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Methylation patterns of transposons linked to rapid adaptive responses in insects

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Work done in the lab of Dr. Suresh Nair at the International Centre for Genetic Engineering and Biotechnology

Ayushi Gupta obtained her Bachelor's degree from Gargi College and her Master's in Botany from the Department of Botany, University of Delhi. She was awarded the Panchanan Maheshwari Memorial Prize (Gold Medal) for being the best candidate in M.Sc. Botany examinations. She is currently pursuing her doctoral studies, under the able guidance of Dr. Suresh Nair, at the International Centre for Genetic Engineering and Biotechnology, New Delhi. Her research primarily focuses on understanding the molecular mechanisms underlying the rapid adaptive nature of insect pests. In addition, she is also interested in studying the role of the gut microbiome in insects' survival. Furthermore, she aspires to pursue a career in research in the field of plant-insect interactions.

How would you explain your research outcomes to the non-scientific community?

Insect pests continue to scourge our efforts to cultivate plants for food, fiber, and other needs. Owing to their rapid adaptive nature, they have invaded almost all agro-ecosystems. However, the molecular mechanisms underlying the rapid adaptations and evolutionary success of insect pests are unclear. In this regard and using brown planthopper (BPH) – the second most devastating pest of rice – as a model organism, our group investigated the role of transposable elements (TEs) in mediating rapid adaptations in insects. TEs exhibit vast diversity across insect orders and are one of the major factors driving insect evolution and speciation. Once regarded as 'genomic parasites,' they are now recognised as insect symbionts, which can be both beneficial and deleterious to their host, depending on the circumstances. Besides, the TE landscape within insects is an essential determinant of their life-history traits, adaptations, and survivability under hostile environments. Congruently, the study of these elements in BPH revealed at least two major transpositional events during its evolutionary history, thereby highlighting the contribution of TEs in shaping the BPH genome.

Further, it is interesting to note that while the presence of TEs can facilitate quick adaptations, they also impose an immense load on the genome. Hence, we speculated the involvement of regulatory processes (s) such as DNA methylation in keeping the activity of transposons in check. In this regard, we performed comparative analyses of DNA methylation patterns of Tf2 elements (a type of transposon) in BPH, exposed to pesticide and nutritional stress, across its life stages. Our results confirmed the involvement of methylation in the regulation of TE dynamics under stress thereby adding to our current understanding of the role of transposons in influencing the evolutionary trajectory and survival strategies of BPH.

How do these findings contribute to your research area?

Investigation of molecular mechanisms underlying genome flexibility, phenotypic plasticity, and rapid stress-adaptation(s) enhances our understanding of the emergence of BPH as a major destructive pest of rice. Further, the insights obtained from our study would help in determining the influence of climate change on the migration pattern, life-cycle, and population dynamics of BPH – all vital factors that have enabled it to invade and colonize different agro-climatic zones of the world. Besides, this study provides new avenues and offers an alternate approach for the management of an important rice pest in a more sustainable, precise, and environment-friendly manner. In addition, our findings can serve as the basis for extending such investigations to other pests of agricultural importance.

What was the exciting moment during your research?

The whole journey was exciting as we investigated mechanisms that remain unexplored for any crop pest. Initially, this project started as an idea that I wasn't very clear. So, I discussed it with my mentor, and we evaluated the possibility of developing it into a research project. After a thorough survey of the literature, we realised that this study might help us fill in the lacunae in our understanding of the evolution of insects as destructive pests. Therefore, we laid down our aims and objectives and embarked on this journey, which comprised several moments of excitement and disappointment. But after completion of the project, and publication, I think it was all worth it.

What do you hope to do next?

Our lab is currently working towards establishing the involvement of epigenetic processes in the stress resilience of BPH. We are now focusing on studying the role of DNA methylation in regulating the activity of various stress-associated genes in BPH. In the future, I wish to continue exploring other fascinating aspects of insect biology and pursue a research career in the field of plant-insect interactions.

Where do you seek scientific inspiration?

Science is what I enjoy, and biology is the field that I have been associated with for the past several years. However, I got inclined towards scientific research during my postgraduation days at the University of Delhi. During that time; I was introduced to this fascinating field of plant-insect interactions. Throughout my career, I have been fortunate enough to be around some highly dedicated teachers, professors, and peers who motivated me towards pursuing science. Especially my Ph.D. supervisor, who has always backed my research ideas and is one of the humblest human beings, I have come across. This work is, in fact, the result of lengthy discussions I have had with him. Besides, the cutting-edge research work carried out by eminent scientists across the globe continues to inspire me.

How do you intend to help Indian science improve?

In addition to sharing the research on mainstream research portals, we use social media sites such as Facebook, Twitter, etc., to disseminate our research outcomes to the non-scientific community. Besides, the ICGEB Communications, Public Information, and Outreach Office works with media for the visibility of the Organization, its activities, and dissemination of scientific information to a range of audiences.

At the personal level, in the future, I hope to involve in teaching activities, seminars, and workshops to inspire young Indian minds towards scientific research. Besides, I plan to engage with a broader research community and the public through writing articles, blogs and participating in scientific discussions. While most scientific research in agricultural sciences is based on assumptions and follows a very general and idealistic approach, the ground realities are

way more complex and heterogeneous. Therefore, it is necessary to consider the specific environmental and socio-economic realities faced by the farmers and translate our research from the lab to the field. This is possible by bridging the gap between researchers and the farming community through regular interactions and field trips. I intend to participate in such activities that would improve science and help us achieve our goal of sustainable agriculture. Also, I appreciate this initiative of Biopatrika aimed at fostering scientific communication and encouraging young minds to pursue science.

Reference

Ayushi Gupta, Suresh Nair (2021). Methylation patterns of Tf2 retrotransposons linked to rapid adaptive stress response in the brown planthopper (Nilaparvata lugens). Genomics 113, (6) 4214–4226. https://doi.org/10.1016/j.ygeno.2021.11.007

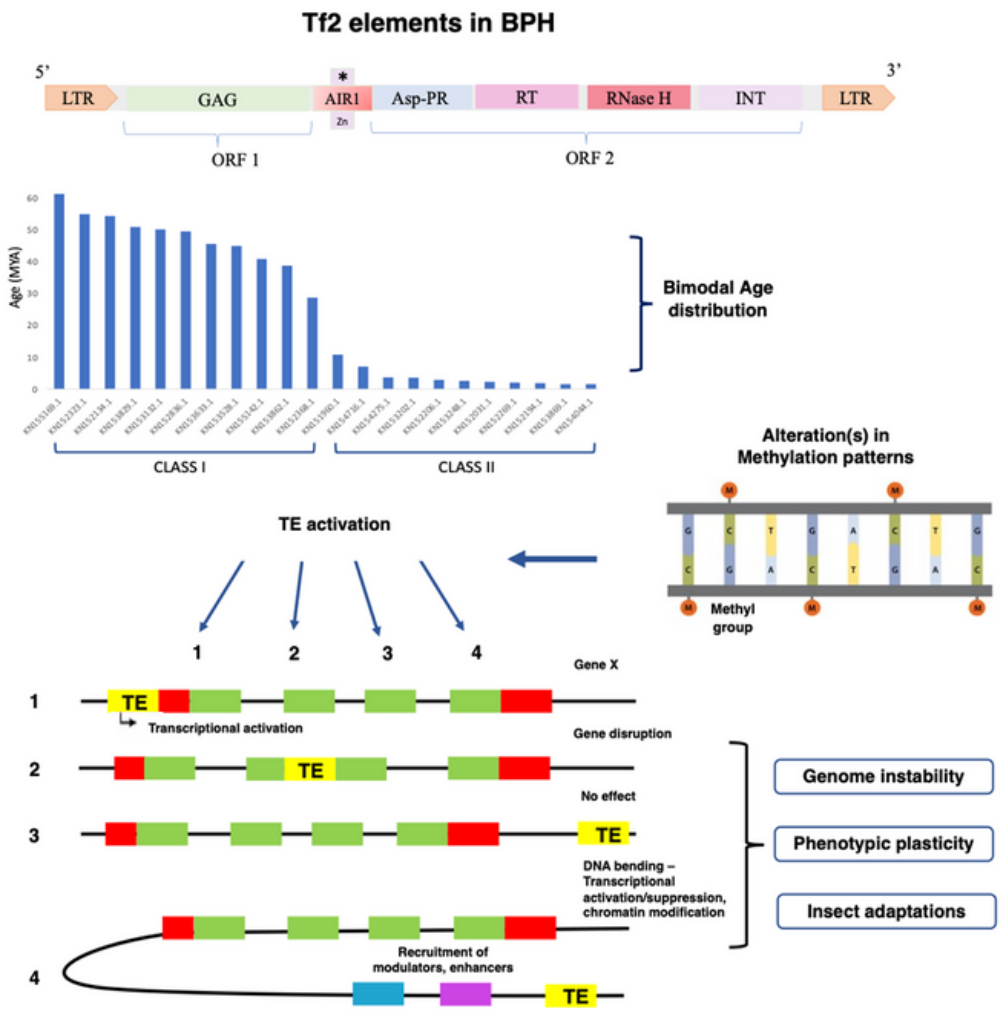

Figure: Depiction of the structure, age, and mechanisms modulating the activity of Tf2 elements (a type of transposon) in BPH.