From fundamental research to population management: refining conservation strategies for the European hamster

[Cricetus cricetus L.]

18TH MEETING OF THE INTERNATIONAL HAMSTER WORKGROUP
STRASBOURG, FRANCE, OCTOBER 14-17, 2011

Program & Conference Proceedings

EDITED BY
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& PAUL PÉVET

CONFERENCE & ACCOMMODATION

CIARUS
7, RUE FINKMATT - STRASBOURG
BUS 6 > TRIBUNAL-FONDERIE, BUS 10 > PALAIS DES FÊTES

PUBLIC EVENING

AMPHITHÉÂTRE VLÈS DE L'INSTITUT DE PHYSIOLOGIE
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COMITÉ DE PILOTAGE

CITÉ ADMINISTRATIVE
14, RUE DU MARÉCHAL JUIN - STRASBOURG
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BANQUET

WINSTUB "ZUEM STRISSEL"
5, PLACE DE LA GRANDE BOUCHERIE - STRASBOURG
TRAM A, D > PORTE DE L'HÔPITAL, BUS 10 > CORBEAU

EXCURSION ON SATURDAY

REINTRODUCTION SITE BLAESHEIM
PARC DE CIGOGNE HUNAWIHR
WINE TASTING IN THE COOPERATIVE HUNAWIHR

EXCURSION ON SUNDAY

TRADITIONAL HAMSTER HABITAT OBERNAI

PREFACE

The prevention of the loss of biodiversity is one of the greatest challenges facing humanity. Although subjected to protection plans in many European countries, the European hamster *(Cricetus cricetus)* is highly endangered. In France it is still present in the plain of Alsace where it is an emblematic species.

We are proud to have the opportunity to welcome you in Strasbourg, France, to participate at the 18th Meeting of the International Hamster Workgroup. It is organized by the INCI, CNRS UPR 3212, University of Strasbourg in association with our partners in administration and different associations, who help to make this an exciting meeting, showcasing the most recent scientific advancements on fundamental and applied research on the European hamster and its protection. This interdisciplinary conference will bring together a unique group of internationally well renowned scientists as well as associations and representatives from public authorities and agriculture acting against the decline of hamster populations. The conference will feature in collegial atmosphere a wide range of topics from physiology to population dynamics to policy and management. In a special event, the results of the current Alsatian conservation plan will be presented and its perspectives discussed. Two excursions to the Alsatian protection sites – one of them open to the public - and a public evening talk will complete the meeting.
The general conference language is English. However, defined parts as the presentation of the Alsatian protection plan and the public excursion and evening will be held in French.

We all expect that this 4 day meeting, which gathers experts from 9 countries, will be an important and fruitful event for ongoing and future conservation measures

On behalf of the organizing committee

Stefanie Monecke
Chair of the organizing committee

ORGANIZING COMMITTEE

Stefanie Monecke (chair)	*INCI CNRS Université de Strasbourg*
Jean-Paul Burger	*Association Sauvegarde Faune Sauvage*
Julien Eidenschenck	*Office National de la Chasse et de la Faune Sauvage*
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Paul Pévet	*INCI CNRS Université de Strasbourg*
Jérôme Renaud	*Centre de Réintroduction des Cigognes et des Loutres*
Bruno Ulrich	*Groupe d'Etude et de Protection des Mammifères d'Alsace*

The organizing committee likes to thank all helpers who worked "backstage" to make our meeting possible, especially Frédérique Dinhof, Catherine Neiss and Denis Wagner. Their support in organizing, accountancy and as webmasters is greatly appreciated.

ACKNOWLEDGEMENTS

Région Alsace
Communauté Urbaine de Strasbourg
Direction régionale de l'Environnement de l'Aménagement et du Logement Alsace (DREAL)
Centre national de recherche scientifique (CNRS)
Université de Strasbourg (UdS)
IFR de Neurosciences de Strasbourg
Institut de neurochimie cellulaire et intégratif (INCI)
Institut Pluridisciplinaire Hubert Curien Strasbourg (IPHC)
Office National de la Chasse et de la Faune Sauvage (ONCFS)
Centre de Réintroduction des Cigognes et des Loutres
Association Sauvegarde Faune Sauvage
Groupe d'Etude et de Protection des Mammifères d'Alsace (GEPMA)

VERY SPECIAL THANKS

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go to Rollin Verlinde *from* Vilda Nature Photography,
who provided the marvellous photos of the European hamster for this book and our webpage. Please visit his webpage ***http://www.vildaphoto.net/***

PROGRAM

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ARRIVAL

Thursday, October 13
The registration desk will be open between 17:00 -19:00

Friday, October 14
The registration desk will open from 10:00

Friday, October 14

OPENING CEREMONY
14:00 - 14:15 Paul Pévet (France)

OPENING LECTURE
14:15 - 15:00 André Malan (France)
— *Mammalian hibernation, as illustrated by studies performed in Strasbourg and especially on the European hamster*

SESSION 1: PHYSIOLOGY AND BEHAVIOR
Chair: Eva Millesi (University of Vienna, Austria)

15:00 - 15:20 Stefanie Monecke (France)
— *Longterm temperature-recordings in the European hamster*
15:20 - 15:40 Cristina Sáenz de Miera (France)
— *Seasonal photoperiodic and circannual influences on hypothalamic reproductive control pathways in the European hamster.*
15:40 - 16:00 Elke Scheibler (Germany)
— *Heterospecific contact affects circadian activity in Desert hamsters (*Phodopus roborovskii, *Satunin, 1903)*
16:00 - 16:20 Carina Siutz (Austria)
— *Calculating body fat content by applying morphometrics in Common hamsters*

16:20 - 16:50 Coffee break

SESSION 2: ONTOGENY
Chair: Maurice La Haye (Alterra, University of Nijmwegen, The Netherlands)

16:50 - 17:10 Eva Millesi (Austria)
— *Time of birth, juvenile development and reproductive performance in Common Hamsters*
17:10 - 17:30 Lisa Heimann (Germany)
— *Conservation breeding of* Cricetus cricetus *in Germany – postnatal development in captivity*
17:30 - 17:50 Christian Stumpf (Germany)
— *Ontogenetic development of the circadian activity rhythm in Djungarian hamsters* (Phodopus sungorus)

POSTER SESSION
Chair: Mireille Masson-Pévet (INCI, Université de Strasbourg)

17:50 - 18:50
— Patrick Vuillez *et al.* (France)
Seasonal variations of clock gene expression in the suprachiasmatic nuclei of the European hamster (Cricetus cricetus)
— Joanna Ziomek *et al.* (Poland)
Burrow density and habitat preference of the common hamster in a mosaic of arable fields
— Chafika Mouhoub-Sayah *et al.* (Algeria)
Seasonal variations of locomotor activity and physiological parameters: an approch by a road kill study in the Algerian hedgehog (Atelerix algirus)
— Michel Saboureau *et al.* (France)
*Variability of hibernation patterns in captive adult jerboas (*Jaculus orientalis: *influence of sex and group*
— Tobias Reiners *et al.* (Germany)
Distribution of Common hamsters (Cricetus cricetus) *in relation to landscape scale crop composition in Hesse (Central Germany).*

— Sylvain Giroud *et al.* (Austria)
Effects of n-6 fatty acids on torpor expression and SERCA activity in a daily heterotherm: the Djungarian hamster (Phodopus sungorus).

CONFÉRENCE GRAND PUBLIC
20:00 - 22:00
— *Table ronde sur le Hamster d'Alsace*: «Le hamster ici et ailleurs»
Animateur: Yves Handrich
Participants: Ulrich Weinhold (Allemagne), Gerard Müskens (Pays-Bas), Julien Eidenschenck (France), Stefanie Monecke (France)

Saturday, October 15

SESSION 3: METHODS
Chair: Emil Tkadlec (Palacky University, Faculty of Science, Department of Ecology and Environmental Sciences, Olomouc, Czech Republic)

08:30 - 08:50 Caroline Habold (France)
— *Field techniques for measuring free-ranging hamsters' fitness*
08:50 - 09:10 Fabrice Capber (France)
— *Intraperitoneal radio-transmitters implants in European hamsters*

SESSION 4: HABITAT
Chair: Agata Banaszek (Institute of Biology, University of Białystok, Poland)

09:10 - 09:30 Olivier Keichinger (France)
— *Development of a method to evaluate habitat quality of the common hamster* (Cricetus cricetus) *to help in its conservation*
09:30 - 09:50 Tobias Reiners (Germany)
— *Impact of climate and agriculture on persistence of common hamsters in central Germany*
09:50 - 10:10 Jérôme Maxant (France)
— *Environmental observatory of the European hamster in Alsace: a regular monitoring from satellite imagery*

10:10 - 10:40 Coffee break

SESSION 5: MONITORING AND POPULATION DYNAMICS
Chair: Florence Bonnafoux (DREAL-Alsace, Strasbourg, France)

10:40 - 11:00 Ralf Schreiber (Germany)
— *Monitoring hamster burrows on compensation sites for road projects in Bavaria*
11:00 - 11:20 Kerstin Mammen (Germany)
— *How favourable is the conservation status of the Common hamster in Saxony-Anhalt? Results of the FFH monitoring in 2010*
11:20 - 11:40 Emil Tkadlec (Czech Republic)
— *Distribution of Czech common hamster populations in the 3rd millennium*
11:40 - 12:10 Mikhail Rusin (Ukraine)
— *Distribution of* Cricetus cricetus *in Ukraine (invited lecture)*

12:10 - 13:10 Lunch break

EXCURSION 1
13:30 - 18:00
— Julien Eidenschenck, Alex Lehmann, Stefanie Monecke (France)
Reintroduction site at Blaesheim and "Parc de Cigogne" at Hunawihr

WINE TASTING
18:00
— *Wine tasting in the cooperative Hunawihr*

BANQUET
20:30
— *Winstub "Zuem Strissel" Strasbourg*

Sunday, October 16

SESSION 6: EVOLUTION
Chair: Caroline Habold (DEPE-CNRS Université de Strasbourg, France)

08:30 - 08:50 Lutz Maul (Germany)
— *Implications from a semi-articulated skeleton of* Cricetus runtonensis *in the late Early Pleistocene of Thuringia (Central Germany)*
08:50 - 09:10 Agata Banaszek (Poland)
— *The phylogeography of the common hamster: the genetic diversity of the Ukrainian, Slovakian and Czech populations.*
09:10 - 09:30 Alexander Scheuerlein (Germany)
— *Hibernating Mammals: the slow road to increased survival.*

SESSION 7: ECOLOGY AND BEHAVIOR
Chair: Pierre Migot (ONCFS, France)

09:30 - 09:50 Jonas Schaffrath (Germany)
— *Behaviour, habitat use, mortality and population ecology of reintroduced Common hamsters* (Cricetus cricetus) *in intensively used agricultural areas in northern Baden-Württemberg, Germany*
09:50 - 10:10 Joanna Ziomek (Poland)
— *Circadian and seasonal activity of the common hamster in a mosaic of arable fields in Central Europe*

10:10 - 10:40 Coffee break

SESSION 8: CONSERVATION AND MANAGEMENT
Chair: Ulrich Weinhold (Institut für Faunistik, Heiligkreuzsteinach, Germany)

10:40 - 11:00 Gerard Müskens (The Netherlands)
— *A key to succesfull hamstermanagement: participation, cooperation and involvement by all who have interests.*
11:00 - 11:20 Maurice La Haye (The Netherlands)
— *Disappearing hamsters in the Netherlands: did we solve the puzzle?*
11:20 - 11:40 Ubbo Mammen (Germany)
— *Do small mammal underpasses mitigate the barrier effect for the Common hamster caused by roads with high traffic volume?*
11:40 - 12:00 Julien Eidenschenck & Anne Villemey (France)
— *Restocking of the common hamster wild populations,* Cricetus cricetus, *in France. Impact of agricultural practices.*
12:00 - 12:20 Pierre Strosser (France)
— *The evaluation of the 2007-2011 French National Plan for the Protection of the common Hamster: have we been successful?*

12:20 - 12:30 **ANNOUNCEMENTS**

12:30 - 13:30 Lunch break

EXCURSION 2
13:30 - 18:30
— GEPMA *Obernai: area of highest hamster density in France*

PROGRAM

Monday, October 17

WORKSHOP IHWG
Chair: Stefanie Monecke (INCI, Université de Strasbourg)

08:30 - 10:30 International hamster workgroup
— *Perspectives of the group, fund raising*

COMITÉ DE PILOTAGE
Présidence: Monsieur le Préfet de Région Alsace, Préfet du Bas-Rhin

10:30 - 11:00 Monsieur le Préfet
— *Introduction de la journée*

EVALUATION DU PNA
11:00 - 12:30 DREAL
— Atelier 1 — *Préservation et restauration des habitats favorables au hamster et agriculture*
— Atelier 2 — *Prise en compte des enjeux de préservation du hamster et de son habitat par l'urbanisation et le développement d'infrastructures*
— Atelier 3 — *Amélioration des connaissances sur l'espèce*
— Atelier 4 — *Développement des actions de communication*

SESSION PLÉNIÈRE DU COMITÉ DE PILOTAGE
12:30 - 13:00 DREAL
— *Reprise en session plénière et synthèse des ateliers*

13:00 - 14:00 Pause déjeuner

PROSPECTIVE
11:00 - 12:30 DREAL
— Atelier 1 — *Préservation et restauration des habitats favorables au hamster et agriculture*
— Atelier 2 — *Prise en compte des enjeux de préservation du hamster et de son habitat par l'urbanisation et le développement d'infrastructures*
— Atelier 3 — *Amélioration des connaissances sur l'espèce*
— Atelier 4 — *Développement des actions de communication*

SESSION PLÉNIÈRE DU COMITÉ DE PILOTAGE
15:30 - 16:00 Monsieur le Préfet
— *Reprise en session plénière, synthèse des ateliers et conclusion de la journée*

LECTURE
/
ABSTRACTS

OPENING LECTURE

André Malan
Neurobiology of Rhythms, INCI, CNRS and University of Strasbourg

OPENING LECTURE

Mammalian hibernation, as illustrated by studies performed in Strasbourg and especially on the European hamster

André Malan
Neurobiology of Rhythms, INCI, CNRS and University of Strasbourg

Hibernation is the major process developed by mammals to survive the seasonal food shortage in cold temperate climates. This short review aims at presenting some of its major features, based essentially on a few selected examples from the studies performed in Strasbourg. Hibernation is a seasonal process. Hibernators store food during summer, most of them as body fat. The European hamster, however, accumulates seeds in its burrow. After the storage period (summer - early fall), the hibernator enters the hibernation season. During this, it will alternate between torpor bouts, in which body temperature Tb stays close to ambient temperature for up to three weeks, and short arousals, in which Tb temporarily returns to euthermic levels (Fig. 1).

Especially if it is stored as body fat, the amount of energy that can be stored is limited. The maximal duration over which the animal can survive on its reserves is determined by the reduction in metabolic rate during torpor. From the beginning of his scientific career in the 1930's, Kayser spent many years measuring O_2 consumption and CO_2 production in a variety of hibernating species, from small bats to marmots, in the active state or hibernating - a painstaking effort with the methods of the time. He thus established that both in the active and the torpid state, an allometric relationship (Kleiber's rule) exists between metabolic rate and body mass. From activity to torpor, energy consumption is reduced by a factor of 30 on the average (Kayser 1964) (Fig. 2).

A major factor of the reduction is the effect of Tb decrease on the speed of biochemical reactions. The Arrhenius law of the thermodynamics of enzymatic reactions (often approximated as Q_{10}) predicts a 12-fold reduction of metabolic rate when Tb decreases from 37 to 5°C (Malan 1983). This leaves a further reduction factor of about 2.5 to be accounted for.

A first confirmation of the existence of additional inhibitory processes was the disappearance of electrical activity in the cortex duriing torpor for extended periods of time (Kayser and Malan 1963). Was hypothalamus involved? Lesions of the posterior hypothalamus resulted in no impairment of temperature regulation, but suppressed hibernation. Provided they got food, the lesioned animals could survive a full winter at 5°C without ever becoming torpid. Thus torpor was an actively controlled phenomenon and not the consequence of an imperfect temperature regulation (Malan 1969).

The persistence of temperature regulation, but with a decreased apparent set point, was evidenced by Heller and Colliver (1974). A similar situation holds for another major homeostatic regulation: the control of ventilation and the resulting regulation of blood pH and Pco_2. The first quantitative measurement of ventilation in a fully unrestrained hibernator was obtained on a marmot (Malan et al 1973).

Figure 1.

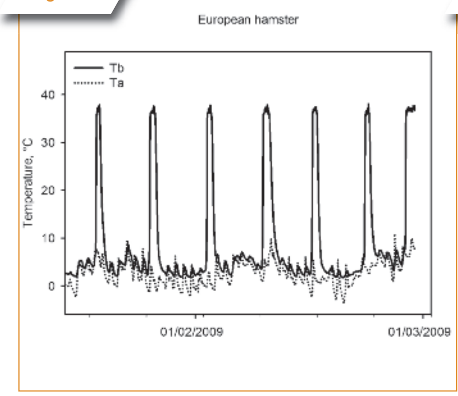

Figure 2.

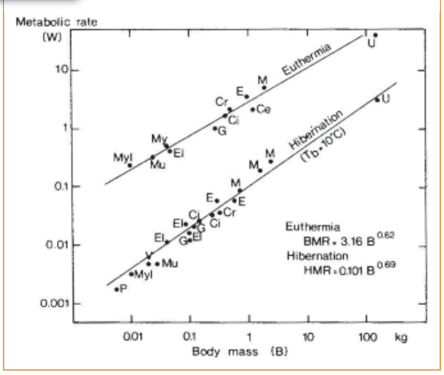

Figure 1.
Torpor/arousal cycling in a European hamster.
Body (T_b) and ambient temperatures (T_a, data from S. Monecke)

Figure 2.
Metabolic rate vs. body mass (log-log scale).
From Malan (1980).
Abbreviations: Ce *Centetes ecaudatus*, Ci *Citellus* ssp., Cr *Cricetus cricetus*, E *Erinaceus europaeus*, El *Eliomys quercinus*, G *Glis glis*, M *Marmota marmota*, Mu *Muscardinus avellanarius*, Myl *Myotis lucifugus*, P *Pipistrellus pipistrellus*, U *Ursus americanus*, V *Vesperugo noctula*.
Data from Kayser (1964) corrected to 10°C.

The constancy of blood pH and P_{CO_2} is maintained in hibernating hamsters and marmots, but with different apparent set-points than in euthermy (Malan et al. 1973). This was later shown to correspond to a respiratory acidosis, resulting from the accumulation of metabolic CO_2 during the entry into torpor (Malan 1982). The acidosis is removed by hyperventilation during arousal (Malan et al 1988).

This temperature-independent reduction of metabolic rate was called metabolic depression. It was hypothesized by Malan (1980) and later demonstrated experimentally (Heldmaier et al 1993; review in Storey 2010). The respiratory acidosis also affects the intracellular milieu (Malan et al 1985). It contributes to the depression of overall metabolic rate (Bharma and Milsom 1993), and specifically inhibits the thermogenic response to norepinephrine in brown adipose tissue. This explains the need for hyperventilation at the beginning of arousal: it relieves acidotic inhibition before the thermogenic effort (Malan 1993). Beyond Mammals, respiratory acidosis is a common feature of seasonal torpidity in air breathers, from Pulmonate Mollusks to Birds (Malan 1998).

Burrowing hibernators need a circannual clock to keep time while deprived of the information of the photoperiod as a Zeitgeber. In the circannual (period close to one year) rhythm of body mass can be entrained by a six months cycle of photoperiod (Canguilhem et al 1973). When maintained in constant conditions the hamsters keep a circannual rhythm of food intake and body mass (Canguilhem et al 1977).

The seasonal cycle of reproduction in is controlled by changes in photoperiod. When the photoperiodic signal controlling testicular regression does not occur when expected, testicular regression takes place notwithstanding at a fixed date (in constant conditions), indicating a control by a circannual clock (Saboureau et al 1999). Phase response curves of the circannual rhythm have been obtained in the European hamster (Monecke et al 2009). In euthermic animals, the circadian rhythm (close to 24 hours) is controlled by a master clock located in the suprachiasmatic nucleus of the hypothalamus (SCN). Contrary to the circannual rhythm, the circadian rhythm of clock genes in the SCN disappears during torpor in the European hamster (Revel et al 2007). But apparently, another circadian clock takes over. It is probably located outside the SCN, and has lost its temperature compensation. When body temperature data recorded from a variety of hibernating species are time-corrected according to the properties of such a clock, torpor bout duration shows as a constant fraction of a subjective day (Malan 2010). The torpor-arousal cycle (Fig.1) is thus a controlled by a circadian clock that slows down as Tb decreases..

In conclusion, the European hamster has played a major role in the discovery of many essential features of the physiology of mammalian hibernation.

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SESSIONS

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©ROLLIN VERLINDE-VILDA

L 1.1

Longterm temperature recordings in European hamsters

Stefanie Monecke, André Malan, Paul Pévet

INCI, Département Neurobiology of Rhythms, CNRS-UPR 3212, University of Strasbourg, Strasbourg, France.

The European hamster lives in a strongly seasonal environment. One of the highest challenges for surviving in these areas is to deal with the pronounced seasonal changes in temperature and food availability. Particularly because in winter a phase of poor food availability coincides with higher energy requirements of the animals. Thus, to survive in these areas special adaptations in the physiology and behaviour are needed. (1) European hamsters are able to prepare for the harsh winter time and store food during late summer, when food availability is at the maximum. (2) The ability to hibernate allows the European hamster to save huge amounts of energy in winter since during the torpor bouts body temperature drops close to environmental values and metabolic needs are reduced accordingly. (3) Body weight and thus body surface-to-volume ratio decreases already in autumn, minimizing heat loss during winter. (4) The animals reproduce only in spring and summer so that the offspring is born at a time with high food availability and convenient temperatures.

Most of these adaptations are reflected in the body temperature of the animals. Thus we recorded the body temperature of European hamsters with ibuttons (Maxxim, Dallas, USA). These sensors weight 3 g (including coating material (Paraffin/Elvax Coating, Mini Mitter, Bend, OR, USA) and can store 4095 recordings. Under short isoflurane anaesthesia up to 3 of them were implanted in the abdominal captivity of European hamsters and were exchanged in 3 to 6 months intervals, depending on the experiment. Animals were recorded in 3 conditions for several years:

a) Animals were maintained in laboratory Macrolon Type 4 cages placed in an outdoor enclosure, which was protected against rain, snow and direct sunlight, but allowed the animals to be in natural temperature and light conditions.
b) Male European hamsters were maintained in Macrolon Type 3 cages indoors. The ambient temperature was held constant but the seasonal changes in photoperiod were mimicked with a timer, with twice the outdoors rate of change in photoperiod: a one-year cycle of photoperiod was thus achieved within 6 months. This technique allowed us to observe more seasonal changes during the life span of a given animal.
c) Male European hamsters were maintained in Macrolon Type 3 cages indoors. From birth until the end of the life span both ambient temperature (20°C) and photoperiod (16h light, 8h darkness) were kept constant.

All animals had food and water ad libitum. Body temperature recording started at an age of 3 to 6 months and was performed during several seasonal cycles often until the natural death of the animals. The sampling interval was 20 min, 30 min or 144 min.

A preliminary analysis of the data shows pronounced seasonal changes in the body temperature recordings. In the outdoor conditions (a) euthermic temperatures were higher in the summer half of the year and lower in the winter half (Fig. 1). Moreover, a clear circadian rhythm could be observed only during summer in counter phase with the environmental cycle however, i.e. with a temperature maximum during the night. In winter torpor bouts lasting several days predominated. During these, body temperature followed the ambient temperature as long as it did not drop below circa

SESSION 1

L 1.1 Physiology and Behavior

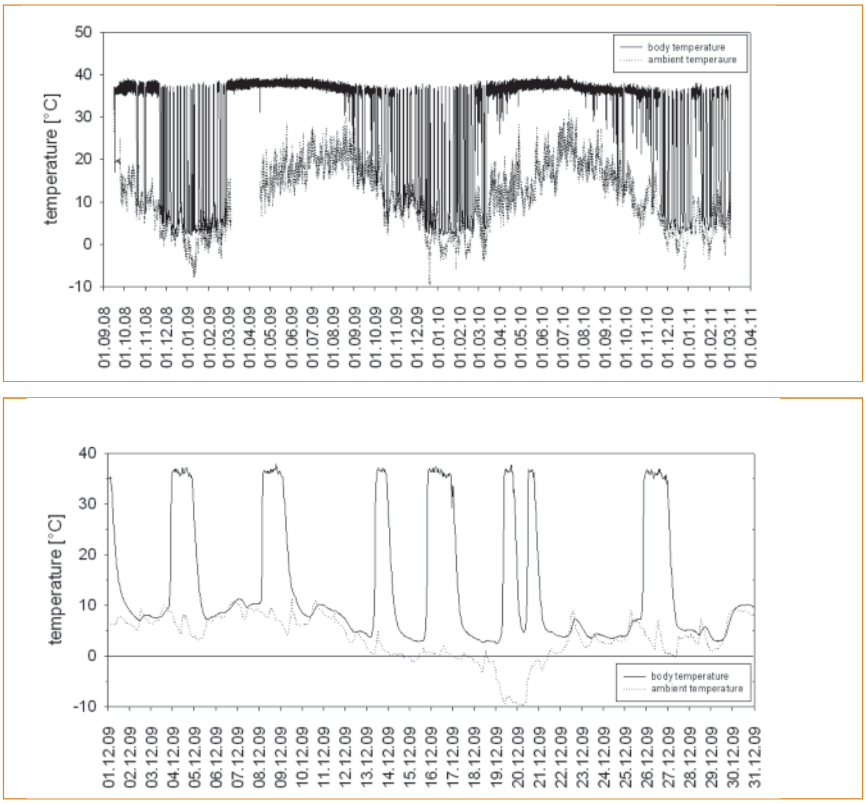

Figure 1.
2.5 years of body temperature recording in a European hamster female in outdoor conditions (top) and a detailed view on the data of December 2009 of the same female (bottom) showing short duration torpor bouts during a phase with low ambient temperatures.

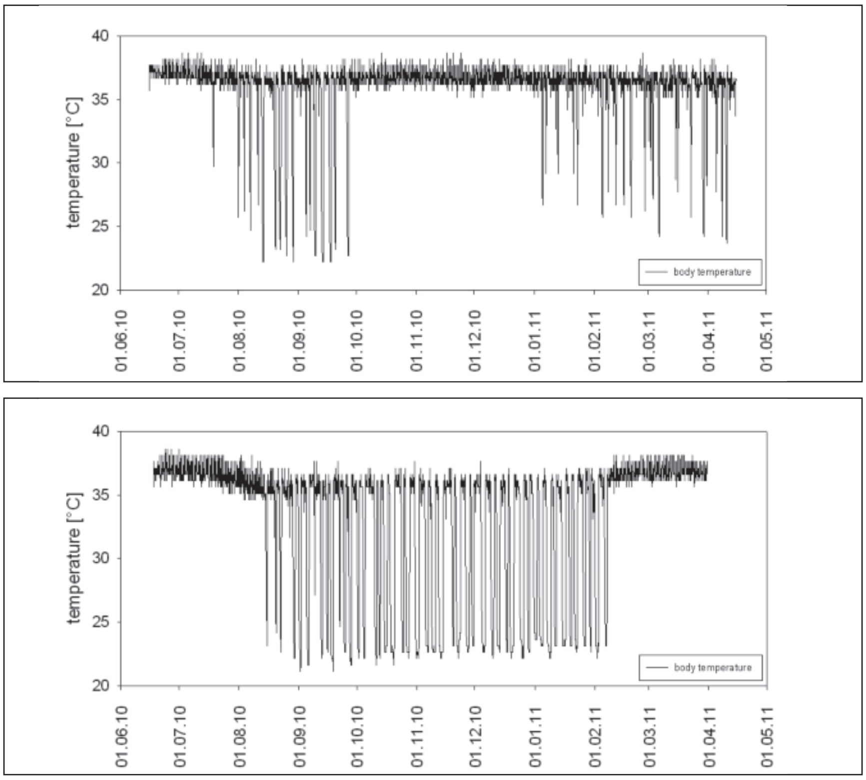

Figure 2.
Temperature recordings of 2 European hamsters in a constant environment, i.e. 20°C and long photoperiod of light 16h: darkness 8h. 1 animal shows 2 euthermic and 2 hibernation phases (top) while the other one cycles with a different period length, thus it shows only 1 long-lasting hibernation phase between 2 euthermic summer phases.

2°C. The lowest body temperature of a hibernating European hamster was 1.9°C. However, when the ambient temperature fell below 0°C torpor bouts were very brief and the animals started immediately the rewarming process when they reached their hibernation temperature (Fig. 1). This shows clearly that similar to other hibernators (Buck and Barnes 2000; Ortmann and Heldmaier 2000) European hamsters are aware of external stimuli during hibernation and able to react.

Indoors, all animals could well synchronise their annual cycle of reproduction and hibernation to the accelerated photoperiod conditions (b) and the period length of this rhythm was 6 months. The animals hibernated also in these conditions. However, the duration of the hibernation phase barely exceeded 2 months and due to the constant high ambient temperature of 20°C body temperature could drop during hibernation to minimal values of 22°C only. Moreover, torpor duration was short and never exceeded 48h. Nevertheless, these data show that it is not the low ambient temperature during winter that triggers the onset and the offset of the hibernation period but the seasonal changes in photoperiod. The accelerated photoperiodic regime revealed also a property of the body temperature regulation which was so far overlooked in former recordings of the seasonal body temperature cycle (Wollnik and Schmidt 1995). Due to the shortening of the environmental cycle to 6 months the period length of the body temperature cycle also dropped to 6 months and as consequence the amplitude of this rhythm increased (Dunlap et al. 2003). Thus in the temperature recordings it became visible for the first time that during the euthermic phase in the summer half of the year, when animals are reproductive the mean body temperature changes continuously. Highest values are reached in the middle of the euthermic phase. However, it still remains unclear why these changes happen and of what benefit they are for the animal.

Animals which were maintained in constant temperature and constant photoperiod (c) thus without any environmental cycle during their lifetime also showed regular alternations of hibernation and euthermic phases (Fig. 2). This indicates that the seasonal cycles in body temperature are under the control of the endogenous circannual clock. As seen from the animals in the accelerated photoperiod these cycles are only synchronized by changes in photoperiod to the environmental cycle.

Last but not least our long-term recordings deliver first insights on the effects of aging on hibernation. A preliminary analysis of our data shows that the minimal torpor temperature increases in subsequent hibernation phases and that this is often accompanied by decreases in the number of torpor bouts (Fig. 1 and 2). In contrast, euthermic temperature between torpor bouts decreases with increasing age, which might compensate at least partly for the resulting increase in energy expenditure when torpor temperature does not drop so far any more.

In conclusion, in the same manner as the cycles of body weight, activity and reproduction, the body temperature cycle is driven by an endogenous circannual clock and synchronised to the environmental year by seasonal changes in photoperiod. During aging some modulations of the properties of this cycle take place.

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L 1.2

SEASONAL PHOTOPERIODIC AND CIRCANNUAL INFLUENCES ON HYPOTHALAMIC REPRODUCTIVE CONTROL PATHWAYS IN THE EUROPEAN HAMSTER

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The breeding season of the European hamster *(Cricetus cricetus)* is determined by an endogenous circannual clock, synchronised to the annual cycle of changing day length *(photoperiod)* (Masson-Pevet et al, 1994). In other seasonal rodent species, two systems in the deep brain area of the basal hypothalamus have been implicated in the seasonal control of reproduction: a group of proteins called RF-amides (Kp and RFRP) (Revel *et al.*, 2008), and the local regulation of thyroid hormone (T3) bioavailability through regulation of the expression of the protein responsible for producing active T3 in the brain: the thyroid hormone deiodinase 2 (DIO2) (Hanon et al., 2010). We aim to extend this work to investigate the hypothalamic control of seasonal reproduction in European hamster. We have investigated these two systems in animals raised outdoors under natural photoperiodic conditions or kept in the lab in constant long photoperiod, when animals have no information about the seasons; to explore whether this expression is circannually (endogenously) driven. Outdoor animals were either sacrificed in mid June (summer group (S)) and mid November (winter group (W)). Indoor animals in constant conditions were pinealectomized (PinX), to remove the influence of the hormone melatonin on the reproductive axis, and a subset was castrated, to remove testosterone effects. In this group the endogenous circannual rhythm can be observed and animals were taken for the experiment which either expressed endogenously a summer like increase of body weight (subjective summer) or a winter like decrease (subjective winter). All brains were fixed using paraformaldehyde 4%, prior to sectioning and processing for protein or gene expression detection. DIO2/DIO3 genes and RFRP neuropeptide show different levels of expression in S and W animals. These studies will provide the first insights into the relationships between photoperiodic and circannual influences on hypothalamic control of seasonal breeding in the European hamster. Understanding the molecular basis of the reproductive cycle in European hamsters might reveal new leads for protection measures.

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L 1.3

Heterospecific contact affects circadian activity in Desert hamsters (*Phodopus roborovskii*, Satunin, 1903)

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Circadian rhythms facilitate the appropriate timing of physiological and behavioral functions with respect to regular cycles in the geo-physical environment. While light is the strongest natural zeitgeber for synchronizing the endogenous pacemaker system with the environment, a variety of non-photic stimuli have been shown to also affect the circadian system. The interaction of these photic and non-photic environmental factors determines the optimal temporal niche for each individual. However, such a temporal niche is neither constant nor identical for all individuals of one species. Instead, animals should be able to alter their circadian rhythms over time and space in order to cope with challenges posed by unpredictable or limited resources. The modulating power of biotic factors is especially relevant under harsh desert conditions. Thus it is not surprising that various rodent communities use temporal resource partitioning to increase their fitness in a desert habitat.

The focus of the present study is on the heterospecific contact between the subordinate Desert hamster and the dominant Mongolian gerbil. Both species are adapted to nocturnal activity and coexist under free-living conditions in the Gobi Desert, China. In a first series of experiments under laboratory conditions both long and short-term contact between the two species was investigated. Changes in the circadian rhythm of the subordinate hamsters were analyzed with key techniques of chronobiological research, i.e. the determinations of phase shifts in phase response curves (PRC) and the verification of changes in the activity pattern. Our results showed phase delays of activity onset at the beginning of subjective night (CT 12) and phase advances at the end of subjective night (CT18). Activity offset was affected even more. Interspecific contact at the beginning of subjective night resulted in a pronounced phase advance of activity offset and thus in a dramatic shortening of the activity period. Along the same line, long-term contact between both species, during which the animals were kept in the same cage and separated only by a wire mesh, resulted in a phase advance of activity offset and a shortening of nocturnal activity by several hours.

These findings are in concordance with recent findings on free-living hamsters under natural conditions in the Gobi Desert, Inner Mongolia, China. Desert hamsters were caught in the field and marked with passive transponders, and burrows were equipped with an integrated microchip-reader and photo-sensors to detect movements into and out of the burrow. Using this method the activity pattern of free-living hamsters was investigated under different conditions of species composition. Without competing species, the nocturnal activity of free-living Desert hamsters lasted approximately 7 hours. However, a dramatic shortening of the activity was observed when Desert hamsters had to cope with a majority of Mongolian gerbils in the same habitat. These findings suggest that interspecific contact between Desert hamsters and gerbils during the first quarter of the activity period induces a shortening of the activity period in the subordinate Desert hamster. Such a change in the activity pattern can be interpreted as a contact avoiding strategy and indicates that activity rhythms in Desert hamsters are much more flexible and sensitive to both biotic and abiotic environmental factors than previously known.

L 1.4

Calculating body fat content by applying morphometrics in Common hamsters

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Hibernation patterns in Common hamsters are known to vary between individuals. Patterns range from regular torpor bouts alternating with short euthermic periods resembling obligate hibernators to extended euthermic periods in the hibernaculum interrupted by short hibernation periods. This variation might be related to how the animals allocate energy reserves prior to winter. During hibernation internal fat stores have to be used. Thus, individual body fat content could serve as a predictor for over-wintering strategies. We therefore aimed at calculating body fat content in free-ranging hamsters using morphometric parameters. To validate this method we measured total body fat content in dead found hamsters using Soxhlet-extractions. In these individuals body fat content varied between 0.5% and 18.4% and increased with season. Based on these values we computed a multiple regression model and hence, were able to estimate body fat content in Common hamsters (with a mean absolute error of 0.49% from measured fat contents) by combining body mass, head, tibia and foot length. Preliminary results of free-ranging hamsters showed that adult individuals had significantly higher body fat content at the end of the active season than juveniles. Additionally, males had more internal fat stores than females in both age groups. These results suggest that age and sex groups differ in their potential of internal and external energy allocation prior to winter, leading to differences in overwinter behaviour. This assumption is supported by sex differences in foraging behaviour with males mainly feeding above ground and females building up food caches throughout the active season. Accordingly males are able to spend more time in torpor during winter than females. Morphometric calculations of body fat content can be easily applied in the field without the use of anaesthesia or other invasive procedures.

L 2.1

Time of birth, juvenile development and reproductive performance in Common hamsters

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In hibernating mammals, seasonal processes like reproduction, moult and fattening exist in a competitive process, associated with both energetic and temporal constraints. Females have to complete gestation, lactation and preparation for hibernation within a limited time period. In most species these constraints result in a very strict timing of seasonal processes and only one litter per year. Common Hamsters, however, are known to have a high reproductive potential with up to three litters per year and early puberty in males and females. Correspondingly, birth dates of juvenile hamsters range from April to August depending on the mother's reproductive timing and her number of litters per season. This high variation in parturition dates leads to differing time spans between natal emergence and hibernation onset in the juveniles. These differences in turn could affect body condition at natal emergence, individual growth patterns, dispersal, age at puberty and reprodutive output. Based on a data set obtained during long-term field studies on two hamster populations in Vienna, we analysed developmental parameters and reproductive output of 15 juvenile females that were born in one of the study areas and could be monitored for at least one complete breeding season. In addition, we compared body mass and growth patterns of individual females' first, second and third litters to determine if the restriced time for development in late born litters can be compensated by maternal investment. Animals were live-trapped in regular intervals, weighed, individually marked and reproductive status was determined at capture. In addition we were able to calculate body fat content using morphometric parameters including head length, tibia length and body mass. The results revealed that females produced more pups in their first litters than in the second ones. First litters emerged with lower body mass and size than second litter offspring. Third litters were produced only by a few females and consisted usually of 1-3 pups with similar emergence mass as first-litter offspring. Second litters could compensate their time deficit partly by starting aboveground activity in a more progressed state than pups of first litters. Nevertheless, at the end of the season, early born juveniles were larger, heavier and had a higher body fat content than those born later in the season. In the subsequent season, all recaptured yearling females were reproductively active. Individuals that descended from first litters mated earlier in the season and produced more offspring than females born later in the previous season. The results demonstrate the adaptive value of producing high offspring numbers early in the season. High maternal investment can - in some cases - compensate the temporal delay for the second litters. Due to the rather small sample size of third litters we can only assume that overwinter survival and successful reproduction in the following season in these individuals requires highly beneficial environmental conditions.

SESSION 2

Ontogeny

L 2.2

Conservation breeding of *Cricetus cricetus* in / Germany – postnatal development in captivity

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According to the Common hamster conservation plan of the City of Mannheim (Baden-Württemberg, Germany), a breeding center was established at the zoo of the neighboring City of Heidelberg in 2004. In comparison to the studies of Vohralik (1975) on the postnatal development, differences in body weight related to age of the young hamsters born in 2007 and of the offspring of those released into the wild, could be observed. With the aim to attain reliable reference data to determine the age of juvenile hamsters in the wild, in 2008 all young hamsters (~170 individuals), born in the breeding center, were regularly measured in body weight and length , between 14 days and 20 weeks of age. Additionally litter size and pedigrees were taken into account.

L 2.3

Ontogenetic development of the circadian activity rhythm in Djungarian hamsters *(Phodopus sungorus)*

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The "biological clock" is an innate mechanism in living organisms that controls the periodicity of many physiological functions. It generates rhythms with a period length of approximately 24 hours. In mammals, the central pacemaker of the circadian clock is located in the suprachiasmatic nucleus (SCN) of the hypothalamus. The most important zeitgeber to synchronize the endogenous rhythm is the daily light-dark cycle. The retinohypothalamic tract (RHT) relays photic information directly from retinal ganglion cells to the SCN.

A number of Djungarian hamsters (Phodopus sungorus) of our institute show noticeable activity patterns with a missing synchronization of activity onset to “lights-off”. The activity onset of those animals is continuously delayed (delayed activity onset – DAO), whereas the activity offset is stably coupled to “lights-on”. In addition, there is a wild type (WT) form, whose activity patterns have a proper adjustment to the periodic light-dark cycle.

The aim of the present study was to investigate, at what time of postnatal ontogenesis the hamsters show circadian activity rhythms, how these rhythms develop further and if this depends on circadian phenotype. Pups where born and nursed inside a nesting box. First individuals of the litter walked around within the nesting box on ninth day after birth. Two days later first pups left the box itself. No correlation with litter size was found. All animals preferred to leave the box during the dark period. From fourteenth day after birth onwards, the light-dark difference of “surface” activity was significant. The parent’s activity patterns were influenced by their pups, depending on the developmental stage. But parents have also an effect on the activity rhythm of their offspring. Mainly the mothers are important for postnatal entrainment of litter’s circadian rhythm, whereas the presence of fathers seems not to be essential.

After weaning, the activity of individually kept hamsters was measured with passive infrared detectors. An increasing amount of total activity, nocturnal activity and rhythm stability was found in WT animals until the tenth week of life. At this time, the values were not different from those found in adult hamsters. The phenomenon of the delayed activity onset was found occasionally just after weaning but in most animals at an age of 5 to 9.5 weeks.

After a three-week period in constant darkness (DD), more than half of the DAO animals showed a WT pattern in the subsequent light-dark period (L:D = 14:10). These animals showed long free-running periods (24.41 hours) compared to the other groups of hamsters. After overrunning a critical value of Tau, a complete loss of timing information leaded to reset the circadian clock in the second LD period. In general, DAO animals showed significantly longer free-running periods (24.34 hours) than WT animals (24.10 hours), without general age dependency. No differences in the amount of activity and stability of circadian rhythm were found between phenotypes in constant darkness. An expected positive correlation between the daily phase delay in LD and the free-running period in DD could not be shown, at least when considering the first three weeks in DD. When hamsters were kept for a longer time in DD, the free-running period increased. Taking this into account, the relation between daily phase delay and free-running period was demonstrated.

Methods

L 3.1

Field techniques for measuring free-ranging hamsters' fitness

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Energy metabolism is probably the most representative physiological trait of the lifestyle of an animal and of its impact on an ecosystem. This concept is based on the fundamental role of energy balance as a factor influencing survival and reproduction, and on the assumption that each behavior, even trivial, will in return affect the energy balance. Thus, it is legitimate to consider that evolution has favored strategies that promote individuals with the best fitness i.e. strategies that maximize net energy gain and optimize energy distribution between the conflicting demands for maintenance, growth, repair, defense and, ultimately reproduction.

Hibernation represents an outstanding capacity of energy economy for survival when confronted with seasonal decline in food resources, and therefore can be viewed as a means to improve survival. The energy savings achieved by hibernation depends on the duration and the depth of torpor bouts. Importantly, depths of torpor are themselves conditioned by the amount and quality of fat reserves made prior to hibernation. This is an important point in an evolutionary perspective since long and deep torpor bouts allow animals to have a better body condition at emergence, which will largely determine subsequent reproductive performances.

The European hamster in Alsace is living in a continuously changing environment due to human activities i.e. intensive agriculture and urbanisation. These anthropic, unpredictable and rapid changes are leading to a drastic decline of European hamsters' population of which the underlying causes are still misunderstood.

The extent to which environmental changes impact the European hamster's energy time- and energy-budget and its consequence on survival and reproduction can be directly addressed in natural conditions through several techniques adapted to field monitoring.

Classically, the energy metabolism of the animals is investigated through measurements of the metabolic rate and energy expenditure, body composition, locomotor activity and time budget.

The metabolic rate can be recorded in the field using a small animal portable indirect calorimetry system. Indirect calorimetry provides a real-time and direct measure of the energy expenditure of an animal and the ratio between CO_2 and O_2 exchanges (QR) gives the participation of the different substrates to cover this expenditure.

Methods based on stable isotopes enable to measure the field metabolic rate (FMR), the body fuel utilization and changes in body composition. The FMR of free ranging animals is measured through the doubly labeled water technique. By tracking differences in the turnover rates of injected isotopes of oxygen (^{18}O) and hydrogen (deuterium),

CO_2 production is measured and thus energy expenditure estimated. Total body composition and particularly fat-free mass (FFM) is evaluated by hydrometry (D_2O). FFM is calculated from total body water assuming a hydration factor of 73%. Fat mass (FM) is calculated as the difference between FFM and body mass. Finally, stable isotopes offer the possibilities to measure substrate use such as fatty acid oxidation rate, glucose and protein turnover rates using appropriate tracers.

The impact of metabolic stress on survival can be assessed by evaluating the ageing rate of free-ranging animals, obtained by measuring the size of telomeres after DNA extraction from white blood cells. Telomere length/rate of loss are indicating individual quality / sensibility to stress, in a sense that they are the sensors of a premature senescence of organism physiological functions, and then may reflect the past-history of the trade-off associated costs that individuals have been submitted to. The inference is that high quality individuals have undergone less costly trade-offs and then have preserved longer telomeres than bad quality individuals.

The use of biologging technologies, i.e. electronic tags (loggers) attached on animals is a new technical key to study the ecophysiology and behaviours of free-ranging animals in their natural environment. With an implanted logger storing each second heart rate frequency and body temperature, indirect but determinant parameters of FMR can be measured at a sufficient time accuracy to establish the energetic cost of specific activity. Adding a tri-axial accelerometer will allow the quantification of the locomotor work and the time-budget (1Hz resolution). External loggers (collar fixation) weighing less than one gram, provide a measure of ambient parameters (temperature, light intensity), thus giving the exact timing of burrow entrance and departure. Passive identity transducers (TIRIS) implanted for the life, coupled with a portable antenna displaced from a burrow to another allow to measure which animal inhabits a given burrow and how he is using it. Finally, using the very new “parallel robot technologies”, one single TIRIS antenna can be used to automatically scan a territory of several hundred of square meters, where a small population of hamsters is living in well established semi-captive conditions. Cable driven parallel robots can potentially cover areas up to 500m x 500m along three axes at a top speed up to 50 km/h. The actuated end-effector is holding a camera that can be rotated around two axes (pan and tilt). Vibrations and oscillations are damped thanks to gyros. Thus, it is a good tool to monitor continuously and automatically free-ranging wild species but in restricted areas.

These techniques allowing measurements of the different parameters of energy balance in free-ranging animals would bring new insights in the current knowledge of the time- and energy-budget of the European hamster, and would also lead to characterize the incompatibilities between the physiological and ecological constraints faced by this species, and the pattern of environmental changes due to human activity.

L 3.2

Intra-peritoneal radio-transmitter implants in European hamsters *(Cricetus cricetus)*

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— SUMMMARY

As part of the National Action Plan for the conservation of the European hamster *Cricetus cricetus* in Alsace (France), hundreds of captive-bred Hamsters are released each year to reinforce the small remaining population. Some of the released Hamsters are fitted with intra-peritoneal radio-transmitters in order to assess the success of the population reinforcement. The surgical procedure is presented and the tolerance of the transmitters in small rodents discussed.

— KEYWORDS

Intra-peritoneal radio-transmitter, anesthesia, rodent, European hamster, *Cricetus cricetus*, population reinforcement, Alsace, France.

— INTRODUCTION

The European hamster (Cricetus cricetus) also called Common Hamster, European hamster or Marmot of Strasbourg, is a small rodent belonging to the *Muridae* family and the Cricetinae sub-family. It measures between 23 and 34cm, including a tail of 3 to 7cm. It weighs from 150 to 550 g. It is a fossorial animal which spends 95% of its life underground. It hibernates from October till March-April and reproduces from April till August at the rate of 1 to 3 gestations a year of 3 to 12 young. It feeds for 80% on vegetables (lucerne, clover, wheat, barley, rye...) and sometimes on small animals (voles, earthworms, insects...). Alsace houses the only French population of the species and constitutes the western limit of its distribution (1).

The European hamster populations kept plummeting during the 20th century due to the massive destructions and the loss of their habitat. In 2010 the region housed no more than 480 dens (2). This figure being an indication of the follow-up of the populations, the total number of hamsters can be estimated to 2 or 3 times this number (Villemey, pers. com.). The European hamster is protected in France since the ministerial decree of October 10th, 1996 and listed on the red list of the threatened species in the "rare" category. It is listed in the appendix IV of the European Union Directive 92/43/EEC of May 21st, 1992 and in the appendix II of the Bern Convention of September 19th, 1979 (3).
Being given its critical status in France, the European hamster is the object of a National Action Plan since the year 2000. In this frame, the National Game and Wildlife Agency (ONCFS) coordinates population reinforcements in three priority working areas with the release of a maximum of 350 captive-bred animals each year. These animals come from three breeding facilities managed by the association Sauvegarde Faune Sauvage (SFS) implanted in Alsace (4, 5).
Some of these animals are fitted with intra-abdominal radio-transmitter implants to be followed by telemetry in order to study all the factors influencing the populations reinforcements (survival, adaptation to the environment, the occupation of dens, reproduction etc.).

— THE RADIO-TRANSMITTER IMPLANTS

They measure 31mm long with a diameter of 13mm (picture 1). They weigh 6.5 g. The maximum distance of the signal emission is 150 meters. The life expectancy of the battery (lithium 3V, 160mA) is 6 to 9 months. The frequency of the signal (26-40 MHz) increases along with the internal temperature (18 pulsations/min at 40°C): when the number of pulsations/min is under 14 or 15, the hamster is either hibernating or dead.

— ANESTHETIC PROCEDURE

Several anesthetic procedures are used in small rodents (6, 7, 8, 9). Within the framework of the program of population reinforcement of European hamsters, tens of animals are anesthetized during a single day (picture 2). Furthermore, European hamsters being a rare protected species, it is advisable to limit at most losses during surgeries. Finally, budgets being tight the procedure should minimize the cost of the operations. To satisfy these requirements the anesthetic procedure must be quick, safe and cheap. At first, a protocol used injectable premedication with medetomidine (0.1-0.2 mg/kg subcutaneous way, Medetor®) followed by inhalational anesthesia with a mixture of isoflurane 2.5% (Isoflurane® Belamont) and oxygen 2.5 l/min. Recovery was speeded-up with a subcutaneous injection of atipamezole (Revertor®, same volume as medetomidine initially administrated). In order to do so, first of all the hamster had to be captured with pliers or landing nets, then placed in a "capture sock" specially studied and made by the association Sauvegarde Faune Sauvage to allow a safe premedication with a subcutaneous injection through the sock. The recovery was relatively fast, with no loss. Forty hamsters went through this procedure with satisfaction. However, this method requires several manipulations before the animal is anesthetized as well as a surveillance of the recovery which takes approximately 10 minutes.

Furthermore, the injectable agents being expensive, immediate inhalational anesthesia was decided. The induction in a plastic bottle holds several advantages: the animal is easily incited to penetrate into the bottle placed at the entrance of its individual transport box and directly anesthetized with a mixture of isoflurane 5% and oxygen 2.5 l/min. The hamster, very sensitive to isoflurane, is immobilized within a minute. It is taken out of the bottle at once and positioned in a nosecone. It is then fixed to a warming carpet using Tensoplast® (pictures 3 and 4). The anesthesia maintenance is realized with isoflurane in 2.5 %. This method is quick for the animal and safe for the manipulator, the bite of a European hamster - even through the "capture sock" - can be dreadful. It requires minimal stressful animal handling. Recovery time is quick and the animal is allowed to breathe supply gas until it begins to awaken. The recovery being fast, during all stages of the procedure and even if the animal seems anesthetized, it is never manipulated directly by hands but only using pliers. Thus, inhalational anesthesia without the use of premedication is quicker and permits with a large margin of safety for the animals and manipulators up to 6 surgeries per hour. The total duration of the surgery up to the complete recovery is about 10 minutes. Anesthesia is deep and myorelaxation satisfactory.

Methods

— SURGICAL PROCEDURE

The implantation of the transmitter is made by means of a laparotomy. An abdominal patch is trimmed and swabbed with alcohol-ether, follwed by chlorhexidine 0.5 % which is sprayed on to the surgery field (picture 1). An antibiotic sub-cutaneous injection with marbofloxacin 5mg/kg (Marbocyl® FD) and an anti-inflammatory subcutaneous injection with meloxicam 1mg/kg (Loxicom® injectable) are administrated. A surgical drape is placed on the surgery field during the operation (picture 5). A 1cm incision is made through the skin along the midline above the umbilicus followed by a stab incision through the abdominal muscle wall along the linea alba. The transmitter is disinfected in a bath of alcohol then rinsed in a bath of physiological saline solution. It is then inserted into the peritoneal cavity by a simple push with the forefinger (picture 5), the muscular wall is then sutured with a X or U stitch using Polysorb® 2-0 then the skin is sutured by two U stitches with Monosyn® 4-0 (picture 6). Surgical glue (Vetbond® 3M) is then applied on the skin suture to strengthen it and avoid any contamination.

— FOLLOW-UP

The recovery is immediate and within minutes some hamsters wash themselves whereas others begin to eat. Complete recovery takes 24 to 48 hours. After 6 days, scarring is satisfactory (picture 7). No self-mutilation occurred in the hundred of the operated animals and the transmitter is well tolerated. Indeed, in the weeks which follow the implantation of the transmitters we were able to assess that the behavior of released fitted animals was comparable to the ones without transmitters. Some females gave birth and animals who suffered predation and were autopsied presented no peritoneal lesion such as inflammation or adhesion. They were in good shape and fed correctly. The autopsies revealed that most transmitters naturally positioned themselves in right inguinal region.

— DISCUSSION

Intra-abdominal radio-transmitters hold many advantages. Contrary to radio-collars, they are inseparable from the animal and minimize the risks of injuries, accidents or losses. In 2004, 21 hamsters were fitted with such collars: 5 collars were found alone and 10 never located. Furthermore, collars provide no information about the condition or activity of the animal. A study on rats (*Ratus ratus* and *Ratus exulans*) (10) also showed the constraints and limits of radio-collars. Rats managed to destroy collars or external antennae, and the mortality rate was higher when collars exceeded 4% of the rat's body weight. So, the challenge is to produce radio-collars with a very resistant material and integrated antennae, but these collars would be heavier.

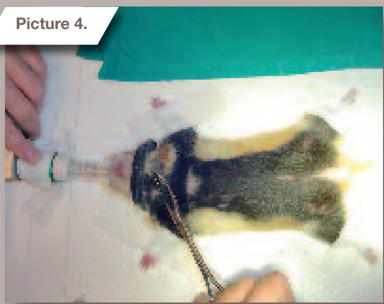
Although intra-abdominal transmitters can't be lost they do however present other problems. Their life expectancy (6 to 9 months) requires the re-capture of the surviving animals to replace them if the hamsters are to be followed over a longer period, generally a whole year. There is also the risk that the radio-transmitter be defective. Furthermore, if they are well tolerated, what is their real impact on the behavior and the survival of the animals? In our study, 100% of the animals survived the surgeries and the behavior of the released subjects seemed not to be affected. All the females having survived more than 60 days gave birth and thanks to the transmitters, the first evidences of reproduction in the wild were brought. Thus, the transmitter does not seem to impair gestation. A study carried out between 1982 and 1985 on 4 species of small mammals *(Peromyscus maniculatus, Microtus montanus, Dipodomys ordii et Spermophilus townsendii)* seems to demonstrate the good tolerance of the transmitters for one month after the releases more than 80% of the animals were alive. These transmitters exceeded 10% of the weight of animals while the studies recommend that they do not exceed 3 to 5% of the body weight of the animal (11). The operated hamsters weigh less than 150g. Our transmitter weighing 6.5g does not exceed 4.33% of the body weight of the hamsters and thus, it does never exceed the recommended range. It explains partially its good tolerance.

Picture 1.

Picture 2.

Picture 3.

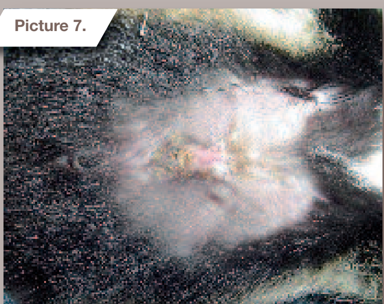
Picture 4.



Picture 5.

Picture 6.

Picture 7.



Picture 1.
Transmitter compared to the hamster's size.

Picture 2.
Recovering hamsters in their transport boxes.

Picture 3.
Hamster placed and hold with pliers in the nosecone.

Picture 4.
Hamster fixed on the warming carpet with Tensoplast®.

Picture 5.
Hamster ready for surgery.

Picture 6.
Surgical wound after surgery.

Picture 7.
Surgical wound 6 days after surgery.

All animals fitted with transmitters found dead had been killed by predators. What is the influence of the transmitters on predation? Are animals not implanted with transmitters less victims of predators? A study on the meadow vole *(Microtus pennsylvanicus)* showed that animals fitted with transmitters lost more weight in winter while there was no difference with the other animals the rest of the year. They also suffer more predation, which would explain their lower survival rate (12). Hamsters hibernating from October till March, this conclusion cannot be applied to them. However, a study on this aspect of the follow-up would be recommended.

Even if the intra-abdominal transmitters present several inconveniences such as surgical implantation, short life expectancy and the overall cost, the advantages they provide and their good tolerance make them good tools to carry out studies in situ on a large scale such as the wild population of small discreet mammals like the European hamsters.

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L 4.1

Development of a method to evaluate habitat quality of the Common hamster *(Cricetus cricetus)* to help in its conservation

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Agriculture is more and more confronted to environmental problems like biodiversity conservation, in particular for some species strongly depending on the cultivated areas. This is the case for the Common hamster *(Cricetus cricetus)* in Alsace (France) where its conservation implies changes in agricultural practices which are contrary to their recent evolutions. This study (project: "The biodiversity in loessic plains of Alsace ", financed by the LU company and the FRB) started in such a context with farmers strategies facing the constraint of hamster's conservation. This conservation needs an action on the species habitat; therefore a part of the study concerned the development of an evaluation tool of the habitat quality by means of agro-environmental indicators. In this communication, we will focus on the elaboration approach of this tool and the possibilities that it offers

First, this method has to answer several constraints: it must be easy to implement (available data and data easy to collect on a farm or on a large area), comprehensive by users (notation on 10) and give a good representation of the reality. From the knowledge collected from a bibliographical synthesis, the most relevant variables were retained in the indicator's calculation. For example, we know the importance of varied food supply outside of the hibernation period; needs evolve during the season between daily food supply and food reserves. Also, the hamster needs a well developed cover to give it protection against predators during its movements (changes of burrow, food or sexual partner seeking). By assuming that the living space of the species is reduced, it is necessary to have a good culture distribution around its burrow to satisfy all its needs. But more that this spatial distribution, a certain duration of this good cultures is also needed in particular between the beginning and the end of the hibernation period, so that when going out of the burrow in spring, the hamster finds its feeding nearby, allowing less movements.

All these criteria can be strongly included to allow a global diagnosis of an area (from tens to some thousand hectares) and the global quality level of it. This evaluation will take the shape of a note included between 0 and 10 and can be of use, for example to the decision-makers in their action plans. On the other hand, we can choose to aggregate less information. In that case, we shall not have a global note but by means of a SIG, we can supply a map of the area which will allow diagnosing the most interesting zones. The tool will serve as a base of discussion with the stakeholders, in particular the farmers, about the area quality. Finally, it will also be possible to make simulations so that the decisions taken by the farmers in favour of the hamster have the best possible effects.

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L 4.2

Impact of climate and agriculture on persistence of Common hamsters in central Germany

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Past and current changes in agriculture practices are considered as the major reason for the dramatic declines in common hamster populations throughout Europe. Controversially climate change is discussed to play a major role in decline as well. To tackle this issue we analyzed international peer-reviewed publications on influence of climate change on Common hamster distribution in Europe (n=3; Dormann et al. 2009, Levinsky *et al.* 2007, Araujo 2005). We will give some quantitative answers to the important question, whether climate change affects or affected hamster distribution on a European scale. Second we linked findings of these studies with species distribution models on smaller scale in the federal state of Hesse. With aid of a large dataset of >4500 spatial locations of hamsters covering a time span of 10 years, spatial distribution of Common hamsters was analyzed. As a base model we used climate variables, soil-characteristics and topographic variables. We then supplemented species distribution model with area-wide crop cover data (InVeKoS, Part of Common Agricultural Policy (CAP) of the EU) of four subsequent years and investigated the amount of certain crops in areas where Common hamsters are present or absent. We will address the questions how crop diversity, the amount of crops and spatial arrangement of crop types affect the distribution hamsters. Results are strongly indicating a dependency of hamsters on wheat and root crops but also being associated with certain climatic conditions. This study is strongly pronouncing that agriculture is not solely responsible for unfavorable conditions. Only by incorporation of climate and soil conditions, favorable crop composition could be pointed out. Furthermore models allowed identifying certain threshold values for Common hamster habitats and will therefore help to highlight areas with unfavorable conditions. This will help to support future conservation strategies especially because crop diversity and composition will change increasingly due to the increase of biomass and energy crops.

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L 4.3

Environmental observatory of the European hamster in Alsace: a regular monitoring from satellite imagery

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Within the context of insuring the long-term viability of the European hamster populations, the DREAL Alsace (Regional Environmental, Planning and Housing Direction) ordered a study to map the hamsters' environment in Alsace using satellite imagery. SERTIT, a service of the University of Strasbourg with more than 25 years experience in remote sensing and geo-information production from Earth Observation data, carried out this work in order to rapidly assess the effectiveness of the existing environmental biodiversity protection measures.

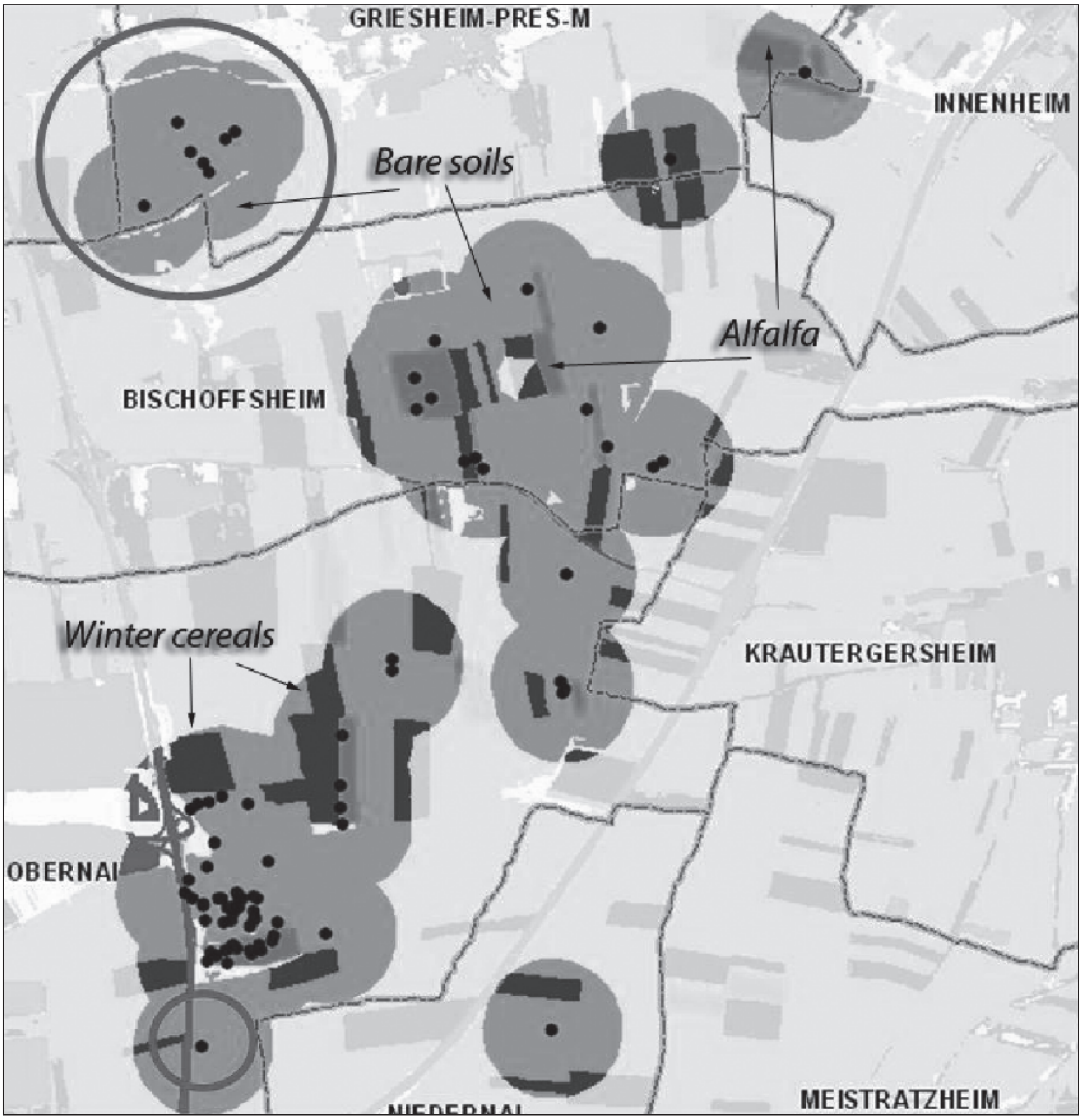
The landcover of the whole area populated by European hamsters in Alsace was mapped from satellite imagery, and a validation was performed via photo-interpretation as well as field observations on a radius of 300 meters around hamster burrows. This operation, highlighting hamster friendly crops (winter cereals and feed crops), bare soils (maize and other spring cultures), artificial features (urban areas and large transport infrastructures), and other features of the green and blue landscape (forest, prairies, vineyards, water bodies), was made around hamster burrows surveyed in 2009 and 2010, giving an idea of the situation at the end of the rodent's hibernation period.

This cartography clearly underlines some of the threats to the European hamster in the area: the fragmentation of their biotope by road infrastructure, isolating populations; the extent of bare soils (compared to favorable crops), which are spring crops a long time after the end of hibernation; the proximity of urban areas, that continuously eat into their natural environment. This work also emphasized the positive effects of the actions made for the preservation of the species: in 2009 as well as in 2010 the proportion of the favorable cultures (alfalfa and winter cereals) was more than the requirements of the European Directives, and bare soils decreased. This study using the location of burrows collected in 2009 and 2010 has also highlighted hamster displacements after hibernation; at the end of hibernation period, certain burrows are found in unfavorable environments, that of bare soils; a few weeks afterwards, hamsters have dug their burrows in vegetated parcels (winter wheat and alfalfa), they had moved to the middle of their biotope. Therefore, this work has helped in the monitoring of favorable crops (distribution, evolution), the targeting of the farmlands where actions have to be planned, the monitoring of urban evolution, and the highlighting of hamsters in danger in order to keep these micro-populations.

The study of the European hamster's habitat and its evolution is a good illustration of the benefits of high resolution Earth Observation data in characterizing biotopes, part of the green and blue landscape. Satellite data are well adapted to multi-scale and multi-temporal analysis; they offer a synoptic view of biotopes, useful in biodiversity preservation. Because of the help provided by the results of this project, DREAL Alsace has extended the monitoring with SERTIT put in charge of continuing the work in 2011, at the end and at the beginning of the hibernation period (spring and autumn); this regular mapping can verify the trends observed during the previous years.

L 4.3 Habitat

Figure 1.
Hamster burrow environments at the end of hibernation in April 2010, Obernai – Bischoffsheim area, Alsace, France.
The circles highlight hamsters in danger (isolated and without favorable crops in the vicinity).



L 5.1

Monitoring hamster burrows on compensation sites for road projects in Bavaria

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The presentation shows genesis and development of the first compensation sites for hamsters in Bavaria (Lower Franconia), affected by various external factors. Besides the effects on a local level, one of the superior results was a compensation standard for the destruction of hamster habitats by infrastructure and urban development.

Monitoring and Population Dynamics

L 5.2

How favourable is the conservation status of the Common hamster in Saxony-Anhalt? Results of the FFH monitoring in 2010

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For Germany a research project funded by the BFN defined how the FFH-monitoring has to be realized. In Saxony-Anhalt 10 monitoring areas were placed inside the continental region. The hamster population within the atlantic part of Saxony-Anhalt should be censused totally.

In Saxony-Anhalt we developed for the Landesamt für Umweltschutz the detailed monitoring scheme. Several modifications of the German draft were necessary. A total census of the atlantic region could not be put into practice because the Hamster population within the atlantic region of Saxony-anhalt is very widespread. Thus, representative monitoring areas were established for the atlantic region as well. All monitoring areas consisted of 100 ha agricultural landscape within known hamster areas. Furthermore, additional monitoring areas for the federal state monitoring of the Common hamster were established. For this purpose the chosen monitoring areas were larger than 100 ha and they consisted of similar soil conditions. The census was restricted to winter wheat fields. Among the most frequent cultivated crops winter wheat turned out to be the crop with the highest proportion of populated fields and with the largest Hamster densities. Thus, we used it as a standard crop for burrow counts. The evaluation parameters of the federal state monitoring were fitted on the changes in area size and method.

During the summer of 2010 the first monitoring census in Saxony-Anhalt took place. This summer was characterized by a lot of rainy days which lead to a very late and prolonged harvesting period. Most burrow counts could be done not earlier than from Mid-August onwards. At this time in Saxony-Anhalt burrow counts normally have finished at all, and the rape and grain fields are harrowed at least one time.

The results of the two monitoring schemes were similar, but not identically. The 100 ha-monitoring areas often could be monitored only partially because they included crops like sugar beet or maize as well, where summer burrow counts can not be done. Most of the 15 German monitoring areas as well as most of the Saxony-Anhalt monitoring areas were evaluated with conservation status C, thus the conservation status in Saxony-Anhalt in general is C. Only a few monitoring areas could be evaluated with B because of higher population densities. All of them are situated north of the Harz mountains where the continental region turns into the atlantic region. Highest density per field we found there in 2010 was 35 burrows per hectare. In contrast, in the whole southern part of Saxony-Anhalt the populations were very weak, sometimes hardly any burrow could be found inside the whole monitoring area. The large Saxony-Anhalt monitoring areas showed furthermore, that several populations are endangerd to persist because of widespread weak population densities and increasing habitat loss and habitat fragmentation.

L 5.3

DISTRIBUTION OF CZECH COMMON HAMSTER POPULATIONS IN THE 3RD MILLENNIUM

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Population numbers of the Common hamster *(Cricetus cricetus)* in western European countries declined over the last 30 years. Recently, shrinking distribution ranges have also been reported from central European countries, such as Poland or Hungary. In the Czech Republic, the latest information on hamsters dates back to the 70's of the twentieth century and the present status of the hamster range is unknown. To fill this gap in knowledge, we assembled information on hamster occurrences in the Czech Republic using data from 3 independent sources: monitoring programme for the common vole *(Microtus arvalis)*, questionnaire data, and public server for mapping species distribution, including our own information from the parallel research. Comparing the distribution of occurrences detected after 2000 with that from the last survey >30 years ago, we show that the present range is severely reduced, with the hamsters retreating to the optimum lowland habitats along large rivers. These results suggest that the demographic processes causing population decline in western populations continue to spread eastward and operate in central Europe as well.

Monitoring and Population Dynamics

L 5.4

Distribution of *Cricetus cricetus* in Ukraine

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Common hamster *(Cricetus cricetus L.)* was an abundant species in Ukraine. It inhabited most part of the country excluding only Carpathian and Crimea mountains. But during the 20th century hamster's range and number drastically decreased. Nowadays *C. cricetus* distribution is restricted to North, West Ukraine and Crimea peninsula (Steppe part). At the same the real status of a Common hamster in Ukraine remains quite enigmatic. In the IUCN Red List of Threatened Species it is stated that *C. cricetus* is still abundant in Ukraine, though it doesn't meet the real situation. There are just several works, related to the distribution and number of hamsters: Gorban et al. (1998) observed the findings of hamsters in the West of Ukraine and as first stated that it requires a protection; Evstafiev (2006), Tovpinetz et al. (2006) and Surov&Tovpinetz (2007) observed the localities and densities of hamsters in Crimea peninsula, especially stating the synanthropization of a Common hamster. At 2010 *C. cricetus* was finally included to the Red Book of Ukraine.

We collected and analyzed the data (literature, personnel communications and our own findings) on hamster localities during last 20 years on the whole of Ukraine. The results show, that the species range and number continues to decrease and most of present localities are dedicated to forest-steppe zone (mostly on fields of wheat, lucerne (alfalfa) and different vegetables).

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L 6.1

Implications from a semi-articulated skeleton of *Cricetus runtonensis* in the late Early Pleistocene of Thuringia (Central Germany)

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In Europe, Pleistocene hamsters of the genus Cricetus can be assigned to 3 groups. These are size classes comprising a small species *(C. nanus)*, larger forms of "normal size", i.e. that of the recent European hamster *(C. cricetus, C. praeglacialis)* (Schaub, 1930), and very large forms exceeding the size of the latter for c. 10-15% *(C. major and C. runtonensis)* (Woldřich, 1880; Newton, 1909). The very rare and exclusively SE European *C. palaeasovicus* (Topachevskij, 1965) is not considered here. The smallest form *C. nanus* is the stratigraphically oldest, followed by the "normal size" forms, whereas the very large forms occur partly in parallel with the latter (see below). However, in contrast to most authors some students (e.g., Schaub, 1930, Kowalski, 2001) refer this taxa to as subspecies of *Cricetus cricetus* thus implying a single phylogenetic line.

In fossil sites of Europe, Cricetus occurs regularly but often only in small numbers. Within the Pleistocene it lived inside but also outside the extant distribution area. Fossil finds of Cricetus originate from Hungary, Romania, Ukraine, Russia, Austria, Czech and Slovak Republic, Germany, Poland, France, Italy, Croatia, Bulgaria and even from England (see in Kowalski, 2001 for a compilation). The very large forms are of particular interest since they are rather poorly recorded and the fossil remains consist mainly of isolated elements. So it is hard to say how dentition and bones correlate to each other.

In the late Early Pleistocene site of Untermassfeld (Thuringia, Central Germany) a rather complete and partly articulated skeleton of a very large hamster could be excavated. This locality is known for its abundant fossil record of large and small mammals and other vertebrate and invertebrate groups. The site is well-studied and gave an age of approximately 1Ma (Kahlke, 2006). At least most of all carcasses were accumulated directly or indirectly due to a flood event (l.c.). Two of the recorded 21 micromammal taxa provide a remarkable preservation: Several individuals of Spermophilus and one of Cricetus could be found as more or less articulated skeletons. In contrast to this all other taxa are recorded mainly as fragments, which is presumably due to their accumulation as prey remnants in owl pellets. The reason for the preservation of Spermophilus and Cricetus is to be seen mainly in particular taphonomic conditions. However, it has to be mentioned that particular skills of the preparators enabled the consolidation of these fossils.

... /...

Morphological characters and measurements of the Untermassfeld Cricetus skeleton were compared with specimen and data from other Pleistocene and recent sites. This could confirm the taxonomic referral of the remains to as *C. runtonensis*. The proportions of skeletal elements are similar to those of the recent European hamster. With caution, this could imply similar abilities of locomotion and digging of this ancient hamster and most probably it lived in similar open area habitats as his recent relatives. According to the fused epiphyses, the skeleton belongs to an adult specimen.

The relative spatial position of the skeletal elements enables some taphonomic inferences concerning death and subsequent covering by sediment (biostratinomy) of the animal body. The data lead to a conclusion about the order of decay of the skeletal parts (skull – vertebra – fore- and hind limbs). Theoretically, there are three possibilities of how the animal died: (1) in its burrow (when flooded), (2) outside the burrow (when covered by mud), or (3) at another place upstream the site and later accumulated in the site. From the preservation pattern option (2) appears to be most probable. However, recent observations on drowned hamsters could provide further hints to this question.

The compilation of the European fossil records of hamsters of the genus Cricetus seems to confirm the existence of different lineages (instead of size fluctuations in one lineage/species). In agreement with Hír (1997) *Cricetus nanus* occurred from the Early (Gelasian) to the late Early Pleistocene (2.5-0.8Ma), *C. praeglacialis* and *C. cricetus* from the early Middle Pleistocene to recent (0.8-0Ma), *C. runtonensis* from the Early to the Middle Pleistocene (1.8-0.3Ma), and *C. major* from the late Middle to the Late Pleistocene (0.3-0.1Ma). For the reason of co-occurrence of different species in contemporaneous sites the giant forms cannot be the ancestor of the recent *Cricetus cricetus*. This is, last but not least, also important for biostratigraphic questions.

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L 6.2

The phylogeography of the Common hamster: the genetic diversity of the Ukrainian, Slovakian and Czech populations

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The Common hamster does not inhabit high mountains. Terefore in Europe the most important split in phylogeographic lineages is induced by the Carpathians. The Carpathian Basin is inhabited by Pannonia lineage, while Northern European Plains are inhabited by two lineages: E1 and North. However in suitable climatic conditions even strong barriers are crossed and it was found that Pannonia lineage expanded northwards into Poland. The aim of this work was two elucidate the ways of migration around and through the Carpathians. A total of 90 hamsters were collected in Ukraine, Slovakia and Czech. All hamsters were typed in 17 microsatellite loci and the sample of 50 was sequenced in ctr, cytb and 16S rRNA of mtDNA. Additionally the sample of 30 males was analyzed in six sequences located on the Y chromosome. The phylogeographic relationships of the analyzed populations will be described on the basis of the gene trees and networks of haplotypes. The levels of diversity will be compared with other described populations. The phylogeographic findings are very important for the conservation plans of the species. The knowledge about phylogeographic splits allows to plan the introductions and restorations to protect or re-establish the natural gene flow from the source populations through historical corridors of migration.

L 6.3

Hibernating Mammals: the slow road to increased survival

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Hibernation, or other low metabolic stages, can be found in many mammalian taxa, such as bats, some carnivores, a few primates, but mostly rodents. This implies that hibernation evolved several times independently throughout the course of mammalian diversification. Yet, it is striking that the hibernators in each group are characterized by a specific combination of life history traits: hibernators generally have slower life histories, implying slower post-embryonal growth, low reproductive rates, larger body sizes, and higher adult survival rates as compared to their non-hibernating relatives. Thus, the special and unique life history strategy of hibernators not only sheds light on some of the evolutionary theories that attempt to explain senescence, but also on the various physiological mechanisms that may promote the extension of lifespan.

Ecology and Behavior

L 7.1

Behaviour, habitat use, mortality and population ecology of reintroduced Common hamsters *(Cricetus cricetus)* in intensively used agricultural areas in northern Baden-Württemberg, Germany

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In May 2011 60 individuals of the Common Hamster *(Cricetus cricetus)* out of a breeding program were reintroduced to three lucerne fields within a intensively managed agricultural area close to Mannheim-Straßenheim in northern Baden-Württemberg, Germany. 17 of the animals were mounted with collar tags and observed for 6 weeks with an emphasis on the first days in wildlife using radiotelemetry to obtain data on behaviour, habitat use and mortality factors after reintroduction. Furthermore drifts in individual body condition and population ecology of the animals were investigated with recapture studies.

The animals showed strongly varying behaviours after reintroduction. Though it could be shown that a burrow was established within an average time of 26 hours and after an initial phase of relatively unstable spatial use the hamsters could set up a first temporary home range 4-12 days after reintroduction, which was eventually abandoned by most of the animals. On average, reintroduced hamsters used bigger areas than hamsters living in wild populations, males using bigger areas than females.

Mortality was shown to be high in the first time after reintroduction, predation being the main mortality factor (90%). The main predators were birds of prey (56%), closely followed by carnivores. Diseases as a direct mortality factor could shown to be less important in reintroduced hamsters. Thus, 56% of the hamsters died within 7 weeks after reintroduction, the fate of 11% could not be determined.

In general it could be shown that strong migration behaviour occurring in hamster populations after reintroduction is highly correlated with mortality events though single individuals can reach distances up to 4.5 kilometres from the release site, with distances up to 1 kilometre covered in less than 8 hours.

Only few animals could be re-caught. They all showed a good body condition; males had slightly lost weight since reintroduction whereas females had gained weight. 50% of the caught females were pregnant.

L 7.2

Circadian and seasonal activity of the Common hamster in a mosaic of arable fields in Central Europe

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Activity of the Common hamster was studied in Jaworzno-Jeziorki (UTM CA-76), the most south-western locality of hamsters in Poland, in the years 2007-2009. The individuals were observed in consecutive years from the moment when first opened winter burrows were found until the termination of hamsters' activity on the surface before the winter sleep.

The activity of young individuals in the social phase (juveniles) was registered by 7 reproductive burrows during eight four-day sessions in July and August. The juveniles after they had left the burrows were observed by five burrows during four-day sessions from July until October. Adult individuals (males and females) were observed on average in every two weeks, during four-day sessions from April until October. The activity was defined as the time of animals' presence above ground, the activity in the nest was not taken into account. The data were collected using standard direct observation methods (Altmann 1974).

The results of the research clearly indicate a diurnal activity of the hamsters with variations between sexes and age classes. The juveniles were active all day, from 4 a.m. until 10 p.m., with four peaks of activity. Subadult individuals shifted their activity to morning and evening hours. Adult males had two peaks of their activity, the first one between 4 a.m. and 8 a.m. and the second one between 6 p.m. and 10 p.m. The activity of adult females was constant as in the juveniles.

The studied individuals were not active before sunrise during the whole observation period, whereas from April to August they were active until up to one hour after the total darkness had fallen. In April and September no activity, neither before sunrise nor after sunset, was reported. The comparison between sexes and age classes showed that females and juveniles are active longer than adult males.

The Common hamster began its post-hibernation activity at the end of April or at the beginning of May. The end of hamster activity, including individuals which sealed their burrows as last, fell mainly at the end of September and the beginning of October.

References:

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SESSION 8

Conservation and Management

L 8.1

A KEY TO SUCCESSFUL HAMSTER MANAGEMENT IS PARTICIPATION, COOPERATION AND INVOLVEMENT BY ALL WHO HAVE INTERESTS IN KEEPING A STABLE HAMSTER POPULATION

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The hamster is a typical species of arable land especially of cereal fields. For a sustainable population a large area of suitable fields is needed. Nowadays special hamster management is more and more necessary and essential to preserve the population. The only possibilities are creating reserves or change the agricultural practices in favor of the hamster or a combination of these two. But nature management is mostly controversial to agricultural management and then there are the prejudices to be dealt with.

In the Netherlands we found a way to solve this problem. The province of Limburg established a special commission for all hamster affairs. In this commission representatives of farmers, nature conservation organizations, hunters, province and researchers are represented. All matters concerning the hamster are discussed in this commission. The commission advises the province. Since this commission is installed a great step forward is made in protecting the hamster.

L 8.2

DISAPPEARING HAMSTERS IN THE NETHERLANDS: DID WE SOLVE THE PUZZLE?

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The last wild population of The Common hamster *(Cricetus cricetus)* went extinct in the Netherlands in 2002, despite efforts to protect the species. A breeding program which had started some years earlier prevented the complete extinction of the Dutch hamster population. In the same year the last wild population went extinct, a research and reintroduction program was started to solve the puzzle of the disappearing hamsters. The combination of research on the ecology of the species, monitoring, and translation of the scientific results into practical Agri-environmental schemes (AES), resulted in a population growth and establishment of several local populations. After 9 years of research we may conclude that the puzzle has been made. However, some important questions still have to be solved and the renewed extinction of the oldest reintroduced population in the Sibbe reserve is a warning we should not neglect.

L 8.3

Do small mammal underpasses mitigate the barrier effect for the Common hamster caused by roads with high traffic volume?

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The intensively used agricultural landscape is the main habitat type where Common hamsters *(Cricetus cricetus)* live within Europe. Beside the intensified agricultural management the species is more and more suffering from habitat loss and habitat fragmentation caused by the development of residential and industrial areas and especially by traffic development. Within Germany most new built roads are presently motorways or major roads with more than two lanes and with high traffic volume. Traffic development also includes the rebuilding of existing roads to fit them to an increasing traffic volume. Higher traffic volume, more lanes and higher travelling speed decrease the chance for animals to cross roads successfully. A daily traffic volume of 10 000 cars is assumed to make animal road crossings nearly impossible (Müller & Berthoud 1994). Either such roads act as a deterrent themselves or the animals run on the lanes and die there colliding with cars. Wildlife underpasses, which lead animals below roads from each road side to the other, can help to mitigate the barrier effect.

Whether Common hamsters use wildlife underpasses or not is frequently discussed. Investigations focused on this topic were not done until now. We studied for longer than 12 months the use of different types of underpasses established especially for Common hamsters. The study was carried out at a new built major road B6n in Saxony-Anhalt (Germany). The road consists of 4 lanes, the travelling speed is only partially limited. Built in were small mammal underpasses (width 1m x 1m) as well as tubes (diameter 0.3 m 0.6 m and 0.8 m). The length of the underpasses reached from 34 m to 44 m. We placed infrared-video cameras at the entrance of one underpass of each dimension type and registered for 24-hours per day all animal activities permanently.

Common hamsters used all types of underpasses. Only the smallest tube seamed to be used less frequently. Altogether the number of registered passages was influenced by the underpass type less than by the density of hamster burrows on the fields next to the entrance. Thus, the highest number of passages was registered at a tube underpass situated near a hamster compensation area. The second most important factor was, if the ground of the underpasses remained dry during rainy periods or at least dried fastly afterwards. Also very important are facilities, which prevent animals from entering the road and guide them to the underpass entrances.

During the course of the year first individuals appeared at the end of May or June, but only a few individuals and not in all underpasses. Starting in the second decade of July the Hamster observations became more frequently, but the majority of passages were registered in all types of underpasses during August. During September hardly any Hamster was seen. The last individuals of the year were registered between 11th and 25th September.

Furthermore, the underpasses were used by a lot of insects, amphibians and other mammals. Only regarding mammals, there were registered Insectivores (Shrews, Hedgehog), Mice and Voles (several Apodemus species, Common vole, Water vole, Rat), Hare, Cat, Weasel, Stoat, Polecat, Fox, Badger, Raccoon, Raccoon dog - a remarkable large set of species regarding the extremely poor structured surrounding landscape. This indicates that mammal underpasses established for Common hamster not only decrease the barrier effect of roads for the Hamster but also for a lot of other species.

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L 8.4

Restocking of the Common hamster wild populations, *Cricetus cricetus*, in France. Impact of agricultural practices.

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Within the framework of the French Action Plan 2007-2011 (NAP) for the Common hamster in Alsace, reinforcement operations of Alsatian wild populations have been implemented since 2003 within Priority Action Areas (PAA) in which habitat has recovered a favourable conservation status. These actions were deemed necessary given the low population levels observed.

In order to improve the success of the reinforcement program, the National Hunting and Wildlife agency (ONCFS) implemented a radio tracking program in 2010 in order to study the released animals and their offspring.

This first year experiment, based on the monitoring of 30 hamsters, showed that the survival of hamster appears higher if they are released inside electrical fences. These anti-predation enclosures allowed the reproduction of at least 4 females released.

In 2011, we decided to study the impact of the crop in which hamsters are released on survival and reproduction. The experimental scheme is based on 3 groups of 14-15 female hamsters radio tracked, all released within electrical fences. The first group was released on 2 lucerne plots, the second group on 2 wheat plots harvested normally (e.g. mid-July), and the last group was released on 2 plots of unharvested wheat (figure 1). Marked-animals are radio tracked twice a week. The comparison between the 3 groups of hamsters will inform us on the influence of the habitat and its management on released animals. As expected, preliminary results show that, harvest has a negative impact on survival and reproduction of released hamsters. More surprising, it seems that restocking success is compromised in lucerne this year. Detailed results will be presented at the International Hamster Workgroup 2011.

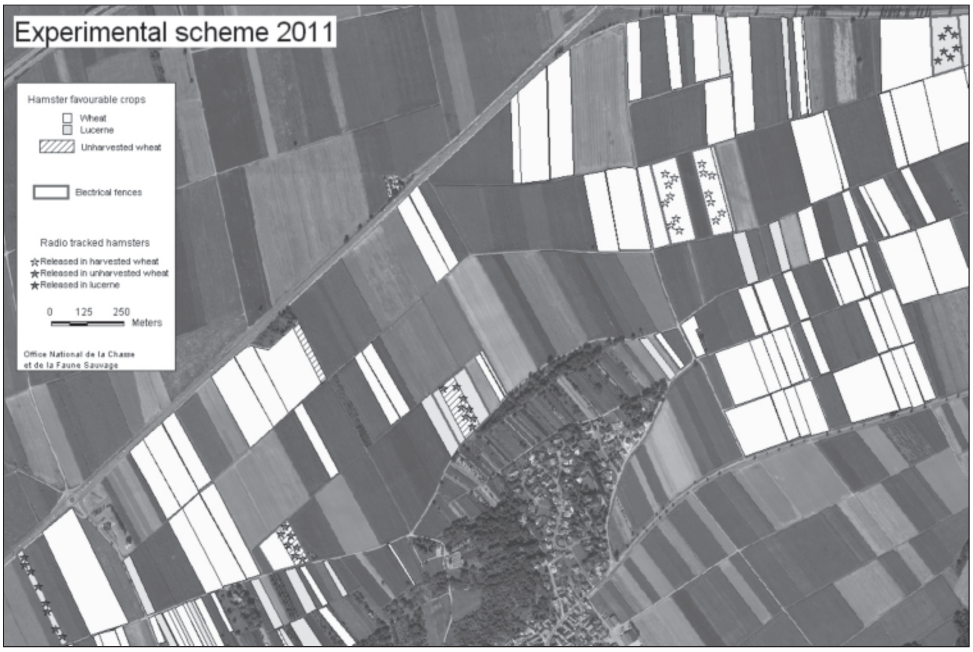

Figure 1.
Location of radiotracked released hamsters in 2011

L 8.5

The evaluation of the 2007-2011 French National Plan for the Protection of the Common hamster: have we been successful?

Preliminary results and recommendations

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The population of the Common Hamster in the Alsace Region has been under serious threat since several decades, the number of individuals being still divided by 7 between 2001 and 2007. To revert this trend and to enhance the overall viability of the hamster population, the French government launched a first National Action Plan for the protection of the Common hamster in 2000, followed by a second action plan for the period 2007-2011.

With this second national plan coming to its end, many questions arise today : has the plan been effectively implemented? If yes, has it been successful in enhancing the viability of the Common hamster population in the Alsace region? Which factors have influenced the effectiveness and efficiency of the plan – and how could existing constraints be solved or removed? And: what could be the objectives, philosophy and practical actions of a follow-up (third) National Action Plan – if such a third plan is considered necessary – taking into account the current state of the hamster habitats and population in Alsace?

The paper summarizes the main results of a comprehensive evaluation of the second National Action Plan for the protection of the Common hamster in France. Launched in 2011, the evaluation built on a wide range of activities including site visits, data collection and analysis, review of progress reports and scientific articles, interviews with key stakeholders and benchmarking with experiences in other EU countries. The evaluation assesses the technical, scientific and financial performance of the plan, giving due attention to its (marginal) impact on the Common hamster habitats and populations. It investigates also the main constraints encountered in implementing the national plan, including organizational and governance issues. The paper finishes with presenting possible options that could be considered as follow-up to make the Common hamster population viable and sustainable.

POSTER
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ABSTRACTS

P 1

Seasonal variations of clock gene expression in the suprachiasmatic nuclei of the European hamster *(Cricetus cricetus)*

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It has been already demonstrated in several species of rodents that day length (photoperiod) is read and encoded in the main circadian clock, the suprachiasmatic nuclei. In turn, the suprachiasmatic nuclei control the seasonal rhythmicity of various physiological processes, in particular the secretion pattern of the pineal hormone melatonin. This hormone then operates as an essential mediator for the control of seasonal physiological functions.

In the European hamster, both hormonal (melatonin) and behavioral (locomotor activity) rhythms are strongly affected by season, making this species an interesting model to investigate the impact of the seasonal variations of the environment. The direct effect of natural short and long photoperiod was investigated on the daily expression of clock genes in the suprachiasmatic nuclei.

Photoperiod altered expression of all clock genes studied. In short photoperiod, whereas Clock mRNA levels were reduced, Bmal1 expression became arrhythmic, probably resulting in the observed dramatic reduction in the rhythm of the expression of Avp, a clock-controlled gene.

Thus, we show that even in this circannual species with high amplitude of annual rhythmicity, the suprachiasmatic nuclei built and distribute seasonal messages.

P 2

Burrow density and habitat preference of the Common hamster in a mosaic of arable fields

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Polish landscape of small scale mosaic of arable fields stands out from landscapes of other European countries. It occurs rarely both in Western Europe, where vast monocultures are dominant, and in other countries of Eastern Europe, where the collectivisation of agriculture was more intense than in Poland.

The investigation took place in a 10 ha area of a mosaic of arable fields in Jaworzno-Jeziorki (UTM CA-75) situated in Upper Silesia, the south-western part of Poland, in the years 2007-2009. It included an inventory of burrows of the Common hamster from spring emergence until the immergence into hibernation in autumn. The appearance of the burrows on the research plot was checked on average once per month. Moreover, 26 stripes of arable fields were evaluated in terms of land-use intensity. During the inventory of hamsters burrows, location of the burrows (baulks, fields) and in case of farmlands the kind of crops were noted.

In total, 231 burrows were reported during three research seasons. The maximum number of burrows, calculated as the sum of new burrows and active last-year burrows, was 112 and 115 in 2007 and 2008 respectively. The burrows used constantly during two or three seasons of activity amounted to 32,2% (n=72) including 5,2 % of burrows inhabited with one-season break between successive settlements. The density of active burrows, estimated per 1 hectare, fluctuated between high and medium density. The lowest spring density of burrows was reported in 2007 (1 per ha), the highest in 2009 (4.4 per ha). The autumn densities decreased from medium in 2007 (5,6 ha) to low (1.7 per ha). The increased density in the two consecutive years does not work as a buffer against such accidental incidents as sudden breaks in the weather or limitation of food resources (year 2009 and 2010) which could sustain a population at a level which guarantees survival. Despite all the reservations, it has to be acknowledged that extensive agriculture is in the Common hamster's favour.

The hamster burrows in Jaworzno-Jeziorki were situated mainly in baulks and wastelands located in the vicinity of arable fields (n=237, 73,8%). The hamsters settled mainly in the fields of wheat and barley (60,7% of crops), they preferred the winter crops (48,2% of the crops). Seasonal changes in the preference for burrow location were noted. In spring and autumn, hamster chose mainly fallow land, especially those located next to arable fields, and baulks between fields. However, in summer, when the crops are ripe and the juveniles start to disperse, hamsters inhabited the baulks in large numbers. One of the significant factors in making a choice about the localisation of burrows is the ground cover that protects the species throughout the whole season. Protection of the Common hamster should involve establishing baulks and narrow stripes of wastelands which would allow the species to function in agricultural landscape in which no perennial crops are grown and intensive soil cultivation is practised.

P 3

Seasonal variations of locomotor activity and physiological parameters: an approch by a road kill study in the Algerian hedgehog *(Atelerix algirus)*

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— INTRODUCTION

There are several reasons for mortality in a population of wild animals, but one of the most important in small animals is the mortality due to traffic circulation. Indirectly, such a study also deliver informations on the different variables of the population such as: the density and distribution of the species in a region or a given environment; the dynamics of the population and its seasonal variations; the sex and age of the animals; the course of seasonal cycles such as reproduction or hibernation, etc.

Due to the dense road network in Western Europe, the hedgehog is one of the species most affected by road kills. In north-African countries and particularly in Algeria, the road network as well as the number of cars has increased considerably during recent decades. Thus, the number of traffic victims of Algerian hedgehogs *(Atelerix algirus)* is common and elevated especially in spring and summer.

— MATERIAL AND METHODS

As in Algeria no study has been done on this subject, along a road of ca. 100 km with high traffic volume (about 13 000 to 22 000 vehicles per 24 h), localized in the Soummam valley (from Béjaia to Bouira), the number, places and dates of hedgehogs found killed were determined during 5 years (from 2002 to 2006). This road, characterized by narrow roadways with grassy borders and hedges which are preferred habitats of hedgehogs, was surveyed from a car, three times a week. In view of the fact that the hedgehog is a nocturnal animal, bodies were collected regularly in the early morning.

— RESULTS

During the 5 year study, the overall number of hedgehogs found killed was 459 and the number of dead animals was irregular and varied widely according to year (maximum 134 in 2002 and minimum 59 in 2005). The distribution of animals respective to the location showed that their density was more pronounced in the periphery of sparsely populated small villages and smaller in the vicinity of strongly urbanized large agglomerations.

In the course of the year, the road kills of hedgehogs was maximal in spring and summer (42.92 and 34.64% respectively), decreasing in autumn (16.78%) and reaching a minimum in winter (5.66%). Monthly data showed that the first road kills were observed in March. Thereafter the number of traffic victims increased regularly to a maximum in May (20.92%) and, from June to September, stayed at a lower but stable level (between 10.89 and 12.82%).

From October on, the number of crushed animals diminished progressively to be very low in December (0.87%) and zero in January and February.

Of the 459 hedgehog cadavers found, it was possible to determine age and sex in 404 animals which were distributed in 3 categories: adult males, adult females and juveniles born during the same year (Fig. 1).

a) Each year, adult male hedgehogs were crushed the first in spring, from March onwards, with elevated values from April to July (maximum in May: 13.12%), that decreased significantly from August on, until they reached values close to zero from October to February.

b) Adult female cadavers appeared only in April in lower numbers than males, the maximal number was observed in May (7.18%) but this level stayed practically stable from June to September (3.96 to 5.94%) and diminished in autumn to be minimal from October to April (0 to 1.98%).

c) The juveniles (unsexed) were found from July onwards, with highest values from September to November (6.44 to 5.69%), a rapid decrease in December and no traffic victims during winter. The period from the end of summer to the beginning of autumn corresponds to dispersion and foraging for winter.

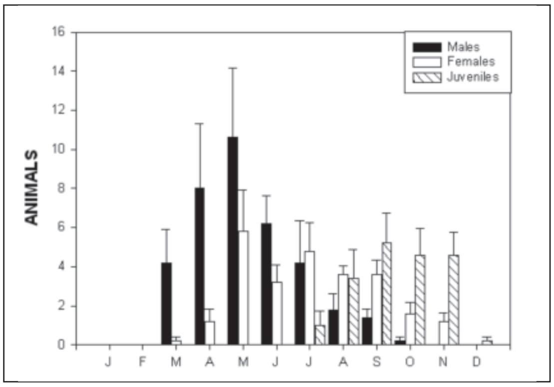

Figure 1.
Monthly distribution of Algerian hedgehogs killed on the road along the Soummam valley as a function of sex and age from 2002 to 2006. Mean ± SEM.«

— CONCLUSIONS

These road kill data in Algerian hedgehogs constitute an initial approach of the spatial and temporal distribution of this species and allow knowleges on the biology of the species such as biotopes of the habitat, seasonal variations of locomotor activity and physiological cycles.

Suburban areas, showing a diversity of common biotopes (such as forests, agricultural areas, hedges, and the woodlands around the affluents of the wadi El Soummam) seemed to be more attractive for the hedgehogs due to a combination of factors such as food availability, possibility to hide and structures facilitating orientation.

During the course of the year, the distribution of hedgehogs crushed on the road (maximal in spring and summer; minimal in autumn and winter) reflects two net seasonal variations characterized by an active life period and a resting period. During the active season, the fact that males were found dead early and more than females (maximum observed in May) reflected a strong locomotor activity which is characteristic of the reproduction period and probably also a home range larger than that of females. In July, the appearance of juveniles (~ period of birth) permits to determine the mating period (May-June).

The resting season is characterized by a progressive decrease of the dead animals (in the three categories) at the end of autumn and their disappearance in winter. During the adverse times of the year (low ambient temperature and photoperiod, reduced food availability) animals started to reduce their locomotor activity in relation to changes in endocrine functions (reproduction, metabolism, etc.) in order to save energy with probably entering into torpor or hibernation.

That approch by a road kill study is a first step for numerous other studies involving relation to the environment, seasonal rhythms of locomotor activity, annual cycles of reproduction and hibernation and mechanisms of regulation.

P 4

Variability of hibernation patterns in captive adult jerboas *(Jaculus orientalis)*: influence of sex and group

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— INTRODUCTION

The jerboa *(Jaculus orientalis)*, a desert rodent member of the North African Dipodidae family, lives in semi-desertic environments characterized by very large variations of ambient temperature T_a, water scarcity and irregular food supply. Even if different aspect of the physiology of this animal model has been extensively studied the data obtained on the occurrence of daily torpor or hibernation are confusing and contradictory. In the past, the jerboa was described as an hibernator but no precise reliable data exists on the daily and seasonal rhythmicity of body temperature (T_b).

— MATERIAL AND METHODS

During this study, adult jerboas were maintained in captivity during autumn and winter, the period of quiescence and putative period of hibernation. Animals were kept in a room with open windows, and submitted to natural variations of light and ambient temperature (T_a).

T_b and T_a variations were recorded with temperature loggers (iButton, Dallas Maxim Integrated Products, UK). After surgically implantation of the loggers in the abdominal cavity of jerboas, T_b and T_a were recorded at 30 min intervals during 2 consecutive years.T_b patterns were determined in different groups of jerboas: isolated males and females, castrated males and grouped animals.

— RESULTS

In isolated female jerboas studied from mid-autumn to the beginning of spring over two consecutive years, 6/13 animals showed numerous hibernation bouts (T_b < 33°C) interspersed with short period of normothermy from mid-November to mid-February. Hibernation bout durations were longer (4-5 days) than those of normothermia phases (1-4 days) (Fig. 1).

In contrast, only 1/12 isolated males showed short hibernation bouts of ca. 2 days late in the hibernation season (February-March) and had higher $T_b$min values (15.1°C).During hibernation, the T_as at which animals hibernated ranged from ca. 9 to 19°C.

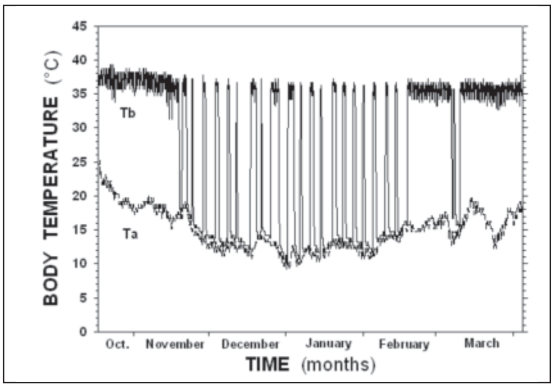

Figure 1.
Patterns of body temperature (T_b°C) in relation with the variations of the ambient temperature (T_a°C) in female jerboa 13 from October 18, 2007 to April 5, 2008.

In females, the highest frequency of hibernation occurred at T_b ~13.2°C which is a little bit higher than the corresponding T_a value (12.4°C). Normothermic T_bs ranged from 33.0 to 39.5°C. A significant linear relation between $T_b$min and $T_a$min was observed and showed that the $T_b$min was explained by the steady decrease in $T_a$min between mid-November and March. The relationship between the duration of hibernation bouts and $T_a$min was established by a linear regression (bout length 8.6 - 0.42T_a, $r^2 = 0.75$, $P < 0.01$, N = 68), and the longest hibernation bouts were associated with the lowest T_as. In females, the relative duration of hibernation bouts and period of normothermy (calculated over 15-day intervals) showed that torpor bout duration increased progressively from mid-November (~30%) to December (~60%), attained a maximum in early January, then decreased slowly from late January to mid-February to be considerably reduced from mid-February to March (Fig. 2).

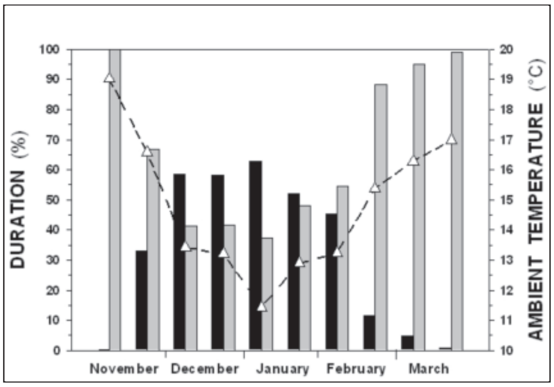

Figure 2.
Duration of torpors (black bars) and euthermia phases (grey bars) in female jerboas from November 2007 to March 2008 in relation with ambient temperature (T_a°C, dotted line and triangle). Data were given as percentage of means obtained over 15-day intervals.

In contrast to predictions, no castrated males hibernated. When jerboas were grouped, females and males exhibited concomitant torpor bouts. In males, the longest bouts were observed during the late hibernation season.

— CONCLUSIONS

In spring and summer, jerboas are normothermic with a T_b pattern (higher during the night [T_b > 37.8°C] than in the day [T_b < 36.5°C]) typical of nocturnal species. The hibernation period commenced in late autumn and ended in late winter or early spring. A bimodal T_bs distribution characterize periods of deep hypothermia alternating with periods of normothermia. During deep hypothermia the $T_b$min-$T_a$min gradient was low and nearly constant (between 1.5-2.5°C, $T_b$min > Tamin). The longest bout durations were observed at the lowest T_as and this relationship is in agreement with those described in numerous hibernators (European hedgehog, European hamster).
According to year and animals, a large variability was observed in jerboa hibernation patterns. Numerous isolated female jerboas showed clearly characteristics of seasonal hibernators but isolated males were more reluctant to become torpid. Castration had no influence. Interestingly, when jerboas were grouped, males showed some torpor in the same time as females. These data revealed the existence of a complex regulation of hibernation in jerboa in relation to environment (changes in photoperiod, lowering of T_as, food availability), sex (male vs female), behaviour (isolated or social group) and required further studies in free-ranging animals.

P 5

Distribution of Common hamsters *(Cricetus cricetus)* in relation to landscape scale crop composition in Hesse (Central Germany)

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The intensification of the agricultural practices and change in crop composition is considered as one of the major reasons for the decline of the Common hamster in Europe. Yet, little is known about the specific effects of changing crop compositions on a landscape scale. In this study we combined a state-wide dataset of 2767 Common hamster records from 2000 to 2010 with an area-wide crop cover data (InVeKos). We analyzed the amounts of certain crops in relation to hamster occurrence. The results are highlighting the strong positive association of Common hamsters to certain amounts of wheat and root crops. Energy crops like maize and rape negatively affected the hamster occurrence. Based on these findings we developed a model, which is able to predict the suitability of certain crop densities for Common hamsters. Furthermore this model enabled to point out threshold values of crops amounts. This study is the first analyzing the relation of crop composition and the occurrence of hamsters on a large spatial scale and is therefore important when considering the effects of future agricultural policies.

P 6

Effects of n-6 fatty acids on torpor expression and SERCA activity in a daily heterotherm: the Djungarian hamster *(Phodopus sungorus)*

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Polyunsaturated fatty acids (PUFA) have profound effects on hibernation and daily torpor in mammals. High contents of dietary PUFA were found to increase torpor propensity, decrease body temperatures and extend duration of torpor bouts. Yet the mechanism by which PUFAs enhance torpor and hibernation is unknown. We therefore hypothesize that, rather than PUFAs in general, the shift in the ratios of n-6 to n-3 PUFAs increases the ability for heterotherms to enter torpor. Specifically, we hypothesize that a high n-6 to n-3 ratio increases the activity of the sarcoplasmic reticulum calcium-magnesium ATPase (SERCA) of the heart, counteract Q10 effects on SERCA activity and protects the cardiac muscle from arrhythmias at low tissue temperatures. To test this hypothesis, we investigated patterns of torpor (by using respirometry) and the activity of cardiac SERCA in Djungarian hamsters *(Phodopus sungorus)* fed with diets containing either 10-wt % of sunflower oil (SF, high n-6/n-3 PUFA) or 10-wt % of linseed oil (LS, low n-6/n-3 PUFA). Although minimal torpor metabolic rates did not differ between SF and LS groups, SF hamsters displayed longer torpor bouts compared to LS animals. This difference was due to a significant delay in the time of arousal in the SF animal's group. Despite of these differences in torpor propensity, no significant difference of the SERCA activity was detected between groups. We conclude that positive effects of n-6 PUFAs (high n-6/n-3 PUFA ratio) on SERCA activity, and on the ability for heterotherms to enter torpor bouts, play only a minor role during daily torpor (body temperatures of c.a. 18°C), but may be important for deep hibernators, which typically reach single-digit body temperatures during their hibernating bouts.

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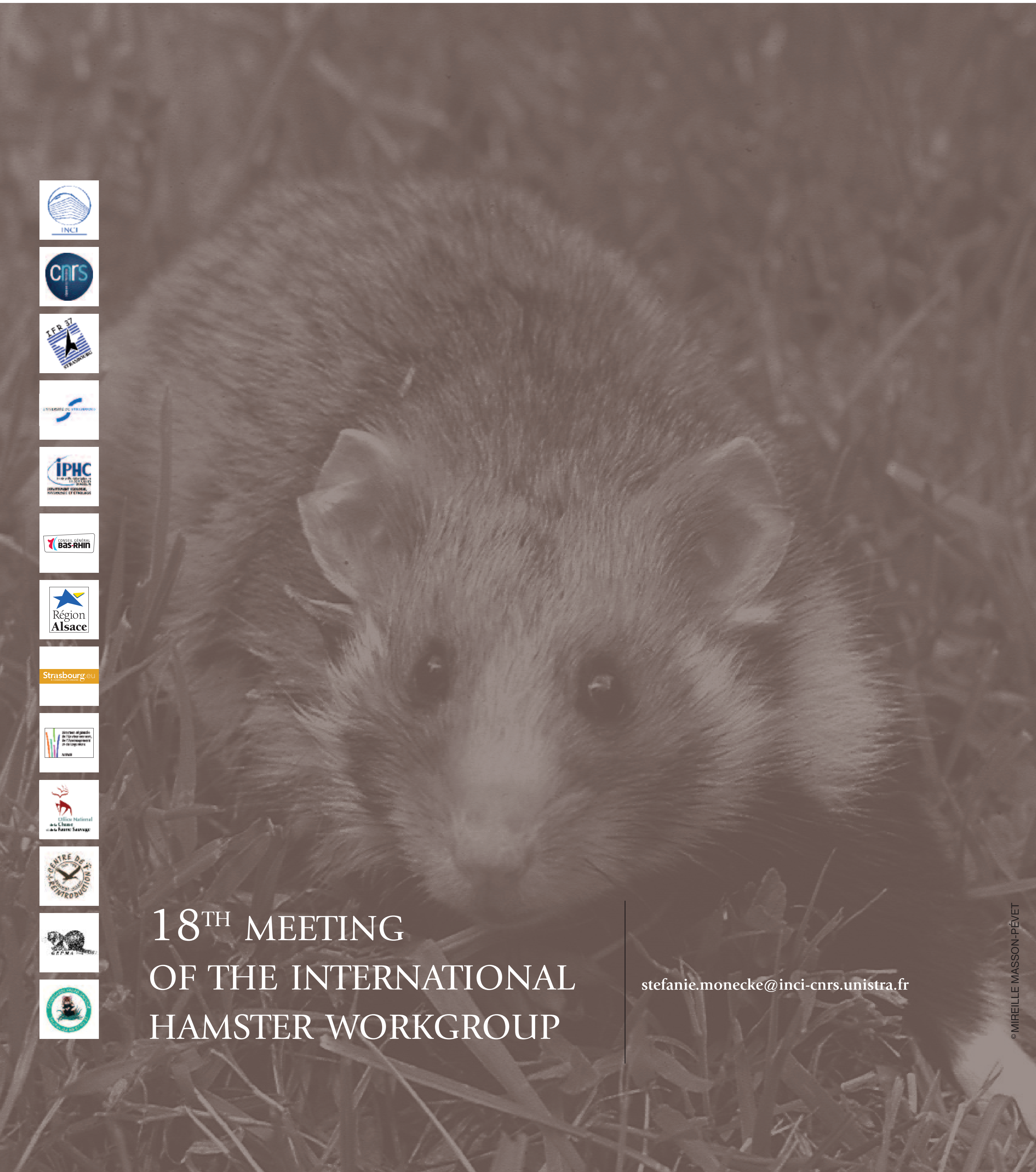

18TH MEETING OF THE INTERNATIONAL HAMSTER WORKGROUP

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