

## Shannon Becker, PhD AMPract RA

[shannon@petrichorapothecary.com](mailto:shannon@petrichorapothecary.com)

### Education

- |           |   |
|-----------|---|
| 2019      | Ashi Aromatherapy<br>Under the direction of Kelly Holland Azzaro<br><i>Animal Aromatherapy certification course (in progress)</i>   |
| 2018      | Registered Aromatherapist™<br><i>Aromatherapy Registration Council™</i>   |
| 2018      | Tisserand Institute, Czech Republic<br>Under the direction of Robert and Hana Tisserand<br><i>Essential Oil Safety Masterclass certificate</i>                              |
| 2018      | Knowledge Institute for Complementary Nursing, Netherlands<br>Under the direction of Madeleine Kerkhof<br><i>Fusion AromaTherapy and Pain</i>                               |
| 2018      | The School for Aromatic Studies<br>Under the direction of Jade Shutes<br><i>French Aromatherapy certification course</i>  |
| 2016-2017 | Institute of Traditional Herbal Medicine and Aromatherapy, London<br>Under the direction of Mark Webb<br><i>International Advanced Diploma in Aromatic Medicine</i>         |
| 2014      | Aromahead Institute, School of Essential Oil Studies<br>Under the direction of Andrea Butje<br><i>Aromatherapist certificate</i>  |
| 2008-2016 | North Carolina State University<br>Under the direction of Matthew Breen<br><i>Doctor of Philosophy (PhD) in Comparative Biomedical Sciences, Cell Biology Concentration</i> |
| 2006-2007 | North Carolina State University<br><i>Post baccalaureate student</i>  |

1997-2001 University of North Carolina at Chapel Hill  
*Bachelor of Science (BS) in Biology*

## Academic/Research Experience

2019 *Aromatherapeutics are a viable option for Ehlers-Danlos Syndrome symptom management*

According to the National Institutes of Health, “pain affects more Americans than diabetes, heart disease and cancer combined”. Uncontrolled pain is debilitating, and can lead to secondary conditions such as anxiety, depression, and sleep disruption. Ehlers-Danlos Syndrome (EDS) causes joint dislocations, can affect internal organs, and leads to significant pain. The current (inadequate) methods for relieving EDS-related pain are limited to opioid medications and management of dislocations. Many EDS sufferers are unable to function in normal life, leading to full medical disability status. EDS sufferers are likely to experience anxiety and depression, and management of these secondary conditions is important for quality of life. Aromatherapy may be an effective and safe method of controlling the pain and inflammation experienced by EDS sufferers. Studies showing the ability of essential oil and aromatic extracts to interact with pain-related cell receptors and nociceptors suggest that essential oils can directly reduce pain. In addition, inhalation of specific essential oils has been shown to relieve stress and anxiety. Identifying an aromatherapy protocol for EDS-related pain and anxiety will increase quality of life.

2008-2016 North Carolina State University  
M. Breen Lab

*PhD candidate/Graduate Research Assistant*

*Karyotypic changes in the Canidae inform characteristics of speciation, and suggest a common mechanism for restructuring chromosomes.*

Understanding karyotypic change helps explain why certain regions of the genome are involved in both disease and speciation. Already, it has been shown that chromosomal breakpoints in genomes are not random, and instead, occur consistently at fragile breakpoint regions. It has been shown that cancer breakpoints and evolutionary breakpoint regions overlap, suggesting there is a common mechanism for karyotypic change that can result in new species, and also genetic disease. Karyotypes of modern canid species range in chromosome from  $2n=34 + Bs$  (red fox) to  $2n=78$  (domestic dog and most wolf-like canids). This wide range in structures represents rapid and dynamic genome restructuring in a short evolutionary period. This rapid karyotypic change includes breakage-fusion events, centromerization, and changes in genetic sequence. The age of divergence between modern canids is short, and the modern chromosome structures contain recognizable karyotypic differences

between closely related species. Homologous chromosome regions were identified by hybridizing panels of dog genome sequence onto chromosomes of 11 additional canid species. Breakpoint regions were identified and narrowed, and these evolutionary breakpoint regions overlapped with canine cancer breakpoints. This suggests a common mechanism for genome rearrangements. Reorientations of homologous regions were identified, which clarified the phylogenetic placements of several canids. Some canid species exhibit a range in diploid number across individuals in the species due to variable numbers of B chromosomes. These chromosomes have historically been considered highly repetitive, inert chromosomes. However, this work identified multiple gene sequences on B chromosomes, suggesting they may be active participants in karyotypic change.

2004-2007    North Carolina State University  
                 M. Breen Lab  
                 *Research Assistant*

*Characterization of genomic abnormalities in canine hemangiosarcoma patients.*

Hemangiosarcoma is a malignancy of endothelial cells and can arise in a variety of organs, most often the spleen and heart, metastasizing most often to the liver and lungs. Copy number aberrations in spontaneously occurring hemangiosarcoma tumors were characterized using a custom 1Mb Bacterial Artificial Chromosome (BAC) array. Subsequently, fluorescently labeled single locus probes were hybridized onto slides prepared from the same tumor. This resulted in a better understanding of this type of cancer, and since in humans it is rare, hemangiosarcoma is more easily studied in a canine population.

*Molecular cytogenetics of the domestic dog.*

As part of this project I worked on developing a genome-wide 1Mb microarray using BAC clones selected from the *C. familiaris* genome. In addition we have over 2,000 BACs available to study single loci found to be aberrant in the array data gathered from cancer patients. This represents a powerful cytogenetic resource to study chromosomal abnormalities in *C. familiaris* cancer patients. A subset of the 1Mb microarray was also developed using clones spaced every 10Mb throughout the canine genome. Already we have explored interesting abnormalities in canine meningioma, glioma, lymphoma, leukemia, and soft tissue sarcoma cases using this resource. This project generated a resource still used in the laboratory in more than five additional projects. Three papers resulted directly from this work, including a paper in *Leukemia Research*, another in *Cytogenetic and Genome Research*, and a collaborative paper in *Journal of Neurooncology*.

*Molecular cytogenetics of Monodelphis domestica.*

The *M. domestica* genome was sequenced by the Broad Institute at MIT. Using a selection of BACs, I performed multicolor fluorescence *in situ* hybridization (FISH) to anchor large scaffolds of the genome sequence assembly to their cytogenetic locations. This was necessary especially for this genome because the high degree of evolutionary divergence from human did not permit comparison of the marsupial sequence segments to the human genome

sequence (a procedure traditionally used to aide assembly construction). While conducting this project, the lab also collaborated with a group at Harvard in a project exploring X-inactivation in *M. domestica*. These two projects resulted in three papers, including a 1st author paper and a collaborative paper in *Chromosome Research* and the Monodelphis genome paper in *Nature*.

2002-2004 Duke University  
A. Bejsovec Lab  
Associate in Research

*Movement of Wingless ligand in living Drosophila embryos.*

*D. melanogaster* stocks were created expressing multiple copies of a UAS transgene driven by various GAL4 drivers, producing an eYFP-tagged Wingless (Wg) protein used to explore the movement of Wg over time in stage 8-11 *D. melanogaster* embryos. Live and fixed, antibody stained embryos were imaged using a Zeiss 510 confocal microscope. My fluorescence recovery after photobleaching (FRAP) and fluorescence loss in photobleaching (FLIP) experiments suggest Wg protein is handled by different types of vesicles to move Wg through cells (rather than around cells) in the developing embryos, consistent with the *planar transcytosis* model.

*EMS Mutagenesis screens yield modifiers of wg phenotypes.*

Modifiers of the *wg* phenotypes were developed using EMS mutagenesis screens of *wg*<sup>NE2</sup> fly stocks. These modifiers were then explored using traditional meiotic recombination mapping techniques.

2002 NC State Department of Public Health  
Mycobacteria Lab  
Laboratory Technician II  
Tested submitted samples for the presence of *Mycobacteria* and reported findings to sample providers.

2000-2001 University of North Carolina at Chapel Hill  
D.S. Threadgill Lab  
Lab Assistant  
Assisted in general lab upkeep and performed routine molecular biology techniques.

## Experience and Service

2019-present Alliance of International Aromatherapists  
Research committee, North Carolina state representative, general member (since 2014)

2019 Institute of Holistic Phyto-Aromatherapy  
Advisory Board, Faculty member

2018-present International Journal of Professional Holistic Aromatherapy

## *Reviewer*

2017-present	Tisserand Institute <i>Contributor</i>
2014-present	Petrichor Apothecary, LLC <i>Owner, registered aromatherapist, aromatherapy educator</i>
2012-2015	Babywearing International, Inc. <i>Certified babywearing educator, President of Babywearing International of the Triangle</i>
2012	North Carolina Museum of Natural Sciences <i>Volunteer</i> Liaised with public to teach microbiology and genetics topics, techniques, and ideas.
2005-2016	North Carolina State University Responsible for teaching graduate, undergraduate, and veterinary students, and new staff the appropriate techniques used in the Breen lab
2001-2002	Charlotte Mecklenburg School System High School Teacher for Biology, Earth Science, Advanced Placement (AP) Environmental Science

## **Publications**

**Becker S** (2018). Essential oils to prevent the flu. Tisserand Institute.  
<https://tisserandinstitute.org/essential-oils-flu/>

**Becker S** (2018). Aromatic formulating with evidence based methods. AromaCulture Magazine. October 2018.

**Becker S** (2017). Buzz buzz buzz...keep away the mosquitoes this spring and summer! AromaCulture Magazine. May 2017.

**Becker S** (2017). Do we really need to be worried about “cleaning” our receptors? Tisserand Institute. <http://tisserandinstitute.org/cleaning-receptors-myth/>

**Becker S** (2017). Can essential oils repair DNA? (the short answer is “no”). Tisserand Institute. <http://tisserandinstitute.org/can-essential-oils-repair-dna-the-short-answer-is-no/>

**Becker SED** (2016). Karyotypic changes in the Canidae inform characteristics of speciation, and suggest a common mechanism for restructuring chromosomes. North Carolina State University Dissertation Repository. <https://repository.lib.ncsu.edu/handle/1840.20/33396>

**Duke Becker SE** (2014). The use of citrus essential oils and lavender in treating anxiety, depression, and stress: a scientific perspective. Aromahead Institute.

**Duke Becker SE**, Thomas R, Trifonov VA, Wayne RK, Graphodatsky AS, Breen M (2011). Anchoring the dog to its relatives reveals new evolutionary breakpoints across 11 species of the Canidae and provides new clues to the role of B chromosomes. *Chromosome Research*. 19: 685-708

Thomas R, **Duke SE**, Wang HJ, Breen TE, Higgins RJ, Linder KE, Ellis P, Langford CF, Dickinson PJ, Olby NJ and Breen M (2009). 'Putting our heads together': insights into genomic conservation between human and canine intracranial tumors. *J Neurooncol* 2009; 94(3):333-349.

Thomas R, **Duke SE**, Karlsson K, Evans A, Ellis P, Lindblad-Toh K, Langford CF and Breen M (2008). Development of a 1Mb resolution, cytogenetically-validated genomic microarray for canine CGH analysis. *Cytogenetics and Genome Research* 2008; 122(2):110-121.

Thomas R, **Duke SE**, Bloom SK, Breen T, Young A, Feiste E, Seiser E, Tsai P-C, Langford CF, Ellis P, Karlsson EK, Lindblad-Toh K and Breen M (2007). A cytogenetically characterized, genome anchored 10Mb BAC set and CGH array for the domestic dog. *Journal of Heredity*. August 16; 98 (5): 474-484

Kisseberth WC, Nadella MV, Breen M, Thomas R, **Duke SE**, Murahari S, Kosarek CE, Vernau W, Avery AC, Burkhard MJ and Rosol TJ (2007). A Novel Canine Lymphoma Cell Line: a Translational and Comparative Model for Lymphoma Research. *Leukemia Research*. Dec; 31(12): 1709-20

Mikkelsen TS, Aken B, Amemiya CT, Chang JL, **Duke SE**, Garber M, Gentles AJ, Goodstadt L, Heger A, Jurka J, Kamal M, Mauceli E, Searle SMJ, Sharpe T, Baker ML, Batzer MA, Benos PV, Belov K, Clamp M, Cook A, Cuff J, Das R, Deakin JE, Grabherr M, Greally JM, Gu W, Jirtle RL, Mahony S, Marra MA, Miller RD, Nicholls RD, Papenfuss AT, Parra ZE, Pollock DD, Ray DA, Schein JE, Speed TP, VandeBerg JL, Wakefield MJ, Wade CM, Walker JA, Webber C, Weidman JR, Xie X, Zody MC, Broad Institute Genome Sequencing Platform, Broad Institute Whole Genome Assembly Team, Marshall Graves JA, Ponting CP, Breen M, Samollow PB, Lander ES, Lindblad-Toh K (2007) Genome of the marsupial *Monodelphis domestica* reveals lineage-specific innovation in coding and non-coding sequences. *Nature*. May 10; 447(7141): 167-77.

**Duke SE**, Samollow P, Mauceli E, Lindblad-Toh K, Breen M (2007). Integrated cytogenetic BAC map of the genome of the gray short-tailed opossum, *Monodelphis domestica*. *Chromosome Res.* *Chromosome Res.* 15(3): 361-70.

Davidow LS, Breen M, **Duke SE**, Samollow PB, McCarrey JR, Lee JT. (2007). The search for a marsupial XIC reveals a break with vertebrate synteny. *Chromosome Res.* 15(2): 137-46.

## Presentations and speaking events

**Shannon E. Becker.** Moving towards evidence-based aromatherapy: A primer on peer reviewed research. Alliance of International Aromatherapists March Webinar, March 27, 2019, Online.

**Shannon E. Becker.** Aromatherapy Science and Dealing with Pain, Inflammation and Anxiety. AromaCulture Podcast, September 27 2018, Online.

**Shannon E. Becker.** All About Breastfeeding Podcast: Episodes 61, 63. 2016, Online.

**Shannon E. Duke Becker,** Robert K. Wayne, Alexander S. Graphodatsky, and Matthew Breen. Exploration of wild canid genomes using chromosome-specific probes show they share evolutionary breakpoints. North Carolina State University Graduate Student Research Symposium, March 21 2011, Raleigh, NC.

**Shannon E. Duke Becker,** Robert K. Wayne, Alexander S. Graphodatsky, and Matthew Breen. Application of chromosome-specific probes onto wild canid genomes reveals shared evolutionary breakpoints. College of Veterinary Medicine 2011 Annual Research Forum, March 11 2011, Raleigh, NC.

**Shannon E. Duke,** Violetta Beklimisheva, Robert K. Wayne, Alexander S. Graphodatsky, and Matthew Breen. A Member of the Pack: Insights into Chromosome Evolution in the Canidae May Reveal Common Breakpoints in Speciation and Cancer. College of Veterinary Medicine 2009 Annual Research Forum, March 13 2009, Raleigh, NC.

**Shannon E. Duke,** Alexander S. Graphodatsky, Robert K. Wayne, and Matthew Breen. A Member of the Pack: Insights into Chromosome Evolution in the Canidae May Reveal Common Breakpoints in Speciation and Cancer. Genes, Dogs, and Cancer: Fifth Annual Symposium, Feb 13-15 2009, Orlando, FL. Published in Proceedings of the Genes, Dogs & Cancer: 5th International Canine Cancer Conference, Feb. 13-15, 2009 - Orlando, Florida, USA. International Veterinary Information Service, Ithaca NY (<http://www.ivis.org/proceedings/keystone/2009/duke.pdf?la=1>)

Rachael Thomas, **Shannon Duke,** Pei-Chien Tsai, Cordelia F. Langford, Susan P. Fosmire, Cristan M. Jubala, Jaime F. Modiano and Matthew Breen. Application of a 2 Mb-resolution canine CGH microarray to the study of lymphoma. Genes, Dogs and Cancer: Fourth Annual Symposium, Sept 14-17 2006, Chicago. Published in: Genes, Dogs and Cancer: Fourth Annual Canine Cancer Conference, 2006 - Chicago, IL, USA, Modiano J.F. (Ed.). International Veterinary Information Service, Ithaca NY ([www.ivis.org](http://www.ivis.org)), P4008.0906

Andrea C. Young, Rachael Thomas, **Shannon E. Duke,** Tessa E. Breen, Pei-Chien Tsai, Eric

L. Seiser, Matthew Breen. Heritable and Breed Specific Genetic Abnormalities in Canine Osteosarcoma. 5<sup>th</sup> Annual Functional Genomics Graduate Student Symposium. April 4 2008,

Raleigh, NC.

Eric L. Seiser, Rachael Thomas, **Shannon E. Duke**, Tessa E. Breen, Pei-Chien Tsai, Steven E. Suter, Matthew Breen. Characterization of Genomic Copy Number Aberrations in Canine Lymphoid Malignancies Using Array-based Comparative Genomic Hybridization. 5<sup>th</sup> Annual Functional Genomics Graduate Student Symposium. April 4 2008, Raleigh, NC.