

Paul L. Babb

10-130 Smilow Translational Research Center
3400 Civic Center Boulevard, Bldg. 421
Philadelphia, PA 19104 USA

Postdoctoral Researcher

Departments of Genetics and Systems Pharmacology

Perelman School of Medicine at the University of Pennsylvania

☎ 1 703 772 4988

✉ pbabb926@gmail.com

🌐 <http://paulbabb.wordpress.com>

EMPLOYMENT HISTORY

2012-present **Postdoctoral Researcher**
Departments of Genetics and Systems Pharmacology
Perelman School of Medicine at the University of Pennsylvania, Philadelphia, PA
Advised by Dr. Benjamin F. Voight

EDUCATION

2012 **Ph.D.**
Biological Anthropology (primate genetics), University of Pennsylvania
Advised by Drs. Theodore Schurr and Eduardo Fernandez-Duque

2003 **B.A.**
Biological Anthropology, University of Pennsylvania, Philadelphia, PA

RESEARCH INTERESTS

I am interested in the evolution of biological novelties and understanding the functional genomic mechanisms underlying EXTRAORDINARY traits. Motivated by this, my research is focused on developing and applying cutting-edge technological and computational tools to decipher genomes and highlight the precise biological mechanisms that give shape to the vast diversity of life.

As such, my work has extended across many subjects and disciplines. Likewise, it has taken me from the field, to the bench, to the computer cluster, and back again. I have investigated the genetics of social behaviors (paternal care and monogamy) in owl monkeys and other non-human primates, retraced ancient human migration routes via patterns of genetic variation, quantified large genomic architectural changes across primate taxa, and examined rare variants associated with extreme HDL-levels in humans. Most recently though, I have concentrated on unraveling the genomic underpinnings of the toughest biological materials on Earth: spider silks.

Spider silks are lighter and tougher than steel, exhibit antimicrobial properties, and are nearly invisible to the human immune system. Yet, despite these amazing qualities, much remains unknown about spider silk genetic structure, functional diversity, and production. To provide a deeper understanding of spider silk biology, I have constructed the genomes and tissue-specific transcriptomes of two orb-weaving spiders (*Nephila clavipes* and *Caerostris darwini*) that build massive webs with extensive repertoires of silks that exhibit a wide range of biophysical properties. Through the assembly, analysis, and dissemination of these resources, it is my goal to both develop and promote industrial and medical innovations that will harness the extraordinary properties of spider silk.

PUBLICATIONS

Babb PL, Lahens NF, Correa-Garhwal SM, Nicholson DN, Kim EJ, Hogenesch JB, Kuntner M, Higgins L, Hayashi CY, Agnarsson I, Voight BF (2017). The *Nephila clavipes* genome highlights the diversity of spider silk genes and their complex expression. *Nature Genetics*. (Advance Online Publication: May 1, 2017) DOI: 10.1038/ng.3852.

Khetarpal SA*, **Babb PL***, Zhao W, DerOrhannessian S, Johnson K, Hancock-Cerutti WF, Elwyn S, Tran T, Brown CD, Voight BF†, Rader DJ†. (*In Preparation*). Multiplexed targeted resequencing identifies rare noncoding variants associated with high HDL cholesterol. [*Co-first authors; †Co-senior authors].

- Vargas-Pinilla P, **Babb PL**, Nunes L, Paré P, Rosa G, Felkl A, Longo D, Salzano FM, Paixão-Côrtes, Gonçalves GL, Bortolini MC. (2017). Progesterone response element variation in the *OXTR* promoter region and paternal care in New World monkeys. *Behavior Genetics* 47:77-87.
- Babb PL**, Fernandez-Duque E, Schurr TG. (2015). Oxytocin receptor gene sequences in owl monkeys and other primates show remarkable interspecific regulatory and protein coding variation. *Molecular Phylogenetics and Evolution* 91: 160-177.
- Huck M, Fernandez-Duque E, **Babb PL**, Schurr TG. (2014). Correlates of genetic monogamy in pair-living mammals: insights from Azara's owl monkeys. *Proceedings of the Royal Society B: Biological Sciences* 281: 1-8.
- Babb PL**, McIntosh AM, Fernandez-Duque E, Schurr TG. (2014). Prolactin receptor gene diversity in Azara's owl monkeys (*Aotus azarai*) and humans (*Homo sapiens*) suggests a non-neutral evolutionary history among primates. *International Journal of Primatology* 35:129-155.
- Babb PL**. (2012). Molecular evolution of vasopressin and oxytocin receptor genes in owl monkeys (*Aotus azarai*) of northern Argentina. *Doctoral dissertation*, 218 pages. Available from ProQuest: UMI Number AAI3508965.
- Babb PL**, Fernandez-Duque E, Baiduc C, Gagneux P, Evans S, Schurr TG. (2011). MtDNA diversity in Azara's owl monkeys (*Aotus azarai azarai*) of the Argentinean Chaco. *American Journal of Physical Anthropology* 146(2): 209-224.
- Gokçumen O*, **Babb PL***, Iskow R, Zhu Q, Shi, X, Mills RE, Ionita-Laza I, Vallender EJ, Clark AG, Lee C†, Johnson WE†. (2011). Refinement of primate copy number variation hotspots identifies candidate genomic regions evolving under positive selection. *Genome Biology* 5(12): R52. [*Co-first authors; †Co-senior authors].
- Babb PL**, McIntosh AM, Fernandez-Duque E, Di Fiore A, Schurr TG. (2011). An optimized genotyping strategy for assessing genetic identity and kinship in Azara's owl monkeys (*Aotus azarai*). *Folia Primatologica* 82: 107-117.
- Babb PL**, Fernandez-Duque E, Schurr TG. (2010). *AVPR1A* sequence variation in monogamous owl monkeys (*Aotus azarai azarai*) and its implications for the evolution of platyrrhine social behavior. *Journal of Molecular Evolution* 71:279-297.
- Friedlaender J, Schurr T, Gentz F, Koki G, Friedlaender F, Horvat G, **Babb PL**, Cerchio S, Kaestle F, Schanfield M, Deka R, Yanagihara R, Merriwether DA. (2005). Expanding southwest Pacific mitochondrial haplogroups P and Q. *Molecular Biology and Evolution*. 22(6): 1506-1517.
- Rubicz R, Schurr TG, **Babb PL**, Crawford MH. (2003). Mitochondrial DNA variation and origins of the Aleuts. *Human Biology* 75(6): 809-35.

PUBLISHED ABSTRACTS

- Khetarpal SA*, **Babb PL***, Zhao W, DerOrhannessian S, Hancock-Cerutti WF, Elwyn S, Tran T, Brown CD, Voight BF†, Rader DJ†. (2016). Multiplexed targeted resequencing identifies rare noncoding variants associated with high HDL cholesterol. *American Society of Human Genetics 66th Annual Meeting Program Guide*:120. [*Co-first authors; †Co-senior authors].
- Agnarsson I, **Babb PL**, Lahens NF, Nicholson DN, Kim EJ, Higgins L, Hogenesch JB, Kuntner M, Voight BF. (2016). *De novo* genomes of orb-weaving spiders reveal the diversity and complexity of spidroins. *The American Arachnological Society 40th Annual Meeting Program Guide*.
- Babb PL**, Lahens, NF, Hogenesch JB, Agnarsson I, Higgins L, Voight BF. (2015). A first generation spider silk gene catalog from the golden orb-weaver (*Nephila clavipes*) genome. *Biology of Genomes Abstract Book* (Cold Spring Harbor Laboratory):29.
- Babb PL**, Voight BF. (2013). Multiple LD-independent signals of extreme sub-population variation at a region associated with type-2 diabetes suggests a non-neutral evolutionary history. *American Society of Human Genetics 63rd Annual Meeting Program Guide*:227.

- McIntosh AM, **Babb PL**, Fernandez-Duque E, Schurr TG. (2012). *PRLR* sequence diversity in owl monkeys (*Aotus azarae*) and other paternal care-giving primates suggests the maintenance of variation by balancing selection. *American Journal of Physical Anthropology* 147(S54):211.
- Babb PL**, Fernandez-Duque E, Schurr TG. (2011). Monogamous owl monkeys differ in the structure of *OXTR* from other non-monogamous primates. *American Journal of Physical Anthropology* 144(S52):79.
- Fernandez-Duque E, **Babb PL**, Schurr TG. (2011). Group structure and dispersal patterns of the socially monogamous owl monkey as revealed by mtDNA data. *American Journal of Physical Anthropology* 144(S52):135.
- Babb PL**, Fernandez-Duque E, Schurr TG. (2009). Vasopressin receptor V1a (*avpr1a*) gene variation in the monogamous owl monkey, *Aotus azarae azarae*. *American Journal of Physical Anthropology* 138(S48):81.
- Babb PL**, Gagneux P, Fernandez-Duque E, Schurr TG. (2008). Genetic variation and population structure in the owl monkey, *Aotus azarae*. *American Journal of Physical Anthropology* 135(S46):62.
- Babb PL**, Sitaldeen R, Ackermann RR, Newman TK. (2005). Mitochondrial DNA sequence evidence for a deep phylogenetic split in chacma baboons (*Papio hamadryas ursinus*) and the phylogeographic implications for *Papio* systematics. *American Journal of Physical Anthropology* 126(S40):67.
- Newman TK, Howell S, Barr CS, **Babb PL**, Westergaard GC, Higley JD. (2005). Genetic and environmental influences on acquired dominance status in free-ranging male rhesus macaques (*Macaca mulatta*). *American Journal of Physical Anthropology* 126(S40):157.
- Newman TK, Barr CS, **Babb PL**, Champoux M, Suomi SJ, Lesch K-P, Higley JD. (2004). *MAOA* gene promoter polymorphism influences aggression and impulsivity in male rhesus macaques (*Macaca mulatta*). *Neuropsychopharmacology* 29:S233.
- Newman TK, Barr CS, **Babb PL**, Becker M, Suomi SJ, Lesch K-P, Higley JD. (2004). Social impulsivity in captive rhesus monkeys (*Macaca mulatta*) is influenced by variation in a functional *MAOA* gene promoter polymorphism. *American Journal of Primatology* 62(S1):102.
- Newman TK, Gibson N, **Babb PL**, Higley JD, Goldman D. (2004). Comparative sequence analysis of a repeat polymorphism in the monoamine oxidase A (*MAOA*) gene promoter region in primates: evidence for selection? *American Journal of Physical Anthropology* 123(S38):152.

ADDITIONAL PRESENTATIONS

- 2016 **Babb PL**, Lahens NF, Correa-Garhwal SM, Nicholson DN, Kim EJ, Hogenesch JB, Kuntner M, Higgins L, Hayashi CY, Agnarsson I, Voight BF. The *Nephila clavipes* genome reveals the diversity and complexity of spider-silk genes. *Perelman School of Medicine Biomedical Postdoctoral Research Symposium*. (Podium presentation)
- Babb PL**, Lahens NF, Hogenesch JB, Gregorič M, Kuntner M, Higgins L, Agnarsson I, Voight BF. Cataloging the genetic toolkit of the strongest spider silk on Earth: the draft genome of Darwin's bark spider. *Perelman School of Medicine's Department of Genetics Annual Retreat*. (Poster presentation)
- 2015 **Babb PL**, Lahens NF, Hogenesch JB, Agnarsson I, Higgins L, Voight BF. A first generation spider silk gene catalog from the golden orb-weaver (*Nephila clavipes*) genome. *Perelman School of Medicine's Department of Genetics Annual Retreat*. (Poster presentation)
- Babb PL**. A first generation spider silk gene catalog from the golden orb-weaver genome. *Yale University Center for Genetic Analyses of Biodiversity, Laboratory of Drs. Gisella Caccione and Jeff Powell*. (Guest lecture)
- 2014 **Babb PL**, Voight BF. Assembly of the golden orb-weaver genome enables full characterization of spider silk gene repertoire. *Perelman School of Medicine Biomedical Postdoctoral Research Symposium*. (Poster presentation)

- Babb PL.** Weaving spider genomes. *Perelman School of Medicine Department of Genetics, Research in Progress Series.* (Podium presentation)
- Siewert K, **Babb PL**, Voight BF. Detecting multiple selective events on linked polymorphisms. *Perelman School of Medicine Genomics and Computational Biology Graduate Program Annual Retreat.* (Poster presentation)
- 2012 **Babb PL**, Fernandez-Duque E, Schurr TG. The enigmatic taxonomic status of *Aotus* among the platyrrhines: signals from five genetic loci. *24th Congress of the International Primatological Society.* (Podium presentation)
- 2009 Gokçumen O, **Babb PL**, Lee A, Mills RE, Smith RS, Vallender EJ, Blake-Kinnin ME, Lee C, Johnson WE. High resolution discovery of copy number variation among rhesus macaques (*Macaca mulatta*). *27th Annual Symposium on Nonhuman Primate Models for AIDS.* (Podium presentation)
- 2006 Hung KE, **Babb PL**, Krastins B, Sarracino D, Korzenik JR, Sands BE, Kucherlapati R. Proteomics approaches to biomarker discovery in inflammatory bowel disease. *Inflammatory Bowel Disease Summit.* (Poster presentation)
- Babb PL**, Wu E, Krastins B, Stoerker J, Sarracino D. Using immobilized lectins for proteomic analysis of glycosylated proteins in human plasma. *Harvard-Partners Center for Genetics and Genomics: Proteomics Symposium.* (Poster presentation)
- Krastins B, **Babb PL**, Satish KK, Wilson SB, Sarracino D. Phosphorylated proteins and peptides from stimulated and unstimulated Jurkat Cells. *Harvard-Partners Center for Genetics and Genomics: Proteomics Symposium.* (Poster presentation)
- 2005 Joshi VA, Verlander P, Anderson ND, **Babb PL**, Fulchiero E, Lindeman N, Longtime J, Louis DN, Janne PA, Sequist LV, Bell DW, Haber DA, Meyerson M, Johnson BE, Lynch TJ, Kucherlapati R. *EGFR* kinase domain sequencing for the prediction of drug response: the mutation spectrum. *American Association for Cancer Research Annual Meeting.* (Podium presentation)

PRESS

- “Using the Penn High Performance Computing Cluster to Unravel the Spider’s Web”. Karen Kreeger. *Penn Medicine News Blog*, April 15, 2014. <https://www.penmedicine.org/news/news-blog/2014/april/using-the-penn-high-performanc>
- “And the award for the best dad goes to...the OWL MONKEY: Mammal is unique in its monogamy and parenting skills”. Victoria Woollaston. *Daily Mail* (website), March 24, 2014. <http://www.dailymail.co.uk/sciencetech/article-2588228/And-award-best-dad-goes-OWL-MONKEY-Mammal-unique-monogamy-parenting-skills.html>
- “Who’s Your Daddy? Owl Monkeys Know For Sure” Mary Bates. *WIRED Magazine* (website), March 20, 2014. <https://www.wired.com/2014/03/whos-daddy-owl-monkeys-know-sure/>

RESEARCH EXPERIENCE

Perelman School of Medicine at the University of Pennsylvania, Laboratory of Computational Genomics

July 2012 - Present

Philadelphia, PA

Led *de novo* genome and transcriptome construction and analysis for two orb-weaving spider species: *Nephila clavipes* and *Caerostris darwini* collaboration with Drs. Linden Higgins, Ingi Agnarsson, Matjaž Kuntner, and Cheryl Hayashi. Co-analyzed rare non-coding burden associated with HDL-C in humans with Dr. Sumeet Khetarpal and the laboratory of Dr. Dan Rader.

University of Pennsylvania, Laboratory of Molecular Anthropology

September 2006 - May 2012

Philadelphia, PA

Studied the phylogeography, population structure and sociobehavioral evolution of a wild population of owl monkeys (*Aotus azarae*) using DNA sequencing, luciferase expression assays, and other molecular techniques.

Harvard Medical School / Brigham & Women's Hospital, Laboratory for Cytogenetic Pathology

Summer 2009

Boston, MA

Conducted custom copy number variant (CNV) microarray assays to reveal the levels of structural variation present in the genomes of rhesus macaques (*Macaca mulatta*) and other primates with Dr. Omer Gokçumen in the laboratory of Dr. Charles Lee.

Harvard Partners Center for Genetics and Genomics, Department of Proteomics

August 2005 - August 2006

Cambridge, MA

Investigated disease biomarker proteins and conducted pathogen proteome discovery sequencing using liquid chromatography and high-resolution nanospray mass spectrometry in the laboratory of Dr. David Sarracino.

Harvard Partners Center for Genetics and Genomics, Laboratory for Molecular Medicine

September 2004 - August 2005

Cambridge, MA

Designed and validated high-fidelity pharmacogenetic DNA sequencing tests for clinical diagnostic screening, in adherence to strict HIPAA and CLIA regulations in the laboratory of Drs. Heidi Rehm and Victoria Joshi.

National Institutes of Health (NIAAA), Laboratory of Neurogenetics

September 2003 - September 2004

Rockville, MD

Investigated sequence diversity and function of neurotransmitter genes (*SERT*, *MAOA*, *COMT* and *DRD4*) in human and non-human primates under the mentorship of Dr. Tim Newman in the laboratory of Dr. David Goldman.

University of Pennsylvania, Laboratory of Molecular Anthropology

March 2002 - September 2003

Philadelphia, PA

Conducted mitochondrial DNA research to identify human population migration and settlement patterns in circum-Arctic and Oceanic populations using PCR, RFLP and Sanger sequencing in the laboratory of Dr. Theodore Schurr.

TEACHING EXPERIENCE

- Spring 2009 University of Pennsylvania, ANTH-003: *Introduction to Human Evolution* (Teaching Assistant)
- Fall 2008 University of Pennsylvania, ANTH-104: *Sex and Human Nature* (Teaching Assistant)
- Spring 2008 University of Pennsylvania, ANTH-003: *Introduction to Human Evolution* (Teaching Assistant)
- Fall 2007 University of Pennsylvania, ANTH-003: *Introduction to Human Evolution* (Teaching Assistant)

FIELDWORK EXPERIENCE

Namorona River, Ranomafana National Park, Madagascar

January 2018 (*scheduled*)

Focal observation, silk collection, and sample collection of Darwin's Bark spiders (*Caerostris darwini*).

Charleston County, South Carolina, USA

August 2017 (*scheduled*)

Focal observation, silk collection, and sample collection of golden orb-weaver spiders (*Nephila clavipes*).

Charleston County, South Carolina, USA

Summers 2012-2016

Focal observation, silk collection, and sample collection of golden orb-weaver spiders (*Nephila clavipes*).

Estancia Guaycolec, Formosa, Argentina

Summer 2008

Focal observation and behavioral data collection of wild Azara's owl monkeys (*Aotus azarai azarai*).

PROFESSIONAL ACTIVITIES

- 2012-present **Journal Reviewer**
American Journal of Primatology, Developmental Science, Genes Brains Behavior, Wiley Publishing
- 2011-2016 **Education Committee Member**, American Association of Anthropological Genetics (AAAG)
- 2013 **Co-organizer** (w/ Omer Gokçumen), *Application of Genomics to Anthropological Research (AGAR) Workshop II*
Texas Biomedical Research Institute, San Antonio, TX, January 2013.
- 2013 **Organizer**, *Teaching Anthropological Genomics and Next-Generation Sequencing Symposium*
American Association of Physical Anthropology Annual Conference, Knoxville, TN, April 2013.
- 2012 **Co-organizer** (w/ Omer Gokçumen), *Application of Genomics to Anthropological Research (AGAR) Workshop*
Texas Biomedical Research Institute, San Antonio, TX, January 2012.
- 2012-present **Member**, American Arachnological Society (AAS), International Society of Arachnology (ISA),
American Society of Human Genetics (ASHG)
- 2006-2012 **Member**, American Association of Anthropological Genetics (AAAG), American Society of
Primatology (ASP), American Association of Physical Anthropologists (AAPA), International
Primatological Society (IPS)

RESEARCH SUPPORT

- 2011 Leakey Foundation General Research Grant
- 2011 University of Pennsylvania GAPSA Travel Grant
- 2010 University of Pennsylvania GAPSA-Provost Award for Interdisciplinary Innovation
- 2008 University of Pennsylvania Department of Anthropology Field Funds Grant
- 2008 University of Pennsylvania GAPSA Travel Grant

AWARDS, HONORS, & FELLOWSHIPS

- 2014 *New England BioLabs Poster Award for Distinguished Next Generation Sequencing Research*
- 2011-2012 *Dissertation Completion Fellowship*, University of Pennsylvania Graduate School of Arts and Sciences
- 2006-2011 *Benjamin Franklin Fellowship*, University of Pennsylvania
- 2009 *Fellowship for Teaching Excellence* (Anthropology nominee), Center for Teaching and Learning
- 2006-2009 *Dean's List* (graduate, all courses), University of Pennsylvania Graduate School of Arts and Sciences
- 2008 *Dean's Scholar Award*, University of Pennsylvania Graduate School of Arts and Sciences
- 2007 *Graduate Research Fellowship*, University of Pennsylvania Department of Anthropology
- 2004 *Partners in Excellence Award*, Harvard Partners Center for Genetics and Genomics
- 2003 *Post-Baccalaureate IRTA Fellowship*, National Institutes of Health
- 2002-2003 *Dean's List* (undergraduate), University of Pennsylvania School of Arts and Sciences

ADDITIONAL SKILLS & INTERESTS

- Spoken languages: English (native), French (proficient)
- Computer languages: Unix, Linux, Perl, R (proficient), and Python, Java, HTML, XML (working knowledge)
- Other software: Adobe Illustrator, Adobe Photoshop, Geneious Pro, Sequencher, IGV, BWA, GATK, SAMtools, VCFtools, BEDtools, PicardTools, PLINK, CASAVA, AllPaths-LG, SOAPdenovo2, Metassembler, Trinity, Maker2, Variant Association Tools, FASTX toolkit, *and many more...*
- Safety training: Working with Human Subjects in Biomedical Research, CITI Good Clinical Practices, Biomedical Responsible Conduct of Research, Universal Precautions, Laboratory Safety, Working Safely with HIV and Bloodborne Pathogens, Using Animals in Intramural Research, Working Safely with Non-Human Primates, Hands-On Animal Techniques, Computer Security, and Protecting Human Subjects.
- Travel: Extensive travel experience, including deserts, ice fields, mountains, swamps, and jungles. (Europe, Asia, Africa, and the Americas)
- Additional interests: Photography, automotive restoration, performance engine construction, autocross racing, electronic music composition, and graphic design.