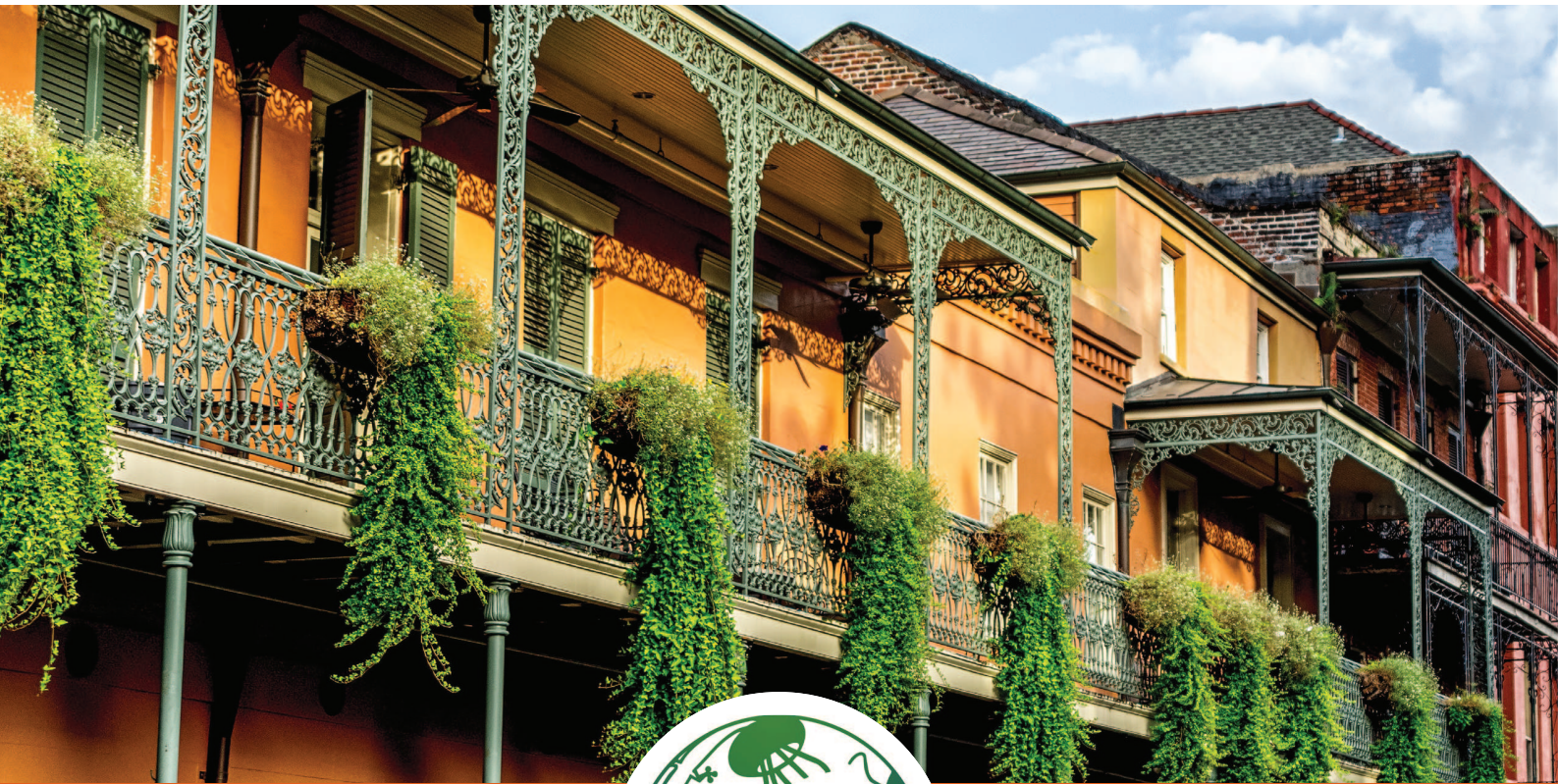


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***The trade-off between biting and singing performance in finches explained by biomechanical modelling***

Field observations have shown that the species of Darwin's finches that specialized to feed on hard seeds have a decreased ability to conduct rapid changes in beak gape during singing. This limits their performance in producing dynamically complex songs. As songs of Darwin's finches are used in species recognition and mate choice, the observed trade-off between force and movement frequency of the beak may have had a direct influence on interspecies mating dynamics, probabilities of hybridization, and ultimately the process of speciation. However, it is unknown what causes this biomechanical trade-off. We analyzed this trade-off by dynamic, multi-body modelling based on a motion analysis of the beak of a species (Java finch) that closely resembles a Darwin's finch with a medium-sized beak, and an existing database of 3D morphology of the head of the Java finch and several Darwin's finches. Counter to our initial expectations, the model shows that increases in beak mass (to avoid beak fractures during forceful biting) have a negligible effect on the maximum attainable frequency of beak gape changes. However, when the beak opener system remains unmodified, the trade-off is caused by shifting of the gearing of the beak closer system to increase static bite force: such imbalance in gearing inevitably causes a pause between beak closing and the start of beak opening due to the twitch relaxation time of the beak closer muscles. Species with a head specialized to crack hard seed are thus mechanically limited to produce complex songs because of the negative effect of increases in moment arms and pennation angles of their beak-closer muscles on beak movement frequency.



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## **FINAL PROGRAM**

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