THE HEIGHT, BREADTH AND DEPTH OF PHYSIOLOGICAL DIVERSITY: VARIATION ACROSS LATITUDINAL, ALTITUDINAL AND DEPTH GRADIENTS

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DELEGATE INFORMATION

BADGES
Name badges contain a barcode which will be scanned on entry to record attendance at meeting for SEB administrative purposes only. Each badge contains the following information which has been supplied during the registration process: full name, institution and email address.

Badges must be worn for the duration of the meeting, both for security purposes and catering identification.

CATERING
Lunch and refreshments during the satellite meeting are included in your registration fee and will be served in the breakout area located on the ground floor of Palazzo Affari.

CERTIFICATE OF ATTENDANCE
Delegates requiring a certificate of attendance should visit the SEB registration desk on their departure or by email from admin@sebiology.org

VENUE
Firenze Fiera Congress and Exhibition Centre
Piazza Adua, 1, 50123, Firenze FI, Italy
Tel: +39 055 49721
Web: www.firenzefiera.it/en/

The scientific sessions will be taking place in room Adua 2 located on the second floor in Palazzo Affari.

WI-FI INTERNET ACCESS
Internet access is available during the meeting and free of charge. Log in details will be available at the registration desk.

LIABILITY
Neither the Society for Experimental Biology nor the Firenze Fiera Congress and Exhibition Centre will accept responsibility for damage or injury to persons or property during the meeting. Participants are advised to arrange their own personal health and travel insurance.

PHOTOGRAPHY
No photographs are to be taken of the speakers and their slides during the satellite meeting unless consent is given by the speaker.

*Please note: The SEB will be taking photos during the event for promotional purposes. If you have any concerns, please visit the SEB registration desk.

POSTER SESSION
The poster session will be taking place in the breakout area between 17:00 – 18:00 on Sunday 1 July. Poster presenters are invited to hang their poster on their arrival (Velcro will be provided) and are asked to remove their posters by 18:00. Any posters left behind will be disposed of.

REGISTRATION
The registration desk will be open during the hours of the meeting and a SEB staff member will be on hand during the refreshment and lunch breaks should you require any assistance.

SOCIAL MEDIA
We're looking to increase the conversation at the meeting using:
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PROGRAMME

SUNDAY 1 JULY 2018

08:30 REGISTRATION

09:00 Introduction
Simon Morley, John Spicer and Francisco Bozinovic
Meeting organising committee

CHAIR: JOHN SPICER

09:10 PLENARY LECTURE
Prof Steven Chown
Monash University, Australia
Thermal foraging traits as mediators of ant abundance and occupancy variation AS18.1

09:40 Dr Jennifer Sunday
McGill University, Canada
Environmental variability across marine and terrestrial gradients AS18.2

10:00 Prof Andrew G Hirst
University of Liverpool, United Kingdom
Patterns in the temperature, latitudinal and seasonal body size gradients within aquatic and terrestrial arthropod species AS18.3

10:15 Prof Johannes Overgaard
Aarhus University, Denmark
Assessing the role of acclimation and adaptation in thermal performance curves AS18.4

10:30 Wilco C E P Verberk
Radboud University Nijmegen, Netherlands
Can an oxygen perspective explain the temperature-size rule? AS18.5

10:45 REFRESHMENT BREAK/POSTERS

CHAIR: FRANCISCO BOZINOVIC

11:15 Enrico Rezende and Prof Francisco Bozinovic
Pontifical Catholic University of Chile, Chile
Thermal performance across levels of biological complexity AS18.6

11:35 Dr Curtis Deutsch
University of Washington, United States
Diversity of marine hypoxia traits: Implications for biodiversity and extinction AS18.7

11:55 Dr Scott Bennett
Mediterranean Institute of Advanced Studies (IMDEA), Spain
Population vulnerability to ocean warming across latitudinal gradients AS18.8

12:15 Lisa B Jørgensen
Aarhus University, Denmark
How to measure insect heat tolerance: unifying static and dynamic assays AS18.9
12:30
Prof David Atkinson
University of Liverpool, United Kingdom
Water depth and contrasting correlations among metabolic scaling, metabolic level and body shape change: cephalopods versus teleost fish
AS18.10

12:45
LUNCH/POSTERS

CHAIR: SIMON MORLEY

13:40
Prof John Spicer
University of Plymouth, United Kingdom
Dr Simon Morley
British Antarctic Survey, United Kingdom
There may be giants – but why? Testing the oxygen hypothesis of gigantism with amphipod crustaceans
AS18.11

14:00
Dr Christine E Cooper
Curtin University, Australia
Macrophysiology informs conservation for widespread species
AS18.12

14:15
Dr Norman L C Ragg
Cawthron Institute, New Zealand
Genetic basis for acute thermotolerance in the mussel Perna canaliculus distributed across a wide latitudinal range
AS18.13

14:30
Miss Saskia Jurriaans
James Cook University, Australia
Thermal acclimation strategies of reef-building corals along a latitudinal gradient on the Great Barrier Reef
AS18.14

14:45
Ms Jacinta D Kong
The University of Melbourne, Australia
The egg stage drives life cycle adaptation to climate in the widely distributed matchstick grasshoppers (Vandieuenella and Warramaba, Orthoptera: Morabidae)
AS18.15

15:00
Discussion: Key Research Questions

15:40
REFRESHMENT BREAK/POSTERS

16:10
Presentation of discussion points

16:40
Closing Remarks

17:00
Poster Session

18:00
END OF MEETING
THE HEIGHT, BREADTH AND DEPTH OF PHYSIOLOGICAL DIVERSITY: VARIATION ACROSS LATITUDINAL, ALTITUDINAL AND DEPTH GRADIENTS

### AS18.1 THERMAL FORAGING TRAITS AS MEDIATORS OF ANT ABUNDANCE AND OCCUPANCY VARIATION

**SUNDAY 1 JULY 2018 09:10**

**STEVEN CHOWN (MONASH UNIVERSITY, AUSTRALIA)**

In this work, we test key hypotheses about the way in which thermal traits mediate interspecific variation in abundance and occupancy across broad spatial scales, and their implications for global change impact forecasts. We use a decade-long, bi-annual survey of abundance variation in 53 ant species from 37 sites, spanning major climatic gradients in Southern Africa.

We show that broad relationships do exist between physiological responses at the organismal level to species-level patterns of abundance and distribution, and their implications for global change impact forecasts. We use a decade-long, bi-annual survey of abundance variation in 53 ant species from 37 sites, spanning major climatic gradients in Southern Africa. We show that broad relationships do exist between physiological responses and species abundance and occupancy.

### AS18.2 ENVIRONMENTAL VARIABILITY ACROSS MARINE AND TERRESTRIAL GRADIENTS

**SUNDAY 1 JULY 2018 09:40**

**JENNIFER SUNDAY (MCGILL UNIVERSITY, CANADA)**

**SUNDAY@ZOOLOGY.UBC.CA**

Connecting physiological responses at the organism level to species-level patterns of abundance and distribution is a key challenge in ecology. Indeed, as the world has warmed over the past half-century, species distributions have responded through range shift, throwing into focus our need to mechanismically understand these connections. Here I present macro physiological analyses showing that marine and terrestrial ectotherms differ in the extent to which they are physiologically limited within their distributional ranges. I then explore the role of thermal variability in improving linkages between physiological data and species distributions, and projecting responses to environmental change. I use records of temperature and species abundance in the warm and cold to elucidate the relative roles of environmental variability in mediating range shifts in a warming world.

### AS18.3 PATTERNS IN THE TEMPERATURE, LATITUDINAL AND SEASONAL BODY SIZE GRADIENTS WITHIN AQUATIC AND TERRESTRIAL ARTHROPOD SPECIES

**SUNDAY 1 JULY 2018 10:00**

**ANDREW G HIRST (UNIVERSITY OF LIVERPOOL, UNITED KINGDOM), CURTIS R HORNE (UNIVERSITY OF LIVERPOOL, UNITED KINGDOM), DAVID ATKINSON (UNIVERSITY OF LIVERPOOL, UNITED KINGDOM)**

**AGHIRST@LIVERPOOL.AC.UK**

Body size is fundamental to the fitness of species and relates to the speed of many biological rates, while the variation in body size has fascinated scientists for over a century. In ectotherms, individuals of the same species commonly grow to a smaller adult body size in the warm than in the cold. This near-universal biological phenomenon, known as the Temperature-Size Rule (TSR), occurs in over 80% of ectothermic species.

### AS18.4 ASSESSING THE ROLE OF ACCLIMATION AND ADAPTATION IN THERMAL PERFORMANCE CURVES

**SUNDAY 1 JULY 2018 10:15**

**JOHANNES OBERGAARD (AARHUS UNIVERSITY, DENMARK), HEIDI J MACLEAN (AARHUS UNIVERSITY, DENMARK), TORSTEN N KRISTENSEN (AARHUS UNIVERSITY, DENMARK), JESPER G SORENSEN (AARHUS UNIVERSITY, DENMARK), VOLKER LOESCHKE (AARHUS UNIVERSITY, DENMARK), KRISTIAN BEEBENHOLM (AARHUS UNIVERSITY, DENMARK), VANESSA KELLERMANN (MONASH UNIVERSITY, AUSTRALIA)**

**JOHANNES.OVERGAARD@BIOS.AU.DK**

Thermal performance curves (TPC) of ectotherms are often used to infer species responses to changes in temperature, including long-term responses to climate change. Even so there are still many aspects of TPCs that are poorly studied as only few empirical studies have investigated theories about the evolution, shape and plasticity of TPCs. Textbook examples often show temperate species to have broader thermal performance curves and lower optimal temperature compared to tropical species. Furthermore, the theory predicts that plasticity of TPCs is larger in species originating from variable environments. Here we measure thermal tolerance limits and TPCs of fitness components in 22 species of Drosophila reared at a common temperature. For 10 species we also measured these traits following acclimation to different temperatures. Using this data we test assumptions about the evolution and plasticity of TPCs. As expected, low temperature tolerance varied strongly and predictably with environmental origin of species and in response to cold acclimation. This confirms the marked effect of adaptation and acclimation on thermal tolerance. However, contrary to expectation the breadth of TPCs is similar in temperate, widespread and tropical species and we also find that plasticity of TPCs is very limited. Accordingly, thermal tolerance limits are under strong selection by the extreme environmental conditions that limits species persistence. In contrast, the temperature range for optimal thermal performance is under selection by the temperatures that prevail during the growing season and TPCs in Drosophila are therefore more stable over evolutionary and ecological space than predicted by current theories.

### AS18.5 CAN AN OXYGEN PERSPECTIVE EXPLAIN THE TEMPERATURE-SIZE RULE?

**SUNDAY 1 JULY 2018 10:30**

**WILCO C E P VERBERK (Radboud University Nijmegen, Netherlands), NATAN HOFNAEGEL (Radboud University Nijmegen, Netherlands)**

**WILCO@AQUATICECOLOGY.NL**

Bergmann noted that animal species from colder habitats (high latitude or altitude) tend to be larger than closely related species living in warmer habitats (low latitude or altitude). These Bergmann’s clines are mirrored by thermal responses in body size when rearing ectotherms in the laboratory: temperature stimulates juvenile growth, but decreases adult size, resulting in animals growing faster but to a smaller size. The majority of ectotherms follow this temperature-size rule, and many physiological and evolutionary mechanisms have been proposed to explain the temperature-size rule. A promising idea that is gaining traction in the literature is that an oxygen perspective may be helpful for understanding how thermal responses in growth, development and body size are linked. Adequate supply of oxygen could be a prerequisite for animals to grow to a large body size even under warmer conditions. Here I discuss this idea in light of recent laboratory experiments on two crustacean species and published
AS18.7 DIVERSITY OF MARINE HYPOXIA TRAITS: IMPLICATIONS FOR BIODIVERSITY AND EXTINCTION
SUNDAY 1 JULY 2018  11:35
CURTIS DEUTSCH (UNIVERSITY OF WASHINGTON, UNITED STATES), JUSTIN PENN (UNIVERSITY OF WASHINGTON, UNITED STATES), BRAD SEIBEL (UNIVERSITY OF SOUTH FLORIDA, UNITED STATES)
CDEUTSC@UW.EDU

The role of climate in shaping species habitats is mediated by a variety of physiological and ecological traits. Here we analyse three traits regulating aerobic habitat of marine animals: the physiological oxygen tolerance, its sensitivity to temperature, and the factor by which resting O₂ demand is elevated by the energetic requirement for ecological activity. Across >70 diverse species, hypoxia vulnerability varies widely, and is shown to arise from coupled variations in O₂ supply and demand. Despite this physiological diversity, species from disparate ocean environments all currently encounter a lower limit of O₂ supply to demand (Metabolic Index) whose distribution of values is indistinguishable from the active to resting energetic ratios of terrestrial animals. These results extend and strengthen previous findings that the geographic range of marine species is limited in part by energetic requirements common to all life.

AS18.8 POPULATION VULNERABILITY TO OCEAN WARMING ACROSS LATITUDINAL GRADIENTS
SUNDAY 1 JULY 2018  11:55
SCOTT BENNETT (MEDITERRANEAN INSTITUTE OF ADVANCED STUDIES (MEDEA), SPAIN), FRANÇOIS DUFOIS (UWA OCEANS INSTITUTE, UNIVERSITY OF WESTERN AUSTRALIA, AUSTRALIA), AMANDA BATES (OCEAN SCIENCES CENTRE MEMORIAL UNIVERSITY, CANADA), GRAHAM J. EDGAR (INSTITUTE FOR MARINE AND ANTARCTIC STUDIES, UNIVERSITY OF TASMANIA, AUSTRALIA), RICK D. STUART-SMITH (INSTITUTE FOR MARINE AND ANTARCTIC STUDIES, UNIVERSITY OF TASMANIA, AUSTRALIA), THOMAS WEBBERG (SCHOOL OF BIOLOGICAL SCIENCES, UWA OCEANS INSTITUTE, UNIVERSITY OF WESTERN AUSTRALIA, AUSTRALIA)

Temperature is one of the most important determinants of species distribution and climate change will likely affect future distributions of many species. Prediction of such distributional changes calls for simple and comparable measures of heat tolerance that correlate with species performance in their natural environments. A recent model (thermal tolerance landscapes – TTLs) uses the exponential relation between temperature and knockdown time to describe the thermal tolerance of ectotherms in different time/temperature intervals. TTLs therefore allow for parametrisation of the complex interaction between absolute temperature (i.e. heat stress intensity) and duration of heat exposure across a range of stressful temperatures. Previous analyses of TTLs have reported an apparent trade-off between tolerance to acute and chronic heat stress in ectotherms. However, this trade-off may represent an inherent property of the model, rather than a true biological phenomenon. To test the “ecological applicability” of TTLs and examine the apparent trade-off, we measured knockdown time at 9-17 static temperatures (0.5°C intervals) to establish TTLs for 11 species of Drosophila representing different thermal ecotypes. Additionally, we measured knockdown temperature during three dynamic assays (heating flies with different ramp rates). With this data we show that static and dynamic assays give comparable information on heat tolerance. We also show that both dynamic and static measures of heat tolerance correlate tightly with the environmental characteristics encountered by the 11 species. Finally, our data clearly demonstrates that trade-offs between chronic and acute tolerance are absent within and between species when the data is analysed using curve interpolation.
A fundamental goal of comparative physiology is to determine how variation in physiological traits differs spatially both between and within species. Macro-physiological studies have commonly focused on broad inter-specific comparisons, but recognition of lower-taxonomic-level physiological variation is gaining prominence. Identifying intraspecific variation in physiological traits is pertinent to conservation physiology. Conservation practitioners would benefit from quantitative approaches to allow predictions of how the physiology of species distributions differs, and how this relates to differences in habitat and climate variables. Here we explore geographic variation in the physiology of the brushtail possum (Trichosurus). This widely distributed marsupial is involved in numerous translocation programmes, particularly in Australia’s arid zone. We found significant geographical patterns in metabolism, body temperature, thermal conductance, evaporative water loss and relative water economy, with less pronounced differences in warmer habitats. We also found increased capacity for heat loss at high temperatures. We suggest that the sub-specific species T. vulpulae and T. hypoleucus from Western Australia would be most physiologically appropriate for translocation to arid habitats, having physiological traits most favourable for the low productivity and variable water availability and extreme Tc of arid environments. Our data indicates that geographically widespread populations can differ physiologically in a manner that makes some populations more suitable for particular habitats than others. Consideration of these differences will likely improve the success and welfare outcomes of translocation, reintroduction and management programs.
The egg stage drives life cycle adaptation to climate in the widely distributed matchstick grasshoppers (Vandiemennella and Warramaba, Orthoptera: Morabidae)

Life cycles mediate the responses of insects to variable and changing climates. Life cycles of widely distributed insects may be adapted to local climates at the egg stage because eggs are immobile and reliant on environmental conditions to develop. Variation in life cycles may be generated by variation in environments, in developmental responses, or through their interaction. Teasing these causal factors apart requires an understanding of the egg stage for life cycles under variable climates. Here, we examine genetic, phenotypic and environmental sources of variation in the thermal response of egg development within and among matchstick grasshoppers (Austral winter active Vandiemennella and summer active Warramaba). Matchstick grasshoppers are widely distributed, have a simple univoltine life cycle driven by the egg stage, are flightless, and have well understood phylogenetic relationships. We characterised the thermal response of egg development within and among species and lineages of these two genera and tested for thermal response of egg development within and among species and lineages of these two genera and tested for local adaptation in egg development. We use the data to parameterise a microclimate-driven model of egg development to examine the adaptive significance of egg development between environments. Matchstick grasshoppers showed remarkable diversity at the egg stage, primarily in the expression of dormancy. Interactions between such developmental variation and local environmental temperatures generated the diversity of life cycle syndromes expressed. This diversity of life cycles highlights the potent role of adaptation at the egg stage for widely distributed insects under a variable climate.

Plasticity of upper critical limits in the eelgrass sea hare, Phyllaplysia taylori, not correlated with habitat thermal history

Intertidal mollusks are subject to extreme temperature changes when low tides expose these nearly-sessile invertebrates to air on extremely hot or cold days. Local weather or microclimate causes variation in the frequency and severity of exposure to extreme temperatures across populations. Furthermore, climate change is expected to increase the magnitude and frequency of thermal extremes. Population and individual responses to variation in thermal means and extremes can be through long-term genetic or short-term plastic mechanisms. We investigated short-term plasticity in multiple populations of the direct-developing sea hare, Phyllaplysia taylori, to determine whether differences in microclimate influenced acclimation capacity. P. taylori were collected along the western US coast from Ocean Shores, WA to Morro Bay, CA and acclimated to winter, summer, and future summer temperatures. Critical thermal maxima, regardless of acclimation temperature, were well above average habitat temperatures across all habitats, even when considering average daily variation in habitat temperature (CTmax ranged from 24-35°C, average=30.1±0.2°C; average habitat temperature ranged from 12-20°C, average=21±0.8°C). Intraspecific variation in CTmax in this species was on the high end of values reported in the literature and was correlated with average habitat temperatures and average daily variation in these temperatures experienced by populations, although the plasticity of this trait was not. This suggests that the plasticity of upper critical limits is not driven by habitat thermal history, and therefore may not be under positive selection.

Divergent melanism strategies in Andean butterfly communities structure diversity patterns and climate responses

Distribution of species result from the combination of environmental exposure and sensitivity. One key trait in deciphering species responses to environment is color. The thermal melanism hypothesis (TMH) states that ectotherms would benefit from dark coloration in environments with low temperatures and that it would result in altitudinal and latitudinal clines in coloration. We used a long-term data set on two prominent butterfly genera Catasticta and Leptophobia for which we recomposed community assemblies across elevation in the Ecuadorian Andes based on color lightness, species-specific heating rate and maximum temperature (under experimental solar exposure). We show that the two genera assemble according to their colour lightness across elevation but exhibit opposite strategies to achieve it – ones are getting
darker and the others are getting lighter with altitude – and opposite pigmentation configurations between their body and body + wings. However, they seem to achieve comparable thermoregulation, assessed via their heating rates under experimental solar exposure. We found that the elevational patterns of traits in *Canis latrans* remained after correction for phylogeny but not in *Leptophobia*. These biogeographic trait patterns correspond strikingly with the distribution of montane cloud forests, where habitat fragmentation and loss of cloud cover due to climate change are likely to result in increased exposure to solar radiation and have important consequences for the vulnerability and distribution of these diverse montane communities.

### AS18.18 LATITUINAL AND ALTITUINAL VARIATION IN BLOOD GLUCOSE LEVELS IN SONGBIRDS

**SUNDAY 1 JULY 2018**

**OLDRICH TOMASEK (CHARLES UNIVERSITY FACULTY OF SCIENCE, CZECH REPUBLIC), LUKAS BOBEK (THE CZECH ACADEMY OF SCIENCES INSTITUTE OF VERTEBRATE BIOLOGY, CZECH REPUBLIC), MARIE ADAMOVA (THE CZECH ACADEMY OF SCIENCES INSTITUTE OF VERTEBRATE BIOLOGY, CZECH REPUBLIC), SAMPATH K ANANDAN (THE CZECH ACADEMY OF SCIENCES INSTITUTE OF VERTEBRATE BIOLOGY, CZECH REPUBLIC), TEREZA KRALOVA (THE CZECH ACADEMY OF SCIENCES INSTITUTE OF VERTEBRATE BIOLOGY, CZECH REPUBLIC), PAVEL MUNCLINGER (CHARLES UNIVERSITY FACULTY OF SCIENCE, CZECH REPUBLIC), ERIC J ARMSTRONG (GENOSCOPE CEA, FRANCE), RICHELLE L TANNER (UNIVERSITY OF NEW ENGLAND, AUSTRALIA), K MILLER (UNIVERSITY OF NEW ENGLAND AND OFFICE OF ENVIRONMENT AND HERITAGE, AUSTRALIA), OLTMISK@GMAIL.COM**

Glucose is one of the major energetic substrates circulating in vertebrate blood mainly fuelling intense short-term activities and thermoregulation. Circulating in vertebrate blood mainly fuelling glucose is one of the major energetic substrates. To this end, we captured 488 and 602 individuals of 40 European and 51 African songbird species, respectively, and measured blood glucose concentration within 3 (baseline; G0) and after 30 minutes (stress; G30) from the capture. Using phylogenetic MCMC GLMM models with individual measurements, we found that tropical lowland species (272 individuals of 22 species) had significantly lower G0 compared to temperate songbirds, attesting to their slow pace of life. Although not significant, tropical lowland species tended to have more intense glucose stress response, resulting in no association between G0 and latitude. In the tropics, altitude was positively correlated with G0, but not with the stress response intensity suggesting higher energy demands of thermoregulation and/or faster pace of life in higher altitudes. In summary, our data show both latitudinal and altitudinal variation in blood glucose with the lowest concentrations found in tropical lowland species. The results suggest that this variation is primarily due to the variation in G0. The low costs and the ease of blood glucose measurement renders it a promising tool for the macrophysiological research.

### AS18.19 WARM ADAPTATION TRADES-OFF AGAINST HEAT TOLERANCE PLASTICITY IN INTERTIDAL NUDIBRANCH MOLLUSCS

**SUNDAY 1 JULY 2018**

**ERIC J ARMSTRONG (GENOSCOPE CEA, FRANCE), RICHELLE L TANNER (UNIVERSITY OF CALIFORNIA BERKELEY, UNITED STATES), NIGEL R ANDREW (UNIVERSITY OF NEW ENGLAND, AUSTRALIA), C MILLER (UNIVERSITY OF NEW ENGLAND AND OFFICE OF ENVIRONMENT AND HERITAGE, AUSTRALIA), ARMSTRONG@BERKELEY.EDU**

Rapid ocean warming may alter habitat suitability for marine ectotherms and susceptibility to thermal perturbations will depend in part on the relative ability to plastically adjust its upper thermal limits of performance. However, we currently lack data regarding heat tolerance and tolerance plasticity for several major marine taxa including nudibranch molluscs. We investigated heat tolerance limits (CT<sub>max</sub>, heat tolerance plasticity (acclimation response ratio), thermal safety margins (TSMs), temperature sensitivity of metabolism (Q<sub>10</sub>), and metabolic cost of heat-shock in nine species of nudibranchs from several sites along the northeastern Pacific coast of California in order to determine relative sensitivity to future warming. Heat tolerance differed significantly between species but not across latitudes within a species and ranged from 25.4 ± 0.5°C to 52.2 ± 1.8°C (x ± SD). Heat tolerance plasticity (ARR) was generally high (0.52 ± 0.06, x ± SE) and was strongly negatively correlated with heat tolerance in accordance with the Trade-off Hypothesis of thermal adaptation. Acute metabolic costs of thermal challenge were low with no significant alteration in respiration rate of any species 1 h post-exposure to heat-shock. Thermal safety margins, calculated against maximum habitat temperatures, were negative for nearly all species examined (−2.6 ± 1.1°C). From these data, we conclude that warm-adaptation in intertidal nudibranchs constrains acclimatory responses to acute thermal challenge, that warm-adapted species are likely most vulnerable to future warming, and that metabolic recovery is rapid after heat shock in these species.

### AS18.20 ANT THERMAL TOLERANCES UNDER CLIMATE, LAND COVER AND LAND USE CHANGE

**SUNDAY 1 JULY 2018**

**NIGEL R ANDREW (UNIVERSITY OF NEW ENGLAND, AUSTRALIA), C MILLER (UNIVERSITY OF NEW ENGLAND, AUSTRALIA), O HALL (UNIVERSITY OF NEW ENGLAND, AUSTRALIA), I OLIVER (UNIVERSITY OF NEW ENGLAND AND OFFICE OF ENVIRONMENT AND HERITAGE, AUSTRALIA), NANDREW@UNE.EDU.AU**

Rapid ocean warming may alter habitat suitability for marine ectotherms and susceptibility to thermal perturbations will depend in part on the relative ability to plastically adjust its upper thermal limits of performance. However, we currently lack data regarding heat tolerance and tolerance plasticity for several major marine taxa including nudibranch molluscs. We investigated heat tolerance limits (CT<sub>max</sub>, heat tolerance plasticity (acclimation response ratio), thermal safety margins (TSMs), temperature sensitivity of metabolism (Q<sub>10</sub>), and metabolic cost of heat-shock in nine species of nudibranchs from several sites along the northeastern Pacific coast of California in order to determine relative sensitivity to future warming. Heat tolerance differed significantly between species but not across latitudes within a species and ranged from 25.4 ± 0.5°C to 52.2 ± 1.8°C (x ± SD). Heat tolerance plasticity (ARR) was generally high (0.52 ± 0.06, x ± SE) and was strongly negatively correlated with heat tolerance in accordance with the Trade-off Hypothesis of thermal adaptation. Acute metabolic costs of thermal challenge were low with no significant alteration in respiration rate of any species 1 h post-exposure to heat-shock. Thermal safety margins, calculated against maximum habitat temperatures, were negative for nearly all species examined (−2.6 ± 1.1°C). From these data, we conclude that warm-adaptation in intertidal nudibranchs constrains acclimatory responses to acute thermal challenge, that warm-adapted species are likely most vulnerable to future warming, and that metabolic recovery is rapid after heat shock in these species.

in climate, land cover and land use, and (ii) assess the ability of multiple use landscapes to confer maximum resilience to terrestrial biodiversity in the face of a changing climate. The research was carried out along a 270km aridity gradient in northern New South Wales, Australia. When we assessed critical thermal maximum temperatures (CT<sub>max</sub>) of meat ants in relation to the environmental variables, and within the model we had critical thermal minimums of meat ants (CT<sub>min</sub>) as a random slope and as a fixed effect we detected a negative aridity effect on CT<sub>max</sub>, a negative effect of land use intensity, and no overall correlation between CT<sub>max</sub> and CT<sub>min</sub>. We also found a negative relationship with warming tolerance of I. purpureus and landscape aridity. In conclusion, we expect to see a reduction in the physiological resilience of I. purpureus as land use intensity increases and as the climate becomes more arid. Meat ants are key ecosystem engineers and as they are put under more stress, wider ecological implications may occur if populations decline or disappear.
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