Nota lepid. 18 (3/4) : 281-288 ; 13.V.1996 ISSN 0342-7536

Larval food shortage and adult dispersal in *Callimorpha dominula* (L.) (Lepidoptera : Arctiidae)

Denis F. Owen

School of Biological and Molecular Sciences, Oxford Brookes University, Headington, Oxford OX3 0BP

Summary

In Oxfordshire, England, the moth *Callimorpha dominula* (L.) occurs in well-established colonies in damp and marshy habitats. Specimens from the within colonies are smaller than those from outside, evidently because larvae just out from hibernation feed on an extremely limited food source. It is suggested that moths constantly leave the main colonies and found small and perhaps temporary breeding populations elsewhere, but whether they leave as a result of starvation in the larval stage is a matter for conjecture.

Résumé

En Angleterre, dans l'Oxfordshire, l'Arctiide *Callimorpha dominula* (L.) se présente en colonies bien établies dans certains biotopes humides et marécageux. Les exemplaires provenant de ces colonies sont plus petits que ceux de l'extérieur, évidemment parce que leurs chenilles sont juste sorties de l'hivernage ne disposent pour se nourrir que de ressources très limitées. On peut supposer que certains imagos quittent régulièrement les colonies principales et fondent de petites populations, peut-être temporaire qui se nourrissent ailleurs, mais on ne peut que des conjectures quant à savoir si ces départs sont dus au manque de nourriture pour le stade larvaire.

In Oxfordshire, England, the scarlet tiger moth, *Callimorpha dominula* (Linnaeus, 1758), forms discrete colonies in damp marshy places, especially in the vicinity of the River Thames which flows through the county. In some years a colony may comprise tens of thousands of adult moths, while in others there may be no more than a few hundred. The population size of one colony, at Cothill, has been monitored since 1939, chiefly to detect changes in frequency of a mutant allele (*medionigra*) that affects wing coloration. This is a rare example of long-term ecological research. Indeed, the first 32 years of work at Cothill stimulated Ford (1975) to claim that, "No natural population

of animals in the world has been so fully quantified as that of the Scarlet Tiger moth, *Panaxia dominula*".

The moths (and larvae) are repeatedly (and perhaps increasingly) found outside the main colonies, either as strays or as temporarily established populations of small size and low density. These occurrences never seem to lead to the formation of strong colonies like the one at Cothill.

C. dominula has a single generation a year, flying (usually in sunshine, but also at night) in July. The eggs are scattered over vegetation and hence young larvae (not female moths) select potential foodplants. The larvae feed in August-October, then hibernate in the third instar beneath leaf litter, sometimes feeding a little on warm winter days, especially in February and March when a few new plant shoots may become available. Feeding recommences in April and pupation occurs in June. The two main foodplants are *Symphytum officinale* (Boraginaceae) and *Eupatorium cannabinum* (Compositae), but in years of high population size up to 43 species of plants belonging to 28 families may be utilised (Owen, 1994). This expansion of hostplant range in years of high population is associated with the depletion of *Symphytum* leaves earlier in the season. The high diversity and disparity of foodplants occurs in May, when the vegetation in the colonies is well-developed ; in April, when larvae emerge from hibernation, there are few plants available, except *Symphytum* and the rosettes of *Cirsium* (Compositae).

Adult size

Several workers have commented on the relatively small size of moths in the Cothill colony. Moths from North Hinksey, a nearby high density colony are also small. Accordingly, I measured the wing lengths of moths obtained from Cothill and Hinksey. I also measured the wing lengths of moths obtained from various sites outside the main colonies. I refer to these moths as the "outsiders". The measurements were made with a vernier calliper (to the nearest 0.1 mm). A wing was measured from its apex to the middle of the thorax, a measurement that accurately reflects body size. The results are given in Table 1 as N (the sample size), $\bar{x}$ (mean wing length) and SD (the standard deviation of the mean). In Table 1 the relatively small sample size for the outsiders is because of difficulty in obtaining specimens from the sites where they occur. All moths were wild-caught, none reared or bred.

Males and females are of similar size and do not differ significantly : Cothill, $t = 1.703$, d.f. $= 38$, North Hinksey, $t = 1.365$, d.f. $= 38$, and

Table 1

Wing length (in mm) of *Callimorpha dominula* in three samples from Oxfordshire.

		N	$\bar{x}$	SD
Cothill	males	20	23.5	1.02
	females	20	22.9	1.15
North Hinksey	males	20	23.0	0.83
	females	20	23.4	0.97
outsiders	males	7	25.9	0.95
	females	5	25.5	0.94

outsiders, $t = 0.661$, d.f. = 10, and so the sexes can be added together for the inter-site comparisons. Comparing Cothill to outsiders, $t = 6.924$, d.f. = 50, $p < 0.001$, and North Hinksey to outsiders, $t = 7.987$, d.f. = 50, $p < 0.001$). Both comparisons give statistical confirmation to the small size of Cothill and North Hinksey moths and the relatively larger size of the outsiders.

The origin of the outsiders

Fig. 1 shows the distribution of *C. dominula* in Oxfordshire. The species is exceptionally well-recorded, chiefly because of its attractive coloration and mainly diurnal flight activity. The distribution shown includes well-established colonies (three are marked on the map) and occasional sightings which may or may not indicate the existence of a colony: many recorders do not differentiate between stray individuals and colonies.

North Hinksey (A in Fig. 1) was established artificially in 1951 by the introduction of 4000 fertile eggs which, assuming 200 eggs from each female, came from about 20 pairs of moths. The circumstances of its establishment are given in Sheppard & Cook (1962), and there is little doubt that the site was chosen because it looked suitable, i.e. like Cothill. The point of the North Hinksey introduction was to monitor the fate of the *medionigra* allele which has been introduced at a known frequency. An essential requirement for such monitoring is that colonies under investigation should be ecologically and geographically isolated from one another to an extent that alleles are not exchanged. Virtually all the early publications on *C. dominula* claim that colonies are isolated and that allele exchange is unlikely. Evidently E.B. Ford and his colleagues did not encounter outsiders as they are not mentioned in the numerous publications on the population genetics of *C. dominula* (review in Jones, 1989). Indeed, Ford (1975), stressing

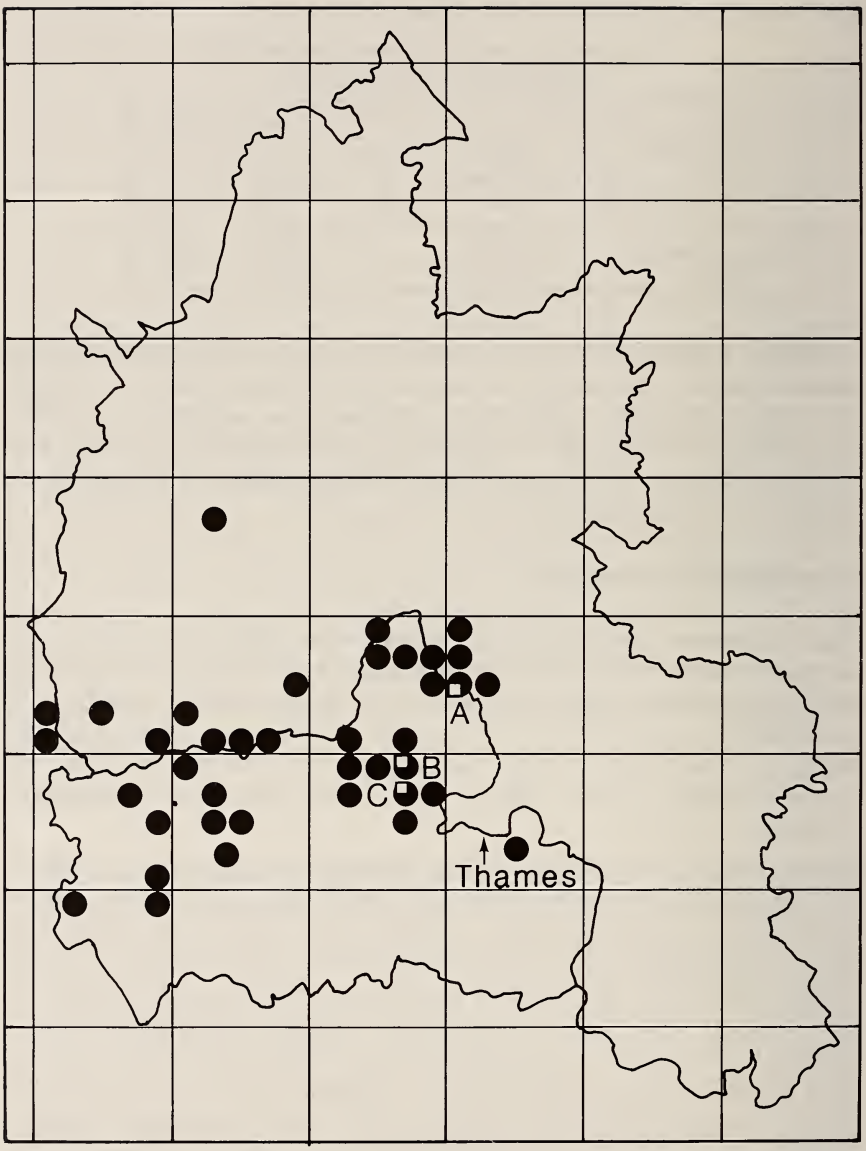

Fig. 1. Map of Oxfordshire showing records of *C. dominula* in 2 × 2 km squares in the period 1960-1993, and the location of the North Hinksey (A), Cothill (B) and Sheepstead Hurst (C) colonies. The distribution of the moth is strongly associated with the River Thames, as shown. The large squares are 10 × 10 km. The map is derived from information held by the Oxfordshire Biological Records Centre, Standlake, Oxfordshire.

the isolation of the Sheepstead Hurst colony (C in Fig. 1) writes, "The whole area is completely surrounded by agricultural land and a neighbouring aerodrome, and the insect, though sometimes present in great numbers, seems to be closely restricted to this habitat and *completely isolated* [my italics] from any of its other colonies, the nearest of which is that at Cothill".

On 2 May 1993, I walked from Sheepstead Hurst to Cothill, following the small stream (Sandford Brook) that links the two sites. Along the banks of the stream there were *Symphytum* plants and *C. dominula* larvae were found feeding on many of them, as shown in Fig. 2. Away from the stream the land is agricultural (exactly as described in Ford (1975)) and there are no *Symphytum* or other plants suitable as food for *C. dominula*. It is difficult to imagine that the situation was substantially different 30 years earlier : the pattern of land use has probably changed, but the essential structure of the countryside would have been much the same then as now. Thus it is likely that these two "isolated" colonies have been and still are linked together by a corridor of *Symphytum*. Moths found in the vicinity of black spots shown in Fig. 2 would count as outsiders. Hence one source of outsiders is that female moths follow *Symphytum* corridors and deposit eggs. This could lead to the establishment of small (perhaps temporary) populations away from the main colonies.

Both moths and larvae are repeatedly found in the densely populated and built-up environment of the City of Oxford. They are reported from gardens and from weedy patches where the land has recently been disturbed. It is difficult to believe that these individuals are the offspring of females that have followed a *Symphytum* corridor from one of the established colonies. One possibility is that contrary to expectation, the moth disperses for long distances over unsuitable habitat, and that it does this quite frequently, a possibility never entertained by the many previous *C. dominula* workers. Another is that the diffuse City of Oxford population is derived from accidental escapes or deliberate releases from captive stocks held by the Zoology Department, University of Oxford, in the 1950s and 1960s. Whatever the explanation, the apparently hostile environment of the City of Oxford contrasts markedly with the damp, marshy habitat occupied by the main colonies.

Larval starvation and dispersal

As Ford (1975) claimed, *C. dominula* is indeed a well-studied species, but there are questions about its ecology that remain unanswered. For

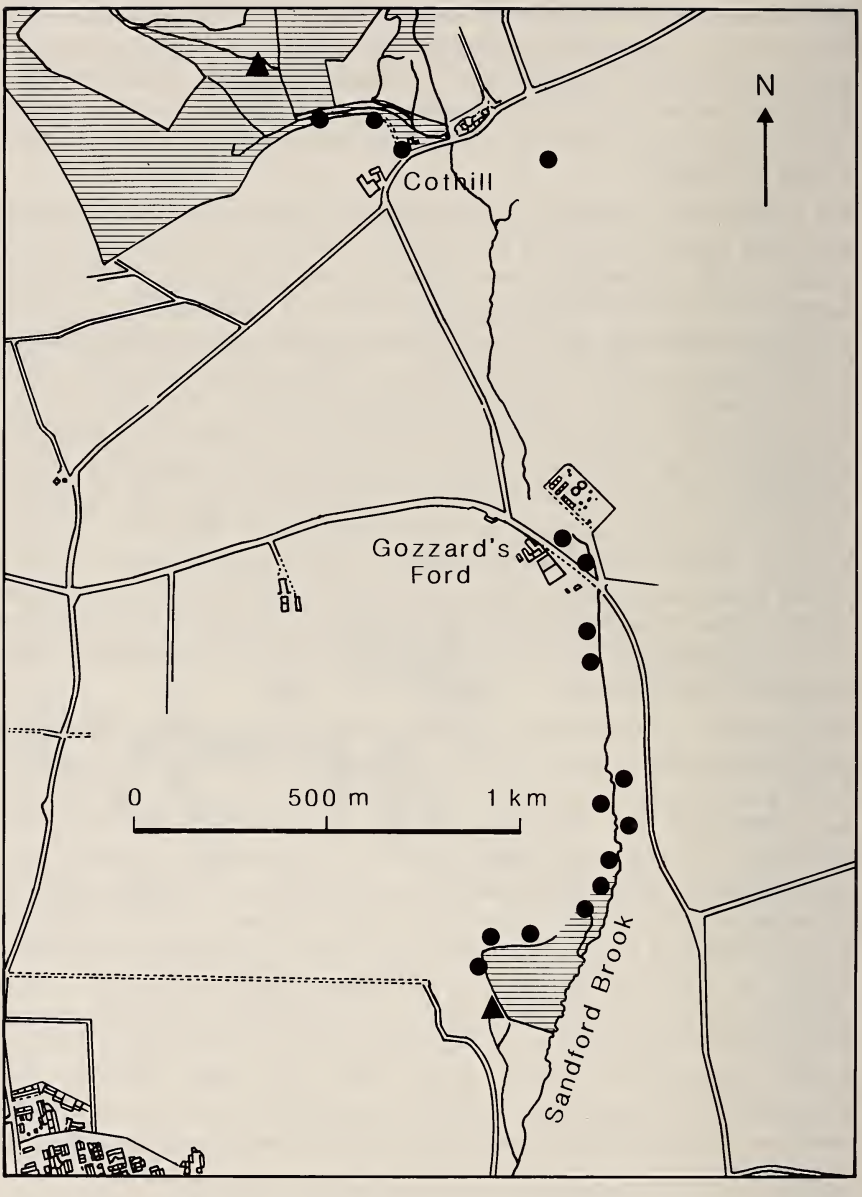

Fig. 2. The distribution of larvae of *C. dominula* (solid dots) in the area between colonies (triangles) at Cothill and Sheepstead Hurst.

example, why are the main colonies located in wet, marshy places, and yet low density breeding can occur almost anywhere ? And why are adult moths from the main colonies significantly smaller than the outsiders ?

At Cothill, the site occupied by the colony is dominated by the reed, *Phragmites*, while at North Hinksey a tall horsetail, *Equisetum telmateia* provides the main ground cover. At North Hinksey in particular, the moth is confined to only a relatively small area of the apparently suitable habitat, and it is difficult to see why this should be so. At both sites the early spring larvae usually eat all the available *Symphytum* shoots as they appear and are clearly deprived of food. *Symphytum* starts to grow in February, considerably earlier than virtually all other possible foodplants, and it is not until later in the spring (mid-April in most years) that additional foodplants become freely available. The inevitable conclusion is that third instar larvae just out of hibernation are in danger of starving, especially in years of exceptionally high population density. This conclusion is not new : more than 30 years ago Cook (1962) suggested that at Cothill larvae might sometimes starve.

Cook (1961) measured wing lengths of *C. dominula* from Cothill and compared them with similar measurements of specimens from a colony in south-west England at Axmouth, Devon. His Cothill measurements are virtually identical to those of mine given in Table 1, differing by only 0.2 mm (males, N = 27) and 0.1 mm (females, N = 25). Interestingly, moths from Axmouth were considerably larger than those from Cothill, but are virtually identical to my Oxfordshire outsider measurements, differing by 0.1 mm for males (N = 68) and for females (N = 42). Cook (1961) concluded that Cothill is at the edge of the moth's geographical range and that the size difference between Cothill and Axmouth is determined primarily by environmental dissimilarities between the colonies which, by implication, could be larval food shortage at Cothill in early spring, but not in the milder area of Axmouth.

This explanation does not, however, account for the large size of the Oxfordshire outsiders, all obtained within 20 km of Cothill (and North Hinksey). These moths are derived from larvae that are unlikely to have experienced food shortage when they start to feed immediately after hibernation. The *Symphytum* plants utilised by outsider larvae are surrounded by other vegetation suitable as larval foodplants, including *Lamium* spp. (Labiatae) and *Urtica dioica* (Urticaceae). It seems therefore that adult size is not so much a matter of geography

but rather is determined by inter-site variation in the availability of larval food in early spring.

As already indicated, the outsiders probably originate from the main colonies, and that areas of countryside surrounding these colonies may periodically support small breeding populations which may or may not persist over a few years or more. It is not known what triggers moths to leave the colonies and breed elsewhere, but the possibility remains that it is associated with larval food shortage early in an individual's life. But the most outstanding problem in *C. dominula*'s ecology is why the main colonies occur in such small and specialised areas, and why even within these areas the moths rarely expand into all the apparently suitable habitat, even though they can breed elsewhere in a variety of totally different habitats.

Acknowledgements

I thank David A.S. Smith for useful discussion and advice and Derek Whiteley for drawing Figs 1 and 2. My research on *C. dominula* is supported by a grant from the Cockayne Trust administered by the Natural History Museum, London.

References

Cook, L. M., 1961. Influence of larval environment on adult size and fecundity in the moth *Panaxia dominula* L. *Nature* 192 : 282.

Cook, L. M., 1962. Some observations on the condition of over-wintering larvae of the scarlet tiger moth, *Panaxia dominula* (Linnaeus). *Entomologist* 95 : 47-50.

Ford, E. B., 1975. Ecological genetics. 4th ed. Methuen, London.

Jones, D. A., 1989. 50 years of studying the scarlet tiger moth. *Trends Ecol. Evol.* 4 : 298-301.

Owen, D. F., 1994. Increase in larval foodplant diversity during a population explosion of the moth, *Panaxia dominula* (L.) (Lepidoptera : Arctiidae). *Nota lepid.* 16 : 267-273.

Sheppard, P. M. & Cook, L. M., 1962. The manifold effect of the *medionigra* gene of the moth, *Panaxia dominula*, and the maintenance of a polymorphism. *Heredity* 17 : 415-426.