



University of Groningen

#### Involvement of clock genes in seasonal, circadian and ultradian rhythms of Nasonia vitripennis

Dalla Benetta, Elena

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

**Document Version** Publisher's PDF, also known as Version of record

Publication date: 2018

Link to publication in University of Groningen/UMCG research database

Citation for published version (APA): Dalla Benetta, E. (2018). Involvement of clock genes in seasonal, circadian and ultradian rhythms of Nasonia vitripennis [Groningen]: University of Groningen

#### Copyright

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

Take-down policy If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): http://www.rug.nl/research/portal. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

# Involvement of clock genes in seasonal, circadian and ultradian rhythms of Nasonia vitripennis

Elena Dalla Benetta



This research has been carried out at the Groningen Institute for Evolutionary Life Sciences (GELIFES) of the University of Groningen (The Netherlands), according to the requirements of the Graduate School of Science (Faculty of Science and Engineering, University of Groningen).

This research was founded by the EU Marie Curie Initial Training Network INsecTIME.

Cover design and layout: Elena Dalla Benetta (Wasp draw by Robert M. Brucker 2016)

Printed by: Gildeprint, Enschede

ISBN (printed): 978-94-034-0539-1 ISBN (digital): 978-94-034-0538-4



## Involvement of clock genes in seasonal, circadian and ultradian rhythms of Nasonia vitripennis

**PhD Thesis** 

to obtain the degree of PhD at the University of Groningen on the authority of the Rector Magnificus Prof. E. Sterken and in accordance with the decision by the College of Deans.

This thesis will be defended in public on

Friday 08 June 2018 at 11:00

by

#### Elena Dalla Benetta

born on 03 July 1987 in Arzignano, Italy

## Supervisor

Prof. L.W. Beukeboom

## **Co-Supervisor**

Dr. L.P.W.G.M. Jacobus Mgn van de Zande

#### Assessment committee

Prof. C. P. Kyriacou Prof. R. Hut Prof. R. Costa

## Contents

Chapter 1	General introduction	7
Chapter 2	Geographical variation in circadian clock properties of <i>Nasonia vitripennis</i>	31
Chapter 3	Circadian clock gene expression in <i>Nasonia vitripennis</i> depends on photoperiod and latitude of origin	53
Box 1	Identification of alternative splicing of period in <i>Nasonia</i> <i>vitripennis</i>	71
Chapter 4	The clock gene <i>period</i> is involved in circadian and seasonal timing in <i>Nasonia vitripennis</i>	79
Chapter 5	Courtship rhythm in <i>Nasonia vitripennis</i> is affected by the clock gene <i>period</i>	105
Box 2	Implementation of genome editing by CRISPR/Cas9 in Nasonia vitripennis	123
Chapter 6	General discussion	141
	Bibliography	153
	Summary	171
	Samenvatting	177
	Riassunto	183
	Personal information	189
	Acknowledgements	193