The ecology of the Brown Hairstreak (*Thecla betulae*) a Lycaenidae butterfly

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Contents

Figures

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1. Introduction

The Brown Hairstreak (*Thecla betulae*) is the largest of the five hairstreak butterflies native to Britain and Ireland. Wingspans are typically between 36 to 41mm for males and 39 to 45mm for females. Both sexes have dark chocolate-brown upper wings with orange tails projecting from the hindwings.

Figure 1: A female Brown Hairstreak (T. betulae). Males are slightly smaller and lack the bright golden orange band across the forewing. (© Vince Massimo, UK Butterflies, 2006).

The Brown Hairstreak was once a relatively common sight amongst hedgerows and deciduous woodland edges in late summer across southern England. However, long-term declines in traditional woodland practices such as layering and coppicing and the great loss of hedgerows that began in Britain after 1945 has led to a severe decline in the distribution and abundance of this member of the Lycaenidae family. The long-term population trend is classed as stable under the UK Butterfly Monitoring Scheme with an increase of 58% since 1983. However, abundance has decreased by 22.9% between 1990 and 2010 and by 53.1% between 2000 and 2010 (Botham *et al*., 2011). The distribution of the species has also declined by 43% from 1970-82 to 1995-2004 (Fox *et al*., 2006). These trends have led to the Brown Hairstreak being classified as a UK Biodiversity Action Plan Priority Species. It is listed as Vulnerable on the new Butterfly Red List and is prohibited from sale under Section 9, Part 5 of the Wildlife and Countryside Act 1981 (JNCC, 2010).

2. Distribution

The butterfly is widely distributed across central Europe from northern Spain to southern Sweden, and east through Asia to Korea. Within Britain it is locally distributed in the heavily wooded clays of the West Weald in Sussex and Surrey; in sheltered valleys in north Devon and south-west Somerset, and in south-west Wales. Within Hampshire, the species is found in low numbers on the clay soils around Noar Hill and Selborne Common in the east of the county and on the drier chalk and clay soils around Shipton Bellinger in the north-west, close to the Wiltshire border.

Figure 2a: The distribution of the Brown Hairstreak in Britain and Ireland between 2000 and 2010. (Source: National Biodiversity Network Gateway, 2km squares, using Butterfly Conservation and Biological Records Centre datasets). Isolated colonies can be found in Dorset, Hampshire, Wiltshire, Gloucestershire, Worcestershire, Oxford and Lincolnshire in addition to its three strongholds in the West Weald, Devon and Somerset, and west Wales. (Source: Thomas & Lewington, 2010).

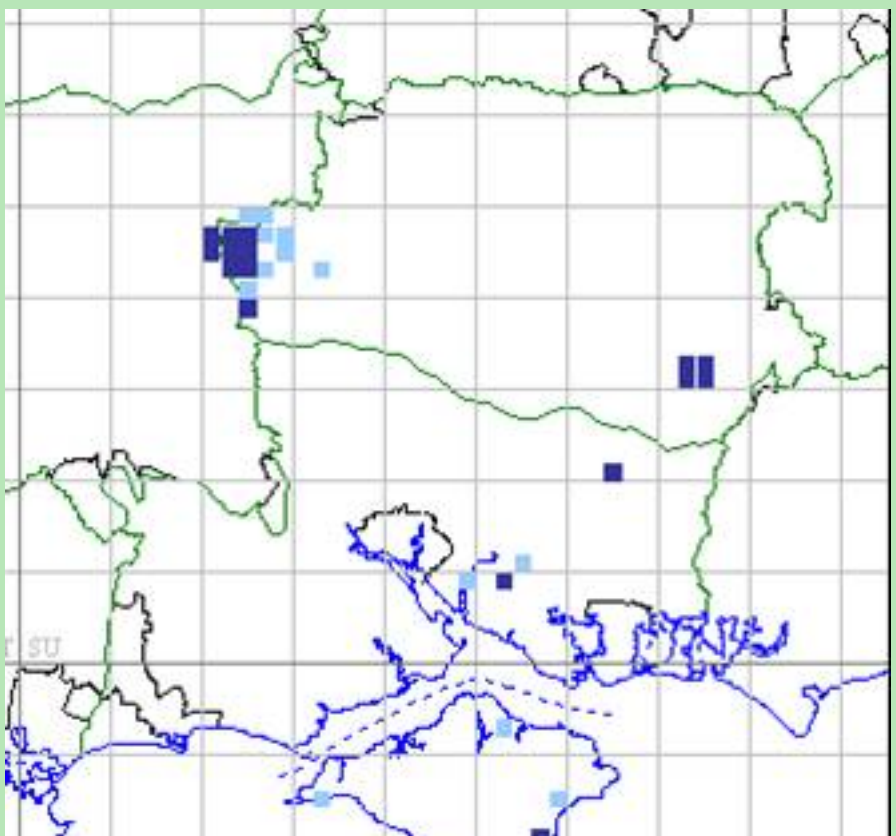

Figure 2b: The distribution of the Brown Hairstreak in Hampshire pre-2000 (light blue) and post-2000 (dark blue). (Source: http://www.hantsiow-butterflies.org.uk/butterflies/brown_hairstreak/brown_hairstreak.htm , 2012)

3. Phenology and life cycle

The species is univoltine. Adults are first seen flying in late July or early August with a mean flight date, nationally, of 25 August (Botham *et al*., 2011)

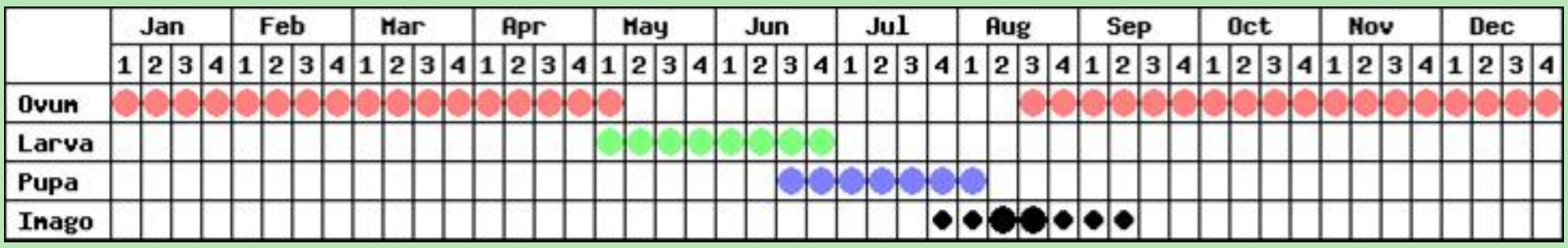

Table 1: The timing of the main life stages of the Brown Hairstreak. (Source: UK Butterflies, 2012)

4. The ecology of the Brown Hairstreak

4.1. Ovum stage

Ova are laid at low densities over wide areas of countryside almost always on the bark of Blackthorn (*Prunus spinosa*) at the base of a spine or where one-year-old wood branches from two-year-old stem (Thomas & Lewington, 2010). Fresh growth is always favoured over old, verdigris-covered growth. Most ova are laid singly (87.8%) in a fork (82.0%) (Merckx & Berwaerts, 2010).

Figures 3 and 4: A Brown Hairstreak egg at the base of a blackthorn spine, left, (© Vince Massimo, 2011) and close-up, right, (© Reg Fry, n.d.). (Source: UK Butterflies, 2012).

The study by Merckx & Berwaerts confirmed earlier observations by Thomas (1974) on the egg-laying preferences of female Brown Hairstreaks: most eggs are laid on young blackthorn less than 1.5m above ground in sheltered positions with a west or south-facing aspect. Merckx and Berwaerts also observed that hedgerows with scalloped borders contained significantly more eggs than those with straight borders.

These preferences are not altogether surprising. Brown Hairstreaks are ectothermic insects and rarely fly in air temperatures below about 20°C (Thomas & Lewington, 2010). Cooler temperatures on north-facing or exposed sites would therefore tend to be less favoured by egg-laying females than sheltered sites. Lower relative temperatures would also have a negative effect on larval development. Nor is the increase in egg numbers in scalloped hedgerows surprising: structurally heterogeneous landscape features typically provide better micro-habitat resources for feeding, mating or egg-laying than homogeneous, linear features.

Mated female Brown Hairstreaks are known to devote a considerable amount of time and energy to locating suitable host plants. They may disperse over several kilometres (Asher *et al.*, 2001) and egg-laying itself may take several minutes (Thomas & Lewington, 2010). This behaviour imposes costs in terms of increased risk of predation, access to food resources and exposure to parasitoids. However, in evolutionary terms, it increases the prospect of reproductive success, or "fitness", through successful egg and larval development. Eggs are laid directly on the sole larval foodplant within a short distance of a leafbud.

What is not properly understood is why females incur these costs in preference to ovipositing on apparently ideal blackthorn growth closer to mating sites (M. Oates, personal communication, 23 February 2012). Allelochemicals on the surface of *P.spinosa* are known to be

tasted by receptors on the front legs of females and to play a role in host-site selection by butterflies generally (García-Barros & Fartmann, 2009). *P.spinosa* is often locally abundant and high female mobility together with reduced competition for intra-site ovipositing sites might normally be expected to result in a metapopulation dividend of wider dispersal, linked colonies, improved ability to survive stochastic events (such as hedgerow removal), and improved gene flow. However, as Asher *et al*., (2001) observe, most Brown Hairstreak colonies are relatively small (rarely more than 300 adults) and colonies usually breed in the same area, year after year, with little colonisation of adjacent, blackthorn-rich areas. A constraining factor is likely to be the ability to locate sufficient quantities of exactly the right type of fresh, un-grazed, suckering *P.spinosa* in warm, sheltered positions.

The late emergence of adult Brown Hairstreaks means that eggs have little time to develop. They enter diapause as white tissue before hatching eight months later in late April or early May. Natural mortality by disease or predatory insects is between 25 and 50% but severe mechanised hedge-trimming can destroy whole egg colonies and has been blamed as a major reason for the species' decline (Thomas & Lewington, 2010). Cutting hedgerows on two- to three-year rotations under agri-environment schemes may benefit egg survival greatly but there is insufficient data to establish this definitively. Local hedgerow management initiatives such as around Selborne, Hampshire, involving Butterfly Conservation staff, the South Downs National Park Authority and local landowners may also help.

4.2. Larval stage

The eight-month hibernation reduces the food demands of the developing larva and is thought by de Vries *et al.*, (2010) to be the result of selective pressure working against prolonged presence as a caterpillar. Once emerged, the larva immediately adopts a number of predator-avoidance strategies. It is monophagous (i.e. it eats only one kind of food) and its first action is to crawl into and commence feeding on an unfurling blackthorn leafbud. After a fortnight the caterpillar moults and spends two further instars hanging upside down from a silk pad spun on the under-surface of a leaf. The caterpillars are extremely well camouflaged and only emerge at dusk to browse on the tips of blackthorn leaves (Newland *et al*., 2010 and Thomas and Lewington, 2010).

Figure 5: A Brown Hairstreak caterpillar attached to the underside of a *P.spinosa* leaf. (© Peter Eeles, 2006). Hosting the caterpillar appears to confer no benefit on the plant nor is there evidence that adults help to pollinate *P.spinosa.* The relationship between the species appears therefore to be a simple predator-prey one.

Synchronicity between the phenology of larval emergence and *P.spinosa* budburst is essential to the survival of the young caterpillar. Emerging too early in response to abiotic factors such as ambient temperature or day length risks starvation and reduced fitness. A study by de Vries *et al*. in 2010 concluded that budburst (and therefore larval food supply) typically preceded emergence by 7 to 9 days and that emergence was very well adapted to phenological shifts in budburst in warmer years.

Nevertheless, Thomas and Lewington (2010) note that up to 80% of caterpillars are found and predated by harvestmen (Opiliones), spiders and insects when small and by Willow Warblers (*Phylloscopus trochilus*), Blue Tits (*Parus caeruleus*) and other insectivorous birds when larger. Endoparasitoids such as *Phobocampe quercus*, an Ichneumonid wasp species, are also recorded as predating on Brown Hairstreak larva (Shaw *et al.*, 2009).

4.3. Pupa stage

The caterpillar becomes a mottled purple between 40 and 60 days after hatching and crawls to the ground to find a pupation site. This is usually in a crevice in the ground, within dead leaf litter, or at the bottom of a grassy tussock. Such micro-habitats offer shelter and some

protection from predation. Like many Lycaenidae butterflies, the chrysalis is attractive to ants including those from the genera *Lasius* and *Formica* (Settele *et al*., 2008). The chrysalis calls with a chirruping noise and the ants bury the chrysalis in loose earth cells, tending them incessantly for four weeks before emergence (Asher *et al*., 2001 and Thomas & Lewington, 2010). Many species of butterfly larva form mutualistic relationships with ants by emitting chemical signals and sugary secretions and this is likely to be the case with the Brown Hairstreak chrysalis.
Once again, predation levels are high. The pupae are highly attractive to mice and shrews and up to 80% can be predated by small mammals (Thomas & Lewington, 2010).

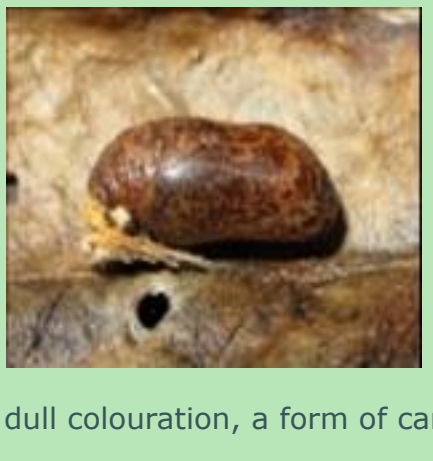

Figure 6: A reared Brown Hairstreak pupa. Note the dull colouration, a form of camouflage. (© Vince Massimo, UK Butterflies, 2011).

4.4. Imago stage

Adults emerge in the morning and males generally appear a few days before females (Eeles, 2012). The problem of locating a mate in a dispersed population is solved by the use of a "master tree". This is often a tall ash (*Fraxinus excelsior*) growing in a shallow basin within a colony. Males congregate on the tree canopy where they feed almost exclusively on aphid honeydew, occasionally descending to feed on Hemp Agrimony (*Eupatorium cannabinum*), Common Fleabane (*Pulicaria dysenterica*) or bramble (*Rubus spp*.) when honeydew is scarce (Newland et al., 2010 and Eeles, 2012). Local colonies can, however, exhibit local preferences. Hemp Agrimony is a highly favoured nectar source in the Noar Hill-Selborne Common area of Hampshire but bramble and Creeping Thistle (*Cirsium arvense*) are most favoured around Shipton Bellinger. Adult Brown Hairstreaks in the Shipton Bellinger area can also be seen imbibing the juices of over-ripe blackberries and ripe Wayfaring (*Viburnum lantana*) berries (Dr A. Barker, personal communication, 10 November, 2012).

Virgin females fly to the master tree as soon as they emerge and mating occurs without any discernible courtship. However, as Thomas and Lewington (2010) comment, this is a rarely observed event. The females spend six to ten days in the canopy whilst their eggs

develop before descending to search for suitable ovipositing sites. They only fly on the warmest days and are entirely diurnal, rarely seen before 10am or after 4pm. Long periods of site selection and egg-laying are punctuated by bouts of nectaring (Merckx & Berwaerts, 2010). Both sexes are oligophagous in this part of their life cycle feeding from a restricted range of food sources.

Thermoregulation plays an important role in the ecology of the species. This is done by micro-habitat site selection and by basking with wings held wide open 180° to the sun in weak sunshine. The tops of the wings are dusky and heat-absorbing. In hot weather, the upper-wings are held tightly closed. This exposes the shiny under-wings and white body hairs that reflect rather than absorb heat.

Figure 7: A male Brown Hairstreak. Note the white hairs on the body. (© Alan Thornbury, 2011).

5. Summary

The Brown Hairstreak occupies a range of habitat niches from cracks in the ground to tree canopies. It has a remarkable lifecycle and plays an important role in many food webs. It is, by any measure, a beautiful creature. It also, sadly, provides a further example of how much of the fauna and flora of lowland Britain today is struggling to survive in a modern agricultural landscape.

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