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Is a small population of Sandhill Rustic *Luperina nickerlii leechi* moths, possibly on the verge of extinction, worthy of conservation effort?


knilli


leechi


gueneei


demuthi


tardenota


albarracina


nickerlii

Introduction

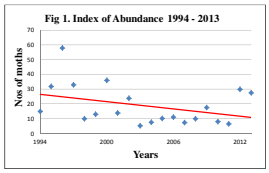
The Sandhill Rustic moth *Luperina nickerlii* Freyer, 1845 (Noctuidae) is widespread in mainland Europe occurring on inland xerothermic slopes where the larvae feed on several grass species; in Britain and Ireland the moth is entirely coastal. Eight subspecies have been described (Table 1), based largely on phenotypes such as wing coloration. Some of these subspecies are of conservation concern, others are widespread and abundant in suitable habitats. Genetic studies using mitochondrial markers show that all subspecies sampled belong to the same species *Luperina nickerlii*, despite considerable differences in appearance, ecology and population isolation. (Spalding, Fukova & ffrench-Constant 2013). Map 1 and Table 2 show that *L. n. nickerlii*, *L. n. knilli* and *L. n. albarracina* individuals formed three separate population clusters. *L. n. leechi* is genetically closer to *L. n. demuthi*, *L. n. knilli* and *L. n. albarracina* (they widely share one haplotype) rather than to *L. n. gueneei* . The populations of *L. n. leechi* and *L. n. gueneei* were very homogeneous and among populations studied here, *L. n. leechi* showed significantly lower heterozygosity. However, in morphometric analysis of wing shape, wing size and body length, *L. n. leechi* is the most variable and shows significant differences between males and females, unlike the other subspecies (Spalding 2013). *L. n. leechi* is the rarest subspecies, being confined to a single site (Spalding & Young 2011) where it occurs on shingle (Spalding, Young & Dennis 2012).

Table 1. The 8 subspecies of Luperina nickerlii known in Europe

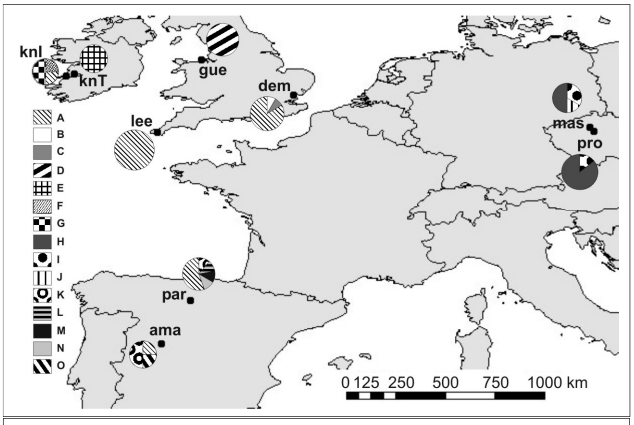
subspecies	habitat	foodplant	countries	rarity
demuthi Goater & Skinner, 1995	Saltmarsh	*Puccinellia maritima*	England	Locally common
graslini Oberthür 1908	Dry slopes	*Festuca ovina*	France	Local
gueneei Doubleday, 1864	Sand dune	*Elytrigia juncea*	England; Wales	Local
knilli Boursin, 1964	Coastal cliff	*Festuca rubra*	Eire	Rare
leechi Goater, 1976	Shingle beach	*Elytrigia juncea*	England	Very rare
nickerlii Freyer, 1845	Sandy heaths	*Festuca rubra*	Germany; Czech Republic; Bulgaria	Local
tardenota Joannis, 1925	Dry grasslands	*Festuca ovina*	France	Local
albarracina Schwingenschuss, 1962	Hot dry slopes	*Festuca rubra*	Spain; Portugal	Local

Luperina nickerlii leechi

By far the rarest of these subspecies is *Luperina nickerlii leechi* Goater 1976, found in one place only, a small shingle beach in Cornwall measuring 400m x 240m, and isolated from other known sites by at least 300km. Total habitat availability for *leechi* based on the presence on the foodplant *Elytrigia juncea* in suitable conditions is just 11,400sq m. It is a BAP Priority Species, listed as a unique subspecies currently under threat. The population size is very small, with the annual Index of Abundance between 1994 and 2013 ranging between 5 to 78 adult moths, showing a steady decline (Figure 1). Morphometric analysis of the 8 subspecies shows that *leechi* is the most variable in the wing and body measurements, with the broadest forewings and the longest body. It has a low forewing ratio, which indicates an adaptation to the strong winds which regularly occur on its exposed beach habitat. The low forewing ratio for *leechi* may fit the theories of Hill, Thomas & Blakeley (1999) and Hill, Thomas & Lewis (1999) who suggest that those individuals colonising new habitats might have larger thoraxes and lower wing aspect ratios, indicating that *leechi* may be a relatively recent arrival to its habitat. High variability may also show recent origin, as differences may disappear over time (Roff, 1990). There are significant differences in the forewing area/body length ratio between males and females; these differences are not apparent in other subspecies. In particular females have the smallest wings in relation to body length of all the subspecies, suggesting a greater investment in reproduction. Males have narrower shorter wings adapted to fast manoeuvrable flight suited to finding females in a small habitat but less useful in the strong winds and in fact the males rarely fly unless the wind speeds are below 1.5 m/s.



Map 1. *Luperina nickerlii* sampling localities and haplotype structure of each sampled population based on the sequence of mitochondrial cytochrome oxidase I (COI).



Each population is represented by a circle which is proportional to the number of specimens used for the analysis. Regions within each circle correspond to the proportion of individual COI haplotypes. Abbreviations: **dem**, *L. n. demuthi;* **gue**, *L. n. gueneei;* **knI** and **knT,** *L. n. knilli*; **lee**, *L. n. leechi;* **mas** and **pro** *L. n. nickerlii*; **par** and **ama** *L. n. albarracina*.

Table 2. Genetic diversity indices based on mitochondrial COI gene

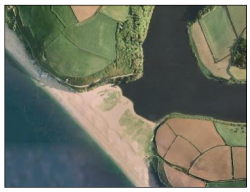
Population	mt COI	
	Gene diversity (h)	Average no. of pairwise differences (π)
demuthi (Essex)	0.49 +/- 0.18	1.02 +/- 0.74
Gueneei (Prestatyn)	0.22 +/- 0.17	0.22 +/- 0.29
knilli (Inch)	0.67 +/- 0.31	1.33 +/- 1.10
knilli (Trabeg)	0.00 +/- 0.00	0.00 +/- 0.00
leechi (Cornwall)	0.00 +/- 0.00	0.00 +/- 0.00
nickerlii (Máslovice)	0.73 +/- 0.16	1.80 +/- 1.20
nickerlii (Praha)	0.26 +/- 0.14	0.79 +/- 0.61
albarracina (Amavida)	0.83 +/- 0.22	1.50 +/- 1.12
albarracina (Páramos)	0.72 +/- 0.16	1.72 +/- 1.10

Is ssp. *leechi* worth conservation effort?

No

- Its genetic structure is shared with other subspecies especially *demuthi*
- On site management is difficult as it occupies a shingle beach exposed to a high energy maritime environment
- It may not survive for long due to the small isolated population resulting in inbreeding
- Subspecies *tardenota*, *knilli* and *gueneei* may all be more worthy of conservation effort as they have large populations on multiple sites and may survive more readily

Yes



- It is recognisably different in appearance from other subspecies, adapted in colour to its substrate
- It is the only subspecies occupying a shingle substrate
- It is a small declining population and its loss will mean the loss of an unique subspecies
- It has an unusual sex ratio (females - male of 70:30) which has yet to be explained
- Its presence on this site may be of recent origin and studies may cast light on evolutionary processes
- It is showing considerable variation in wing size and shape and may be adapting to the maritime environment
- It inhabits a site with secure land tenure, owned by the National Trust
- Its presence in a tiny isolated site allows easy study and in practice forms an outdoor laboratory

On balance, conservation effort and continued studies are considered to be worthwhile. Conservation could include introduction to nearby suitable habitat to reduce reliance on a single site, and may allow study of phenotypic adaptation. Further genetic analysis using nuclear markers may provide additional evidence to support conservation effort to preserve the evolutionary processes acting on this population.

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