The Speculum 2015-2016|

Edited by: Nidhi Kulkarni

"REAL DOCTORS TREAT MORE THAN ONE SPECIES"

IN THIS ISSUE

Natalie C., FVC Co-President

"'I want to be part of that'. That was the major thought that ran through my head when I was in high school looking at the Future Vet Club website. Fast forward 4 years later and here I am.

My name is Natalie Chow and I'm just finishing off my 3rd year of Animal Biology. I share the same passion for veterinary medicine as all of you and I hope to be able to use my knowledge and skills to help both humans and animals. A constant short term goal is to learn and experience as much as I can to help me choose my longer term goals. And that goal brought me to the Future Vet Club.

Being part of this club has been a highlight of my time at Guelph since it is such a unique environment of solidarity, learning, and opportunity. Everyone is so friendly, approachable, and eager to get involved.

Over the past year we have run a successful Symposium, Mock MMI, College Royal event, raised money for the Guelph Humane Society, and published now the first ever edition of the Speculum. And we couldn't have done it without your support.

On behalf of the Future Vets Club executive team, I want to say thank you for being with us on this wild ride."

-Natalie

Geneviève H., FVC Co-President

"My name is Geneviève Harris, and I was one the Co-Presidents of the Future Vets Club for the 2015-2016 year. I am currently in my third year of the Animal Biology program, in the graduating class of 2017.

Like most of you, I have wanted to become a veterinarian for as far back as I can remember. I have always had a passion for learning, science, and all things animals! I'm hoping to pursue a veterinary career working with small animals, more specifically in shelter medicine.

I grew up in Oakville, and I have always known that the University of Guelph was the perfect school for me. After being a general member of the FVC in my first year, I decided that I wanted to become more involved. I was fortunate enough to be chosen as secretary during my second year, where I met many new friends on the executive team. Towards the end of my second year, I decided that I wanted to become an even more active member, and ran for Co-President.

It has truly been a pleasure working as Co-President this year, and I am so fortunate to have had the opportunity to work with such an incredible executive team."

-Genny

The Biggest Threat to the Dairy Farmers

by Jessica Woods

A dairy farmer relies on a herd of cattle that are in pristine health condition to produce large quantities of milk. The most important anatomical feature of a dairy cow is, of course, the udder. Farmers must use every effort to avoid diseases and conditions which may compromise udder function, and in turn, their business.

One of the farmer's worst enemies is a condition called mastitis (4). Mastitis causes the milk produced by the cow to be in decreased quantity and of uneven consistency, off-taste, and can even contain bacteria from the infection, making the milk unsafe and unusable (4). Since mastitis greatly affects the milk production of cattle, and can easily be spread from cow to cow, it must be controlled if the farmer wishes to earn their next paycheck (1).

Mastitis occurs when the mammary gland becomes inflamed in response to bacteria invading the teat canal. This inflammation can be seen in the image to the top- right, courtesy of AHDB Dairy website (1, 4). The bacteria becomes exposed to the udder through incidents such as milking machine contact, unsanitary living conditions, and even transmission through nursing calves (4).

The major bacterial causes of mastitis are the environmental pathogens *Escheria coli* and *Streptococcus uberis*, as well as the transmittable pathogens *Staphylococcusaureus, Streptococcus dysgalactiae* and *Streptococcus agalactiae* (3). These bacteria are spread fast and easy, and the effects can be extremely detrimental to the herd, as well as the farmer (1).

Mastitis is divided into two categories; sub-clinical and clinical (1). Sub-clinical Mastitis has no visible effects on the milk produced, although the cow's overall body condition is worsened, especially in the udder, and milk production is much less than average (3). Clinical mastitis has more severe effects, including fever and lethargy, as well as poor milk condition and greatly reduced production (3). Since mastitis has such detrimental symptoms for cattle, it seems necessary to treat this disease to ensure health of the herd, as well as maximum milk yield for the farmer.

Infusion of antibiotics into the teat of the cow.
From: ANSCI.Illinois. "Mastitis Treatment & Control." Mastitis Treatment & Control. N.p., 2013. Web. 20 Oct. 2015. <http://ansci.illinois.edu/static/ansc438/Mastitis/control.html>

Inflamed, painful udders are characteristics of mastitis. This can cause many health complications for the cow.
From: Agriculture and Horticulture Development Board. "Mastitis in Dairy Cows." AHDB 2015. Web. 27 Oct. 2015. <http://dairy.ahdb.org.uk/technical-information/animal-health-welfare/mastitis/>

It is essential for milk producers to treat mastitis as fast as possible to avoid the disease from spreading and amplifying in severity. Treatment of mastitis for cows is usually done through antimicrobial drugs, such as being infused in the image on the left below (2). When the cattle are in the dry period of the milking cycle, longer acting antimicrobial drugs can be used to treat infection (2). During milking, however, faster acting drugs are used (2).

As with any sort of agricultural production that is consumed by humans, there is always controversy in the treatment of the disease and its effect on human consumption. Some speculate that traces of antibiotics in milk from dairy cows can be ingested by humans and cause people to develop antibiotic resistance, but the research is very lacking (7).

If the consumer demand for antibiotic-free milk arises, farmers do have a few options to conform. A few of these options, outlined in an article by McGill University, include; clay therapy, which is said to absorb the infection, as well as phytotherapy for treating with herbs, and the use of aloe cream to soothe the inflammation (5) While the results between antibiotic treatment and other methods vary, antibiotics seem to prevail (2).

In conclusion, the understanding of mastitis and how it is treated is essential to dairy farmers, and as such is a valuable tool for veterinarians. The treatment of mastitis is greatly debated, and it is essential to know which treatment will be of more value to the farmer so that they may increase their milk production, as well as their net profits.

The prevention and treatment of mastitis will continue to be under research as we find faster and more effective ways to protect the farmer's livelihood.

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Conservation's Biggest Weapon: GENETICS

by Werdah Iqbal

Admittedly, as students, the questions "so what?" or "how will this help me" remain in the back of our minds as we search for meaning in our grueling coursework. Initially, concepts and theories seem like facts to be memorized and forgotten once the course comes to an end. However, there is a point when that course transitions into what we always hoped it would—relevant to real life.me, this epiphany happened during my very first conservation genetics class, when I realized how many real-life implications there were to this field of research. Although this field seems to fly under the radar in the news about conservation programs, it is absolutely vital in the progress being made.

What is conservation genetics?

CONSERVATION GENETICS: HOW IS IT DONE?

DNA MARKERS ARE USED TO IDENTIFY AND PROTECT SPECIES. METHODS INCLUDE:

- MITOCHONDRIAL DNA MARKERS, WHICH INCLUDES RIBOSOMAL DNA, NON-CODING SEQUENCES AND MITOCHONDRIAL PROTEIN ENCODING GENES

- NUCLEAR DNA MARKERS, WHICH INVOLVE RANDOM AMPLIFIED POLYMORPHIC DNA, AMPLIFIED FRAGMENT LENGTH POLYMORPHISM (AFLP) AND MICROSATELLITES.

With as many as 8.7 million known species living in the natural world and nearly 16,306 endangered species at risk of extinction, conservation genetics is an emerging field used to maintain the biodiversity that exists on our planet. It involves using genetic approaches to aid in the conservation of species and ecosystems. One of the take-home messages to know about conservation genetics is that its goal is to protect a process of life (2).

Since extinction and endangerment is rarely due to one cause alone, loss of genetic variation acts synergistically with other threats to biodiversity. Populations, including our own, are dependent on genetic variation to evolve, adapt to and thrive in the changing and sometimes harsh conditions on Earth: it is the foundation of our, and every other species' existence. Accordingly, the main goal of conservation genetics is to be able to maintain and improve the genetic diversity of individuals, populations and species, which allows them to evolve, adapt, and form new species.

Case study: Conservation genetics of the Rhinoceros

A simple Google search about rhinoceros will tell you that a 1-3 kg rhinoceros horn can be sold for as much as $300,000 dollars. Not surprisingly, the price of a horn has increased over the years as rhino populations have consistently declined. Although media outlets have been able to provide updates on laws being enforced and petitions against poaching, few have mentioned the progress being made in regards to population growth. That's right; rhino populations are not completely doomed as conservation genetics is allowing for researchers to put their best foot forwards in getting population levels up.

"There has to be a better way to deal with this rhino's feet. Blood dropped from Mohan's foot pads as veterinarian and technicians worked furiously to carve away diseased tissues. These were not small feet-each one measured about ten inches in diameter" (The Rhino with Glue-On Shoes).

The rhinoceros mentioned in this story by Dr. Lucy Spelman, is an example of how vulnerable rhinoceros are to disease, epidemics and inbreeding. Having genetic differences in individuals and populations substantially decrease the chances of these detrimental effects. In research, microsatellite loci are used to assess genetic variation in individuals and populations. De Groot, Peter J. Van Coeverden, *et al.* (4) used nine microsatellite loci to measure the genetic variation of 144 individuals within *D. bicornis bicornis*, one of the four subspecies of black rhinoceros (*Diceros bicornis*). These sub-species have been through a significant population increase over the past few decades, thus looking at their genetic diversity can aid in the monitoring of their population. When comparing between the four sub-species of black rhinoceros, nuclear and mitochondrial analyses have been used to genetically differentiate between the sub-species.

Furthermore, the microsatellite loci were able to tell that *D.b.bicornis* had lower levels of genetic diversity as compared to *D.b.michaeli* but higher levels of genetic diversity than the *D.b.minor.* Since these rhinoceros are maintained in natural parks, deciding to treat the sub-species as a metapopulation or individual populations are management decisions with great weight in their affect. A recent study completed in northern India (3) also used microsatellite loci to show that wild one-horned rhinoceros (*Rhinoceros unicornis*) have moderate to high levels of genetic diversity. When trying to understand what has contributed to their higher genetic diversity, they hypothesized that rhinoceros were migrating between connected river islands, which may have contributed to their gene pool.

The next steps

In 2013, poachers killed one thousand and four rhinoceros, which is the highest recorded amount of poached rhinoceros (South African Department of Environmental Affairs). Although there are times when it seems the fight against poachers is going unnoticed, there are some rhinoceros populations that are steadily increasing in numbers. With the use of conservation genetics, effective population management are being put into place. From determining to treating sub-species as metapopulations or measuring genetic variation between populations, conservation genetics allows conservation to take a giant leap forwards.

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Palliative Treatment: Compassion for Our Pets in the Wake of Terminal Illness

by Stephanie Posa

Stephanie's dog, who underwent palliative treatment for his cancer (image courtesy of Stephanie Posa)

Having to accept that your dog is a candidate for palliative as opposed to curative treatment isn't exactly ideal. If someone had asked me one week prior to his cancer diagnosis, I would have said my dog was as healthy as ever and would be devastated by the thought of losing him 5 years down the road. However, given his terminal prognosis, I unexpectedly found comfort in the prospect that he could live anywhere between 3 to 12 months with palliative treatment.

About a year ago, my dog was diagnosed with hemangiosarcoma, a malignant cancer that arises in the vascular endothelial cells that line blood vessels (3). It is an aggressive disease, characterized by rapid tumor formation and high metastatic potential.

Without treatment, my dog's life expectancy was predicted to range from a few weeks to at most, a couple months. Our veterinarian also affirmed that surgical removal of his tumor was risky due to its large size and subcutaneous location within his abdominal cavity.

Feeling disheartened that our dog had little options in terms of treatment, our veterinarian suggested palliative radiation therapy at the Animal Cancer Centre here in Guelph.

Palliative radiation aims to eliminate the symptoms associated with an inoperable tumor, such as pain, inflammation, and impaired mobility (4). While palliative treatment cannot cure a terminal disease, it can slow its progression, and may often improve a patient's quality of life. In a study involving dogs with osteosarcoma, palliative radiation reduced pain associated with the cancer within 2-4 months, and also enhanced limb function after 11-15 days (2).

My dog's treatment consisted of 5 rounds of radiation over the course of 5 consecutive days. Prior to treatment, his abdominal tumor was measured at 8 cm x 6.5 cm. After two rounds of radiation, the tumor was reduced to 6 cm x 5 cm. Following the fifth and final round, the tumor had been significantly minimized. To further inhibit the rapid growth of the tumor, chemotherapy was recommended as the final phase of my dog's treatment.

Our veterinarian suggested that my dog undergo four rounds of conventional chemotherapy, followed by metronomic chemotherapy (MC). MC involves the oral administration of mildly dosed chemotherapy drugs on a continual, unremitting basis (1).

The continuous nature of metronomic therapy prevents the development of new blood vessels that facilitate tumor growth (1). This process, known as angiogenesis, often occurs during the gaps between doses that are crucial to the conventional chemotherapy regimen (1). Conventional chemotherapy may also increase the risk of toxicity in patients, as the drugs administered are close to maximum tolerated dose levels, unlike those of the metronomic alternative (Biller, 2014).

My dog underwent one round of conventional chemotherapy every three weeks, for a total of four rounds. After each of these rounds, my dog experienced severe fatigue, appetite loss, and vomiting. We were told that these negative side effects were temporary and often isolated to the immediate moments following treatment. This was true, and my dog was quick to bounce back to his normal self after a day or so.

By the fourth round of chemotherapy, my dog's tumor was poorly defined and measured to be about 2 cm x 3 cm. To stabilize his tumor at this reduced size, we began the oral administration of the metronomic chemotherapy drugs on a daily basis.

The lack of side effects associated with this regimen made it easy to forget my dog was sick at all. His resilient nature returned as he would urge us to walk him around that additional block before returning home, to throw his soccer ball around a few more times before going inside, and to give him another treat even though he had plenty for the day. My dog was able to enjoy this uncompromising, normal quality of life for 9 months.

Although palliative radiation concurrent with conventional and metronomic chemotherapy did not grant my dog a cure, these treatments gave my dog time to live the remainder of his life without having to endure the worsening symptoms associated with his aggressive cancer.

Opting for palliative treatment is a hard choice to make, one that many people may question as it does not guarantee or even suggest that a cure will be reached. However, seeing that my dog's quality of life was improved, we found comfort in the overall sense of stability, although temporary, that palliative treatment provided him.

My dog's battle with hemangiosarcoma allowed me to realize that even in the face of a terminal diagnosis, palliative therapy can allow those you love to live a life undisturbed by the pain, or burdens associated with severe sickness. Even if the treatment itself is temporarily effective, the gratitude for the comfort that palliative therapy can provide a loved one is enduring.

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Small Birds, Big Hearts: How Jack Frost Makes Birds Grow

by Paula Baya

Like many of us, birds tend to pack on some pounds during the winter season. However, unlike us, it is not all fat; some of it is muscle. Birds have the ability to adjust their bodies to enhance survival in their changing environment. This is known as reversible phenotypic flexibility and it is true for birds wintering in cold climates and those migrating to warmer destinations.

In wintering birds, muscle growth helps them handle the cold a lot better (cold tolerance) whereas in migratory birds it increases their ability to fly longer and use oxygen more effectively. The type of metabolism changes seen in birds during the winter is known as summit metabolism (M_{sum}) which is a change in metabolic rate in response to the cold. David Swanson and his associates, the authors of this study, tried to determine whether temperature or light was the reason for the increase in mass and metabolism.

Although numerous studies have been conducted on the relationship between organ mass variation and metabolism, the effect temperature and light exposure (photoperiod) have on metabolism is not fully understood. Swanson and his team believed exposing dark-eyed juncos to cold temperatures would have a greater effect on muscle growth and M_{sum} than light exposure. Furthermore, they believed that exposing juncos to long days (LD) with longer light periods would indirectly induce winter phenotypes as opposed to short days (SD) with shorter light periods.

The authors separated the birds into four treatment groups for 6 weeks:

1.Warm SD (24°C; 8h light: 16h dark)

2.Warm LD (24°C; 16h light: 8h dark)

3.Cold SD (3°C; 8h light: 16h dark)

4.Cold LD (3°C; 16h light: 8h dark)

Swanson and his associates used an ultrasound to find the average flight muscle width after the 3rd and 6thweek of the experiment. They found that the increase in flight muscle width correlated with the increase in flight muscle mass. Furthermore, the LD treatment groups had the greatest increase in body mass.

To measure changes in M_{sum} in cold temperatures, they placed the juncos in an oxygen tank which was then placed in an ice bath. Next, they calculated how much oxygen the birds consumed in their 20 minute ice bath. They determined that birds that were accustomed to the cold temperatures had significantly higher M_{sum} than the warm temperature groups. So the higher your M_{sum}, the higher your tolerance to the cold.

Swanson and his team then euthanized the juncos to analyze changes in enzyme activity in the muscles. They used a spectrometer to analyze citrate synthase (CS) and carnitine palmitoyl transferase (CPT), which are enzymes help control shivering rate. Shivering helps the bird make enough heat to stay warm. Swanson and his team found that the pectoralis, one of the flight muscles, had significantly higher CS and CPT activity on cold long days than warm short days.

Unlike previous studies, the authors of this study found that increase in overall body mass was influenced by the photoperiod rather than the temperature. They believed that this was likely due to the light stimulating migratory birds to prepare for their flight back.

However, in both Cold LD and Cold SD groups, they found the heart had increased significantly in size after 6 weeks. The research team believed that the increased CS activity, CPT activity and heart size was in response to cold exposure because the cold would cause the birds to increase their M_{sum} which in turn would help the birds increase their shivering rate. Ultimately, Swanson and his associates showed that sunlight does not mean a lighter body and that Jack Frost's love makes the heart grow.

A dark- eyed junco. Photographed by Christopher L. Wood.
Image courtesy of Wood, L. Christopher. "1st-winter male Cassiar Junco, Tompkins Co., NY." Photograph. Webshots. Flickr, 21 Jan. 2012. Web. 6 Apr. 2016. <https://www.flickr.com/photos/pinicola/6737559091/>

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Chimp-Lit: Southern Belles of the DRC

by Shruti Madhusudan

Behold a cluster of bonobo females grooming and resting under the canopy of the Congolese forests! Across the Atlantic Ocean, observe another group of female primates readying themselves for rest under the luxurious silk canopies of a Georgian plantation house.

Within this house, there is one individual that shares more in common with bonobos than her peers and this similarity does not end with a propensity for fleshy fruit. This female human is Scarlett O'Hara, a native of the red soils Tara, residing in the southern U.S.A during the tumultuous Civil War.

Even though bonobos lack a propensity for war and intergroup, aggressive conflict, the females of Wamba, DRC are all regular Scarletts in that they are philopatric, territorial, and strong-willed about the nature and extent of their food consumption, and house many genial relationships with other females and males within their groups.

Scarlett thrives in the social, gregarious and calm environment of pre-war Georgia where she reigned as alpha female of the community. Most individuals of the community (especially southern gentlemen in quest for a mate) looked to please Scarlett to maintain rank within society, in hopes of birthing offspring with greater social and physical fitness (as Scarletts are immensely good-looking).

Scarlett forms strong relationships with both males and females within her society. Rhett Butler, Charles Hamilton and Ashley Wilkes are only a few men awarded her affection with two of those men going onwards to have her children. Clearly, her flirtatious behavior with many men can be mirrored to promiscuity in bonobo females.

Scarlett is noted to spend more time with males than females in her youth as she hunted and played with her peers (similar to greater levels of male-female congeniality in bonobos) in comparison to their close chimpanzee cousins. Eventually, she matured to form strong female coalitions with her mother, Mammy, Prissy, Melanie Hamilton and Aunt Pittypat to name a few. It is primarily with the help of these woman that Scarlett is given the strength to rebuild Tara post the aftermaths of war.

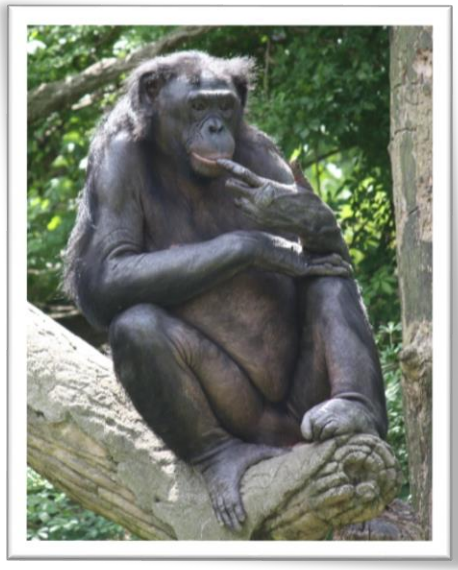
Similarly, Bonobo communities are largely matrilineal with power falling to females over males. Peace and structure in the communities are maintained via formation of strong female coalitions with emphasis placed on female reproductive choice. As bonobo females are thought to select for less aggressive males as mates (1) to maintain structure, Scarlett marries the war-evading, draft-dodging Rhett Butler and continues to have four children with him in their short but peaceful marriage.

Scarlett's constant need to return to her childhood home of Tara is a reflection of philopatry in female bonobos. Unlike with chimpanzees, territorial inheritance follows a matrilineal line in bonobo communities. Thus, males emigrate while females settle in natal grounds. Scarlett bolsters female philopatry in a patrilineal society by taking over the estate business of Tara from her parents after the Civil War ends.

Intergroup encounters between bonobo communities are more often genial than aggressive and if aggressive, involve close to no (reported) physical contact. These sessions often involve play (copulation for the adults and literal play for juveniles).

The great balls thrown in the south – be they for charity or pure entertainment – involve dancing as play and potential trysts between the bolder, less propitious individuals present. Scarlett, as an alpha female, refrains from dancing while manning a charity booth at a ball similar to minimal play activity shown by alpha females in intergroup encounters. However, alpha females occasionally let loose and show their skill and prowess upon the dance floor in appropriate social climates.

Scarlett O'Hara and female bonobos, thus, house many similarities with regards to their behavioral nature- even though one prefers peaches and the other, bananas.



A bonobo.
Image courtesy of Ltshears. "Bonobo *Pan paniscus* at Cincinnati Zoo." Photograph. *Webshots.* Wikimedia Commons, 9 Jan. 2005. Web. 7 Apr. 2016. <https://commons.wikimedia.org/wiki/File:Bonobo_0155.jpg>

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Editor's Note:

"Hello, everyone. I sincerely hope that all you readers enjoyed the various subjects touched on in the 2015-2016 edition of The Speculum. To the ruminant lovers out there, I am sure you could grasp the toll that mastitis could have, not simply on the well-being of the dairy cows in questions, but the farmers as well, in The Biggest Threat to the Dairy Farmers (pg. 2).

To the wildlife and exotic fans, the conservation of rhinos may have been a topic discussed numerous times before, but I doubt that the field of conservation genetics was ever explored quite to the extent as in the article, Conservation's Biggest Weapon: GENETICS (pg. 3), especially regarding the potentially positive outcomes of such a technique.

On the other hand, I believe all could empathize with Stephanie Posa in Palliative Treatment: Compassion for Our Pets in the Wake of Terminal Illness (pg. 4), where she describes her struggle when learning about her dog's terminal illness and exploring alternative forms of treatment to make his last few months with her as comfortable and meaningful as possible.

With the seemingly endless winter that we seem to be having this year, I certainly wish I could adapt like one of the migratory birds mentioned in Small Birds, Big Hearts: How Jack Frost Makes Birds Grow (pg. 5). I suppose I will simply have to settle for my winter coat for now.

Of course, we couldn't forget about the bonobo gals from the Democratic Republic of the Congo and their various antiques, as shown in Chimp-Lit: Southern Belles of the DRC (pg. 6). After all, there is a little bit of Scarlett in us all.

I would like to give a personal thanks to all those who submitted an article for this year's edition. Being a university student in no easy feat, what with balancing out different lectures, assignments, extracurriculars, and of course, that all-important social life! Yet, even with all this on your plates, you all managed to write some absolutely amazing articles, the topics of which clearly stemmed from a passionate place.

Again, thank you all so much for taking the time to read some interesting articles from your peers and best of luck for your up-coming exams!"

-Nidhi K., Editor for The Speculum

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