^{0}C points to deep seated origins. The low magnesium and non-alkaline hardness reflect the composition of the Great Scar limestone (Table 1).

Table 1: Water chemistry average data

Date 22.06.2002	Headwater SD8886 6920	Source SD8888 6924	Middle SD8968 6998	Lower SD9300 7194
Total hardness, mg $CaCO_3\ l^{-1}$	261	202	198	176
Alkaline hardness	259	198	196	172
Non-alkaline hardness	2	4	2	4
Calcium	258	200	195	172
Magnesium	3	2	3	4
pH	6.9	7.4	7.1	7.9
Temperature, ^{0}C	8	9	10	12

Figure 1: Plan of Cowside Beck showing sample sites



Entering from the south are two streams (Yew Cogar and Dewbottoms), two major springs, a resurgence and several calcareous flushes and small tufa springs. (Fig.1)

Yew Cogar Beck (5), hardness 120 - 132, has significant tufa deposits; discharge rates vary enormously from a mere trickle to a raging torrent.

Dewbottoms Beck (7), hardness 126 - 196 also has significant tufa deposits and screens and very variable discharge rates. These two waters share a number of similar characteristics and are thought to come from the same aquifer.

Spring (2), hardness 148 - 190, temperature 8 - 9^{0}C, discharge rates variable but there is always a visible surface flow of water.

Spring (8), hardness 142 - 192, temperature 8 - 9^{0}C, flow rates variable but rapidly respond to rainfall. Under such conditions it contributes significant volumes of water to the main stream.

Resurgence (6), this water comes from Darnbrook Pot which is 3 km away high up on Darnbrook Fell.
Small tufa springs and calcareous flushes (3, 4), hardness 200 - 300 and flows insignificant.

Entering from the north are two streams (Thoragill and Darnbrook), a rising, a resurgence and six springs. The rising (9) is the first permanent flow of Cowside Beck, hardness 180 -202, temperature 8 - 9^{0}C.

The resurgence (11) hardness 162 - 180, comes from Cherry Tree Hole, a cave system, some 1.3 km away high up on Darnbrook Fell. The hardness at the resurgence is twice that of that flowing in Cherry Tree Hole itself.

Thoragill Beck (12), hardness 132 - 180. This stream runs continually.

Darnbrook Beck (13), hardness 32 - 136 is the major tributary of Cowside Beck. It rises in the blanket bog of Darnbrook and Fountains Fells and its headwaters have a hardness in the region of 20 - 50.The beck has an average gradient of 1:7. It is subject to violent flash floods but in times of drought and low flow it sinks underground at a point in the stream bed some 500 m above Darnbrook House. The route taken by this underground flow has not been established but it does not appear to connect with Cowside Beck.

Spring (14), hardness 134 - 222, and the five springs (15), hardness 160 - 180, contribute little to the overall flow of Cowside Beck.

Two or so decades ago Tennant Gill (10) flowed into upper Cowside Beck. It now finds its way underground just below Tennant Gill Farm. No connection with Cowside Beck has been identified.

Acknowledgements
The project would not have been possible had it not been for the help provided by Messrs Allan. H. Heaton, David Hodgson, Dr. M. Proctor, the National Trust and local farmers.

Author: Douglas T. Richardson

COWSIDE BECK LICHEN SURVEY

Introduction

During the two years since the second Malham Tarn Research Seminar in 2001, the lichen flora of Cowside Beck and its tributaries have been thoroughly surveyed for lichens. During summer 2003 water levels were very low providing ideal conditions for survey work and revealing that much of Darnbrook Beck is a winterbourne stream, subject to periodic drying out. According to the nature of the stream course the lichen flora varies from non-existent, through poor to moderate, but with a few sites very rich. Three such 'hot spots' were identified one on the main beck and two on upper Darnbrook. The watercourses elegantly illustrate what makes good and bad habitat for aquatic lichens.

Cowside Beck

For most of their length both Upper and Lower Cowside have a bed of limestone boulders between earth banks. The boulders support an almost complete cover of large and aggressive aquatic bryophytes supplemented for half the year by a dense growth of filamentous green algae. There is little room for lichens in this community with just occasional *Leptogium plicatile*, *Thelidium decipiens* and a few common Verrucarias present on the larger boulders.

The winterbourne headwaters above the permanent springs are characterised by *Verrucaria aethiobola*, an aquatic species that can withstand drying out, and *V. praetermissa* on the moist underside of the stones. Lichens characteristic of damp limestone are also present such as *Aspicilia contorta*, *Caloplaca citrina*, *Leptogium plicatile* and *Thelidium papulare*. Lichen cover may reach 25%.

The dozen or so permanent head water springs issue from small caves which are stable habitats not being subject to trampling by cattle, and the semi-shade discourages bryophytes and algae. The water is highly alkaline with a pH well over 7 and a total hardness of 130-198 mg $CaCO_3$ l^{-1}. The larger stones in these springs carry colonies of *V. rheitrophila* and *V. elaeomelaena*, both can spend their entire lives totally submerged, they are nationally scarce with the latter the rarest.

The most exciting length of Cowside Beck for lichens is the 600m gorge below the Darnbrook confluence. Here the bed of the stream is outcropping limestone, its course is flanked by shelving beds of limestone, and a pool riffle structure is present. Bryophytes and algae still dominate but there is bare limestone where the flow is fastest and on prominences subject to scouring during floods. Around twenty fluvial lichens are present zoned in relation to height above water level. At the upper levels some of the lichens such as *Agonimia tristicula, Lempholemma polyanthes, Peltigera* spp. and *Psoroma luridum* are found overgrowing the moss cover. A particular rarity, found several times, is *Staurothele bacilligera*. For a long time it was known only on Ingleborough where it was discovered in 1964. It is now known also from the Northern Pennines and NW Scotland but this is a new Craven site for it. Its conservation classification is 'Near

Threatened'. Other species of note are *Psorotichia schraderi, Staurothele guestphalica* and *S. hymemogonia,*

The Tufa Tributaries

The bed of these two streams are covered in tufa which is being actively deposited by the most strongly alkaline water in the catchment (pH 7.7-8.1). Tufa (travertine) is too soft and unstable to support lichens so the group is absent from the stream bed. A non tufa-depositing seepage near the bottom of Waterfall Beck supported submerged colonies of the rare calcareous aquatic *Placynthium tantaleum* new to the Malham area. On the valley sides of Waterfall Beck, high above the level of the present stream, there are lumps of old tufa in the scree suggesting a huge flood associated with the collapse of a former tufa dam. This old, well-weathered and hardened tufa supports interesting lichens such as *Hymenelia epulotica, Polyblastia deminuta* and *Solorina saccata.*

Darnbrook Beck

The lower part of this major tributary runs for the most part over limestone boulders and behaves as a winterbourne, only a few aquatic lichens such as *Leptogium plicatile*, *Thelidium decipiens* and certain *Verrucaria spp.* can tolerate these conditions. In a number of places permanent seepage drains from limestone bedding planes flanking the stream. These sites support true aquatic lichen communities with *Pyrenocollema monense*, *Staurothele bacilligera* and *Verrucaria elaeomelaena.* A further feature of this reach is the presence of communities associated with bird perches. The larger, more prominent and stable boulders in the stream bed regularly have guano deposited on them by dippers, ring ouzels and other birds working the stream for insects. This encourages a community of nutrient-loving lichens to develop which are found nowhere else on the fell. They include abundant *Phaeophyscia orbicularis* supported by *Candelariella vitellina, Lecanora albescens, Physcia adscendens, P. caesia, P. tenella* and the yellow *Xanthoria parietina.*

Higher up where it traverses the Wensleydale Series the stream again mostly has an unstable stony bed, and earth banks. At two sites, however, limestone lichens are richly developed, one is in the vicinity of a short limestone ravine just above the Cockpits, the other is a 10 m high waterfall formed where the beck flows over Wensleydale Group Hawes-Gayle Limestones.

The ravine site is carved in the top of the Gordale Limestone and provides a range of niches from dark and sheltered in the ravine to well-illuminated at its south-facing mouth. Sheltered faces are covered with *Bacidia fuscovirens, Belonia nidarosienensis, Gyalecta jenensis* and *Opegrapha saxatilis.* The lichens on well-lit limestone are zoned in relation to length of submergence; the succession is terminated at the base by silt deposition and at the top by a declining influence of the stream at around 60m. Around 40 lichens can be found in the vicinity of the ravine the majority being in well-lit sites. There are six jelly lichens including *Collema cristatum, C. fuscovirens, Lempholemma polyanthes*, and *Leptogium gelatinosum*. Pyrenocarpous lichens are well represented notable species being *Dermatocarpon miniatum, Polyblastia albida, P. dermatoides, Thelidium fontigenum,* and *T. papulare.* Two lichenicolous fungi are present, *Toninia verrucarioides* overgrowing *Placynthium nigrum* and *Roselliniopsis tartaricola* on *Acarospora glaucocarpa.* This is only the second British record of the latter, it seems to be something of a Craven speciality as the first record was from Ribblehead.

The waterfall formed by the Hawes-Gayle Limestone of the Wensleydale Group is a steep jumble of large boulders of impure limestone about 10 m high. These provide a range of niches varying from aquatic through fluvial to merely damp. A number of the lichens of the Cowside system were only seen here, for example, *Diploschistes muscorum, Farnoldia jurana, Myxobilimbia lobulata, Peltigera didactyla* and *Placynthium subradiatum.* In the 1960's there were some large patches of *Peltigera leucophlebia* in grassland by the fall but they could not be relocated though *P. membranacea* and *P. lactucifolia* were present. This is a good site to see *Acarospora glaucocarpa, Dermatocarpon miniatum, Hymenelia prevostii* and *Petractis clausa.*

Millstone Grit Tributaries

Above the Wensleydale Group Limestones, Darnbrook Beck branches into a number of small tributaries flowing over drift. These have a low pH and low total hardness (pH 4.3-4.6; hardness 2-50). Rushes often form a canopy over them so they flow in shady tunnels and their beds are lined with loose shale, these factors combine to eliminate lichens from most of their length. Where the light conditions are better such as at bends, path crossings or by small waterfalls lichens come in if there are stable sandstone boulders embedded in the water course. Species constantly submerged by 2-3 cm of water during mean flow include *Verrucaria aquatilis, V. funckii* and *V. rheitrophila.* Slightly higher is a *V. margacea/V. praetermissa* zone. On the sides of stones around water level *Bacidia inundata, Baeomyces rufus, Hymenelia lacustris* (rare), *Porpidia soredizoides, Rhizocarpon laevatum, Trapelia coarctata* and *T. involuta* are sparingly present. These calcifuge lichens are too scattered to form communities. The headwaters of Tennant Gill support the same assemblage of common acidic lichens.

Fountains Fell Tarn

This shallow, highly acidic tarn (pH 3.5; hardness <2-8) lies in a hollow among eroding blanket bog. Its shore line is composed of heavily leached, flat pieces of coarse gritstone. These support a <1 % lichen cover which means that many stones are bare. They comprise *Lecidea plana, Porpidia crustulata, P. tuberculosa* and *Trapelia coarctata,* the former is a first record for the Malham area. These species, which are lichens of damp rock rather than true aquatics, are not obviously zoned in relation to the water margin.

Summary

Much of the Cowside Beck system is poor in lichens due to competition from bryophytes and filamentous green algae, having a bed that is unstable during times of flood, depositing tufa which is not a suitable substrate for lichens, or, as in the case of lower Darnbrook, being a winterbourne and drying out in summer. Three 'hot spots' for lichens were encountered, all where outcropping limestone was present in and flanking the stream. These are the 600 m long Cowside gorge, and on Darnbrook, a short ravine cut into the Gordale Limestone above the Cock Pits, and the 10 m high waterfall created by the Wensleydale Group Limestone. At these sites 30 to 40 lichens were found several being new to the Malham area and many regarded as uncommon (Seaward & Pentecost 2001). The presence of acid headwaters on Darnbrook Beck and Tennant Gill add a small number of calcifuge lichens but due to shade and an unstable bed rivulets rarely support well developed lichen communities.

A national survey of chalk and limestone streams (Gilbert 1996) showed that the richest sites in terms of lichen diversity are those with the greatest area of exposed limestone bed-rock. These tend to be rejuvenated stretches of river in the middle reaches where wide, gently shelving beds of limestone flank the watercourse e.g. Aysgarth Falls on the River Ure and Ghaistrill's Strid on the River Wharfe. This paper describes the restraints and opportunities for lichens on a typical head water section of a Dales river flowing over the Malham Formation (Great Scar) Limestone, Wensleydale Group and Millstone Grit.

References

Gilbert, O. L. (1996) The lichen vegetation of chalk and limestone streams in Britain. Lichenologist 28: 145-159.

Seaward, M. R. D. & Pentecost, A. (2001) Lichen Flora of the Malham Tarn area. Field Studies 10: 57-92.

Author: Oliver Gilbert

COWSIDE BECK - FRESHWATER INVERTEBRATES

The beck is fed by high quality water from various springs. The annual overall hardness of the water varies between 120 and 200 mg $CaCO_3$ l^{-1}; it has a relatively shallow average gradient of 1 in 16 which affects the flow rate, the substrata is stony with luxuriant growths of aquatic bryophytes. Where it levels out on the approach to Arncliffe (GR. SD 93 71) there are marginal deposits of sand and gravel.

The following species have been recorded :-

HEMIPTERA (Water Bugs)
Gerris thoracus
Velia caprai

MOLLUSCA (Snails)
Ancylus fluviatilis
Lymnaea peregra

TRICHOPTERA LARVA (Caddisflies)
Agepetus fuscipes
Allogamus auricollis
Hydropsyche instabilis
siltali
Leidostoma hirtum
Philopotamus montanus
Polycentropus flavomaculatus
Potamophylax latipennis
Rhyacophila dorsalis

COLEOPTERA (Water Beetles)
Helophorus grandis
Oreodytes davisii
sanmarkii

EPHEMEROPTERA LARVA (Mayflies)
Baetis muticus
rhodani
scambus
Caenis rivulorum
Ecdyonurus torrentis
Ephemerella ignita
Heptagenia lateralis
sulphurea
Paraleptophlebia submarginata
Rithrogenia semicolorata

AMPHIPODA (Freshwater Shrimps)
Gammarus pulex

PLECOPTERA LARVA (Stoneflies)
Amphinemoura sulcicollis
Dinocras cephalotes
Isoperla grammatica
Leuctra geniculata
hippopus
inermis
Protonemura meyeri
Siphonoperla torrentium

Ephemeroptera larvae - *Baetis rhodani, B. muticus, Ecdyonurus torrentis and Ephemerella ignita* are by far the most abundant. *B. scambus* has turned up sporadically in small numbers; it is not at all common in the area. The only other local record is from Dowber Gill, Kettlewell (SD 977 725) in 2000. *Caenis rivulorum* is plentiful in the sand and gravel deposits of the lower reaches near Arncliffe.

Plecoptera larvae are all are present in large numbers, notably the very large *Dinocras cephalotes*.

Hemiptera (both species) prefer areas of still or very slow flowing water and are more or less confined to such areas along the stream.

Mollusca are both true aquatic species. No attempt has been made to record the marginal species.

Coleoptera all three are very small species which crawl about on submerged vegetation. The flow and stony nature of the stream is on the whole not condusive to the survival of the larger swimming species.

Acknowledgements: I have to thank Allan H Heaton of Harrogate without whose help the field work could not have been carried out.

Author: Douglas T. Richardson

COWSIDE BECK BRYOPHYTES

Bryophytes, mostly mosses, are the dominant green plants in Cowside Beck and its tributaries. The most striking contrast in the character of the stream flora is between the headwater tributaries draining from the Millstone Grit and the blanket bog on the Grit and drift on Fountains Fell, with less than 1 mg/litre calcium and magnesium and pH around 4.3-4.5, and the rest of the streams, receiving at least some solute input from limestone, with pH>7 and substantial amounts of calcium. Almost the only bryophyte in the acid headwater streams is the leafy liverwort *Scapania undulata*, growing on fragments of Millstone Grit in the stream bed, but *Sphagnum fallax* and *Polytrichum commune* are common in the fringing vegetation of the banks.

Once pH is around neutrality or above, a much wider range of species occur. Many of these can be found from high on Darnbrook Beck to the lower reaches of Cowside Beck near Arncliffe. However, there is a degree of contrast between the middle section of Darnbrook Beck, flowing over the shales, sandstones and thin limestones of the upper parts of the Yoredales, with 4-20 mg/litre calcium, and the lower parts of the Darnbrook-Cowside system which flow over solid limestone, with calcium concentrations typically above 50 mg/litre. This middle section of Darnbrook Beck has a moss cover which tends to be rather open and diverse, for reasons which may have as much to do with physical factors as with water chemistry, and some species are much more conspicuous here than in Cowside, e.g. *Racomitrium aciculare*, *Amblystegium fluviatile*.

Throughout the calcareous parts of the catchment the moss cover is dominated by a small number of bulky species. *Cinclidotus fontinaloides*, *Brachythecium rivulare*, *Rhynchostegium riparioides* and *Hygrohypnum luridum* are almost ubiquitous, with subtle but important differences in detailed distribution. *C. fontinaloides* can grow submerged but is also very desiccation tolerant. It is at its best, forming blackish-green straggling masses, on limestone rocks in situations seasonally or intermittently flooded but also dry for long periods, as in the headwaters of Cowside Beck and various other intermittent stretches of stream, but it occurs almost everywhere in the middle and lower parts of Darnbrook and in Cowside Beck in the flood zone on boulders. *B. rivulare*, a common pleurocarpous moss of damp places, is the most ubiquitous of the three, but shuns either continuous inundation or severe desiccation. *R. riparioides* needs to be more or less continuously submerged and is intolerant of drying out, so it typically occurs below normal water level on slabs and boulders, and in sections of stream with intermittent flow it is generally confined to such pools as remain in dry weather. *H. luridum* can be found almost everywhere but is less bulky and thus often less conspicuous than the last three; it will stand high flow rates and it is tolerant of desiccation, so it can be prominent in both torrential and intermittent stretches of stream. Two further species are somewhat more restricted. *Schistidium rivulare* is ecologically similar to *C.inclidotus* but is a smaller plant which cannot compete with a dense cover of larger species. It is almost constant in Darnbrook Beck and above normal water level on boulders in lower Cowside Beck, but is excluded from much of the headwater section of Cowside Beck by the dense growth on the rocks of *C. fontinaloides* and the big pleurocarpous mosses.

Palustriella commutata (*Cratoneuron commutatum*) seems to require a combination of high calcium content and reliably continuous water flow. It is common in the headwaters of Cowside Beck where there is continuous flow, in Yew Cogar Beck, and in lower Cowside where springs emerge along the course of the beck, but virtually absent from Darnbrook Beck although it is present in lateral springs and flushes not far from the stream.

Slabs and shelving banks have a characteristic streamside flora including *Philonotis fontana*, *Dichodontium pellucidum*, *Cratoneuron filicinum*, various *Bryum* and *Didymodon* species and *Marchantia polymorpha*. The Cowside valley, as a whole, is very rich in bryophytes, but most of these are in grassland, wet flushes or on limestone outcrops above water level. Perhaps the most notable aquatic species here is the moss *Fissidens rufulus*, which is locally frequent on limestone slabs in the gorge below the Darnbrook confluence, submerged for most of the year but exposed during periods of low water level in summer.

Author: Michael C.F. Proctor

COWSIDE BECK - DIATOMS

Samples were collected from the following eight sites during 2002.

A	Cowside main rising	N.G.R. SD 8888 6924	(On algae)
B	Cowside Beck	SD 895 698	(Stream foam)
C	Cowside Beck	SD 9088 7002	(On moss and algae)
D	Spring	SD 8878 6912	(On algae)
E	Spring	SD 9242 7112	(On algae)
F	Calcareous flush	SD 9288 7169	(On algae)
G	Wet rock face	SD 9136 7052	
H	Wet rock face	SD 9045 7001	

Samples were treated with hydrochloric acid, sulphuric acid and potassium dichromate and the frustules mounted on microscope slides in Clearax R. I. 1.666.

Species	Sites							
	Stream			Spring		Flush	Rock Face	
Cocconeis pediculus Ehrenberg	A	B	C	D		F	G	H
placentula Ehrenberg		B		D				
Cymbella cistula (Ehrenberg) Kirchner					E	F		
cymbiformis Agardh								H
Diatoma tenue Agardh		B						
vulgare Bory		B	C					
Didymosphenia geminata (Lyngbye)	A							
M.Schmidt								
Diploneis ovalis (Hilse) Cleve	A				E	F		
Encyonema minutum (Hilse) D.G.Mann		B			E		G	
Eunotia arcus Ehrenberg			C			F		H
Frustula rhomboides (Ehrenberg)								
De Tony	A						G	H
Gomphoneis olivaceum (Hornemann) P.Dawson					E	F		
Gomphonemia acuminatum Ehrenberg					E			
Melosira varians Agardh		B						
Meridion circulare (Greville) Agardh	A		C	D	E	F	G	
Navicula radiosa Kutzing	A		C		E		G	
Nitzschia linearis W.Smith	A				E		G	
Pinnularia viridis (Nitzsch) Ehrenberg A					E			
Rhopaloida gibba (Ehrenberg) O.Muller					E		G	
Synedra ulna (Nitzsch) Ehrenberg					E	F		
ulna var *oxyrhynchus*		B						
(Kutzing) Van Heurck								

Species determined by reference to *An Atlas of British Diatoms.* B. Hartley, H. G. Barber & J. R. Carter,

The limited number of samples makes it difficult to draw conclusions; the exercise must therefore be regarded as a window to the study of the diatoms of the beck and its environs. A permanent record in the form of microscope slides has been made.

References: *An Atlas of British Diatoms.* B. Hartley, H. G. Barber & J. R. Carter, Biopress Limited 1996.

Author: Douglas T. Richardson

THE ALGAE OF WATERFALL BECK, MALHAM

Introduction

Waterfall Beck is a first-order limestone stream about 900m in length within the Cowside Beck catchment. It is a typical steep-gradient stream of this limestone region and falls over many small cascades on its short journey to the confluence with Cowside. Carbon dioxide produced by soil and plant respiration dissolves in the rainwater and the aggressive waters dissolve the limestone to give calcium bicarbonate solutions of around 1.5-2 mMol/litre. Once emerging at the springs the waters degas their excess carbon dioxide leading to the deposition of travertine ('tufa') on almost all of the cascades of Waterfall Beck. The stream bed consists almost entirely of limestone bedrock, about one third of which is covered with travertine, the remainder being bare limestone. The beck is a good example of a highly calcareous upland stream within an unwooded, exposed catchment.

Travertine deposits provide a favourable habitat for many aquatic cryptogams, algae and bryophytes being particularly well represented. Four well-defined algal communities have been recognised in this stream. Algae grow both within the bedrock and travertine as endoliths down to depths of about 3m below the surface. Here they are protected from erosion and grazing but their growth is limited by lack of light. Most algae however occur on the surface of the travertine as epiliths where they often become encrusted with calcium carbonate, and a third well-defined community grows on the surface of the bryophytes. The fourth community is much more seasonal and consists of abundant growths of filamentous algae associated with the bryophytes in summer. Nearly 100 species of algae are recorded from Waterfall Beck and it is probably one of the most intensively studied karst streams in the country.

The biota

Detailed quantitative studies have been made of all four algal communities. Relative biovolumes of all of the major algae have been calculated over a 12 month period and primary production rates estimated. The endoliths are volumetrically (and thus in terms of their biomass) the smallest community and consist mainly of cyanobacteria. Three species are common in the beck; *Hyella fontana, Phormidium favosum* and *Schizothrix perforans*. Both species are capable of etching into the limestone and probably assist in its erosion. The encrusting community of the travertine deposits is more species-rich and has a biomass per unit area about three times higher than the endolithic community. It too is dominated by cyanobacteria, mainly *P. favosum, P. incrustatum* and *Schizothrix calcicola agg.* The green alga *Gongrosira incrustans* is also important here, often imparting a pale green colour to the travertine. About 20 species of diatoms also occur, but only *Achnanthes minutissima* and *Navicula tripunctata* are important biomass contributors. The algal communities of the bryophyte leaves are entirely different. In terms of biomass these are much more significant. The major contributors are all diatoms, with *Cocconeis placentula* overwhelmingly abundant. Other important contributions are made by *Achnanthes minutissima, Cymbella cistula* and *Eunotia arcus.* The seasonal filamentous green algal community is dominated by species of Oedogonium and Mougeotia.

Conclusion

Less detailed observations from other calcareous Dales streams suggest that similar communities are widespread throughout the region.

Author: Allan Pentecost

WIDER DISSEMINATION OF INFORMATION AND THE AMATEUR/ACADEMIC INTERFACE

Introduction

It is often said that the golden age of the amateur is past, that the vast accumulation of biological knowledge of the last half century has left very little original research for the amateur to do. A brief wander around the web bears testimony to the fact that amateurs are hard at work throughout the country organising Natural History Societies and specialist groups.

These organisations comprise enthusiastic individuals, many not academically qualified in their chosen field of expertise. Many are happy to continue in isolation. However, others would like to see their efforts utilised in ways other than the publishing of a list on the World Wide Web. In general this is not for personal agrandisement but a genuine desire to contribute. Their recording schemes can provide a valuable resource to those in academia.

What is necessary?

The role of academia in all this:-

- Requests for information
- Guidance on how it is to be collected and recorded to suit a particular need
- Enthuse upon their chosen subject in terms that are understandable to the lay person.

The amateur may provide on-going projects with data that under normal circumstances might prove expensive or time-consuming. This might include simple identification records or counts. It might also include photographs.....

Authors: Steve Gill and Mike Samworth

AUTHORS' CONTACTS

Dr J. Allinson	6 Willow Wood Cottages, Langcliffe, Settle North Yorkshire, BD24 9NT jallinson@daelnet.co.uk
Dr P. Ashton	Edge Hill College, St Helens Road, Ormskirk, Lancs, L39 4QP ashtonp@edgehill.ac.uk
Mr P. Bradley	University of Sheffield, c/o 18 Strathtay Road, Sheffield, S11 7GU p.bradley@sheffield.ac.uk
Mr P. Coletta	Kings College, University of London, c/o 15 Jeddo Rd, London, W12 9EB Pietro.Coletta@kcl.ac.uk
Dr O. Gilbert	University of Sheffield, 42 Tom Lane, Sheffield, S10 3PB
Dr H. S. Goldie	University of Durham, 2 Springwell Rd, Durham, DH1 4LR h.s.goldie@dur.ac.uk
Mr S. Gill	123 The Longshoot, Nuneaton, Warwickshire, CV11 6JQ
Mr G. Hinton	English Nature, Northminster House, Peterborough, PE1 1UA George.hinton@english-nature.org.uk
Mr D. Hodgson	9 Craven Terrace, Settle, N.Yorkshire
Prof. M. Marker	5 Wytham Close, Eynsham, Oxfordshire, OX29 4NS mem@prof-marker.fsnet.co.uk
Mr A. Norris	17 West Park Drive, Leeds, LS16 5BL AdrianXNorris@aol.com
Dr A. Pentecost	Division of Biosphere Science, Kings College, University of London, Franklin Wilkins Building, 150 Stamford Street, London, SE1 9NN allan.pentecost@kcl.ac.uk
Dr M.C.F. Proctor	School of Biological Sciences, University of Exeter, Washington Singer Laboratories, Prince of Wales Road, Exeter EX4 4QG M.C.F.Proctor@exeter.ac.uk
Mr M. Samworth	6 Moorfield Bungalows, Scotton, Catterick Garrison, North Yorks. DL9 3ND apochrome@ukgateway.net
Dr P. Vincent	Geography Department, Lancaster University, Lancaster, LA1 4YB p.vincent@lancs.ac.uk
Dr T. Whitaker	VC64 Recorder Butterfly Conservation, 4 Crowtrees, Low Bentham, Lancaster LA2 7EE tmw1@globalnet.co.uk

ATTENDEES

Judith Allinson
Tori Annis
Paul Ashton
Paul Bradley
Cynthia Burek
Julian Carlisle
Pietro Coletta
Paul Evans
Oliver Gilbert
Steve Gill
Helen Goldie
George Hinton
David Hodgson
Tom Lord
Margaret Marker
Adrian Norris
Keith Orrell
Allan Pentecost
Adrian Pickles
Michael Proctor
Douglas Richardson
Irene Ridge
Claire Robinson
Mike Samworth
Phil Shaw
Robin Sutton
Janet Swain
Dave Tayler
Tony Thomas
Steve Tilling
Steve Trudgill
Peter Vincent
Terence Whitaker