Darwin (1871) defined sexual selection as selection on those traits specifically involved with acquiring mates. Examples of traits that are thought to be sexually selected include bright, conspicuous coloration (e.g. a peacock's tail) to attract mates, or weaponry in males (e.g. tusks or horns) to battle other males for access to females. Often, traits that convey a sexual selection advantage may be counterbalanced by natural selection. For example, African Widowbird males have unusually long tails, much longer than females of the species. Andersson (1981) found that females prefer males with experimentally lengthened tails but that these males were more likely to succumb to predation. Thus the naturally occurring tail lengths are thought to be a balance of natural and sexual selection.

This model is an agent-based simulation of John Endler's (1980) classic experiment on the balance of sexual selection and natural selection. Guppies are familiar small fish that live in freshwater on Caribbean islands and in South America. They are sexually dimorphic, with males being smaller than females, with much larger tails and fins. In Trinidad they live in small pools associated with mountain streams, some of which have pike cichlid (which prey on guppies) and some do not. Endler found that females prefer to mate with 'flashier' males, those with more orange spots on their tail. However, the flashier males may also be more conspicuous to predators and be more likely to be eaten. Thus, there are conflicting selective pressures on male guppies. With this model, you can set up virtual experiments similar to Endler's artificial pond experiments. You can vary the strength of female preference and the number of pike, and another species *Rivulus*, in the pool.

Model Details

The agents are fish in a small pond. Tracked is the number of tail-spots on male (range 0 to 10). The model simulates overlapping generations, with reproduction occurring whenever guppies may meet. Pike and *Rivulus* will attack male guppies, with the likelihood of attack increasing with the number of tail-spots. Female guppies are attacked at a rate similar to unspotted males. Most of the genes for tail-spots are on the Y-chromosome (Brooks & Endler, 2001; Karino & Hajima, 2001) and are modeled as such. Females exhibit preference by roughly comparing an individual male to their sense of the average population (Houde, 1997). Thus preference is relative, not absolute, and is modeled as such.

Figure 1: Screen shot of 'Endler's Guppies' simulation

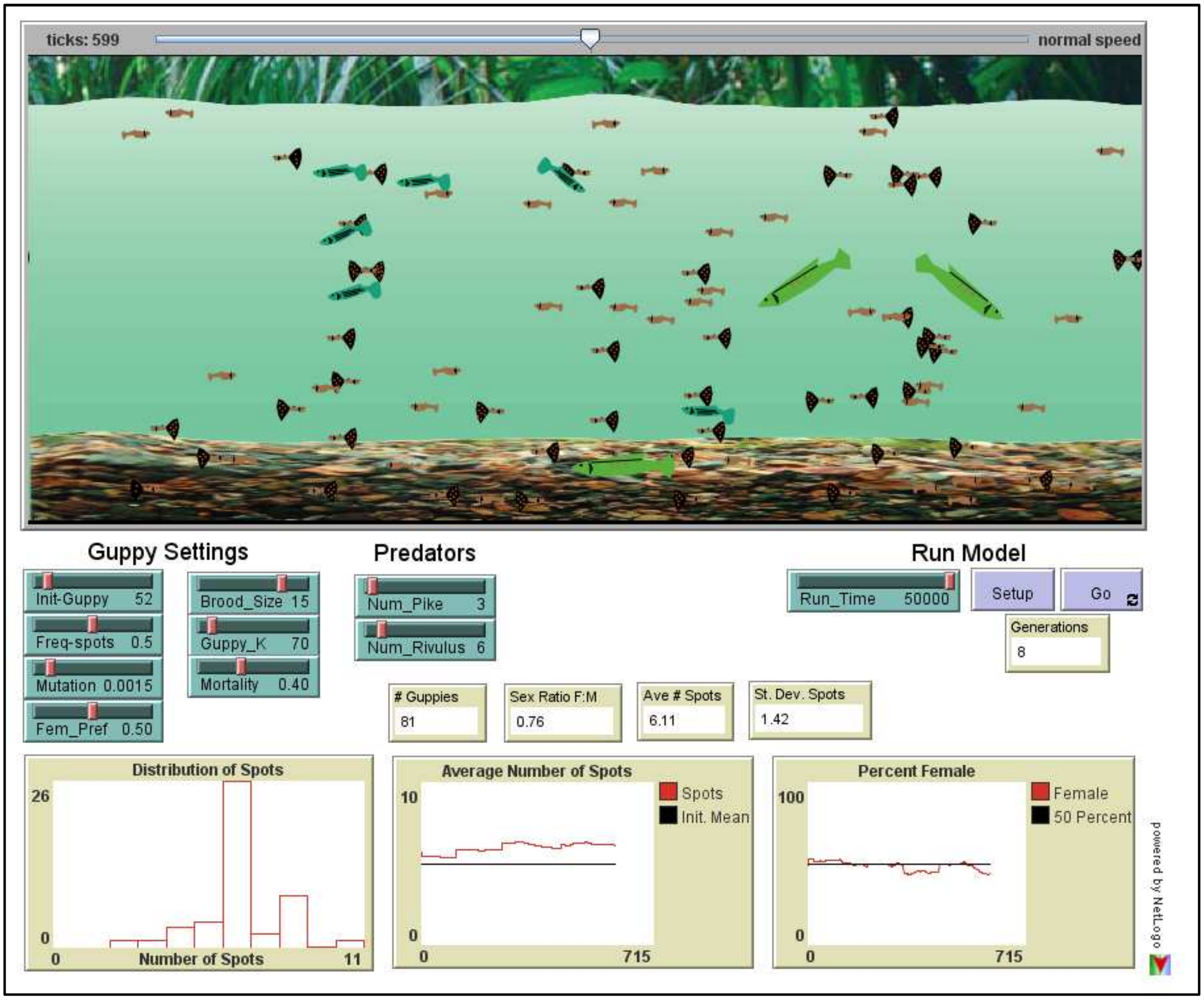

Table 1: Controls for 'Endler's Guppies' simulation

Control	Action
Init_Guppies	Starting population size of guppies (0-400)
Brood_Size	The number of guppies hatched in a reproductive event (0-20)
Freq_Spots	Average number of tail-spots at the start (0-1.0)
Guppy_K	The maximum number of guppies that can be sustained in the pond (0-500)
Mortality	The probability that a guppy will randomly die in 100 ticks (0-1.0)
Fem_Pref	The likelihood that a female will reject a male with less than the mean spots
Num_Pike	The number of pike cichlids in the pond
Num_Rivulus	The number of *Rivulus* in the pond
Run_Time	The number of ticks the model will run

Table 2: Reporters for 'Endler's Guppies' simulation

Reporter	Description
# Guppies	The current population size of guppies
Sex Ratio F:M	The ratio of female to male guppies
Ave # Spots	The current mean number of spots among males
St. Dev. Spots	The current standard deviation in the number of spots among males
Generations	The number of generations that have passed since the simulation start
Distribution of Spots (graph)	Histogram of the number of males by spots
Average Number of Spots (graph)	The mean number of spots among males over time
Percent Female (graph)	The percent of the population that is female over time

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