

## 1.0 Introduction

This is the final report on research carried out for the project BGN/169 Buttoned snout *Hypena rostralis*. The aim was to conduct autecological research to inform habitat management. Dr Paul Waring acted as Consultant on this project and much of the early work was based on his knowledge of similar species and their behaviour.

The research was based mainly in Cambridgeshire and Essex, as funding was allocated to the Cambridgeshire and Essex Branch of Butterfly Conservation. Much of the research has been carried out by the Centre for Environment and Rural Affairs (CERA) at Writtle College, Chelmsford, Essex, where the author was based.

## 2.0 Literature Review

Butterfly Conservation reports were the main source of information for this project, but smaller articles by Waring (in press), Waring (2004), Waring (2003a & 2003b), Plant (1987), Frohawk (1934) and Wedd (1986) were all reviewed. Townsend (2002) suggested July was the best time to search for larvae while Plant (2000 & 2004) observed larvae in early June and suggested May might be a better time for larvae. Townsend (2002) identified that numbers of larvae increased significantly with the amount of *Humulus lupulus* Hop present and numbers of larvae decreased significantly with decreased building proximity. Numbers of larvae were significantly greater where *H. lupulus* was in dense, low clumps than when it was largely climbing.

The demolition or removal of old buildings and the flailing of hedgerows containing *H. lupulus*, *Rubus* spp. Bramble, and *Salix caprea* Sallow would appear to be part of the possible reason for the reduction in numbers (Townsend, 2002).

In a survey in urban South Hampshire, Budd (2001) beat larvae from *H. lupulus* during the period 13th July to the 30th July. In Hertfordshire and Middlesex Plant (2002) only discovered larvae at one site, a similar result to a survey of North London (Plant, 2000). Collins (2000) discovered larvae at 29 sites during a survey of Surrey between 28th June and 27th July. It was suggested that the reduction in records in recent years could well be erroneous because it relies on modern records from light-traps instead of more traditional

field techniques. Collins (2003) observed that many more adults are light-trapped in spring and early summer than in autumn. Of 21 records only one was in autumn.

One publication has been generated by this research project (Field *et al.*, 2004), plus two reports (Field, 2003; Field, 2004) and one student thesis.

### **3.0 Methods**

A range of techniques have been used.

#### **3.1 Searches for *H. lupulus***

Searches for *H. lupulus* and the larvae were conducted in 2002, 2003 & 2004:

- (a) In Cambridgeshire using the hop records for the County and information from local butterfly and moth recorders.
- (b) In Cambridgeshire and Essex by searching sites adjacent to where the moth had been light trapped.
- (c) In Cambridgeshire and Essex by searching large stands of hops (very common in Essex).

The searches were carried out by beating hop plants which showed signs of larval feeding. The amount of hops, growth type and distance from the nearest buildings were also recorded in 2002 using the method from Townsend (2002). The searches started on late June and continued until mid August. These searches were carried out during day light hours and usually ceased when larvae were located.

#### **3.2 Light-trapping**

Records at light traps in Cambridgeshire and Essex were gathered.

#### **3.3 Beating for larvae**

*H. lupulus* plants were beaten until larvae were discovered or all the plant had been checked. The recorders in 2002 were asked to complete a recording form with criteria adapted from Townsend (2002).

### **3.4 Searching for pupae**

Small *H. lupulus* plants where larvae had been observed were checked for pupae and in one case cut down and checked. The leaf litter and top soil was also removed searching for pupae.

### **3.5 Searching for hibernating adults**

Sites were checked where large numbers of larvae had been observed and where suitable buildings were nearby. Once hibernating adults were found detailed checks on temperature and timing of movements were recorded. Local knowledge was used to help identify possible sites and these were intensively searched.

### **3.6 Observation of captive larvae and adults**

A number of larvae were taken as captive stock and placed with a large cage with two large *H. lupulus* plants in it. These were kept in the cage once they emerged as adults and a specially built hibernation box was placed in it. Suitable nectar plants were placed in the cage to allow nectaring in autumn and spring. The adults remained in the cage during egg-laying and the resultant larvae were observed again over the summer period.

## **4.0 Results**

### **4.1 Essex survey**

#### **4.11 Light-trapping**

No specific light-trapping was undertaken but local records were monitored, however there were few records for the period 2002/5.

#### **4.12 Larval survey**

A survey of Essex found 44 new sites in 2002, 26 in 2003 and 18 in 2004, plus three new sites just into Hertfordshire (Tables 1-3). This added to two known sites, one at Dovercourt found by Essex Moth group in 2001 and the other at East Ham described in Plant (2000). A distribution map (Figure 1) identifies the records from various areas and this relates to sites searched. At two sites, Southend Prior Park and East Ham, the larvae were found on Ornamental Hops *Humulus scandens*. A list of *H. lupulus* in Essex where no larvae were found is included (Appendix 4).

**Table 1 : Larvae observed in Essex and Hertfordshire during 2002**

<b>Date</b>	<b>Site</b>	<b>Grid ref</b>	<b>Surveyor</b>
17/7	Sandon	TL744049	A. Deane & G Watkins
18/7	Wix	TM170285	A. Deane & G Watkins
18/7	Wix	TM174284	A. Deane & G Watkins
18/7	Gt Oakely	TM190274	A. Deane & G Watkins
18/7	Lt Oakely	TM190274	A. Deane & G Watkins
18/7	Moze	TM201253	A. Deane & G Watkins
18/7	Kirby le Soken	TM215222	A. Deane & G Watkins
20/7	Duton Hill	TL603263	A. Deane & G Watkins
20/7	Duton Hill	TL602267	A. Deane & G Watkins
20/7	Great Easton	TL602258	A. Deane & G Watkins
20/7	Great Easton	TL606261	A. Deane & G Watkins
25/7	Epping	TL450013	A. Deane & G Watkins
25/7	Buckhurst Hill	TQ423940	A. Deane & G Watkins
25/7	Woodford	TQ414908	A. Deane & G Watkins
25/7	Woodford	TQ414906	A. Deane & G Watkins
25/7	Waltham Abbey	TL377015	A. Deane & G Watkins
25/7	Waltham Abbey	TL378017	A. Deane & G Watkins
25/7	Waltham Abbey	TL376023	A. Deane & G Watkins
1/8	Writtle	TL678062	A. Deane & G Watkins
1/8	Roxwell	TL656085	A. Deane & G Watkins
1/8	Aythorpe Roding	TL591149	A. Deane & G Watkins
1/8	Little Easton	TL610240	A. Deane & G Watkins
1/8	Saffron Walden	TL522395	A. Deane & G Watkins
1/8	Wendon Ambo	TL501363	A. Deane & G Watkins
1/8	Poor Bridge	TL475304	A. Deane & G Watkins
1/8	Ugley	TL516289	A. Deane & G Watkins
6/8	Buckhurst Hill	TQ415929	A. Deane & G Watkins
25/7	East Ham	TQ4282	Howard Vaughan
24/7	Little Waltham	TL711117	John Williams
18/7	Roxwell	TL643086	Martin Heywood
18/7	Roxwell	TL628094	Martin Heywood
24/7	Newland Grove	TL715108	Martin Heywood
19/7	Southend Park Lane	TQ878854	G. Watkins
19/7	Southend Park Street	TQ878854	G. Watkins
19/7	Southend	TQ865870	G. Watkins
27/6	Writtle College	TL669069	A. Deane & G Watkins
11/7	Writtle College	TL667069	P. Waring <i>et al</i>
11/7	Writtle College	TL673068	P. Waring <i>et al</i>
11/7	Writtle College	TL679073	P. Waring <i>et al</i>
11/7	Writtle College	TL682072	P. Waring <i>et al</i>
31/7	Writtle College	TL673066	G. Watkins
14/8	Writtle College	TL664075	G. Watkins
12/7	Southend	TQ877874	R. Field & D. Down
10/8	Nr Beazley End	TL735282	A. Deane
10/8	Nr Beazley End	TL734282	A. Deane
18/8	Rotten End	TL728289	A. Deane
18/8	Lindsell	TL 645271	A. Deane
July 2001*	Dovercourt	TM226304	C. Gibson

\*Not previously known

**Table 2 : Larvae observed in Essex during 2003**

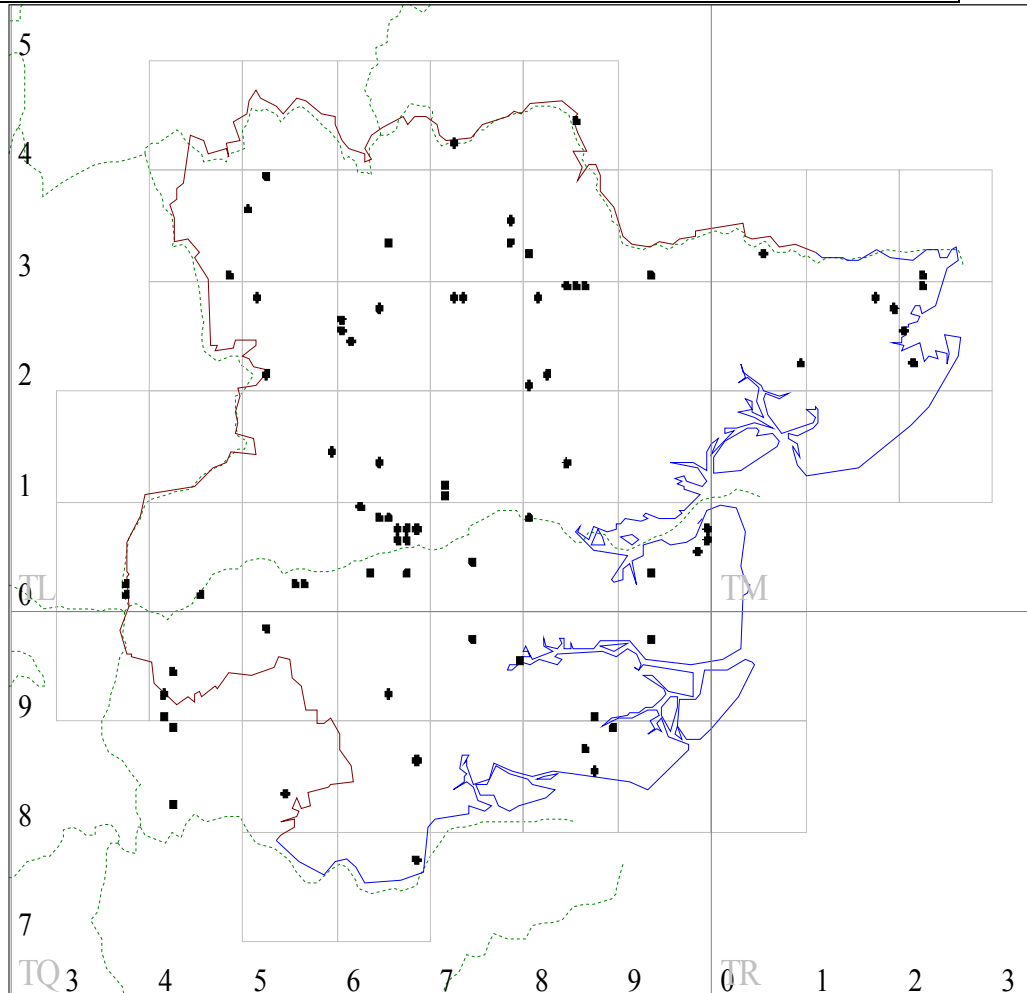
<b>Date</b>	<b>Site</b>	<b>Map ref.</b>	<b>Surveyor/s</b>
4/7	Writtle College	TL 681073	G. Watkins
4/7	Hanningfield	TQ 743978	G. Watkins
7/7	Galleywood	TL 671039	G. Watkins
15/7	Battlesbridge	TQ 792950	G. Watkins
21/7	Tilekiln Green	TL 521212	R.G. Field
23/7	Greenstead Green	TL 815288	R.G. Field
27/7	Steeple Bumpstead	TL 724428	A. Deane
27/7	Baythorn End	TL 724428	A. Deane
27/7	Castle Hedingham	TL 784354	A. Deane
27/7	Sible Hedingham	TL 785339	A. Deane
28/7	Steeple Green	TL 938031	G. Watkins & L. Green
28/7	Bradwell Wick	TL 988057	G. Watkins & L. Green
28/7	Bradwell on Sea	TL 997069	G. Watkins & L. Green
28/7	Bradwell on Sea	TL 999071	G. Watkins & L. Green
30/7	Greenstead Green	TL 815284	G. Watkins & L. Green
3/8	Does Corner	TL 805321	A. Deane
3/8	Earls Colne	TL 848292	A. Deane
3/8	Earls Colne	TL 859299	A. Deane
3/8	Earls Colne	TL 862299	A. Deane
6/8	Chipping Ongar	TL 551028	G. Watkins & L. Green
6/8	Hallsford Bridge	TL 561022	G. Watkins & L. Green
6/8	Little Burstead	TQ 659927	G. Watkins & L. Green
6/8	Ingatestone	TL 665991	G. Watkins & L. Green
6/8	Fryerning	TL 635030	G. Watkins & L. Green
13/8	Steppen Farm	TM 989236	G. Watkins & L. Green
21/8	Messing	TM 901195	G. Watkins & L. Green
22/8	Long Melford	TL 857449	A. Deane

**Table 3 : Larvae observed in Essex during 2004**

<b>Date</b>	<b>Site</b>	<b>Map ref.</b>	<b>Surveyor/s</b>
6/7	Holly House	TM 091225	G. Watkins
8/7	Nr Herons Farm	TL 825214	G. Watkins
8/7	Silver End	TL 809204	G. Watkins
8/7	Hedgerow	TL 659082	G. Watkins
9/7	Rochford	TQ 873904	G. Watkins
9/7	Butlers Farm Cottages	TQ 897890	G. Watkins
13/7	Ulting	TL 808083	G. Watkins
14/7	Burnham	TQ 939970	G. Watkins

15/7	One Tree Hill	TQ 687864	G. Watkins
15/7	East Tilbury	TQ 686773	G. Watkins
15/7	Berwick Pond Road	TQ 543835	G. Watkins
15/7	Navestock	TQ 528982	G. Watkins
16/7	Little Braxted	TL 840138	G. Watkins
16/7	Fordham	TL 932303	G. Watkins
16/7	Dedham	TM 059328	G. Watkins
20/7	near HJ Warder	TL 648139	G. Watkins
20/7	Little Sampford	TL 654338	G. Watkins
20/7	Near Bamber Hall	TL 656330	G. Watkins

**Figure 1 : Larval distribution in Essex 2002-2005**



Out of a sample of 37 sites in 2002, larvae were found most often on Amount type 2 *H. lupulus* in form 1 (Townsend, 2002). Over 72% of sites were near water and over 78% near buildings (Table 4). This may reflect the needs of the plant rather than the needs of the larvae.

**Table 4 : Sample of 37 sites visited in 2002**

Hops	Number where larvae present	%
Amount type		
1	6	18
2	18	55
3	9	27
Form		
1	24	73
2	9	27
Buildings	26	79
Water	24	73

Larvae were found at 89% of the sites in the sample and no larvae were found after 18th August 2002.

#### 4.13 Search for hibernating adults

A large range of buildings were searched during January and February of 2003 (Table 5). Live adults were identified at two sites plus a dead adult was found at a third. The first three adults were discovered in October in a garage where *H. rostralis* had been known to hibernate before. This was next to the site where larvae were beaten from *H. lupulus* in 2001 (Chris Gibson pers. com.). By early February when checked again they had disappeared. The second site where an adult was observed was in a garage on the Writtle College estate. In the winter of 2003-4 one adult was again found hibernating in that garage, while in 2004-5 four adults were noted in December 2004. A data logger was fitted to this building and the moths were monitored. A dead adult was also discovered on the College estate in 2003, but this time in a farm building. The area where the moth was discovered was used as a staff rest room and the moth was dead on the back of an arm chair. All the sites searched were adjacent to where larvae had been discovered on *H. lupulus* and in most cases these buildings formed the nearest buildings to the site.

**Table 5 : Buildings searched for hibernating adults in January/February 2003**

Site	Wooden	Brick/stone	Steel	Concrete	Larvae
Writtle College	all	all	all	all	2
Gunpowder mills Waltham Abbey		11		10	0
Southend Priory Park		3	1		0
Southend Park Lane	2	1			0
Writtle Church		1			0
Garage, Dovercourt		Asbestos			3 - Oct 0 - Feb
Pill boxes TL 6026 TL 5926				4	0
Garage TL 6026	1				0
Hollow tree TL 6026					0

Large numbers of *H. rostralis* have been observed hibernating at a site in East Tilbury over the last 14 years (Down, 2004 Appendix 1). This site was searched on 2nd February 2004 and 48 adults were found, of which 13 were males and 35 females. They were all hibernating alone with the nearest adult usually being about 2-3 metres away. In one bunker there were 22 (4 m & 18 f). In a second bunker there were 25 (9 m & 16 f), while in the third bunker, which was larger and darker and had cork on the walls, only one female was found.

#### 4.14 Search for pupae

No pupae were observed during the later larval searches and when plants were completely searched. Searches were also carried out on the leaf litter and topsoil but once again no pupae were observed.

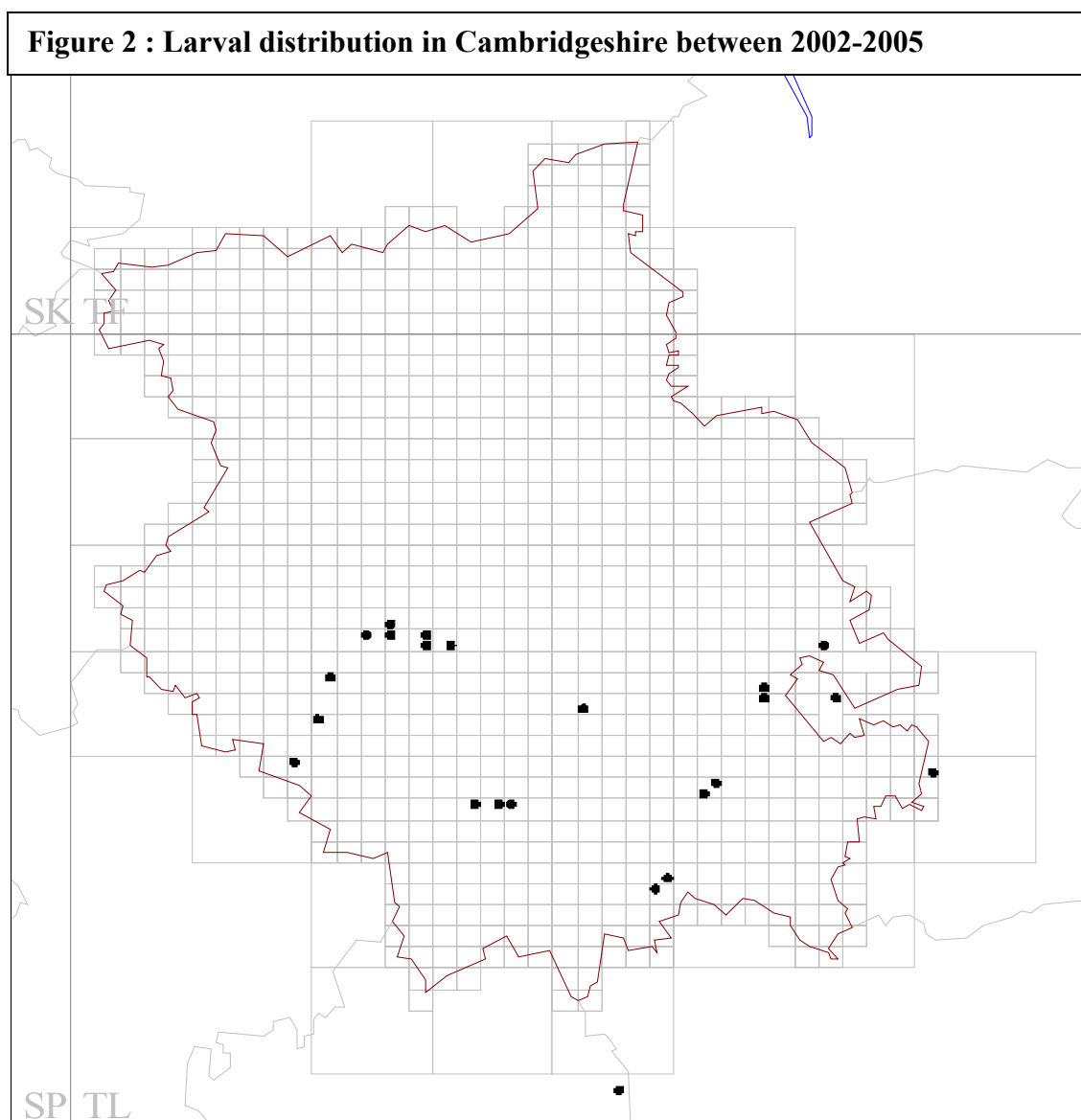
## 4.2 Cambridgeshire Survey

### 4.21 Light-trapping

No specific light-trapping was undertaken but local records were monitored. There were few records for 2002/3 but one adult was light-trapped on 26<sup>th</sup> April 2004 in a garden at Barton (TL 399549).

### 4.22 Larval survey

*H. lupulus* is not as common in Cambridgeshire as in Essex and so specific site records were searched for *H. rostralis* larvae. Five sites were discovered in 2002 (Table 6). The first survey was carried out on the 11th July and the final survey was on the 31st July. Of six records of *H. lupulus* investigated on that last day, three had no larvae and no signs of larval damage, two had larvae and at one site *H. lupulus* was no longer present. Further searches discovered 18 new sites in 2003 (Table 7) and three in 2004 (Table 8) which gave a distribution mainly around Cambridge (Figure 2). Colonies of *H. lupulus* in northern Cambridgeshire were



searched in 2003 and 2004 but no larvae of *H. rostralis* were found (Appendix 2).

**Table 6 : Larvae observed in Cambridgeshire during 2002**

Date	Site	Map ref.	Surveyor/s
31/7	Toft	TL 358557	R.G. Field
31/7	Toft	TL 362558	R.G. Field
11/7	Bourn	TL 338559	P. Waring & R.G. Field
July	Fulbourn	TL 5357	J. Dawson
July	Fulbourn Woods	TL 527561	J. Dawson

**Table 7 : Larvae observed in Cambridgeshire during 2003**

Date	Site	Map ref.	Surveyor/s
18/7	St. Ives	TL 310705	R. G. Field & N. Greatorex-Davies
18/7	St. Ives	TL 311707	R.G. Field & N. Greatorex-Davies
18/7	St. Ives	TL 311708	R.G. Field & N. Greatorex-Davies
18/7	Huntingdon Ring Road	TL 243 717	R.G. Field & N. Greatorex-Davies
18/7	Hartford Marina	TL 266727	R.G. Field & N. Greatorex-Davies
18/7	Hemingford Grey	TL 298712	R.G. Field & N. Greatorex-Davies
21/7	Hemingford Grey	TL 298706	N. Greatorex-Davies
23/7	Lidgate	TL 718584	S. Hearle
25/7	Oakington	TL 420648	S. Hearle
28/7	Little Paxton Pits	TL 203639	B. Dickerson
29/7	Eynesbury	TL 180595	B. Dickerson
29/7	Newmarket	TL 633653	S. Hearle
31/7	A505/River Can	TL 489473	R.G. Field & S. Hearle
31/7	Pampisford	TL 491483	R.G. Field & S. Hearle
31/7	Toft	TL 363559	R.G. Field
2/8	Reach	TL 571663	S. Hearle
2/8	Swaffham Prior	TL 573650	S. Hearle
4/8	Fordham	TL 623702	S. Hearle

**Table 8 : Larvae observed in Cambridgeshire during 2004**

Date	Site	Map ref.	Surveyor/s
12/7	Buckden Marina & Offord Cluny	TL 2167	B. Dickerson
12/7	Cow Lane Pits	TL 2671	B. Dickerson
12/7	Great Paxton	TL 2063	B. Dickerson

#### 4.23 Search for hibernating adults

No specific search has been undertaken in Cambridgeshire.

#### 4.24 Search for pupae

No pupae were discovered during the larval searches.

### **4.3 Captive stock**

Three larvae were collected on the 11th July 2002 at Writtle to confirm identification. These were kept in captivity and they fed on *H. lupulus* leaves nocturnally. During the day the larvae laid along the leaf stalks or plant stems and not on the undersides of the leaves. Two pupated (23/7 and 2/8) in curled up leaves, but this was never found in the wild. Of the three larvae collected, one was parasitised. The parasitoid was a male (larval emergence 15/7, adult 23/7) of the genus *Protapanteles* (Braconidae: Microgastrinae), possibly a very common generalist *P. immunis* (Haliday) that use an enormous range of microlepidoptera larvae in trees and shrubs (Mark Shaw pers. com.).

## **5.0 Hibernation Research**

### **5.1 Introduction**

Hibernation is a strategy that allows organisms to survive unfavourable periods. This period of dormancy is governed primarily by day length. Temperature tends to fluctuate wildly at all times, but the alternation of night and day, or changes in day length throughout the year, have shown regular and exact rhythms for millions of years. Moths have adapted to these rhythms and make use of them (Novak, 1999; Young, 1997).

Other factors, including temperature, also play a role. Temperature is a basic factor controlling the life of moths and activity can only take place within a certain temperature range. Below this range activity is reduced to the basic physiological process required for survival. Being cold-blooded, the temperature of moths is largely determined by the external environment. Once they have reached some minimum temperature they can further raise their temperature by flapping their wings and thus become active (Novak, 1999).

Conversely, once their temperature has fallen below some minimum temperature they are unable to generate enough heat and so they must become inactive.

In temperate species hibernation is intense from November to January, the unfavourable winter period, and hibernation can consist of several phases (Novak, 1999). This appears to

apply to the moth, which seems to be virtually inactive at this time, over-wintering in the adult stage.

## 5.2 Results

The data from this project was examined for indications of the conditions that trigger the moth's hibernation behaviour. As the minimum temperature will have the most influence on the moth's hibernation activity, it is this temperature, together with day length, that has been concentrated on. Where there was evidence of extremely high winds, either from local reports or damage at the site, this was taken into account. It is important to remember that these results are based on observations over only one and a half seasons with relatively few individuals at two sites. A range of photographs from this study can be found in Appendix 4.

### 5.21 Into Hibernation

#### Sportsfield - Autumn 2003

The moth(s) was variously present and absent from the time of first sighting (26<sup>th</sup> September) until 24<sup>th</sup> November, when it became present more frequently. Up until this time the minimum temperature had not fallen below 0.7 °C and the day length had reduced to 10.1 hours. Between 27<sup>th</sup> November and 5<sup>th</sup> December the moth was present but moving intermittently, minimum temperature: 28<sup>th</sup> November: -1.4 °C, day length reduced to 8 hours. Prior to 28<sup>th</sup> the minimum temperature had fallen steadily from 11 °C (19<sup>th</sup>) to 1.1 °C (27<sup>th</sup>). Activity ceased from 9<sup>th</sup> December until the end of March the following year. The minimum temperature had reached -2.2 °C (8<sup>th</sup> December) and day length 7.92 hours (Table 9).

**Table 9: Sportsfield - Autumn 2003**

Dates	No. of adults	Min temp °C	Day length (hours)	Remarks
25-29/9	2	5.8 to 15.3	11.9 to 11.7	1 adult left 26/9 second left 29/9 after slight movement
30/9-6/10	0	5.8 to 13.5	11.65 to 11.25	
7/10	1	8.0	11.18	
8/10 to 21/10	0	0.7 to 13.1	11.12 to 8.53	

24/10	1	3.9	8.4	
25/10	0	2.7	8.37	
27/10 to 5/12	1	-1.4 to 7.3	8.27 to 8.0	Moved intermittently ( max 20 cm)
8/12	0	-2.2	7.93	
9/12 to 23/1	1	-5.3 to 9.1	7.92 to 8.67	No movement

### Stablefield - Autumn 2003

The moths were active within the cage up until 26<sup>th</sup> September, when they began to settle for days in the same place. Just prior to this time the minimum temperature had fallen to -2.2 °C. Day length had reduced to 11.9 hours. A moth was present in the hibernation chamber between 7<sup>th</sup> October and 4<sup>th</sup> November, and others were moving intermittently about the cage, being seen less frequently as time went by. Between these dates the minimum temperature had varied between -4.9 °C (28<sup>th</sup> October) and 7.7 °C (10<sup>th</sup> October), and day length had reduced to 9.42 hours. Between the 5<sup>th</sup> and 18<sup>th</sup> November the moths in the hibernation chamber and the cage became more active, minimum temperature: -0.1 °C, day length reduced to 8.67 hours. Activity ceased from 4<sup>th</sup> December until January the following year. The minimum temperature had reached -0.1 °C (9<sup>th</sup> November) and day length 8.05 hours. Prior to 4<sup>th</sup> the minimum temperature had risen from -4.4 °C (28<sup>th</sup> November) to 6.9 °C (4<sup>th</sup> December)(Table10).

**Table 10: Stablefield - Autumn 2003**

Dates	No. of adults	Min temp °C	Day length (hours)	Remarks
23/9 to 26/9	1 to 4	-2.2 to 1.1	11.9	Adults seen in varying locations
29/9 to 6/10	1 to 4	-0.6 to 11.3	11.7 to 11.25	Some adults in same place for more than one day
7/10 to 16/10	1 in hc	1.9 to 7.7	11.18 to 10.6	Other adults in varying locations
20/10 to 4/11	1 in hc	-4.9 to 6.5	10.35 to 9.42	Other adults seen occasionally
5/11 to 11/11	1 in hc	-0.1 to 7.3	9.37 to 9.03	2 other adults seen daily in cage
13/11 to	2 in hc	0.7 to	8.92 to	One other adult seen in cage on 13/11

17/11		11.7	8.67	
18/11 to 3/12	1 in hc	-4.4 to 10.2	8.58 to 8.07	Occasional change of position
4/12	1 in hc	6.9	8.05	No further movement until January

hc – hibernation chamber

## 5.22 Out of Hibernation

### Sportsfield - Spring 2003

Prior to the first movement (21<sup>st</sup> March) the minimum temperature had not fallen below freezing for 25 days and day length had reached 12.15 hours. The fall in minimum temperature between 7<sup>th</sup> April and 13<sup>th</sup> April seems to coincide with the moth not moving. Prior to the moth leaving the minimum temperature rose on the 14<sup>th</sup> April and remained at a warmer level for about 6 days and day lengths had reached 14.12 hours (Table 11).

**Table 11: Sportsfield - Spring 2003**

Dates	No. of adults	Min temp °C	Day length (hours)	Remarks
14/1 to 19/3	1	-3.5 to 8.8	8.35 to 12.15	No movement
21/3	1	4.3	12.28	Slight movement
24/3 to 2/4	1	3.9 to 8.8	12.48 to 13.07	Slight changes in orientation from original
3/4 to 16/4	1	0.3 to 10.6	13.15 to 13.98	No movement
18/4 to 20/4	0	6.5 to 9.9	14.12 to 14.25	Left hibernation

### Sportsfield - Spring 2004

Prior to the first significant movement (1<sup>st</sup> April) the minimum temperature had not fallen below freezing for 28 days and day length had reached 14.43 hours. The movement on 1<sup>st</sup> April seems to coincide with a marked rise in the minimum temp on that day. Prior to the moth leaving (20: 23<sup>rd</sup> April) the minimum temperature rose sharply on the 21<sup>st</sup> April (20<sup>th</sup>: 3.1, 21<sup>st</sup>: 10.6) and day lengths had reached 14.3 hours (Table 12).

**Table 12: Sportsfield - Spring 2004**

Dates	No. of adults	Min temp °C	Day length (hours)	Remarks
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9/12 to 23/1	1	-2.2 to 7.7	7.92 to 8.67	No movement
26/1 to 30/3	1	-3.1 to 11.3	8.82 to 12.87	Slight movement
1/4	1	9.9	13.02	Moved 1.5 m
2/4 to 20/4	1	1.5 to 9.5	13.07 to 14.25	Moved 0.5m on 2/4 then no movement
23/4	0	7.7	14.33	Left hibernation

### **Stable Field (Inside Hibernation Chamber) - Spring 2004**

Prior to the first significant movement (Monday, 12<sup>th</sup> Jan) the minimum temperature had not fallen below freezing for 8 days and day length had reached 8.2 hours and there had been very high winds the previous weekend. The original moth in the hibernation chamber began moving before the introduction of more moths (4<sup>th</sup> Feb). The introduced moths may have taken time to find a satisfactory place to hibernate within the cage. This might account for the various movements of those visible within the cage between 9<sup>th</sup> Feb and 14<sup>th</sup> April, although there was a general rise in minimum temp from the 9<sup>th</sup> to 21<sup>st</sup> March. The minimum temp only again fell below freezing on 25<sup>th</sup> and 26<sup>th</sup> March but reached 9.9 on 16<sup>th</sup>. The frame of the cage was found to have been bent, probably by the wind, at some time between the 4<sup>th</sup> and 23<sup>rd</sup> of March and there was further evidence of high wind again on 5<sup>th</sup> and 7<sup>th</sup> April. When the first moth left the hibernation chamber (14 - 15<sup>th</sup> April) the minimum temperature had dropped from 5.8 (13<sup>th</sup>) to -0.1 (14<sup>th</sup>). The minimum temp rose and fell again (-1.8, 20<sup>th</sup>) but after that did not fall below freezing again and the moths left on the nights of 23<sup>rd</sup>, 24<sup>th</sup> and 26<sup>th</sup>. Day length had reached 14.62 hours (Table 13).

**Table 13: Stable Field (Inside Hibernation Chamber) - Spring 2004**

<b>Dates</b>	<b>No. of adults</b>	<b>Min temp °C</b>	<b>Day length (hours)</b>	<b>Remarks</b>
4/12 to 6/1	1 in hc	-5.8 to 7.7	8.05 to 8.00	No movement
12/1 to 4/2	1 in hc	-4.4 to 11.7	8.2 to 9.32	Move occasionally
4/2	7 in hc			6 moths introduced
9/2 to 1/3	4 in hc	-6.3 to 7.7	9.6 to 10.95	2 in cage
4/3	3 in hc	4.6	11.15	2 in cage
23/3 to 14/4	4 in hc	-2.2 to 8.8	12.42 to 13.87	2 in cage
15/4 to 26/4	1 to 3 in hc	-1.8 to 9.5	13.92 to 14.62	2 in cage

27/4 to 18/5	0 in hc	4.3 t 10.2	14.67 to 15.83	“ seen in cage but none after 18/5
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## 5.3 Discussion

### 5.31 Into Hibernation

After the summer activity the moths appeared to begin to settle down from about 26<sup>th</sup> September. After this time, lone wild moths were variously present and absent from the Sportsfield store until 24<sup>th</sup> November, from when they appeared more settled. Activity ceased on 9<sup>th</sup> December. The captive moths in the cage in Stable Field began to settle about the cage and hibernation chamber with varying frequency from 29<sup>th</sup> September, until 18<sup>th</sup> November, when the moth in the hibernation chamber also became more settled. From 4<sup>th</sup> December activity ceased. Nectar sources were available within the cage but no adults were noted nectaring either in autumn and spring.

This appears to demonstrate distinct stages of preparation for hibernation. After the summer the moths appear to begin to investigate different hibernation sites from about 26<sup>th</sup> September. They become more settled at about 18<sup>th</sup> to 24<sup>th</sup> November, and these varying periods of activity and inactivity last until about 4<sup>th</sup> to 9<sup>th</sup> December, when activity ceases. It is the periods when summer activity ends, the settling down process and when activity ceases, that are examined (Table 14).

**Table 14: The data for 2003**

Dates and day lengths	End summer activity (date)	End summer activity (day length)	Begin to settle down (date)	Begin to settle down (day length)
Sport Autumn 03	26/09/03	11.9	24/11/03	8.40
Cage Autumn 03	29/09/03	11.7	18/11/03	8.67

previous 7 days <u>MINIMUM</u> temp	End summer activity Min (°C)	End summer activity Max (°C)	Begin to settle down Min (°C)	Begin to settle down Max (°C)
Sport Autumn 03	not known	15.3	6.9	11.0
Cage Autumn 03	-2.2	7.3	1.5	7.3

Dates and day lengths	Become inactive (date)	Become inactive (day length)
Sport Autumn 03	09/12/03	7.92

Cage Autumn 03	04/12/03	8.05
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<b>previous 7 days MINIMUM temp</b>	<b>Become inactive Min (°C)</b>	<b>Become inactive Max (°C)</b>
Sport Autumn 03	-2.2	7.3
Cage Autumn 03	-4.4	6.20

Sport = Inside the store at the Sportsfield, Writtle College.

Cage = Inside the hibernation chamber in the cage in Stable Field, Writtle College.

The moths seemed to begin to settle down from about 26<sup>th</sup> to 29<sup>th</sup> September. The day lengths for this period ranged between 11.7 and 11.9 hours. The minimum temperature in the previous week ranged between -2.2 and 15.3 °C. This seems to indicate that they begin to investigate hibernation sites as a response to day lengths. Although the day lengths were almost the same for both locations, the preceding week's minimum temperature had a wide range.

The moths become more settled between 18<sup>th</sup> and 24<sup>th</sup> November. The day lengths for this period ranged between 8.4 and 8.67 hours. The minimum temperature in the previous week ranged between 1.5 and 11.0 °C. This seems to indicate that they begin to settle as a response to day length, regardless of the temperature. Again, although the day lengths were almost the same, the preceding week's minimum temperature had a wide range.

Activity ceases between 4<sup>th</sup> and 9<sup>th</sup> December. The day lengths for this period ranged between 7.92 and 8.05 hours. The minimum temperature in the previous week ranged between -4.4 and 7.3 °C. This seems to indicate that activity ceases as a response to day length, regardless of the temperature. Once more, the day lengths were almost the same, but the preceding week's minimum temperature had a wide range. It may be significant that in both cases the minimum temperature had fallen well below freezing in the previous week (2 and 7 days before).

### 5.32 Out of Hibernation

Generally the moth remains inactive during the winter months, and first begins to move in the spring but remains within its winter shelter. After various periods of activity and inactivity within the shelter the moth leaves. It appears that the moth becomes aware that it should prepare to leave the shelter of the hibernation site and, when all the required conditions are

met, it leaves. It is these periods of first activity and eventual departure from the hibernation shelter that were examined (Table 15).

**Table 15: Data from spring 2003 and 2004**

Dates and day lengths	First movement (date)	First movement (day length)	Leave hibernation (date)	Leave hibernation (day length)
Sport Spring 03	21/03/03	12.28	18 - 20/04/03	14.12 - 14.25
Sport Spring 04	01/04/04	13.02	20 - 23/04/04	14.25 - 14.43
Stable Spring 04	12/01/04	8.2	14 - 26/04/04	13.87 - 14.62

previous 7 days <u>MINIMUM</u> temp	First movement Min ( $^{\circ}$ C)	First movement Max ( $^{\circ}$ C)	Leave hibernation Min ( $^{\circ}$ C)	Leave hibernation Max ( $^{\circ}$ C)
Sport Spring 03	1.1	5.4	0.7 - 5.4	10.6 - 10.6
Sport Spring 04	2.3	6.9	4.6 - 3.1	8.4 - 10.6
Stable Spring 04	2.3	5.4	-2.2 - -1.8	5.8 - 9.5

Sport = Inside the store at the Sportsfield, Writtle College.

Stable = Inside the hibernation chamber in Stable Field, Writtle College.

The moths begin to move between 12<sup>th</sup> January and 1<sup>st</sup> April. The day lengths for this period ranged between 8.2 and 13.02 hours. The minimum temperature in the previous week ranged between 1.1 and 6.9  $^{\circ}$ C. In this instance it is not clear whether day length or minimum temperature influenced the first stirring of the moth, as the day lengths and the minimum temperature both had a wide range. It might be significant that the temperature had not fallen below freezing in the previous week or more, regardless of the day lengths.

The moths left their hibernation shelter between 14<sup>th</sup> April and 26<sup>th</sup> April. The day lengths for this period ranged between 13.87 and 14.62 hours. The minimum temperature in the previous week ranged between -2.2 and 10.6  $^{\circ}$ C. This seems to indicate that they leave their place of hibernation as a response to day length, regardless of the temperature. The day lengths had all reached about 14 hours whereas the previous week's minimum temperature had ranged between -2.2 and 10.6  $^{\circ}$ C.

The Stable Spring 04 data differs in that the first activities were considerably earlier than the Sportsfield data. The hibernation chamber was not as stable as the brick Sportsfield store, and all of the earlier-than-usual movements made by the original moth may have been in response to the high winds or other disturbance and not by the previous week's above-freezing temperatures. The moth in the Sportsfield store in the spring of 2004 may have changed orientation slightly (26<sup>th</sup> January) after a similar period of above-freezing conditions.

However, after this minor adjustment it did not move again until 1<sup>st</sup> April. There had been similar periods of above-freezing conditions in between, for example around the 3<sup>rd</sup> and 15<sup>th</sup> February. However, it should be noted that the moths in the hibernation chamber appeared undisturbed by the high winds evident on 5<sup>th</sup> and 7<sup>th</sup> April and these were also preceded by similar periods of above-freezing conditions.

It is possible that moth has two distinct phases of hibernation. The moths might enter a midway stage between hibernation and full activity, triggered by some element in their environment. If this stage were triggered by above-freezing conditions throughout the preceding week, then the uncharacteristic early activity could have been due to high winds buffeting the unstable hibernation chamber when the moth was in this midway stage. However, on other occasions similar conditions did not appear to cause any disturbance to other moths in the hibernation chamber.

The last moths left the hibernation chamber slightly later than the wild moths left the Sportsfield store. It may be they waited for a couple of days as the temperature had fallen below freezing in the previous week.

However, if the unusually early movements of the moth in the hibernation chamber in the Spring of 2004 is considered untypical that data can be discounted (Table 16).

**Table 16: Movement spring 2003 and 2004**

Dates and day lengths	First movement (date)	First movement (day length)	Leave hibernation (date)	Leave hibernation (day length)
Sport Spring 03	21/03/03	12.28	18 - 20/04/03	14.12 -14.25
Sport Spring 04	01/04/04	13.02	20 - 23/04/04	14.25 -14.43
Stable Spring 04	04/03/04	11.5	14 - 26/04/04	13.87 -14.62

previous 7 days <u>MINIMUM</u> temp	First movement Min (°C)	First movement Max (°C)	Leave hibernation Min (°C)	Leave hibernation Max (°C)
Sport Spring 03	1.1	5.4	0.7 - 5.4	10.6 - 10.6
Sport Spring 04	2.3	6.9	4.6 - 3.1	8.4 - 10.6
Stable Spring 04	-6.3	-1.8	-2.2 - -1.8	5.8 - 9.5

Sport = Inside the store at the Sportsfield, Writtle College.

Stable = Inside the hibernation chamber in Stable Field, Writtle College.

In this case the moths began to move between 4<sup>th</sup> March and 1<sup>st</sup> April. The day lengths for this period ranged between 11.5 and 13.02 hours. The minimum temperature in the previous week ranged between -6.3 and 6.9 °C. This seems to indicate that day length might be more important than temperature to trigger the first movement. The days had all reached similar lengths whereas the previous week's minimum temperatures had a wide range. The data for leaving the hibernation sites is similar.

#### **5.4 Conclusions**

This study, based on limited data, indicates that the moth's hibernation behaviour seems to be governed more by day length than temperature, although cold weather in early April may delay their departure, and cold weather in early December may influence the beginning of their period of total inactivity.

It appears that the early movements of the moth in the hibernation chamber in the spring of 2004 were untypical, although there is no real indication of the cause. The moth's choices within the cage were limited and the hibernation chamber may not have been ideal.

The adult moths generally first become active within their hibernation shelter from the first week in March to the beginning of April, when day lengths have reached 11.5 to 12.28 hours. Until they finally leave, they change position or orientation but remain within the hibernation shelter. They finally leave in about the third week in April, when day lengths have reached 13.87 to 14.62 hours.

The next generation of adults began to settle down at the end of September, when day lengths had reduced to 11.9 - 11.7 hours. They continued to investigate hibernation sites until about the third week in November, when day lengths had reached 8.67 - 8.4 hours. Activity ceased about a week into December when day lengths reached 8 - 7.9 hours.

#### **6.0 Discussion**

The findings from the larval survey tend to agree with the findings of Townsend (2002), that July is the best time for larval searches but larvae have also been found well into the third

week in August. No agreement can be made with Plant (2000) that May and early June might be a better time. In Essex, larvae were found in almost every location where *H. lupulus* was present. As only presence and absence was being noted, no correlation with Townsend (2002) findings on *H. lupulus* type and amount could be identified. The larvae were found on *H. lupulus* near water but not exclusively. In Cambridgeshire *H. lupulus* is not as widespread as in Essex but the distribution of the moth does not follow the plants distribution pattern. No reason is known for the absence of the moth in the northern part of Cambridgeshire as there are plenty of apparently suitable areas of habitat.

Collins (2000) suggested that the reduction in *H. rostralis* in recent years was due to the change in recording methods. This research agrees with that as larvae seemed to be far more common in Essex and Cambridgeshire than the records from light-trapping might suggest. At Writtle only one adult has been caught in over the period 1968-2004 in the Rothamsted light trap (Gardiner & Field 2001) even though larvae have been found on the surrounding *H. lupulus* plants and there are adults hibernating only 300 m from the trap. Collins (2003) recorded more adults in light-traps in spring than in autumn, and the results from Essex and Cambridgeshire follow that trend.

Hibernation is not as simple as the adults using the nearest suitable buildings. Many suitable buildings near large stands of *H. lupulus* have been searched and hibernating adults have only been located in two such buildings. Finding hibernating adults in natural locations is almost impossible but is suspected to be the norm. The data loggers at two sites suggest that day length is more critical than temperature with regard to both the start and finish of hibernation. The moths showed no interest in leaving the hibernation sites in warm spells in spring and the first adults recorded at light-traps tend to occur around the end of April which agrees with our assessment that the adults leave hibernation around 20<sup>th</sup> April.

No adults were observed mating or egg-laying either in the trial cage or in captive stock (D. Down pers.com). In fact the moths seem reluctant to go near another moth. When observing moth hibernating no moths were nearer than 2-3 m to the next moth and in free flight in the cage if one moth landed near another moth the first one usually flew off. The first minute larvae were seen at the beginning of June and this would lead to full grown larvae by the start of July. For larvae to first start appearing in early June the eggs would need to have been laid

mid/late May, which could mean mating takes place early May. No eggs were found on the *H. lupulus* plants within the cage, but eggs must have been laid as larvae were found. *H. lupulus* plants start to grow rapidly in the first week of May and as no eggs were found on our plants (on leaves and stems) it is suspected that the females must lay a single egg into the leaf ligule or on the dead stems from previous years (not as likely).

In the wild adults have been observed flying around nectar plants. A range of nectar plants were placed within the trial cage in both spring and autumn but no nectaring was observed. The main period of activity of the adult moth seemed to be in the hour after dusk after which they seemed to settle down and then often did not move again. Little movement was observed around the period of dawn.

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