

PHD PROPOSAL FOR THE DOCTORAL SCHOOL « Ecologie, Géosciences, Agronomie, ALimentation »

GENERAL INFORMATION

Thesis title: Phenotypical and ecophysiological consequences of short- and long-term temporal variations on the thermal ecology of the invasive spotted wing Drosophila.
Acronym: ThermoDroso
Disciplinary field 1: Ecology Disciplinary field 2: Agronomy
Three keywords: biological invasions, seasonal ecology, ecophysiology
Research unit : UMR CNRS 6553 ECOBIO
Name of the thesis director HDR required: Hervé COLINET (CR CNRS - Dr. Ir. HDR) Email address of the thesis director: herve.colinet@univ-rennes1.fr Name of the thesis co-director (if applicable): Patricia GIBERT (DR CNRS - Dr. HDR) Email address of the thesis co-director : Patricia.gibert@univ-lyon1.fr
Thesis grant : ANR DROTHERMAL (2021 - 2024) ; 117000 EUR for 36 month PhD Salary
Contact(s) (mailing address and E-mail): Hervé COLINET: UMR CNRS 6553 ECOBIO, Université de Rennes 1, Campus de Beaulieu, bat. 14A, 35042, RENNES CEDEX ; herve.colinet@univ-rennes1.fr Patricia GIBERT : UMR CNRS 5558 LBBE "Biométrie et Biologie Évolutive", UCB Lyon 1 - Bât. Grégor Mendel, 43 Boulevard du 11 novembre 1918, 69622 VILLEURBANNE; Patricia.gibert@univ-lyon1.fr
Recruitment process: Recruitment process depends on thesis funding. To select the corresponding recruitment process, please visit the EGAAL website here . This information is needed for proposal publication. <input type="checkbox"/> Doctoral school contest <input checked="" type="checkbox"/> Interview <input type="checkbox"/> Other (indicate) :

All sections must be filled. Once filled, please save the proposal form in pdf format using the following naming: Supervisor Name_Unit_Subject Acronym_EN.pdf

ED EGAAL

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SCIENTIFIC DESCRIPTION OF THE PhD PROJECT

Socio-economic and scientific context : (10 lines)

The recent invasion by the Spotted Wing Drosophila (SWD) is a major concern for the fruit sector worldwide. Temperature and thermal biology of this species are recognized as the main factors dictating the distribution, populations' dynamics and seasonal phenology of SWD. However, major knowledge gaps remain regarding its thermal and seasonal ecology, thus compromising the assessment and prediction of field population dynamics from year to year. In particular, there is a critical lack of knowledge about the winter survival strategies of this invasive species, which are essential for anticipating spring population levels and dynamics. Small insects such as fruit flies certainly respond to environmental variations on much finer temporal and spatial scales than those generally considered so far in classical experimental studies and predictive models. The thesis will generate and integrate fine-scale information from both experimental and field observation data to better define SWD's thermal ecology and thus its performance and invasive success in the nature.

Assumptions and questions (8 lines)

Current demographic/phenologic models for Spotted Wing Drosophila (SWD) rely on lab-experiments that used constant temperatures. These models are poor predictors of thermal limits and population dynamics. We assume that rapidly fluctuating temperatures (from hours to hours), such as daily natural thermoperiods, allow both development and survival under conditions that with constant temperatures would normally be lethal. Over longer time scales (from days to weeks), insects are rarely submitted to constant conditions; in contrast they are repeatedly exposed to stress during their life time. Effects of these repeated exposures are unknown. Changes over longer time scales (from season to season) may also trigger some specific adaptations. We assume that the most critical bottleneck periods for SWD persistence is the winter and thus some unknown phenotypic and physiological adaptive strategies must be used during this period.

The main steps of the thesis and scientific procedure (10-12 lines)

- 1) Assessing the effects of ecologically-relevant rapid (hourly) thermal changes by exposing SWD to natural thermal variations in outdoors cages.
- 2) Assessing the effects of relevant parameters of nature-mimicking thermo-periods (from days to days) using lab assays to have full control over key parameters: thermal amplitude, duration/occurrence of extreme (cold/hot) events and their frequency (*i.e.* repeated thermal stress)
- 3) Assessing the effects of adaptive responses of SWD across seasonal times (focusing on winter) by combining both lab-controlled and outdoor cage-assays in experimental gardens

In all three types of assessment, metrology will be constantly monitored and SWD will be characterized by 1) phenotypic markers (e.g. survival, stress tolerance, development, reproduction) and 2) physiological markers using *i*) bio-energetics, *ii*) metabolomics and *iii*) lipidomics

Methodological and technical approaches considered (4-6 lines)

Both field monitoring and lab-controlled approaches. High-resolution metrology. Phenotyping of life history traits and stress related traits. Eco-physiological characterization that will include Omics such as metabolomic profiling (GC- & LC-MS/MS), lipidomics (LC-MS/MS) and bio-energetics (e.g. enzymatic biochemical assays and respirometry).

Scientific and technical skills required by the candidate

Background in ecology/evolution/agronomy. Animal ecophysiology skills (e.g. ecology-related biochemistry or molecular biology), Omics-type data analysis, statistic, English, good writing ability (french & english)

THESIS SUPERVISION¹

Unit name: UMR CNRS ECOBIO 6553	Team name: Ecostress-Ecotox
Unit director name: Joan Van Baaren	Team director name: David Renault
Mailing address of the unit director: joan.van-baaren@univ-rennes1.fr	Mailing address of the team director: david.renault@univ-rennes1.fr
<p>Thesis director</p> <p>Surname, first name: COLINET Hervé</p> <p>Position: CR CNRS</p> <p>Obtained date of the HDR : June 2019</p> <p>Employer: CNRS</p> <p>Doctoral school affiliation: EGAAL</p> <p>Rate of thesis supervision in the present project (%): 50%</p> <p>Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 50%</p> <p>Number of current thesis supervisions/co-supervisions: 1</p>	
<p>Thesis co-director</p> <p>Surname, first name: GIBERT Patricia</p> <p>Position: DR CNRS</p> <p>Obtained date of the HDR : February 2012</p> <p>Employer: CNRS</p> <p>Doctoral school affiliation: E2M2</p> <p>Rate of thesis supervision in the present project (%): 50%</p> <p>Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 0%</p> <p>Number of current thesis supervisions/co-supervisions: 0</p>	

¹ In EGAAL Doctoral School, if only one scientist in thesis supervision = 100% of supervision rate; if 2 people involved in thesis supervision = from 50% to 70% of supervision rate for the director; if 3 people involved in thesis supervision = 40% / 30% / 30% of supervision rate distribution among supervisors.

Private partner (if CIFRE funding, private funding,...)

Surname, first name:

Position:

Employer:

Rate of thesis supervision in the present project (%):

Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%):

Number of current thesis supervisions/co-supervisions:

International partner (if Cotutelle thesis)

Surname, first name:

Position:

Employer:

Rate of thesis supervision in the present project (%):

Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%):

Number of current thesis supervisions/co-supervisions:

Professional status of previous PhD students supervised by both director and co-supervisors (from 5 years)

Please provide the following information for each PhD students supervised

Surname, first name: **Youn HENRY**

Date of PhD beginning and PhD defence: oct 2015 to dec 2018

Thesis supervision: David Renault & Hervé COLINET

Professional status and location: Postdoc (3 years) in Evolutionary Ecology Group, Vorburger Lab, Zürich (Switzerland)

Contract profile (post-doc, fixed-term, permanent): postdoc

List of publications from the thesis work: 5

1-Henry, Y., Piscart, C., Charles, S., Colinet, H. 2017. Combined effect of temperature and ammonia on survival and molecular response of the freshwater crustacean *Gammarus pulex*/ Ecotoxicology and Environmental Safety. 137: 42-48.

2-Henry, Y., Renault, D., Colinet, H. 2018. Hormesis-like effect of mild larval crowding on thermotolerance in *Drosophila* flies. *Journal of Experimental Biology*. doi: 10.1242/jeb.169342

3-Henry, Y. & Colinet, H. 2018. Microbiota disruption leads to reduced cold tolerance in *Drosophila* flies. *Science of Nature*. 105:59.

4-Henry Y., Overgaard, J. Colinet, H. 2020. Dietary nutrient balance shapes phenotypic traits of *Drosophila melanogaster* in interaction with gut microbiota. *Comparative Biochemistry and Physiology, Part A*. 241:110626

5-Henry, Y., Tarapacki, P. Colinet, H. 2020. Larval density affects phenotype and surrounding bacterial community without altering gut microbiota in *Drosophila melanogaster*. *FEMS Microbiology Ecology*. 96: fiae055.

Surname, first name: **Thomas ENRIQUEZ**

Date of PhD beginning and PhD defence: March 2016 to May 2019

Thesis supervision: Maryvonne CHARRIER & Hervé COLINET

Professional status and location: Postdoc at UCL (Louvain Belgium)

Contract profile (post-doc, fixed-term, permanent): postdoc

List of publications from the thesis work: 8

1-**Enriquez**, T & Colinet, H. 2017. Basal tolerance to heat and cold exposure of the spotted wing drosophila, *Drosophila suzukii*. Peer Journal. 5:e3112.

2-Nikolouli K., Colinet, H., Renault, D., **Enriquez**, T., Mouton, L., Gibert, P., Sassu, F., Cáceres, C., Stauffer, C., Cardoso-Pereira, R., Bourtzis, K. 2018. Sterile insect technique and Wolbachia symbiosis as potential tools for the control of the invasive species *Drosophila suzukii*. Journal of Pest Science. 91: 489-503

3-**Enriquez**, T., Ruel, D., Charrier, M., Colinet, H. 2018. Effects of fluctuating thermal regimes on cold survival and life history of the spotted wing *Drosophila* (*Drosophila suzukii*, Matsumura). Insect Science (DOI 10.1111/1744-7917.12649).

4-**Enriquez**, T., Renault, D., Charrier, M., Colinet, H. 2018. Cold acclimation favors metabolic stability in *Drosophila suzukii*. Frontiers in Physiology. 9:1506.

5-**Enriquez**, T. & Colinet, H. 2019. Cold acclimation triggers lipidomic and metabolic adjustments in the spotted wing drosophila *Drosophila suzukii* (Matsumura). American Journal of Physiology-Regulatory, Integrative and Comparative Physiology. 316: R751–R763

6-**Enriquez** T., Colinet H. 2019. Cold acclimation triggers major transcriptional changes in *Drosophila suzukii*. BMC Genomics. 20:413

7-**Enriquez** T., Sassù F., Cáceres C., Colinet H. Hypoxia combined with chilling maintains quality of irradiated *Drosophila* flies: a simulated shipment experiment. Bull Ent Res (*in press*).

8- De Ro, M., **Enriquez**, T., Bonte, J., Ebrahimi, N., Casteels, H., De Clercq, P., Colinet, H. 2021. Effect of starvation on the cold tolerance of adult *Drosophila suzukii* (Diptera: Drosophilidae). Bull Ent Res (*in press*).

Nom, prénom : **Pierre MARIN**

Date de début et de fin de thèse : 2016 to 2020

Direction de thèse : Patricia GIBERT & Cristina VIEIRA

Emploi actuel, lieu : CHU Clermont Ferrand

Contrat (post-doc, CDD, CDI) : CDD

Liste des publications issues de ce travail de thèse : 2

Marin P, Genitoni J, Barloy D, Maury S, Gibert P, Ghalambor C, Vieira C. 2019. Biological Invasion: The Influence of the Hidden Side of the (Epi) Genome. Functional Ecology 34 : 385-400

Marin P, Jacquet A, Picarle J, Fablet M, Merel V, Delignette-Muller M-L, Ferrarini MG, Gibert P, Vieira C. Phenotypic and transcriptomic response to stress differ according to population geography in an invasive species. bioRxiv

Nom, prénom : **Antoine ROMBAUT**

Date de début et de fin de thèse : 2015 to 2019

Direction de thèse : Simon FELLOUS & Patricia GIBERT

Emploi actuel, lieu : IF Tech Protection Biologique Intégrée

Contrat (post-doc, CDD, CDI) : CDI

Liste des publications issues de ce travail de thèse : 2

Rombaut A, Guilhot R, Xuereb A, Benoit L, Chapuis MP, Gibert P, Fellous S. 2017 Invasive *Drosophila suzukii* facilitates *Drosophila melanogaster* infestation and sour rot outbreaks in the vineyards. *Royal Society Open Science* 4 :170117.

Rombaut A, Gallet R, Qitout K, Mukherjy S, Guilhot R, Ghirardini P, Becher PG, Xuereb A, Gibert P, Fellous S. Microbiota – mediated competition between pest insects and its application to the evolution-proof protection of crops. *bioRxiv*

Nom, prénom : **Julien CATTEL**

Date de début et de fin de thèse : 2013 to 2016

Direction de thèse : Laurence MOUTON & Patricia GIBERT

Emploi actuel, lieu : start-up SymbioTIC

Contrat (post-doc, CDD, CDI) : CDI

Liste des publications issues de ce travail de thèse : 4

Cattel J, Kaur R, Gibert P, Martinez J, Fraimout A, Jiggins FM, Andrieux T, Siozios S, Anfora G, Miller WJ, Rota-Stabelli O, Mouton L. 2016. *Wolbachia* in European populations of the invasive pest *Drosophila suzukii*: regional variation in infection frequencies. *PLoS ONE* 11: e0147766

Fraimout A, Debat V, Fellous S, Hufbauer R, Foucaud J, Pudlo P, Marin J-M, Price DK, **Cattel J**, Chen X, et al.: Deciphering the routes of invasion of *Drosophila suzukii* by means of ABC random forest. *Mol Biol Evol* 2017, 10.1093/mo:1–32.

Cattel J, Martinez J, Jiggins FM, Mouton L, Gibert P. 2016 *Wolbachia*-mediated protection against viruses in the invasive pest *Drosophila suzukii*. *Insect molecular Biology* 25 : 595-603.

Cattel J, Nikolouli K, Andrieux T, Martinez J, Jiggins, Charlat S, Vavre F, Lejon D, Gibert P, Mouton L. 2018 Back and forth *Wolbachia* transfers reveal efficient strains to control *Drosophila suzukii* populations. *Journal of Applied Ecology* 55 : 2408-2418.

Nom, prénom : **Christophe PLANTAMP**

Date de début et de fin de thèse : 2012 to 2015

Direction de thèse : Patricia GIBERT & Emmanuel DESOUHANT

Emploi actuel, lieu : ANSES Lyon

Contrat (post-doc, CDD, CDI) : CDI

Liste des publications issues de ce travail de thèse : 5

Asplen MK, Anfora G, Biondi A, Choi D-S, Chu D, Daane KM, Gibert P, Gutierrez AP, Hoelmer KA, Hutchison WD, Isaacs R, Jiang Z-L, Kárpáti Z, Kimura MT, Pascual M, Philips CR, **Plantamp C**, Ponti L, Vétek G, Vogt H,

Walton VM, Yu Y, Zappalà L & N Desneux. 2015. Invasion biology of Spotted Wing *Drosophila* (*Drosophila suzukii*) : a global perspective and future priorities. *Journal of Pest Sciences* 88 : 469-494.

Gibert P, Hill M, Pascual M, **Plantamp C**, Terblanche JS, Yassin A, Sgrò CM. 2016 *Drosophila* as models to understand the adaptive process during invasion. *Biological Invasions*. 18:1089-1103.

Plantamp C, Salort K, Gibert P, Dumet A, Mialdea G, Mondy N, Voituron Y. 2016 All or nothing : survival, fecundity and oxidative balance of the Spotted Wing *Drosophila* (*Drosophila suzukii*) in response to cold. *Journal of Insect Physiology* 89 :28-36.

Plantamp C, Estragnat V, Fellous S, Desouhant E, Gibert P. 2017 Where and what to feed ? Differential effects on fecundity and longevity in the invasive *Drosophila suzukii*. *Basic and Applied Ecology* 19 :56-66.

Plantamp C, Henri H, Andrieux T, Regis C, Mialdea G, Dray S, Gibert P, Desouhant, E. 2019. Phenotypic plasticity in the invasive pest *Drosophila suzukii*: activity rhythms and gene expression in response to temperature. *Journal of Experimental Biology*, 222 (14) jeb 199398.

Five main recent publications of the supervisors on thesis subject:

- 1- **Colinet, H.**, Sinclair, B.J., Vernon, P., Renault, D. 2015. Insects in Fluctuating Thermal Environments. *Annual Review of Entomology* 60: 123-140.
- 2- **Colinet, H.**, Renault, D., Javal, M., Berková, P., Šimek, P., Košťál, V. 2016. Uncovering the benefits of fluctuating thermal regimes on cold tolerance of *Drosophila* flies by combined metabolomic and lipidomic approach. *BBA - Molecular and Cell Biology of Lipids*. 1861: 1736-1745.
- 3- Enriquez T., **Colinet, H.** 2019. Cold acclimation triggers lipidomic and metabolic adjustments in the spotted wing *Drosophila suzukii* (Matsumara). *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*. 316: R751–R763.
- 4- Enriquez T., **Colinet, H.** 2019. Cold acclimation triggers major transcriptional changes in *Drosophila suzukii*. *BMC Genomics*. 20:413.
- 5- Enriquez, T., Ruel, D., Charrier, M., **Colinet, H.** 2020. Effects of fluctuating thermal regimes on cold survival and life history traits of the spotted wing *Drosophila* (*Drosophila suzukii*, Matsumara). *Insect Science*. 27, 317–335.

5 publis P GIBERT sur SUZUKII; il y a le choix

- 1- Poyet M, Le Roux V, **Gibert P**, Meirland A, Prévost G, Eslin P & O Chabrierie. 2015. The wide potential trophic niche of the asiatic fruit fly *Drosophila suzukii*: the key of its invasion success in temperate Europe ? *PLoS ONE* 10 : e0142785.
- 2- Poyet M, Eslin P, Chabrierie O, Desouhant E, **Gibert P**. 2017 The invasive pest *Drosophila suzukii* uses trans-generational medication to resist parasitoid attack. *Scientific Report*. 7 : 43696
- 3- Nikolouli K, **Colinet H**, Renault D, Enriquez T, Mouton L, **Gibert P**, Sassu F, Caceres C, Stauffer C, Cardoso-Pereira ,R, Bourtzis K. 2018 Sterile insect technique and *Wolbachia* symbiosis as potential tools for the control of the invasive species *Drosophila suzukii*. *Journal of Pest Science* 91: 489-503.
- 4- Gibert P, Debat V, Ghalambor C. 2019. Phenotypic plasticity, global change, and the speed of adaptive evolution. *Current Opinion in Insect Science*, 35: 34-40. (2 citations) **F1000Prime**
- 5- Marin P, Genitoni J, Barloy D, Maury S, Gibert P, Ghalambor C, Vieira C. 2019. Biological Invasion: The Influence of the Hidden Side of the (Epi) Genome. *Functional Ecology* 34 : 385-400

THESIS FUNDING

Origin(s) of the thesis funding: ANR Drothermal 2021 - 2024
Gross monthly salary: 3251 EUR
Thesis funding state : Acquired
Funding beginning date/Funding ending date: 01/09/2021 to 31/08/2024

Date: 17/02/2021

Name, signature of unit director:

Joan VAN BAAREN
Directrice de l'UMR Ecoblo



Name, signature of team director:

David RENAULT



Name, signature of thesis project directors:

Hervé COLINET



Patricia GIBERT

