



Colloque d'EcoPhysiologie Animale

CEPA

3^{ème} édition

Strasbourg - 6 au 8 novembre 2017



Amphithéâtre Grünewald – Bâtiment 25

Campus de Cronembourg

23 rue du Loess

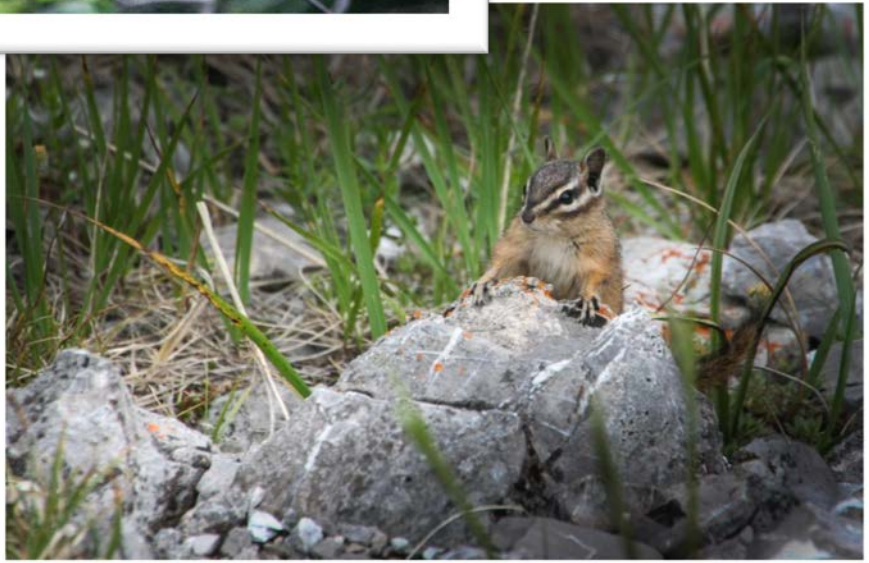
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Présentation

Evaluer et prédire les effets de l'environnement et des activités humaines sur les populations animales nécessitent une meilleure compréhension des mécanismes physiologiques développés par les individus pour faire face à la variabilité de leur milieu. L'écophysiologie est une discipline dont l'objectif principal est l'étude de ces mécanismes. Elle s'appuie sur une approche intégrative, développée à plusieurs niveaux d'organisation biologique, du gène à la population.

Ce 3^{ième} Colloque d'Ecophysiologie qui est organisé à Strasbourg par le Département de Biologie (DEPE) de l'Institut Pluridisciplinaire Hubert Curien (IPHC, UMR 7178, CNRS-Université de Strasbourg) succédera aux deux premières éditions organisées en 2013 par le LEHNA (UMR 5023, Université Claude Bernard - Lyon I) et en 2015 par le laboratoire LIENSs (UMR 7266) et le CEBC (UMR 7372) de l'Université de La Rochelle. Il permettra de poursuivre et de développer la structuration entre les divers champs disciplinaires et laboratoires sur lesquels repose la recherche en écophysiologie.

Le programme du colloque, qui se déroulera sur 3 jours, s'articule autour de 5 sessions :

Session 1- Changements environnementaux, flexibilité métabolique et épigénétique

Session 2- Activités humaines et physiologie de la conservation

Session 3- Ecophysiologie chez les animaux sauvages

Session 4- Plasticité et qualité individuelle

Session 5- Ecophysiologie comportementale

Ce colloque, ouvert à tous les chercheurs et étudiants intéressés par l'écophysiologie animale, permettra la présentation de travaux au travers de séances plénières, de symposiums thématiques et de sessions de posters qui porteront sur les différentes thématiques d'actualité liées à l'écophysiologie. Cet environnement sera une opportunité unique pour échanger entre acteurs scientifiques impliqués dans des programmes de recherche en écophysiologie animale. Ce colloque permettra ainsi de faire le point sur les dernières avancées de cette discipline nécessaires à la mise en place de futures collaborations innovantes. La pérennisation de son organisation tous les deux ans se veut être le point d'ancrage de l'Ecophysiologie en France.

Au travers de ce colloque nous avons voulu élargir notre impact au-delà de la seule communauté francophone. Ceci s'est notamment traduit par des conférences plénières données en grande partie par des spécialistes européens (Allemands, Anglais et Autrichien). Nous avons également cherché à aborder des thématiques encore exotiques en Ecophysiologie avec des communications concernant des approches en épigénétique, en métabolomique ou encore en protéomique. Enfin, dans le but de promouvoir la recherche réalisée par les jeunes chercheurs, des bourses de voyages ainsi des prix des meilleures communications ont pu être financés grâce à l'appui de la *Compagny of Biologists*, du *Parc Zoologique de Ste Croix* et des *Sociétés de Physiologie et d'Ecologie*. Ce colloque sera également une occasion unique pour les étudiants du master d'Ecophysiologie et Ethologie de Strasbourg de faire une première immersion avant d'être des acteurs des futurs CEPA.

Thanks to the support of **The Company of Biologists**, we have the pleasure to promote the participation of students, post-docs and early career scientists to the meeting via travel grants.

Total amount of the Grant: 3000£

Grâce au soutien de **The Company of Biologists**, nous avons le plaisir de soutenir des étudiants, post-docs et jeunes chercheurs pour leur venue au colloque, au travers de l'attribution de bourses de voyage.

Montant total de la subvention 3000£



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Experimental
Biology

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& Mechanisms

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Comité d'organisation

- | | |
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| * Vincent A. VIBLANC | |

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Partenaires



| | |
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| | |
| 8h00 – 9h30 | Registration |
| 9h30 – 9h50 | <p>Meeting Opening : Jean-Patrice ROBIN (IPHC-DEPE)</p> <p>Inaugural address: Stéphane BLANC (IPHC-DEPE)</p> |
| 9h50 – 10h30 | <p>Environmental constraints, metabolic flexibility and epigenetics</p> <p>Keynote: Christoph GRUNAU A systems biology approach to epigenetic inheritance</p> |
| 10h30 – 10h50 | <p><i>Lefrançois, C. et al.</i> From the mitochondria to the individual: how temperature influences performances in juvenile sea bass</p> |
| 10h50 – 11h10 | BREAK |
| 11h10 – 11h30 | <p><i>Pigneret, M. et al.</i> Impact of urban pollution on energy metabolism in the oligocheta <i>Limnodrilus hoffmeisteri</i></p> |
| 11h30 – 11h50 | <p><i>Saraux, C. et al.</i> Can we define a critical body condition in wild sardines through a fasting experiment in tanks?</p> |
| 11h50 – 12h10 | <p><i>Rind, K. et al.</i> Morphological and physiological traits of the Mediterranean sticklebacks living in the Camargue wetland (Rhône river delta)</p> |
| 12h10 – 12h30 | <p><i>Heintz, D.</i> Environmental metabomics: where we are now</p> |
| 12h30 – 14h00 | LUNCH |

Lundi 6 novembre 2017

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| | |
| 14h00 – 14h40 | Environmental constraints, metabolic flexibility and epigenetics Keynote: Walter ARNOLD Seasonal acclimatization: from the whole organism to the fatty acid composition of membranes |
| 14h40 – 15h00 | <i>Landes, J. et al.</i> State transitions: a major mortality risk for seasonal species |
| 15h00 – 15h20 | <i>Giroud, S. et al.</i> Being born late in the active season: implications for growth, fattening, torpor use and fertility |
| 15h20 – 15h40 | <i>Chazarin, B. et al.</i> Muscle molecular responses elicited during hibernation in brown bears |
| 15h40 – 16h00 | <i>Exbrayat, J.M. et al.</i> Some adaptations of the reproductive cycles of caecilians amphibians to the environment: a synthesis |
| 16h00 – 16h20 | BREAK |
| 16h20 – 16h40 | FLASH POSTER TALKS |
| 16h40 – 18h20 | POSTERS |
| Soirée | FROM 18h to 21h WELCOME COCKTAIL AND SOCIAL MIXER EVENT AT THE IPHC |

Mardi 7 novembre 2017

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|---------------|--|
| 8h30 – 9h10 | <p>Anthropogenic activity and conservation physiology</p> <p>Keynote: Christian VOIGT Anthropogenic activity and conservation physiology</p> |
| 9h10 – 9h30 | <p><i>Angelier, F. et al.</i> Stress in the city: physiological and fitness consequences of urbanisation in a wild vertebrate species.</p> |
| 9h30 – 9h50 | <p><i>Humann-Guillemot, S.</i> Sub-lethal effect of a neonicotinoid insecticide in the house sparrow</p> |
| 9h50 – 10h10 | <p><i>Massemin S. et al.</i> Urban environment on health of birds</p> |
| 10h10 – 10h30 | <p><i>Zgirski, T. et al.</i> Synergetic effects of a low-dose pesticide administration and food reduction on bird growth rate</p> |
| 10h30 – 10h50 | BREAK |
| 10h50 – 11h10 | <p><i>Cheghib, Y. et al.</i> Toxicité chronique d'un néonicotinoid, le Thiaméthoxam, sur une espèce non-visée <i>Gambusia affinis</i>: vitellines ovariennes, indices métriques et activité enzymatique de la glutathion S-transférase</p> |
| 11h10 – 11h30 | <p><i>Chastel, O.</i> Physiological and fitness consequences of contaminants in polar seabirds</p> |
| 11h30 – 11h50 | <p><i>Tissier, M. et al.</i> The ecophysiology of infanticide in corn-fed European hamsters due to nicotinamid deficiency</p> |
| 11h50 – 12h10 | <p><i>Theuerkauff, D. et al.</i> Differential effects of wastewater exposure on subtropical Mangrove crabs: towards the identification of vulnerable species</p> |
| 12h10 – 12h30 | <p><i>Touzot, M. et al.</i> Artificial light at night perturbs the energy balance and activity of common toads during breeding period</p> |
| 12h30 – 14h00 | LUNCH |

Mardi 7 novembre 2017

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| 14h00 – 14h40 | Ecophysiology in free ranging animals Keynote: Jonathan GREEN Ecophysiology in free-ranging seabirds: Insights from energetics approaches |
| 14h40 – 15h00 | <i>Rey, B. et al.</i> Physiological plasticity of free-living aardvark facing climate change |
| 15h00 – 15h20 | <i>Dupoué, A. et al.</i> Ecophysiological responses preceding population extinctions in wild lizards |
| 15h20 – 15h40 | <i>Brischoux, F.</i> Hypernatremia in marine snakes: implications for the evolution of euryhaline physiology |
| 15h40 – 16h00 | <i>Georges, J.Y.</i> Overwintering survival and behaviour of captivebred released European pond turtles <i>Emys orbicularis</i> on Site du Woerr, Alsace, NE of France |
| 16h00 – 16h20 | BREAK |
| 16h20 – 16h40 | <i>Hicks, O. et al.</i> Evidence for the energetic cost of parasitism |
| 16h40 – 17h00 | <i>Ngama, S.</i> Ecophysiology of elephants to better understand their crop selection: first results of a case study from Gabon |
| 17h00 – 17h20 | <i>Cheyne, L. et al.</i> Immunocompetence and telomere length in a wild long-lived mammal |
| 17h20 – 17h40 | <i>Eckbo, N. et al.</i> Indexing the impact of multi-factors on the status of Adélie penguins |
| 17h40 – 18h00 | <i>Boël, M. et al.</i> Une approche mitochondriale pour étudier la relation entre le métabolisme et la taille des individus. |
| 18h00 – 18h20 | <i>Mouzaia-Salhi, A. et al.</i> Hibernation et fonctionnement de la glande thyroïde chez le hérisson d'Algérie (<i>Atelerix algirus</i>) |
| Soirée | FROM 20h to 23h CONFERENCE DINNER AT THE MAISON KAMMERZELL https://www.maison-kammerzell.com/ |

Mercredi 8 novembre 2017

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| | |
| 8h30 – 9h10 | <p>Plasticity and individual quality</p> <p>Keynote: Charlotte RECAPET Doing poorly or doing differently? An evolutionary view on individual quality</p> |
| 9h10 – 9h30 | <p><i>Meniri, M. et al.</i> Morphological and physiological shortterm consequences of a bad start in the Seba's shorttailed bats</p> |
| 9h30 – 9h50 | <p><i>Stier, A. et al.</i> Embryo growth rate and stability influence telomere length: new insights from an avian model</p> |
| 9h50 – 10h10 | <p><i>Losdat, S. et al.</i> Effects of an early-life stress exposure on adult resistance to oxidative stress, plumage colour and sperm performance in a wild bird</p> |
| 10h10 – 10h30 | <p><i>Desprat, J. et al.</i> Testosterone, vocal sac coloration and bio-availability of carotenoids in <i>Hyla arborea</i></p> |
| 10h30 – 10h50 | BREAK |
| 10h50 – 11h10 | <p><i>Jimeno, B. et al.</i> Is corticosterone more than a metabolic hormone?</p> |
| 11h10 – 11h30 | <p><i>Renault, D. et al.</i> Sensitivity of <i>Alphitobius diaperinus</i> (Coleoptera: Tenebrionidae) continuously exposed to one or multiple abiotic constraints</p> |
| 11h30 – 11h50 | <p><i>Gangloff, E. et al.</i> Lizards on the peak: hypoxia induces physiological responses and bears performance consequences in common wall lizards transplanted to high elevations</p> |
| 11h50 – 12h10 | <p><i>Mortz, M. et al.</i> Identification of small Open Reading Frames (ORF) in avian 16S mitochondrial rRNA genes</p> |
| 12h10 – 12h30 | <p><i>L'Honoré, T. et al.</i> Phenotype plasticity in freshwater acclimated sea bass</p> |
| 12h30 – 14h00 | LUNCH |

Mercredi 8 novembre 2017

| 14h00 – 14h40 | <p style="text-align: center;">Behavioural ecophysiology</p> <p style="text-align: center;">Keynote: Wolfgang GOYMANN Male-to-female testosterone ratios, dimorphism and life history in birds – and what may be different about females</p> |
|---------------|---|
| 14h40 – 15h00 | <p><i>Dunn, R. et al.</i> The post-breeding diving behaviour of three auk species</p> |
| 15h00 – 15h20 | <p><i>Bauch, C. et al.</i> Reproductive effort and telomeres: a longitudinal study in jackdaws</p> |
| 15h20 – 15h40 | <p><i>Viblanc, V.A. et al.</i> Oxidative stress and reproduction in Columbian ground squirrels: constraint, cost or shielding mechanism</p> |
| 15h40 – 16h00 | <p><i>Helpfenstein, F.</i> Antioxidant allocation modulates sperm quality across changing social environments</p> |
| 16h00 – 16h20 | BREAK |
| 16h20 – 16h40 | <p><i>Rimbach, R. et al.</i> Alternative reproductive tactics in African striped mice: solitary roamers spend more energy than bourgeois males but grow less than philopatric males</p> |
| 16h40 – 17h00 | <p><i>Quque, M. et al.</i> How can social organization explain the differences in longevity in the black garden ant (<i>Lasius niger</i>)</p> |
| 17h00 – 17h20 | <p><i>Siegwalt-Baudin, F. et al.</i> Trophic ecology of the green turtle (<i>Chelonia mydas</i>) in the Caribbean: role on ecosystem dynamics in a colonization context of the invasive phanerogam <i>Halophila stipulacea</i></p> |
| 17h20 – 17h40 | <p><i>Chaise, L. et al.</i> Huddling and social thermoregulation of moulting female Southern elephant seals at Kerguelen island</p> |
| 17h40 – 18h | <p>STUDENT AWARDS ORGANISATION OF CEPA IV CLOSING CEREMONY</p> |

Conférences plénières

Lundi 6 novembre

9h50 – Christoph GRUNAU

A systems biology approach to epigenetic inheritance



14h00 – Walter ARNOLD

Seasonal acclimatization: from the whole organism to the fatty acid composition of membranes



Mardi 7 novembre

8h30 – Christian VOIGT

Anthropogenic activity and conservation physiology



14h00 – Jonathan GREEN

Ecophysiology in free-ranging seabirds: insights from energetics approaches



Mercredi 8 novembre

8h30 – Charlotte RECAPET

Doing poorly or doing differently ? An evolutionary view on individual quality



14h00 – Wolfgang GOYMANN

Male-to-female testosterone ratios, dimorphism and life history in birds – and what may be different about females



A systems biology approach to epigenetic inheritance

Christoph Grunau ^{*† 1}

¹ IHPE UMR 5244 – Université de Perpignan Via Domitia – 58 Avenue Paul Alduy, F-66860 Perpignan, France

Evolution is based on the selection of phenotypic variants that must (i) confer a reproductive advantage to the individual, and (ii) are heritable. Heritability has traditionally be thought to be exclusively genetic, i.e. based on variations in the DNA sequence. During the last years it became however clear, that a substantial amount of heritable phenotypic variance can be coded by non-genetic means. We have conceptualised this view as a systems approach to inheritance that includes genetic, epigenetic, cytoplasmic and microbial elements. They interact mutually with the environment to give raise to the phenotype. Exemples from our lab will be used to illustrate this concept (parental effects in oyster, adaptation of the human parasite *Schistosoma mansoni*, and immune memory in invertebrates).

Mots-Clés: Phenotypic variants, Heritability, DNA sequence, Genetic and non, genetic

*Intervenant

†Auteur correspondant: christoph.grunau@univ-perp.fr

Seasonal acclimatization: From the whole organism to the fatty acid composition of membranes

Walter Arnold*†¹

¹Research Institute of Wildlife Ecology, University of Veterinary Medicine Vienna, Austria – Autriche

Résumé

Mammals and birds living in seasonal environments face during winter a two-fold challenge: The energetic cost of maintaining a high body temperature is higher at lower ambient temperatures while food availability and quality is poor. Hibernators and daily heterotherms cope with these challenges by switching to fat reserves as the major metabolic fuel, reducing locomotor activity, and, most importantly, by abandoning maintenance of a high body temperature. We found similar reactions in several non-hibernating large mammals, except that temperature changes were only substantial in peripheral body parts. Nevertheless, metabolic rate, approximated by continuous measurement of heart rate, was in these species during winter also remarkably reduced, to about half of the summer level.

The reduction of body temperature in hibernators is preceded by incorporation of essential polyunsaturated fatty acids (PUFA) into phospholipids (PL). Upon termination of hibernation, these PUFA are cleared again from PL. First results from red deer suggest that similar remodeling of membranes also occurs in species undergoing only minor seasonal changes of core body temperature.

A change of the PL environment apparently can compensate temperature (Arrhenius) effects on membrane-bound enzymes, but with specific roles for different PUFA. For instance, activity of the sarcoplasmic reticulum Ca⁺⁺-ATPase (SERCA) is increased in membranes rich in omega-6 linoleic acid (LA), a mechanism presumably pivotal during hibernation by ensuring proper Ca⁺⁺ handling in cardiac myocytes at low body temperatures. In contrast to LA, PL-omega-3 docosahexaenoic acid seems to improve ATP production but has detrimental effects on SERCA.

I conclude that seasonal acclimatization, in particular hypometabolism and voluntary hypothermia seem to be ubiquitous among endotherms, as is associated membrane remodeling. Specific effects of PUFA in PL suggest trade-offs determining a state-dependent optimization of the fatty acid composition of membranes.

Mots-Clés: Hibernation, Polyunsaturated fatty acids, Phospholipids, membranes

*Intervenant

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Anthropogenic activities and conservation physiology

Christian Voigt ^{*† 1}

¹ Department of Evolutionary Ecology, Leibniz Institute for Zoo and Wildlife Research, Berlin – Alfred-Kowalke-Str. 17, 10315 Berlin, Allemagne

In the newly-defined geological epoch of the Anthropocene, animals are exposed to a multitude of anthropogenic threats. Indeed, while witnessing the 6th mass extinction event and the disappearance of species in real-time, we are yet at the starting point of understanding the causes that are responsible for the survival or extinction of species. Conservation physiology is pivotal for developing a mechanistic understanding of how e.g. degrading habitats influence animals on the individual, population and species level. Physiological pathways sensitive to sensory stress, nutritional status, chronic hormonal stress and deprived immunology are at the core for understanding and predicting the long-term survival of animals in human-shaped landscapes. In my research, I focus on a taxon that is particularly susceptible towards anthropogenic threats: bats. Bats are long-lived and highly mobile. They reproduce at a low rate and use torpor to survive adverse conditions. In our group, we studied the body condition, immunology and pathogen load of bats in fragmented rainforests of Borneo to develop a predictive framework that helps to estimate the survival probability of forest species. For example, we found that tree-dwelling bats are more susceptible to chronic stress than cave-dwelling bats in forest fragments, which makes tree-dwelling species more likely to perish from forest patches; probably because they are more dependent on local food resources and thus more susceptible to temporal and spatial fluctuations of food than cave-dwelling bats with larger home ranges. In Europe, some tree-dwelling bat species are migrating annually over more than 4000 km. As a consequence, they cross a multitude of habitats which exposes them to various threats, including misleading sensory cues from anthropogenic sources, low-quality habitats with reduced insect biomass and an increased mortality risks at wind turbines. In the last part of my talk, I will summarize our recent insights into these anthropogenic threats and assess how they might impact the physiology and survival of migratory bats during their seasonally journeys. Conservation physiology contributes to an understanding of mechanisms underlying biodiversity losses and may thus have the potential to mitigate or even reverse some of the detrimental effects that humans have on animals and ecosystems worldwide.

Mots-Clés: chronic stress, bats, habitat

*Intervenant

†Auteur correspondant: ccvoigt@googlemail.com

Ecophysiology in free-ranging seabirds: Insights from energetics approaches

Jonathan Green ^{*† 1}

¹ University of Liverpool – Royaume-Uni

Seabirds are the perfect model group in which to study ecophysiology. Firstly their lifestyle compels them to spend time at sea, on the land and in most cases in the air, and these very different environments present a number of simultaneous physiological challenges that they have to adapt to. Secondly, seabirds are the world's most threatened group of birds, experiencing population declines due to climate change, overfishing, habitat loss and invasive species. For the last 20 years I have worked on projects which have attempted to increase our understanding of how this fascinating group of animals functions in, and is influenced by, their environment using energetics as a common currency to link behaviour, physiology and ecology. From migration in Arctic cormorants to fine-scale decision making in kittiwakes to windfarm interactions in gannets, I will talk about work from the past, present and future that attempts to highlight the importance of understanding ecophysiology in all free-ranging animals.

Mots-Clés: ecophysiology

*Intervenant

†Auteur correspondant: Jonathan.Green@liverpool.ac.uk

Doing poorly or doing differently? An evolutionary view on individual quality

Charlotte Récapet ^{*† 1}

¹ UMR 1224 ECOBIOP INRA-UPPA – UFR Sciences et techniques de la côte Basque – France

Because of its tight links to medical science, physiology has often adopted a normative view of individual state and classified the deviation from average of individual markers as "healthy" or "pathogenic". This framework, inherited from the medical need of simple biomarkers for health and disease, has led to the transposition or creation of various physiological metrics into the fields of ecology and evolutionary biology. Although simple to use, such metrics can be misleading, as they are usually too simple to capture the complexity of biological and ecological systems. First, the life of organisms involves complex regulatory systems that make individual biomarkers, taken separately, poor predictors of individual quality. Crude mathematical summaries of these biomarkers, instead of improving our understanding of the biological processes at play, usually obscure them. On the opposite, various approaches have been developed that make a better use of our improved computing capacity to understand individual variation in physiological state and its relevance to individual fitness.

Then, a biomarker can show different response according to individual and environmental characteristics, e.g. individual variation in reaction norms. Far from being random noise, this individual variation may relate to evolutionary relevant variation in life-history strategies. Disregarding this source of variation when classifying individuals along a "poor" to "successful" axis will thus often lead to inappropriate conclusions on the ecology and evolution of the species.

Adopting a more integrative and individualized view of physiology could therefore help us understand the mechanisms underlying individual variation in life-history strategies and behaviour, but also improve the communication between evolutionary biology and the developing field of evolutionary medicine.

Mots-Clés: Biomarkers, individual variation, life history strategies, evolutionary biology

*Intervenant

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Male-to-female testosterone ratios, dimorphism and life history in birds – and what may be different about females

Wolfgang Goymann *† 1

¹ Abteilung für Verhaltensneurobiologie, Max-Planck-Institut für Ornithologie, Seewiesen, Germany –
Allemagne

Testosterone is a key hormone for the development of secondary sexual characters and dimorphisms in behavior and morphology of male vertebrates. Because females often express detectable levels of testosterone, testosterone has been suggested to also play a role in the modulation of secondary sexual traits in females. Previous comparative analyses in birds and fish demonstrated a relationship between male-to-female testosterone ratios and the degree of sexual dimorphism. Furthermore, female maximum testosterone was related to mating system and coloniality. In this presentation, I will re-evaluate these previous ideas using phylogenetic analyses and effect size measures for the relationship between birds' male-to-female maximum testosterone levels. Further, I will investigate the seasonal androgen response of female birds (the difference from baseline to maximum testosterone), which in males is strongly related to mating system. I could not confirm a relationship between male-to-female testosterone, maximum female testosterone, or the seasonal androgen response of females with most of the previously investigated life history parameters. I will elaborate on why the expectation that testosterone regulates traits in females in a similar manner as in males may be misleading and should be reconsidered, and exemplify this using an example of hormonal factors influencing territorial aggression in sex-role reversed female black coucals.

Mots-Clés: Testosterone, aggression, females, sexual dimorphism

*Intervenant

†Auteur correspondant: wolfgang@goymann.org

Session 1

Environmental constraints, metabolic flexibility and epigenetics

1 - Lefrançois, C. et al.

From the mitochondria to the individual: how temperature influences performances in juvenile sea bass

2 - Pigneret, M. et al.

Impact of urban pollution on energy metabolism in the oligocheta *Limnodrilus hoffmeisteri*

3 - Saraux, C. et al.

Can we define a critical body condition in wild sardines through a fasting experiment in tanks?

4 - Rind, K. et al.

Morphological and physiological traits of the Mediterranean sticklebacks living in the Camargue wetland (Rhône river delta)

5 - Heintz, D.

Environmental metabolomics: where we are now

6 - Landes, J. et al.

State transitions: a major mortality risk for seasonal species

7 - Giroud, S. et al.

Being born late in the active season: implications for growth, fattening, torpor use and fertility

8 - Chazarin, B. et al.

Muscle molecular responses elicited during hibernation in brown bears

9 - Exbrayat, J.M. et al.

Some adaptations of the reproductive cycles of caecilians amphibians to the environment: a synthesis

From the mitochondria to the individual: how temperature influences performances in juvenile sea bass

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The aim of our study was to investigate the links between individual performance (in terms of swimming and aerobic scope) and mitochondrial bioenergetics in fish, since mitochondria are essential organelles responsible for the generation of cellular energy in the form of ATP. We explored these links in European sea bass juveniles acclimated to three different temperatures. The temperatures were chosen in regards to the temperature considered as optimal in term of aerobic scope for this species: 22°C as the optimal level, 18 and 26°C as sub- and sus- optimal conditions, respectively. Oxygen consumption was measured in resting and active individuals during a step-protocol swimming test, using a swim-tunnel respirometer. Concomitantly, swimming performance was assessed in each individual through (1) U_{max} , the swimming speed from which the fish presents burst and glide swimming mode associated to recruitment of white anaerobic muscles, as well as (2) U_{crit} , the swimming speed at which the fish get exhausted. Afterwards, skeletal muscles were collected in each individual and mitochondrial bioenergetics parameters (oxidative phosphorylation activity, ATP synthesis and mitochondrial efficiency) were investigated. The bioenergetics signature at these sub-individual levels and fish performances were analyzed in regards to the temperature. Our results suggest that mitochondrial oxidative phosphorylation activity and efficiency exhibited a strong resilience towards the temperature at which individuals were acclimated. Inter-individual variability in performance will be also discussed in relation to the pattern observed at the muscle and the mitochondrial levels

Mots-Clés: skeletal muscle, performance, mitochondria, fish, thermal acclimation, aerobic scope, bioenergetics

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Impact of urban pollution on energy metabolism in the oligochaeta *Limnodrilus hoffmeisteri*

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In urban areas, numerous pollutants accumulate on sealed surfaces (roads, parks, industrialized areas...). ...). Rainfall events drain these contaminants, which are finally accumulated in the sediment layer of stormwater infiltration basins. These structures are designed to detoxify runoff water that reach out groundwater, and it is now necessary to evaluate the toxicity of pollutants in such receptor ecosystems. Only a few organisms - among them the tubificid worm *Limnodrilus hoffmeisteri* - live in these sediments and play a major key role in the functioning of infiltration basins (e.g. influence of biogeochemical processes, organic matter recycle...). But urban pollutants could impact the physiology of these organisms, as they are directly exposed (sediment ingestion). According to Lauer et al. (2012), some pollutants impact the mitochondria functioning and may force the organisms to partially switch from the aerobic to the anaerobic metabolism (displaying a limited ATP production). The aim of our study was to develop biomarkers of energy metabolism in the oligochaeta *L. hoffmeisteri* after a long-term exposure (upon 6 months) to polluted sediments collected from different infiltration basins (more or less polluted). Several mitochondrial parameters and end products of anaerobic metabolism (succinate, lactate, propionate and alanine) were evaluated. A decrease of the activity of the electron transport chain (ETC) was observed but mitochondrial efficiency was not impacted by urban pollutants. However, propionate and succinate concentrations increased during the experiment for the organisms exposed to the most polluted sediments. Thus, a metabolic switch to the most efficient anaerobic pathways (in term of ATP production) seemed to be induced by pollutants. Moreover, our study demonstrated that the use of anaerobic metabolism and products as biomarkers of pollution was relevant.

Mots-Clés: pollution, anaerobic metabolism, mitochondria, biomarkers, tubificid worms

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Can we define a critical body condition in wild sardines through a fasting experiment in tanks?

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A recent shift in small pelagic fish populations (anchovy, sardine and sprat) has been observed in the Gulf of Lions ecosystem, with considerable changes in fish biomass and mean fish weight. Surprisingly, these changes do not appear mediated by changes in recruitment (which remains high) or by fishing pressure (the current rate of exploitation being extremely low). Top-down control by tunas and marine mammals, as well as migration and epidemics were also refuted as principal drivers of these changes. Rather, changes in size, condition and adult over-mortality are suggested to derive from bottom-up control (i.e. changes in plankton composition) and possibly a change in life-history trade-offs, fish investing more into reproduction than earlier despite being in lower condition. However, the mechanisms relating a low food intake or a low body condition to adult over-mortality are unknown. Here, we used an experimental approach to investigate whether we could determine a critical body condition, indicative of when sardine survival might be at stake. We subjected 78 wild-caught sardines to prolonged fasting in controlled tanks. Using small Radio Frequency IDentification (RFID) pit-tags, sardines were marked individually and their body mass and length estimated every week over a 2-month period. Preliminary results show that initial body condition significantly explains the duration that sardines can fast. Further, the probability to survive over a week strongly decreased with decreasing body condition (BC) index (from 100% when BC=1, i.e. the long-term average of the population, to 25% when BC=0.5, through 76% when BC=0.7, present mean in winter in the wild). Finally, metabolic rate and ammoniac excretion were measured at the tank level due to the gregarious character of sardines (from 5 to 18 individuals per tank according to their initial body condition) in order to better understand the use of different substrates during fasting.

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Mots-Clés: fasting, critical body condition, marine fish, respirometry

Morphological and physiological traits of the Mediterranean sticklebacks living in the Camargue wetland (Rhône river delta).

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Population heterogeneity and salinity acclimation capacities of southern three-spined sticklebacks (*Gasterosteus aculeatus* L.) living in different saline habitats of the Camargue area (Rhône delta, northern Mediterranean coast) were investigated. Individuals from lagoons with different salinity ranges and from freshwater canals were exposed to seawater (SW; 30 ‰), brackish water (BW; 15 ‰), or freshwater (FW; 5 ‰). Morphological measurements of sub-adult fish sampled from 1994 to 2017 were determined from fish inhabiting in these different habitats. Also, oxygen consumption rates and osmoregulatory parameters (branchial Na⁺/K⁺-ATPase, NKA activity and gene expression of the $\alpha 1$ subunit and $\alpha 1a$ and $\alpha 1b$ NKA isoforms, gill ionocytes morphology) were measured from fish living in three contrasted habitats and after exposure to and different salinities.

At all the studied locations, only the low-plated leirus morphotype was observed with also limited morphological variations. No short term effect of salinity could be detected on oxygen consumption from fresh, brackish, and saltwater fish. In these animals, gill NKA activity was salinity-dependent with also less NKA $\alpha 1b$ in FW- than in SW-fish. Ionocytes in FW-fish gills were located along the lamellae and at their base, whereas these cells were restricted to gill filaments in SW-fish. Finally, electron microscopy revealed three different types of apical structures for these ionocytes: a honeycomb-like structure and a dome shape in FW, and deeply encrypted in SW.

Therefore, sticklebacks of the Camargue area living in contrasted saline conditions belong to a very homogenous euryhaline population and are not exposed to strong metabolic demands due to salinity changes.

Mots-Clés: Fish, osmoregulation, metabolism, sticklebacks, Camargue, Méditerranée

Environmental metabomics: where we are now

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Our team is specialized in the development of experimental design aimed to the identification of small bioactive molecules coming from plants, animals, microbes and human. Small molecules made by living organism are named metabolites (sugar, lipids, nucleic acids, organic acids, hormones). Therefore has been coined in the late 90s the word Metabolomics which represent the field that study the metabolomes. More recently has emerged a new field of research named environmental metabolomics. It is linked to the discovery of many bioactive molecules named micropollutants like pesticides, drugs and other new emergent micropollutants (cosmetics, house care products) present in the environment and that can accumulate in living organisms. Some of these micropollutants can have toxicological effects even if most of the molecules are present as trace in the environment. Only high sensitive analytical tools like mass spectrometers can survey those low abundant molecules in complex matrices (soil, water, plant, animals, microbiota..) In our group small molecules identification is made by means of modern analytical tools using chromatography and mass spectrometry. Recently we introduced a new technology named mass spectrometry imaging MSI. This new imaging technic allows molecule and micropollutant identification directly on flat surface of histological cuts. The simultaneous identification of tens of molecules can be done now without the need of any previous tedious labeling. Thus metabolites, lipids, peptides, small proteins or RNA and micropollutants can be identified simultaneously in different tissues of plants, animals and human.

Mots-Clés: bioactive molecules, metabolomics, micropollutants, trace levels, mass spectrometry imaging MSI

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State transitions: a major mortality risk for seasonal species

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Ageing results from the accumulation of multifactorial damage over time. However, the temporal distribution of this damage remains under-understood. In seasonal species, transitions between seasons are critical periods of massive physiological remodelling. We hypothesised that these recurrent peaks of physiological remodelling are costly in terms of survival. We tested whether captive small primates exposed to an experimentally increased frequency of seasonal transitions die sooner than individuals living under natural seasonality. The results show that experiencing one additional season per year increases the mortality hazard by a factor of 3 to 4, whereas the expected number of seasons lived is only slightly impacted by the seasonal rhythm. These results demonstrate that physiological transitions between periods of high and low metabolic activity represent a major mortality risk for seasonal organisms, which has been ignored until now. Broader implications of these results, and alternative hypotheses to be assessed will be discussed

Mots-Clés: metabolic flexibility, seasonality, mortality, torpor, accelerated ageing

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Being born late in the active season: implications for growth, fattening, torpor use and fertility

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Prior to winter, juvenile hibernators have to allocate energy to both growth and fattening, to survive winter hibernation and to avoid possible disadvantages during the first reproductive season. Being born late in the active season may have important effects on growth and fattening. Torpor is thought to sustain these processes in young individuals. We tested the hypothesis that late-born ('LB') female juvenile garden dormice (*Eliomys quercinus*) (i) grow and fatten at higher rates, (ii) reach similar pre-hibernation levels of body size and fat reserves due to (iii) an increased use of torpor, (iv) show similar hibernating patterns and (v) reproduce less than early born ('EB') individuals. We found that LB juveniles grew and gained mass twice as fast as EB individuals during their post-weaning period. Accelerated growth of LB juveniles was sustained by an increased food intake and reduced activity duration, leading to body sizes similar to EB individuals prior to hibernation. Torpor use was low during intensive growth (*i.e.* the first weeks of body mass gain), but increased after the termination of growth, during pre-hibernation fattening. LB juveniles increased their torpor use to a greater extent and showed 10%-lower pre-hibernation fat reserves, compared to EB individuals. Intermittent fasting (IF) had no effect on fat stores prior to hibernation, neither in EB nor in LB juveniles. Apart from a 4-week difference in their hibernation duration, EB and LB juveniles showed similar hibernating patterns. Surprisingly, after their first winter, LB dormice reproduced overall more than EB individuals, and dormice that were IF showed a lower fertility than individuals that were fed *ad-libitum*. Hence, our results suggest that torpor is incompatible with structural growth, but instead promotes pre-hibernation fattening late in the season. This study further supports that being born late in the reproductive season is associated with a fast life history.

Mots-Clés: Torpor, Hibernation, Juveniles, Structural growth, Fat reserves, Life histories, Reproduction, Somatic maintenance

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Muscle molecular responses elicited during hibernation in brown bears

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Physical inactivity is a major risk factor for developing obesity, diabetes, cardiovascular diseases, and muscle atrophy in humans. Conversely, muscle mass is fairly well preserved during hibernation in some hibernating species including the brown bear. Deciphering regulated metabolic networks in inactive *vs.* active bears could therefore help in understanding how the bear succeeds where the human fails. From muscle biopsies collected in free-ranging brown bears (*Ursus arctos*), we developed a combined proteomic and metabolomic analysis. Bears were sampled during their denning (February) and active (July) periods. Regarding proteomics, we used two different and complementary approaches, namely the 2D-DIGE-MS/MS and label-free nanoLC-MS/MS strategies. Because there is no available protein sequence for brown bears, we analyzed proteomic data using both classical database searches and *de novo* sequencing strategy. Data treatment was done using our in-house developed software suite MSDA (<https://msda.unistra.fr/>). From the analysis of hundreds of muscle proteins, abundance of dozens of them were found to be different between the inactive and active states. These differential proteins are known to be involved in muscle contraction/structure/function, the protein balance, extracellular matrix remodeling, carbohydrate and lipid metabolism, and response to oxidative stress. Data are in line with the minimal muscle mass loss during winter dormancy, but also with maintenance of muscle functionality in the inactive state. MS-based metabolomics data were globally in-line with the proteomics results. Differential metabolites indeed notably reflect possible mechanisms favoring muscle development, mitochondrial function and biogenesis, increase in antioxidant systems, and a fine tuning of muscle protein breakdown. In summary, the unraveled muscle metabolic network regulation provides key information for identifying molecular players that promote muscle sparing during inactivity in denning bears.

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Mots-Clés: Hibernation, bear, muscle sparing, omics

Some adaptations of the reproductive cycles of caecilians amphibians to the environment: a synthesis

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Caecilians or Gymnophionans are limbless lengthened amphibians living in tropical and equatorial areas. Among the species known (150 to 170), only some of them were investigated in order to understand the reproductive patterns related to environment. Species can be oviparous, direct-developing, viviparous without any form of placentation, or viviparous with a placenta-like structure. Reproductive cycles are narrowly linked to the seasonal variations (temperature or rain). Male genital tract is composed with a pair of testes associated to a pair of fat bodies, a pair of Mullerian glands, and a cloaca. Male cycles are annual, continuous or discontinuous. Female genital tract is composed with a pair of elongated ovaries associated to a pair of fat bodies, a pair of oviducts divided in several parts according to the reproductive mode, and a cloaca. Female cycles can be annual in oviparous or direct-developing species. They may also be biennial in the viviparous species of Central America and South America. The variations of genital tracts according to the season and, in females, the pregnancy, are under hormonal control (pituitary, endocrine tissues of gonads, neurohormones). The breeding cycles are well adapted to the seasonal variations. At birth, the new-born find an environment for which they are perfectly adapted and in some species, they eat the skin secretions of their mother. The reproductive cycles of the Caecilians are closely linked to seasonal variations with precise modalities. A crucial question may arise: what will happen if their normal environment is changed?

Mots-Clés: Amphibian, Caecilian, reproduction, sexual cycle

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Session 2

Anthropogenic activity and conservation physiology

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Toxicité chronique d'un néonicotinoïde, le Thiaméthoxam, sur une espèce non-visée *Gambusia affinis*: vitellines ovariennes, indices métriques et activité enzymatique de la glutathion S-transférase

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Artificial light at night perturbs the energy balance and activity of common toads during breeding period

Stress in the city: Physiological and fitness consequences of urbanisation in a wild vertebrate species

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Since their settlement, cities have drastically changed and they are one of the environments where global changes are the fastest and most pronounced. Despite these environmental constraints, some animals are able to inhabit in cities and studying these sentinel species can help us to better understand the costs and benefits of urbanization in wild vertebrates. In this context, we investigated the impact of urbanization in a human-commensal species, the house sparrow (*Passer domesticus*). This species is especially relevant because it is one of the only wild vertebrate that is supposed to be well adapted to an urban lifestyle. Importantly, several European populations of sparrows have been declining in the past decades, suggesting that ongoing and emerging urban constraints may be detrimental to this species. In this study, we examined the impact of urbanization on the behavior, the physiology and the performances of house sparrows. Firstly, we compared the morphology and the stress physiology of multiple urban and rural populations of sparrows and we demonstrated that living in an urban environment was associated with important detrimental effects in developing sparrows (reduced body size, poor plumage quality, and elevated stress levels). Because early-life stress could be one of the main constraints for urban populations, we then experimentally manipulated the environment and the corticosterone levels (the primary avian stress hormone) of developing house sparrows. We found that both early life stressors and increased corticosterone levels were associated with important alteration of growth, stress physiology, anti-predator behavior, reproduction and longevity. Therefore, our study demonstrates that early life-stressors and its physiological consequences could be key mechanism to understand the ability to wild vertebrate species to cope with the urban environment.

Mots-Clés: stress, body condition, development, corticosterone, urbanisation

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Sub-lethal effect of a neonicotinoid insecticide in the house sparrow.

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Neonicotinoids are new generation insecticides well known for their high toxicity in insects and the great threat they pose to pollinators. However, little, if anything, is known in wild vertebrates. Since neonicotinoids target acetylcholin receptors in the central nervous system, they may interfere with a number of downstream physiological processes such as the regulation of the hypothalamus-pituitary-adrenal axis involved in the "stress" response. We experimentally tested whether sublethal doses of the common neonicotinoid acetamiprid affected the HPA axis of wild house sparrows. In a first experiment conducted in 2015, we kept 112 male and female house sparrows in 15 aviaries and dosed them every second day with 0.5 % of the lethal dose for zebra finches for three weeks. We plucked two feathers before the treatment and collected the newly grown feather at the end of the dosing period to assess the amount of corticosterone, the stress hormone of birds, deposited into the feathers. We found that males dosed with acetamiprid failed to downregulate their HPA axis and stress response, therefore suggesting the acetamiprid may act as an endocrine disruptor. We repeated this experiment in 2016, and were then able to also collect sperm from all males. However, in this second experiment, none of the birds appeared to be affected by the treatment. The two experiments differed in several ways - e.g. timing in the season – and we discuss the discrepancies in the results in the light of these differences.

Mots-Clés: Neonicotinoids, House sparrow, Corticosteron, Sperm, Stress

Urban environment on health of birds

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How urban stressors such as chemical pollution or food availability can affect the ecological and physiological traits of birds is important to understand the mechanisms by which birds can colonize urban environment. To highlight how species can adapt to urban constraints, we studied the fitness of the Great tit (*Parus major*) during three years along an urban gradient around Strasbourg (France). Three areas were followed on this gradient (one in Strasbourg, two outside). We showed that they were different according to the atmospheric and ground pollution, the food availability and the vegetation cover around the nests. In the town (few food, less polycyclic aromatic hydrocarbons and pesticides), few great tits pairs bred, adults were smaller and reproductive success of these birds was lower compared to the two other areas. We will present results concerning oxidative stress and telomere attrition as physiological parameters in adults and fledglings. In addition, we will propose an international collaboration on the great tits as an urban ecological and physiological observatory.

Mots-Clés: urbanisation, birds, environmental stress, ecophysiology

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Synergetic effects of a low-dose pesticide administration and food reduction on bird growth rate.

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Consequences of intensive agriculture are multidimensional. In addition to natural habitat reduction, biodiversity modification and resource availability, pesticides application have deleterious effects on wildlife. Pesticides can impact top consumers by directly reducing key biodemographic traits or indirectly by reducing resource availability. Several pesticides have been identified as endocrine disruptors leading to more insidious effects. For example, Neonicotinoids, a family of pesticides, known to have contributed to the decline of pollinators such as honey bees, can decrease invertebrates density and is also suspected to disrupt vertebrate metabolism regulation. For insectivorous bird species, neonicotinoids application potentially result in two stressors : reduction of food availability and alteration of metabolism. To date, potential synergetic effects among those two stressors during breeding (when energy demand is maximal) remain poorly understood. We experimentally manipulated food abundance and neonicotinoid exposure during chick rearing using a cross-design with zebra finches (*Taeniopygia guttata*). Treated nestlings were daily exposed to imidacloprid (0.5% LD50) from day 5 to day 30 after hatching. Furthermore, food access to parents was reduced leading to four groups (Control ; Food restricted ; Imidacloprid ; Imidacloprid+Food restricted). As expected, our results showed a negative impact of food restriction on mass gain during chick growth. However, this effect was totally compensated when birds were exposed to imidacloprid. Mass-gain was greater in birds exposed to neonicotinoids for all treated groups. Thyroid hormones (T3, involved in metabolism regulation in birds) levels measured at day 15 and 30 after hatching revealed that birds exposed to imidacloprid exhibit higher T3 level at day 15 only (i.e., during the peak of growth rate). Future experimentations and analyses will focus on the long term consequences (breeding capacity or longevity) of early life exposure to pesticides.

Mots-Clés: endoc

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Chronic Toxicity of a Neonicotinoid "Thiamethoxam" in adult females of a mosquitofish *Gambusia affinis*: Ovarian Vitelline, Metric Indices and Enzymatic Activity of Glutathione S-Transferase.

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The contamination of water by insecticides, including neonicotinoids, is mainly due to intensive agriculture combined with surface runoff and subsurface drainage. Fish are particularly sensitive to such pollution. Insecticides, absorbed through the gills, skin or alimentary ducts, can affect morphometric parameters together with physiological and biochemical processes. In this study, we evaluated the effect of a second-generation neonicotinoid (commercial preparation Actara® 25WG, active substance Thiamethoxam) extensively used in agriculture on a freshwater fish, *Gambusia affinis*, during the reproduction phase. This fish is introduced in Algeria for the biological fighting against the mosquito larvae and has been chosen as a biological model for its importance over the aquatic ecosystems, its great availability in the area and its great tolerance over different pollutants including pesticides.

The effect of the Actara® preparation was investigated at 3 different levels. First, we determined the activity of the liver enzyme Glutathione S-transferase (GST). The liver is the major organ allowing degradation and bioinactivation of pesticides. Thus, the biochemical parameters in fish liver are sensitive for detecting potential adverse effects and relatively early events of pollutant damage. Second, we measured levels of ovarian vitelline that is a second biomarker which allow evaluating defense phenomena to toxic expositions. Finally, various metric indices (K, RSI, HSI) that provide a simple way to measure up how fish interact with their environment were determined.

Adult females were exposed for 28 days to various concentrations (10 mg/l, 20 mg/l, 40 mg/l) of the commercial preparation to determine the vitelline ovaries rate, the metric indices and the enzymatic activity of the GST. We selected lower concentrations than those applied in agriculture. Indeed, the insecticide is applied at concentrations ranging from 800 to 4000 mg/l, corresponding to 200 to 1000 mg/l of thiamethoxam. Results were compared with control animals (no pesticide exposition).

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The overall results show a decrease in the ovarian vitelline levels, condition index (K) as well as an increase of the GST activity in the exposed females compared to the control ones. No significant effect has been recorded in the 2 other metric indices (RSI and HIS).

The elevated GST activity is linked to the detoxification capacity rise in the liver which is triggered by the insecticide presence. The effect on vitelline levels can be linked to the anti-estrogenic effect of certain substances such as insecticides. They can bind to the estrogenic receptors, and alter their binding site conformation. Thus, the receptors are not anymore responsible for the stimulation of the transcription genes normally activated in healthy conditions. This can lead to a liver deterioration caused by the rundown of the vitellogenin production which subsequently explains a decrease in the rate of vitelline. Therefore, we can conclude that females are more sensitive to Actara® during the reproduction period and this may impact population dynamics.

Mots-Clés: Reproduction, Thiamethoxam, *Gambusia affinis*, GST, Metric indexes, Vitelline.

Physiological and fitness consequences of contaminants exposure in polar seabirds

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Seabirds are top predators of the marine environment that accumulate contaminants over a long life-span. Chronic exposure to pollutants is thought to compromise survival rate and long-term reproductive outputs, thus inducing population decline. Although toxic effects of heavy metals and persistent organic pollutants (POPs) have been described under controlled laboratory conditions, their consequences on long-term fitness have been virtually neglected in free-living vertebrates because of the dearth of long-term data sets that would be required to address this topic. Further, to date very few data are available on the physiological mechanisms involved in the fitness consequences of contaminants exposure in free-living birds. In this talk we will present results from various projects conducted in Arctic (Svalbard) and Antarctic (French Southern Territories) seabirds to investigate the fitness consequences of contaminant exposure. Contaminants considered in these studies are heavy metals such as mercury, legacy POPs (PCBs, chlorinated pesticides) and POPs of emerging concern (Poly- and Perfluoroalkyl Substances, PFASs). Using several long-term capture-mark-recaptures studies, we show that exposure to mercury and POPs can negatively impact long-term breeding probability, fecundity and even adult survival. Using matrix population models, we projected population declines in response to an increase in mercury and POPs concentrations. At the proximate levels, the mechanisms underlying these deleterious fitness effects are multifaceted, through endocrine disruption (adrenocortical stress response, pituitary hormones), increased oxidative damages, telomere attrition, metabolic impairments and interactions with reproductive costs. These studies also show that the different types of contaminants target specific hormonal pathways and can even exert opposite effects on key physiological mechanisms (basal metabolic rate, glucocorticoids secretion).

Mots-Clés: Ecophysiologie, ecotoxicologie, contaminants, hormones, reproduction, oiseaux

The Eco-physiology of infanticide in corn-fed European hamsters due to nicotinamid deficiency

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With agriculture intensification, farmland species are restricted to monotonous diets. In Western Europe, the European hamster (*Cricetus cricetus*) is particularly threatened by corn and wheat monocultures, resulting in a substantial decrease in reproductive success. However, the underlying mechanisms responsible of this phenomenon still remain to be fully investigated. To tackle this issue, we designed an experimental study to understand how corn- and wheat-based diets modulate hamsters' reproduction. We fed 30 reproductive females with corn or wheat, supplemented with 5g of proteins/day (earthworms or clover). Females fed with corn-based diets showed a reduction of up to 75% of their reproductive success compared to wheat-fed females, mainly caused by a high rate of infanticides. However, these reduced reproductive rate were not associated to a reduction in body mass or in oxytocin plasma levels. In fact, corn-fed females were the heaviest and had the highest oxytocin plasma levels. Nonetheless, the few pups raised by these females were up to 45% lighter at weaning than pups from wheat-fed females. In a second experiment, we demonstrated that a nicotinamide supplementation – known to be lacking in corn – completely restored maternal behavior, pups growth and ultimately females' reproductive success. Given the importance of niacin in red-ox reactions (through its implication in NAD and NADP synthesis), we evaluated the diet effects on hamsters cellular ageing by measuring telomere length in white blood-cells. Females supplemented with nicotinamide tended to have longer telomeres and greater telomere loss reflecting their higher investment in reproduction. However, because of high inter-individual differences, these tendencies were not significant. Taken altogether, our data suggest that the observed decrease in hamsters' reproductive success in Alsace is partially owing to nicotinamide unbalanced metabolism caused by intensive corn monoculture. Our research is now focusing on finding crop-associations of agronomic interest that could be beneficial to hamsters.

Mots-Clés: Maize, Fitness, Niacin, Pellagra, Micronutrient deficiencies, Reproduction, Conservation

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Differential effects of wastewater exposure on subtropical Mangrove crabs: towards the identification of vulnerable species

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Mangroves forest are increasingly used as bioremediation tool for wastewater (WW) treatment in tropical countries. If mangrove trees benefit from this nutrient load, the impact on the associated macrofauna is unclear. In Mayotte (Comoros archipelago), a pilot study started in 2007 involving the discharge of domestic effluent following primary treatment.

We investigated the effects of this WW on physiological parameters of three key-engineering mangrove crabs: *Uca urvillei*, *Neosarmatium meinerti* and *Perisesarma guttatum*. WW consists of a cocktail of contaminants (containing notably high ammonia levels) and could induce a salinity stress (seawater to freshwater). The O₂ consumption rate of submerged and emerged crabs in SW, FW and WW and their osmoregulatory response against salinity change from 0 ‰ to 50 ‰ were investigated. For *U. urvillei*, the effect of WW exposure on the redox metabolism (catalase activity in gills and reactive oxygen species (ROS) formation in hemolymph) was also evaluated.

Results showed that *U. urvillei* is physiologically tuned for low salinity but exposure to 0 ‰ induces high mortality. *N. meinerti* and *P. guttatum* are stronger hyper/hypo osmoregulators. WW exposure induces a burst in O₂ consumption rate for *N. meinerti* and *U. urvillei* (by 3- and 4-fold respectively) but a metabolic depression for *P. guttatum* that breathes normally in air after acute exposure. These differences in respiration rate imply different sensibility to WW exposure between species. WW also induces ROS production as well as catalase activity in *U. urvillei* but did not impair osmoregulatory capacity compared to FW stress. Even if previous results revealed less mortality on *N. meinerti*, its osmoregulatory capacity was affected. Therefore, this differential vulnerability towards WW must be considered in order to provide adequate conservation measures when mangroves are used as biofiltering system.

Mots-Clés: Crab, wastewater, respirometry, ROS

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Artificial light at night perturbs the energy balance and activity of common toad during breeding period

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Over the last 100 years, the extension of cities and road networks that are illuminated at night modified the daily cycle of light and dark. Artificial light at night, termed light pollution or ALAN, may directly affect individual's physiological condition of many organisms because it disrupts physiological processes, such as hormonal regulation, body temperature of endotherms, energy expenditure, timing of daily rhythms or food intake. As a consequence, nocturnal light pollution can lead to fatigue, functional disturbances and pathological disorders. Because, among vertebrates, amphibians host a large proportion of nocturnal species (93%), whose activities and movement strongly depend on absence of light, this group may likely be affected by ALAN. Here, we experimentally exposed male toads (*Bufo bufo*), during the breeding period, at three intensities of nocturnal artificial light (0.1, 5 and 20 lux) and we studied the impact of ALAN on locomotor activities, energy balance and oxidative stress. Nocturnal light pollution increased toad mass gain, without affecting their food intake but by reducing their locomotor activity and their energy expenditure. In particular, the optional energy expenditure (linked to physical activities and digestion metabolism) of toads was impaired from the first night of exposure (~30% down) but after 20 days of exposure, it returned at the control level for 5 lux group, whereas it dramatically dropped for 20 lux toads. In the same time, antioxidant defences increased leading to a decrease of total oxidative damages. These results suggest that ALAN highly impacted the regulation of the energy balance in this species.

Mots-Clés: Light pollution, metabolism, oxydative stress, amphibian

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Session 3

Ecophysiology in free ranging animals

1 - *Rey, B. et al.*

Physiological plasticity of free-living aardvark facing climate change

2 - *Dupoué, A. et al.*

Ecophysiological responses preceding population extinctions in wild lizards

3 - *Brischoux, F.*

Hypernatremia in marine snakes: implications for the evolution of euryhaline physiology

4 - *Georges, J.Y.*

Overwintering survival and behaviour of captivebred released European pond turtles *Emys orbicularis* on Site du Woerr, Alsace, NE of France

5 - *Hicks, O. et al.*

Evidence for the energetic cost of parasitism

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Ecophysiology of elephants to better understand their crop selection: first results of a case study from Gabon

7 - *Cheyne, L. et al.*

Immunocompetence and telomere length in a wild long-lived mammal

8 - *Eckbo, N. et al.*

Indexing the impact of multi-factors on the status of Adélie penguins

9 - *Boël, M. et al.*

Une approche mitochondriale pour étudier la relation entre le métabolisme et la taille des individus.

10 - *Mouzaia-Salhi, A. et al.*

Hibernation et fonctionnement de la glande thyroïde chez le hérisson d'Algérie (*Atelerix algirus*)

Physiological plasticity of free-living aardvark facing climate change

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Aardvark (*Orycteropus afer*) are keystone fossorial mammals distributed widely throughout sub-Saharan Africa except for the arid deserts. Because of their prodigious burrowing activity, aardvark provide refuges from extreme and fluctuating temperatures to many commensal species; in the context of climate change, such a role as ecosystem engineer is increasingly important for promoting African biodiversity.

Aardvark are listed as Least Concern in the IUCN Red List categories, however, reliable information on aardvark populations distribution and density lacks in the literature. Furthermore, while their habitats are predicted to become hotter and dryer, physiological and behavioral capacity of aardvark to cope with climatic stressors is currently unknown.

We captured seven free-living aardvark in the South African Kalahari and implanted them with abdominal temperature recording biologgers, motion sensors and tracking telemeters to investigate their thermoregulatory competence and behavioral plasticity in response to environmental changes.

During a particularly hot and dry summer, six of the studied aardvark -along with eleven other aardvark- died at the study site. Initially, their body temperature records showed good homeothermy but heterothermy increased progressively through the summer (amplitude of 24h body temperature rhythm increasing from $1.73 \pm 0.29^\circ$ to $3.77 \pm 31^\circ\text{C}$) while body temperature dropped to as low as 25°C from which the aardvark did not recover. The motion sensors revealed a marked shift of activity patterns from almost exclusively nocturnal to a diurnal mode during the drought. Despite these physiological and behavioral adjustments would have reduced energy demand, our data indicate that aardvark were facing energetic stress causing progressive loss in body condition and suggest that death occurred after prolonged starvation due to prey (ant and termites) scarcity. Further drought episodes are to be expected in the Kalahari with a feared impact on aardvark populations and underestimated impact on local biodiversity.

Mots-Clés: climate change, body temperature, physiological flexibility

*Intervenant

Ecophysiological responses preceding population extinctions in wild lizards

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Identifying the early warning signals of catastrophic extinctions has recently become a central focus for ecologists. In vertebrates, hormone such as corticosterone at the baseline level may correlate with population state since its secretion to chronic stress can impair survival and reproduction. Besides, telomere length (TL) may correlate with early population decline, since telomere attrition is associated with aging processes and accelerates after a recurrent exposure to environmental stressors. In the southern margin of their range, populations of the common lizard (*Zootoca vivipara*) recently became extinct at lowest elevations due to changes in climate conditions. In summer 2015, we sampled 14 natural populations along the extinction risk gradient. We used cross-sectional studies in which we compared the relationships between baseline corticosterone levels, TL, climatic conditions and population extinction risk. We also used a longitudinal study in 8 populations to examine the effects of an extreme heat wave period on changes in corticosterone levels. Contrary to our expectations, we found that corticosterone decreased with increasing thermal conditions, and was not correlated with extinction risk. Similarly, corticosterone decreased following the exposure to an extreme heat wave period, especially in the populations without access to standing water. Lowering corticosterone level might therefore help down-regulating behavioural activity to limit the costs of the exposure to abnormally high temperatures. We found a non-linear relationship between TL and population extinction risk, with extremely short telomeres in collapsing populations when compared to non-threatened ones. Altogether, our results suggest pervasive effects of climate change since lizards seem to not perceive increased temperatures as stressful conditions, while those may cause an irreversible loop of physiological aging leading to population collapse.

Mots-Clés: climate change, corticosterone, ectotherm, population extinction, telomere, temperature

*Intervenant

Hypernatremia in marine snakes: implications for the evolution of a euryhaline physiology

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Secondary transitions from terrestrial to marine life provide remarkable examples of evolutionary change. Although the maintenance of osmotic balance poses a major challenge to secondarily marine vertebrates, its potential role during evolutionary transitions has not been assessed. However, the widespread relationship between salt excreting structures (e.g., salt glands) and marine life strongly suggests that the ability to regulate salt balance has been crucial during the transition to marine life in tetrapods. In the current presentation, I review the role of oceanic salinity as a proximate physiological challenge for snakes during the phylogenetic transition from the land to the sea. A review of osmoregulatory physiology in species situated along a continuum of habitat use between fresh- and seawater shows that snake species display a concomitant tolerance toward hypernatremia, even in species lacking salt glands. Free-ranging marine snake species usually display hypernatremia despite having functional salt glands. Overall, sea snakes exhibit a marked tolerance to salt load compared to other marine tetrapods and apparently trigger substantial salt excretion only once natremia exceeds a high threshold. Collectively, these data suggest that a physiological tolerance toward hypernatremia has been critical during the evolution of a euryhaline physiology, and may well have preceded the evolution of salt glands.

Mots-Clés: natremia, osmolality, salinity, tetrapods

Overwintering survival and behaviour of captive-bred released European pond turtles *Emys orbicularis* on Site du Woerr, Alsace, NE of France

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Evaluating the success of (re-)introduction of species consists in measuring, at first, the survival of released individuals. This is particularly relevant for captive-bred individuals since several studies have reported relatively low survival in start headed individuals, including pond turtles. Yet, captive-breeding and releasing protocols are highly variable so that results cannot be generalised. Identifying the factors of individual survival, both environmental (e.g. weather conditions, habitat quality) and individual (e.g. health status, behaviour, etc.) is primordial for better assessing (un-)success, and propose potential enhancements of such conservation actions. Part of a program of reintroducing captive-bred European pond turtles *Emys orbicularis* in Alsace (NE of France), a first group of 15 subadults (6-7 yr old) raised at Petite Camargue alsacienne research station (St Louis, France) have been released in the dedicated Site du Woerr (Lauterbourg, France) in late summer 2013. Before their release, 9 of these turtles were fitted with a miniaturized pressure/temperature/light recorder (IPHC-made WACU loggers, <http://www.iphc.cnrs.fr>) sampling at 1 Hz.

Successive recapture sessions in spring 2014 permitted to recover all 15 individuals. During these 5-mo winter, turtles lost 0.6 ± 1.0 g/month (0.7 ± 1.0 g/month for equipped turtles) for an initial body mass averaging 210 g (range = 162-263 g). The diving behaviour of the turtles changed throughout winter, with fewer but longer apneas as temperature decreased, so that in deepest winter (water temperature between 6°C and 9°C), turtles only surfaced to breath once every 24 hours. These record apneas mostly occurred when water temperature was < 8.5 °C, suggesting a thermal threshold above which other activities occur.

Additional releases in 2014 and 2016 do confirm the very high survival the European pond turtles in Alsace, with a population presently strong of 80 individuals.

Mots-Clés: ectotherms, temperature, diving, reintroduction

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Evidence for the energetic cost of parasitism

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Many species exhibit reproductive skew with some individuals consistently more successful than others. The mechanisms underpinning this skew are often poorly understood yet can help us understand how individual variation can have consequences for population level changes. Recent work has illustrated that parasitism may play a crucial role in driving reproductive skew but may have differential impacts in different environmental conditions. We suggest that our understanding of how parasitism interacts with both intrinsic drivers and environmental conditions to determine breeding performance can be greatly improved by considering energetics, since many life-history processes can be quantified through their impacts on rates of energy use and gain. Using a novel endoscope technique to quantify parasite load and tri-axial accelerometers to estimate behaviour-specific energy expenditure in European shags we are able to determine the energetic cost of parasitism and understand how individual responses may vary with changing environmental conditions. Here we present analyses on a population of European shags that suggest that the cost of different behaviours varies with parasite load and environmental conditions. This work provides a potential mechanism linking the energetic cost of parasitism to its role in driving reproductive skew, which may ultimately be influencing population success.

Mots-Clés: Energetics, Parasitism, Life, history, Flight

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Ecophysiology of elephants to better understand their crop selection: first results of a case study from Gabon

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Parasites and hormones are one of the best indicators of animal ecophysiology which clarify the role and importance of physiological processes in the ecological relations of species in their natural habitat. As damages on crops are often sources of conflict between humans and elephants in elephant home ranges, few data on the relevance of elephant physiology on crop selection exist. For that we investigate elephant ecophysiology to better understand if their parasitism and stress conditions underlie their crops selection. For that we measured parasite loads and stress hormone levels in feces of some elephants eating banana and others eating natural food. We conducted the study during fifteen months covering five different local seasons of the research site in Mont de Cristal, Gabon. Here we report first results from two seasons. We collected 485 samples of elephant dungs and more than 1200 samples of food items eaten by elephants. While stress levels are not correlated to banana selection, the presence of parasites is. Our results show higher parasite loads in dungs of elephants eating banana than in those of elephants eating natural food resources species. Thus elephants may eat banana more as a medicine item than a food resource. But we still need to confirm these results by assessing this trend over seasons and with reproduction hormones.

Mots-Clés: elephants, crops, hormones, parasites, ecophysiology

*Intervenant

Immunocompetence and telomere length in a wild long-lived mammal

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In animals most physiological functions decline with age. This is notably the case for the performance of the immune system, a process called immunosenescence that leads to an increased sensitivity to pathogens, a higher risk of contracting diseases and an increased mortality risk. Altered efficiency of the immune response at old ages is the consequence of numerous age-related changes in immune effectors, like a decrease in the quantity and the diversity of antigen repertoire, an increase of impaired immune cells and an increase of deleterious inflammatory effectors. The decrease in immune cells quantity with age can potentially be caused by replicative cells senescence, resulting from progressive decline in the length of protective telomeres at chromosomes ends. On other words, progressive telomere erosion in immune cells like lymphocytes, with successive rounds of cell divisions, could be one mechanism that underlies immunosenescence. We recently observed that wild populations of long-lived roe deer suffer from immunosenescence. Thus we hypothesised that this decline in immune function could be associated with accelerated telomere erosion in leukocytes. Using qPCR method, we measured telomere length in males and females roe deer, captured in 2016 and 2017 in two populations living in contrasted environments. We then tested if immune competences match variation in leukocyte telomere length. I will discuss effects of sex and environmental conditions in the relationship between telomere length and immunocompetence.

Mots-Clés: immunosenescence, telomere length, aging, life history traits, wild, mammal, roe deer

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Indexing the impact of multi-factors on the status of Adélie penguins: a study case of breeding and contaminant indices

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A common question in ecological studies is that of quantifying the impact of multi-factors on the status (e.g. physiological) of animals. In other words, how to rank individuals based on their status as a function of both intrinsic and extrinsic fluctuating conditions. Such effective ranking algorithms, based on heterogeneous ecological variables, are also of great value for conservation actions. We present a theoretical framework based on machine learning and ranking algorithms that allow us to separate the process into two well differentiated stages. First, we apply a dimensional reduction procedure in our data to obtain a one-dimensional score. Secondly, we apply a nonlinear transformation to maximize the agreement of the score with the desired measured effect. In this approach, the result from the first reduction stage can be seen as an exposure index to multiple effects, while the nonlinear version can be seen as a response index to those effects. We will show in detail two examples of use of the indices on the case of the Adélie penguin (*Pygoscelis adeliae*). First, we will link a number of contaminants with telomere lengths. During its lifetime, an individual will be exposed to a cocktail of contaminants (PFAS, Hg, POPs) with different chemical properties and toxicological potential. Here, one of our motivating questions is how to best extract a one-dimensional variable from the multidimensional space of contaminants that captures both the cumulative process of contaminant exposure and the toxicological weight of the single contaminants, and possibly sex differences in sensitivity to contaminants. Likewise, in a second example, we will show how a consistent ranking for individual breeding performances can be built based on life history data (e.g. cumulative breeding attempts, success) and used to predict individual responses to the environmental variability.

Mots-Clés: index, individual status, telomere length, seabird, Polar Regions

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Une approche mitochondriale pour étudier la relation entre le métabolisme et la taille des individus

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Des études interspécifiques menées chez les mammifères ont montré qu'à l'échelle de l'animal entier la consommation d'oxygène spécifique des individus (exprimée par unité de masse) est négativement corrélée avec leur masse corporelle. A l'échelle cellulaire, l'oxygène est majoritairement consommé pour produire de l'énergie sous forme d'ATP, indispensable à la réalisation des performances individuelles (croissance, survie et reproduction). Cette conversion d'énergie est principalement catalysée par les mitochondries via l'oxydation phosphorylante des substrats énergétiques issus de l'alimentation. Cependant, durant ce processus biochimique, tout l'oxygène consommé n'est pas totalement converti en ATP, 20% étant dissipés sous forme de chaleur pour contrebalancer les pertes énergétiques ou " fuites de protons ", indissociables de cette conversion d'énergie, et 1-3% étant utilisés dans la génération de radicaux libres de l'oxygène. Ainsi, la consommation d'oxygène seule ne permet pas d'évaluer la quantité d'ATP produite, que les individus peuvent réellement investir dans leurs performances. Pour corréliser ces deux paramètres, l'intensité des fuites de protons doit être prise en compte afin de déterminer l'efficacité de l'oxydation phosphorylante servant à produire de l'ATP à partir de l'oxygène (ATP/O). Le but de notre étude est de mesurer les trois composantes de l'oxydation phosphorylante mitochondriale (consommation d'oxygène, synthèse d'ATP et efficacité) dans les tissus musculaire et hépatique, puis de corréliser ces mesures avec la masse corporelle d'un large panel d'espèces mammaliennes. Les fuites de protons sont négativement corrélées avec la masse corporelle des mammifères, suggérant que les plus gros mammifères ont une meilleure production d'ATP. Nos résultats montrent que la consommation d'oxygène et la synthèse d'ATP des mitochondries musculaires et hépatiques sont négativement corrélées avec la masse corporelle. En revanche, l'efficacité mitochondriale de l'oxydation phosphorylante (ATP/O) reste constante quelle que soit la masse corporelle de l'espèce considérée ; elle serait une des rares fonctions métaboliques indépendante de la masse corporelle.

Mots-Clés: Consommation oxygène, synthèse ATP, efficacité mitochondriale, mammifères

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Hibernation et fonctionnement de la glande thyroïde chez le hérisson d'Algérie (*Atelerix algirus*)

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Résumé

Le hérisson d'Algérie est un hibernant vrai manifestant des hypothermies profondes au cours de l'automne et l'hiver. L'hibernation se définit par des changements métaboliques : de prise alimentaire, d'activité et de composition corporelle. La fonction thyroïdienne intervient dans la régulation du métabolisme énergétique et pourrait ainsi jouer un rôle dans le contrôle de l'hibernation. Dans ce contexte, nous avons recherché chez le hérisson d'Algérie les différentes variations structurales (anatomiques, histologiques) et physiologiques (hormonales) de la glande thyroïde qui peuvent se manifester pendant et après l'hibernation. Pour cela, nous avons prélevé la glande thyroïde chez des hérissons d'Algérie et effectué un dosage de la thyroxine durant différentes saisons (automne, hiver, printemps). La masse de la glande thyroïde a montré une variation saisonnière bien marquée par une fluctuation entre les valeurs maximales (47,2 mg) en hiver et les valeurs minimales au printemps (21,1mg). L'étude histologique de cette glande, en se basant sur la structure du follicule a clairement montré des changements cycliques de l'activité de cette glande, caractérisés par un repos automnal, une reprise hivernale et une séquence d'activité maximale printanière. Cette activité cyclique a été confirmée par des concentrations plasmatiques de thyroxine minimales en automne, ré-augmentant en hiver pour atteindre un maximum au printemps. Les hormones thyroïdiennes joueraient donc un rôle de signal d'entrée en hibernation et de passage à la vie active.

Mots-Clés: *Atelerix algirus*, torpeur, hibernation, glande thyroïde, thyroxine

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Session 4

Plasticity and individual quality

1 - Meniri, M. et al.

Morphological and physiological shortterm consequences of a bad start in the Seba's shorttailed bats

2 - Stier, A. et al.

Embryo growth rate and stability influence telomere length: new insights from an avian model

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Effects of an early-life stress exposure on adult resistance to oxidative stress, plumage colour and sperm performance in a wild bird

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Testosterone, vocal sac coloration and bio-availability of carotenoids in *Hyla Arborea*

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Identification of small Open Reading Frames (ORF) in avian 16S mitochondrial rRNA genes

9 - L'Honoré, T. et al.

Phenotype plasticity in freshwater acclimated sea bass

Morphological and physiological short-term consequences of a bad start in the Seba's short tailed bats

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The environment that individuals experience during their early life can have major consequences on their life histories. Oxidative stress has been hypothesized to be one of the mechanisms leading to short- and long-term negative consequences of a poor start.

Since many tropical bats undergo substantial variation in food availability within short time-spans, and because very little is known about how they cope with transient food shortage, we restricted the food availability for Seba's short-tailed bat (*Carollia perspicillata*) mothers of unweaned pups during 10 days, followed by *ad libitum* provisioning. We also had a control, unrestricted group. We explored the morphological and physiological short-term consequences of a poor start by measuring growth rate (size and mass) from birth until the end of growth 48 days later. We also measured three markers of blood oxidative balance immediately after the food restriction and at the end of growth. Finally, we assessed the level of cortisol, and its inactive form cortisone, in the hairs of the pups, as markers of the hypothalamus-pituitary-adrenal stress response.

Food restriction triggered a slowdown in growth followed by compensatory growth in size, with restricted individuals growing at a higher rate when *ad libitum* was restored compared to control individuals. Eventually, restricted pups managed to fully compensate their bad start. We predicted that increased growth rate would entail physiological costs on the short term. However, by the end of growth, we found no evidence for physiological costs linked to compensatory growth, neither for oxidative stress nor HPA response. Individuals now need to be monitored on the long term to investigate potential long-lasting effects of a difficult start. Nevertheless, this study highlights the extreme plasticity in growth of tropical bats, which likely undergo great variation in food availability in the wild.

Mots-Clés: oxidative stress, early life, bats, cortisol

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Embryo growth rate and stability influence telomere length: new insights from an avian model

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Telomere length is increasingly used in ecophysiology as a biomarker of future survival prospects in wild and captive vertebrates. While the potential impact of post-natal environmental conditions on telomere length has received considerable attention in the past decade, there is little information on the importance of pre-natal environmental conditions for telomere dynamics despite their known impact on subsequent health, fertility and lifespan in both human and captive mammalian models.

Mammalian models do not allow experimental manipulation of embryo development independently of maternal influence and nutritional state (*i.e.* without the mother potentially compensating for any manipulation). Therefore, we developed an avian model that allowed us to control the rate and stability of embryo growth through fine-scale modulations of incubation temperature. Incubation temperature has profound consequences for offspring phenotype, yet is variable in nature, being affected both by parental incubation behaviour and by current environmental conditions.

We incubated Japanese quail eggs under 4 different experimental thermal conditions: control (37.6°C), warm (38.2°C) and cool (37.0°C) (which would speed up and slow embryo growth rate respectively), and also fluctuating (37.0°C with five 30 min incubation recesses to 28°C per day). We collected blood samples from embryos at a standardized developmental stage, and also blood samples at birth, during peak growth and at adulthood to investigate the impact of pre-natal environmental conditions on pre- and post-natal telomere length and dynamics. We measured telomere length using the terminal restriction fragment (TRF) method since the classically used qPCR was not appropriate for our study species. I will present preliminary data from this experiment and discuss briefly the potential perils of using qPCR for measuring telomere length in ecophysiological studies.

Mots-Clés: Telomere, ageing, early, life, trade, offs, embryo

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Effects of an early-life stress exposure on adult resistance to oxidative stress, plumage colour and sperm performance in a wild bird

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Early-life stressful conditions can shape individual phenotypes and ultimately influence fitness. Oxidative stress is a pervasive threat that affects many fitness-related traits and can modulate life-history trade-offs. Yet, the extent to which exposure to oxidative stress during early life can have long-lasting effects on key fitness-related traits remains to be elucidated, particularly in natural populations of vertebrates.

Using a wild-population of great tits *Parus major*, we experimentally mimicked an acute exposure to oxidative stress in 11 day-old birds by dosing them with paraquat, a pro-oxidant molecule. One year later, we recaptured 39 of them as adult recruiting breeders and quantified effects of the paraquat exposure on their resistance to oxidative stress, carotenoid-based plumage colouration and male sperm performance.

Pre-fledging exposure to paraquat induced a reduction in individual oxidative damage measured at adulthood. Further, paraquat-dosed individuals had brighter plumage, but no effect was observed on male sperm performance.

For the first time in a natural population of vertebrates, we experimentally show that an early-life acute exposure to reactive species has long-lasting effects on individual resistance to oxidative stress at adulthood. Our results are in line with the environmental matching and the hormesis hypotheses but may also reflect selective disappearance of individuals with lower resistance to oxidative stress.

Mots-Clés: early environment, long, term effects, oxidative damage, plumage colour, sperm performance

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Testosterone, vocal sac coloration and bio-availability of carotenoids in *Hyla arborea*

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Numerous species use coloured sexual signals in intersexual communication during reproduction. In most of cases, red-orange coloration is linked to carotenoid pigments in integument of animals. Coloured sexual signals have often been shown to be testosterone dependent. Carotenoids, which have antioxidant properties and enhance immune system function, are a key molecule in the honesty of coloured signal. The red coloration of the vocal sac of *Hyla arborea* males, an attractive signal for females, was maintained during the breeding period by high testosterone levels. We hypothesized that testosterone levels could modulate the distribution of carotenoids among the liver, the plasma and the vocal sac to maintain the attractiveness of male. During 20 days at the beginning of the breeding season, we experimentally modified the testosterone level of males and we qualitatively and quantitatively analysed, the carotenoids present in liver (for storage forms), plasma (for circulating forms) and vocal sac (for the ornamentation function) using a high-performance liquid chromatography tandem with mass spectrometry. Our results highlighted that composition in carotenoids differed among physiological compartments, the most variability were found in the vocal sac. We did not highlight a significant testosterone effect on the carotenoids distribution among physiological compartment. However, our results show a time variation of the carotenoids distribution in the vocal sac that partly could explain the vocal sac coloration variation and are in agreement with their supposed functions.

Mots-Clés: Amphibian, carotenoid pigment, coloration, liver, plasma, sexual signal, steroid hormone, vocal sac

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Is corticosterone more than a metabolic hormone?

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The metabolic function of Glucocorticoids (GCs) is thought to be ubiquitous across vertebrates, but direct tests of this function appear to be non-existent. Furthermore, whether the predicted association between GCs and metabolism depends on the cause of variation in metabolism remains unexplored. We studied the relationship between plasma corticosterone (CORT) and metabolic rate (MR) in captive zebra finches, using two different stimuli to increase MR: temperature and a psychological stressor, that induced similar increases in MR. For each individual we measured MR during three trials with respectively low MR (22°C during 3h), higher MR through increased thermoregulatory costs (1.5h at 22°C followed by 1.5h at 12°C) and higher MR through psychological stress (3h at 22°C with 15 min of human and predator noise preceding the end of the trial). CORT was measured in samples collected at the end of each trial. At the between-individual level, we found a positive relationship between CORT and MR, with an accelerating slope towards higher values. In contrast, the within-individual changes in CORT and MR in response to high energetic demands were linearly correlated between individuals. These associations were independent of the trigger of the increase in MR, with the association under psychological stress being indistinguishable from the other two trials. Our findings confirm the interpretation of CORT variation as indicator of metabolic needs, over a wide range of CORT variation, including CORT concentrations falling into baseline and stress-induced ranges. Furthermore, the association between CORT and MR was independent of treatment. This suggests that GC differences are mainly driven by differences in energy expenditure, independently of what is commonly labelled as ‘stress’.

Mots-Clés: corticosterone, metabolic rate, stress response

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Sensitivity of *Alphitobius diaperinus* (Coleoptera: Tenebrionidae) continuously exposed to one or multiple abiotic constraints

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Because of their ectothermic nature, the responses of insects to adverse thermal conditions have been intensively investigated over the past decades. Several other abiotic components may vary and become stressful at the same time, but the interactive effects of these abiotic factors on insect survival and physiology remains understudied. In the present work, we have examined if an exposure of the insects to multiple environmental constraints would result in additive, synergistic or antagonistic responses. To address this question, we worked with the lesser mealworm *Alphitobius diaperinus* (Tenebrionidae), as this insect can survive for several weeks when exposed at different abiotic stressors (temperature [10°C], desiccation [0% relative humidity], starvation, insecticide [Solfac 10]). These constraints were applied alone or in combination (simultaneously or successively), and we monitored beetles' locomotor activity and survival, and compared adults' physiological responses (antioxidant capacity, metabolic profiling). Antagonistic responses were observed when starvation was combined to desiccation, *i.e.* the survival of the insects was increased as compared to the exposure at one or the other stress. When beetles were subjected to thermal stress combined with one of the three other constraints, additive effects were recorded. Responses to joint exposures to starvation + pesticide and desiccation + pesticide were synergistic. Physiological analyses, and more particularly metabolomics approaches, allowed us to discriminate the three types of effects. Insects that have been exposed to experimental conditions including temperature were characterized by increased amounts of amino acids. Insects exposed to conditions that included starvation were characterized by decreased amounts of sugars, and insects exposed to a single stressor separated from the two other groups. This study demonstrated that our knowledge of the responses of insects to the multiple environmental constraints of their habitats may greatly vary as compared to exposure to single stressors.

Mots-Clés: insect, survival, metabolomics, multiple stressors, additive effect, antagonistic effect, synergistic effect

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Lizards on the peak: Hypoxia induces physiological responses and bears performance consequences in Common Wall Lizards transplanted to high elevations

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As climates continue to change, formerly inhospitable habitats at high elevations have warmed to become suitable for some low-elevation species. In France, the widely distributed Common Wall Lizard (*Podarcis muralis*) lives generally at low elevations, but can be found up to 2500 m above sea level. While warmer mountain climates may allow colonization of higher altitudes, we do not understand how reduced oxygen availability will affect lizard physiology, performance, reproduction, and ultimately fitness. To test the within-individual plastic response to acute moderate hypoxia, we kept adult male lizards (N = 86) at two laboratories: at the CNRS research station in Moulis, France (436 m above sea level) and at the Observatoire du Pic du Midi (2877 m above sea level) and measured performance and physiological traits at three time points over six weeks. We found that lizards at high altitude reached exhaustion more quickly, though sprint speed did not differ between groups. Correspondingly, we found that post-exercise maximal metabolic rates were higher in lizards kept at low altitudes. To test for underlying physiological responses that may compensate for high-altitude hypoxia, we also measured blood parameters related to oxygen transport. Lizards at high altitude increased packed red blood cell density (haematocrit) but did not change the number of red blood cells. Taken together, these results quantify the capacity of individuals to respond to novel oxygen environments over relatively short time periods, including physiological acclimation mechanisms and performance consequences.

Mots-Clés: elevation, haematocrit, hypoxia, metabolic rate, performance, *Podarcis muralis*, red blood cells

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Identification of small Open Reading Frames (ORFs) in avian 16S mitochondrial rRNA genes

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Birds have colonized many different environments indicating large abilities to adjust their mitochondrial metabolism to energetic constraints. Such abilities might potentially relate on a large plasticity in the expression of newly discovered regulatory peptides, called MOTS-c, Humanin and SHLPs 1 to 6 and encoded by small Open Reading Frames (ORFs) included in mitochondrial 12S and 16S rRNA genes as described in human and rodents. The existence of similar highly conserved ORFs in avian mitochondrial genome has therefore been investigated using a large scale in silico approach based on the alignment of available (NCBI database) bird mitochondrial genome sequences (561 species).

Results showed that the rate of polymorphism along avian 16S gene was heterogeneous regardless of rRNA secondary structure, with two highly conserved regions. Deeper analysis revealed the presence of 8 highly conserved ORFs in these conserved regions, including two sequences homologous to the encoding ORFs identified in human as Humanin and SHLP6. The other six ORFs found in avian sequences were different from those described in human or rodents. Further, the deduced amino-acid sequences potentially encoded by avian ORFs exhibited a lower mean peptidic p-distance and a similar mean non-synonymous substitution frequency than the other known bird mitochondria-encoded proteins. This indicated a higher conservation of the peptides potentially encoded by the conserved ORFs than the other known proteins encoded by mitochondrial genes, providing further support for the potentially biological encoding function of the detected ORFs.

In conclusion, our large-scale in silico analysis identified an unusual heterogeneity in the conservation of the avian 16S gene, with two highly conserved regions containing 8 ORFs found in all investigated bird species. Two ORFs were homologous to human or rodent Humanin and SHLP6. The other 6 ORFs have never been identified elsewhere. The potential regulatory role of these new putative peptides deserves more investigations.

Mots-Clés: Birds, Bioenergetics, Mitochondria, Genetic, Mitochondrial encoded peptides

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Phenotype plasticity in freshwater-acclimated sea bass

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Salinity acts as an important environmental factor for aquatic organisms. In fish, the regulation of intra- and intercellular solute levels and water balance has a direct impact on physiological functions, biochemical processes, and can influence behavior, distribution and survival. The European sea bass *Dicentrarchus labrax* undertakes seasonal migrations from seawater to brackish, estuarine and even fresh water. Preliminary work has shown differential mortality when juvenile sea bass face freshwater environments. In the wild, differential migration patterns have been found between individuals, either entering coastal lagoons or staying at sea. These distinct life-histories may be linked to differential physiological capacities to cope with salinity change and/or a differential habitat choice. We identified distinct phenotypes following freshwater exposure. The physiological and molecular bases of this variability in osmoregulatory mechanisms still remain to be investigated. For this purpose, juveniles *D. labrax* were transferred from seawater to fresh water during 3 weeks, in order to discriminate between tolerant and non-tolerant phenotypes according to their behavior. About 10% of fish were isolated due to behavioral features such as erratic swimming behavior, lower speed, isolation from the shoal, darker color and sometimes floating on their back. Blood was sampled to determine the osmotic pressure, Na⁺ and Cl⁻ levels. Oxygen consumption has also been measured in normoxic and hypoxic conditions between different phenotypes and salinities. Significant lower blood osmolality and lower ion levels were measured in fish showing atypical behavior and were thus considered as non-tolerant to fresh water. Intraspecific plasticity in osmoregulatory strategies clearly deserves further attention.

Mots-Clés: Phenotypic plasticity, Osmoregulation, Metabolism, Intraspecific variability

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Session 5

Behavioural ecophysiology

1 - *Dunn, R. et al.*

The post-breeding diving behaviour of three auk species

2 - *Bauch, C. et al.*

Reproductive effort and telomeres: a longitudinal study in jackdaws

3 - *Viblanç, V.A. et al.*

Oxidative stress and reproduction in Columbian ground squirrels: constraint, cost or shielding mechanism

4 - *Helfenstein, F.*

Antioxidant allocation modulates sperm quality across changing social environments

5 - *Rimbach, R. et al.*

Alternative reproductive tactics in African striped mice: solitary roamers spend more energy than bourgeois males but grow less than philopatric males

6 - *Quque, M. et al.*

How can social organization explain the differences in longevity in the black garden ant (*Lasius niger*)

7 - *Siegwalt-Baudin, F. et al.*

Trophic ecology of the green turtle (*Chelonia mydas*) in the Caribbean: role on ecosystem dynamics in a colonization context of the invasive phanerogam *Halophila stipulacea*

8 - *Chaise, L. et al.*

Huddling and social thermoregulation of moulting female Southern elephant seals at Kerguelen island

The post-breeding diving behaviour of three auk species

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Many species of seabird have undergone recent population declines due to their sensitivity to multifaceted marine environmental change. In an effort to understand and address this, seabird movement, behaviour and energetics throughout the breeding season have been increasingly well studied in recent years. Despite this, insight into the behaviour and energy expenditure of seabirds upon their departure from the colony at the end of the breeding season is currently limited. This is an energetically demanding period throughout which high mortality is incurred. In-depth studies into behaviour during this time are therefore of high conservation importance. In order to describe the post-breeding foraging behaviour of three sympatric species, we deployed time-depth recorders on Atlantic puffins, common guillemots and razorbills on the Isle of May, Scotland. We hypothesised that despite diminished competition pressures during this period, caused by a lack of spatial constraint to the breeding colony, the diving behaviour of the three species would continue to differ systematically by body size. The foraging behaviour of all three species did vary throughout the months subsequent to departure from the colony. In addition to this temporal variation, post-departure diving behaviour also continued to be interspecifically dissimilar. Guillemots accessed deeper depths and participated in diving activity for a higher proportion of the day than both puffins and razorbills. The organisation of diving behaviour throughout the 24 hour period varied by month across all three species. Birds appeared to become increasingly time constrained during the winter months; high frequency diving became restricted to daytime periods, potentially challenging energetic balances. This is the first detailed, multi-species comparison of seabird diving within the Northeast Atlantic throughout the poorly studied, energetically demanding, post-breeding period. We provide unique insight into the behavioural plasticity that auks demonstrate in response to differing temporal environmental constraints.

Mots-Clés: seabird, behaviour

*Intervenant

Reproductive effort and telomeres - a longitudinal study in jackdaws (*Corvus monedula*)

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Where resources are limited, life-history theory predicts that the allocation of resources towards reproduction comes at the expense of somatic maintenance. The underlying mechanisms remain poorly understood. Telomere dynamics with its relation to survival in many species (including jackdaws) presents a candidate biomarker. Previous investigations in our study population of free-living jackdaws have shown that individuals with an experimentally increased reproductive effort suffered an increased rate of actuarial senescence, an effect we show to persist in an expanded data set. Our subsequent aim was to test if telomere dynamics mediate or reflect this trade-off between reproduction and lifespan. To this end, we applied a longitudinal brood size manipulation approach to increase or reduce brood size over life in jackdaw parents. Individual-based data on reproduction and blood samples for telomere analysis were collected during every breeding season since 2005. We find that telomere attrition rate did not differ between experimental groups, but the relationship between telomere length and survival was affected by reproductive effort. While there was no relationship between telomere length and survival in the group of parents raising reduced broods, in the group of parents raising enlarged broods only individuals with the longest telomeres survived. We discuss these results in a life-history context.

Mots-Clés: telomeres, survival, reproduction, lifehistory

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Oxidative stress and reproduction in Columbian ground squirrels: constraint, cost or shielding mechanism ?

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Oxidative stress has been proposed as a central causal mechanism underlying the life history trade-off between current and future reproduction and survival in wild animals. Mixed evidence suggests that maternal oxidative stress may act both as a constraint and a cost to reproduction (oxidative constraint and cost hypotheses). Other studies have reported a lack of association between reproduction and maternal oxidative stress. The oxidative shielding hypothesis offers an alternative explanation, suggesting that mothers may pre-emptively mitigate the oxidative costs of reproduction by increasing antioxidant defences prior to reproduction. We tested these alternative hypotheses using a longitudinal field study of oxidative stress levels in Columbian ground squirrel (*Urocitellus columbianus*), a sciurid rodent species that breeds on daily energy income. Elevated maternal oxidative damage before reproduction was associated with higher maternal investment in litter mass at birth, but not at weaning. Breeding females increased their antioxidant capacity and decreased their oxidative damage from birth to lactation, compared to non-breeding females measured at the same time periods. Our results provided little evidence for maternal oxidative stress acting as a constraint on reproduction in Columbian ground squirrels, but support the idea that oxidative shielding occurred to buffer potential oxidative costs of reproduction.

Mots-Clés: cost of reproduction, life, history trade off, mammal, oxidative shielding, oxidative stress, rodent

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Antioxidant allocation modulates sperm quality across changing social environments

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In promiscuous species, male reproductive success depends on their ability to mate with fertile females and on the fertilizing ability of their sperm. Sperm competition models predict that, owing to a trade-off between pre- and post-copulatory reproductive traits, males with lesser access to females should increase resource investment into those sperm traits that enhance sperm quality and fertilizing success. This prediction has been validated in several taxa, yet studies on the physiological mechanisms modulating ejaculate quality are lacking. Sperm cells are highly vulnerable to oxidative stress, which impairs male fertility. Therefore, males that better protect their sperm from oxidative stress are expected to achieve higher ejaculate quality. Based on theoretical expectations, and since social dominance is a major determinant of mating opportunity, we predicted that subordinate males should invest more into the antioxidant protection of their sperm in order to achieve higher ejaculate quality. We tested this hypothesis on wild-caught house sparrows *Passer domesticus*, by experimentally manipulating male social status. We measured cellular oxidative stress and enzymatic antioxidant activity in blood and sperm both before and after manipulating social ranks. Before manipulating the social status, ejaculate viability correlated with oxidative stress level in sperm, with dominant males producing more oxidized and less viable ejaculates. Further, males at the lower end of the hierarchy produced ejaculates of similar quality to those of dominant males. After experimentally manipulating the social status, males matched their ejaculate quality to their new rank, while increases in antioxidant investment into ejaculates paralleled increases in ejaculate viability. Our results highlight oxidative stress and strategic antioxidant allocation as important proximate physiological mechanisms underlying male reproductive strategies.

Mots-Clés: sperm competition, social dominance, antioxidants, oxidative stress, reproductive tactics, soma/germline allocation trade, off, sperm quality

*Intervenant

Alternative reproductive tactics in African striped mice: solitary roamers spend more energy than bourgeois males but grow less than philopatric males!

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In many species, males follow alternative reproductive tactics (ARTs), where one tactic (bourgeois) often has much higher reproductive success than alternative tactics followed by males with lower competitive ability. The extent to which ARTs differ in energetic costs is unknown, but important to understand the evolution of ARTs. We studied male African striped mice (*Rhabdomys pumilio*), in which males follow one of three ARTs: (1) small philopatric male that remains in his natal group; (2) solitary roamer, or (3) large bourgeois territorial breeding male which defends a territory with 2-4 breeding females. Roamers were found to have ten times higher reproductive success than philopatrics, but only 1/10 of the reproductive success of territorial breeders. We predicted that roamers will face higher energetic costs as they have larger home ranges and do not gain thermoregulatory benefits of huddling in groups at night. Using the ‘doubly labelled water’ method, we measured daily energy expenditure (DEE) of 30 males. Roamers had the highest DEE, most likely due to increased thermoregulatory costs at night, as only breeders and philopatrics benefit from social huddling. Roamers also have the lowest resting metabolic rate, possibly a mechanism to reduce overall energy expenditure. Adult philopatric males that remained at their natal nest instead of becoming roamers spent less energy than roamers and gained more body mass than bourgeois males and roamers, thereby increasing their competitive ability and thus the probability of switching to a tactic of higher reproductive success. Our results suggest that males following the best-of-a-bad-job tactic suffer energetic costs that might reduce the possibility of switching to the bourgeois tactic, indicating evolutionary trade-offs.

Mots-Clés: alternative reproductive tactic, daily energy expenditure, RMR, fitness

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How can social organization explain the differences in longevity in the black garden ant (*Lasius niger*)?

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Even facing similar conditions, individuals from the same species may have different longevities. Species-specific differences in social organization can explain part of this individual variation in longevity. Ants are an attractive model to study the links between longevity and social organization: colony's members are genetically close and there is a strict division of labour – with a caste system – covarying with ageing rates among castes (queens, foragers and domestic workers). Still, we need to learn more about the cellular pathways explaining these caste-depending ageing rates.

Thanks to a proteome analysis of these three castes in the ant *Lasius niger*, we have been able to highlight different protein patterns depending on the role of ants. Two results shed light on the way the social organization could affect longevity.

First, how ants interact and particularly make trophallaxes would conduct to isolate the queen. Thus, the queen is protected from pathogens without investing a load of her own energy in the immune system. This **social immunity** could lead the queen to invest the energetic surplus in reproduction or mechanisms aiming to avoid or repair damages to macromolecules (*i.e.* DNA, proteins, lipids, carbohydrates).

Secondly, workers are characterized by protein profiles with more proteins involved in the **ToR** (Target of Rapamycin) pathway. In ant's societies workers are more in contact with food and this activates the nutrient sensitive ToR pathway – known to shorten lifespan in many model systems.

Hence, through almost two distinct mechanisms the ants' social organisation could partially explain the coexistence of individuals with contrasted lifespans within the same species. In further studies, it will be necessary to test separately the influence of the age and caste.

Mots-Clés: ageing, proteomics, division of labour, eusociality, ToR, social immunity

*Intervenant

Trophic ecology of the green turtle (*Chelonia mydas*) in the Caribbean: role on ecosystem dynamics in a colonization context of the invasive phanerogam *Halophila stipulacea*

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Résumé

Invasive species in marine coastal habitats generally lead to worrying ecological modifications on ecosystems. The seagrass *Halophila stipulacea* has expanded since 2002 from the Red Sea to most Caribbean islands where it competes with native phanerogams. To identify possible factors able to control its expansion we focused on the trophic ecology of green turtles (*Chelonia mydas*), the only large herbivores present in the area. The concentration of immature individuals in Martinique, allowed us studying foraging habitat selection through direct observations, associated to spatial information and biocenosis characterisation. Food selection was described using video-records of individuals, preference indices and isotopic values from epidermal biopsy and plants samples. Energy, ash and nutrient contents were measured in tissues of plants, as explanatory factors for food selection. Conspicuous patterns of habitat use highlight high preferences for *Syringodium filiforme*-rich communities, but multispecific seagrass meadows with dominance of *H. stipulacea* were also selected. Green turtles preferentially chose to feed on native species (*Thalassia testudinum*), but *H. stipulacea* was not avoided. Isotopic signatures support these findings and provide data about turtle size-related preferences, with an important consumption of algae by young immatures as well as higher trophic levels, indicating that they still rely on animal matter in neritic environments. Lower C contents in algae and *H. stipulacea*, which could reflect lower fibre content, may explain that they are targeted by young individuals. Furthermore, algae do not contain lignin, and therefore are more digestible. Conversely, large immatures have a more efficient digestion system that permit the consumption of native lignin-rich phanerogams that have also higher energy contents. If *H. stipulacea* outcompetes native species in the future and does not satisfy turtle's energy requirements, this raises concerns on the future status of green turtle populations in Caribbean ecosystems.

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Mots-Clés: habitat selection, food selection, isotopic ratios, energy and nutrients content, sea-grasses, algae.

Huddling and social thermoregulation of moulting female southern elephant seals at Kerguelen Island

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Southern elephant seals (*Mirounga leonina*) alternate foraging periods at sea, where they replenish their body fuels, and periods on land where they fast to complete their breeding cycle and moult. Unlike most phocid species, southern elephant seals experience a catastrophic moult where they not only replace their hair but also their epidermis when ashore for approximately one month. Elephant seals are known to move about and aggregate while moulting on land, but few studies have investigated behavioural and physiological adaptations of this species during the moult. In addition to transect surveys on various habitats, 60 females captured and equipped with VHF transmitters were tracked between 2012 and 2016 on the Kerguelen Archipelago (colony of Pointe Suzanne) to study their habitat selection, aggregation behaviour, moult rate and heat loss (using infrared images) during the moulting phase. In addition, 9 animals were equipped with stomach temperature pills during 1-10 (5 ± 3) days in 2016. Our results showed that wallows were a warmer habitat compared to other substrate types (grass and beach). Females experienced maximised heat loss at the middle of their moult, where they selected preferentially wallows. Moreover, seals aggregated more in wallows compared to other habitat, and when the weather was deteriorating too. Gradient of body surface temperature and stomach temperature were inferior in females observed in aggregation compared to isolated animals. Finally, we found that individual moult rate was positively correlated to wallows use and tended to be correlated to aggregation rate. Our study suggests that huddling behaviour of southern elephant seals would bring thermal benefits associated to a social thermoregulation strategy to save energy during the

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moult (i.e. to minimise heat loss) and that wallows appear as a specific and favourable moulting habitat.

Mots-Clés: moult, marine mammals, phocids, heat loss, habitat use, infrared thermography

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Role of mucins and mucus production in the digestive system of the tropical orbicular batfish (*Platax orbicularis*): impact of nutritional and environmental conditions

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In teleosts, tegumental and digestive mucus play a key role in immunity, nutrient assimilation and hydromineral balance. It is mainly composed of glycoproteins (mucins). Mucus composition and production are dependent on the environment and can induce fish metabolism disorder. One of the most promising fish species for French Polynesian aquaculture is the orbicular batfish. But, this is threatened because of a widespread bacterium, *Tenacibaculum maritimum* inducing considerable economic losses to fish farms. Mortality only occurs when 2-months old juvenile batfish reared in bio-secured hatchery tanks are transferred to floating net-cages located in Polynesian lagoons.

Therefore, we focused on batfish intestinal mucus during development, testing different rearing conditions in bio-secured hatchery tanks (*T. maritimum* free), and during an experimental *T. maritimum* infection.

Mucus was characterized using histological techniques in 15 and 20 days post-hatching (dph) fish using open vs. recirculating rearing systems and clay- and probiotic-enriched open systems. Additionally, two nutritional conditions were tested: a reference diet (from rotifers, nauplii, artemia to micro-pellets during development) vs. a nauplii-lacking diet. Finally, the effect of *T. maritimum* on the epidermis and intestinal wall of naive batfish was tested by experimental infection in 50-dph juveniles in the open system.

We show that mucus production and mucin types are significantly modified during development and according to the different rearing conditions. At 15 and 20-dph, mucins are mainly acidic whereas in the later stage, mucins are mostly neutral. Nevertheless, infection in 50-dph fish has a strong effect on mucus composition and production, acid mucins becoming dominant 40h post-infection.

In conclusion, acidic mucins could optimize nutrient assimilation during the early development. The change of mucin composition following primo-infection may indicate either an effective immune defense towards *T. maritimum* attack or that batfish immunity is compromised. Further molecular studies are needed targeting known cellular and humoral immune factors.

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Mots-Clés: mucins, digestive system, environmental conditions, *T. maritimum*, *P. orbicularis*

Matrilysin (MMP-7) immunodetection in the seminal vesicle of the Libyan jird (*Meriones libycus*) during the seasonal reproductive cycle and after orchiectomy

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An immunohistochemical study of matrilysin (MMP-7) using the indirect method with streptavidin-biotin-peroxydase was carried out on the seminal vesicle of a nocturnal Saharan rodent, the Libyan jird (*Meriones libycus*) in order to investigate their involvement in the physiology of this organ and in the seasonal reproductive cycle. The animals were collected from their natural habitat (Béni-Abbès, Algerian Sahara) during the breeding period (spring and early summer) and the resting phase (late of summer, autumn and late of winter) of the seasonal sexual cycle. The castration was performed in the spring after ether anesthesia, and castrated *Meriones* were euthanized a month later. During the breeding period, the immunohistochemical signal of the MMP-7 was intense and essentially localized in the epithelial cells and smooth muscle cells (SMCs) with no immunoreactivity in the extracellular matrix and the secretion that abundantly fills the seminal vesicle lumen. In the quiescence phase and after castration the same pattern of immunostaining was observed, the epithelial cells and SMCs immunoreaction persisted, and the epithelial fold axis was enlarged and showed a slight dispersed immunoreaction. MMP-7 have a physiologic function in the Libyan jird seminal vesicle and may be involved in the tissue remodeling associated to the seasonal reproductive cycle as has been demonstrated for Siberian hamster ovaries (Shahed et al., 2015) and in the endometrium during menstrual cycle (Grzechocińska et al., 2017). MMP-7 could also be related to the fertilization process as it was postulated by Ferrer et al. (2012, 2016) which have demonstrated an MMP-2 presence in the inner acrosomal membrane at the moment of acrosome reaction.

Mots-Clés: Matrix metalloproteinases, seminal vesicle, matrilysin, reproductive cycle, tissue remodeling, extracellular matrix.

Study of the diversity of terrestrial isopodes in the Soummam Valley

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Pollution by pesticides mainly affects agricultural soils, which can have a detrimental effect on the populations present (pedofauna). In soil quality assessment some species are now used in the laboratory in standardized ecotoxicity tests. This is the case of terrestrial earthworms, collembola, snails, and Isopods, often used to measure the effects of pollutants by studying their survival, growth, reproduction and behavior of these products. Terrestrial Isopods are known for their major role in the functioning of the soil ecosystem by degrading organic matter and contributing to the structuring of soils. These species can be qualified as biological indicators, designated as an organism that informs us about the quality of the environment (or an environmental compartment). Our study consists of Knowledge on the diversity and biology of terrestrial Isopods, this group is very little known in Algeria. No study has been made on this macrofauna in the valley of the Soummam. Our work is carried out in five (05) different study stations, located in the Soummam valley. To carry out this step, two sampling methods were carried out: trapping by barber pots and captures by hand. The overall inventory of Isopoda species captured 1059 individuals belonging to three families: the Armadillidiidea (408 38.52% individuals represented by the species *Armadillidium vulgare*), the Armadillidea (152 14.35% individuals belonging to the species *Armadillo officinalis*), the Porcellionidea (499 47.12% individuals divided into three species *Porcellio laevis*, *Porcellio variabilis* and *Porcellionides pruinosus*). Through this first field of investigation, it was found, a remarkable abundance of the species *Armadillidium vulgare*.

Mots-Clés: Terrestrial isopods, Cloportes, Arthropods, Diversity, bio indicator

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What can we learn from body fuel and wing loading adjustments? From experimental studies to the management of wetlands and waterfowl.

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The starvation-predation risk trade-off predicts that birds should store important body fuels when the probability to cope with fasting periods increases but without impairing too much their flight escape capabilities. We conducted an experimental study in three duck species during winter where we increased disturbance/predation risk. We showed that body mass decreased up to a level in order to reach a definite optimal wing loading. Body mass remained at this downregulated level until the end of the risk manipulation. Investigations of body composition using labelled water revealed that this transient decline in body mass resulted from a controlled mobilization of body lipids although the body protein compartment was preserved. During this experiment, disturbed ducks maintained a mean adiposity above 14%. Overall, wing loading increased with the amount of body reserves, however the slope was higher in control than in disturbed birds ($p < 0,001$). Additionally to changes in plasmatic enzymes and metabolites relevant for detecting chronic stress (allostatic overload), we suggest that the relationship between wing loading and body reserves can be a valuable proxy to determine whether birds perceive or not disturbance as a threat similar to predation risks. Such an application has been performed on several wintering sites in France (program AVIPER) where nearly 1600 birds have been subjected to measurements of body condition and wing loading. The results we obtained show that overall, ducks responded to environmental pressures by maintaining biological parameters close to what we found in experimentally undisturbed birds. Those results support the need to consider controlled experimental studies before addressing ecological issues in wildlife management and to further incorporate conservation physiology into ecological models to better understand animal responses to pressing environmental challenges in order to support adaptive management plans

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for habitats and species.

Mots-Clés: body fuels, disturbance, predation risk, wing loading, adaptive management

First studies of the modalities of reproduction in *Boulengerula boulengeri* (Tornier, 1896), *amphibia gymnophiona (caecilia)*

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Boulengerula boulengeri is a gymnophionan amphibian (caecilian) belonging to the family Herpelidae. This lengthened species is endemic to the Usambara Mountains in northeastern Tanzania. Living in soggy soils, it burrows deeply in dry season, making it difficult to catch. Although being not considered as an endangered species, rapid changes in cultivation practices and local deforestation could alter its biotope and weaken the endemic biodiversity, as already observed for other caecilian species. This is the reason why the reproductive ecophysiology of *Boulengerula boulengeri* was undertaken and more especially the study of the female genitalia. Sexually mature females were collected locally each month from 2002 to 2003. Their left ovaries and oviducts were dissected, fixed and stored in 70% ethanol. After inclusion in paraffin, the organs were cut with a vertical (Minot) microtome in longitudinal or transverse 7 μ m sections. The histological study was carried out using modified azan staining. The various follicular stages have been described and it has been found that folliculogenesis is continuous. The observation of the corpora lutea allowed specifying what are the months of reproduction of this oviparous species. The evolution of the oviduct tissues during the year showed that the reproductive cycle was annual and strongly dependent on the seasons. This cycle can be divided into 3 periods: preparation for breeding (between July and September), breeding period (between October and January) and sexual rest (between February and June).

Mots-Clés: Amphibian, Caecilian, reproduction, sexual cycle, female

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Effect of mil on histomorphometry parameters in femur pups from rat fed high calorie diet

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The World Health Organization estimates that approximately 1.2 billion people in the world are overweight, of which at least 300 million are obese. The aim of this study is to test the effect of pearl millet extract seed on femur in pups from rats that intrauterine exposure to maternal obesity a cafeteria diet. Female Wistar rat were randomized in two groups: control group (CG) (n = 10) fed standard rat diet, experimental group (n = 20) fed cafeteria diet (CD) to induce obesity. Experimental group was divided into 2 groups: CD group (n = 10) and CD + aqueous extract of mil (AEM) with dose of 250 mg/kg body weight group (n = 10). Half of pups from dams was weighed and then sacrificed at the 12-days-old and the other half at 21-day-old. Femur, tibia and liver were removed and weighted. Macro and microscopic parameters of femur, tibia and liver were evaluated. Bone volume (BV), tissue volume (TV), bone surface (BS), and osteoid surface (OS) parameters of femurs were calculated. There were no significant differences in weight at the birth between offspring. Our finding significantly showed an increase in body weight, liver in pups of CD and CD+AEM groups compared to CG at time 12 and 21-day-old. We noted that phosphorus mineral content of 21-day-old pups from rats fed CD group significantly increased compared to CG group ($p < 0.004$). Our data revealed that cafeteria diet decreased BV/TV and OS/BS parameters in pups at 21-day-old of CD group compared to CD+AEM group ($p < 0.05$, $p < 0.0046$) respectively. We found that cafeteria diet induced steatosis disease in CD group compared with control group. High fat diet induces obesity in rats, and provokes overweight in the pups. This study demonstrated the efficacy of aqueous extract of mil in preventing histological and biochemical parameters induced by high calorie diet in pups from obese dams.

Mots-Clés: obesity, cafeteria diet, femur, rat, mil

Regional and general oxidative stress in hibernating brown bears

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Muscles play a crucial role in supporting overall health and wellness. However, muscle atrophy is an inevitable part of ageing and disuse (e.g. due to immobilization, sedentary behaviour, or microgravity). In particular, extended periods of inactivity in humans promote decreases in skeletal muscle strength and size. Although this is still debated, growing evidence suggest that oxidative stress possibly contributes to alterations of the muscle protein balance during disuse. Brown bears (*Ursus arctos*) exhibit unique muscle protein sparing during winter sleep and fasting. It could be that lower intensity oxidative stress could favor maintenance of skeletal muscle mass/function in inactive bears during hibernation. To test this hypothesis, Scandinavian brown bears were sampled in Dalarna County (Sweden) during their active and inactive periods. The general and regional oxidant/antioxidant balance and oxidative damages were explored. In inactive bears, increased systemic oxidant ability was paralleled by enhanced total antioxidant barrier, and a selective regulation of antioxidant enzymes. As a result, circulating oxidative damages during inactivity were restricted to a very small increase in lipid peroxidation, while protein carbonylation was decreased. In white adipose tissue, no change in the levels of peroxidized lipids and carbonylated proteins was found, while a global upregulation of antioxidant systems was observed during the denning period. Finally, the levels of mitochondrial enzymes were in line with a decreased production of reactive species in muscles of inactive bears, where a global induction of antioxidant systems was also observed. Levels of muscle protein carbonylation and lipid peroxidation were lowered during inactivity, while protein nitrosylation and DNA oxidation were increased. As a conclusion, this study suggests that oxidative stress is restricted to a minimum during hibernation in brown bears. This could be linked to the so-called cold response, which could hence contribute to muscle protein sparing.

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Mots-Clés: Hibernation, bear, oxidative stress, muscle sparing

Anatomo-histopathological aspects of some species of fish collected in the gulf of Bejaia (Algeria)

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The present study was devoted to an anatomo-histopathological analysis of eight fish species (*Merluccius merluccius*, *Liza aurata*, *Liza ramada*, *Sarpa salpa*, *Boops boops*, *Pagellus acarne*, *Gobius niger*, *Trachurus mediterraneus*) collected from the fishing port of Bejaia (Algeria). The aim of this work was to determine the impact of environmental stress on fish health. The morphological abnormalities were described with macroscopic and histological approaches. The macroscopic examination of all specimens of fish revealed various anatomical abnormalities in all parts of the body. Indeed, haemorrhagic lesions, deformations of the body and more particularly of the fins were observed as well as alterations of the color and the detachment of the scales. Several cases of opacity, exophthalmos and ocular haemorrhage were noted in some fishes. Some malformations in the liver and gonads with mild to severe parasitic infestations by *Anisakis sp.* (nematodes) were also recorded. Microscopic examination of the histological sections performed on modified parts previously detected by macroscopic examination made it possible to detect a set of perturbations of the tissues. In the liver, very marked internal parasitic infestations were observed in the lobules, as well as lymphocytic infiltrations, thrombosis and congestion of the blood vessels and necroses. Lesions of lens associated with detachments and windings of the retinal layers were observed in the eyes. In the female gonads, various atresic forms were noted associated with parasitic infestations by *Anisakis sp* located inside and at the periphery of the ovarian blades. These macroscopic and microscopic anomalies of fish living in a harbor area suggest that they are the result of the spread of pollution from the harvesting area.

Mots-Clés: Anomalies, fish, gulf of Bejaia, pollution, anatomo, histopathology

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Distribution of RFRP-3 and its receptors GPR147 and GPR74 in the active testis of *Gerbillus tarabuli*

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Rfamide-related peptide-3 (RFRP-3), the mammalian ortholog of Bird Gonadotropin-Inhibitory Hormone (GnIH) and its GPR147 and GPR74 receptors have been studied in *Gerbillus tarabuli* testes using an immunohistochemical approach. *Gerbillus tarabuli*, a desert rodent, was chosen for the seasonality of its reproductive cycle. It was a nocturne rat with a period of activity extending from April to November and a period of sexual quiescence in winter. The study was conducted in adults at active season. The results indicate that RFRP-3 was strongly detected in the spermatocytes I and Leydig cells. GPR147 and GPR74 were distributed differentially in the Leydig cells with a different intensity and also in the germline. GPR147 was only detected in spermatids at elongation step and in spermatozoa while GPR74 was essentially identified in spermatogonia, spermatocytes I and round spermatids. RFRP-3 appeared to be involved in all the phases of spermatogenesis. GPR74 seemed to act on gonial multiplication and meiosis and GPR147 during spermiogenesis. At the interstitial level, the action of RFRP-3 was mediated via both receptors with varying degrees. RFRP-3 seemed to be an important molecular marker of testicular seasonality in this species.

Mots-Clés: RFRP, 3, GPR147, GPR74, testis, spermatogenesis, *Gerbillus tarabuli*

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Utilisation des réserves énergétiques chez l'éléphant de mer austral femelle (*Mirounga leonina*) : approche méthodologique et résultats préliminaires.

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Certaines espèces animales ont un cycle de vie alternant des périodes de recherche alimentaire intenses et des périodes de jeûne long. Lors du jeûne, les seuls apports énergétiques proviennent alors de l'utilisation des réserves énergétiques constituées en amont. La mue des éléphants de mer austraux se déroule à terre, pendant un mois. Les animaux restent à jeun et font face à des dépenses énergétiques importantes liées à la perte de chaleur et au renouvellement de tout le pelage et de la couche cornée de l'épiderme. Les objectifs étaient 1) de comparer les différentes méthodes permettant d'analyser la dépense énergétique totale et les modifications de composition corporelle des animaux et 2) d'étudier la dépense énergétique et les modifications de composition corporelle des éléphants de mer austraux femelles au cours de la mue. Les méthodes s'appuyaient sur la consommation d'oxygène à partir des fréquences cardiaques, des données massiques et morphométriques, l'épaisseur du pannicule mesuré par échographie et l'impédancemétrie. L'étude de la consommation d'oxygène a permis d'estimer le taux métabolique des éléphants de mer lors de la mue. Les compositions corporelles obtenues par les données massiques et morphométriques ainsi que par celles d'épaisseur du pannicule étaient imprécises mais semblaient exactes comparées à la littérature. Elles indiquent que la composition corporelle des éléphants de mer semble peu varier au cours de la mue, que l'apport principal d'énergie provient de l'oxydation lipidique, les protéines utilisées participant majoritairement au renouvellement du pelage. Enfin, l'impédancemétrie, qui n'a pas pu être calibrée par une méthode de référence comme la dilution des isotopes, a fourni des résultats inexacts et dont la précision n'a pas pu être évaluée. Des études futures permettront de mieux calibrer les différentes techniques, la consommation d'oxygène par la fréquence cardiaque semble cependant fournir des résultats prometteurs pour mieux comprendre l'énergétique de cette mue.

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Mots-Clés: éléphant de mer austral, mue, réserve énergétique, impédancemétrie, fréquence cardiaque

17 β estradiol effect on β -endorphin expression in the germ cells of male *Psammomys obesus*.

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The effect of 17 β estradiol on the expression of testicular β -endorphin was investigated for the first time. *Psammomys obesus*, a desert rodent chosen for the seasonality of its reproductive function. It was a diurnal rat with a maximum of sexual activity in winter and a rest that spreads from the end of spring to the end of summer. This study was approached by an immunohistochemical and molecular analysis (western blot) after estrogen treatment of resting animals. Treatment with 17 β estradiol significantly decreases the signal of β -endorphin in all seminiferous tubules. This observation was confirmed by western blot because the expression of the band corresponding to the 3.5 kDa peptide decreases significantly in the treated with respect to the controls. In the active period, the estrogen receptor α (ER α) was detected only in spermatocytes I, round and elongated spermatids while it was totally absent in resting males and controls. 17 β estradiol induces the expression of ER α in spermatocytes I. This result suggests for the first time that the expression of β -endorphin in the germ line can be subjected to intra-testicular regulation of 17 β estradiol. Spermatocytes I would be the target cells.

Mots-Clés: Testis, β , endorphin, 17 β estradiol, spermatogenèse, *Psammomys obesus*.

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Impact des variations saisonnières sur la distribution du récepteur des androgènes dans l'épididyme du rat des sables, *Psammomys obesus*

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L'épididyme est un organe clé de maturation post-gonadique des spermatozoïdes. Cette maturation est sous le contrôle des androgènes qui peuvent agir directement via les récepteurs des androgènes (RA) ou après conversion en DHT par la 5α réductase. Le but de cette étude est la mise en évidence d'une variation éventuelle des RA au cours du cycle de reproduction saisonnier. Le modèle utilisé est le rat des sables, *Psammomys obesus* Cretzschmar 1828, rongeur déserticole diurne de la famille des *Gerbillidae*, qui présente un cycle saisonnier avec une période de reproduction en automne, hiver et début du printemps et une période de repos limitée à la fin du printemps et au début de l'été. Les animaux ont été répartis en deux lots : un lot en saison de reproduction et un lot en saison de repos sexuel. Les épididymes prélevés ont subi les étapes classiques de l'histologie. Les récepteurs des androgènes ont été recherchés par la méthode immunohistochimique indirecte par amplification. Pendant la saison de reproduction, les RA présentent une immunoréactivité intense et une distribution ubiquitaire dans l'épididyme proximal et distal. Cette immunoréaction subit une diminution pendant la saison de repos sexuel au niveau nucléaire et cytoplasmique. Ces résultats montrent une modulation saisonnière des RA témoignant une fluctuation saisonnière très probable de la testostérone.

Mots-Clés: épididyme, rat des sables, variations saisonnières, récepteurs des androgènes

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Effect of the Seasonal Variation on P450 Aromatase and Estradiol immunoexpression in the Testis of Sand Rat

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Several studies showed the importance of estrogen in male reproduction. However, the majority of these works was based on animal models having a reproductive activity independent with the season. In order to show a possible implication of estrogen in testis function of *Psammomys obesus* and to illustrate a probable effect of the season in modulation of estrogen pathways, the immunoexpression of aromatase, estradiol were investigated in fat sand rats during both the breeding and resting seasons by indirect immunohistochemistry. Leydig cells showed a strong immunoreactivity for aromatase exclusively in breeding season; however, estradiol was present in breeding and resting season. Sertoli cells showed a positive signal for estradiol in breeding season, though; aromatase and estradiol were present in resting season. Spermatogonia were immunoreactive for E2 only in breeding season contrarily to spermatocytes I, which presented a moderate immunoreaction for E2 in both breeding and resting season. Spermatocytes I exhibit an immunostaining for aromatase only in resting season. Spermatids and spermatozoa present exclusively in breeding season were immunoreactive for both molecules except round spermatids, which were negative for aromatase. Our results converge for the implication of estrogens in spermatogenesis and steroidogenesis.

Mots-Clés: sand rat, testis, season, aromatase, E2

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Some aspects of skin hydromineral regulation in *Typhlonectes Compressicauda* (Dumeril et Bibron, 1841), caecilian amphibian

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Typhlonectes compressicauda is a viviparous caecilian living in tropical areas of South America. This lengthened amphibian is submitted to seasonal variations characterized by a rainy (January till June) and a dry season (July till December). The animal's population studied, captured at Kaw (French Guyana), lives in the flooded savannah in the rainy season and in the moody ground, when water level falls during dry season. The aim of this study was to investigate the role of skin in the animal hydromineral regulation on males, pregnant and non-pregnant females captured during both seasons. To this end, we worked on the antidiuretic hormone, arginine-vasotocine (AVT) and its receptor. After previous analyses on hypothalamus and kidney, we studied the skin, another organ well implied in amphibians osmoregulation. In the present study, we localized by immunohistochemistry the AVTR, the antidiuretic hormone receptor. The receptor expression was stronger in females than males, without any variation according to the season, excepted in few cases in which a stronger signal was observed in rainy season. We therefore conclude that in the skin, in contrast to our previous observations in kidney, the AVTR expression was not linked to the hydromineral regulation, but rather to the breeding cycle.

Mots-Clés: Amphibian, Caecilian, hydromineral balance, hormonal regulation, reproduction, skin

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Réponses physiologiques d'un Isopode terrestre (*Armadillidium* sp.) à la toxicité des pesticides

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L'emploi de pesticides a connu un développement sans précédent au cours la dernière décennie dans l'agroecosystème de la vallée de la Soummam (Algérie). L'usage des pesticides s'accompagne d'une contamination terrestre entraînant une influence négative sur la biodiversité du sol. Afin d'évaluer la qualité du sol, il est nécessaire de s'intéresser à son fonctionnement biologique qui dépend, notamment, du fonctionnement optimal de la pédofaune. Celle-ci contribue en effet à la décomposition des matières organiques, aux cycles des nutriments et à la structuration du sol. Parmi cette pédofaune, les Isopode terrestres vu leur abondance, leur facilité d'échantillonnage, peuvent être considérés comme un outil écotoxicologique intéressant pour mesurer l'effet de toxicité des pesticides. Dans ce contexte nous nous sommes intéressés à l'évaluation de la toxicité de trois pesticides fréquemment utilisés par les agriculteurs de la région : le chlorpyrifos-Ethyl (dursban), l'Ethylène bis manganèse (mancozebe) et la Deltaméthrine (décis).

Un test de toxicité aiguë visant à déterminer la DL50 a été effectué en laboratoire sur le genre *Armadillidium*, un Isopode, abondant dans les agro système de la région. Pour chaque pesticide, nous avons testé trois concentrations définies à partir de la dose utilisée sur le terrain (correspondant à notre concentration maximale), pendant 28 jours.

Un taux de mortalité de 100% a été observé dès la première semaine pour le Dursban à une concentration de 720mg/L. Concernant le décis (12,5mg/l) et le Mancozebe (800mg/l), la mortalité a été respectivement de 10 et 5% aux concentrations les plus élevées. A la fin du test et pour toutes les concentrations confondues, les taux respectifs de mortalité des Isopodes ont été de 22.5%, 26,25% et 71, 25 % pour le Mancozebe, le Décis et le Dursban.

Ce biotest montre que le Mancozebe et décis présentent une mortalité faible, par rapport au Dursban qui s'est révélé très toxique.

Mots-Clés: toxicité aiguë, Isopode terrestre, *Armadillidium* sp., pesticides, Vallée de la Soummam

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Ecophysiology of bees to better understand their defensive behavior against elephants: case study in Gabon

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Elephant crop raiding threatens both local farmer livelihood and elephant conservation. To deter elephants from raiding crops beehives have been successfully employed in East Africa with savanna elephants (*Loxodonta africana*) while providing honey for the farmers. Whether this technique could work on forest elephants (*Loxodonta cyclotis*) was unknown. Interestingly, bee activity is known as a good indicator of bee ecophysiology because of its high correlation with lots factors such as bee reproduction, heat, predator attack, etc. For this reason, we investigated bee ecophysiology to better understand how bees deter elephants. We recorded videos of bees at beehive entrances and estimated the rate of bee activity as the number of "bee movements (entering and exiting hives) per minute" (b.mvt/min). We also harvested honey as often as possible and used camera trap to record elephant reaction behaviors during 70 consecutive weeks. We recorded 334 videos of bee activities and captured 8151 photos of elephant reaction behavior. The presence of queen and male cells was related to high bee activities with a drop of honey harvests confirming the tradeoff between bee reproduction and honey production. Our results showed a significant correlation between the effectiveness of beehives as deterrents of elephants and bee activity. Hence, elephant disturbance of hives do not inhibit honey production, but there is a tradeoff between the deterrence ability and the quantity of honey produced, with the reproduction maturity stage of colonies being the cutoff point. Interestingly, the two goals of deterring elephants and producing honey are achieved at an optimum activity ranging from 40 to 60 (b.mvt/min); meaning when the colonies have matured enough but have not yet start to breed new bee queens and males individuals. Thus *Apis mellifera adansonii* bees can effectively be used as elephant deterrent but beehives must be actively managed to maintain bees' colonies at the optimum activity level.

Mots-Clés: honey bees, elephants, interactions, ecophysiology

Seasonality and interactions between metabolism and genomic stability in the grey mouse lemur

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Environmental disturbances currently challenge phenotypic plasticity of species, especially in tropical regions, and can even reveal the limits of this plasticity therefore endangering resilience capacities. According to some theories, males and females would express different adaptive capacities to environmental variations, as in the context of seasonality, conforming to their different biological constraints. The Grey Mouse lemur (*Microcebus murinus*) is a small nocturnal primate, remarkable for its adapted and synchronized physiology to seasonal rhythms. It is characterized by strong modifications of body condition, consequently to important metabolic variations. In this regard, males and females behave differently, males anticipating reproductive period before summer. We questioned whether this sexual dimorphism could be reflected in the mechanisms involved in the synchronization between the organism and its environment. Amongst important factors are genomic stability, which conditions the individuals’ survival. We realized measurements at the beginning and at the end of the winter in both sexes, to further characterize animals’ physiology, their oxidative stress and the impact on genomic stability. Our results confirmed the existence of a major difference between males and in females in winter metabolic and genomic plasticity in *Microcebus*, notably observable at the level of mitochondrial metabolism and telomere dynamics. These observations support the “Thrifty female hypothesis”, which should be further investigated to better anticipate species resilience abilities in the current context of global warming.

Mots-Clés: Saisonality, genomic stability, telomere dynamics, primate

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Activity and feeding behaviour of indoor and outdoor cats throughout the seasons

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Literature is conflicting regarding the activity rhythm of the cat: results are often contradictory and many authors point out a great interindividual variability. Circadian rhythms, controlled by the suprachiasmatic nucleus (SCN), enable individuals to keep synchrony with different environmental factors. Such a rhythm has not yet been demonstrated in the cat, distinguishing it from pure nocturnal species or diurnal species. No study has yet focused on a feeding rhythm in the cat, most authors considering the cat's feeding pattern as entirely random and specific to the individual. The influence of the seasons on the cat's activity and feeding rhythm has not been studied so far. In order to investigate this issue, the activity and feeding behaviour of two groups of cats, one living in an outside enclosure and one living indoors, have been studied during the four seasons. Using precise automatic tracking technologies (RFID), we observed peaks of activity and food intake when humans are present and around dawn and dusk. The indoor group showed stronger overall rhythms than the outdoor group, especially concerning the feeding rhythm. No impact of the season has been found on the cats' daily consumption or on the outdoor cats' feeding rhythm, whereas the indoor group showed a stronger feeding rhythm throughout the seasons. The indoor cats' activity rhythm was least pronounced in autumn. Unfortunately, a lack of winter activity rhythm data for the outdoor group prevents us from complete analyses of the seasons' impact. As seen in previous studies, a great interindividual and intraindividual variability was found among the cats, some being arrhythmic at times and others showing a tendency towards rhythmic bimodality. However, most cats showed a rhythm's period of 24 hours. The feeding rhythm was less robust than the activity rhythm.

Mots-Clés: Activity, behaviour, consumption, feeding, cats, rhythm, indoor, outdoor, seasons

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Detection of RE β or RE α receptors of 17 β estradiol in the oviduct of *Boulengerula taitanus* (Loveridge, 1935), a Kenyan caecilian, in relation to the seasonal cycle of reproduction

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Boulengerula taitanus is an oviparous Gymnophiona living in the volcanic mountains of southwestern Kenya. This species presents remarkable biological features such as direct development and maternal care. These animals are submitted to a local climate characterized by two dry and two wet seasons. Females lay about 10 eggs per year between November and February during the short rainy season and at the beginning of the short dry season. The oviduct is a paired organ divided into three parts which undergoes morphological and histological variations throughout the year. They are characterized by a period of full development from November till February, showing highly secretory and diversified cells, and a resting period from March till August, with a reduced epithelium. A short period of transition is observed from September till October. The regulation of these cyclic variations is under the control of the ovarian hormones. Immunohistochemical methods allowed to detect in tissues and cells the presence of ovarian hormones receptors, especially the receptors Re α and RE β of 17 β estradiol. Results showed both nuclear and cytoplasmic labels. The variations of these labels suggested a differentiated distribution of RE β and RE α in various tissues of the genital tract, according to the period of the cycle. This study allowed to report the pleiotropic action of 17 β estradiol, as well as the existence of an action not only genomic but also metabolic.

Mots-Clés: Amphibian, Caecilian, reproduction, sexual cycle, female, hormonal regulation

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Age-related variations of health parameters in the Asian elephant

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Although senescence is often observed in the wild, its underlying mechanistic causes can rarely be studied alongside its consequences, because longitudinal data on health, physiological and physical measures of senescence are rare. Documenting how different health risks and sources of "stress" (such as disease or environmental factors) accelerate ageing at a mechanistic level, is key if we are to better understand the ageing process. Nevertheless, very few studies, particularly on natural populations of long-lived animals, have investigated age-related variations in biological markers of health and their interconnectedness with variations in stress hormone levels and environmental conditions. Our study aims to identify how physiological markers of health vary with age and how they are influenced by environmental factors in a long-live mammal, the Asian elephant. Taking advantage of a unique multigenerational demographic dataset on a semi-captive population of Asian elephants, we examine how different physiological markers of health (body score index, blood cells count, liver and kidney functions) vary across age and interact with endocrinological measures of stress.

Mots-Cl es: ageing, senescence, health, long, lived mammal

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La réponse au stress chez les isopodes terrestres: une étude comparative sur la glycémie

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Les facteurs de stress sont présents dans l'environnement des êtres vivants et engendrent des réponses physiologiques et/ou comportementales spécifiques. Ces réponses sont bien connues chez de nombreuses espèces de vertébrés, mais restent peu étudiées chez les invertébrés. Parmi les paramètres permettant de quantifier l'impact du stress sur la physiologie, le glucose est un indicateur couramment utilisé chez les crustacés. Les isopodes terrestres sont des crustacés, utilisés comme bioindicateurs de la qualité du sol; cependant, leur réponse au stress reste encore peu documentée. Ainsi, nous avons choisi de mesurer la glycémie dans l'hémolymphe circulante de deux espèces d'isopodes terrestres (*Armadillidium vulgare*; *Porcellio dilatatus*), recevant différents stimuli imitant des situations potentiellement stressantes rencontrées dans leur environnement. Nos résultats montrent, chez ces deux espèces, que la glycémie n'est pas impactée par un choc thermique (1h, 40°C), ni par des vibrations (1min) ou des secousses (1min), ni après 4 semaines d'isolation sociale, au niveau populationnel. Cependant, pour les deux espèces, la glycémie est significativement plus élevée chez les males isolés que chez les males maintenus en groupes (*A. vulgare*: $3,05 \pm 0,23$ vs. $2,48 \pm 0,08$; *P. dilatatus*: $1,48 \pm 0,13$ mM vs. $1,08 \pm 0,12$ mM), suggérant une différence due au genre. L'exposition au glyphosate (1,8-2,5 kg/Ha) n'affecte pas la glycémie d'*A. vulgare*, après 96h ou 21 jours d'exposition. Cependant, pour les deux doses, les individus exposés pendant 25 jours et recevant un stress additionnel (prélèvement d'hémolymphe; 96h), ont une glycémie significativement plus élevée que les témoins (prélèvement d'hémolymphe seul) ($2,52 \pm 0,18$; $2,66 \pm 0,33$ vs. $1,87 \pm 0,16$ mM). La survie est aussi affectée par l'application conjointe de glyphosate et du prélèvement intermédiaire d'hémolymphe. Nous concluons que le glucose est un indicateur physiologique potentiel pour l'étude du stress chez les isopodes terrestres. Des études complémentaires pour ce paramètre, combinées avec d'autres indicateurs physiologiques sont nécessaires pour mieux caractériser cette réponse.

Mots-Clés: stress, physiologie, glucose, espèces bioindicatrices, isopodes terrestres

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Corrélation fonctionnelle entre l'activité stéroïdogène ovarienne et la fonction vaginale chez *Meriones libycus* au cours du cycle saisonnier de reproduction : approche histologique et immunohistochimique

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Afin de mieux comprendre les mécanismes intervenant dans la physiologie de la fonction de reproduction saisonnière de *Meriones libycus*, une étude de l'ovaire et du vagin est respectivement réalisée par la technique immunohistochimique indirecte avec amplification à la streptavidine-biotine-peroxydase et la technique histologique classique. L'**ovaire** révèle une activité stéroïdogène importante en **période active**, accompagnée d'une forte immunoexpression d'oestradiol (E2), de la progestérone (P4) et de la testostérone (T) dans tous les follicules en croissance ; ceci a conduit à une cyclicité de la fonction ovarienne avec une activité gamétogène aboutissant à une ovulation et formation d'un corps jaune oestro-progestatif. En **période de repos**, l'ovaire est caractérisé par une anovulation saisonnière et une absence de corps jaune ; la stéroïdogénèse est très réduite ; celle-ci atteste une faible immunoréactivité à l'oestradiol et à la progestérone dans les follicules préantraux ; la testostérone est pratiquement indétectable ; certains follicules secondaires n'expriment pas la progestérone. Le vagin, examiné en coupe histologique, montre en **période active** et en **oestrus**, un épithélium de revêtement pluristratifié est fortement kératinisé et squameux. Au **métaoestrus**, l'épithélium de surface apparaît histologiquement peu modifié et caractérisé par une infiltration leucocytaire qui débute d'abord dans le tissu conjonctif puis vers l'épithélium de revêtement. Au **dioestrus**, l'épithélium de surface diminue d'épaisseur ; il est envahi de leucocytes. Au **proestrus**, le développement de l'épithélium vaginal est net ; ceci reflète une prolifération cellulaire ; l'infiltration leucocytaire disparaît de la muqueuse. En **période de quiescence**, l'atrophie de l'épithélium de surface est nette ; celui-ci est caractérisé essentiellement par la présence de nombreux leucocytes. En conclusion, nos observations histologiques et immunohistochimiques nous ont permis de mettre en évidence des **corrélations fonctionnelles** entre les variations de l'activité ovarienne et vaginale. Il semble que les fluctuations hormonales ovariennes cycliques et saisonnières observées au

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cours du cycle saisonnier de reproduction ont également influencé la fonction vaginale.

Mots-Clés: Ovaire, Vagin, Variations saisonnières, Immunohistochimie, Histologie, Physiologie, Meriones libycus

Global warming impacts on the hibernation of the garden dormice (*Eliomys quercinus*)

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Torpor is an energy saving strategy achieved by substantial reductions of metabolic rate (MR) and body temperature (Tb) to survive periods of low food and/or water availabilities. Previous studies showed that the rate of periodic rewarming from torpor is associated with a decrease of telomere lengths over winter hibernation. Telomere shortening is traditionally used as a proxy for physiological aging and is directly impacted by the production of reactive oxygen species during phases of high MR, such as that experienced during periodic arousals. Increasing temperatures during winter could have an effect on both energy-savings and telomere changes associated with hibernation. To determine if mild winters have an impact on these two aspects, we compared torpor patterns of garden dormouse (*Eliomys quercinus*), a small, hibernating rodent, kept at controlled temperatures of either 15°C or 4°C. We assessed body mass loss and sampled DNA, via buccal swabs, for analyses of relative telomere length (RTL) at four time points during winter (at onset and at emergence from hibernation and at two time-points during hibernation). Our results show that animals hibernating at the warmer temperature significantly spent less time torpid and experienced more and longer arousals than animals hibernating at 4°C. Additionally, body mass loss was significantly greater in those animals. Surprisingly, RTL significantly increased over the course of hibernation in both groups. Further, we found a significant higher increase among individuals experiencing warmer temperatures. Importantly, our data suggest that garden dormice are able to elongate their telomeres, presumably during inter-bout euthermia of normothermic Tb. Although hibernation at warmer temperatures has a positive effect on telomere length, hence physiological aging, our data clearly show that hibernating at higher temperatures causes an additional energy expenditure which increases the risk to entirely deplete fat reserves before natural emergence from hibernation.

Mots-Clés: Arousal frequency, Climate change, Metabolic rate, Relative telomere length, Temperature

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Etude ecologique des Nereides (annelides polychetes) du littoral ouest Algerien

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Les Annélides Polychètes sont généralement le taxon le plus abondant dans les communautés benthiques en terme de richesse numérique et biodiversité et ils sont bien représentés dans la plupart des milieux marins et estuariens, à la fois en nombre d'individus et d'espèces et constituent un pourcentage significatif de la diversité totale de la macrofaune benthique. Les polychètes forment un groupe zoologique dominant et ils occupent une place prépondérante dans les chaînes alimentaires.

Les Néréides font partie des Annélides Polychètes les mieux connus. On en rencontre de nombreuses espèces sur les littoraux du monde entier dont certaines ont une importance économique car elles servent d'appâts de pêche mais également de nourriture d'appoint pour l'aquariophilie et l'aquaculture.

Cette étude vise à établir un inventaire faunistique des Néréidés du littoral Ouest Algérien dans le but de recenser les espèces présentes en fonction des différents types de milieux et de déterminer les indices écologiques pour une meilleure représentation des différentes populations.

Dans cet objectif, plusieurs prospections ont été effectuées sur le littoral de l'Ouest Algérien et deux sites particulièrement prometteurs ont été retenus : Oran et Mostaganem. Au niveau de ces sites nous avons décelé la présence de plusieurs espèces et nous avons fait le suivie de la dynamique d'une population de Nereides : *Perinereis cultrifera*.

Mots-Clés: Néréidés, indice écologique, écologie, Dynamique des Populations, Littoral Ouest Algérien.

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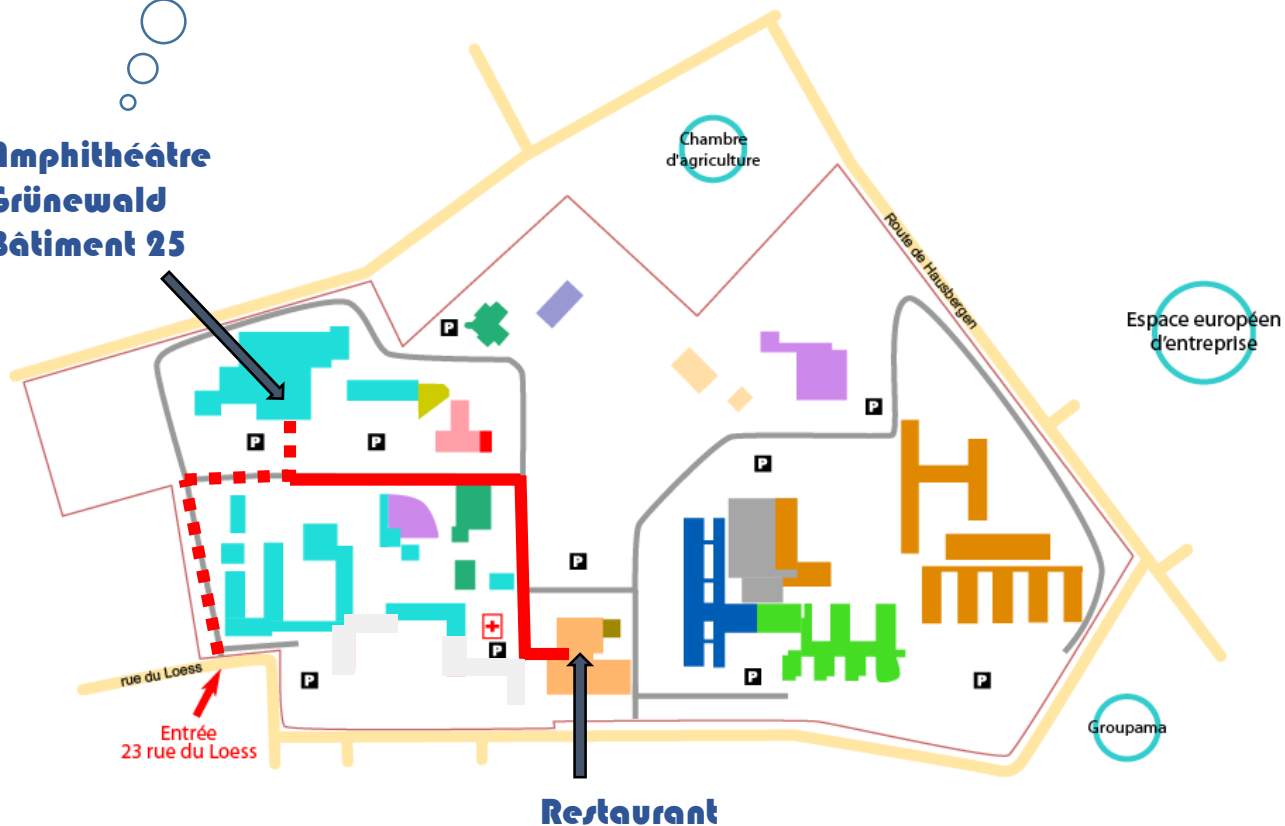
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