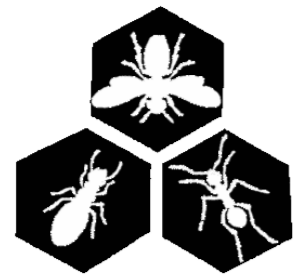


SEASONAL CHANGE IN PHOTOTROPIC BEHAVIOR OF *FORMICA POLYCTENA*



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INTRODUCTION:

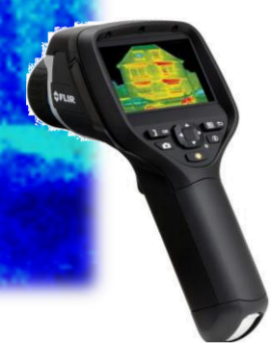
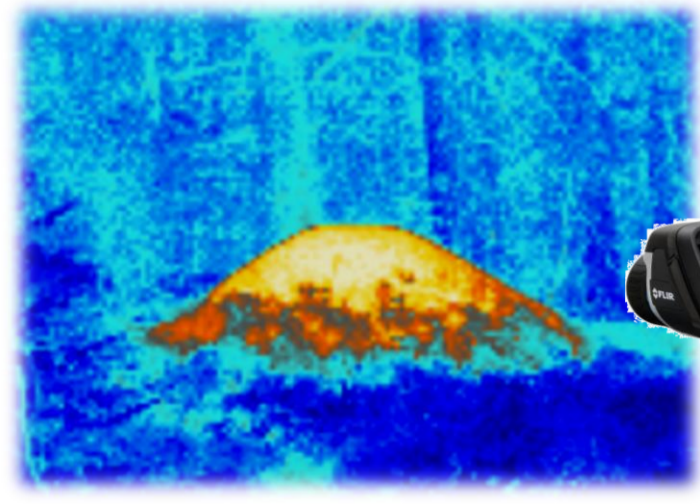
Red wood ants (*Formica rufa* group)

- inhabit boreal and temperate forests, protected
- ecosystem engineers: affect nutrients and tree growth
- collect honeydew, prey on other insect
- huge nest mounds, population size in millions
- polygynous, polydomous, aggregated nests



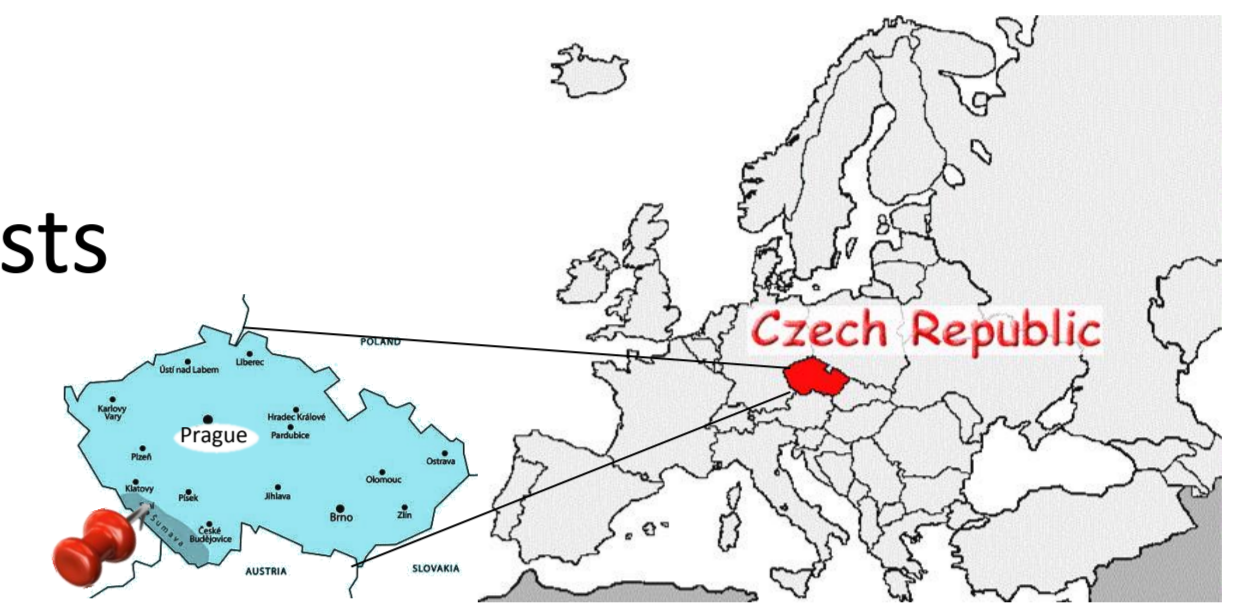
THERMOREGULATION!

- unique properties of nest material (heat capacity...)
- increased and stable nest temperature $T > 20^\circ\text{C}$
- brood is placed in the nest core, NOT relocated¹
- mature nests rely on inner heat sources²:
 microbial heating & ant metabolic heat production
- solar radiation used in spring sunning behavior³



METHODS:

- two years long observation and temperature measurement of 12 *F. polyctena* nests
- locality: South Bohemia, Czech Republic (49°03.334'N, 013°46.564'E)
- nest temperature measured with thermometer and IR camera (FLIR E30bx)



SHADING EXPERIMENT:



ants sunning on nest surface → shading with cardboard shield (40x40cm) for 3 minutes → IR and digital photos of nest
 → change in ants density on nonshaded vs. shaded nest surface scored in % (more ants in shade = positive change)

RESEARCH QUESTIONS

&

RESULTS

- Do ant workers show any phototropic reaction?
- Does the phototropic reaction change in time?
- Which factors affect the response direction?

YES!

Spring = POSITIVE phototropism

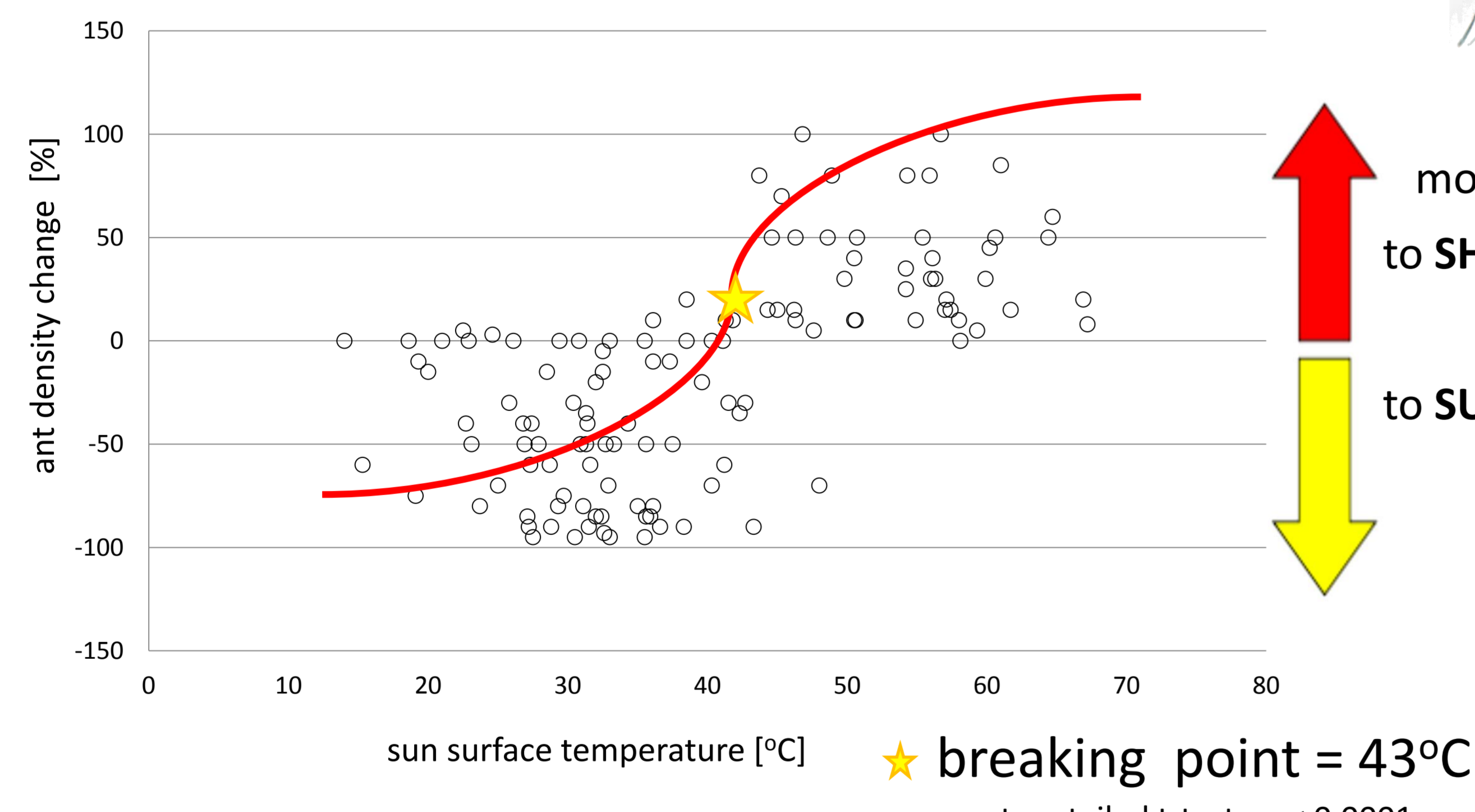
- ants move out of the shade to the sun

X

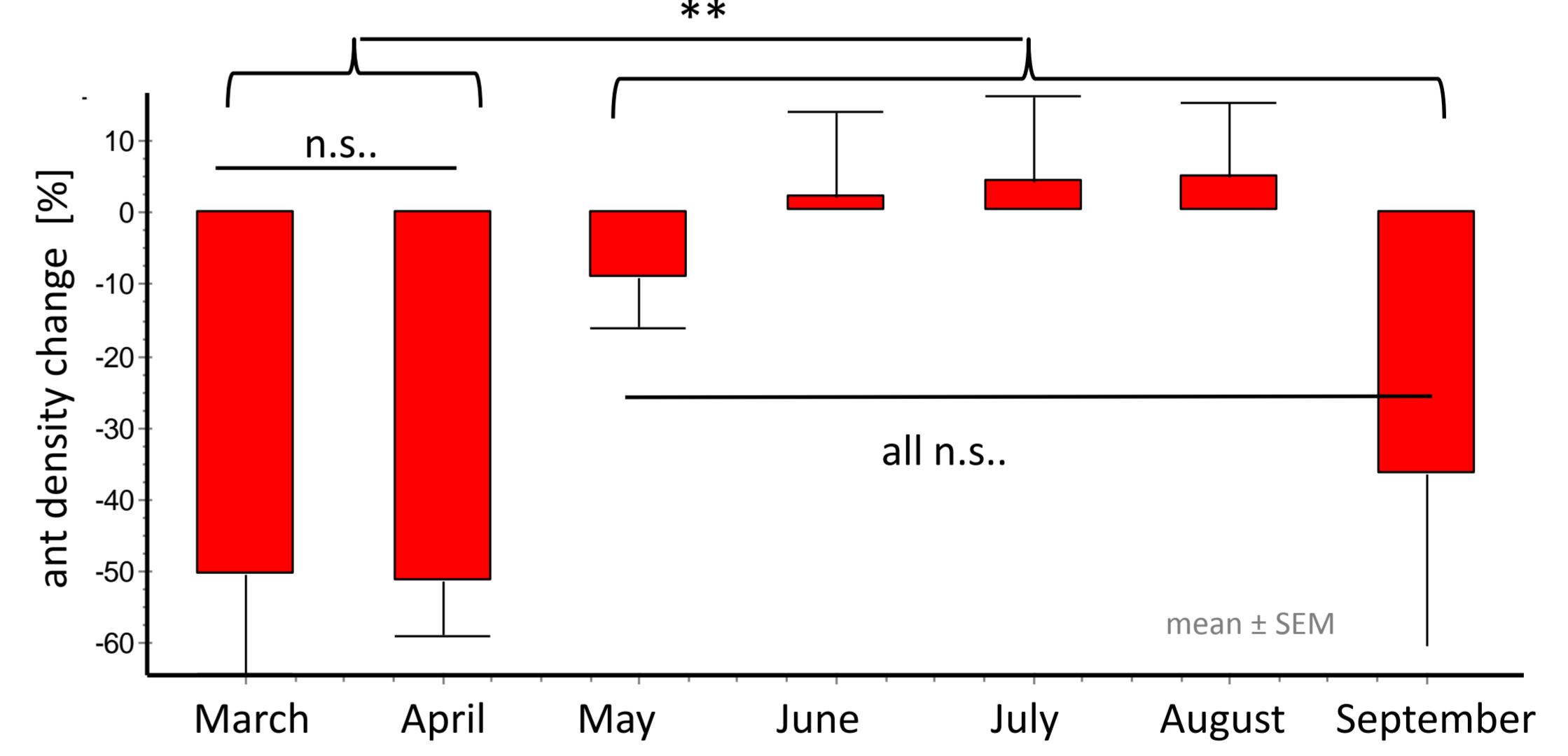
Summer = NEGATIVE phototropism

- ants move into the shade, avoid the sun

=> Effect of nest surface temperature ($p < 0.001$)



=> Ant reaction significantly affected by date ($p = 0.018$)



Early spring - March and April differ from other months

Tukey-Kramer Multiple Comparisons, $p < 0.01$

=> Significant effect of:

solar radiation ($p = 0.0017$), weather ($p < 0.001$), nest population size ($p = 0.008$)

CONCLUSION

- Spring positive phototropism of *F. polyctena* is a thermoregulatory mechanism which helps to establish thermal homeostasis of nest and speed up brood development. Ants heat themselves on sun and transport the heat into the nest. This is in agreement with sunning behavior theory³.
- Summer negative phototropism is physiological self-protecting mechanism which makes the ants avoid higher than lethal temperatures which are found on the nest surface.
- The switch occurs at 43°C which is two degrees higher than experimentally measured lethal temperature ($LD_{50} = 40.673 \pm 0.346^\circ\text{C}$) for *F. polyctena*⁴ => red wood ants seem to tolerate exceeded temperatures to a certain extent.

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References: 1- Kadochová Š and Frouz J (2013) Thermoregulation strategies in ants in comparison to other social insects, with a focus on *Formica rufa*; F1000Research. 2:280 | 2 - Frouz J (2000) The effect of nest moisture on daily temperature regime in the nests of *Formica polyctena* wood ants; Insectes Soc. 47 : 229–235 | 3 - Zahn M (1958): Temperatursinn, Wärmehaushalt und Bauweise der Rote Waldameisen (*Formica rufa* L). Zoologische Beitrage. 3: 127–194 | 4 - John R (2008) Sunning behavior of *Formica polyctena* ants; diploma thesis, Charles University in Prague, Faculty of Science