

M Owen Christopher W. Tubbs, Ph.D.

San Diego Zoo Global, Institute for Conservation Research, 15600 San Pasqual Valley Road, Escondido, CA 92027, Phone: 760.291.5422, ctubbs@sandiegozoo.org

Adjunct Assistant Professor of Animal Sciences, Department of Animal Sciences, The University of Missouri, Columbia MO

EDUCATION

2007 The University of Texas at Austin, Ph.D., Marine Science
-Emphasis in comparative fish reproductive physiology and
characterization of novel mechanisms of steroid hormone action

2001 University of Florida, B.S., Zoology

RESEARCH

San Diego Zoo Institute for Conservation Research

Associate Director, Reproductive Sciences

2007-present

PI of the Endocrinology Laboratory of the Reproductive Sciences Team. Research focuses on the effects of environmental chemicals on the reproductive physiology of endangered species. Promoted to Scientist from the position of Postdoctoral Associate in August 2011, to Senior Scientist in January 2017 and to Associate Director in September 2019.

The University of Texas at Austin Marine Science Institute

Graduate Research Assistant

May 2003-Aug 2007

Conducted doctoral research characterizing signaling mechanisms of a novel, membrane-bound steroid hormone receptor and its role in the regulation sperm motility of two estuarine fishes.

Marine Biological Laboratory, Woods Hole, MA

May 2006

Attended Frontiers in Reproduction: Molecular and Cellular Concepts and Applications; summer course for young scientists that develops the knowledge and experimental skills needed to pursue a career in the reproductive sciences.

Florida Fish and Wildlife Conservation Commission

Jun 2000-Aug 2002

Field Biologist

Field biologist with Alligator Management Section. Assisted in the collection and incubation of alligator eggs and evaluated hatching success of egg clutches from different lakes in Florida. Assisted in the capture of juvenile and adult alligator for research purposes.

University of Florida

Undergraduate Researcher

Aug 1999-May 2001

Undergraduate researcher in laboratory examining the effects of endocrine disrupting contaminants of reproduction of fish and alligators. Designed and conducted senior research project on the effects of pesticides on reproductive development of male mosquitofish.

TEACHING

Palomar College, San Marcos, CA Adjunct Professor of Biology

Aug 2009-Dec 2014

General Biology Laboratory BIO101L

Introductory, non-majors laboratory exercises in cell structure and function, energy transfer, reproduction, genetics, and ecology (Fall 2013, 2014; Spring 2013, 2014).

Molecules and Cells BIO102

An introductory course designed for pre-nursing students consisting of lecture and laboratory components. Explores the basic principles of life including biochemistry, cellular structure and function, energy transfer, cellular division, inheritance and molecular genetics. Was responsible for development of lecture and laboratory curriculum (Spring 2011; Fall 2011).

Animal Behavior Z00120

Lead instructor for this introductory, non-majors course that explores the physiological and evolutionary basis of animal behavior. Developed and implement active-learning curriculum that engages students in the process of guided scientific inquiry. Mentor co-instructors in the development of active-learning curriculum (Fall 2009, 2010, 2011, 2012, 2014; Spring 2010, 2011, 2012, 2013, 2014).

National Academies Summer Institutes on Undergraduate Biology Education Education Mentor in the Life Sciences

2011-2013

Mentor research university faculty who attended the Pacific Northwest Regional Summer Institute to learn how to incorporate active-learning techniques, learning outcome assessment and appreciation for student diversity in their classrooms.

Faculty Institutes for Reforming Science Teaching (FIRST IV) Regional Team Leader

Jun 2011-May 2013

One of five postdocs selected to help train and mentor second cohort of one hundred FIRST IV Postdoctoral Teaching Fellows. Responsible for yearlong mentorship of two teams of postdocs and providing assistance in developing two one semester courses (Introduction to Marine Biology and Science and Society) using backwards design and active-learning techniques.

Faculty Institutes for Reforming Science Teaching (FIRST IV) Postdoctoral Teaching Fellow

Jun 2009-Jun 2010

One of one hundred applicants selected to participate in NSF-funded program aimed at reforming science education by training future educators to 1) develop and implement innovative active-learning, inquiry-based curricula and 2) use scientific approaches to measure student learning outcomes (SLO's) and assess the effectiveness of pedagogical methods. Co-developed a one semester introductory Cell Biology active-learning course as part of this fellowship.

The University of Texas Marine Science Institute, Port Aransas, TX

Teaching Assistant

Aug 2002-Aug 2005

Introduction to Oceanography

An introductory lecture and laboratory course for non-majors that surveys the physical, chemical, geological and biological processes that define the ocean environment and discusses how the ocean environment influences human society. Was responsible for development of new laboratory curricula and teaching laboratory sections. (Fall 2002, Spring 2003).

Reproductive Physiology of Fishes

A graduate level lecture, laboratory and field course that examines the environmental, hormonal and behavioral aspects of teleost reproduction. Assisted in all course components, including giving lectures, training students in the field collection of fish, training students to perform oocyte maturation and sperm motility bioassays and data analysis. (Summer 2004)

Biology of Fishes

An upper division course that discusses the anatomy, physiology, behavior, life history, taxonomy, and distribution of fishes, with emphasis on field sampling and laboratory studies. Served as a volunteer teaching assistant and provided training in deep-sea fish collection and dissection. (Summer 2005)

STUDENTS SUPERVISED

Graduate

2012-2014: Rachel Felton (co-chair of Master's committee, University of Missouri, Department of Animal Sciences)

2015-2018: Zeka Kuspa (member of Ph.D. committee, University of California, Santa Cruz)

Undergraduate

San Diego Zoo Institute for Conservation Research Summer Fellows

2019 Allison Carothers, University of Nebraska (co-mentor)

2018 Morgan Orsolini, California Polytechnic Institute (co-mentor)

2017 Alexis Ybarra, UC-San Diego (co-mentor)

2016 Juliana Candelaria, University of Maryland (currently Ph.D. student at UC-Davis)

2015 Corie Owen, California Polytechnic Institute (currently Ph.D. student at University of Connecticut)

2014 Katie Bidne, University of Nebraska-Lincoln (currently Ph.D. student at Iowa State University)

Rebecca Joyce, Rutgers University

2013 Laura Moley, University of Missouri (currently Ph.D. student, Utah State University, co-author on peer reviewed publication)

2012 Caitlin McDonough, Beloit College (currently Ph.D. student, Syracuse University, co-author on peer-reviewed publication)

2011 Rachel (Gerrard) Felton, Missouri State University (currently Research Coordinator, Reproductive Sciences, San Diego Zoo Institute for Conservation Research)

PUBLICATIONS

- 2020** Felton, R.G., C.M. Owen, J.M. Cossaboon, C.S. Steiner, C.W. Tubbs. 2020. Identification of California condor (*Gymnogyps californianus*) estrogen receptor variants and their activation by xenoestrogens. *General and Comparative Endocrinology* 289, 113392.
- 2019** Williams, C.L., A. R. Ybarra, A.N. Meredith, B.S. Durrant, C.W. Tubbs. Gut Microbiota and Phytoestrogen-Associated Infertility in Southern White Rhinoceros. *mBio* 10, e00311-00319
- Tan, W., Y. Pang, C. Tubbs, P. Thomas. Induction of sperm hypermotility through membrane progesterin receptor alpha (mPR α): A teleost model of rapid, multifaceted, nongenomic progesterin signaling. *General and Comparative Endocrinology* 279, 60-66.
- 2018** Glucs, Z.E., D.R. Smith, C.W. Tubbs, J.J. Scherbinski, A. Welch, J. Burnett, M. Clark, C. Eng, M.E. Finkelstein. Glucocorticoid measurement in plasma, urates, and feathers from California condors (*Gymnogyps californianus*) in response to a human-induced stressor. *PLoS ONE*. DOI: 10.1371/journal.pone.0205565.
- Tubbs, C.W., C.E. McDonough. Reproductive Impacts of Endocrine Disrupting Chemicals on Wildlife Species: Implications for the Conservation of Endangered Species. *Annual Review of Animal Biosciences* 6 287-304.
- Tubbs, C.W. Advancing Laboratory-Based Zoo Research to Enhance Captive Breeding of Southern White Rhinoceros. Pages 279-285 in *The Ark and Beyond: The Evolution of Zoo and Aquarium Conservation*. Edited by B.A. Minter, J. Mainschein, and J.P. Collins. University of Chicago Press, Chicago, Illinois.
- 2017** Tubbs, C.W., Durrant, B.S., and Milnes, M.R. Reconsidering the use of soy and alfalfa in southern white rhinoceros diets. *Pachyderm*, 58 135-139.
- 2016** Tubbs, C.W., Moley, L.A., Ivy, J.A., Metrione, L.C., LaClaire, S., Felton, R.G., Durrant, B.S., and Milnes, M.R. Estrogenicity of captive southern white rhinoceros diets and their association with fertility. *General and Comparative Endocrinology*, 238 32-38.
- Tubbs, C.W. California condors and DDT: Examining the effects of endocrine disrupting chemicals in a critically endangered species. *Endocrine Disruptors*, 4(1).
- 2015** Felton, R.G., C.C. Steiner, B.S. Durrant, D.H. Keisler, M.M. Milnes, and C.W. Tubbs. Identification of California condor estrogen receptors 1 and 2 and their activation by endocrine disrupting chemicals. *Endocrinology* 156(12) 4448-4457.
- 2014** Tubbs, C, McDonough, C, Felton, R, and Milnes, M. Advances in conservation endocrinology: The application of molecular approaches to the conservation of

- endangered species. *General and Comparative Endocrinology*, 203 29-34.
- 2012** Tubbs, C, Hartig, P, Cardon, M, Varga, N and Milnes, M. Activation of southern white rhinoceros (*Ceratotherium simum simum*) estrogen receptors by phytoestrogens: potential role in the reproductive failure of captive-born females? *Endocrinology*, 153(3) 1444-1452.
- 2011** Tubbs, C, Tan, W, Shi, B and Thomas, P. Identification of 17,20 β ,21-trihydroxy-4-pregnen-3-one (20 β -S) receptor binding and membrane progesterin receptor alpha on southern flounder sperm (*Paralichthys lethostigma*) and their likely role in 20 β -S stimulation of sperm hypermotility. *General and Comparative Endocrinology*, 170 629-639.
- 2010** Tubbs, C, Pace, M, and Thomas, P. Expression and gonadotropin regulation of membrane progesterin receptor alpha in Atlantic croaker (*Micropogonias undulatus*) gonads: Role in gamete maturation. *General and Comparative Endocrinology*, 165 144-154.
- 2009** Tubbs, C and Thomas, P. Progesterin signaling through an olfactory G protein and membrane progesterin receptor alpha in Atlantic croaker sperm: potential role in induction of sperm hypermotility. *Endocrinology*, 150(1) 473-484.
- Thomas, P, Tubbs, C and Garry, VF. Progesterin functions in vertebrate gametes mediated by membrane progesterin receptors (mPRs): Identification of mPR α on human sperm and its association with sperm motility. *Steroids* 74 (7): 614-621.
- 2008** Tubbs, C and Thomas, P. Functional characteristics of membrane progesterin receptor alpha (mPR α) subtypes: A review with new data showing mPR α expression in seatrout sperm and its association with sperm motility. *Steroids* 73 (9-10): 935-941
- 2007** Nunez, B, Applebaum S, Berg A, Dressing, G, Evans A, Tubbs, C, Barry, T. Molecular aspects of steroid action in marine fishes. In: *Biotechnology*, Doelle, HW, DaSilva, EJ. *Encyclopedia of Life Support Systems (EOLSS)*, Oxford, UK, <http://www.eolss.net>
- Thomas, P, Tubbs, C, Berg, H, Dressing, G. Sex steroid hormone receptors in fish ovaries. In: *The fish oocyte: from basic studies to biotechnological applications*, 203-233. Babin, P, Cerda, J and Lubzens, E (eds). Springer.
- Thomas P, Pang Y, Dong J, Groenen P, Kelder J, de Vlieg J, Zhu Y, and Tubbs C. Steroid and G protein binding characteristics of the seatrout and human progesterin membrane receptor alpha subtypes and their evolutionary origins. *Endocrinology* 148 (2): 705-718.
- 2006** Thomas P, Dressing G, Pang Y, Berg H, Tubbs C, Benninghoff AD, and Doughty K. Progesterin, estrogen and androgen G-protein coupled receptors in fish gonads. *Steroids* 71: 310-316.

2005 Thomas P, Tubbs C, Detweiler D, Das S, Ford L, and Breckenridge-Miller D. Binding characteristics, hormonal regulation and identity of the sperm membrane progesterin receptor in Atlantic croaker. *Steroids* 70: 427-433.

Bermudez DS, Milnes MR, Bryan TA, Gunderson MP, Tubbs C, Woodward AR, and Guillette LJ Jr. 2005. Seasonal variation in plasma thyroxine concentrations in juvenile alligators (*Alligator mississippiensis*) from three Florida Lakes. *Comparative Biochemistry and Physiology A Molecular and Integrative Physiology* May 141(1): 8-14.

GRANTS, AWARDS and HONORS

2018 *Co-investigator*, Assessing marine endocrine disrupting chemicals in the critically endangered California condor: Implications for reintroduction to coastal environments, National Sea Grant College Program, \$257,486

2014 *Finalist*, Distinguished Faculty Award for Excellence in Teaching, Palomar College, San Marcos, CA

2011 *Nominee*, Distinguished Faculty Award for Excellence in Teaching, Palomar College, San Marcos, CA

Role of Dietary Phytoestrogens in Impaired Southern White Rhino Reproduction, San Diego Zoo's Ocelots Grant

2010 *Nominee*, Distinguished Faculty Award for Excellence in Teaching, Palomar College, San Marcos, CA

Novel Methods for Monitoring Reproductive Status in Giant Pandas, San Diego Zoo's Ocelots Grant

Changes in Vaginal Cell Gene Expression as a Diagnostic Tool for Monitoring Reproductive Status in the Giant Panda, Morris Animal Foundation, Co-Investigator

2009 Postdoctoral Teaching Scholarship, National Science Foundation, Faculty Institutes for Reforming Science Teaching (FIRST IV)

The San Diego Zoo's Adopt a Project Program: Monitoring Reproductive Status in Giant Pandas, Co-Investigator

2008 *Nominee*, Outstanding Dissertation Award, College of Natural Sciences, The University of Texas at Austin

2006 Scholarship, Frontiers in Reproduction, Marine Biological Laboratory, Woods Hole, MA

E.J. Lund Fellowship in Marine Science, Marine Science Institute, The University of Texas at Austin

2005 E.J. Lund Fellowship in Marine Science, Marine Science Institute, The University of Texas at Austin

Laura Brooks Flawn, M.D. Endowment, Marine Science Institute, The University of Texas at Austin

2002 Dean's Excellence Award, College of Natural Sciences, The University of Texas at Austin

SELECT PRESENTATIONS

2014 California condors and endocrine disrupting chemicals. California Condor Field Team Meeting, Santa Barbara Zoo, Santa Barbara, CA.

Ex situ efforts in rhinoceros conservation: working to enhance southern white rhino reproduction in zoos. 2014 History of Biology Seminar, Marine Biological Laboratory, Woods Hole, MA.

2013 Potential role of dietary phytoestrogens in the reproductive failure of captive southern white rhinoceros (invited speaker). North American Society for Comparative Endocrinology (NASCE), Universidad Nacional Autónoma de México, Querétaro, MX

Assessment of phytoestrogen content of southern white rhinoceros diets. International Rhino Keeper's Association Rhino Keeper's Workshop. San Diego, CA

2011 Activation of rhinoceros estrogen receptors by phytoestrogens: potential role in reproductive failure of captive-born female white rhinoceros. International Rhino Keeper's Association Rhino Keeper's Workshop. Fossil Rim Wildlife Center, Glen Rose, TX

2010 New approaches to an old question: Why can't captive born white rhinos reproduce?

-San Diego Zoo President's Club Dinner, San Diego Zoo, San Diego, CA

-American Junior Academy of Sciences, San Diego Zoo's Institute for Conservation Research, Escondido, CA

-122nd Aardvarks Dinner, San Diego Zoo, San Diego, CA

-Chula Vista Rotary Club, Chula Vista, CA

2008 Sex, snacks and steroids: is food causing reproductive problems in captive white rhinos? Night Moves Seminar Series, San Diego Zoo's Wild Animal Park, Escondido, CA

2007 Mechanisms of progestin-stimulated sperm hypermotility in two teleosts: Atlantic croaker and southern flounder. Toxicology Seminar Series, Division of Pharmacology and Toxicology, The University of Texas at Austin, Austin, TX

A novel mechanism stimulates sperm motility in Atlantic croaker. Semi-Annual Meeting for the Marine Science Advisory Council, The University of Texas Marine Science Institute, Port Aransas, TX

G-olfactory proteins are activated by the teleost progesterin, 17,20 β ,21-trihydroxy-4-pregnen-3-one, to stimulate sperm hypermotility in the Atlantic croaker (platform presentation). Society for the Study of Reproduction: 40th Annual Meeting, San Antonio, TX

2006 Identification of the membrane progesterin receptor alpha subtype on human and seatrout sperm and its association with sperm motility (poster). ENDO, Boston, MA

The role of a membrane progesterin receptor in the regulation of sperm motility in the Atlantic croaker (oral presentation). Frontiers in Reproduction 2006 Symposium, Woods Hole Oceanographic Institution, Woods Hole, MA

2005 The role of membrane progesterin receptors in the regulation of sperm motility in the Atlantic croaker (invited presentation). The University of Texas at Austin, Section for Integrative Biology, Austin, TX

PROFESSIONAL SERVICE

2016-present San Diego Zoo Global Institutional Animal Care and Use Committee (IACUC), IACUC Chair 2017-2018

2017-2018 San Diego Zoo Global Animal Welfare Panel

2008-2016 Laboratory Instructor, San Diego Science Alliance, Better Education for Women in Science and Engineering (BE WiSE), San Diego Zoo's Institute for Conservation Research, Escondido, CA

2008-present Laboratory Instructor, Zoo InternQuest, San Diego Zoo's Institute for Conservation Research, Escondido, CA

2008-2015 Judge, Animal Science Division, Greater San Diego Science Fair, San Diego, CA

Reviewer: Theriogenology, Domestic Animal Reproduction, CBE-Life Sciences Education, Journal of Experimental Zoology, PLoS One, Bioscience, Environmental Science and Technology, Frontiers in Endocrinology, General and Comparative Endocrinology, Molecular and Cellular Endocrinology, Aquaculture

Memberships: North American Society for Comparative Endocrinology, International Rhino Keeper's Association (Treasurer)