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Oral presentation

Session: Genetics, evolutionary ecology & management

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Federation of Finnish
Learned Societies



Experimental evidence of strong divergences of European whitefish *Coregonus lavaretus* (L.) embryos' response to temperature increase in Fennoscandian and perialpine populations.

Charles BRUN¹, Mikko MAKINEN², Chloé GOULON¹, Jean GUILLARD¹, Martin DAUFRESNE³, Taylor STEWART⁴, Juha KARJALAINEN², Emilien LASNE⁵

Corresponding author: emilien.lasne@inrae.fr



See Tandem Talks

- Talk 1: Background, Methods, *Coregonus artedii* and *C. albula* Results

Influence of Changing Lake Temperatures on Coregonine Embryogenesis at Local to Global Scales.

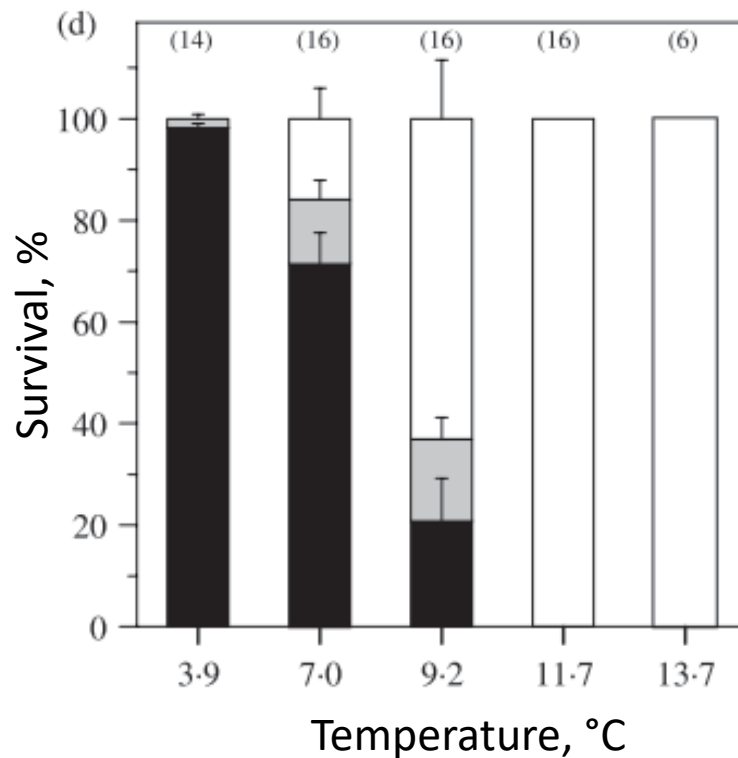
Taylor STEWART, Mikko MAKINEN, Charles BRUN, Chloé GOULON, Jean GUILLARD, Timo MARJOMÄKI, Emilien LASNE, Juha KARJALAINEN, and Jason STOCKWELL

- Talk 2: European experiments and *C. lavaretus* results



Context

- *Coregonus lavaretus* is distributed in a large latitude gradient 45°N to over 70°N
- They are adapted to and require cold-water



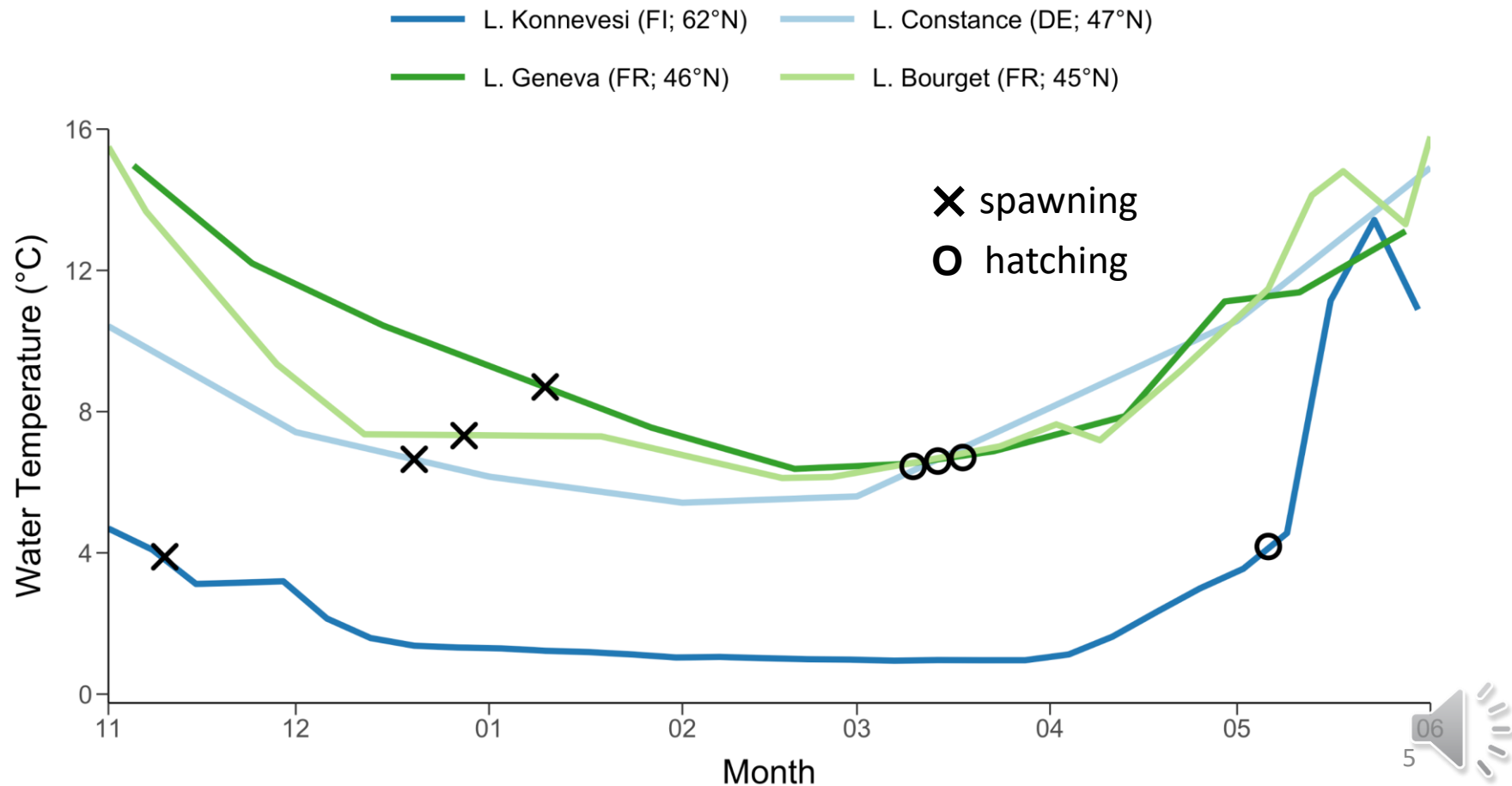
Eyed-stage embryos of anadromous *C. lavaretus* from Gulf of Botnia, FI:

- Normal development
- Abnormal development
- Unfertilized + dead eggs

[Cingi et al. 2010](#)

Context

- Highly contrasted incubation temperatures
- Southern populations close to putative thermal limits for incubation



Context

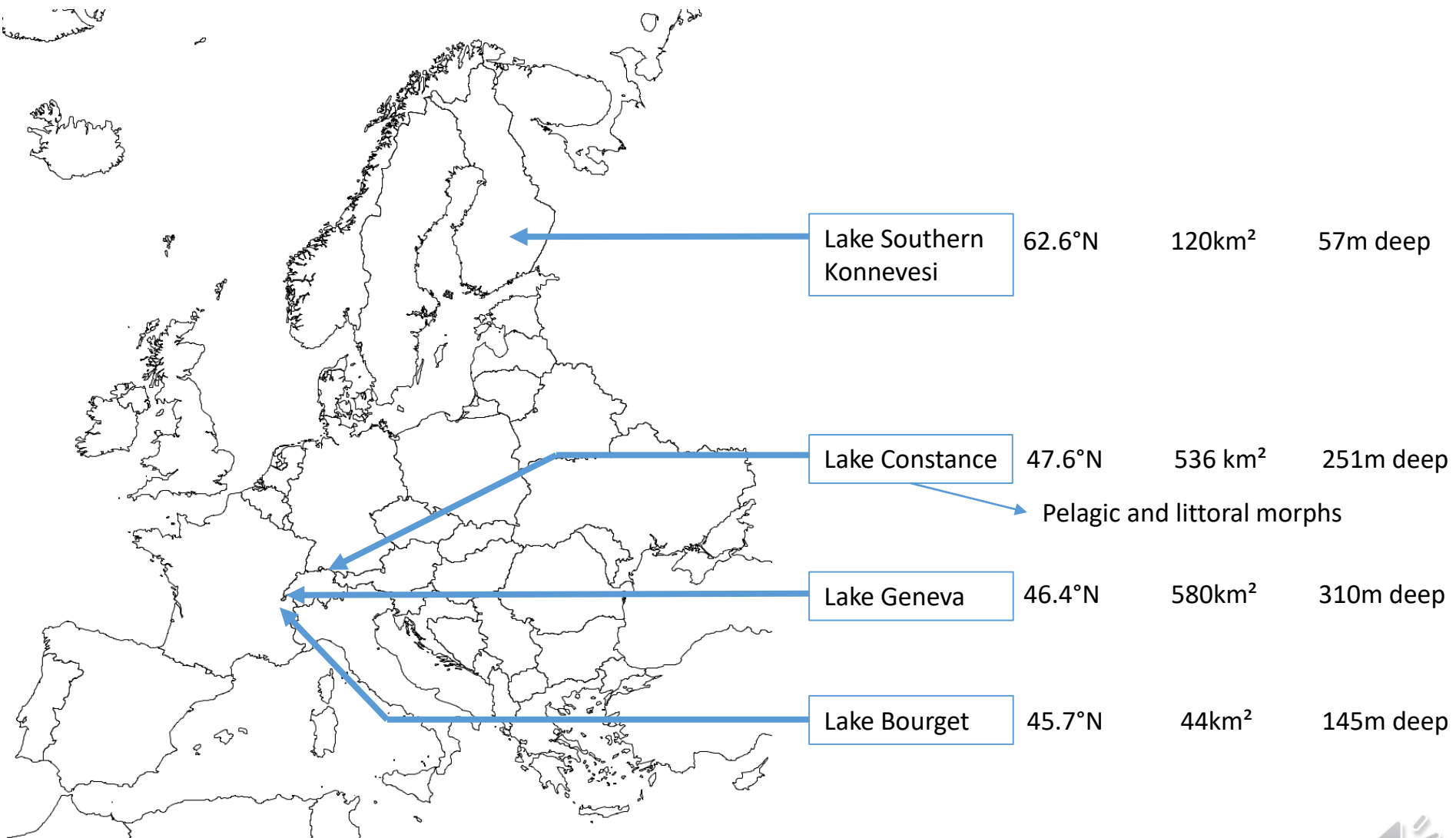
- *C. lavaretus* is known to be highly plastic but little is known about thermal plasticity
- Important to examine how *C. lavaretus* could respond to T° increase in the future
- Do populations from different locations have the same potential for thermal response?

Objectives

- Evaluate how *C. lavaretus* embryos respond to various but realistic thermal conditions
- Populations from different locations, different scaling (high vs low latitude and regional comparisons)
- Focus on basic fitness related traits
 - Survival rates at hatching
 - Incubation duration (hatching timing)
 - Size at hatching (work in progress)



Studied populations



Crossing design

Expected for each population:

		Sire											
		1	2	3	4	5	6	7	8	9	10	11	12
Dams	A												
	B												
	C												
	D												
	E												
	F												
	G												
	H												
	I												

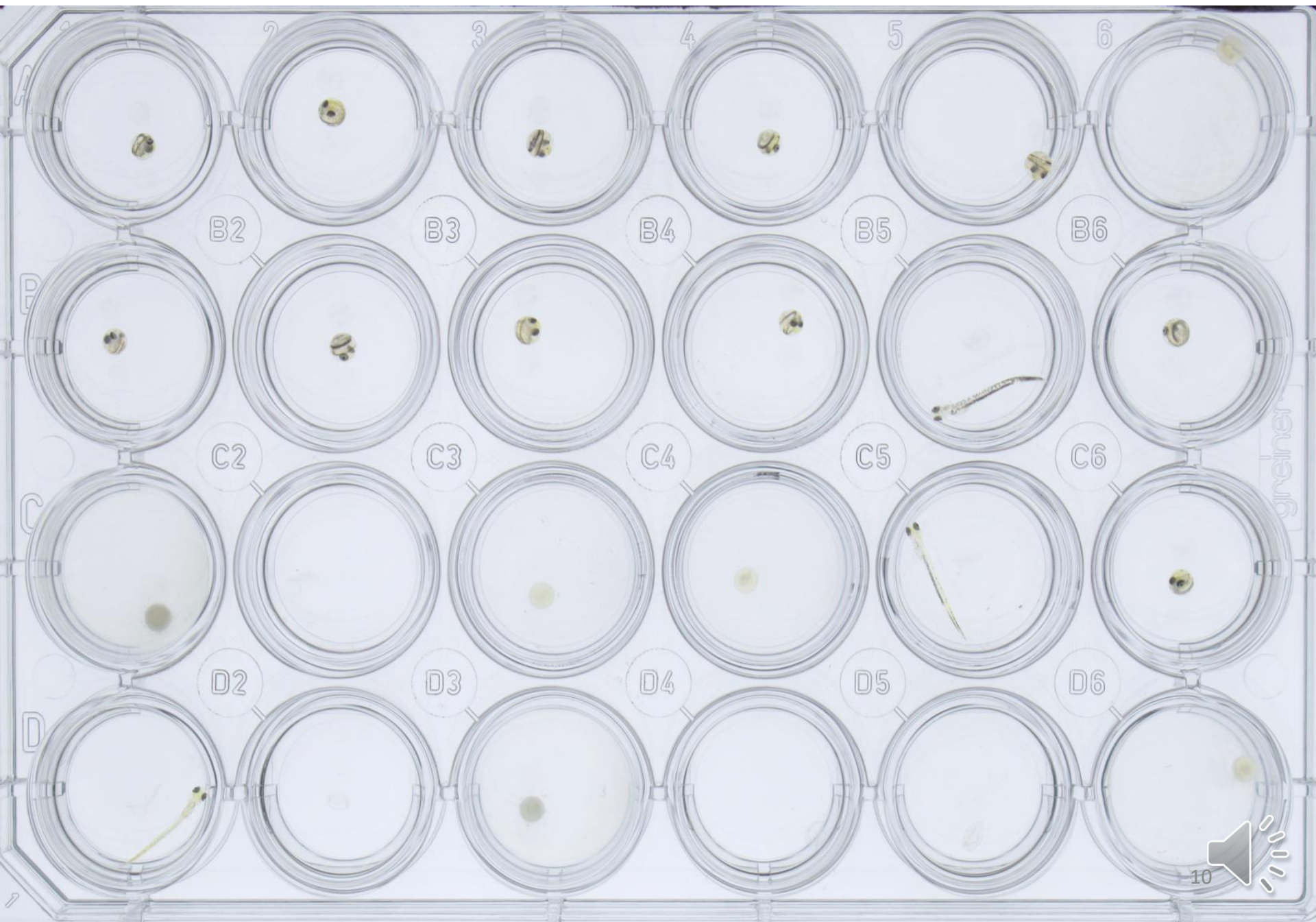
36 replicates (embryos)
per treatment

Realized:

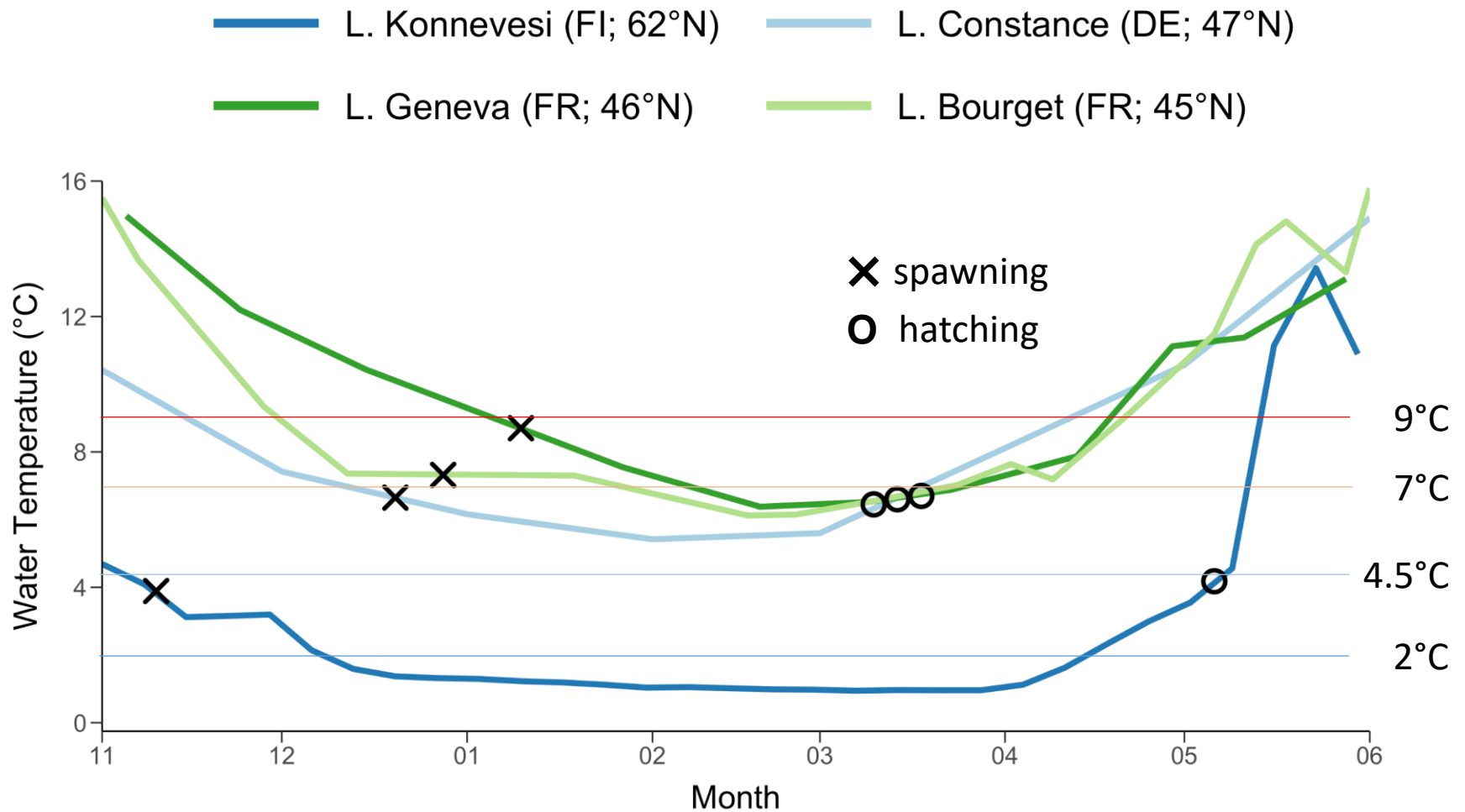
population	Block 1	Block 2	Block 3	Nb families
L Konnevesi	4 sires x 3 dams	3x2	3x2	24
L Constance pelagic	4x3	4x3	4x3	36
L Constance littoral	4x3			12
L Geneva	4x3	4x3	4x3	36
L Bourget	4x3	4x3	4x3	36

36 replicates in most cases, a minimum of 24.

Experimental design



Thermal treatments



France



Finland



Mean temperatures:

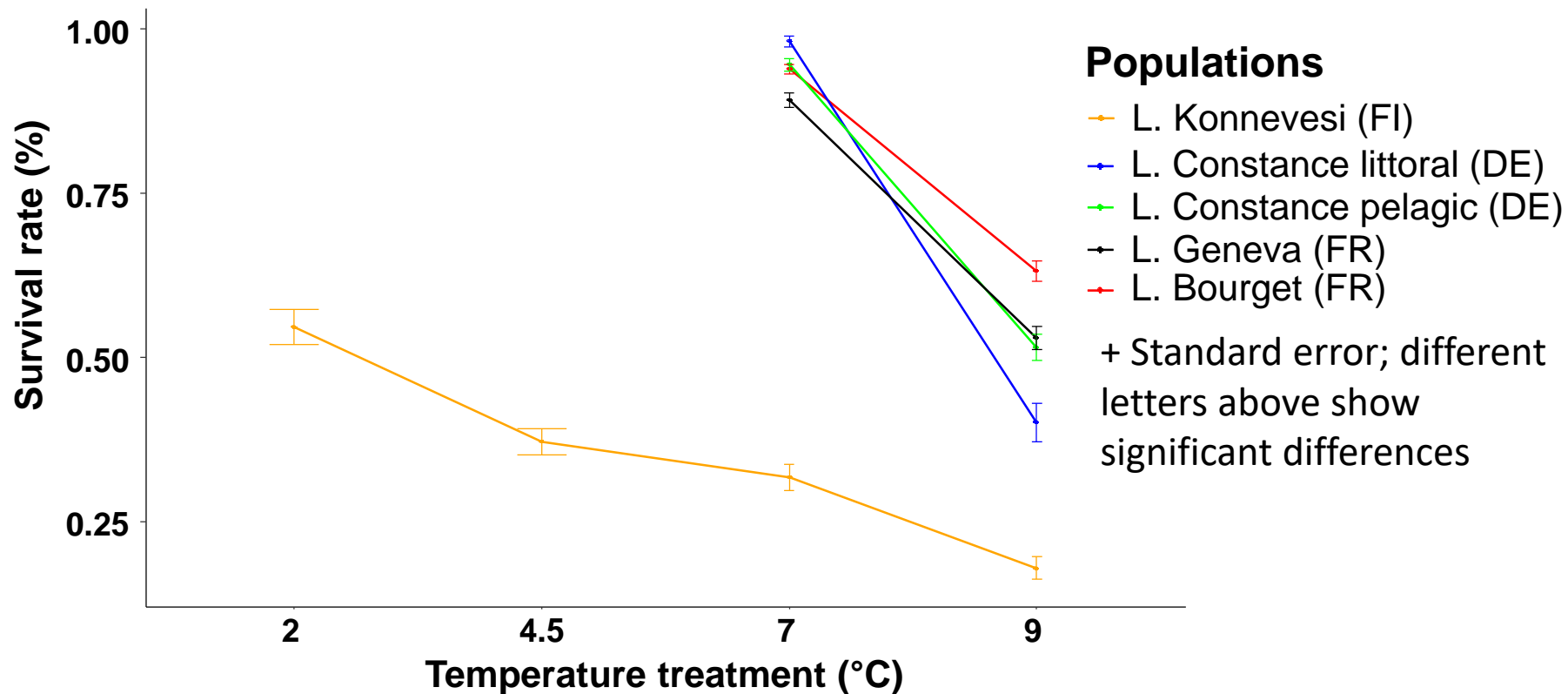
Facilities	2°C	4.5°C	7°C	9°C
France (southern pops)	-	-	7.43°C	9.27°C
Finland	2.2°C	4.0°C	6.9°C	8.0°C

More/complementary details about experimental settings in the twin talk (same session):

Influence of Changing Lake Temperatures on Coregonine Embryogenesis at Local to Global Scales

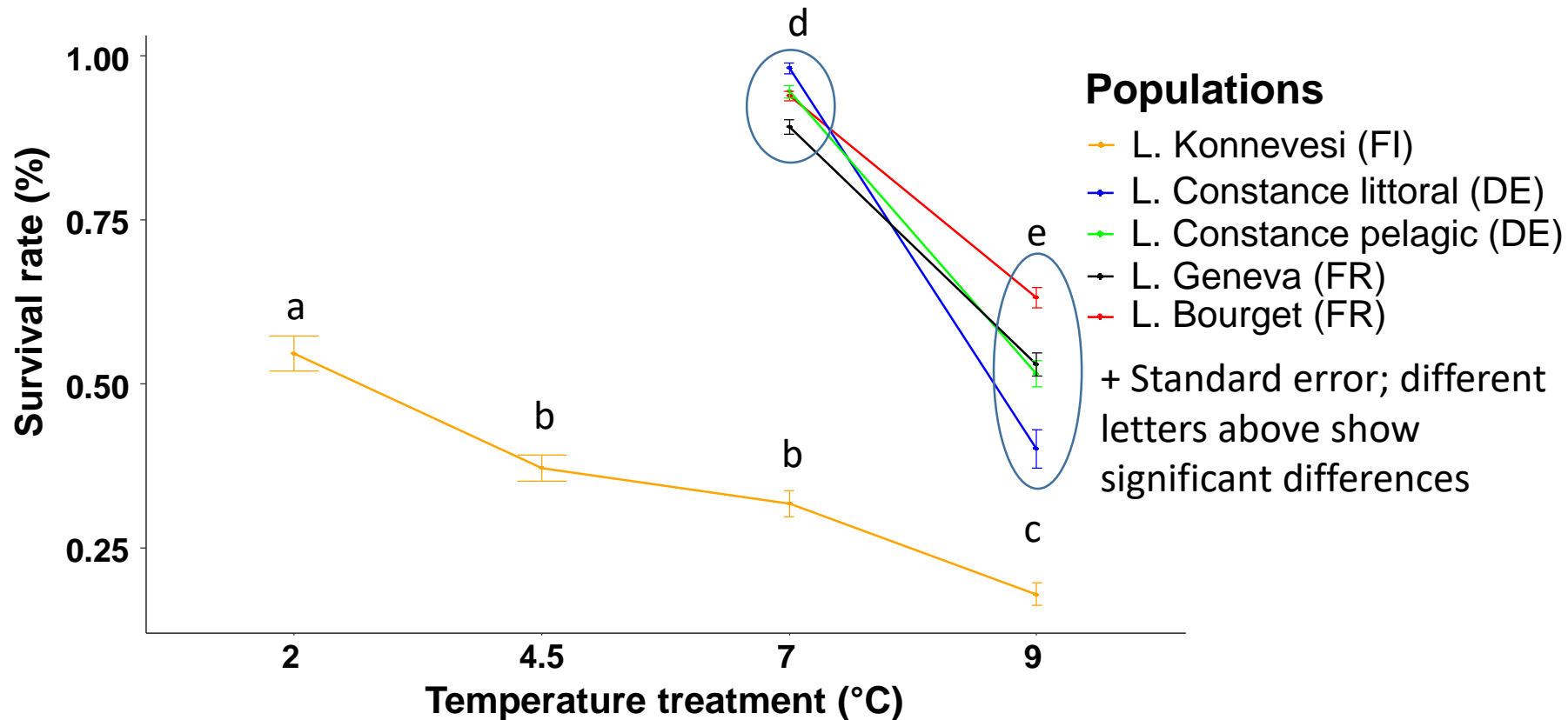
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Survival rates from eyed stage to hatching



Unexplained low survival in L Konnevesi (experimental bias?)
Rather high survival at 7°C for perialpine populations

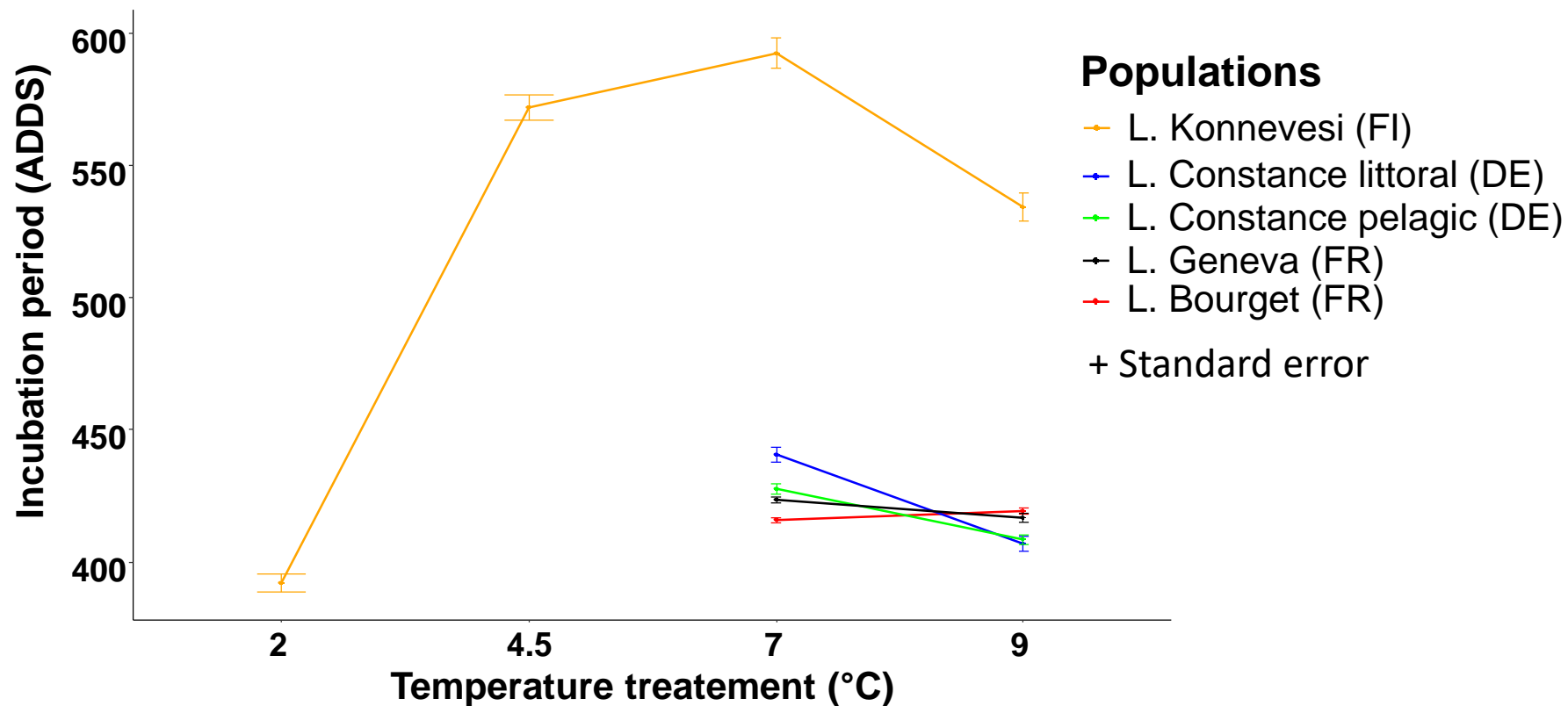
Survival rates from eyed stage to hatching



Strong effect of temperature increase for all pops

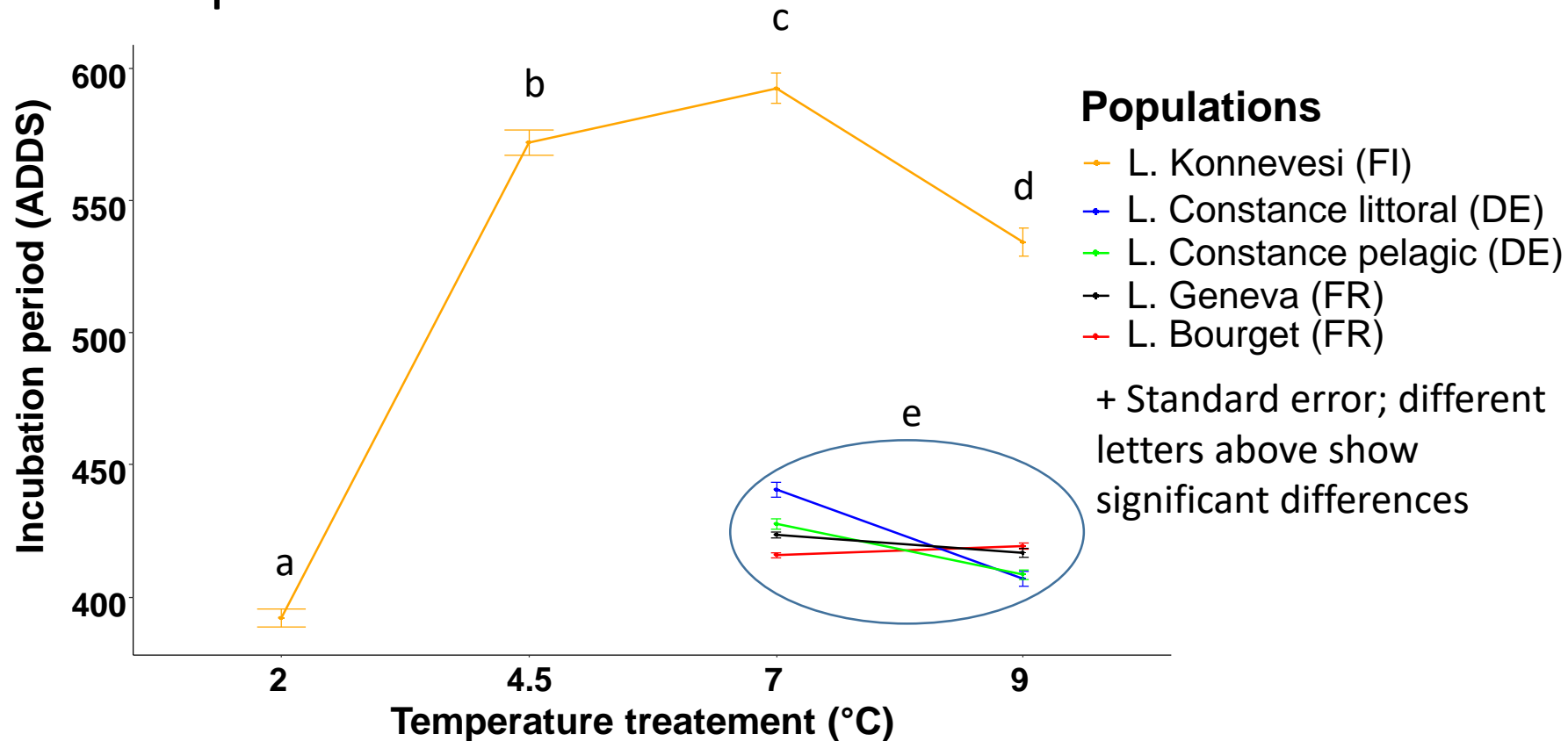
Northern pop more sensitive to the higher temperature?

Incubation period



Strong divergences between latitudes

Incubation period



Strong divergences between latitudes

Strong norm of reaction for temperature in all populations for both survival and incubation period

Temperature increase will likely impact populations
Analysis of heritability as an indicator of adaptive potential (in progress).

Southern populations seems to perform better at the higher temperatures than northern one

Suggest genetic adaptation to warmer temperatures
Would be interesting to evaluate how they would perform at colder T°

Limits, problems, things to be improved

- fertilization issues
- temperature control/facilities (use the same incubators)
- Unable to standardize additional larval work

Limits, problems, things to be improved

- fertilization issues
- temperature control/facilities (use the same incubators)
- What happens after hatching?

... and things that can not be improved

- Ideally, experiments should be carried on at the same place at the same time
- Standardization for some experimental settings are not possible/desirable (e.g. chemical composition of water used)

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Great collective and scientific experience!

Authors' affiliation

Charles BRUN¹, Mikko MAKINEN², Chloé GOULON¹, Jean GUILLARD¹, Martin DAUFRESNE³, Taylor STEWART⁴, Juha KARJALAINEN², Emilien LASNE^{5*}

¹ UMR CARTEL INRAE-Université Savoie Mont Blanc, 75 bis, avenue de Corzent, 74203 Thonon les Bains Cedex, FRANCE

² Department of Biological and Environmental Science, University of Jyväskylä, Jyväskylä, Finland

³ INRAE, UR Recover - Equipe Freshco, 3275 Route de Cézanne, CS 40061 13182 Aix-en-Provence Cedex 5, FRANCE

⁴ University of Vermont, 3 College St, Burlington VT, 05401, USA

⁵ UMR ESE Agrocampus Ouest-INRAE, 65, rte de St Briec, 35042 Rennes cedex, FRANCE



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