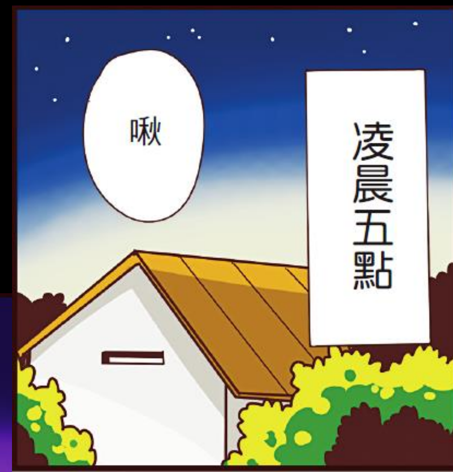
擾人清夢！光害讓鳥提早高歌

文／林大利（特有生物研究保育中心助理研究員） 圖／BIGUN



Singing from North to South:
Latitudinal Variation of the Effects of ALAN on Timing of Dawn Song

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Max Planck Institute for Ornithology

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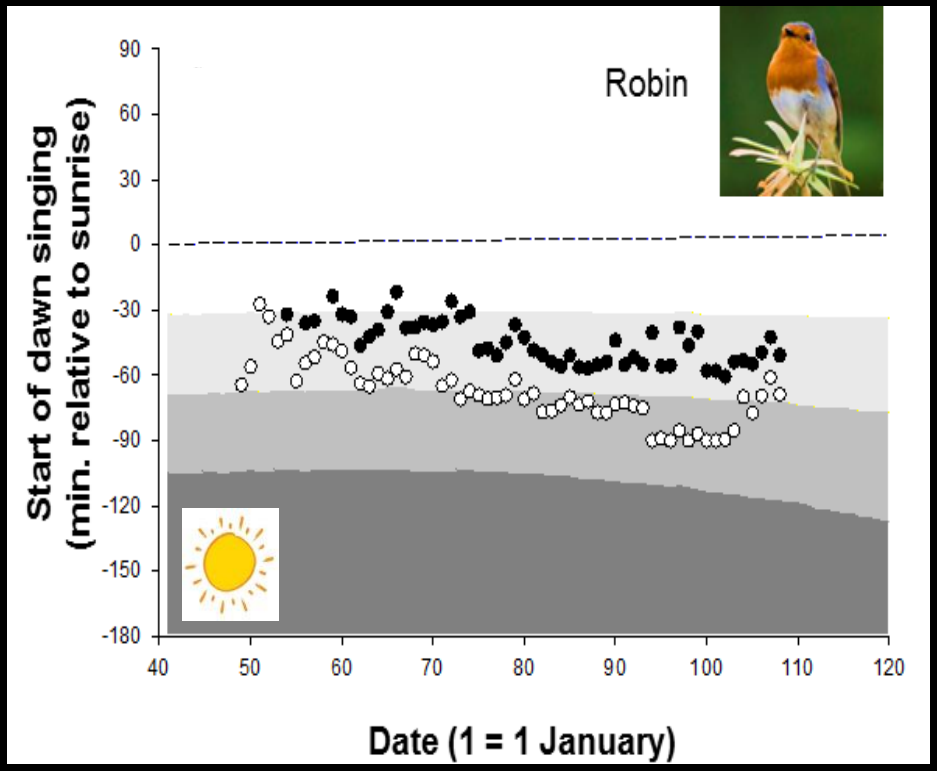
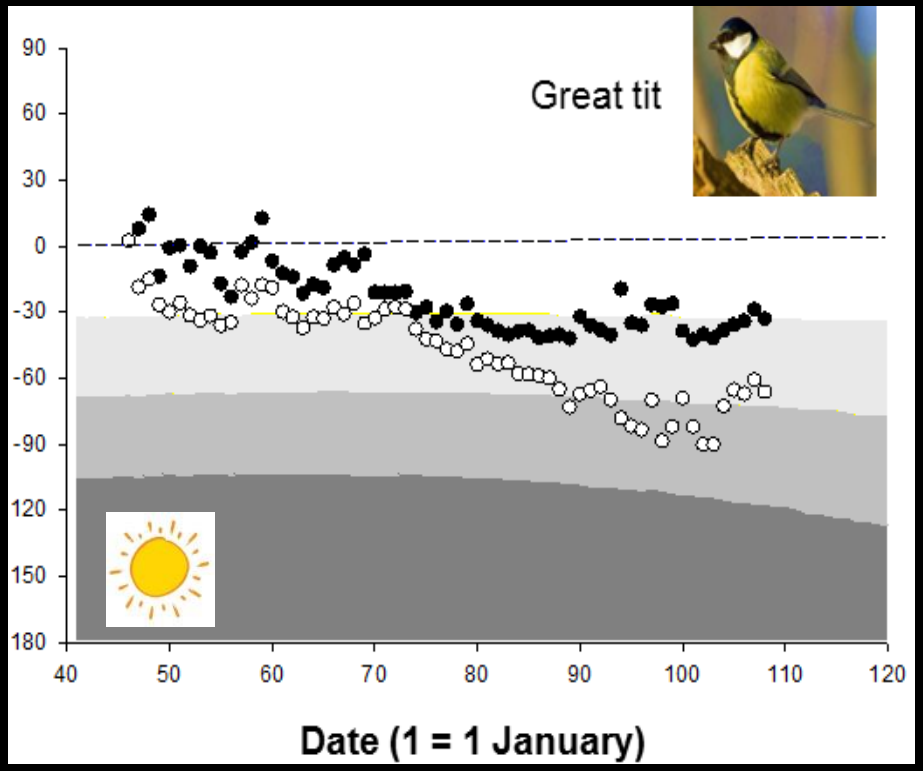
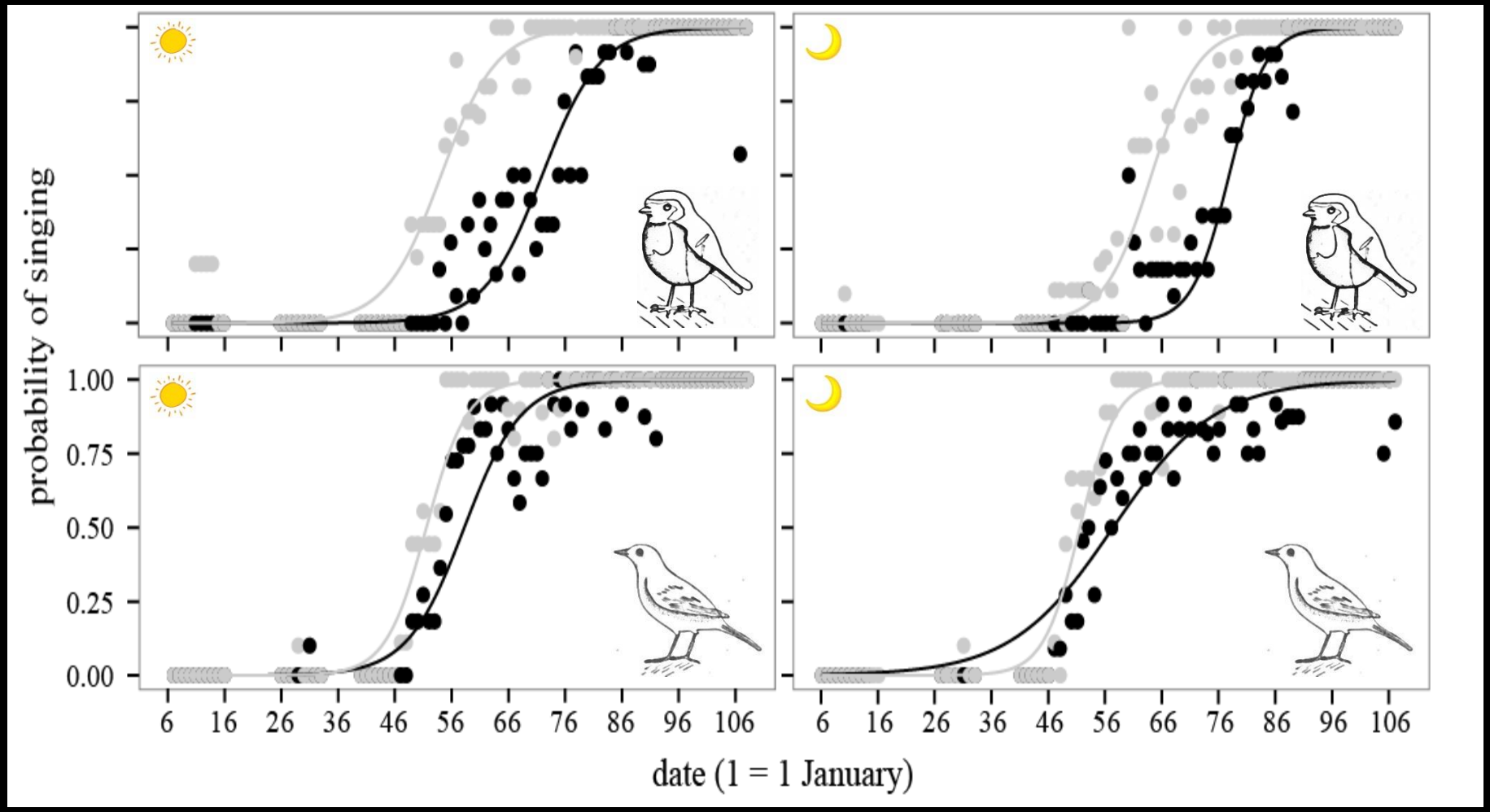




Light pollution (rather than noise pollution)

→ Earlier **daily** start of dawn song

Da Silva et al. 2014 (Behav. Ecol.)



Light pollution

→ Earlier **yearly** start of song production

Da Silva et al. 2015 (Phil. Trans. Biol. Soc. B)

Light effect on dawn song across latitudes

- Most studies carried out at same intermediate latitudes:

Germany, Netherlands, England, USA[1]

- Lack an understanding of the impact of light pollution in relation to variation in natural light conditions

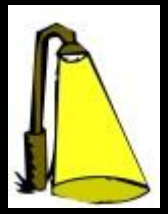
- 3 study sites in Europe that differ in natural daylength variation

[1] Miller 2006, Nordt & Klenke 2013, Da Silva et al. 2014, Dominoni et al. 2014,


ARTIC OCEAN
BARENTS SEA
ICELAND
1 : MACEDOINE
2 : SLOVENIE
3 : LUXEMBOURG
ATLANTIC
NORTH SEA
NORWAY
SWEDEN
FINLAND
65°N
ESTONIA
LATVIA
LITHUANIA
Russia
DENMARK
UNITED KINGDOM
NETHERLANDS
BELGIUM
GERMANY
POLAND
BELARUS
CZECH REP.
48°N
SLOVAK
UKRAINE
MOLDOVA
FRANCE
SWITZERLAND
AUSTRIA
HUNGARY
ROMANIA
CROATIA
BOSNIA-HERCEGOVINA
YUGOSLAV
PORTUGAL
SPAIN
37°N
ITALY
ALBANIA
GRE
Adriatic Sea
MEDITERRANEAN SEA
MOROCCO
ALGERIA
TUNISIA
MALTA

Light effect on dawn song across latitudes

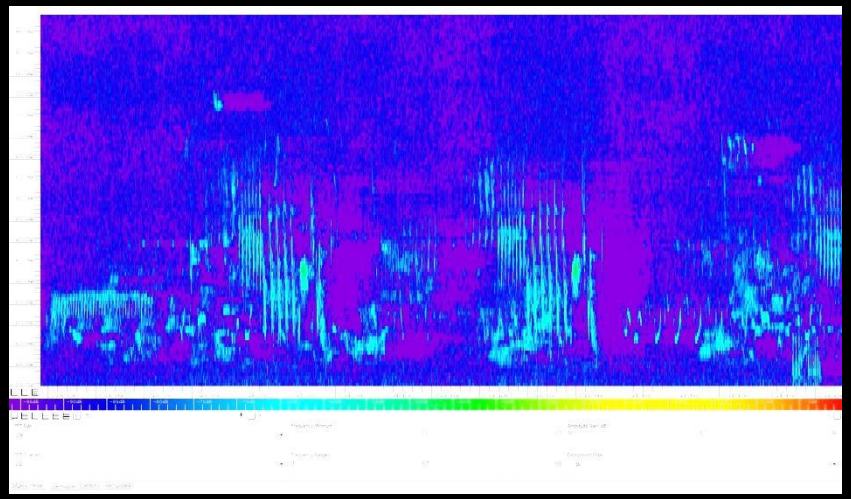
- 10 peri-urban forest patches: 5 with and 5 without light pollution (street lights)



Light effect on dawn song across latitudes

- 10 peri-urban forest patches: 5 with and 5 without light pollution (street lights)

- From 25 March to 18 April in Germany and Spain
- From 2 to 26 May in Finland



Wildlife Acoustics

Light effect on dawn song across latitudes

- 10 peri-urban forest patches: 5 with and 5 without light pollution (street lights)

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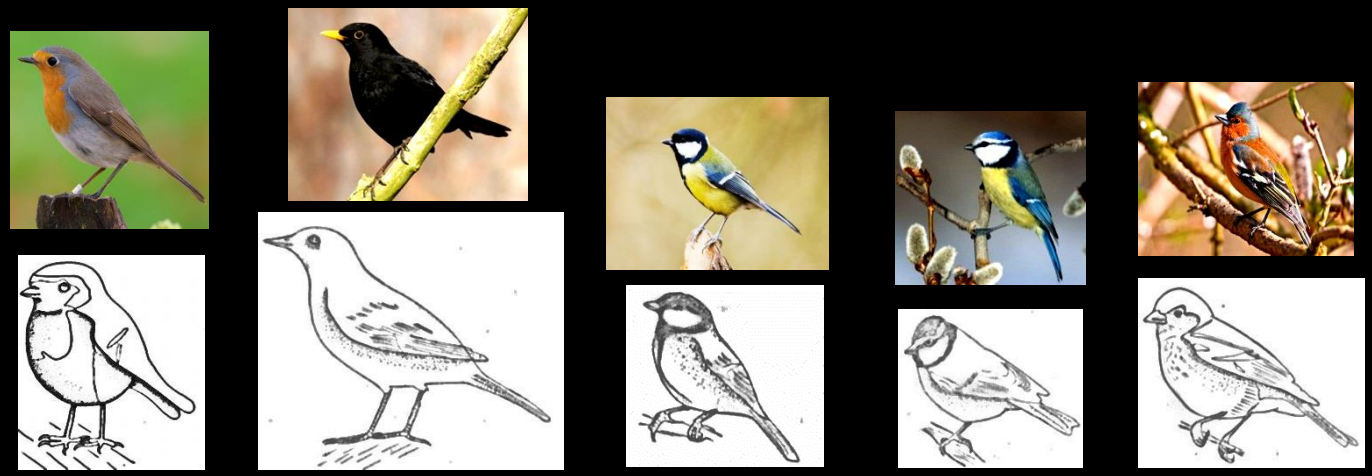


Statistical analysis

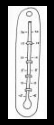
- Dependent Variable

Onset of dawn song (min before sunrise)

- Explanatory Variables

Light (yes/no)  * **Latitude** (F/G/S)  ***Standardized date** 

Rain (yes/no) 

Temperature (residuals) 

- Random Variable

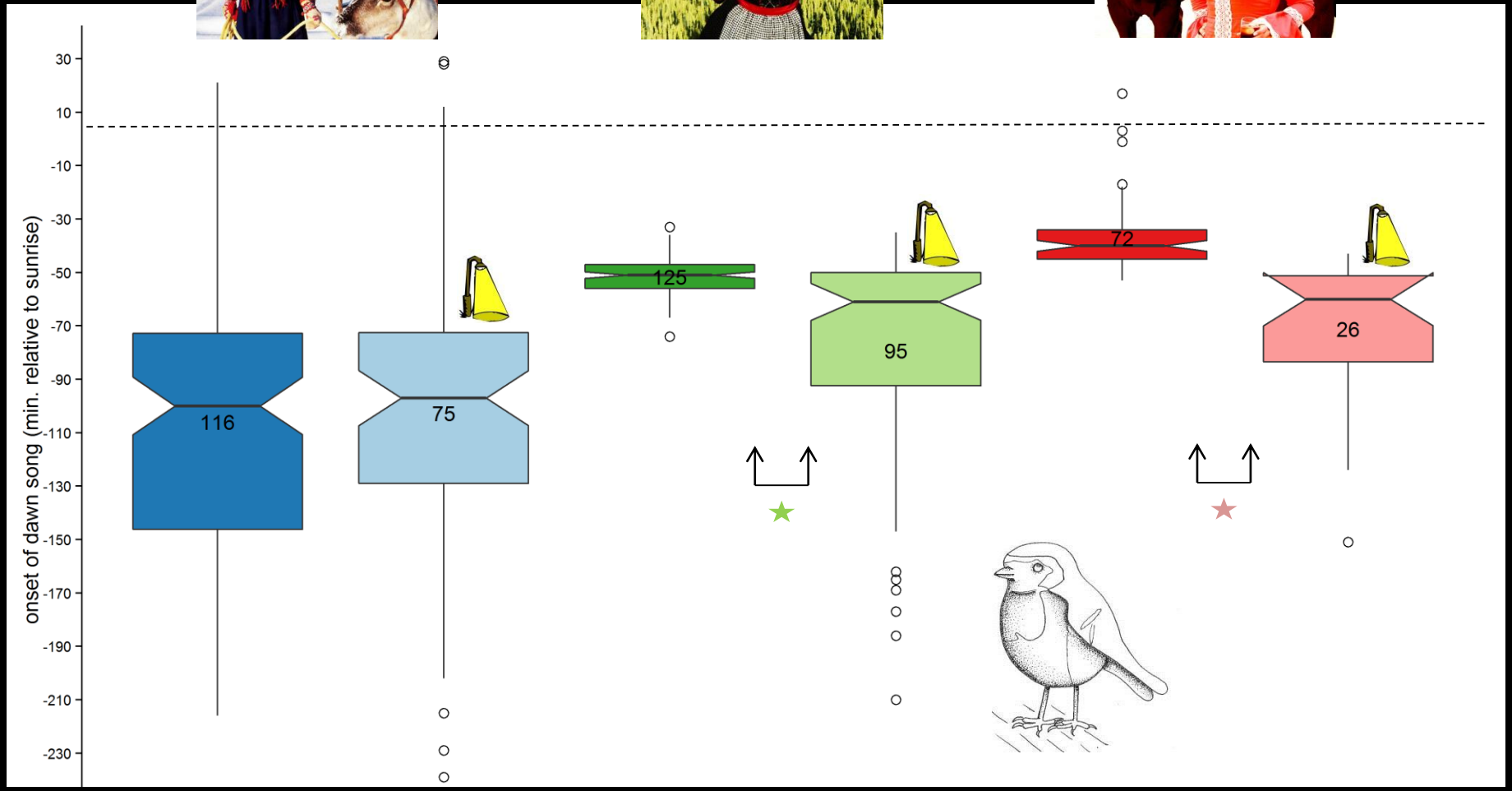
Site

- Model selection according to AIC criterion

Onset of singing (min before sunrise)

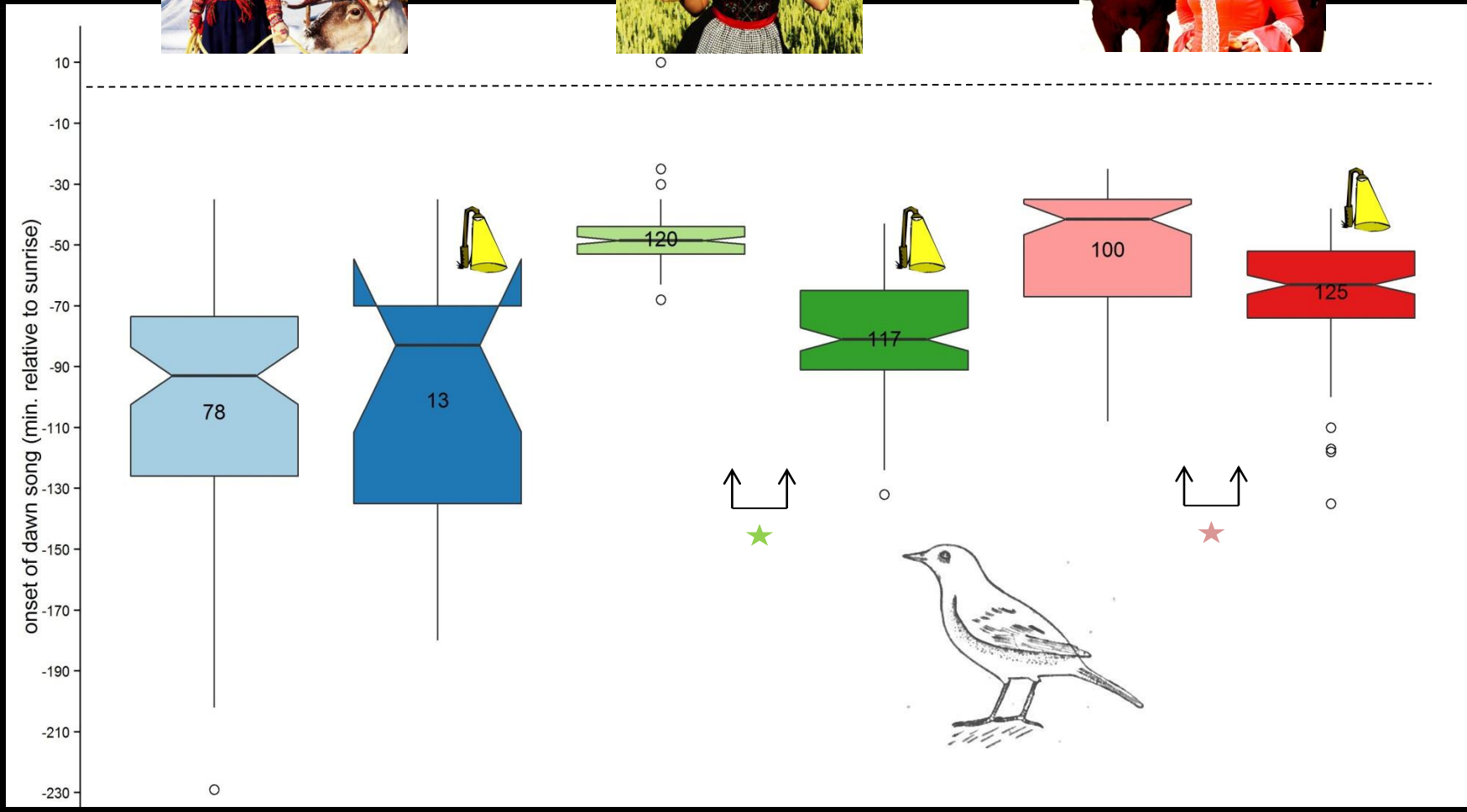
~ Light * Latitude + Latitude * Date + Rain + Temperature (residuals)

	F-value	p-value
Light	11.9	0.003
Latitude	43.9	<.0001
Date	28.3	<.0001
Rain	5.1	0.02
Temperature (residuals)	0.4	0.5
Light * Latitude	**3.0**	**0.08**
Latitude * Date	**20.7**	**<.0001**



Earliest onset of dawn song in the northern latitude

Light effect only in the intermediate and southern latitude

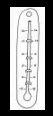


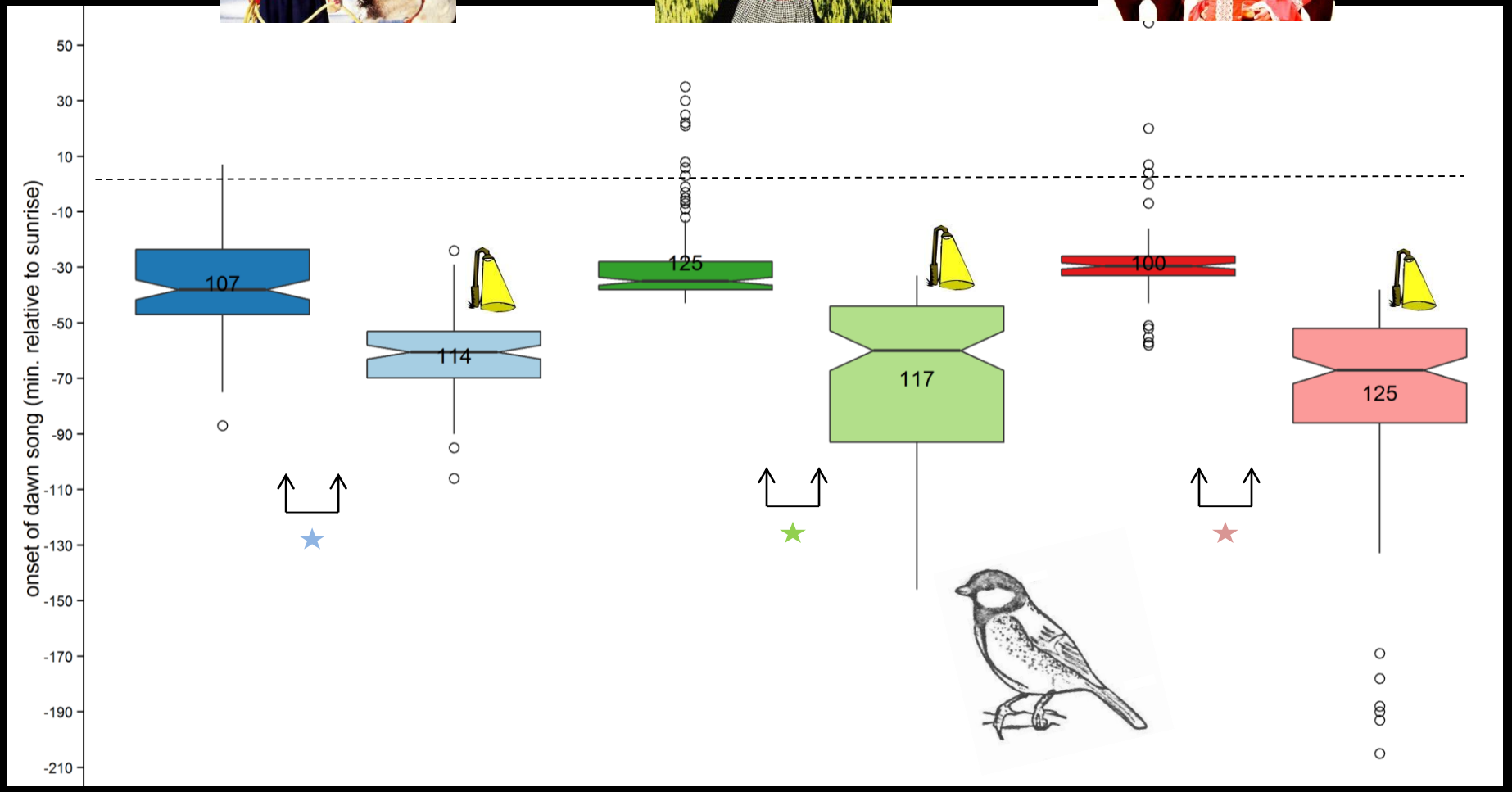
Earliest onset of dawn song in the northern latitude

Light effect only in the intermediate and southern latitude

Onset of singing (min before sunrise)

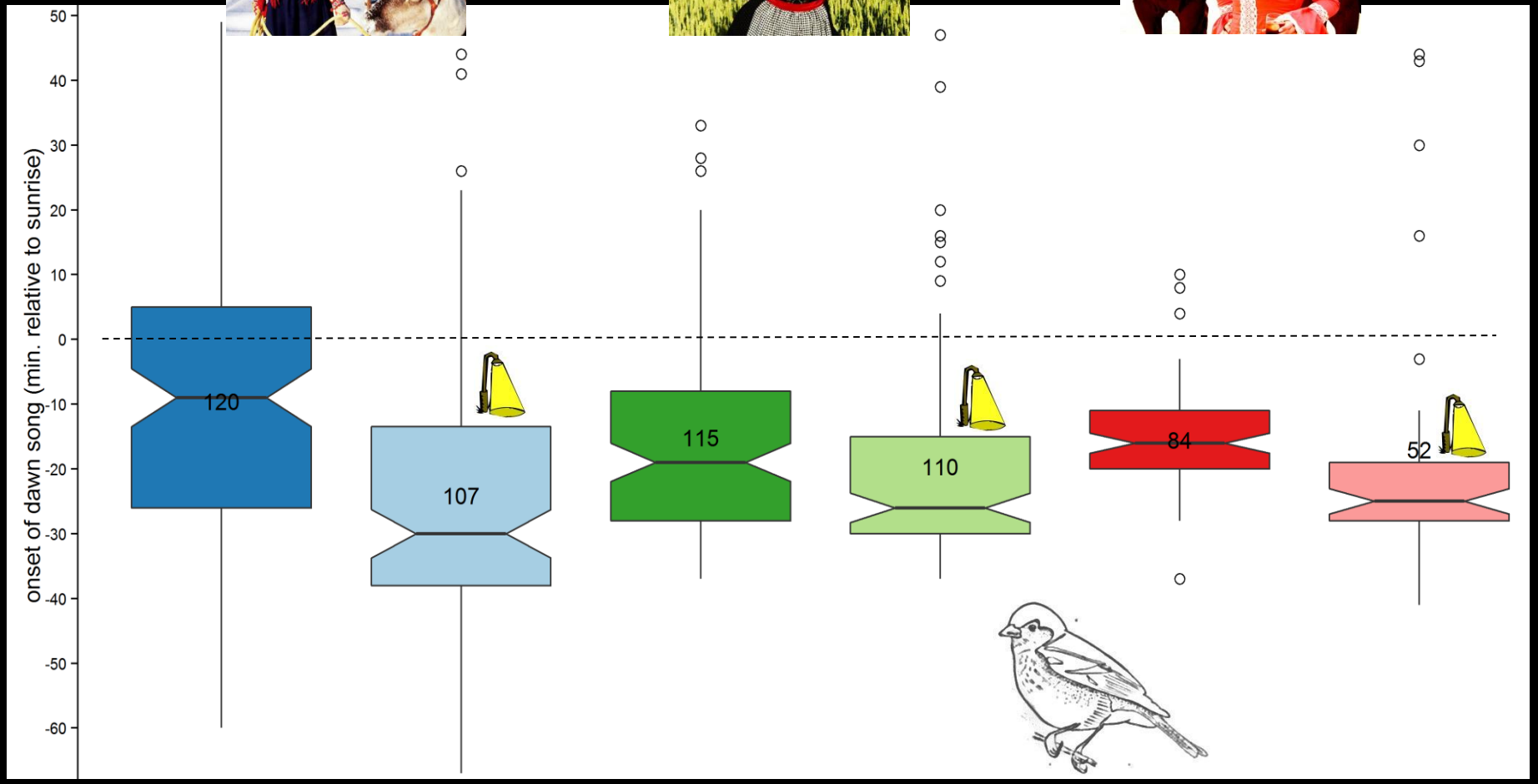
~ Light + Latitude + Date + Rain + Temperature

	F-value	p-value
	**47.0**	**<.0001**
	**0.3**	**0.8**
	0.5	0.5
	1.2	0.3
	0.04	0.8



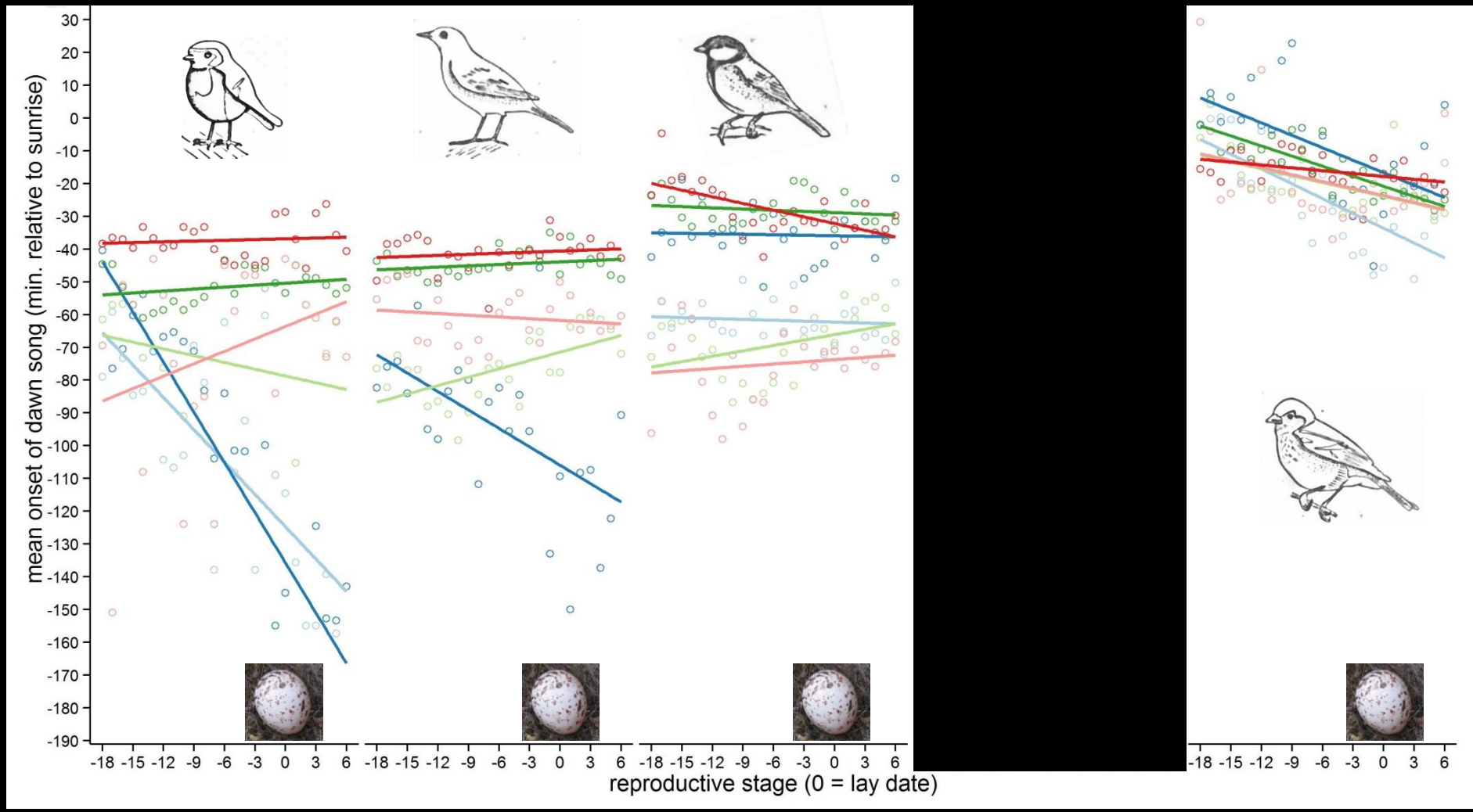
Light effect strong (-36 min) and similar at all latitudes

Onset of dawn song similar at all latitudes



Light effect weak (-6 min) and similar at all latitudes

Onset of dawn song similar at all latitudes



The strength of the effect of ALAN on onset of dawn song

depends on the latitude and on the species

Implications

- Singing at night for robins and blackbirds: a natural situation?

- Fitness consequences of early singing for great tits, especially in Northern latitudes?

What's next?

- Mechanisms underlying the effect of ALAN on daily timing of singing → plastic reaction to light?

- Compensatory behaviours?

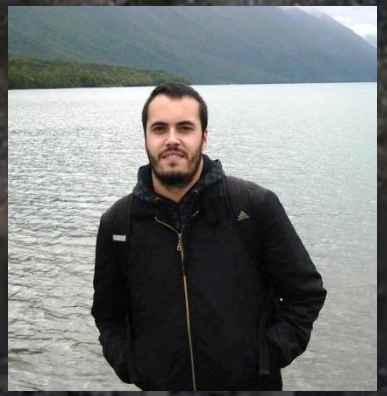
(light avoidance, condition-dependent choice)

International Max Planck Research School for Organismal Biology

Thanks for listening!

Bart Kempenaers

Satu Tolvanen



David Diez

Any questions?