



DEPARTMENT OF BIOLOGY

INDIANA UNIVERSITY
College of Arts and Sciences
Bloomington

November 26, 2018

Florida State University
Faculty Search (Evolution/Ecology Theory)

Dear Search Committee,

It is my pleasure to write in strong support of Dr. Rafael Guerrero's application for your tenure track faculty position. Since August 2013, Rafael has been a postdoctoral researcher at Indiana University, working in Matthew Hahn's lab, but also in extensive collaboration with my group and with me. Rafael is a very bright and broad-thinking population geneticist who uses theoretical, computational, and 'next generation' genomic approaches to address fundamental evolutionary problems—most especially the diverse mechanisms of evolutionary antagonism. In my experience he is also a valuable and collegial collaborator, and a thoughtful and attentive research mentor to younger scientists. I recommend him highly, and hope you'll consider his application for your position closely.

Rafael came to IU from doctoral work with Mark Kirkpatrick at the University of Texas, Austin. His PhD focused on theoretical and statistical approaches to understand the evolution of chromosomal (inversion) variation within populations. Using an impressive range of theoretical tools in a series of papers, Rafael developed several new analytical approaches to understanding the evolutionary dynamics of inversions, and their role in adaptation and speciation, producing ten publications (four first authored), in addition to one review.

After completing his dissertation, Rafael moved to IU primarily to work with Matthew Hahn on theoretical and analytical problems related to the evolutionary role of chromosomal inversions and sex chromosomes in lineage divergence. Much of this work was initially focused on *Anopheles* (mosquitoes), including data emerging from recent genome-wide sequencing efforts. Nonetheless, because of Rafael's powerful quantitative skills, and his interest in genetic interactions and divergence/speciation processes, Rafael also quickly began work with my group on projects related to our primary empirical system: the plant group *Solanum* (wild tomato species and their close relatives). Through this and his work in *Anopheles*, Rafael has become expert in handling and analyzing genome-wide data from next-generation sequencing approaches, skills that neatly complement his more analytically-focused doctoral work.

Rafael's mosquito research involves a collaborative interaction between the Hahn lab and other groups, and no doubt Matt will speak to these projects in his recommendation letter. In terms of his collaborative work with me, Rafael has made significant contributions to two general evolutionary problems. First, in conjunction with Greg Anderson at University of Connecticut (as well as Matt and I at IU), Rafael has been examining the evolution and genetics of dioecy (separate male and female sexes). Dioecy is uncommon, and recently evolved, in plant systems. Newly evolved dioecious species offer a unique opportunity to observe and test theories about the very first stages in the evolution of separate sexes, including the *de novo* evolution of sex chromosomes. As part of this work, Rafael is working with a graduate student in my group (Meng Wu) to assemble and analyze whole-genome

sequences from a recently diverged, dioecious species (*Solanum appendiculatum*), and a second somewhat older dioecious species (*Solanum polygamum*), using long-read (PacBio) and short read (Illumina) sequence data, along with gene expression (RNA-seq) data. Our initial goal in this work is to identify sex-linked regions in both these species. In the medium to long term, Rafael's goal is to use these new resources to address fundamental questions about the mechanism and tempo of *de novo* sex chromosome evolution in these newly evolved dioecious species.

Second, Rafael and I have collaborated on several projects related to gene expression, gene interactions, and the evolution of reproductive isolation between *Solanum* species. For example, using data from my lab and from previously published studies, Rafael analyzed and wrote an elegant paper on the relative importance of locally- versus distantly-regulated gene expression for species regulatory differences (Guerrero et al. 2016 *Evolution*). Similarly, in collaboration with another (now former) Hahn lab member James Pease, Rafael analyzed data from gene expression (RNAseq) data to detect expression differences accompanying post-mating prezygotic reproductive isolation barriers between tomato species (Pease, Guerrero, et al. 2016 *Molecular Ecology*). Most recently, Rafael and I worked on a dataset generated in my group that examined pairwise epistasis among loci that contribute to pollen and seed sterility between *Solanum* species. Rafael's network analysis approach showed that hybrid sterility loci often interact antagonistically, leading to 'diminishing returns' during the accumulation of reproductive isolation between lineages (Guerrero et al. 2017 *PLoS Genetics*).

While I am PI on the projects that collected the empirical data, Rafael is a true collaborator on this work, and the driving force behind the elements that are focused on theoretical and analytical approaches. Given this, we anticipate that this work will form the basis of long-term collaborative relationship between my lab and Rafael's own research program, once he accepts his own faculty position. Within this, Rafael will be the driving force behind (and 'owner' of) research focused on *de novo* sex chromosome evolution and on the evolution of genome-wide gene expression changes. With the increasing availability of genomic tools and resources across *Solanum*, including large datasets generated in my lab, and with his distinctive skills and background, Rafael is uniquely positioned to lead an integrated, conceptually-driven program that addresses evolutionary theory and genomics of reproductive interactions and novelty.

Overall, these and his other current and future research directions make Rafael an excellent match for a faculty position focused on using genomic, statistical, and analytical tools to understand fundamental evolutionary genetic processes.

Finally, apart from research talents, Rafael is simply a very pleasant, modest, and down to earth, colleague. He is open, collegial, and generous with his time. He's a respected contributor to my lab community, and when he decides to take a faculty position I will genuinely miss our intellectual interactions. During his time at IU, he has mentored several younger scientists, including graduate students in both the Hahn lab and in my own. He is currently leading several complex research projects, including shaping both their practical and conceptual directions. Given the combination of research, collaborative, and interpersonal skills he would bring to a leadership position, I have no hesitation in recommending him highly.

Sincerely,



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