BIOLOGY GRADUATE STUDENT SYMPOSIUM 2023

DEPARTMENT OF BIOLOGY

UNIVERSITY OF SASKATCHEWAN

PROGRAM AND BOOK OF ABSTRACTS

UNIVERSITY OF SASKATCHEWAN

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Welcome to the Biology 990 Symposium, our showcase of graduate student research

Welcome to the Biology 990 Graduate Student Symposium. We're pleased to welcome everyone back on campus to participate this year and are happy to announce the return of our 990 Barbeque, in the CSRB Lounge.

The symposium will kick off with electronic posters on all three floors of CSRB on Wednesday afternoon at 2:30 and 3:30 pm. We will then meet in the lounge for burgers and salads at 5:00 pm that evening. Thursday will be a day of oral presentations over in Arts 263.

We are trying something different this year and will not be announcing the graduate student awards immediately following the oral presentations. Instead, be on the lookout for an invitation to our Department of Biology celebration of excellence later this spring.

Finally, I want to wrap up by saying that Biology 990 is one of my personal favourite times of the year. I love hearing about the diversity of research taking place in the department and I appreciate the thought, effort, and creativity, put into the student presentations. The ongoing success of events like this lies with the people behind it and I want to thank all the students, supervisors, evaluators, and staff that help put it on. It is the people that make the Biology department such an amazing place to work and learn.

Have a wonderful symposium and best of luck to all of our presenters.

Chris

SYMPOSIUM SCHEDULE

Day 1 – Wednesday April 5th, 2023

	POSTER PRESENTATIONS – CSRB DISPLAY SCREENS			
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7.	**3:30-4:20 p.m.**	Tammie Windsor	F1 LOBBY L	8
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12.		Md Helal Uddin	CSRB 315	10
	5:00 pm	**990 Symposium BBQ** - CSRB lunch room		

Day 2 – Thursday April 6th, 2023

	ORAL PRESENTATIONS (ARTS room 263)		
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13.	**9:00 a.m.**	Joseph Abrams	11
14.	**9:15 a.m.**	Lindsay Carlson	11
15.	**9:30 a.m.**	Tong Jyun (Tom) Ho	12
16.	**9:45 a.m.**	Adrian Diaz Sanchez	12
17.	**10:00 a.m.**	Alex Preagola	13
	10:15 a.m.	**20 minute break**	

		Cont'd (ARTS room 263)	
18.	**10:35 a.m.**	Amirsaeed Sabeti Aghabozorgi	13
19.	**10:50 a.m.**	Lynsey Bent	14
20.	**11:05 a.m.**	Carter Wotton	14
21.	**11:20 a.m.**	Alec Schindler	15
22.	**11:35 a.m.**	Sravan Putnala	15
	11:50 a.m.	**Lunch**	
23.	**1:15 p.m.**	Jacob Ulrich	16
24.	**1:30 p.m.**	Kayla Caruso	16
25.	**1:45 p.m.**	Neda Fattahi Miab	17
26.	**2:00 p.m.**	Raylene Hartl	17
27.	**2:15 p.m.**	Delanie McEvoy	17
	2:30 p.m.	**20 minute break**	
28.	**2:50 p.m.**	Michelle Vanderwel	18
29.	**3:05 p.m.**	Ilsa Griebel	18
30.	**3:20 p.m.**	Kevin Kardynal	19
31.	**3:35 p.m.**	Wathmini De Silva	19
	3:50 p.m.	**Closing comments**	

ABSTRACTS FOR APRIL 5 POSTER PRESENTATIONS

1. Owen H. Luo, Douglas P. Chivers, & Soumya Niyogi. Behavioral effects of organic and inorganic selenium on arsenic exposed larval zebrafish (*Danio Rerio*). Department of Biology, University of Saskatchewan, Saskatoon, SK.

Arsenic is a non-essential and highly toxic element that has emerged as a global priority pollutant due to the risk it poses to all organisms and the health of the environment. Selenium on the other hand is an element that is essential in small amounts for human and fish health but can cause toxic effects when exposed to larger concentrations. We know that selenium can both alleviate and worsen arsenic toxicity and that in one study on zebrafish organic selenium increased arsenic toxicity. Therefore, the first objective of my experiment will be to determine whether organic or inorganic selenium will alter the effects of arsenic toxicity on larval zebrafish. My second objective is to examine the influence of early life stage exposure to both elements through acute toxicity on the behavioral effects on larval zebrafish as they grow. The findings of this research will enhance our knowledge of the interactive effects of selenium and arsenic in the environment and allow us to determine if organic or inorganic selenium will be more beneficial to organisms.

2. Molecular and physiological analysis of Arabidopsis mutants to investigate phloem-mediated signaling under phosphorus-starvation stress conditions.

Abdul-Waseh Mumtaz[1] & Byung-Kook Ham[1].

[1]Department of Biology, University of Saskatchewan, Saskatoon, SK.

Phosphorus (P) is one of major mineral nutrients for plant growth and physiology, and application of phosphate (Pi) fertilizer enables sustainable crop yield in agriculture. However, as the resource of Pi fertilizers is from the finite rock Pi, at current rate of Pi fertilizer consumption, P reserves will be depleted within around 80 years. And Pi-starvation stress causes significant decrease of yield potential in agriculture, therefore, it will be crucial to understand P nutrition for enhancing P-use efficiency in crop plants. Various plant responses and adaptation have been studied against Pi-deficiency and, recently, it has been proposed that plant phloem serves as delivery conduit of various signaling molecules to sink tissues to maintain Pi homeostasis within a whole-plant level. In this study, the role of potential phloem-mediated long-distance signaling molecules will be examined in Arabidopsis, which has been used as a model plant in many research fields of plant biology, by using genetics, phenotyping, physiology, and molecular biology technologies. Based on results, novel phloem-mediated signaling pathways will be characterized in response to Pi-starvation stress.

3. AYICIA N. NABIGON & PHILIP D. MCLOUGHLIN. Habitat selection, mortality, and apparent competition in Boreal Plains ungulates. Department of Biology, University of Saskatchewan, Saskatoon, SK.

Since 2000, the moose population in the Boreal Plains of western Canada has declined by ~30%. Extensive landscape and climate change has resulted in a poorly understood shift in the food web, including recent northward invasions of white-tailed deer (WTD). Consequently, apparent competition (two prey species indirectly competing with each other by sharing a common enemy) has been documented between WTD and boreal caribou through increased wolf predation. The extent of apparent competition between WTD and moose, however, remains unknown. Using GPS collar data collected over two seasons (March 2023 and 2024), I will examine the extent of WTD apparent- competitive exclusion of moose via the increased potential for contact with predators and pathogens (ex. wolves, chronic wasting disease, meningeal worm). I will determine moose habitat use at the population and individual level via resource selection functions using used vs. available landscape features. I will determine range overlap with WTD using latent-selection difference functions and test my prediction that moose with resource selection patterns closely overlapping with WTD will have greater mortality and lower recruitment rates. This project will provide valuable evidence for the significance of indirect food web interactions, and how they relate to environmentally and culturally significant species.

4. Role of *Cucumis sativa* Phloem Phosphate-stress-repressed 2 in phosphate homeostasis

Chuanhezi Quan[1], Byung-Kook Ham[1]

[1]Department of Biology, University of Saskatchewan, Saskatoon, SK S7N 5E2

Phosphorus (P) is essential, for plants, in photosynthesis, respiration and biosynthesis of nucleic acids and membranes. Therefore, application of P fertilizer, made for phosphate rock (Pi), enables sustainable and high yields in agriculture. However, as phosphate rock is not a renewable resource and excessive Pi fertilizer application causes numbers of serious environmental problems, plant scientists have developed phosphate (Pi)-efficiency plants. Recent studies have raised the role of plant vascular system as important plant tissue that mediates shoot-root communication to maintains Pi homeostasis. In this regard, root-derived signals, induced by the Pi-stress environment, will be perceived by the shoot through xylem transpiration stream. Then, the shoot generates long-distance signals which are delivered into sink tissues via the phloem to reallocate photosynthates and nutrients. Phloem-mobile mRNAs have been proposed as one of long-distance signaling molecules in plants and potential regulators in Pi uptake, translocation and utilization. In this study, we identified a cucumber protein, CsPPSR2 (*Cucumis sativa* Phloem Phosphate-stress-repressed 2), which is responded to Pi-deplete stress. Further, a homologs of CsPPSR2 was isolated from Arabidopsis. We will discuss the potential role of PPSR2 as a regulator to operate phloem-mediated systemic gene regulation for adaptive plant development and physiology under Pi-deplete conditions.

5. SHUQI REN. Exposure, Repellency, and Learned Aversion to Neonicotinoid Treated Seeds in Granivorous Birds. Department of Biology, University of Saskatchewan, Saskatoon, SK.

Neonicotinoid seed treatments are the most widely used insecticides that show significant toxicity to vertebrate wildlife, particularly granivorous birds. This study aims to evaluate 1) the exposure of neonicotinoid seed treatments on granivorous songbirds and 2) assess whether birds avoid or acquire learned aversion to treated seeds following exposure. Field experiments were conducted in spring 2022 on five pre-seeding crop fields to simulate clothianidin-treated seed spills and document visiting wildlife activities using camera traps, RFID PIT tags and nanotags. Three experimental phases were implemented for each site: capture and release (2 days), treatment phase 1 (1 week), and treatment phase 2 (1 week). During treatment phase 1, 2 stations per field site were baited with clothianidin-treated wheat seeds and 2 had untreated wheat seeds. During treatment phase 2, the assigned treated or untreated seeds were reversed for all sites. A total of 7 mammalian species and 17 avian species were recorded by camera traps visiting the simulated seed spills, but the RFID and nanotags were not effective. Average consumption durations were higher at the untreated stations than the treated stations and the number of species occurrences declined after first exposure. Further statistical analysis will be conducted to quantify the consumption duration and number of seeds consumed at each station by species and treatment. This study will be repeated in spring 2023 to increase the sample size and number of sites and test the effect of different seed colourants on avian detection and consumption. The findings of this study will inform the regulation and use of neonicotinoid insecticides and contribute to the conservation of wild granivorous bird populations.

6. CRESILDA ALINAPON, CHRISTOPHER TODD & PETA BONHAM-SMITH. **Characterization of effector *Pb*PE48: Its potential role in successful *Plasmodiophora brassicae* colonization in *Brassica napus* L. (canola)**. Department of Biology, University of Saskatchewan, Saskatoon, SK.

Clubroot, a swollen gall or club-shaped root, is a devastating disease caused by *Plasmodiophora brassicae*, a soil-borne obligate biotrophic plant pathogen of the kingdom Protista, that negatively affects canola yield. Clubroot management programs have been developed throughout the world to try to mitigate this problem. Unfortunately, these strategies have been unsuccessful in limiting the spread of disease. Therefore, this study aims to understand the disease progression program and characterize the molecular function of the *P. brassicae* secreted effector protein *Pb*PE48 isolated from infected roots of canola. NCBI BLAST and STRING analyses predicted that *Pb*PE48 localizes to the endoplasmic reticulum of the host plant cell and as such, could play a crucial role in the ubiquitin-dependent degradation pathway, the response to ER-stress and/or protein folding/unfolding. To investigate *Pb*PE48 function, I will clone *Pb*PE48 from infected root galls of canola into different binary and expression vectors and use it to: (i) identify subcellular localization in tobacco; (ii) check chaperone function in *E. coli* BL21; (iii) determine protein interactions in a) yeast (Yeast-two-hybrid methodology) and b) plants (Bi-fluorescence complementation); (iv) determine over-expression phenotype, response to ER-stress and pathogen infection in transgenic *Arabidopsis thaliana*; and (v) identify the role in *P. brassicae* infection and subsequent clubroot disease progression.

7. WINDSOR T. & MCLOUGHLIN P. The Ecology of the Saskatchewan Cougar (*Puma concolor*). Department of Biology, University of Saskatchewan, Saskatoon, SK.

With a potential growing population of cougars within Saskatchewan leading to the legalization of trapping in 2017, it is critical to understand their populations for management purposes. The allusive nature of cougars poses challenges for conventional methods of data collection without previous knowledge of their home ranges. A collection of reports on cougar occurrences from the public, professional community, and organizations will be compiled, given a credibility rating, and built into a database. We will evaluate baseline ecological factors such as population dynamics, habitat use versus availability, and landscape utilization. We will investigate cougar adaptation in human dominated regions to explain cougar/human occurrences. This involves detecting changes in nocturnality, habitat use, and immigration levels compared to human influence indices. Historical accounts of cougars would be limited amongst public reports. These details will be gathered through interviewing First Nations communities to develop a timeline of ecological changes amongst cougar populations. This study will contribute to the Saskatchewan Conservation Data Centre for provincially ranking cougars and to the Saskatchewan Ministry of Environment for conservation and management decisions.

8. BASIRAT T. LIADI-AZEEZ & JACK GRAY. Effect of sublethal dose of pesticides on visually guided behaviour of bees. Department of Biology, University of Saskatchewan, Saskatoon, SK.

Bees are the most abundant and effective natural pollinators contributing enormously to mass production of agricultural crops through their foraging behaviour. This group, like most insects, possess visual systems that are highly motion-sensitive, and efficiently enhance navigation within their complex environment with high precision. They rely on motion of visual elements (optic flow) within their environment to guide their numerous sophisticated behaviour. These visually guided behaviours include navigation, estimation of objects' distance, location of food, and communication within the hive. However, the ability to engage in these complex behaviours are negatively impacted by low dosage of insecticides and other agrochemical compounds in their environment. These compounds are currently and persistently being used to treat seeds despite their negative effect on non-target organisms like pollinators and birds and include the common neonicotinoids and sulfoximines. This study will investigate the effects of the two common pesticide groups (neonicotinoids and sulfoximines) on bee locomotion in a newly designed experimental arena that simulates the natural visual environment. I will measure optomotor responses to moving gratings or object motion by analyzing the turning behaviour and walking path using motion analysis software. These experiments will address important questions of how environmental contaminants affect ecologically relevant behaviour.

9. A K M MUNZURUL HASAN, DOUGLAS P. CHIVERS & SOM NIYOGI. Investigating the transgenerational neurobehavioural and reproductive toxicity of Bisphenol S in zebrafish *(Danio rerio).* Department of Biology, University of Saskatchewan, Saskatoon, SK, Canada

Bisphenol S (BPS) is an emerging environmental contaminant of global concern. Recent work in our lab demonstrated that chronic exposure to BPS causes neurobehavioural and reproductive toxicity in adult zebrafish. Maternal BPS exposure has also been found to cause neurobehavioural impairment in zebrafish offspring. However, the underlying molecular and physiological mechanisms of such adverse effects of BPS remain poorly understood. Moreover, it is not yet known whether these effects persist beyond the second generation. Thus, the main objectives of my research will be: (i) to assess how chronic BPS exposure affects the cognitive and social behaviours in zebrafish and to elucidate the pertubations of neuroregulatory pathways in the brain that mediate these behavioural deficits; (ii) to determine how chronic exposure to BPS affects the reproductive performance of both male and female zebrafish and to examine whether the reproductive effects occur due to the disruption of the hypothalamus-pituitary-gonad endocrine axis; and (iii) to examine the transgenerational inheritance (F_0-F_2 generations) of neurobehavioural and reproductive effects of ancestral BPS exposure in zebrafish and to characterize the potential epigenetic mechanisms that mediate these transgenerational effects. Our research is expected to provide new insights into the long-term adverse effects of BPS exposure in fish.

10. K.A. DINITHI KUMARAPELI, YANGDOU WEI & KEN WILSON. Lignin deposition during penetration resistance and its interaction with the salicylic acid defense pathway. Department of Biology, University of Saskatchewan, Saskatoon, SK.

The plant cell wall is actively remodelled to prevent pathogen attack by reinforcing its structure through the deposition of papillae underneath the pathogen penetration site. Lignin is a well-known component in papillae, playing a pivotal role in plant penetration resistance. The precise composition and deposition of monolignols, enzymes, and factors regulating lignin biosynthesis at papillae during penetration resistance is still elusive. The invasion of plant cells by biotrophic pathogens often leads to the activation of salicylic acid (SA) dependent defense responses. The genetic interaction between the monolignol biosynthesis pathway and SA defense signalling in mediating plant immunity remains unexplored. In this study, the interaction between host *Arabidopsis thaliana* and the adapted (*Erysiphe cchoracearum*) or non-adapted (*Blumeria graminis* f. sp. *hordei*) powdery mildews will be used as model pathosystems to study the cellular and molecular pathways involved in lignin biosynthesis and the SA defense pathway during plant immunity. The knowledge gained from this study will provide a deeper understanding of underlying cellular and molecular mechanisms involved in lignin biosynthesis and SA defense pathway function during plant immunity against powdery mildews invasion in *Arabidopsis*. A long-term goal of this work is to develop durable disease resistance in plants for sustainable agriculture.

Key words: Lignin; Papillae; Powdery mildew; Salicylic acid; *Arabidopsis*

11. NICHOLAS G. SHEPHARD[1], MATTHEW W. REUDINK[2], & ANN E. MCKELLAR[1,3]. Movement Tracking, Productivity, and Diet of North American Black Terns (*Chlidonias niger*). [1]Department of Biology, University of Saskatchewan, Saskatoon, SK; [2]Department of Biology, Thompson River University, Kamloops, BC; [3]Environment and Climate Change Canada, Wildlife Research Division, Saskatoon, SK.

Migratory bird populations are in decline globally; however, without proper knowledge of where individuals are going and what might be occurring at critical stages of the annual cycle, conservation of these at-risk populations is difficult. Black Tern (*Chlidonias niger*) populations are declining across their range in North America, but specific causes of declines remain unclear. Events occurring across the annual cycle (staging, wintering, and breeding) may influence population demographics. However, our understanding of migration timing, routes, stop-over sites, or ecology of over-wintering Black Terns, remains limited. In addition, breeding productivity is variable across the range, suggesting that variation in Black Tern diet could be influencing the success of both adults and chicks. I aim to 1) understand the connectivity of Black Tern colonies across the breeding range and throughout the annual cycle by deploying geolocators on individuals at sites across the breeding range; 2) assess breeding site fidelity and inter-annual breeding dispersal of Black Terns in the core of the range by deploying avian nanotags; 3) assess productivity at four Black Tern colonies across the North American breeding range, as well as assess nest-site use and factors influencing nest survival; and 4) analyze and compare the diets of adult Black Terns throughout the full annual cycle (using stable isotopes) to ask whether diet is influencing individual condition and productivity.

12. MD HELAL UDDIN, DOUGLAS P. CHIVERS & SOM NIYOGI. An investigation of the developmental and reproductive toxicity of selenium in zebrafish (*Danio rerio*). Department of Biology, University of Saskatchewan, Saskatoon, SK.

Selenium (Se) is an indispensable micro-nutrient for numerous living organisms including fishes; however, its narrow safe intake makes it a high-priority environmental contaminant. Worldwide various anthropogenic activities have increased the loading of Se into aquatic environments, specifically in North America. Se is known to be particularly toxic to oviparous animals because of its maternal transfer to eggs and embryos. Previous studies have revealed that both dietary and waterborne Se exposures at environmentally relevant concentrations cause reproductive and developmental toxicity in fishes. However, the molecular and physiological underpinnings of such adverse effects of Se in fishes remain poorly understood. With that in mind, I will investigate the effects of chronic exposure to Se *via* a natural diet impairs zebrafish reproduction by disrupting the hypothalamus-pituitary-gonadal-liver axis and/or by inducing oxidative damage to reproductive tissues. Furthermore, I will also examine whether the effects of Se on the early development of zebrafish are different when it is maternally transferred to the embryo from that in embryos that are directly exposed to selenium through the exposure medium. My research findings would provide new mechanistic insights into Se toxicity in fishes and may help to develop better regulatory strategies to mitigate its effects in aquatic ecosystems.

13. JOSEPH E. S. ABRAMS & JAMES D. BENSON. An Ellipsoidal Cell Agent Module for the PhysiCell Platform. Department of Biology, University of Saskatchewan, Saskatoon, SK.

Cell-based models are agent-based mathematical models whose discrete agents represent individual cells. Cell-based models are frequently used in simulating tissue dynamics and have seen wide use in oncological modelling. Cell-based models capture complex emergent phenomena caused by interacting discrete entities. The emergent biophysics of cell-based models is used to construct relatively accurate approximations of mass transport and viscoelastic mechanics in tissues. Because of their computational simplicity, cell based models nearly universally use spherical representations of the cell. This leads to inaccurate representations of cell morphology and, thus, importantly tissue mechanics. Ellipsoidal agents can more accurately simulate a wide range of cell morphologies and morphology-dependent cellular processes, including approximating the typical cell shapes seen in adherent cell cultures and epithelial wound healing. Due to the increased availability of computational resources, it is now possible to simulate non-spherical cell morphology in tens of thousands to millions of cells. In this work, we demonstrate how to implement ellipsoidal cell agents in PhysiCell, and how we will inform these agents with parameters to capture anisosmotic equilibration in hanging drop spheroid cultures. We show how using custom code, we can model intercellular connectivity, uniaxial elongation, uniaxial compression, rotation of polar cells, directional motility, and cell aggregation for thousands of heterogeneously sized cell agents.

14. LINDSAY G CARLSON[1], JOSHUA C. STILLER[2], THEODORE C. NICHOLS[3], MARC DUNN[4], ERNEST RABBITSKIN[4], JOSÉE LEFEBVRE[5], KENNETH F. ABRAHAM[6], FANNY NOISETTE[7], MELANIE-LOUISE LEBLANC[8], JAMES O. LEAFLOOR[9], FRANK B. BALDWIN[10], SCOTT G. GILLILAND[10], ALAN HANSON[10], STUART M. SLATTERY[11], MITCH D. WEEGMAN[1] Ascribing the importance of Atlantic brant staging areas for holistic conservation planning

1 Department of Biology, University of Saskatchewan, Saskatoon, SK; 2 New York State Department of Environmental Conservation, Albany, NY; 3 New Jersey Division of Fish and Wildlife, Woodbine, NJ; 4 Niskamoon Corporation, Montréal, QC; 5 Canadian Wildlife Service, Québec Region, Québec, QC; 6 Ministry of Natural Resources and Forestry, Peterborough, ON; 7 Institut des Sciences de la Mer, Université du Québec à Rimouski, Rimouski, QC; 8 Department of Zoology, University of British Columbia, Vancouver, BC, QC; 9 Canadian Wildlife Service, Prairie Region, Winnipeg, MB; 10 Canadian Wildlife Service, Atlantic Region, Sackville, NB; 11 Ducks Unlimited Canada, Stonewall, MB

Recent research on a variety of wildlife species has highlighted how events and conditions such as climate and habitat quality experienced by an individual in one season can carry-over to affect reproductive success, survival or both in subsequent seasons. Despite compelling links between pre-breeding environmental conditions and reproductive success in migratory birds, researchers have not disentangled these relationships seasonally for Atlantic brant. Atlantic brant (*Branta bernicla hrota*) breed across the Foxe Basin, and nearly the entire population stages in James Bay during both spring and fall migration, and winters along the coasts of New York and New Jersey. The population has fluctuated dramatically over recent decades despite near constant adult survival, suggesting that booms and busts in productivity drive population trends. Over the same period, dense eelgrass beds have declined by ~40% in James Bay staging areas. We aim to link the effects of winter and spring habitat quality and weather conditions to individual reproductive success. We will examine these processes in a full annual cycle modeling framework to develop targeted conservation plans based on regions and seasons of greatest importance to reproductive success.

15. Functional studies of phosphate-stress-induced ribonucleoprotein complexes involved in phloem-mediated systemic signaling.

Tom Ho[1], Byung-Kook Ham[1]

[1]Department of Biology, University of Saskatchewan, Saskatoon, SK.

Phosphate (Pi) is an essential macronutrient and ubiquitous in many plant processes for growth and development. To maintain whole-plant Pi homeostasis, plants can utilize the phloem translocation stream to deliver specific signals into target tissues for eliciting a Pi-starvation responses and, recently, it has been proposed that phloem-mobile mRNAs, composed of RNA-binding proteins (RBPs), function as systemic signaling agents in shoot-root communication under Pi-deficiency/starvation conditions. The previous proteomics analyses identified 105 RBPs in cucumber phloem exudate and, in this study, we characterized one of potential phloem-mediated long-distance signals, PHLOEM PHOSPHATE-STRESS RESPONSIVE RNA-BINDING PROTEIN (PPRR), in Pi homeostasis. It has been reported that Arabidopsis PPRR homologs play a role in regulating reactive oxygen species (ROS) production and various abiotic stress signaling pathways in response to temperature, light and osmotic stress. Arabidopsis PPRRs will be examined whether PPRRs interact with ACCELERATED CELL DEATH 11 (ACD11), using yeast-2-hybrid system. Expression patterns and subcellular localization of Arabidopsis PPRRs will be characterized using GUS reporter and PPRRs-GFP lines under the control of native PPRR promoters. Shoot area, root length and density, biomass and ROS accumulation will be measured in PPRR knock-out mutant and overexpression lines, to test the role of PPRRs in Pi-stress signaling pathway.

16. ADRIAN A. DÍAZ-SÁNCHEZ & NEIL B. CHILTON. Does the centre-periphery hypothesis explain the distributional range limits of parasites? Department of Biology, University of Saskatchewan, Saskatoon, SK.

The ‘centre–periphery’ hypothesis (CPH) is a major biogeographical paradigm that aims to provide a general explanation as to what limits species distributions. However, no study has determined if the CPH is applicable to ixodid ticks, particularly the American dog tick (*Dermacentor variabilis*) is expanding its distributional range in western Canada. Our ultimate goal is to determine the genetic structure, diversity, and divergence of *D. variabilis* populations throughout its range in North America and Mexico, and test the validity of the CPH. In this study, we compare the genetic variation in the mitochondrial gene cytochrome *c* oxidase subunit 1 (*cox*1) for 143 *D. variabilis* adults collected from three different years (2011, 2013, 2022) at the Blackstrap Lake, Saskatchewan. Overall, 29 *cox*1 haplotypes were detected among 143 adult *D. variabilis*, where the two most common haplotypes occurred at frequencies of 26% (H1) and 16% (H2). The haplotypes H1 and H2 were detected in all sampled years, while the presence of singletons was only observed in year 2022. Differences in the haplotype frequencies and diversity among ticks from different years provides important information to fully understand factors that limits the distributional range of *D. variabilis*.

17. ADAM L. CRANE[1,2], GABRIELLE H. ACHTYMICHUK[1,2], ITA A.E. RIVERA-HERNANDEZ[1], ALEXYZ A. PREAGOLA[1], HIMAL THAPA[1] & MAUD C.O. FERRARI[2]. Uncertainty about old information results in differential predator memory in tadpoles. [1]Department of Biology, University of Saskatchewan, Saskatoon, SK; [2]Biomedical Sciences, WCVM, University of Saskatchewan, Saskatoon, SK

As information ages, it may become less accurate, resulting in increased uncertainty for decision makers. For example, chemical alarm cues are a source of public information about a nearby predator attack, and these cues can become spatially inaccurate through time. These cues can also degrade quickly under natural conditions, and cue receivers are sensitive to such degradation. Although numerous studies have documented predator-recognition learning from fresh alarm cues, no studies have explored learning from aged alarm cues and whether the uncertainty associated with this older information contributes to shortening the retention of learned responses (i.e., the 'memory window'). Here, we found that wood frog tadpoles, *Lithobates sylvaticus*, learned to recognize a novel odour as a predator from alarm cues that were aged under natural conditions for up to one hour. However, only tadpoles conditioned with fresh alarm cues were found to retain this learned response when tested 9 days after conditioning. These results support the hypothesis that the memory window is shortened by the uncertainty associated with older information, preventing the long-term costs of a learned association that was erroneous.

Keywords: alarm cues, conditioning, learning, memory, predator recognition

18. Amir S. Aghabozorgi & Carlos E. Carvalho. Characterizing a *hif-1* transcript as a novel neuronal-specific transcript in *C. elegans*. Department of Biology, University of Saskatchewan, Saskatoon, SK.

Hypoxia-Inducible Factor-1 (HIF-1) is a conserved protein family of transcription factors in metazoans that evolved to cope with hypoxic stress by activating the expression of genes required for adaptation to low oxygen levels. Among animal cells, neurons are particularly susceptible to hypoxia-induced damage. Thus, unraveling how neurons differentially manage the challenges of hypoxia via HIF-1 activation is of clinical relevance. We identified the first neuron-specific *hif-1* transcript in the model *C. elegans,* expressed by the internal promoter in intron 4 of the worm *hif-1* locus.

So far, we could specify a short sequence resides within intron-4 upstream to exon-1 of hif-1c neuron-specific transcript which is necessary for this neuron-specific *hif-1* transcript. Further alignment analysis showed that this region is a putative TSS region conserved in different Caenorhabditis species.

Characterizing novel *hif-1* transcripts in *C. elegans* may better understand tissue-specific adaptations to hypoxia and reveal conserved transcriptional mechanisms in humans where hypoxia-associated neuronal defects during embryonic development are associated with several complex neurological disorders.

19. LYNSEY C. BENT[1], ADAM F. G. LEONTOWICH[2], JIM P. BAHR[3], KIRSTY E. B. GURNEY[4]. Evaluating lead exposure in scavenging species linked to big-game hunting in Saskatchewan, Canada. [1]Department of Biology, University of Saskatchewan, Saskatoon, SK; [2]The Canadian Light Source, Saskatoon, SK; [3]School of Natural Resources and Built Environment, Saskatchewan Polytechnic, Prince Albert, SK; [4]Environment and Climate Change Canada, Prairie and Northern Wildlife Research Centre, 115 Perimeter Road, Saskatoon, SK.

For free-ranging animals, chronic exposure to lead, a toxic heavy metal, can manifest in discrete physiological changes, alter behaviours, and contribute to increased mortality. In Canada, although lead ammunition has been banned for hunting waterfowl, carrion contaminated with lead fragments from bullets used in rifle-hunting remains a potential source of exposure for wildlife, particularly scavenging species. Data to quantify lead exposure in these species related to hunting activities in most of Canada, however, are lacking. The main goal of my thesis research is therefore to evaluate the risk of lead exposure to scavenging wildlife as a result of big-game hunting in Saskatchewan, Canada. By quantifying lead mass in hunted animal remains (i.e. viscera and organs), and evaluating scavenger community assemblages feeding at kill sites, I aim to achieve two main objectives: (i) enhancing techniques to quantify lead in large tissue samples by bridging the gap between traditional (medical radiography) and advanced (synchrotron based) imaging technologies and (ii) identifying spatial and temporal factors that affect scavenger community composition. My findings will contribute important information to the continuous assessment of terrestrial lead and its potential impact on wildlife.

20. CARTER R. WOTTON & CHRISTOPHER D. TODD. Effects of the ureide allantoin in response to salt stress in *Arabidopsis thaliana.* Department of Biology, University of Saskatchewan, Saskatoon, SK.

Purine degradation is a metabolic pathway that plants use to recycle nitrogen from the adenine and guanine bases that make up nucleic acids. These are converted to xanthine, which is metabolized through ureide intermediates to generate NH_3 for reassimilation. One of these intermediates, allantoin, has previously been shown to confer a generalized abiotic stress tolerance when provided exogenously, or in Arabidopsis mutants which lack the enzyme allantoinase that is responsible for metabolizing it. This has been tested recently using a sodium chloride and cadmium chloride stress where the allantoin-accumulating mutant plants, *aln-3,* were used as a control to compare with their wild-type progenitor strain Col-0. Surprisingly, in my hands, the phenotypic difference between *aln-3* and Col-0 was not evident as previously described. This may be due to differences in seed quality or due to changes in growing conditions brought on by a move to CSRB. Discovering why the two strains are not showing differences in phenotype may lead to insight into the mechanism for conferring allantoin-induced stress tolerance.

21. ALEXANDER R. SCHINDLER[1], ANTHONY D. FOX[2], CHRISTOPHER K. WIKLE[3], BART M. BALLARD[4], ALYN J. WALSH[5], SEÁN B. A. KELLY[5] & MITCH D. WEEGMAN[1]. Evaluating the fitness tradeoffs of reproduction across the annual cycle of Greenland white-fronted geese. [1]Department of Biology, University of Saskatchewan, Saskatoon, SK, CA; [2]Department of Ecoscience, Aarhus University, Aarhus, DK; [3]Department of Statistics, University of Missouri, Columbia, MO, USA; [4]Caesar Kleberg Wildlife Research Institute, Texas A&M University-Kingsville, Kingsville, TX, USA; [5]National Parks and Wildlife Service, Dublin, IE.

Reproduction is energetically demanding, and migratory species evaluate tradeoffs of long-distance movement with reproduction and survival. Long-lived migratory species may lower reproductive effort or forgo reproduction altogether in a particular breeding season to maximize survival and increase potential for producing future offspring. The Greenland white-fronted goose (*Anser albifrons flavirostris*) is a long-distance migrant whose population has experienced a ~50% decline in the past 23 years. We used GPS-acceleration devices deployed on Greenland white-fronted geese to quantify individual decision-making throughout the full annual cycle. We quantified the effects of preparation for reproduction during spring migration on subsequent breeding outcomes, breeding outcomes on fall migration characteristics, and fall migration characteristics on subsequent survival of parents. We found weather and land cover affected behavior of geese during spring and fall migrations. Individuals that spent more time feeding in early and late spring migration were more likely to successfully reproduce. Individuals that successfully reproduced expended less energy and spent less time feeding during fall migration, potentially demonstrating a negative fitness consequence to breeding. These comparisons improve our understanding of the potential fitness trade-offs between attempting and deferring breeding, which is an important step in understanding the mechanism(s) for declines in Greenland white-fronted geese.

22. SRAVAN KUMAR PUTNALA & SOM NIYOGI. Developmental and behavioural effects of early life stage exposure to arsenic in zebrafish (*Danio Rerio).* Department of Biology, University of Saskatchewan, Saskatoon, SK.

The current study is designed to investigate the effects of sub-lethal embryonic exposure to arsenic (As) on the early development and behaviour of zebrafish. To this end, zebrafish embryos were exposed to an increasing concentration of arsenic *via* culture media [0 (control), 5, 10, 50, and 100 µg/L; as arsenite]. Survival, hatching success, and arsenic-induced reactive oxygen species (ROS) and apoptosis were evaluated following embryonic exposure to arsenic from 1 – 120-hour post fertilization (hpf). In addition, to examine the effects of As exposure on larval behaviour, fish were exposed to As from 1 hpf - 26 dpf (days post fertilization). To understand the effects of As on various types of larval behaviour, we evaluated the photo-motor response (an indicator of reflexive behaviour) at 5 dpf, thigmotaxis at 15 dpf, social preference at 21 dpf, and novel object recognition at 26 dpf, respectively. Our preliminary observations indicate that survival rate and hatching success were not affected by embryonic As exposure. However, As exposure was found to increase reactive oxygen species production and apoptosis in 120 hpf zebrafish embryos, as revealed by DCFDA and acridine orange staining methods, respectively. The behavioural effects of As are currently being analyzed.

23. JACOB C. ULRICH[1], DOUGLAS P. CHIVERS[1], MAUD C. O. FERRARI[2]. The effect of abiotic stimuli on the predation efficiency of water tigers (*Dytiscus alaskanus*). [1]Department of Biology, University of Saskatchewan, Saskatoon, Canada; [2]Department of Veterinary Biomedical Sciences, University of Saskatchewan, Saskatoon, Canada.

Predation efficiency is subject to experiential learning via repeated exposures to prey items in a similar environment. Water tigers – a common name given to the larvae of the predaceous diving beetle – are notably voracious predators that have significant influences on seasonal amphibians and aquatic invertebrate populations. Natural and anthropogenic abiotic changes to the larvae's environment may reduce predation efficiency via sensory interference. Indeed, water tigers use chemical, vibrational, and visual cues to successfully attack their prey. To assess the effect of abiotic alterations on the predation efficiency of the water tigers, I exposed larvae and their prey items to control (no), low, and high ranges of wind, vibration, or turbidity stimuli during 10-minute survival trials. During these trials, larvae and prey were assessed for speed and distance moved as well as additional behavioural events that were reduced into different predatory behaviours via Principal Component Analysis. Our results show evidence of context-dependent foraging behaviour when faced with natural stimuli of wind and turbidity, and additional evidence of abiotic novelty causing ineffective predatory behaviour. These findings support necessary actions to limit anthropogenic encroachment on native wetlands and provide future frameworks for similar abiotic interference experiments in insects and other arthropods.

24. KAYLA CARUSO[1], CHRISTY MORRISSEY[1] & ANN E. MCKELLAR[2]. Evaluating changes in shorebird population trends in relation to climate and lake habitat characteristics

[1]Department of Biology, University of Saskatchewan, Saskatoon, SK; [2]Canadian Wildlife Service, Prairie and Northern Wildlife Research Centre, Saskatoon, SK.

Many shorebird populations are in steep decline, threatened by climate change, human disturbance, and habitat alteration. Shorebirds migrate thousands of kilometers from their wintering grounds to breeding grounds and often rely on a restricted set of high-quality staging sites to rest and refuel. Shorebirds migrating through the interior of North America rely on saline wetlands and lakes opportunistically as stopovers, but the prairie region has historically received less study than coastal stopover sites. Wet-dry cycles in the interior prairie pothole region (PPR) can drastically affect the availability of wetland habitat and the characteristics of saline lakes. This project aims to assess spatial and temporal changes in shorebird populations by revisiting lakes in Saskatchewan with historically high shorebird numbers that have not been surveyed since the 1990s. The objectives of this project are to 1) understand changes in shorebird populations by comparing current and historic counts; 2) evaluate changes in populations in relation to wet-dry cycles and surrounding land-use to understand effects on shorebird habitat suitability. With shorebird populations declining globally, this project will provide critical information about how climate and land use change in the prairies alters lake habitats that are critical staging areas for migrating shorebirds.

25. Chris Todd & Neda Fattahi. Accumulation of allantoin in response to combined abiotic stresses in Arabidopsis (*Arabidopsis thaliana*).

Plants are exposed to biotic and abiotic stresses which affect plant growth and development. Allantoin, produced by the ureide catabolic pathway, is a nitrogen-rich compound responsible for recycling nitrogen from purine bases in plants and other organisms. Previous studies on individual stresses illustrated that there is a direct link between allantoin accumulation in plants and increased abiotic stress tolerance through induction of stress-related genes. My research addresses the effect of combined salt and high light stress on ureide metabolism and its consequence on plants. I am taking a genetic approach using Arabidopsis allantoinase mutants (*aln-3*), allantoinase-overexpressed lines (*ALNox*), ABA mutations (*abi, nced3)* and double mutants including (abi/ALNox), (aln/abi), (aln/nced3) and (ALNox/ NCED3ox) to explore the interaction between ABA signaling pathway and allantoin accumulation. I predict that these lines will respond differently, including changes in transcript levels of antioxidant genes, allantoinase enzyme activity, allantoin content, and growth and development, these will help us the mechanism underlying allantoin-induced stress tolerance.

26. RAYLENE M. HARTL. The effects of temperature on the associative learning abilities of *Lymnaea stagnalis*, the Great Pond Snail. Department of Biology, University of Saskatchewan, SK.

Lymnaea stagnalis is a freshwater snail that is found across the northern hemisphere and is well studied in the field of learning and memory. *L. stagnalis* has the ability to learn associations between stimuli, such as a food odour and a predator odour; in which they respond to the food odour as they would a predator when re-exposed to the food. These associations can be affected by environmental factors such as physical stress and chemicals. Temperature has not yet been observed in associative learning capabilities. Water temperature has been shown to affect the growth, reproduction, metabolism, and long-term memory formation in freshwater snails and may affect learning. To observe learning, feeding behaviours were observed in carrot odour before and after an associative learning period at five temperatures. Associative learning was performed by placing snails in the carrot odour with predator odour. If learning occurred, feeding should decrease after this associative learning training. Thus far, learning capabilities are population specific and temperature dependent. Currently, data analysis and collection are not complete, yet the current data supports the hypothesis that temperature affects learning ability.

27. DELANIE MCEVOY & CHRIS AMBROSE. The Feedback Between Cell Shape and Microtubule Dynamics on Cell Division Over Time in *Arabidopsis*. Department of Biology, University of Saskatchewan Saskatoon, SK.

The interdigitated sidewalls of leaf epidermal pavement cells (PCs) in *Arabidopsis thaliana* are flat prior to lobing, a process where sidewall curvature intensifies over time, and curvature alterations are induced by new divisions. Interdigitated regions are frequent intercept sites for new walls, which form unlobed, but become curvaceous over time. Typically, divisions bisect the mother cell area asymmetrically, yielding inequivalent daughter cells and sidewall segments. These asymmetric divisions are essential for initiating stomatal lineage, where all but the terminal division are asymmetric. Future division sites are predicted by the pre-prophase band (PPB) microtubule (MT) array.

The goal of the current study is to determine if the lobes of PC sidewalls are an additional factor for determining future division sites. Lobe indentations (LIs) expand inward, towards the cell center, and create narrow regions within the cell. Divisions that orient towards LIs support the shortest distance rule, where

divisions must occur between sidewalls in proximity. Persistent MT bands are observed at LIs and have been observed to become PPBs. In addition, I have also observed new walls enhance the existing curvature of the mother wall. This data supports the hypothesis that there is a feedback loop between cell shape and cell division.

28. K. MICHELLE VANDERWEL[1], MAUD C.O. FERRARI[2] & DOUGLAS P. CHIVERS[1]. Effects of Water Temperature on Personality Traits in Crayfish: Implications for Invasiveness. [1] Department of Biology, University of Saskatchewan, Saskatoon, SK; [2] Department of Biomedical Sciences, WCVM, University of Saskatchewan, SK.

Consistent interindividual differences in animal behaviour (animal personality) have been shown to exist across many taxa. Personality traits, such as boldness and exploratory activity, are believed to be important behaviours associated with invasiveness in crayfish. Additionally, water temperature is known to impact movement of aquatic invertebrates. We measured behavioural traits across two temperature treatments in *Faxonius virilis*, a crayfish that has become invasive across many watersheds. Individuals were assessed on their emergence time from shelter (boldness) and in a separate assay on their time spent moving in a novel tank (exploration). The effect of temperature on boldness and exploration was dependent on treatment order in one group of individuals (collected in spring) but not in a second group (collected in late summer). Boldness and exploration scores were correlated within individuals, indicating a boldness-exploration behavioural syndrome. The difference in reaction norms between the groups in response to temperature may be explained by the reproductive status of the crayfish. Individuals in breeding condition may be less risk-adverse than those in a non-breeding state. Our work suggests that the reproductive status of the individuals, as well as water temperature, may impact their behaviour and therefore the ability of an introduced population to spread.

29. ILSA A. GRIEBEL & MITCH D. WEEGMAN. Time activity budget trade-offs of black ducks (*Anas rubripes*) in response to inter-individual variation in spring migration strategies. Department of Biology, University of Saskatchewan, Saskatoon, SK.

Migration is an energetically expensive period of the annual cycle for migratory species. Individual variation in migration strategies likely corresponds with variation in individual behaviours. Using a tracking study on black ducks (*Anas rubripes*) that includes birds wintering across a wide latitudinal range (Ontario to Virginia), we explored how migration characteristics, including total migration duration and distance, number of stopovers, mean stopover duration, total stopover duration and mean stopover radius, explain variation in time activity budgets before, during and after spring migration. I hypothesize that individuals that migrate longer distances will experience greater energetic demands than individuals that migrate shorter distances and therefore, will need to spend a greater proportion of their time feeding prior to, during and after migration to replenish nutrient reserves. Spending more time feeding will result in less time spent on other behaviours, such as preening and resting. Individuals that migrate longer distances may also compensate by taking longer to migrate and increasing the number and/or duration of stopovers. This initial analysis will be part of a larger-scale analysis examining how migration characteristics, behaviour and habitat use influence subsequent reproductive success of black ducks.

30. KEVIN J. KARDYNAL[1,2] & KEITH A. HOBSON[1,2]. Consequences of living near water: Habitat and diet effects on mercury exposure in boreal passerines. [1]Department of Biology, University of Saskatchewan, Saskatoon, SK; [2]Wildlife Research Division, Environment & Climate Change Canada, Prairie and Northern Wildlife Research Centre, Saskatoon, SK.

In the boreal forest, aquatic ecosystems including wetlands are key drivers of spatial heterogeneity, productivity, and diversity at local and landscape scales. Terrestrial shoreline habitats generally contain higher avian species richness than nearby upland habitats resulting from increased availability of water, greater habitat structure, nutrients and insect abundance. Biotic subsidies from aquatic ecosystems in the form of emergent aquatic insects also have potential benefits for macronutrient (e.g. omega-3 polyunsaturated fatty acids) consumption but may also increase exposure to contaminants including neurotoxic methylmercury (MeHg) representing a potential trade-off for consumers. I will present preliminary results showing how habitat use, diet and trophic level, inferred from feather stable isotopes (δ^2H, δ^{13}C, δ^{15}N), influence exposure to mercury measured as feather total mercury (THg) in a suite of boreal passerines sampled along a gradient from wetland (0 m) to upland (~3 km from water) in the Boreal Plains of Saskatchewan. Preliminary results indicate that riparian and wetland breeding passerines have overall higher feather THg concentrations than upland breeding conspecifics and a weak effect of distance from water on isotope and THg in upland breeding birds. I will discuss the results in the context of avian habitat selection and conservation of boreal forest birds.

31. WATHMINI DE SILVA[1], ANN MCKELLAR[1,2] & CHRISTY MORRISSEY[1]. Investigation of Sanderling utilization of Chaplin Lake, Saskatchewan as a stopover site during spring migration. [1]Department of Biology, University of Saskatchewan, Saskatoon, SK; [2]Environment and Climate Change Canada, Saskatoon, SK.

Chaplin Lake is a hyper-saline lake and a site of hemispheric importance for shorebirds as a staging area, where an active sodium sulphate mine manages water levels within sub-basins. The objective of this study is to determine the site use of Sanderling (*Calidris alba*) and to determine if water quality in each basin influences Sanderling use in Chaplin Lake. Measurements of water quality parameters and the abundance of Sanderlings were recorded twice weekly from May to mid-June in each basin. Sanderlings arrived at Chaplin Lake in early May in very small numbers and completely left the site by mid-June. The peak aggregation happened during the fourth week of May. In the six-week-long migrations staging period, 2264 Sanderlings were observed in total. Among the basins, the West Chaplin Lake (Division #2) (brining basin) and Midtskogen Bay (freshwater storage) were the most and the least used by Sanderlings respectively. The peak Sanderling abundance occurred at; salinity – 76.54±0.92 ppt, conductivity - 91946.67±1246.81 um, pH - 9.89±0.08, water density - 14.8 °Bé and 6.51% of Na2SO4 in water. These results provide insight that operations of the local mine play an important role in providing apparently ideal conditions for migrating Sanderlings as a stopover site.

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C. Todd – April 2023