SESSION IV

FATIGUE
ADAPTATION TO ENVIRONMENT
THERMOREGULATION

Wednesday (September 15, 2021; 12:05 – 15:40)
Thursday (September 16, 2021; 10:05 – 10:55)

Chair:

Prof. Pawel Zalewski
Department of Physiology and Functional Anatomy, Collegium Medicum, Bydgoszcz

Prof. Malgorzata Tafil-Klawe
Department of Human Physiology, Collegium Medicum, Bydgoszcz

Prof. Justyna Rogalska
Department of Animal Physiology and neurobiology, The Nicolaus Copernicus University, Torun

DETAILED SESSION IV SCHEDULE

Part I - **FATIGUE**

Opening lectures (Wednesday, September 15, 2021; 12:05 – 13:25; *virtual stream A*)

S4.L1 STANDING UP FOR FATIGUE. **J. Newton** (Newcastle University - Consultant Physician, Newcastle Hospitals - Medical Director - Academic Health Science Network for North East and North Cumbria, United Kingdom).

S4.L2 FATIGUE AND NEUROLOGICAL IMPAIRMENT IN LONG-HAUL COVID-19. **M. Murovska** (Institute of Microbiology and Virology, Riga Stradins University, Riga, Latvia).

S4.L3 THE ROLE OF THE MICROBIOME IN FATIGUE: DOES SEX MAKE A DIFFERENCE? **K. Morten[1], I. Williams[1], J. Maclennan[2] J. Kenyon[4]** (Nuffield Department of Women's and Reproductive Health, University of Oxford, UK, [2]SoftCell Biological Research Soft Cell Biological Research, St. George, USA, [3]The Doveclinic, Hampshire, United Kingdom).

S4.L4 CARDIOPULMONARY AND AUTONOMIC CHARACTERISTIC OF FATIGUE. **S. Kujawski** (Nicolaus Copernicus University in Torun, Torun, Poland).

Oral presentations (Wednesday, September 15, 2021; 13:25 – 13:40; *virtual stream A*)

S4.L5 EFFECT OF FATIGUE GENERATED BY EFFORT ON REACTION TIME. **A. Jastrzebska, E. Bakonska-Pacon, I. Wierzbicka-Damska** (Department of Physiology and Biochemistry, University of Physical Education, Wroclaw, Poland).

Questions and answers

Part II – ADAPTATION TO ENVIRONMENT. THERMOREGULATION

Opening lectures (Wednesday, September 15, 2021; 13:45 – 15:05; *virtual stream A*)

S4.L6 PHYSIOLOGICAL ADAPTATIONS TO HEAT STRESS AND EXERCISE IN CELL CULTURE MODELS AND HUMANS. **K. Dokladny, P. Moseley** (University of New Mexico, Department of Internal Medicine, Division of Gastroenterology, Albuquerque, New Mexico, USA).

S4.L7 NEW VIEW ON THE IMPACT OF THE LOW FREQUENCY ELECTROMAGNETIC FIELD (50 HZ) ON STRESS RESPONSES - IS THE ADAPTATION POSSIBLE? **M. Stankiewicz, A Klimek, H. Kletkiewicz, A. Siejka, M. Klimiuk, J. Maliszewska, M. Jankowska, A. Nowakowska, J. Wyszkowska, J. Rogalska** (Department of Animal Physiology and Neurobiology, Faculty of Biological and Veterinary Sciences, Nicolaus Copernicus University in Torun, Torun, Poland).

S4.L8 FREEZE TO SURVIVE: ROLE OF MICROBIOM **A. Nowakowska, P. Idczak** (Nicolaus Copernicus University in Torun, Faculty of Biological and Veterinary Sciences, Department of Animal Physiology and Neurobiology, Torun, Poland).

Oral presentations (Wednesday, September 15, 2021; 15:05 – 15: 40; *virtual stream A*)

S4.L9 CAPSAICIN AND THERMOREGULATORY RESPONSES IN THE AMERICAN COCKROACH. THE INVOLVEMENT OF TRP RECEPTORS. **J. Maliszewska, M. Jankowska, H. Kletkiewicz, M. Stankiewicz, J. Rogalska** (Department of Animal Physiology and Neurobiology, Faculty of Biological and Veterinary Sciences, Nicolaus Copernicus University, Torun, Torun, Poland).

S4.L10 SOME FEATURES OF COLD ADAPTATION IN MEN DURING OVERWINTERING IN ANTARCTICA **D. Lutsenko[1], O. Shylo[1], K. Danylenko[2,3]** ([1]Institute for Problems of Cryobiology and Cryomedicine, Kharkiv, Ukraine, [2]National Antarctic Scientific Center, Kyiv, Ukraine, [3]Kharkiv National Medical University, Kharkiv, Ukraine).

Session summary

Poster session (Thursday; September 16, 2021; 10:05 – 10:55; *virtual stream D, interactive*)

S4.P1 DO ELITE ATHLETES HAVE DIFFERENT LEVELS OF A PHYSIOLOGICAL STRAIN (PSI) IN RESPONSE TO A SIMILAR SUBMAXIMAL EXERCISE PERFORMED UNDER TEMPERATE CONDITIONS AFTER A MEDIUM-TERM ACCLIMATION TO WHOLE BODY HYPERTHERMIA (MWBH) AND WHOLE BODY CRYOSTIMULATION (MWBC)? **I. Pokora[1], L. Wolowski[2], P. Wyderka[2]** ([1]The Jerzy Kukuczka Academy of Physical Education in Katowice, Institute of Sport Sciences, Department of Physiological-Medical Sciences, Katowice, Poland; [2]The Jerzy Kukuczka Academy of Physical Education in Katowice, Doctoral Studies, Katowice, Poland).

S4.P2 THE INFLUENCE OF REGULAR PROFESSIONA TRAINING ON THE RESTING TEMPERATURE DISTRIBUTION OF THE BODY SKIN. **M. Binek[1,2], I. Pokora[1], Z. Drzazga[2]** ([1]Academy of Physical Education in Katowice, Katowice, Poland, [2]University of Silesia in Katowice, Katowice, Poland).

S4.P3 EFFECT OF ANTI-INFLAMMATORY EXTRACTS ON COELOMOCYTES OF THE EARTHWORM LUMBRICUS TERRESTRIS. **A. Gren[1], G. Formicki[1], P. Massanyi[1,2], M. Halo[2], M. Massanyi[2]** ([1]Department of Animal Physiology, Institute of Biology, Pedagogical University of Krakow, Poland; [2]Department of Animal Physiology, Faculty of Biotechnology and Food Sciences, Slovak University of Agriculture, Nitra, Slovak Republic).

S4.P4 GEOGRAPHICAL ORIGIN REFLECTED IN PHYSIOLOGY - DIFFERENCES IN THERMAL BEHAVIOUR OF THREE HONEYBEE *APIS MELLIFERA* SUBSPECIES. **J. Bacia, P. Grodzicki** ([1]Nicolaus Copernicus University, Faculty of Biological and Veterinary Sciences, Department of Animal Physiology and Neurobiology, Torun, Poland).

S4.P5 BIORITHMOGENIC PROBLEMS OF HUMAN ADAPTATION TO ANTARCTIC CONDITIONS OF ACTIVITY. **Y. Moiseyenko, N. Vaschenko, E. Rozova** (Bogomoletz Institute of Physiology of the National Science Academy of Ukraine, Kyiv, Ukraine).

S4.P6 A NEW VIEW ON OVERWINTERING IN SNAILS: THE ROLE OF MICROBIOTA IN FREEZE TOLERANCE. **P. Idczak[1], A. Nowakowska[1], A. Kalwasinska[2]** ([1]Department of Animal Physiology and Neurobiology, [2]Department of Environmental Microbiology and Biotechnology, Nicolaus Copernicus University in Torun, Torun, Poland).

S4.L1

STANDING UP FOR FATIGUE

J. NEWTON

Newcastle University; Academic Health Science Network for North East and North Cumbria;
Newcastle Hospitals - Consultant Physician; United Kingdom

Fatigue is a common symptom experienced by people with a range of chronic conditions. Its cause is unknown but its presence and severity associate with the presence of autonomic nervous system dysfunction. Abnormalities in autonomic function can be subjectively and objectively assessed and evidence is emerging that an individualized approach to management can lead to improvements in some patients. Innovative approaches to management such whole body cryotherapy might offer those with fatigue new treatments.

S4.L2

FATIGUE AND NEUROLOGICAL IMPAIRMENT IN LONG HAUL COVID-19

M. MUROVSKA

Institute of Microbiology and Virology, Riga Stradins University, Riga, Latvia

Emerging aspects of the COVID-19 clinical presentation are its long-term effects, which are characteristic of the so-called “long-haul COVID”. Long-haul COVID-19 was defined as symptoms persisting for more than 6 weeks, with the consensus that most patients fully recover from COVID-19 in 4 to 6 weeks. Many COVID-19 „long haulers“ experience at least four lingering neurological symptoms, such as brain fog, headache and the loss of sense of smell or taste, even if they were never hospitalized for their initial illness. Overall, 85% of participants reported at least four neurological symptoms. The most common symptom was „brain fog“ or trouble thinking, reported by 81% of participants; followed by headaches, reported by 68%; and numbness or tingling, reported by 60% of participants. More than half reported problems with their sense of taste or smell; 47% reported dizziness; 30% reported blurred vision; and 29% reported ringing in the ears. Other common, but not neurological, symptoms included fatigue, depression and anxiety, insomnia and gastrointestinal symptoms. In many patients, their symptoms fluctuated, or came and went, for months. When they were asked how much they felt they had recovered to their pre-COVID-19 level, on average, patients said they felt only 64% recovered after about five months. As COVID-19 causes ME/CFS-relevant symptoms in patients and this increases the need for monitoring of patients for even longer after recovering from COVID-19’s symptoms, in order to prevent complications and the progression of chronic diseases. The similarity and overlap of ME/CFS and long-haul COVID19 symptoms suggest possibility of similar pathological processes.

Address for correspondence: Modra Murovska (Modra.Murovska@rsu.lv)

S4.L3

THE ROLE OF THE MICROBIOME IN FATIGUE: DOES SEX MAKE A DIFFERENCE?

K. MORTEN[1], I. WILLIAMS[1], J. MACLENNAN[2], J. KENYON[3]

[1]Nuffield Department of Women's and Reproductive Health, University of Oxford, Oxford, United Kingdom,
[2]SoftCell Biological Research Soft Cell Biological Research, St. George, USA, [3]The Doveclinic, Hampshire, United Kingdom

Microbial imbalance of the intestinal biome is a key associated factor in many chronic conditions including Myalgic Encephalomyelitis (ME/CFS). Our major research goals are too increase our understanding of ME/CFS and open up new treatment options. If a leaky gut is a key component of ME/CFS, restoring a normal gut microbiome balance could be a life changing treatment options. Our collaborator SoftCell Biologicals Research (SBR) have developed approaches examining the host tissue biome. This is an un-tapped area of medicine with the presence of significant levels of wall-less (L-Form) opportunistic pathogens present in many chronic disease states. Using novel L-Form culturing methods SBR have treated L-form cultures from patients with chronic urinary tract infections (CURTIs) using a standard antibiotic panel. Clinicians acting on this information have noticed improvements in a number of patients. Clinical studies, using this approach will allow antibiotics tested in the laboratory to be used to treat patients in a blinded trial setting. In this presentation, I will highlight our research with the Doveclinic exploring levels of gut dysbiosis in a broad range of conditions many of whom suffer with fatigue. The impact of age and sex on the gut microbiome will be explored with a focus on ME/CFS and cancer. Exciting data from a comparison of recent trials of Gut Floral Replacement Therapy (GFTR) to the more conventional Faecal Microbiota transplantation (FMT) will be presented.

S4.L4

CARDIOPULMONARY AND AUTONOMIC CHARACTERISTIC OF FATIGUE

S. KUJAWSKI

Nicolaus Copernicus University in Torun, Torun, Poland

Fatigue is a physiological phenomenon when it follows prolonged activity, and resolves completely with rest. Overreaching occurs as a result of increase of intensity of physical exercise training program is also considered as its physiological side-effect. However, there are conditions in which fatigue is not resolved with rest easily. Overtraining syndrome (OTS) and chronic fatigue syndrome (CFS) are conditions in which underlying pathophysiology is related to, inter alia, chronic fatigue. In the above study, cardiopulmonary and autonomic profile of subjects with chronic fatigue would be explored. CFS patients were included if they met the diagnostic criteria of, the Fukuda case definition. Initially, 1400 volunteers were assessed for eligibility onto the trial with 1308 being excluded. This left 69 individuals who met the trial inclusion criteria. VO_{2peak}, $VO_{2submax}$ and heart rate (HR) were assessed using cardiopulmonary exercise testing. A Task Force Monitor was used to assess ANS functioning. Results: Two autonomic nervous system function profiles could be distinguished in the above sample (parasympathetic dominant and sympathetic dominant). Moreover, based on indicator of sympathetic nervous system activity, several clusters with distinct clinical profiles could be distinguished. Conclusions: Both cardiopulmonary and autonomic nervous system function could are important features related to chronic fatigue. Future should further explore pathophysiology of OTS. Presumably, knowledge from this field could be applied to development of therapeutic strategies of chronic fatigue treatment in other pathological conditions.

S4.L5

EFFECT OF FATIGUE GENERATED BY EFFORT ON REACTION TIME

A. JASTRZEBSKA, E. BAKONSKA-PACON, I. WIERZBICKA-DAMSKA

Department of Physiology and Biochemistry, University of Physical Education in Wroclaw, Wroclaw, Poland

The simple reaction time (SRT), minimal time needed to respond to a stimuli, is a physiological response toward a neutral sense stimulus. The aim of presented study was to estimate the changes of simple reaction time (RT) in fatigue condition induced by two efforts of a different nature. Twenty participants performed incremental test (INC) to volitional exhaust for fitness level and VO_{2max} estimation. The 40-min effort (LE) with intensity of 80% VO_{2max} was performed for fatigue elicitation. Respiratory parameters were measured breath-by-breath (K4b2, Cosmed, Italy). Participants performed a SRT task before (pre-test) and follows the 5 min of recovery (post-test) for incremental and 40-min effort. Visual: red, orange, green light and auditory: one sound, stimuli were given in random order. The mean value of reaction time was calculated excluding the first and last values and separately for each type of stimuli (3 colors and a sound). Blood was collected for estimation of lactate concentration (Dr Lange Kuvettentest, LKM 140, Germany) and venous blood was collected to determine the concentration of selected neurotransmitters (ELISA Test Demeditec Diagnostics GmbH Germany). VO_{2max} in incremental test was 53.79 ± 4.52 ml/kg/min. Lactate concentration in blood reach 9.25 ± 2.77 and 4.25 ± 1.2 (mmol) for INC and LE respectively. Concentration of neurotransmitters: adrenaline, noradrenaline and dopamine in plasma, and serotonin in serum increased significantly as a result of both efforts ($p < 0.05$). Independently on effort performed, the direction of alteration in reaction time was the same and showed decrease. There was no differences in SRT in pre-test measurement while significant effect of conducted efforts on SRT were noted (INC, P=0.04; LE, P=0.003, respectively). Significant decrease in SRT for red and orange light after INC (P=0.05 and P=0.003) and LE (P=0.02, P=0.04), and sound stimuli after LE (P=0.03) effort were noted. We expected the longer reaction time after the efforts made. Five minutes after the tests, RT were still shorter than at rest. Interestingly, the most noticeable reduction in reaction time was noted for red and orange stimuli, but not for green. The increase of neurotransmitters in plasma and serum indicates the development of fatigue, although not translated into a decline of SRT directly after the efforts. It may be that 5 min after the effort the excitation of nervous system enables faster reaction and a biochemical changes resulted by effort occur before fatigue appears in nervous system function.

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Address for correspondence: Agnieszka Jastrzebska (agnieszka.jastrzebska@awf.wroc.pl)

S4.L6

PHYSIOLOGICAL ADAPTATIONS TO HEAT STRESS AND EXERCISE IN CELL CULTURE MODELS AND HUMANS

K. DOKLADNY, P. MOSELEY

University of New Mexico, Department of Internal Medicine, Division of Gastroenterology, Albuquerque, New Mexico

Cells utilize heat shock proteins to fold de novo synthesized cellular proteins, to refold dysfunctional proteins that were damaged during cellular stress, or to send a protein for degradation if its repair is beyond the capacity of a cell. In eukaryotic cells, there are two main mechanisms responsible for degradation of dysfunctional proteins: proteasomal degradation and autophagy which recycles cellular proteins as well as protein complexes, or cellular organelles. Both protein synthesis and degradation depend on the coordination between autophagy and HSPs. In our studies, we have utilized heat stress or exercise to illustrate the importance of HSPs in the regulation of fever, proinflammatory cytokine expressions, or tight junction barrier in cell culture models, animals, or humans. We have also shown the sequential activation and inhibition of autophagy in the initial phase of exercise (protein degradation) that is followed by a progressive induction of heat shock protein response in the later phase of exercise (protein synthesis). We conclude that HSPs by maintaining internal protein homeostasis are necessary for the physiological adaptations of the cell and the whole organism.

Address for correspondence: K. Dokladny (KDokladny@salud.unm.edu)

NEW VIEW ON THE IMPACT OF THE LOW FREQUENCY ELECTROMAGNETIC FIELD (50 HZ) ON STRESS RESPONSES – IS THE ADAPTATION POSSIBLE?

M. STANKIEWICZ, A. KLIMEK, H. KLETKIEWICZ, A. SIEJKA, M. KLIMIUK, J. MALISZEWSKA, M. JANKOWSKA, A. NOWAKOWSKA, J. WYSZKOWSKA, J. ROGALSKA

Department of Animal Physiology and Neurobiology, Faculty of Biological and Veterinary Sciences, Nicolaus Copernicus University in Torun, Torun, Poland

Problem of the impact of low frequency electromagnetic field (50 Hz) (ELF-EMF) on human health seems to be still far from the definitive explanation. Effects of the ELF-EMF are inconclusive (beneficial or harmful) and there is no clear concept put forward that would give the comprehensive explanation of the observed phenomenon. Whether or not magnetic field exposure is causally related to increased health risks has led many scientists to examine the potential mechanisms by which ELF-EMF might affect human health. Obviously electromagnetic fields accompany the life of the organisms and probably, to certain extent modify some crucial neuronal processes, but we suggested that the impact is not definitely negative, and direction and dynamics of ELF-EMF depend on value of magnetic induction (magnetic flux density). Our research has been directed into 1) determining whether ELF-EMF exhibits hormesis, it means bidirectional action depending on field strength (magnetic induction: 1 or 7 mT) and 2) into verifying the possibility of adaptation to ELF- EMF exposure on animal model. Many studies have suggested an association between chronic ELF-EMF exposure and anxiety and/or depression. Existing data indicate that the exposure to ELF-EMF may count as a mild stress situation and could be a factor in the development of disturbances of brain stress system: hypothalamo-pituitary-adrenal (HPA) axis. Thus, we suggested that effects of low and high intensity ELF-EMF exposure might be related to different activation of HPA axis (changes in the level of HPA axis hormones (corticotropin-releasing hormone (CRH), adrenocorticotropic hormone (ACTH) and corticosterone) and their receptors. The exposure to ELF-EMF can establish a new "set-point" for stress systems activity. Corticosterone initiates physiological and behavioural responses through two types of receptors: mineralocorticoid (MR) and glucocorticoid (GR) receptors. Moreover, both MR and GR receptors are abundant in the hippocampus; which regulates the negative feedback of the HPA axis through this MR/GR dual-receptor system of crucial importance for the homeostatic control. The interplay between all components of stress response (hormones and their receptors) seems to determine the final effect of ELF-EMF exposure. We have found the hormetic (bidirectional) effect of ELF-EMF which results in different activation of stress response system hypothalamo-pituitary-adrenal (HPA) axis and as the consequence of that the subsequent changes in stress hormones and their receptors levels also appeared. A single exposure to ELF-EMF with a value of 1 mT resulted in a slight increase in HPA axis activity (CRH in hypothalamus; ACTH in the pituitary gland, CORT in adrenal glands and plasma). However, after each subsequent exposure the level of measured parameters was lower or not different from control level. It may indicate that ELF-EMF of low intensity activates some endogenous adaptive processes. ELF-EMF of 7 mT led to sustained stimulation of stress systems activity which was higher with each next exposure, indicating that the stronger field - 7 mT is a factor, which can be recognised as harmful for organism. We have also found the increase of MR receptors density only in rats exposed to ELF-EMF of 1 mT, however in 7 mT group the level of MRs was not detectable. The level of GR receptors in 1 mT group was similar to control level or slightly decreased, but in 7 mT group the diminished level of GR receptors was clear. MR receptors needs to be present and functional for neuronal survival in the damaged brain regions. The MR expression in 1 mT ELF-EMF exposed group possibly represents an endogenous response that may serve as a compensatory mechanism designed to increase the neuronal plasticity. On the other hand, the strong imbalance between MR/GR receptors expression after exposure to 7 mT ELF-EMF suggests the disturbed control of HPA axis activity, which could result in some harmful processes leading to nervous system disorders. The ELF-EMF-induced dose dependent different activation of HPA axis can in turn can initiate cellular hormesis, it means bidirectional activation of intrinsic signaling pathways: 1) of compensative character promoting the neuroadaptation as the consequence of low intensity ELF-EMF (1 mT), or 2) causing disturbance of intracellular homeostasis leading to increase of the sensitivity to subsequent stress factors in case of high intensity ELF-EMF (7 mT). For the first time we demonstrated the bidirectional (hormetic) mode of action of ELF-EMF in vertebrates. Our research provided the new comprehensive data on the impact of ELF-EMF on mammals' organism with reference to HPA-axis activity with the accent on potential consequences of the ELF-EMF for health. The project can contribute to explaining the fundamental mechanisms of bidirectional responses to ELF-EMF and it can lead to a new view on possible therapeutic properties of magnetic field and provide new data for reliable risk assessment of the exposure to ELF-EMF, what is of crucial importance for the human health.

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Address for correspondence: Maria Stankiewicz (stankiew@umk.pl)

S4.L8

FREEZE TO SURVIVE: ROLE OF MICROBIOM

A. NOWAKOWSKA, P. IDCZAK

Department of Animal Physiology and Neurobiology, Faculty of Biological and Veterinary Sciences,
Nicolaus Copernicus University in Torun, Torun, Poland

Animals have evolved special mechanisms to counteract the life-endangering effect of extremely low temperatures and to survive freezing. The mechanism include a large variety of structural and functional adaptations such as changes in the cell membrane fluidity, proteins conformation, reduced metabolic activity, and particular ability to avoid intracellular ice formation resulting from synthesis of cryoprotectants, which overcomes uncontrolled freezing. All above mentioned factors are characteristic of both endotherms and ectotherms that experience seasonal temperature changes and pass long periods of cold-stress in a hypometabolic state called hibernation or overwintering. Recently, the importance of the gut microbiome in freezing tolerance has been highlighted. Environmental temperature is an important factor that affects the composition of gut microbial communities in many animal taxa, including invertebrates and vertebrates, and the microbiome's relationship with the host. Gut bacteria are involved in multiple physiological processes, assisting their hosts with digestion, disease resistance, environmental resistance and cold hardiness during hibernation, and subsequently to maintenance and survival. Gut microbiota upregulate the levels of cryoprotectant transcripts and metabolites, which increases the resistance to long-term low-temperature stress by stimulating the host cryoprotectant pathways. Because microbes are ectotherms, the microbiome of ectothermic animals will be exposed to the same temperature fluctuations as those of their hosts. In mammalian heterotherms, e.g. in hamsters and bats, the thermal conditions experienced by bacteria during winter are likely to change less dramatically in metabolically active animals than they do during hibernation. These fluctuations have a great potential to challenge the host's microbe community, and to modify the community interactions with the host. In ectothermic organisms, both vertebrates and invertebrates, microbes are subjected to the same temperature changes as those of their hosts, therefore, the host overwintering-related changes may be less relevant than those induced by winter itself. It must be stressed that for some ectothermic hosts the only possibility to survive winter is due to certain types of bacteria that control the partial freezing process by acting as ice-nucleating factors. Despite the progress that has been made, understanding of how temperature affects the animals gut microbiota remains still limited. Therefore, we will try to answer the following questions: 1) do microbes influence overwintering entry and exit? and 2) which physiological changes in the host affect the conditions under which different bacterial species compete.

Address for correspondence: S. Nowakowska (noann@umk.pl)

S4.L9

CAPSAICIN AND THERMOREGULATORY RESPONSES IN THE AMERICAN COCKROACH. THE INVOLVEMENT OF TRANSIENT RECEPTOR POTENTIALS RECEPTORS

J. MALISZEWSKA, M. JANKOWSKA, H. KLETKIEWICZ, M STANKIEWICZ, J. ROGALSKA

Department of Animal Physiology and Neurobiology, Faculty of Biological and Veterinary Sciences,
Nicolaus Copernicus University in Torun, Torun, Poland

Transient receptor potential (TRP) receptors are cation channels involved in detection of multiple stimuli, with some members acting as temperature sensors (thermo-TRP). In insects thermos-TRP receptors are responsible for sensation of temperatures in normal temperature range (dTRPA1), as well as nociceptive temperatures (painless, pyrexia, TRPL, Brivido or Pkd2). Thermo-TRP are also sensitive to chemicals ligands, which affect channel activity and therefore induce changes in insects' thermal behavior. We demonstrated that capsaicin, an alkaloid that activates mammalian heat receptor (TRPV1), induces thermoregulatory responses in American cockroach. Changes in behavioral thermoregulation (preference for cold), as well as physiological thermoregulation (decrease of head temperature in cockroaches placed at constant ambient temperature) were observed after capsaicin treatment. This alkaloid changed also cockroaches' response to noxious ambient temperature. These results indicate involvement of TRP receptor in cockroaches' thermosensation. We also aimed to determine the role of octopamine (potential neurotransmitter in TRP related processes) in capsaicin-induced thermoregulatory response in the American cockroach.

Address for correspondence: ojustyna@umk.pl

S4.L10

SOME FEATURES OF COLD ADAPTATION IN MEN DURING OVERWINTERING IN ANTARCTICA

D. LUTSENKO[1], O. SHYLO[1], K. DANYLENKO[2,3]

[1]Institute for Problems of Cryobiology and Cryomedicine, Kharkiv, Ukraine, [2]National Antarctic Scientific Center, Kyiv, Ukraine, [3]Kharkiv National Medical University, Kharkiv, Ukraine

Wintering in Antarctica is associated with the impact of extreme environmental factors, including the cold exposure. The adaptation of human to extreme conditions is largely ensured by the vegetative mechanisms of regulation of the organism. We used heart rate variability (HRV) analysis to evaluate the winterer's adaptation to cold. There were 23 winterers of 21 and 23 Ukrainian Antarctic expeditions aged from 22 to 63 years old (all men, average age 39.5 years) took part in the study. Additionally, 17 winterers took part in the study with 3 min cold pressure test (CPT). The CPT was performed by immersing the right hand into a cold water (T water 9.2 ± 1.2°C). The measurements were carried out every month. All participants were informed about the objectives of the study and agreed to participate in it. We found that winterers can be divided into at least 2 groups depending on the type of response to cold. In one group the responses were connected with the sympathetic nervous regulation (an increase in heart rate and blood pressure, a significant predominance of LF components of HRV). But in the other group the heart rate decreased, LF components were only slightly higher than HF ones, and were even less sometimes, indicating about parasympathetic regulation mechanisms activation. Recently it was described the reduction of sympathetic and growth of parasympathetic activity in winterers after overwintering. (Harinath et al, 2005) and we believed that this phenomenon may be related to the one we observed.

Address for correspondence: D. Lutsenko (lutsenkodmytro@gmail.com)

S4.P1

DO ELITE ATHLETES HAVE DIFFERENT LEVELS OF A PHYSIOLOGICAL STRAIN (PSI) IN RESPONSE TO A SIMILAR SUBMAXIMAL EXERCISE PERFORMED UNDER TEMPERATE CONDITIONS AFTER A MEDIUM-TERM ACCLIMATION TO WHOLE BODY HYPERTHERMIA (MWBH) AND WHOLE BODY CRYOSTIMULATION (MWBC)?

I. POKORA[1], L. WOLOWSKI[2], P. WYDERKA[2]

[1]The Jerzy Kukuczka Academy of Physical Education in Katowice, Institute of Sport Sciences, Department of Physiological-Medical Sciences, Katowice, Poland, [2]The Jerzy Kukuczka Academy of Physical Education in Katowice, Katowice, Poland

The aim of this study was to indicate the differences in the body physiological strain (PSI) in response to exercise performed under temperate conditions after a medium-term sauna-based heat acclimation (MWBH) and after a series of whole body cryostimulation (MWBC) in elite cross-country skiers. Ten elite cross-country skiers participated in four exercise trials, (2) before and after a series of ten sauna baths (MWBH) or (2) before and after a series of ten MWBC. Thermal and physiological variables were measured before and after the exercise tests. The series of ten sauna baths induced a moderate decrease in the heart rate (HR) at rest, but did not influence the baseline internal (Tac; p=0.31), body ($\overline{T}$b; p=0.53) and skin ($\overline{T}$sk; p=0.38) temperatures. The series of MWBC did not induce an either change in the heart rate (HR) at rest or the baseline internal (Tac; p=0.31) and body ($\overline{T}$b; p=0. 38) temperatures but influenced on the skin temperature ($\overline{T}$sk; p=0.008). In response to exercise, physiological strain (PSI) tended to be lower (p=0.31) after MWBH but not after MWBC (p=0.88). There was a significant difference in *f*HR PSI (p=0.02) and *f*Tac PSI (p=0.02) in response to exercise between MWBH and MWBC groups. The results of this study indicated that level of physiological strain was similar during exercise test performed after MWBH and MWBC acclimations. There were differences in the share of contribution of the cardiovascular fraction and the thermoregulatory fraction to the PSI (circulatory strain, thermoregulatory strain) during exercise trials performed in this study after heat and cold adaptations in athletes.

Address for correspondence: Ilona Pokora (i.pokora@awf.katowice.pl)

S4.P2

THE INFLUENCE OF REGULAR PROFESSIONA TRAINING ON THE RESTING TEMPERATURE DISTRIBUTION OF THE BODY SKIN

M. BINEK[1,2], I. POKORA1[1], Z. DRZAZGA[2]

[1]Academy of Physical Education in Katowice, Poland, [2]University of Silesia in Katowice, Poland

The aim of study was to evaluate the difference in skin temperature in selected muscles zones of limbs at rest in ten male cross-country skiers who train competitively and ten AWF students with normal physical activity. For both groups, measurements were carried out thermal imaging camera FLIR E95. Measurements were made in conditions necessary for proper thermal imaging. Generally, infrared thermography indicated that at rest skin temperature over muscle of non-training people is higher than that of professional cross-country skiers. The analysis of the results showed that the temperature obtained at rest differs statistically significantly in the area of chest and back, while in the lower parts of the body these differences are generally invisible(except for vastus lateralis and knees). The greatest relative differences in skin temperature are for the trapezius and deltoid muscles, and the smallest for the muscles on the back of the calf. Our research shows that professional sports training has an impact on the resting body temperature distribution of an athlete. In our research group (cross-country skiers), it lowered the skin temperature compared to the control group.

Address for correspondence: m.binek@awf.katowice.pl

S4.P3

EFFECT OF ANTI-INFLAMMATORY EXTRACTS ON COELOMOCYTES OF THE EARTHWORM LUMBRICUS TERRESTRIS

A. GREN[1], G. FORMICKI[1], P. MASSANYI[1,2], M. HALO[2], M. MASSANYI[2]

[1]Department of Animal Physiology, Institute of Biology, Pedagogical University of Krakow, Poland,
[2]Department of Animal Physiology, Faculty of Biotechnology and Food Sciences,
Slovak University of Agriculture, Nitra, Slovak Republic

Due to the specific habitat conditions in which they live, earthworms are constantly exposed to pathogens. Consequently, they have evolved various immuno-defense mechanisms, including cellular (coelomocytes) and humoral responses, which may help to repair and/or protect host cells and tissues but also can kill ingested pathogens. Earthworm coelomocytes are important for the assimilation and elimination of exogenous compounds and play a key role in the processes of phagocytosis and inflammation. Plants can provide a vast source of active natural products for the discovery of new drugs. Natural products play a significant role in relation to the prevention and treatment of inflammatory conditions. In the present works, we studied the effects of the dermal exposure of *Lumbricus terrestris* (*in vivo*) to different anti-inflammatory extracts: α-bisabolol, licorice, honey and then earthworms coelomocytes (*in vitro*) were exposed to anti-inflammatory extracts. Our results imply that extracts affect the earthworms immune system. We hypothesized that that studying the simpler immune response demonstrated by earthworm is important for understanding the evolution of immune system in higher vertebrates.

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Address for correspondence: Agnieszka Gren (agnieszka.gren@up.krakow.pl)

S4.P4

GEOGRAPHICAL ORIGIN REFLECTED IN PHYSIOLOGY - DIFFERENCES IN THERMAL BEHAVIOUR OF THREE HONEYBEE *APIS MELLIFERA* SUBSPECIES

J. BACIA, P. GRODZICKI

[1]Department of Animal Physiology and Neurobiology, Faculty of Biological and Veterinary Sciences, Nicolaus Copernicus University in Torun, Torun, Poland

Thermal preferences of three honeybee Apis mellifera subspecies reared in Poland-Caucasian, Carniolan and Central European bee were compared using the thermal gradient. Eighteen virgin honeybee Queens (six repetitions for each subspecies experimental group) with their retinues, counting 5–12 workers (3–14 day-aged), originated from that year's breeding (2019) in breeding apiaries. The 24-hour average ambient temperature selected was slightly lower in the Caucasian bee (*A.m. caucasica* G.), compared with the Carniolan bee (*A.m. carnica* P.) and the Central European bee (*A.m. mellifera* L.). Simultaneously, both in the 16 hours of daily activity and 8-hour of nocturnal rest Caucasian bee (*A.m. caucasica* G.) chose significantly lower ambient temperatures than the Carniolan bee (*A.m. carnica* P.) and the Central European bee (*A.m. mellifera* L.). Caucasian bees during the entire (3-day) registration period showed higher oscillations of the ambient temperature selected than in the other tested subspecies, which most probably results from differences between given subspecies in single individual body size and abundance of families. Our experiments undoubtedly showed the influence of the honeybee subspecies geographical origin on the thermoregulation of those insects.

Address for correspondence: P. Grodzicki (grodzick@umk.pl)

S4.P5

BIORITHMOGENIC PROBLEMS OF HUMAN ADAPTATION TO ANTARCTIC CONDITIONS OF ACTIVITY

Y. MOISEYENKO, N. VASCHENKO, E. ROZOVA

Bogomoletz Institute of Physiology of the National Science Academy of Ukraine, Kyiv, Ukraine

A large number of scientific works are devoted to the study of the role of melatonin in the regulation of circadian rhythms of organism systems. With a certain degree of probability, the state of melatonin secretion can be judged by changes in human body temperature, because the correlations between the dynamic changes of these indicators are extremely close. Therefore, in order to establish the characteristic features of regulatory influences on changes in circadian architectonics of indicators of functional systems of the human organism in Antarctica, studies of circadian organization of body temperature were conducted (body temperature was measured at three points oral cavity, under the armpit and on the scalp). The results showed that at the initial stage of winter the body temperature did not have the correct shape of the circadian rhythm, which is known to be characterized by low values at night, a gradual increase in the morning, and peak values in the afternoon. In the Antarctic autumn, night decrease in body temperature did not occur, the acrophase of the minimum shifted to 8 o'clock in the morning with its subsequent increase, but already at 16 o'clock there was a tendency to decrease. In winter, sinusoidal dynamics of periods of decrease and increase in body temperature of winterers (approximately every four hours) during the day was observed, which probably reflected the presence of significant changes in the mechanisms of humoral regulation. In the spring, the circadian architectonics of body temperature leveled off somewhat, but the duration of the low level remained shifted to the morning hours. In summer, the state of circadian rhythms of body temperature deteriorated, which led to the absence of significant changes in body temperature, even at night, when winterers need complete rest. At the same time, the body temperature briefly decreased in the morning, and remained at the same level for most of the day. Thus, the established dynamics of changes in the circadian architectonics of the body temperature of winterers may be indirect evidence of significant changes in the humoral regulatory chain, which occur under the influence of biorhythmogenic factors (season inversion, change of photoperiodicity and time zone, daily alternations and monochromaticity of the environment), which indicates the presence of desynchronous and maladaptive disorders. These changes are confirmed by the parallel results of the study of the dynamics of morpho-functional characteristics of the mitochondrial apparatus, which indicate the rearrangement of subcellular structures that signaling the formation of consequential signs of stress.

Address for correspondence: erozova@ukr.net

S4.P6

A NEW VIEW ON OVERWINTERING IN SNAILS: THE ROLE OF MICROBIOTA IN FREEZE TOLERANCE

P. IDCZAK[1], A. NOWAKOWSKA[1], A. KALWASINSKA[2]

[1]Department of Animal Physiology and Neurobiology, Nicolaus Copernicus University in Torun, Torun, Poland,
[2]Department of Environmental Microbiology and Biotechnology, Nicolaus Copernicus University in Torun, Torun, Poland

Snails in the temperate zone are seasonally subjected to extreme climatic conditions with temperatures below freezing point of their body fluids. Because water is necessary for all life processes, animals developed two adaptive mechanisms. The first one is avoidance of freezing (supercooling) and the other one is the ability to endure ice formation. Before winter, land snails empty their gut, reduce body water content, and produce cryoprotectant substances that prevent ice crystals from forming inside their cells. However, the role of cryoprotectants in cold tolerance of *Helix pomatia* snails is still uncertain. We suppose that despite emptying the gut by the snails in the autumn, some bacteria remain in the intestine even during hibernation and are known to have ice-nucleating activity. Gut bacteria are involved in both of those mechanisms related to cold resistance and also in multiple physiological processes, such as digestion, disease and environmental resistance. To test whether freezing tolerance in the wild population of the *H. pomatia* snails is associated with their intestinal microbiota, we conducted a series of experiments on animals collected over the period of their annual activity at two-month intervals, starting from spring, immediately after their arousal from winter torpor. Additional experimental groups were animals acclimated to autumn conditions during summer (8D:16N, low temperature), and to summer conditions during autumn (16D:8N, high temperature). Gut microbiota samples obtained from the intestinal tract were cultivated in 10°C for 14 days on selective media containing colloidal hitine, cellulase and MRS, followed by 16S rRNA gene sequencing as well as the whole genome sequencing. The analysis of 16S rRNA gene sequences allowed us to identify cultivable psychrophilic snail gut bacteria belonging mostly to Alphaproteobacteria and Gammaproteobacteria class in all seasons and to Betaproteobacteria and Mollicutes class in some seasons. The obtained results show that both photoperiod and temperature affecting intestinal microbiota are related to external hibernation signaling in land snails. The conducted experiments have also contributed to expanding the collection of externally cultivable cultures.

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Address for correspondence: P. Idczak (pidczak@doktorant.umk.pl)