Determinants of nest thermoregulation in *Formica exsecta;* insights and implications

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CONTEXT & AIM

Mound building ants are dominant, ecologically important species in temperate ecosystems [1,2,3,4,5]. In Britain, the distribution of the endangered narrow-headed ant, *Formica exsecta*, has contracted and it is now restricted to several remnant populations [6,7,8]. Ecological knowledge of this species is still in its infancy [9], and insight is becoming increasingly important with the rising adoption of translocation [10].

To date, research suggests that temperature and sunlight conditions largely underpin the survival of this species [9,11,12,13,14]. In an effort to further knowledge in these areas, this study explores the daily temperature regime of this species in addition to its above-nest light conditions.

METHODS

In an isolated population at Chudleigh Knighton Heath, the temperature variability of populated nests was separately compared with **a**) undisturbed soil and **b**) abandoned nests using iButton data loggers and OneWireViewer software. All temperature monitoring was conducted in the nest thatch of *F. exsecta* nests. Above-nest hemispherical photographs were obtained according to the protocol outlined in Fraser et al., (1995)[15]. Mean daily temperature regimes were quantified, followed by pairwise comparison for comparisons **a** and **b**. Light parameters were quantified through Gap Light Analyser software [15]. Lastly, daily temperature data derived from comparison **a** was compared with predicted daily sunlight duration.

RESULTS

The daily temperature regime of populated nests exhibited clear differentiation in temperature to that of undisturbed soil (t_{3552} = 59.74, P < 0.0001)(Fig 1a), but comparatively little with abandoned nests (t_{938} = -1.88, P = 0.06)(Fig 1b). Populated nests did however have higher thermal maxima in both observation periods (Fig 1). Nests were generally situated in relatively open, bright areas with most canopy cover situated near the horizon relative to the nest position. Canopy cover was found to share a significant association with nest temperatures (t_{72} = 4.91, P < 0.0001), wherein increasing daily duration of sunlight corresponded to an increase in mean nest temperatures.

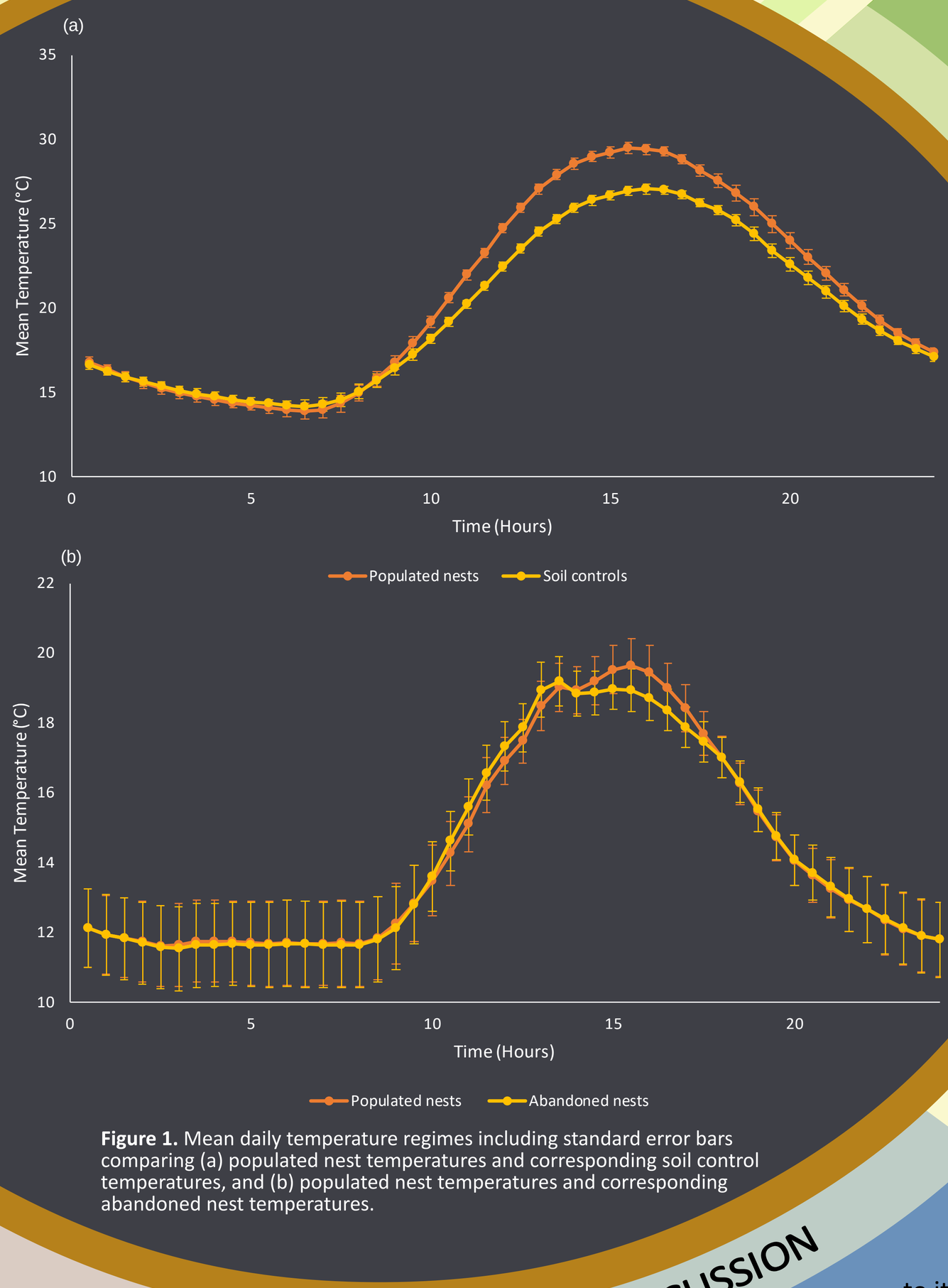

Figure 1. Mean daily temperature regimes including standard error bars comparing (a) populated nest temperatures and corresponding soil control temperatures, and (b) populated nest temperatures and corresponding abandoned nest temperatures.

DISCUSSION

The nest thatch of *F. exsecta* has been shown to have higher thermal conductance than undisturbed soil (Fig 1a), most likely due to its unique composition (Fig 1b). Some nest heating may be due to the biological activity of the ants themselves, but further monitoring would be required to fully elucidate this relationship. Individual nests were also found in relatively open, bright areas with little canopy cover, which may be selected as nest sites to complement the specific thermal requirements of this species [11,16]. Taken together, these findings suggest that *F. exsecta* thermoregulate their nests according to sunlight induced thermal gradients [17], mediated by the unique thatch composition. Of further support is the positive correlation found between daily sunlight duration and nest temperature. The particular thermoregulatory and nest site selection strategies observed in this study are likely employed to complement the developmental processes of this species [11], the most notable of which being brood production and development [16,18]. These strategies could also be employed as a response to ecosystem pressures (of importance to this site could be interspecific competition [10,19], disturbance and resource limitation [21,22]), indicating that habitat at Chudleigh Knighton Heath may be sub-optimal [9]. Further investigation into the interactions between *F. exsecta* and their biotic environment could provide invaluable insights, and facilitate more effective conservation management of this population and others.

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