Agent Based Models of competitive sympatric speciation: an investigation into the role of mate search tactics and complex phenotypes

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Competition can be a creative force. The evolution of new species due to competition for a limited resource between individuals of a population is one example that has received increased theoretical attention in evolutionary biology. Competition is one form of disruptive selection in sympatric speciation models. In contrast to allopatric speciation where geographical isolation enforces reproductive isolation between new newly formed populations, there is no barrier to gene flow in sympatric speciation. Competition and the subsequent evolution of assortative mating can generate such a barrier.

After a first phase of studies that showed that sympatric speciation does work in principal attention is now slowly shifting towards understanding the nuts and bolts of this species creation process. Published analytical and simple individual based models, however, are very limited in “biological realism” due to their complexity constraints. Individuals are not treated as single units, resources (such as food) are not explicitly modeled and many other simulation features are also highly simplified. Mate search tactics in the context of assortative mating and complex phenotypes are just two domains that fell prey to mathematical intractability in analytical models and simple IBM’s.

Here I present an agent based model of competitive sympatric speciation that does not suffer the aforementioned complexity constraints. One reason lies in the very nature of agent based modeling and the other resides in the implemented architecture of the model. By following a plug-and-simulate approach (similar to what Gulyas calls “Relational Agent Models”) based on interfaces and dynamic class loading it is possible to test many different scenarios by simply exchanging a few simulation objects. Several different, spatial and non-spatial ecological conditions (food distributions, e.g. 2-patches, gaussian and gradient) can be tested against different implementations of mate search tactics (best-of-n and threshold-based variants). Results indicate that best-of-n mate search is significantly more successful in splitting a population than threshold-based search.

A second line of investigation refers to complex phenotypes. In traditional models only a single fitness trait is considered. This model implements phenotypes that consist of pleiotropically linked sub-units. Agents with complex phenotypes have to compete for multidimensional food items. Results show that there exists an optimal degree of interaction between sub-units for speciation to occur.