

CARLOS ALBERTO TABOADA

Assistant Professor

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EDUCATION AND EXPERIENCE

Assistant Professor , Vanderbilt University, Department of Biological Sciences	Aug 2023-
Postdoctoral Associate , Duke University, Department of Biomedical Engineering, USA	2021-present
Postdoctoral Fellow , Duke University, Department of Biology, USA	2018-2021
Postdoctoral Fellow , Faculty of Pharmaceutical Sciences of Ribeirão Preto, University of São Paulo, Brazil	2017
PhD in Biology – University of Buenos Aires, Faculty of Exact and Natural Sciences, Argentina	2011-2017
Degree in Biological Sciences – University of Buenos Aires, Faculty of Exact and Natural Sciences, Argentina	2005-2011

PUBLICATIONS

Taboada, C., Delia, J., Chen, M., Peng, X., Zhu, X., Jiang, L., Vu, T., Zhou, Q., Yao, J., O’Connell, L., Johnsen, S. (2022). Glassfrogs conceal blood in their liver to maintain transparency. *Science*, 378(6626), 1315-1320.

- **Featured in New York Times**, "[How a See-Through Frog Hides Its Red Blood From Predators](#)", by Veronique Greenwood, December 22, 2022
- **Featured in National Geographic**, "[What makes glass frogs transparent? The secret is in their blood](#)", by Jason Bittel, December 22, 2022
- **Featured in The Atlantic**, "[How Glass Frogs Weave the World's Best Invisibility Cloak](#)", by Katherine Wu, December 22, 2022
- **Featured in Science News**, "[Sleeping glass frogs hide by storing most of their blood in their liver](#)", by Susan Milius, December 22, 2022
- **Featured in Science**, "[Glassfrogs become see-through by hiding their blood](#)", by Jack Tamisiea, December 22, 2022
- **Featured in Defector**, "[How the Glass frog hides its blood](#)", by Sabrina Imbler, December 22, 2022
- **Featured in BBC News**, "[Scientists find secret to how glass frogs turn transparent](#)", by Georgina Rannard, December 23, 2022
- **Featured in BBC Mundo**, "[El 'superpoder' de a rana de cristal que la vuelve casi invisible \(y lo que puede significar para el desarrollo de la medicina\)](#)", December 26, 2022

- Featured in **Associated Press**, "[Glass act: Scientists reveal secrets of frog transparency](#)", by Christina Larson, December 22, 2022
- **SINC**, "[Las ranas de cristal 'esconden' sangre en el hígado mientras duermen](#)", by Enrique Sacristán, December 22, 2022
- Featured in **AMNH**, "[Glassfrogs hide red blood cells in liver to 'Disappear'](#)", December 2022
- Featured in **NPR**, "[The astonishing vanishing act of the glassfrog, revealed](#)", by Ari Daniel, December, 2022
- Featured in **Science Friday**, "[By hiding Their Blood, These Frogs Pull Off The Ultimate Disappearing Act](#)". Interview

Rong, Q., Lee, Y., Tang, Y., Vu, T., **Taboada, C.**, Zheng, W., Xia, J., Czaplewski, D.A., Zhang, H.F., Sun, C., Yao, J. (2022). High-Frequency 3D Photoacoustic Computed Tomography Using an Optical Microring Resonator. *BME Frontiers*, 2022.

Oliinyk, O. S., Ma, C., Pletnev, S., Baloban, M., **Taboada, C.**, Shen, H., Yao, J., Vekhusa, V. (2022). Deep-tissue SWIR imaging using rationally designed small red-shifted near-infrared fluorescent protein. *Nature Methods*

Taboada, C., Brunetti, A. E., Lyra, M. L., Fitak, R. R., Faigon, A., Ron, S. R., Lagorio, M.G., Haddad, C. F. B., Lopes, N.P., Johnsen, S., Faivovich, J., Chemes, L. B., Bari, S. E. (2020). Multiple origins of green coloration in frogs mediated by a novel biliverdin-binding serpin. *Proceedings of the National Academy of Sciences of the United States of America*, 117(31), 18574-18581. (**In this Issue** article and **cover** article)

- Featured in **PNAS**, Davis, T. H. (2020). QnAs with Carlos Taboada. *Proceedings of the National Academy of Sciences*, 117(40), 24612-24613.
- Featured in **Nature** "How frogs became green — again, and again, and again", July 14, 2020. Nature Research Highlights
- Featured in **Science** "How a blue protein turns tree frogs bright green", by Elizabeth Pennisi, July 2020. Science; doi:10.1126/science.abd8020.
- Featured in **El Pais** "Por que las ranas son verdes", by Agathe Cortes, July 13, 2020.
- Featured in **Duke today** "Green is more than skin-deep for hundreds of frog species", by Karl Bates, July 13, 2020.

Taboada, C., Brunetti, A. E., Pedron, F. N., Carnevale Neto, F., Estrin, D. A., Bari, S. E., Chemes, L. B., Peperine Lopes, N., Lagorio, M. G., Faivovich, J. (2017). Naturally occurring fluorescence in frogs. *Proceedings of the National Academy of Sciences of the United States of America*, 114(14): 3672-3677. (**In this Issue** article and **cover** article)

- Featured in **Science News**: "First fluorescent frogs might see each others' glow", by Susan Milius, April 15, 2017. Science News, 191 (7): 4 (2017)
- Featured in **Nature News**: "First fluorescent frog found", by Anna Nowogrodzki, March 16, 2017. Nature, 543 (297); doi:10.1038/nature.2017.21616
- Featured in **Physics Today**: "Frog fluorescence", by Richard J. Fitzgerald. Physics Today, 70 (5): 23 (2017); doi: 10.1063/PT.3.3549
- Featured in **Chemistry World**: "Fluorescent frog first down to new molecule", by Anthony King, March 13, 2017.

- Featured in **New Scientist**: “Luminous frog is the first known naturally fluorescent amphibian”, by Sam Wong, March 13, 2017.
- Featured in **Smithsonian.com**: “Researchers Find the First Naturally Fluorescent Frog Species”, by Jason Daley, March 15, 2017.
- Featured in **earthtouchnews.com**: “These frogs are positively glowing!”, by David Moscato, March 13, 2017.

Rong, Q., Lee, Y., Tang, Y., Vu, T., Taboada, C., Zheng, W., Xia, J., Czaplewski, D.A., Zhang, H.F., Sun, C., Yao, J. (2022). High-Frequency 3D Photoacoustic Computed Tomography Using an Optical Microring Resonator. *BME Frontiers*, 2022.

Caves, E. M., Schweikert, L.E., Green, P. A., **Taboada, C.**, Zipple, M. N., Peters, S., Nowicki, S., Johnsen, S. (2020). Variation in retinal carotenoids correlates with individual variation in perception of carotenoid-based signal coloration. *Behavioral Ecology and Sociobiology*. 74(7), 1-14.

Lagorio, M. G., Cordon, G. B., Iriel, A. Romero, J. M., Faivovich, J., **Taboada, C.** (2020). Lagorio, M. G., Cordon, G. B., Iriel, A., Romero, J. M., Faivovich, J., & Taboada, C. (2020). Biophotonics. Fluorescence and reflectance in living organisms. *Science Reviews from the end of the world*. 2, 18-41.

Targino, M., Elias-Costa, A. J., **Taboada, C.**, & Faivovich, J. (2019). Novel morphological structures in frogs: vocal sac diversity and evolution in Microhylidae (Amphibia: Anura). *Zoological Journal of the Linnean Society*. 187(2), 479-493

Brunetti, A., Carnevale Neto, F., Vera, M., **Taboada, C.**, Pavarini, D., Bauermeister, A., & Peoporine Lopes, N. (2018). An integrative omics perspective for the analysis of chemical signals in ecological interactions. *Chemical Society Reviews*. 47, 1574-1591.

Taboada, C., Brunetti, A. E., Alexandre, C., Lagorio, M. G., & Faivovich, J. (2017). Fluorescent Frogs: A Herpetological Perspective. *South American Journal of Herpetology*, 12(1), 1-13. (**cover** article)

Vera Candiotti, F., **Taboada, C.**, Salica, M. J., Baldo, D., Faivovich, J., & Baêta, D. (2017). The Adhesive Glands during Embryogenesis in Some Species of Phyllomedusinae (Anura: Hylidae). *Journal of Herpetology*, 51(1), 119-129.

Brunetti, A. E., **Taboada, C.**, & Faivovich, J. (2015). Extended vocal repertoire in *Hypsiboas punctatus* (Anura: Hylidae). *Journal of Herpetology*, 49(1), 46-52.

Brunetti, A. E., **Taboada, C.**, & Faivovich, J. (2014). The reproductive biology of *Hypsiboas punctatus* (Anura: Hylidae): male territoriality and the possible role of different signals during female choice. *Salamandra*, 50(4), 215-224.

Taboada, C., Grant, T., Lynch, J. D & Faivovich, J. (2013). New morphological synapomorphies for the new world direct-developing frogs. *Herpetologica* 69(3):342-357

Luna, M.C., **Taboada, C.**, Baêta, D. & Faivovich, J. (2012). Structural diversity of nuptial pads in Phyllomedusinae (Amphibia: Anura: Hylidae). *Journal of Morphology* 273(7):712-724.

MANUSCRIPTS SUBMITTED

Rong, Q.*, **Taboada, C.***, del Águila, A., Merutka, I., Jayasundara, N., Zeng, Y., Yang, W., Zhou, Q., Yao, J. From Ultraviolet to Near-infrared: Label-free Reflection-mode Hyperspectral Photoacoustic Microscopy of Model Organisms with Cellular Resolution. *Submitted. Nature Communications*

Ferraro, D. P., Pereyra, M. E., Barrionuevo, J. S., Quinzio S., Vera, M.C., **Taboada, C.**, Faivovich, J., Brunetti, A.E. Vascularization inside the epidermis of Neotropical anurans (Nobleobatrachia). *In revision. Journal of Morphology*

MANUSCRIPTS IN PREPARATION

Taboada, C., Delia, J., Vu, T., Johnsen, S., Yao, J. A novel palette of infrared fluorescent proteins for in vivo imaging of deep tissues. *In prep*

Delia, J.*, **Taboada, C.***, Chen, M., Vu, T., Yao, J. Johnsen, J. Anatomical and ultrastructural mechanism of animal transparency. *In prep. *Co-first authors*

Taboada, C., Rong, Q., Davis, A., Delia, J., Johnsen S., Yao, J. Infrared reflectance in frogs mediated by pteridine nanospheres. *In prep.*

INVITED TALKS

Taboada, C. March 2021. **Invited seminar.** Colorado State University, Fort Collins

Taboada, C. January 2022. **Invited seminar.** Vanderbilt University, Nashville

Taboada, C. February 2022. **Invited seminar.** Duke University

Taboada, C. February 2022. **Invited seminar.** University of Central Florida

Taboada, C. March 2022. **Invited seminar.** Villanova University

Taboada, C. April 2023. **Invited seminar.** CalTech

PATENTS

Taboada, C. 2021. Novel near-infrared fluorescent proteins for in vivo, ex vivo and in vitro imaging. Filed 10/2021. Provisional patent

SCHOLARSHIPS AND GRANTS

- NGS-65348R-19 Explorer Grant. Awarded by National Geographic Society. 2020-2021. CoPI with Dr. Jesse Delia at Stanford University.
- Postdoctoral Long-Term Fellowship (LTP). Awarded by Human Frontier Science Program Organization (HFSPO). 2018-2021
- Internal Doctoral Fellowship Type I. Awarded by The National Research Council of Argentina (CONICET). 2011-2014
- Internal Doctoral Fellowship Type II. Awarded by The National Research Council of Argentina (CONICET). 2015-2016

- UBACyT 2010-2012. Ultrastructure of spermatozooids in anurans: Phylogenetic studies and reproductive biology. (UBACyT 20020090200727). Directors: J. Faivovich and G.n. Hermida. Research associate.
- PICT-2007-02202. Systematics and Evolution of Hylids: Diversification of the largest anuran family. Director: Julián Faivovich. Research associate.
- PICT-2011-01895. The anuran tree of life from the roots to the leaves: evolution and phylogeny of sudamerican anurans. Director: Ana María Baez. Research associate.

RESEARCH EXPERIENCE

Duke University, Department of Biomedical Engineering
Human Science Frontier Organization Postdoctoral Fellow;
Advisor: Junjie Yao

USA
2021-Present

Use of multiple types of imaging modalities to characterize physiological processes in vivo in non-model amphibians.

- Experience with ultrasound imaging
- Fluorescence imaging
- Photoacoustic imaging

Duke University, Department of Biology
Human Science Frontier Organization Postdoctoral Fellow;
Advisor: Sönke Johnsen

USA
2018-2021

Use of multiple types of optical equipment and computational simulations to characterize transparency of tissues.

- Mathematical and Bioinformatical analyses and modelling. Python programming, Image and Video analyses.
- *In vivo* non-invasive Photoacoustic Imaging in collaboration with Prof. JunJie Yao, Duke Pratt School of Engineering.
- Chemistry of carotenoids, purifications, analytical chemistry and analysis of their influence in color vision.
- Modelling of sensitivity and acuity in amphibian vision.

Faculty of Pharmaceutical Sciences of Ribeirão Preto, University of São Paulo
Postdoctoral Fellow; Advisor: Norberto Peporine Lopes

Brazil
2017

Characterization of proteins and metabolites associated to skin coloration in non-model organisms

- Isolated and characterized novel natural compounds associated to coloration using liquid chromatography, mass spectrometry and NMR techniques.
- Sequenced proteins from organisms with unsequenced genomes using *de novo* interpretation of MS/MS spectra.
- Performed bottom-up proteomics using different mass spectrometry ionization sources (MALDI, ESI) and analyzers (quadrupole, TOF, Ion Trap).
- Analyzed microanatomical distribution of natural products using confocal microscopy and MALDI imaging.

Faculty of Exact and Natural Sciences, University of Buenos Aires
Graduate Researcher; Advisor: Julián Faivovich and Sara Elizabeth Bari

Argentina
2011-2017

Study of the metabolic and chemical origins of the blue coloration of plasma and fluorescence emission in frogs

- Isolated and characterized tetrapyrroles from frogs using UV-Vis and FTIR spectroscopy and NMR.
- Extracted and characterized organic photonic crystals from animals' peritonea using elemental analysis and SEM/EDS.
- Developed photophysical methods to quantify fluorescence contribution in animals' coloration.
- Study of amphibian behavior and comparative anatomy and histology.

Bernardino Rivadavia Natural Sciences Museum, Argentina
Graduate Researcher

Argentina
2011-2017

- Performed comparative anatomical and histological studies.
- Executed RNA isolation, next generation sequencing and transcriptome assembly of liver samples from several non-model organisms. Performed bioinformatics analyses.
- Managed laboratory functions such as organization, scheduling equipment use and monitoring consumable supplies and reagents.
- Trained new students.

Leloir Institute Foundation
Graduate Researcher

Argentina
2011-2017

- Developed purification strategies (different liquid chromatography, differential precipitation and solubility) to isolate novel proteins involved in heme catabolism.
- Performed biophysical characterization of proteins by circular dichroism, fluorescence spectroscopy, static and dynamic light scattering.

OUTREACH

- Volunteer at the Museum of Natural Science, Argentina "Nights in the museum", (2012,2013,2014)
- Volunteer at "A night in the swamp" to teach children about amphibian biodiversity, (2010)
- Gave interviews for different broadcasting media: BBC, Reuters, France Press, National Geographic, El País, The Atlantic.
- Gave interviews for local radio shows in different countries to promote science communication
- Gave interviews for various scientific journals (Science, Nature, Physics Today, Chemistry World)
- Participated in the TV show "La liga de la Ciencia" (English: The Science League). "Las increíbles ranas fluorescentes, el descubrimiento argentino que sorprende al mundo". Hosts: Andrés Rieznik and María Eugenia López. Broadcasted by TV Pública, April, 2017.
- Participated in the short documentary "La rana fluorescente" (English: The fluorescent frog) explaining biological and photophysical aspects of frog fluorescence. <http://www.conicet.gov.ar/descubren-el-primer-caso-de-fluorescencia-en-ranas/>

PEER REVIEW

Reviewer for: *Biochemistry, Science of the Total Environment, Journal of Experimental Biology, Micron, South American Journal of Herpetology, Australian Journal of Zoology, Acta Herpetologica, Journal of Morphology*

FIELD EXPERIENCE

More than 10 years of field experience in Argentina and Brazil working with wildlife. Videos and tape recordings of animals in different physiological and behavioral contexts to understand the diversity of vocalizations, breeding patterns, camouflage strategies of many amphibian species.

TEACHING

Classes taught

Experimental design and data analysis, 2017 (Grad level, NPPNS, Faculty of Pharmaceutical Sciences, University of Sao Paulo, Brazil)

Invited lectures

Amphibians anatomy and physiology, 2015 (Undergrad level, Vertebrates, University of Buenos Aires, Argentina)

LANGUAGES

Spanish, English, Italian

REFERENCES

- (1) **Name:** Prof. Sönke Johnsen
University: Duke University
Email: sjohnsen@duke.edu

- (2) **Name:** Prof. Norberto Peporine Lopes
University: University of São Paulo
Email: npelopes@fcfrp.usp.br

- (3) **Name:** Prof. Junjie Yao
University: Duke University
Email: junjie.yao@duke.edu