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Research Article

Differences in basking site selection between the sympatric snakes *Vipera berus* and *Natrix natrix*

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ABSTRACT - The contributions of habitat selection to survival are of great importance to all species but especially in terrestrial, diurnal basking ectotherms. Despite a well-documented influence on thermoregulation efficiency, factors that influence basking, secondary to temperature are often overlooked. To assess the importance of secondary factor importance, basking site selection of *Vipera berus* and *Natrix natrix* was comparatively observed. Their sympatric distribution provided the opportunity to determine whether they select similar basking sites. Significant differences in basking site distance from cover were revealed; *V. berus* demonstrated preference for close-to-cover basking sites, *N. natrix* selected more open basking areas. No significant difference in surface temperature was found at the basking sites of either species', nor was there significant correlation shown between temperature and basking site DFC. Similarly habitat structure showed no significant impact on basking site selection. Body size correlation with site selection was however found to be inconclusive. Investigation into predator diversity and pressure, as well as prey habitat use are recommended for future research as this may offer explanation for the observations that are currently unexplained.

INTRODUCTION

Behaviours surrounding habitat selection in animals are of great interest in ecology (e.g. Eskew, Willson & Winne et al., 2009) as they represent the principal factors in the evolution of behavioural characteristics (e.g. Huey et al., 2003). Influences over resource availability and predation risk (e.g. Brown, 1999) are key factors in survival particularly in the case of terrestrial, diurnal basking reptiles. An added dependence on basking for thermoregulation creates supplementary selection pressures, placing basking habitat selection at the centre of survival (see for example Stevenson, 1985; Blouin-Demers & Weatherhead, 2002).

The selection of optimal basking habitat is therefore crucial for basking reptiles such as snakes. The value of a basking site is primarily determined by its obtainable thermal energy; higher quality, warmer sites offering increased basking efficiency (Huey, 1991a; Row & Blouin-Demers, 2006; Diaz, 1997). Mosaic basking is an alternative strategy utilised by some basking reptiles (Bauwens et al., 1990) including *Vipera berus* (Palmer, 2011) as a predator avoidance strategy. Basking in such a way can impact basking efficiency however, as lower quality/more covered basking sites though safer will ultimately require longer basking sessions (see Cooper, 1997; Row & Blouin-Demers, 2006), costing hunting time (Avery, Bedford & Newcombe, 1982).

Despite a well-documented influence over basking behaviour and duration, "secondary" factors e.g. predation pressures, resource availability or body size (see Dunham, Grant & Overall, 1989; Webb & Whiting, 2005), are less frequently reported. To assess such secondary influences, basking site selection of *V. berus* and *Natrix natrix* was observed and compared. Both of these species occupy the same habitat and this enabled observations of basking site selection that gave insight into whether each species will select basking sites, and exploit their thermal environment in similar ways.

MATERIALS AND METHODS

Data were collected across Hatfield Moor, Doncaster, South Yorkshire, UK, along two separate 3 km transects; woodland border habitat "Triangle Woods", and pathway habitat "Green Mile". Observations were made in August through to September 2011, between 0800 h and 1300 h; attempts later in the day proving impractical due to an increased alertness of the animals. Similarly, preliminary investigations showed little basking activity before 0800 h, and absence of snake activity on days of heavy rainfall, most likely due to low temperatures.

Basking site distance from cover (DFC in cm) was measured by running a ten metre tape measure at ground level, from the edge of a snakes coiled body, to the nearest point of cover. This was considered the best method of measuring DFC as snakes being long and thin animals, have no obvious centre. For the purpose of this investigation, cover was regarded as a patch of vegetation, or other matter, that would provide adequate obstruction for predator evasion.

Injury during capture was considered as too great a risk for gravid female snakes, and subsequently body size was estimated to the nearest five centimetres, as well as body temperature (T_b) and basking site ground temperature (T_g) being measured using an infra-red thermometer gun (FLUKE 68 ir thermometer, Fluke Corporation, Washington, USA).

Statistical Analysis

The Mann-Whitney U test was selected to determine significance between interspecific DFC median values, data sets from both species being found to be non-normal by a Shapiro-Wilk normality test (see Results). Additionally Pearson correlation coefficients were used to identify trend significance between between body length and temperature with DFC data, with r^2 values depicting trend direction.

RESULTS

A total of 126 snakes were observed throughout this investigation; 45 *N. natrix*, 81 *V. berus*.

Interspecific Distance from Cover (DFC) Comparison: Triangle Woods

Triangle woods DFC data for *V. berus* and *N. natrix* were non-normal (Shapiro-Wilk $p < 0.001$ for both species). Basking site DFC values differed significantly between species (Mann-Whitney U-test = 142.500, $p = 0.011$); *V. berus* median DFC = 11, range = 490 cm, *N. natrix* median DFC = 50.50 cm, range = 419 cm (Fig 1.).

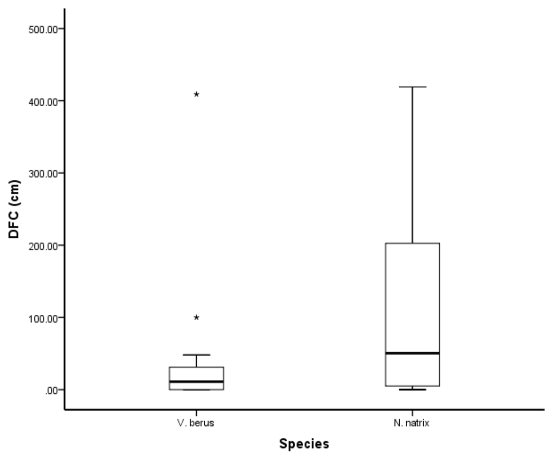

Figure 1. Differences in species median DFC values, full DFC range, and interquartile ranges of measurements taken in Triangle Woods habitat.

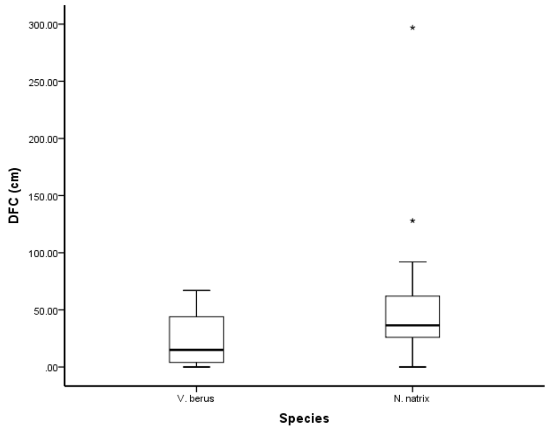

Figure 2. Differences in species median DFC values, full DFC range, and interquartile ranges of measurements taken in Green Mile habitat.

Interspecific Distance from Cover Comparison: Green Mile

Green Mile data samples were similarly non-normal (Shapiro-Wilk, $p < 0.002$ for both species). Basking site DFC values differed significantly between species (Mann-Whiteny U-test = 313.00 $p = 0.003$), *V. berus* median DFC = 15.00 cm, range 67 cm, *N. natrix* median DFC = 35. 00 cm, range = 297 (Fig 2.).

Temperature and Distance from Cover

Basking site ground temperatures (T_g), demonstrated no significant correlation for either habitat or species when plotted against DFC (Triangle Woods: *V. berus* $r^2 = 0.083$, $p = 0.182$; *N. natrix* $r^2 = 0.098$, $p = 0.179$; Green Mile: *V. berus* $r^2 = 0.009$, $p = 0.557$, *N. natrix* $r^2 = 0.022$, $p = 0.472$). No significant correlation between basking site DFC and snake body temperature (T_b) was found for either habitat or species (Triangle Wood: *V. berus* $r^2 = 0.002$, $p = 0.150$, *N. natrix* $r^2 = 0.002$, $p = 0.842$; Green Mile: *V. berus* $r^2 = 0.024$, $p = 0.378$ *N. natrix* $r^2 = 0.032$, $p = 0.194$).

Individual Body Length and DFC

Length showed a non-significant correlation with DFC in both species ($r^2 = 0.011$, $p = 0.512$) in Triangle Woods habitat. Samples from Green Mile also showed no significant trend for *N. natrix* ($r^2 = 0.007$, $p = 0.678$,) however *V. berus* demonstrated a significant trend in DFC and body length ($r^2 = 0.128$, $p = 0.026$).

DISCUSSION

The results have revealed a significant difference in basking site DFC selection between these snakes. Although neither species was observed to mosaic bask, *V. berus* has demonstrated a strong preference for close-to-cover basking sites. *N. natrix* has alternatively been shown to exploit more open basking habitats, particularly in the Triangle Woods area. Absence of correlation between DFC and temperature (T_b or T_g) suggests no thermoregulatory influence to site DFC selection. Similarly, absence of competitive displacement (Reitz & Trumble 2002) between *N. natrix* and *V. berus* described by Luiselli (2006) suggests this also is an unlikely cause for the difference in species basking site selections. Data collected regarding body length and DFC selection remains inconclusive, showing conflicting results between both sites and within species groups.

The foraging lifestyle of *N. natrix* (Meister et al., 2010) may result in less detailed habitat familiarity than in the more sedentary *V. berus* (see Chelazzi & Calzolai, 1986). Predator impact on basking site selection has not been assessed here but may be involved. For instance, it is perhaps surprising that *V. berus* is the species seen to opt for safer basking areas, given that they are aposematic and venomous (see Wϋster et al., 2004) but increased mortalities from basking in more exposed locations have been found in other vipers, for instance *V. aspis* (e.g. Bonnet & Naulleau, 1996; Naulleau et al., 1997; Meek, 2013). The latter perhaps suggests that the survivorship costs associated with higher DFC basking in vipers (see Carrascal et al., 1992; Burger, 1998; Cooper, 2003; Reading & Jofre, 2009) are lower for *N. natrix*, for example, they may be less easily detected by predators, or are outweighed by key benefits from basking in more exposed locations. The observations here have highlighted a potential gap in knowledge of basking site selection of *V. berus* and *N. natrix*, as well as the importance of secondary factors in basking site selection in terrestrial reptiles. Further research is now needed to more accurately identify the key factors involved.

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REFERENCES

Avery, R.A., Bedford, J.D. & Newcombe, C.P. (1982) The role of thermoregulation in lizard biology: Predatory efficiency in a temperate diurnal basker. *Behavioural Ecology and Sociobiology* 11: 261- 267.

Bonnet, X. & Naulleau, G. (1996). Catchability in snakes: consequences on breeding frequency estimates. *Canadian Journal of Zoology* 74: 233–239.

Blouin-Demers, G. & Weatherhead, P.J. (2002) .Habitat-specific behavioural thermo-regulation by black rat snakes (*Elaphe obsoleta obsoleta*). *Oikos* 97: 59-68.

Brown, J.S. (1999). Vigilance, patch use and habitat selection: Foraging under predation risk. *Evolutionary Ecology Research* 99: 49-71.

Burger, J. (1998). Antipredator Behaviour of Hatchling Snakes: Effects of Incubation Temperature and Simulated Predators. *Animal Behaviour* 56: 547-553.

Carrascal, L.M., López, P., Martín, J. & Salvador, A. (1992). Basking and Antipredator Behaviour in a High Altitude Lizard: Implications of Heat-exchange Rate. *Ethology* 92: 143-154.

Chelazzi, G. & Calzolai. R. (1986). Thermal benefits from familiarity with the environment in a reptile. *Oecologia* 68: 557-558.

Cooper, W.E. (2003). Shifted Balance of Risk and Cost after Autotomy Affects Use of Cover, Escape, Activity, and Foraging in the Keeled Earless Lizard (*Holbrookia propinqua*). *Behavioural Ecology and Sociobiology* 54: 179-187.

Cooper, W.E. Jr. (1997). Escape by a refuging prey, the broad-headed skink (*Eumeces laticeps*). *Canadian Journal of Zoology* 75: 943-947.

Diaz, J.A. (1997). Ecological Correlates of the Thermal Quality of an Ectotherms Habitat: A Comparison Between Two Temperate Lizard Populations. *Functional Ecology* 11: (1) 79-89.

Bauwens, D., Aurora, M.C., Van Damme, R. & Verheyen Field, R. (1990). Body Temperatures and Thermoregulatory Behavior of the High Altitude Lizard, *Lacerta bedriagae*. *Journal of Herpetology* 24: 188-91.

Dunham, A.E., Grant, B W. & Overall, K.L. (1989). Interfaces between Biophysical and Physiological Ecology and the Population Ecology of Terrestrial Vertebrate Ectotherms. *Physiological Zoology* 62: 335-355.

Eskew, E.A., Willson, J.D. & Winne, C.T. (2009). Ambush site selection and ontogenetic shifts in foraging strategy in a semi-aquatic pit viper, the Eastern cottonmouth. *Journal of Zoology* 277: 179-186.

Luiselli, L. (2006). Resource partitioning and interspecific competition in snakes: the search for general geographical and guild patterns. *Oikos* 114: 193-211.

Meek, R. (2013). Post hibernation movements in an aspic viper, *Vipera aspis*. *Herpetological Bulletin* 125: 22-24.

Meister, B., Hofer, U., Ursenbacher, S. & Baur, B. (2010). Spatial genetic analysis of the grass snake, *Natrix natrix* (Squamata: Colubridae), in an intensively used agricultural landscape. *Biological Journal of the Linnean Society* 101: 51–58.

Naulleau, G., Verheyden, C. & Bonnet, X. (1997). Predation specializees sur la Vipere aspic *Vipera aspis* par un couple de buses variables *Buteo buteo*. *Alauda* 65:155–160.

Palmer, K. (2011). Vegetation structure at basking sites of the adder *Vipera berus*: Implications for site management. *The Herpetological Bulletin* 117: 25-27.

Reading, C.J. & Jofre, G.M. (2009). Habitat selection and range size of grass snakes *Natrix natrix* in an agricultural landscape in southern England. *Amphibia-Reptilia* 30: 379-388.

Reitz, S.R. & Trumble, J.T. (2002). Competitive Displacement Among Insects Arachnids. *Annual Review of Entomology* 47: 435-465.

Row, J.R. & Blouin-Demers. G. (2006). Thermal quality influences effectiveness of thermoregulation, habitat use, and behaviour in milk snakes. *Oecologia* 148: 1-11.

Stevenson, R.D. (1985). The Relative Importance Of Behavioural And Physiological Adjustments Controlling Body Temperatures In Terrestrial Ectotherms. *The American Naturalist* 126: 362-386.

Webb, J.K. & Whiting, M.J. (2005). Why don’t small snakes bask? Juvenile broad-headed snakes trade thermal benefits for safety. *Oikos* 10: 515-522.

Wüster, W. Allum, C.S.E., Bjargardóttir I.B., Bailey, K.L., Dawson, K.J., Guenioui, J., Lewis, J., Mcgurk, J., Moore, A.G., Niskanen, M. & Pollard, C.P. (2004). Do aposematism and Batesian mimicry require bright colours? A test, using European viper markings. *Proceedings of the Royal Society London, Biological Sciences* 271: 2495-2499.