Effect of spectral composition of artificial light on the attraction of moths

Frank van Langevelde

Jody Ettema, Maurice Donners, Michiel WallisdeVries & Dick Groenendijk

WAGENINGEN UR For quality of life

PHILIPS

De Vlinderstichting

Ecology of the night

- Light pollution is global problem (Rich & Longcore 2006)
- Not same recognition as other forms of global change
- Lack of knowledge about ecology of the night

Effects on predator-prey interactions

Effects on behaviour of individuals

Effects on pollination

Ecology of the night

- Light pollution is global problem (Rich & Longcore 2006)
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Effects on communities

Hypotheses

1. Artificial light with smaller wavelengths attracts higher species richness and higher abundances of moths

2. Attraction correlated with morphological characteristics of moths, especially eye size

Van Langevelde *et al.* 2011 Biological Conservation

Experiment

Kampina nature reserve

Homogenous conditions

12 trapping sessions

species and # individuals

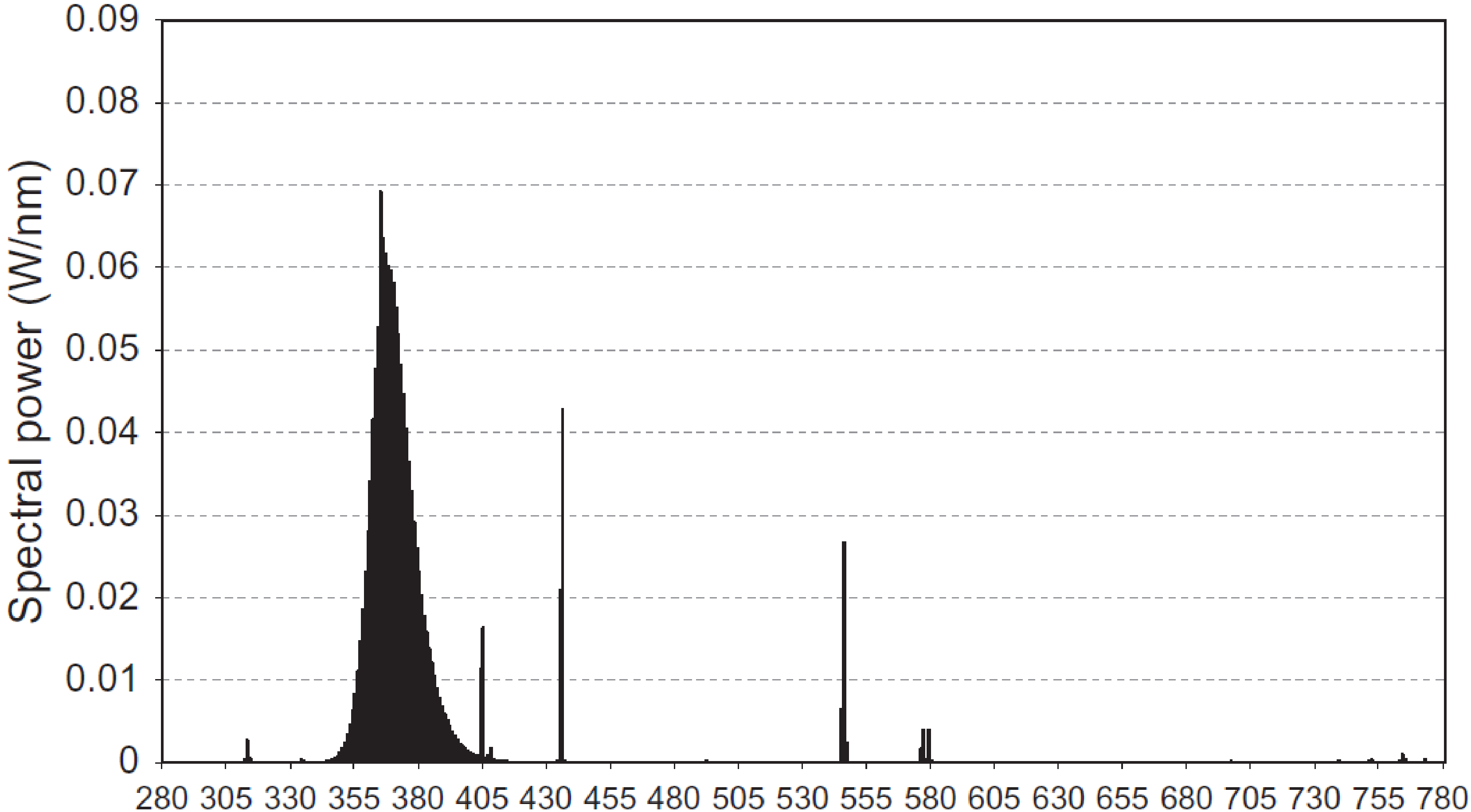
112 moth species were caught in 18 traps during 6 weeks

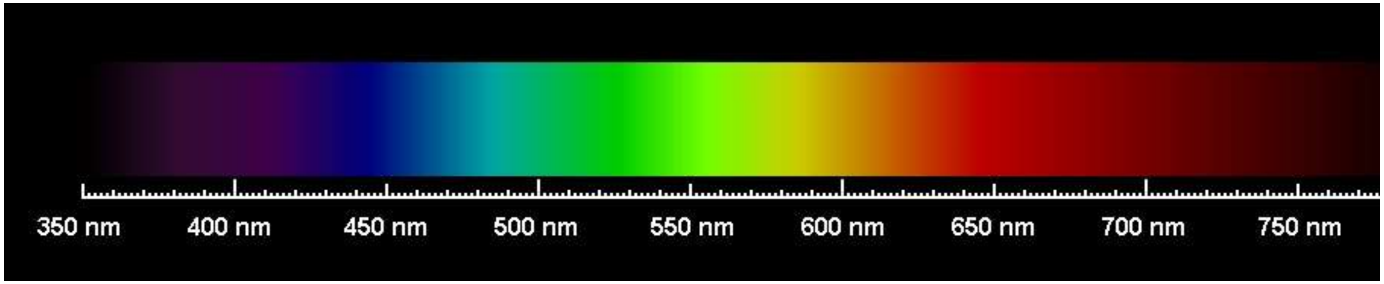
40 moth species

Traits

- Fore wing length
- Fore wing width
- Dry body mass
- Eye diameter

Heath's collapsible portable traps





Ultraviolet **Infrared**

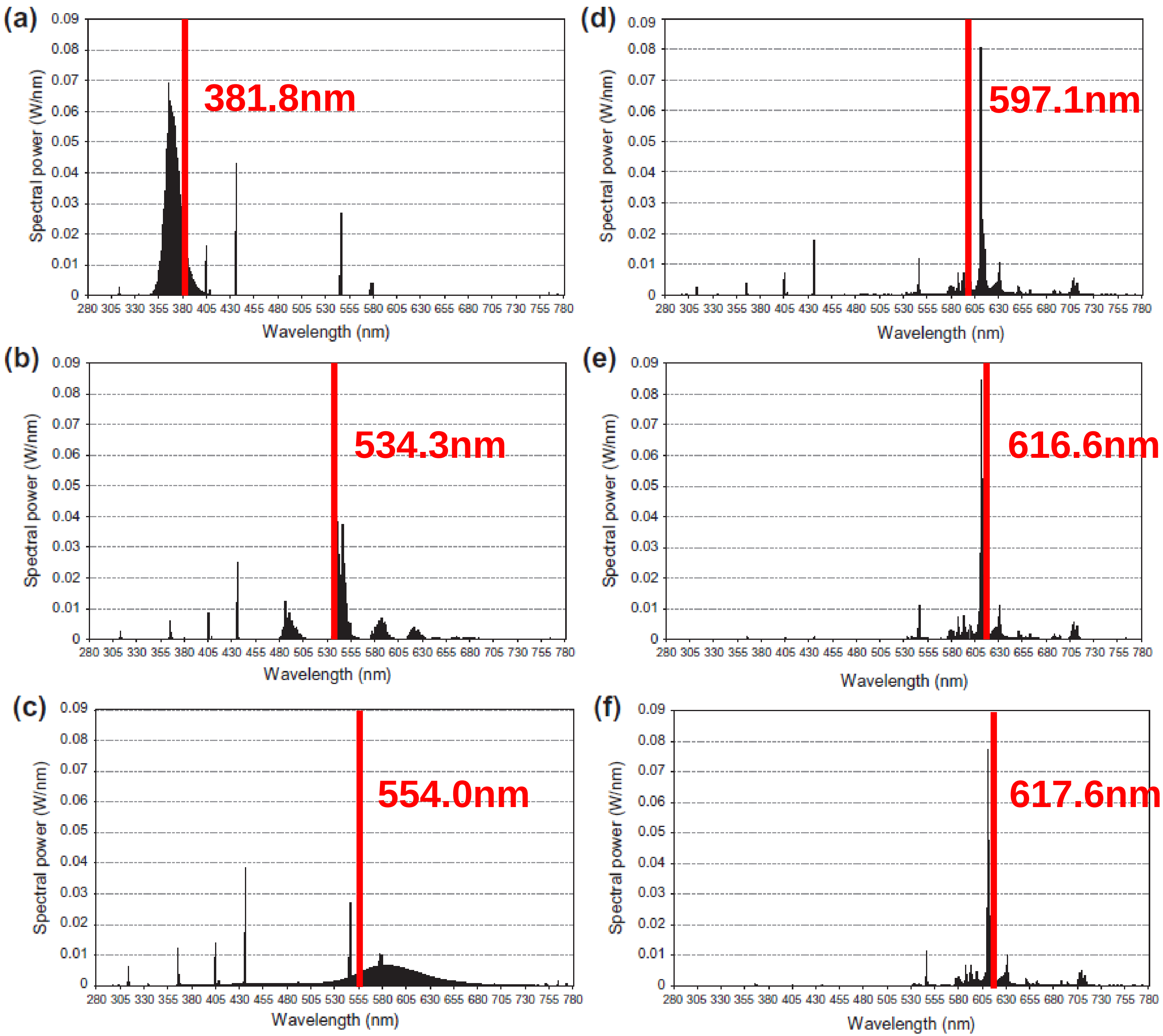
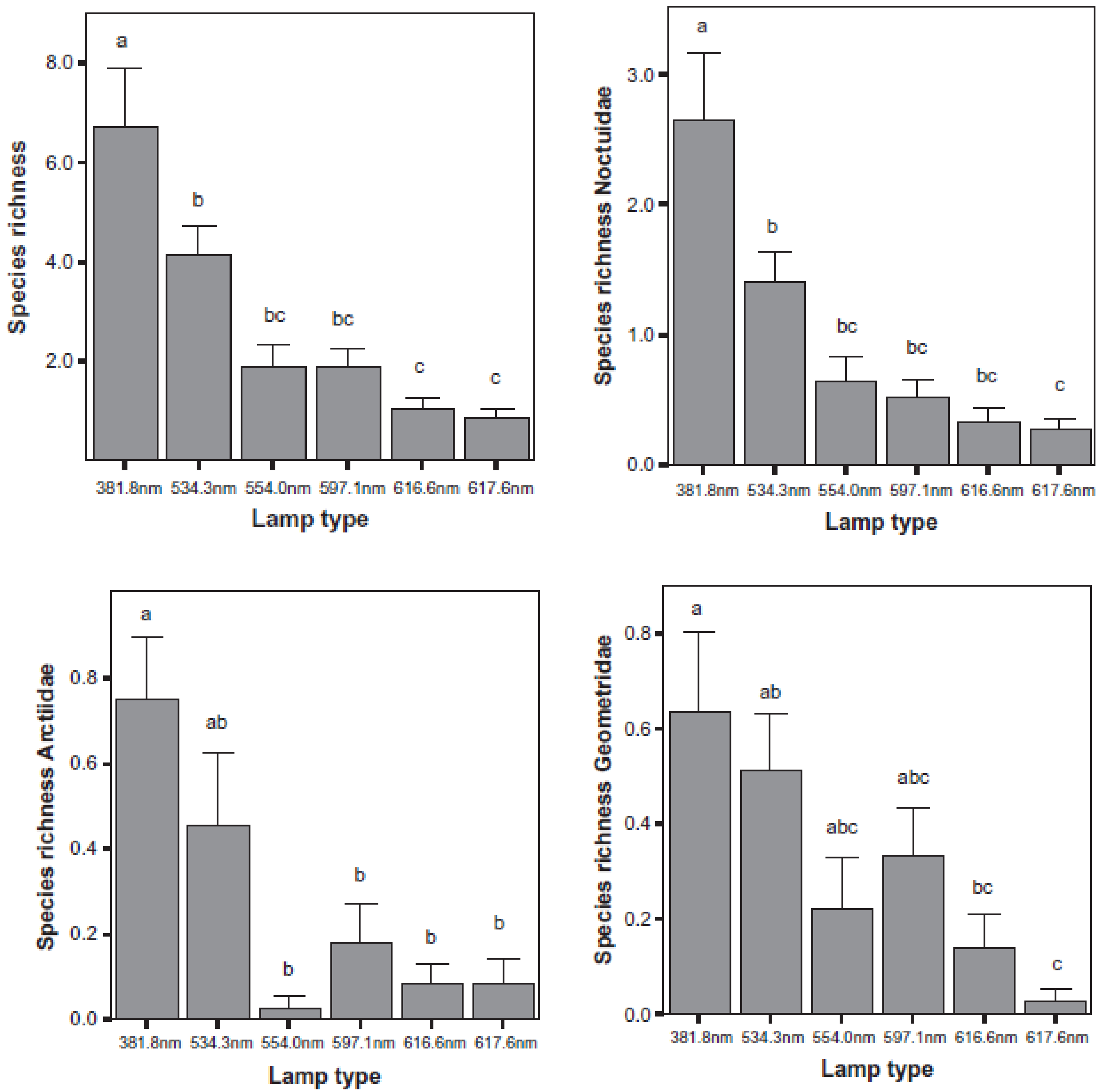


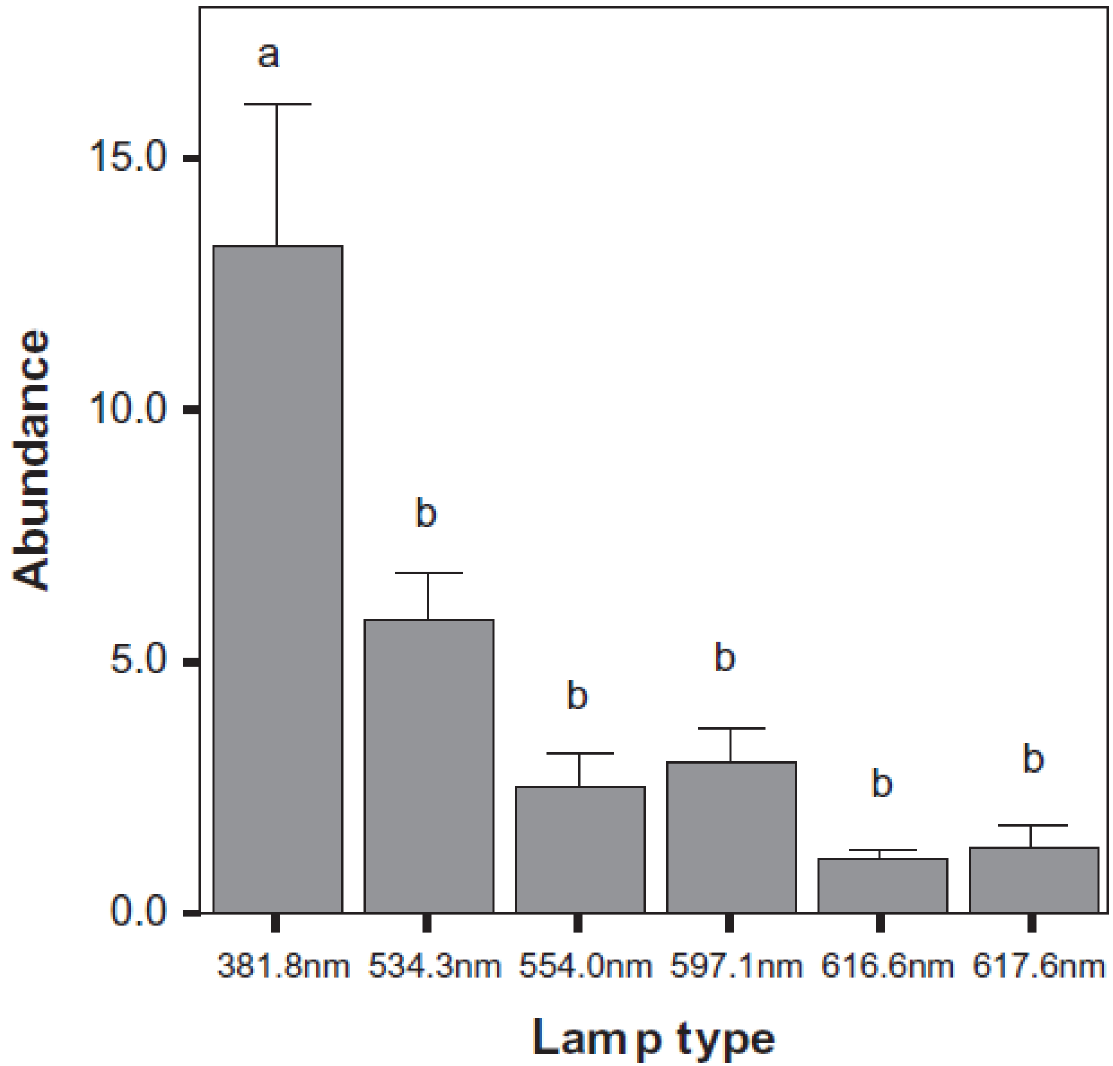
Fig. 1. Spectral power distribution (W/nm) of the six lamp types (with the weighted mean wavelength of the lamp types): *a* (381.8 nm), *b* (534.3 nm), *c* (554.0 nm) (597.1 nm), *e* (616.6 nm) and *f* (617.6 nm).

Results



Species richness
8.0
6.0
4.0
2.0
a
b
bc
bc
c
c
381.8nm 534.3nm 554.0nm 597.1nm 616.6nm 617.6nm
Lamp type
Species richness Noctuidae
3.0
2.0
1.0
0.0
a
b
bc
bc
bc
c
381.8nm 534.3nm 554.0nm 597.1nm 616.6nm 617.6nm
Lamp type
Species richness Arctiidae
0.8
0.6
0.4
0.2
0.0
a
ab
b
b
b
b
381.8nm 534.3nm 554.0nm 597.1nm 616.6nm 617.6nm
Lamp type
Species richness Geometridae
0.8
0.6
0.4
0.2
0.0
a
ab
abc
abc
bc
c
381.8nm 534.3nm 554.0nm 597.1nm 616.6nm 617.6nm
Lamp type

Results

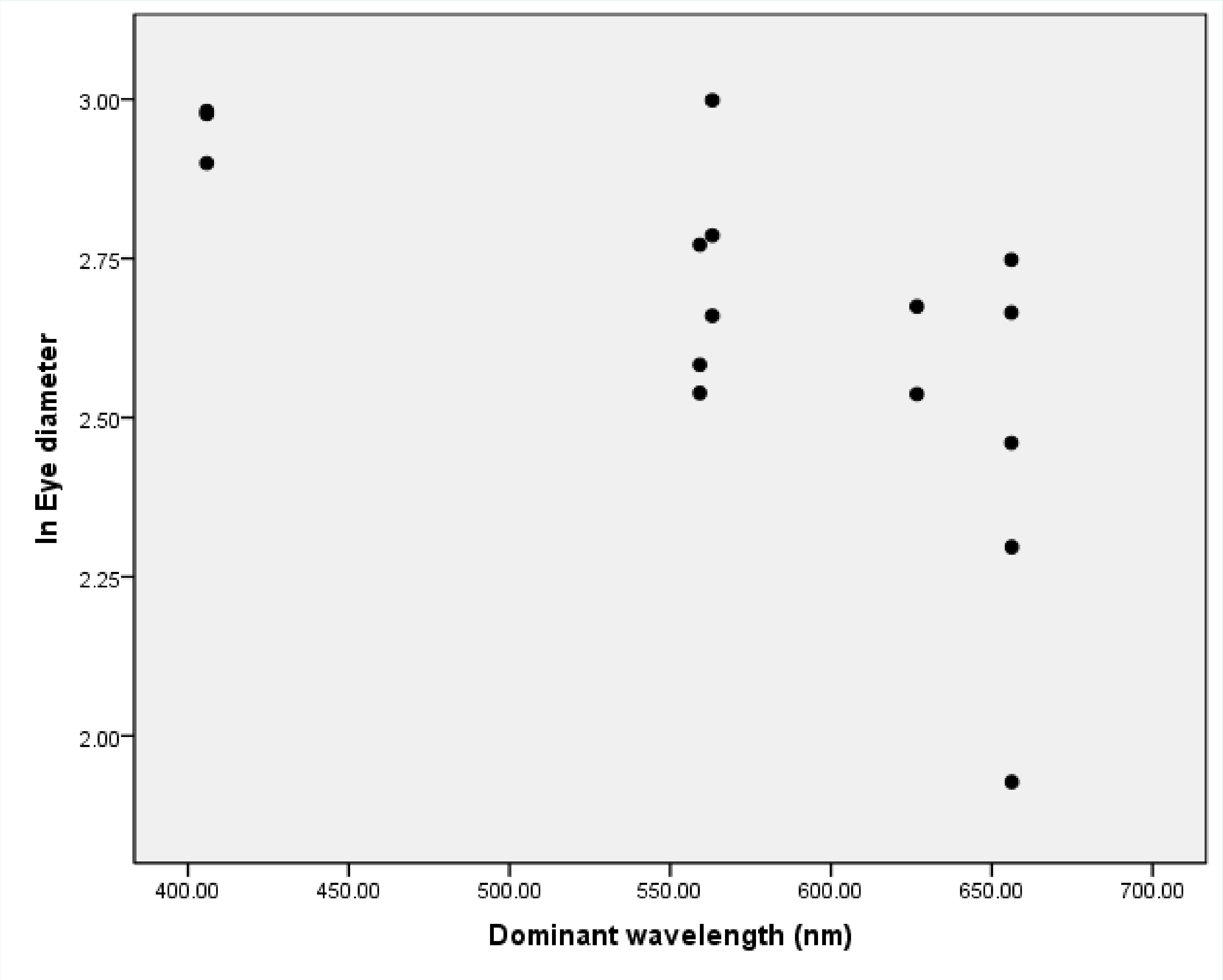

a
b
b
b
b
b
15.0
10.0
5.0
0.0
Abundance
381.8nm
534.3nm
554.0nm
597.1nm
616.6nm
617.6nm
Lamp type

Relation mean wavelength – moth traits

Moth characteristics	R^2	Slope (± s.e.)	P
Forewing length	0.70	−0.030 (± 0.005)	<0.001
Forewing width	0.66	−0.015 (± 0.003)	<0.001
Dry weight	0.42	−0.001 (± 0.0002)	0.007
Eye diameter (ln-transformed)	0.46	−0.002 (± 0.001)	0.005

Spilosoma lubricipeda (G. Gelmers)

Timandra comae (A. Baas)



Larger average eye sizes (μm) with smaller wavelength (nm)

Conclusion

1. Artificial light with smaller wavelengths attracts higher species richness and higher abundances of moths (agrees o.a. with Cowan & Gries 2009)

2. Artificial light with smaller wavelengths attracts larger moth species

Discussion

1. Male-biased flight-to-light behavior of moths

(Altermatt *et al.* 2008)

Our study: size-biased flight-to-light behavior

2. Possible cascading effects for biodiversity and ecosystem services

Pollination services

Moth species are important pollinators (Boggs 1987, Pettersson 1991)

Size-dependent mortality of moths reduces pollination by larger moth species

→ *Silene latiflora* Jürgens *et al.* 1996, *Platanthera bifolia* Nilsson 1983, *Silene sennenii* Martinell *et al.* 2010

Predator-prey interactions

Large part of diet of spider, bird and bat species contains moths or caterpillars (Sierro & Artellaz 1997, Visser *et al.* 2006)

→ Brown long-eared bat (*Plecotus auritus*): almost exclusively larger moth species from Noctuidae (83%, Rostovskaya *et al.* 2000)

→ European nightjar (*Caprimulgus europaeus*): feed young mainly with larger moth species (Cramp 1985)

Timandra comae (A. Baas)

Thank you!

Leo de Bruijn, Jippe van der Meulen, Ab Baas, Gert Gelmers

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ABSTRACT

During the last decades, artificial night lighting has increased globally, which largely affected many plant and animal species. So far, current research highlights the importance of artificial light with smaller wavelengths in attracting moths, yet the effect of the spectral composition of artificial light on species richness and abundance of moths has not been studied systematically. Therefore, we tested the hypotheses that (1) higher species richness and higher abundances of moths are attracted to artificial light with smaller wavelengths than to light with larger wavelengths, and (2) this attraction is correlated with morphological characteristics of moths, especially their eye size. We indeed found higher species richness and abundances of moths in traps with lamps that emit light with smaller wavelengths. These lamps attracted moths with on average larger body mass, larger wing dimensions and larger eyes. Cascading effects on biodiversity and ecosystem functioning, e.g. pollination, can be expected when larger moth species are attracted to these lights. Predatory species with a diet of mainly larger moth species and plant species pollinated by larger moth species might then decline. Moreover, our results indicate a size-bias in trapping moths, resulting in an overrepresentation of larger moth species in lamps with small wavelengths. Our study indicates the potential use of lamps with larger wavelengths to effectively reduce