DOCTORAT ECOLOGIE
BRETAGNE GEOSCIENCES
LOIRE AGRONOMIE ALIMENTATION

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

GENERAL INFORMATION

Thesis title: The role of greenhouses on the diversification and evolution of chrysidoid wasps
Acronym: CHRYSIS
Disciplinary field 1: Geosciences
Three keywords: phylogeny, insect diversification, divergence dating
Research unit : UMR 6118 Géosciences Rennes
Name of the thesis director HDR (Habilitation thesis to supervise research) required: Perrichot, Vincent **Email address of the thesis director:** vincent.perrichot@univ-rennes1.fr **Name of the thesis co-director (if applicable): HDR (Habilitation thesis to supervise research) required:** Legendre, Frédéric **Email address of the thesis co-director (if applicable):** frederic.legendre@mnhn.fr **Name of the thesis co-supervisor 1 (if applicable):** Wang, Bo **Email address of the thesis co-supervisor 1 (if applicable):** bowang@nigpas.ac.cn
Thesis grant (funding origin and amount): for functioning, Chinese Academy of Sciences (CAS) projects "Mid-Cretaceous terrestrial ecosystems" (2018-2023, $500.000) and "Amber paleobiology" (2021-2023, $200.000), PI: Bo Wang, NIGP, China – granted; project(s) CNRS-INSU (Interrvie) – to be applied.
Contact(s) (mailing address and E-mail): vincent.perrichot@univ-rennes1.fr – Géosciences, Université Rennes 1 – Campus de Beaulieu bat. 15 – 263 avenue du Général Leclerc – 35042 Rennes cedex
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. ☒ **Doctoral school contest** ☐ **Interview** ☐ **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

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SCIENTIFIC DESCRIPTION OF THE PhD PROJECT

Socio-economic and scientific context : (10 lines)

The impact of a new, current greenhouse on the evolution of terrestrial biota is questioned. Four major climatic optimums have occurred since the Cretaceous (CTM, PETM, ETM2, MMCO), and the study of their impact on a model organism may help answering some questions. Insects typically correspond to such model organisms, due to their great antiquity, their presence in nearly all terrestrial ecosystems, and their megadiversity. The present project will focus on Chrysidoidea, a group of parasitic wasps currently with a broad distribution and family-level specificities. It is thus an excellent model to test the impacts of a brief but major biodiversity crisis vs. long-term climatic changes on the insect evolution.

Assumptions and questions (8 lines)

The evolutionary history of Chrysidoidea remains poorly known, particularly the timing of diversification and the underlying factors. This project aims at testing the role of four major greenhouses vs. the K-Pg crisis on the diversification dynamics of these insects. The integration of the chrysidoid fossil record should be crucial, as it may help improving phylogenetic reconstructions, divergence-dating, and patterns of biogeographical distribution. The project will try to answer the following questions:

- is there any synchronicity between episodes of diversification and greenhouses ?

- are such non-biotic factors sufficient to explain the diversification? Or should biotic factors (competition, host/ prey availability) be more important?

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

- Step 1. Selection of fossils for descriptions and characters for coding; compilation of available morphological and molecular data for preliminary analysis
- Step 2. Elaboration of a 'supermatrix' (combining new morphological and molecular characters) and data analysis in *Total Evidence Dating* (TED); description of fossil taxa
- Step 3. Analysis of diversification and synchronicity with paleo-events (crisis, greenhouse); writing of an article presenting the chrysidoid's divergence dating estimates
- Step 4. Analysis of the patterns of biogeographical distribution and patterns
- Step 5. Synthesis of results, writing of articles and thesis manuscript.

Methodological and technical approaches considered (4-6 lines)

- Systematic descriptions of fossils (using optical microscopes or microtomography)
- Bayesian analyses for phylogenetic reconstructions, divergence dating estimates, and geographic distribution: morphological matrix, fossil calibrations in *Total Evidence Dating* (TED), distribution matrix.

Scientific and technical skills required by the candidate

- insect systematics (M.Sc. in paleontology, systematics, or evolutionary biology)
- phylogenetic analyses (paup, TNT, CladeAge, FDB, …), biogeography (Lagrange), 3D imaging (Avizo, …)
- scientific English (written and spoken)

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THESIS SUPERVISION[1]

Unit name: Geosciences Rennes	**Team name:** BIPE
Unit director name: Dauteuil, Olivier	**Team director name:** Vullo, Romain
Mailing address of the unit director: olivier.dauteuil@univ-rennes1.fr	**Mailing address of the team director:** romain.vullo@univ-rennes1.fr

Thesis director

Surname, first name: Perrichot, Vincent

Position: Assistant professor

Obtained date of the HDR (Habilitation thesis to supervise research): 05/2015

Employer: Université Rennes 1

Doctoral school affiliation: EGAAL

Rate of thesis supervision in the present project (%): 40

Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%):100

Number of current thesis supervisions/co-supervisions: 1

Thesis co-director

Surname, first name: Legendre, Frédéric

Position: Assistant professor

Obtained date of the HDR (Habilitation thesis to supervise research): 03/2018

Employer: Muséum national d'Histoire Naturelle

Doctoral school affiliation: ED 227 MNHN-SU « Sciences de la nature et de l'homme : évolution et écologie »

Rate of thesis supervision in the present project (%): 30

Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 130

Number of current thesis supervisions/co-supervisions: 3

Thesis co-supervisor 1

Surname, first name: Wang, Bo

Position: professor

Habilitation thesis to supervise research ☐ yes ☒ no If yes, date diploma received:

[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.**

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Employer: Nanjing Institute of Geology and Palaeontology, China

Doctoral school affiliation: Not applicable

Rate of thesis supervision in the present project (%): 30

Total rate of thesis supervision in ongoing theses (supervisions and co-supervisions) (%): 150

Number of current thesis supervisions/co-supervisions: 3

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: Chény, Cédric

Date of PhD beginning and PhD defence: 01/10/2017 – 17/12/2020

Thesis supervision: Perrichot, Vincent & Wang, Bo

Professional status and location: unemployed

List of publications from the thesis work:

1. **Chény C**, Wang B & Perrichot V. 2019. A new genus of myrmicine ant (Hymenoptera: Formicidae) from Eocene Baltic amber. *Comptes Rendus Palevol* 18: 589-597.
2. Wang *et al*. (incl. C. Chény as 8/30 co-authors). 2021. The mid-Miocene Zhangpu biota reveals an outstandingly rich rainforest biome in East Asia. *Science Advances*: in press.
3. **Chény C**, Wang B & Perrichot V. A new species and first fossil record of the ant genus *Proatta* (Hymenoptera: Formicidae) from Miocene Zhangpu amber of China. *Palaeoworld*: in press.
4. **Chény C**, Wang B & Perrichot V. The myrmicine ant genus *Trichomyrmex* (Hymenoptera: Formicidae) in Miocene Ethiopian amber. *Palaeoentomology*: in press.
5. **Chény C**, Wang B & Perrichot V. First fossil occurrence of the myrmicine ant *Lordomyrma* (Hymenoptera: Formicidae) in the Miocene Chinese amber of Zhangpu: phylogenetic and biogeographic implications. *Zoological Journal of the Linnean Society*: in review.

Surname, first name: Troudet, Julien

Date of PhD beginning and PhD defence: 10/2014 – 09/2017

Thesis supervision: Vignes-Lebbe, Régine & Legendre, Frédéric

Professional status and location: software developer, non-academic permanent position, in Rennes

List of publications from the thesis work:

1. **Troudet J**, Grandcolas P, Blin A, Vignes-Lebbe R & Legendre F. 2017. Taxonomic bias in biodiversity data and societal preferences. *Scientific Reports*, 7: 9132.
2. **Troudet J**, Vignes-Lebbe R, Grandcolas P & Legendre F. 2018. The increasing disconnection of primary biodiversity data from specimens: How does it happen and how to handle it. *Systematic Biology*, 67: 1110-1119.

Surname, first name: Zhang, Qingqing

Date of PhD beginning and PhD defence: 01/2015 – 06/2019

Thesis supervision: Wang, Bo

Professional status and location: researcher, post-doc, University of Bonn, Germany

List of publications from the thesis work:

1. **Zhang QQ**, Nel A, Azar D, Wang B. 2016. New Chinese psocids from Eocene Fushun amber (Insecta: Psocodea). *Alcheringa*, 40: 366-372.
2. **Zhang QQ**, Zhang JF, Wang B. 2016. A remarkable brachyceran fly (Diptera: Tabanomorpha) from Late Cretaceous Burmese amber. *Cretaceous Research*, 67: 1-7.
3. **Zhang QQ**, Zhang JF, Feng YT, Zhang HC, Wang B. 2016. An endoparasitoid Cretaceous fly and the evolution of parasitoidism. *The Science of Nature*, 103: 1-7.
4. **Zhang QQ**, Wang B. 2017. Evolution of lower brachyceran flies (Diptera) and their adaptive radiation with angiosperms. *Frontiers in Plant Science*, 8: 1-6.
5. **Zhang** QQ, Zhang JF, Wang B. 2017. First record of the subfamily Archinemestriinae in the family Nemestrinidae (Diptera: Brachycera) from Upper Cretaceous Burmese amber. *Cretaceous Research*, 75: 141-145.
6. **Zhang QQ**, Zhang JF, Wang B. 2017. First record of the subfamily Archinemestriinae in the family Nemestrinidae (Diptera: Brachycera) from Upper Cretaceous Burmese amber. *Cretaceous Research*, 75: 141-145.
7. **Zhang QQ**, Li XK, Xu BQ, Zhu YM, Lu RQ, Wang B, Yeates DK. 2018. Two new genera of Apsilocephalidae from mid-Cretaceous Burmese amber. *Cretaceous Research*, 84: 525–532.
8. **Zhang QQ**, Mey W, Ansorge J, Starkey TA, McDonald LT, McNamara ME, Jarzembowski EA, Wichard W, Kelly R, Ren XY, Chen J, Zhang HC, Wang B. 2018. Fossil scales illuminate the early evolution of lepidopterans and structural colors. *Science Advances*, 4: e1700988.
9. Liu Q, Lu XM, **Zhang QQ**, Chen J, Zheng XT, Zhang WW, Liu XY, Wang B. 2018. High niche diversity in Mesozoic pollinating lacewings. *Nature Communications*, 9: 3793.
10. **Zhang QQ**, Chen KY, Wang YT, Xue RX, Jarzembowski E. A. Wang B. 2019. Long-proboscid zhangsolvid flies in mid-Cretaceous Burmese amber (Diptera: Stratiomyomorpha). *Cretaceous Research*, 98: 18-25.

Five main recent publications of the supervisors on thesis subject:

- Barden P, **Perrichot V** & **Wang B**. 2020. Specialized predation drives aberrant morphological integration and diversity in the earliest ants. *Current Biology*, 30: 3818-3824.
- Chintauan-Marquier IC, **Legendre F**, Hugel S, Robillard T, Grandcolas P, Nel A, Zuccon D & Desutter-Grandcolas L. 2016. Laying the foundations of evolutionary and systematic studies in crickets (Insecta, Orthoptera) : A multilocus phylogenetic analysis. *Cladistics*, *32*, 54-81.
- Cockx PFD, McKellar RC & **Perrichot V**. 2016. First records of the subfamilies Bethylinae (Hymenoptera: Bethylidae) and Cleptinae (Hymenoptera: Chrysididae) in Upper Cretaceous amber from France. *Cretaceous Research*, 68: 1-8.
- Condamine FL, Nel A, Grandcolas P & **Legendre F**. 2020. Fossil and phylogenetic analyses reveal recurrent periods of diversification and extinction in dictyopteran insects. *Cladistics*, *36*: 394-412.
- Jouault C, Maréchal A, Condamine FL, **Wang B**, Nel A, **Legendre F** & **Perrichot V**. 2021. Including fossils in phylogeny: a glimpse onto the evolution of the superfamily Evanioidea 9Hymenoptera, Apocrita) under tip-dating and the fossilized birth-death process. *Zoological Journal of the Linnean Society*: in press.
- Jouault C, **Perrichot V** & Nel A. 2021. New flat wasps from mid-Cretaceous Burmese amber deposits highlight the bethylid antiquity and paleobiogeography (Hymenoptera: Chrysidoidea). *Cretaceous Research*, 123: 104772.
- **Legendre F** & Condamine FL. 2018. When Darwin's special difficulty promotes diversification in insects. *Systematic Biology*, 67: 873-887.
- Nattier R, Pellens R, Robillard T, Jourdan H, **Legendre F**, Caesar M, Nel A, & Grandcolas P. 2017. Updating the phylogenetic dating of New Caledonian biodiversity with a meta-analysis of the available evidence. *Scientific Reports*, 7: 3705.
- Perkovsky EE, Martynova KT, Mita T, Olmi M, Zheng Q, Müller P, Zhang Q, Gantier F & **Perrichot V**. 2020. A golden age for ectoparasitoids of Embiodea: Cretaceous Sclerogibbidae (Hymenoptera, Chrysidoidea) from Kachin (Myanmar), Charentes (France) and Choshi (Japan) ambers. *Gondwana Research*, 87: 1-22.
- **Perrichot V**, **Wang B** & Barden P. 2020. New remarkable hell ants (Formicidae: Haidomyrmecinae stat. nov.) from mid-Cretaceous amber of northern Myanmar. *Cretaceous Research*, 109: 104381.
- **Perrichot V**, **Wang B** & Engel MS. 2016. Extreme morphogenesis and ecological specialization among Cretaceous basal ants. *Current Biology*, 26: 1468-1472.
- Seyfullah LJ, Beimforde C, Dal Corso J, **Perrichot V**, Rikkinen J & Schmidt AR. 2018. Production and preservation of resins – past and present. *Biological Reviews*, 93: 1684-1714.
- **Wang B** & 29 co-authors (incl. **Perrichot V**). 2021. The mid-Miocene Zhangpu biota reveals an outstandingly rich rainforest biome in East Asia. *Science Advances*: in press.

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THESIS FUNDING

Origin(s) of the thesis funding: University Rennes 1, doctoral contract
Gross monthly salary: 1770 €
Thesis funding state : Non acquired
Funding beginning date/Funding ending date: 01/10/2021 – 3 years

Date: 22/03/2021

Name, signature of unit director: Olivier Dauteuil

Name, signature of team director: Romain Vullo

Name, signature of thesis project director: Vincent Perrichot