Eckhart Arnold

Explaining Altruism

A Simulation-Based Approach and its Limits

www.eckhartarnold.de

Contents

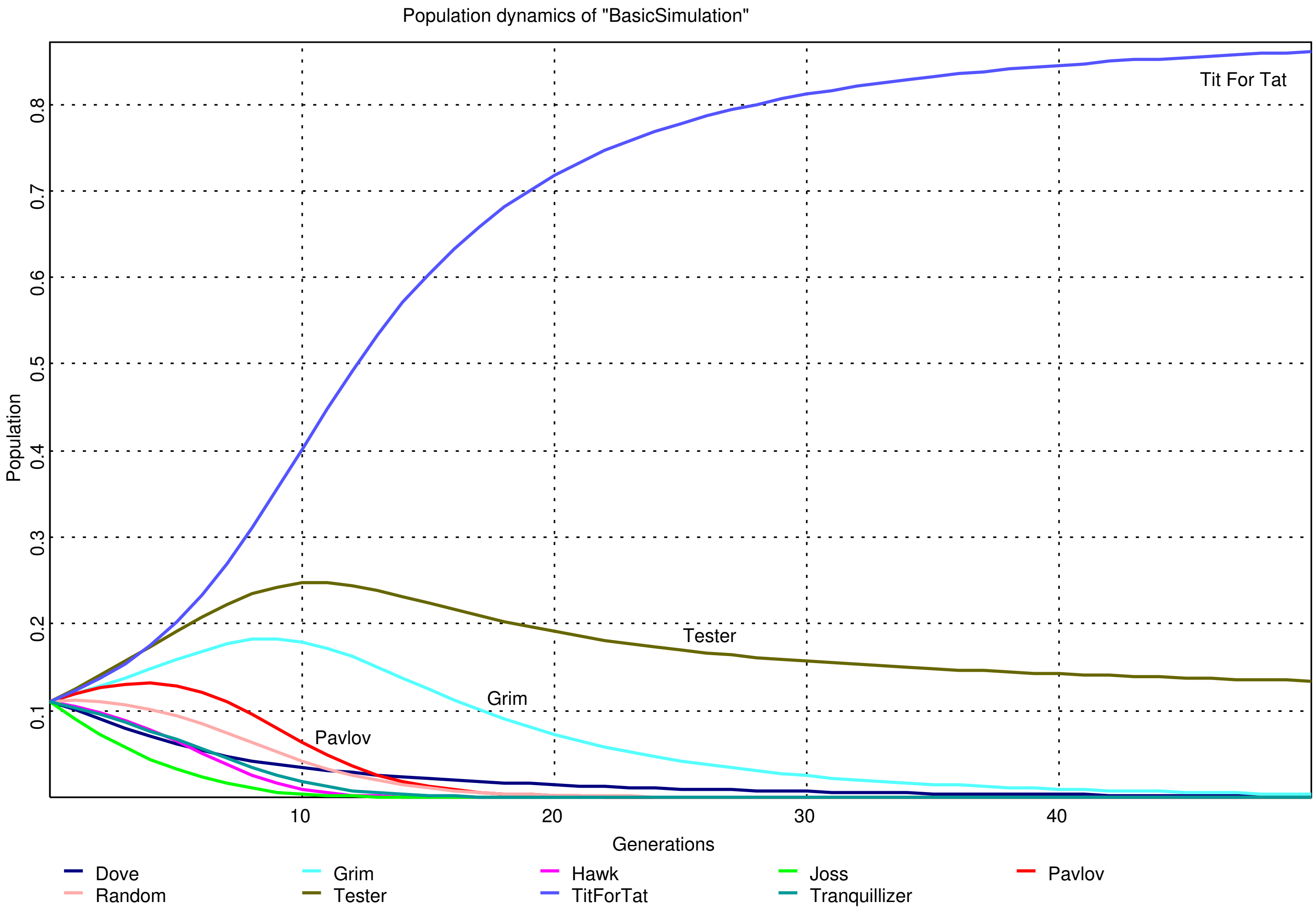

Figure 4.3: An evolutionary simulation of the reiterated Prisoner's Dilemma.

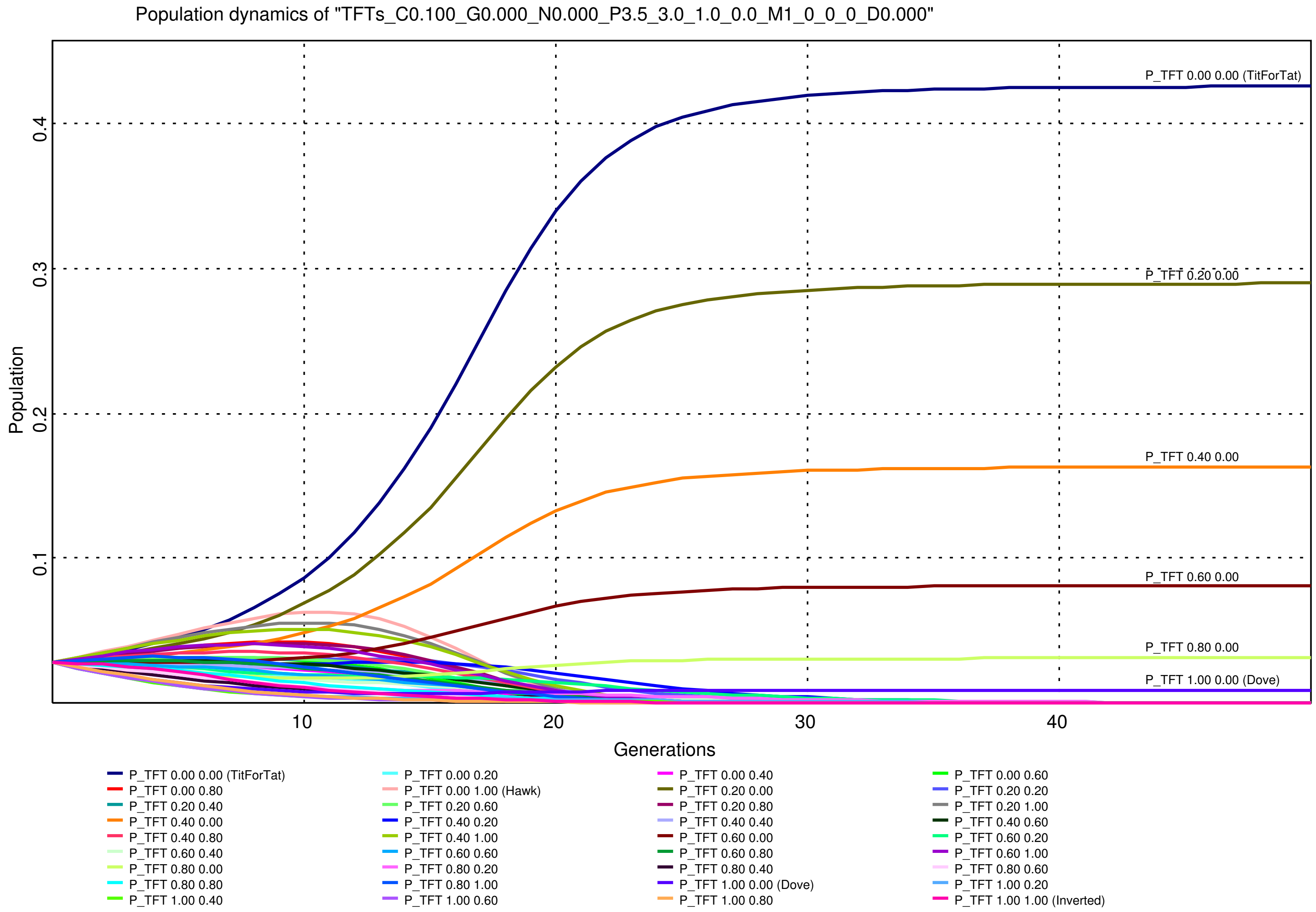

Figure 4.5: A stable mixed equilibrium with *Tit for Tat* as the winning strategy and even more cooperative strategies surviving in the "slip stream" of *Tit for Tat*. The simulation (no. 580 of the "big series") uses the payoff parameters T=3.5, R= 3, P=1 and S=0 and a correlation value of 10%.

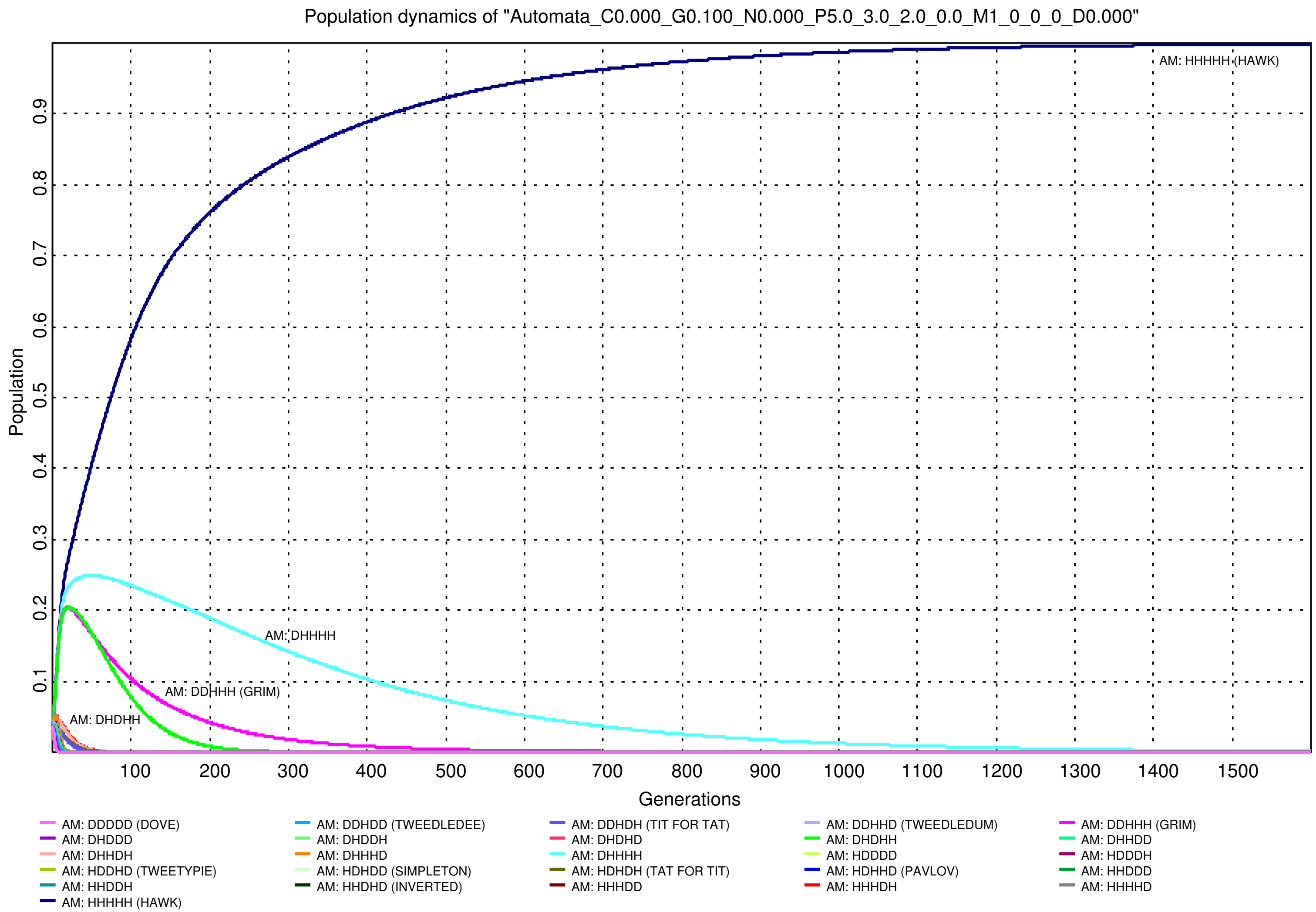

Figure 4.6: Example of a pure strategy equilibrium. In this case the non-cooperative strategy *Hawk* takes over the whole population. In the simulation (no. 106 of the "big series") a strong game noise of 10% was present. The payoff parameters were set to T=5, R=3, P=2, S=0.

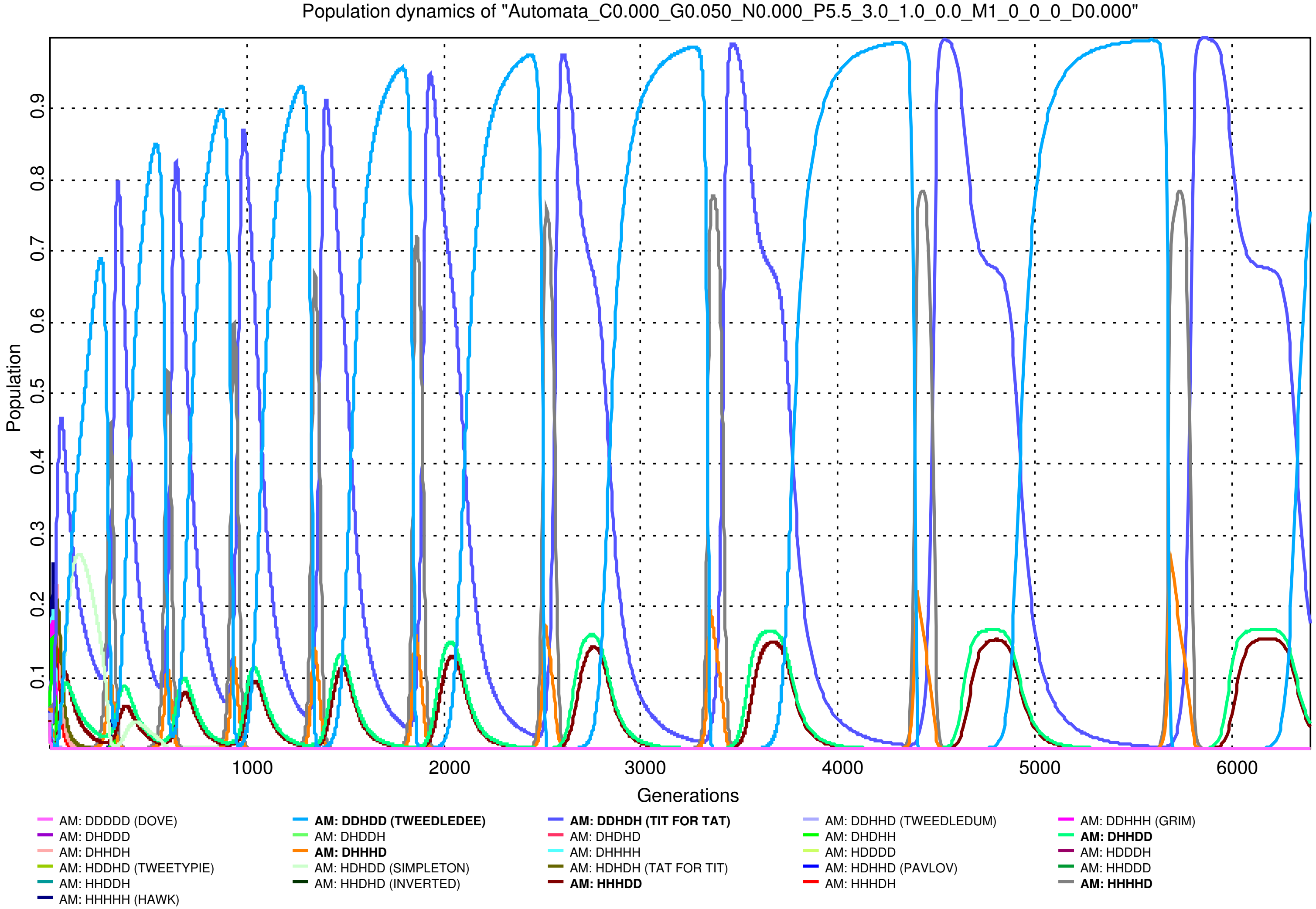

Figure 4.7: Example of strategies dominating the population in interchanging cycles. The result occured in simulation no. 55 of the "big series" under a game noise of 5% and the payoff parameters T=5.5, R=3, P=1, S=0.

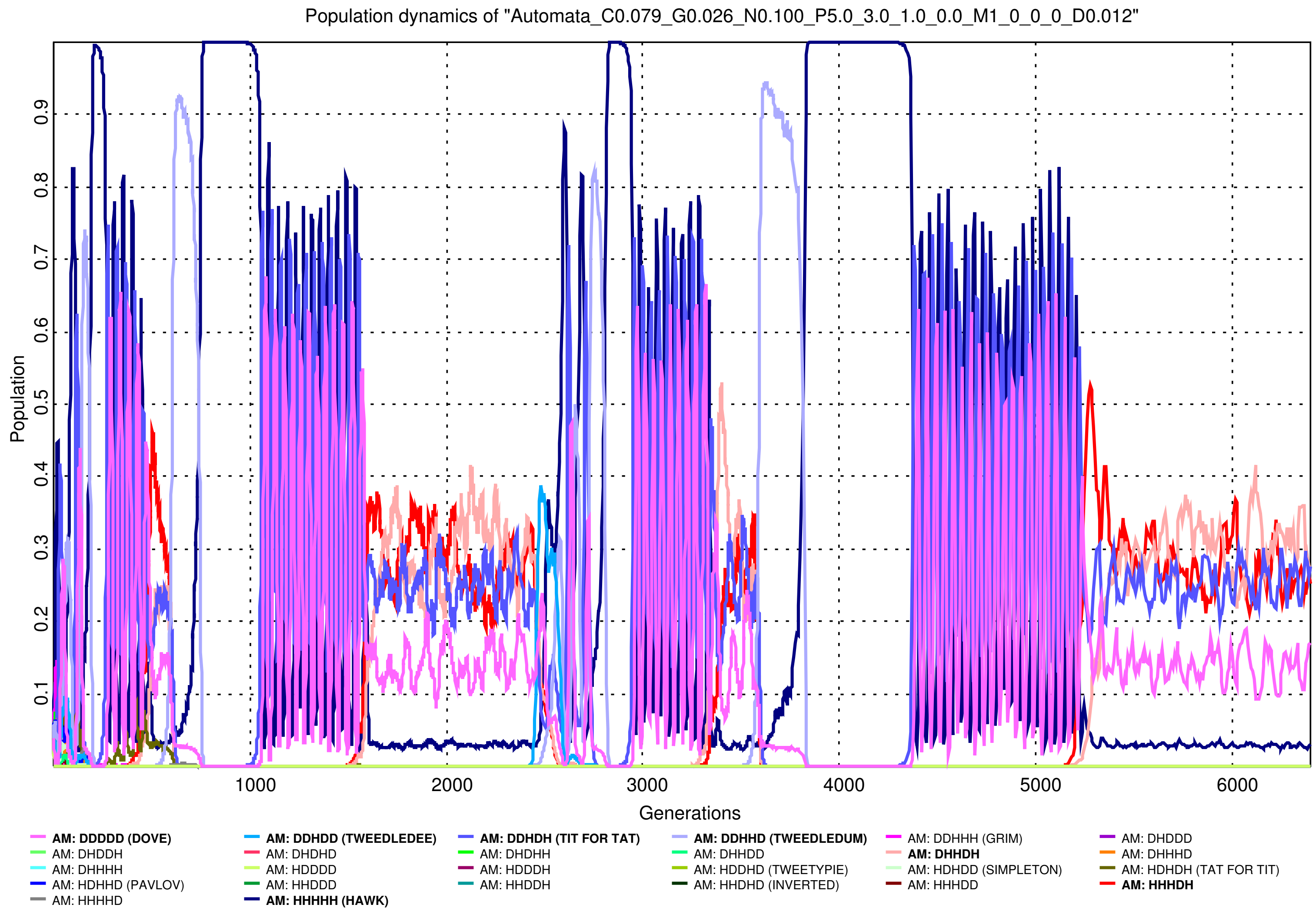

Figure 4.8: Example of strategies dominating the population in interchanging cycles. The simulation was taken from the "Monte Carlo series" (simulation Nr. 634). It uses the standard payoff parameters of T=5, R=3, P=1, S=0 with a correlation factor of 0.079301, a game noise of 0.025585, 0.09998, an evolutionary noise of 0.99980 and degenerative mutations that occur with a proabability of 0.01191.

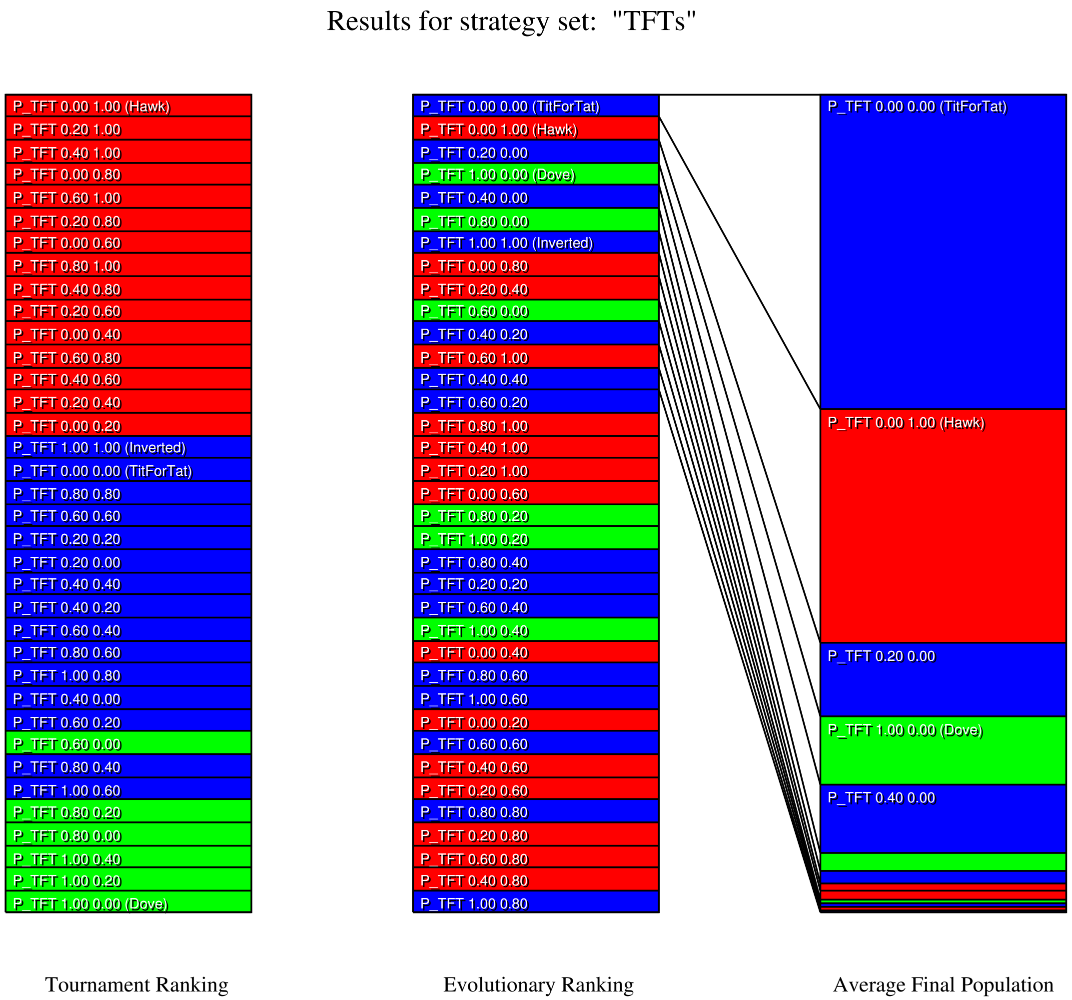

Figure 4.9: The aggregated results of the 432 simulations from the "big simulation series" using the set of *Parametrized TFT* strategies.

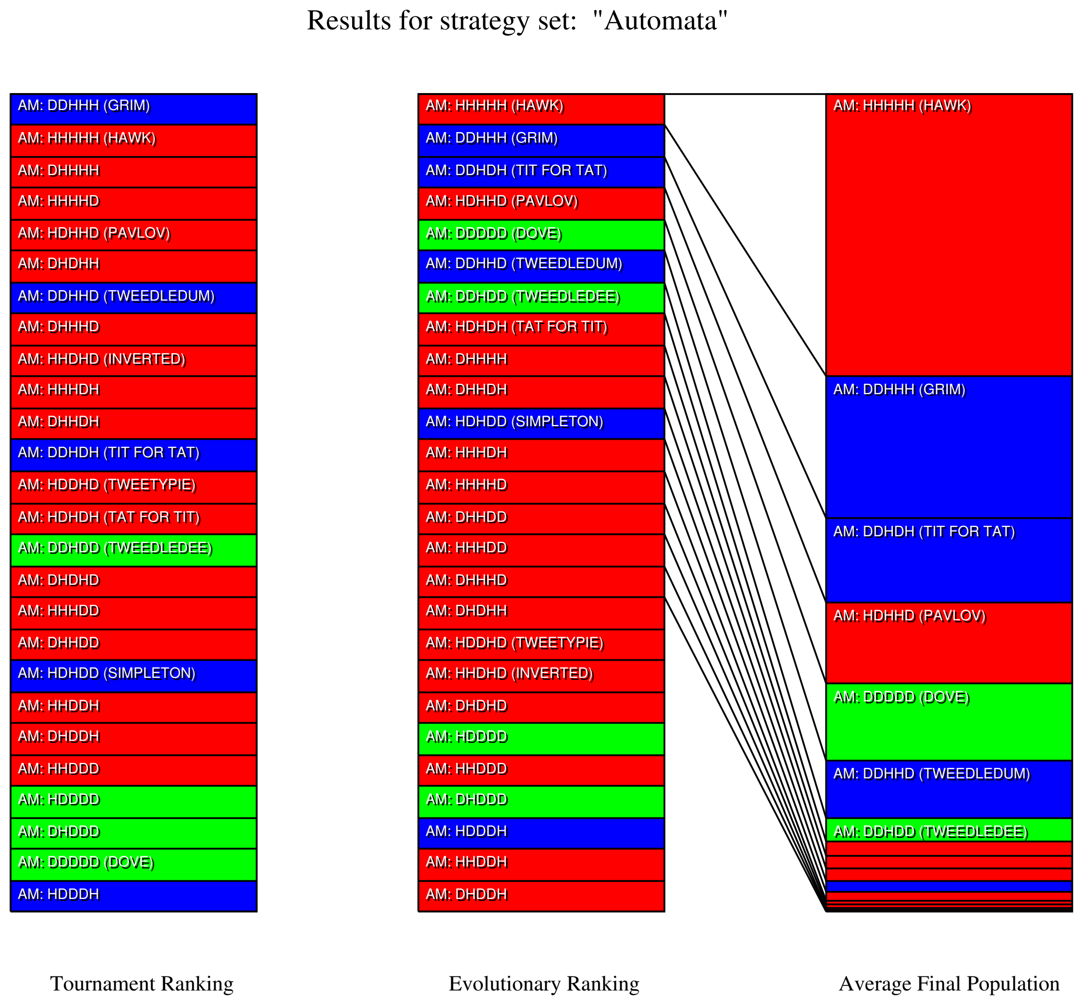

Figure 4.10: The aggregated results of the 432 simulations from the "big simulation series" using the set of *Two State Automata* (see appendix 8.1.3) strategies.

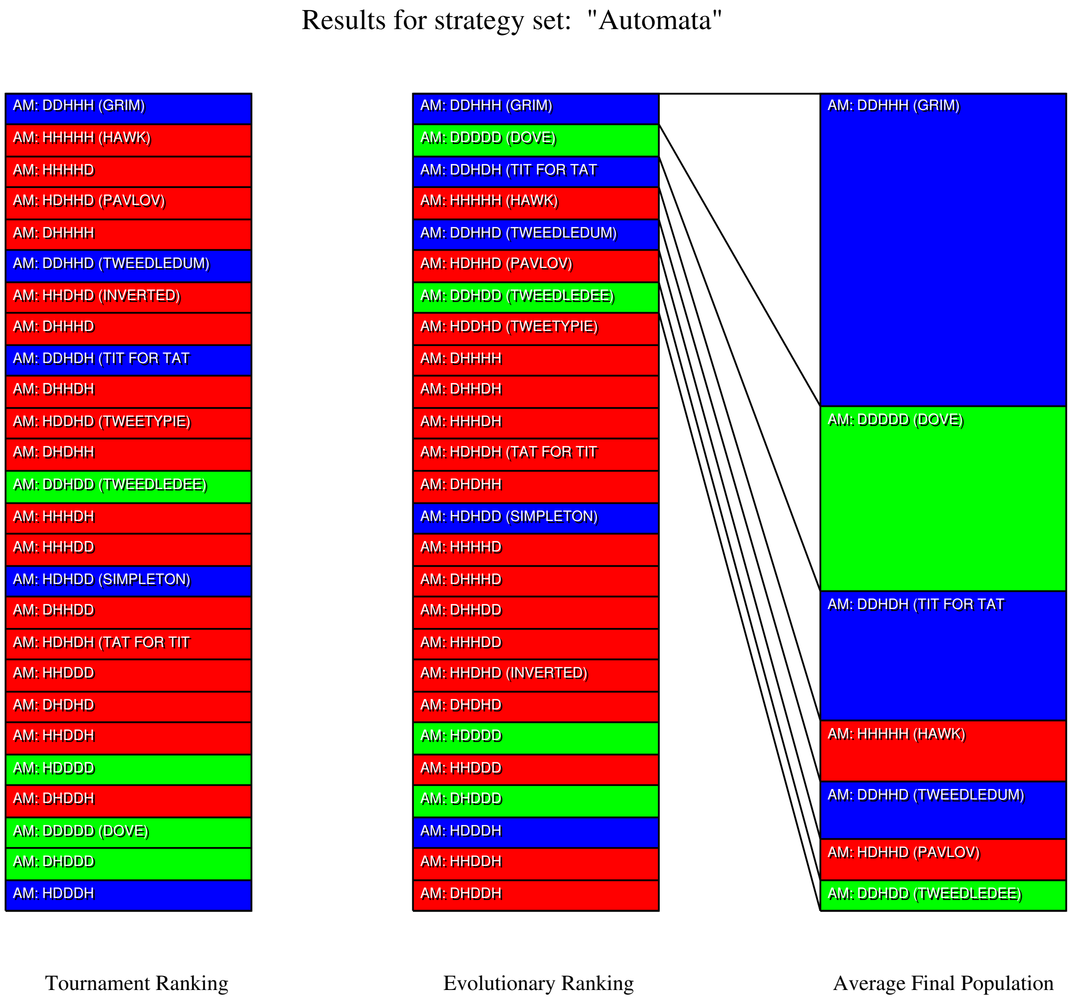

Figure 4.11: Absence of *game noise* strongly increases the success of reciprocal and altruistic strategies. (See figure 4.10 in comparison.)

Results for strategy set: "Automata"

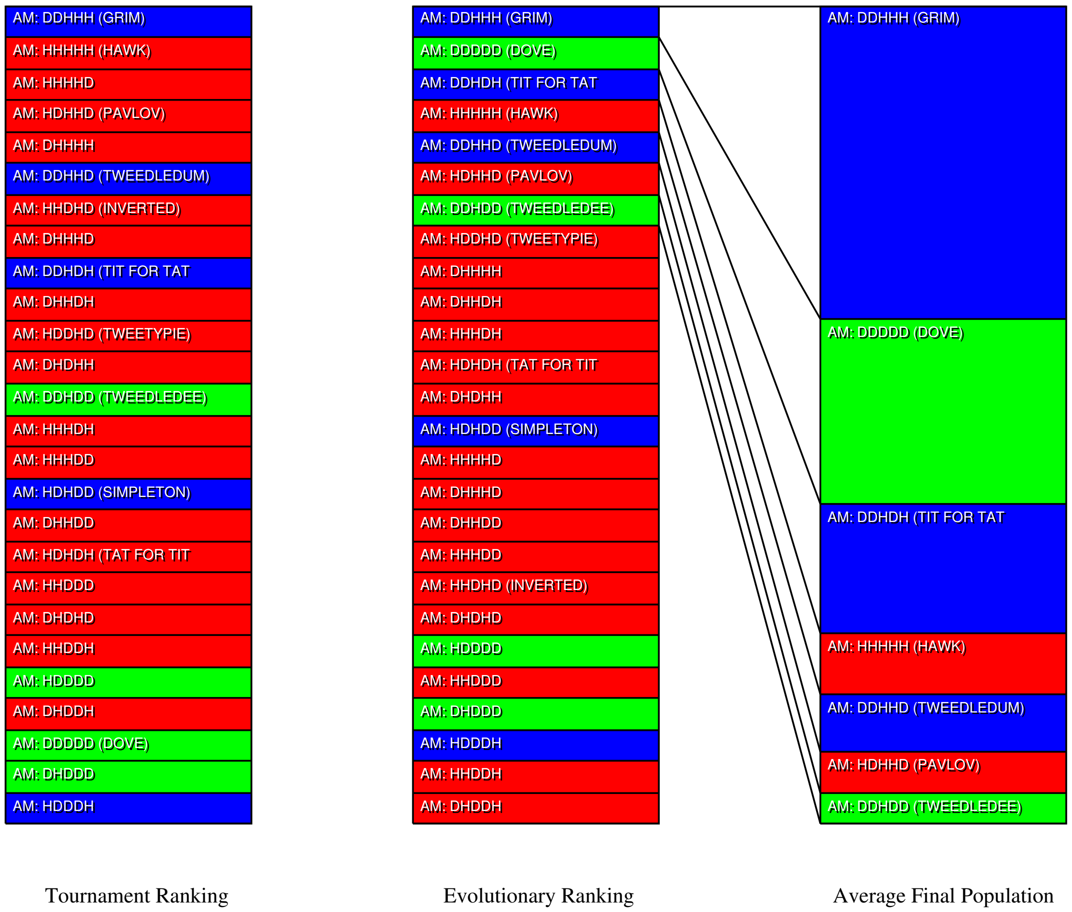

Figure 4.12: The absence of *game noise* has the same positive effect on the evolution of cooperation for the strategy set consisting of the *parametrized TFT* strategies. (See figure 4.9 in comparison.)

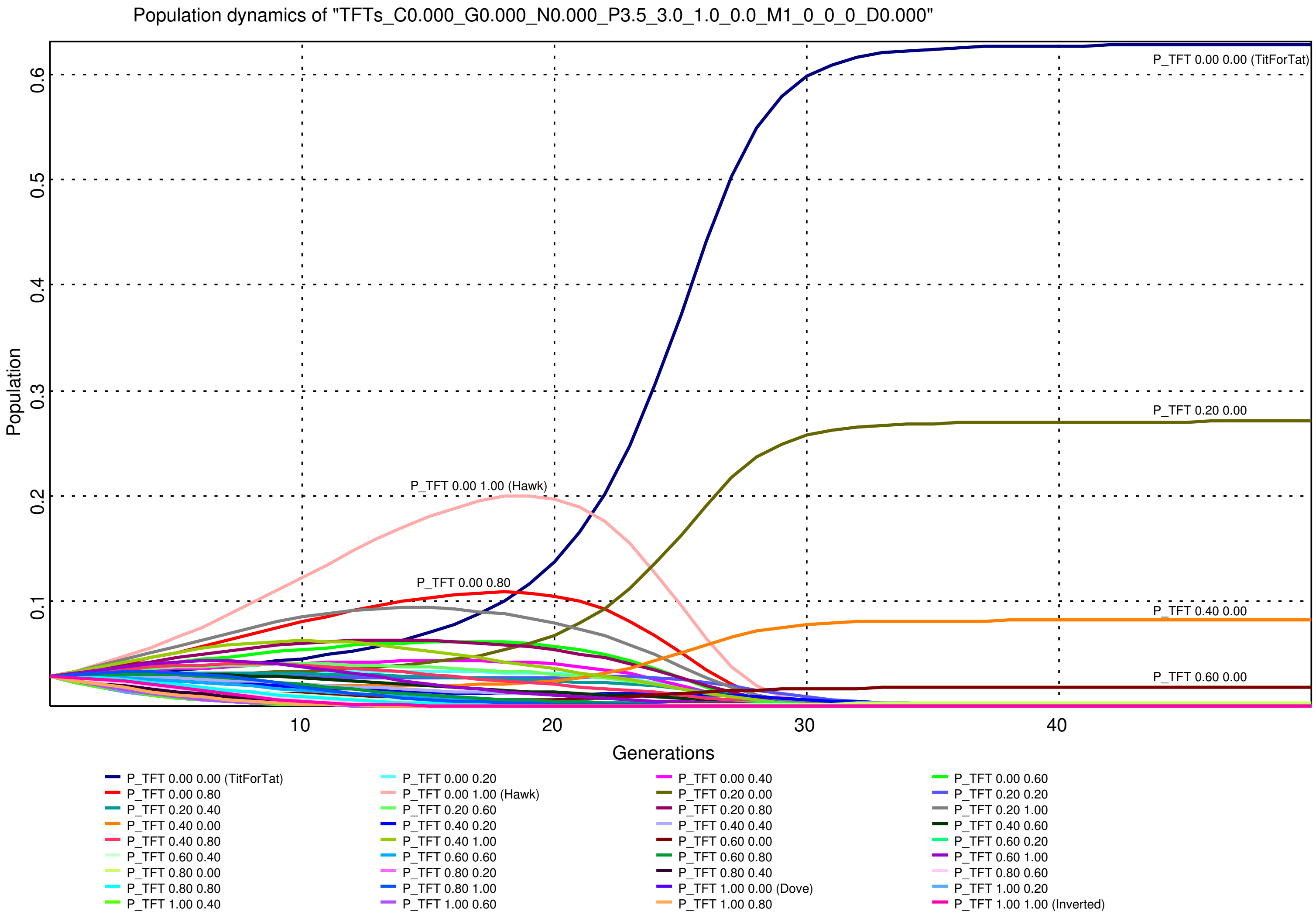

Figure 4.14: In the slip stream of reciprocal strategies like "Tit for Tat" more genuinely altruistic strategies thrive. (Simulation no. 436 from the "big series" with payoff paramters T=3.5, R=3, P=1, S=0.)

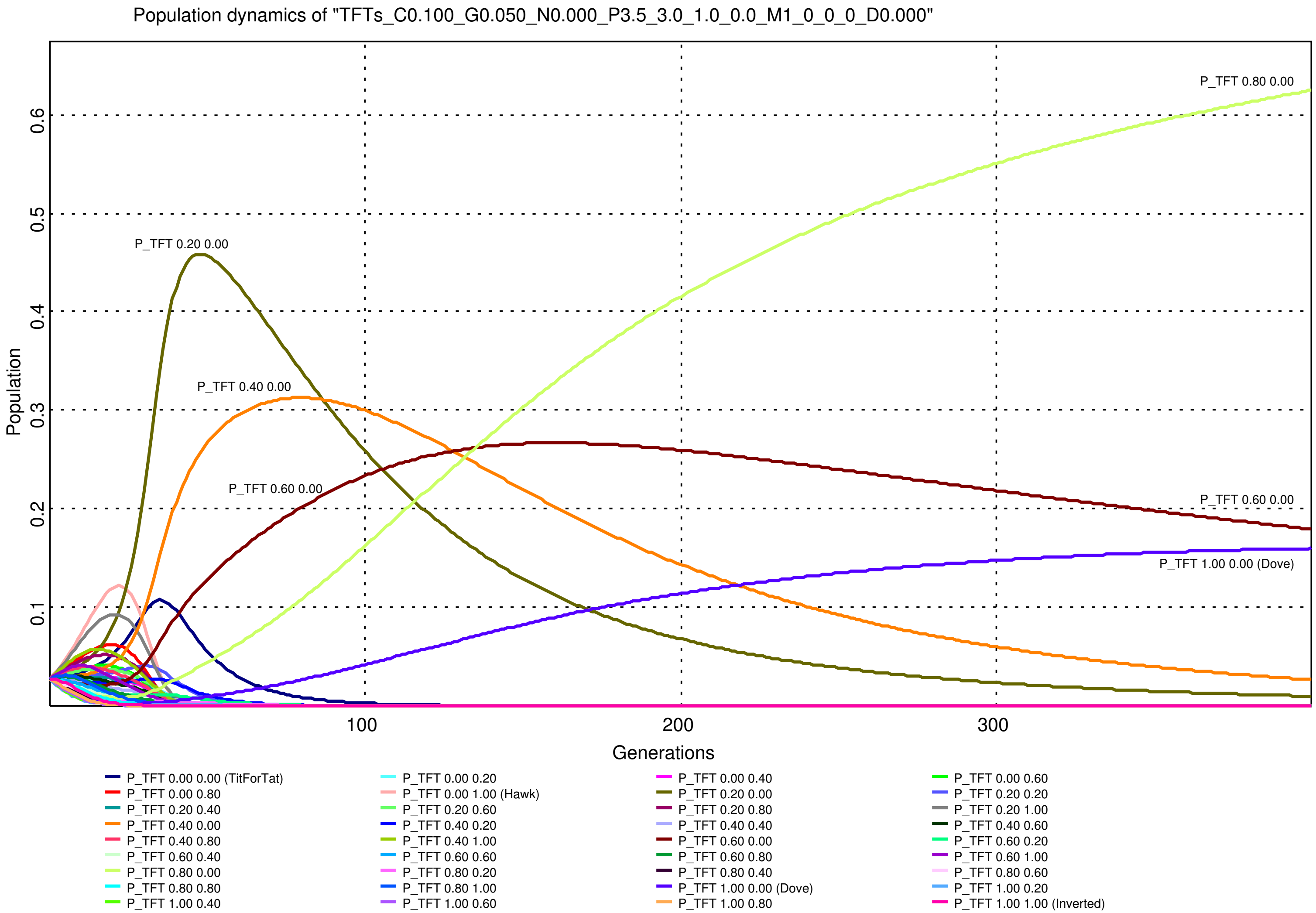

Figure 4.15: Another example of how genuine altruism may evolve in the "slip stream" of reciprocal altruism: After the reciprocal strategies have cleared the way the genuine altruists take over the population. (Simulation no. 628 from the "big series" with a correlation factor of 10%, a game noise of 5% and payoff parameters T=3.5, R=3, P=1, S=0.)

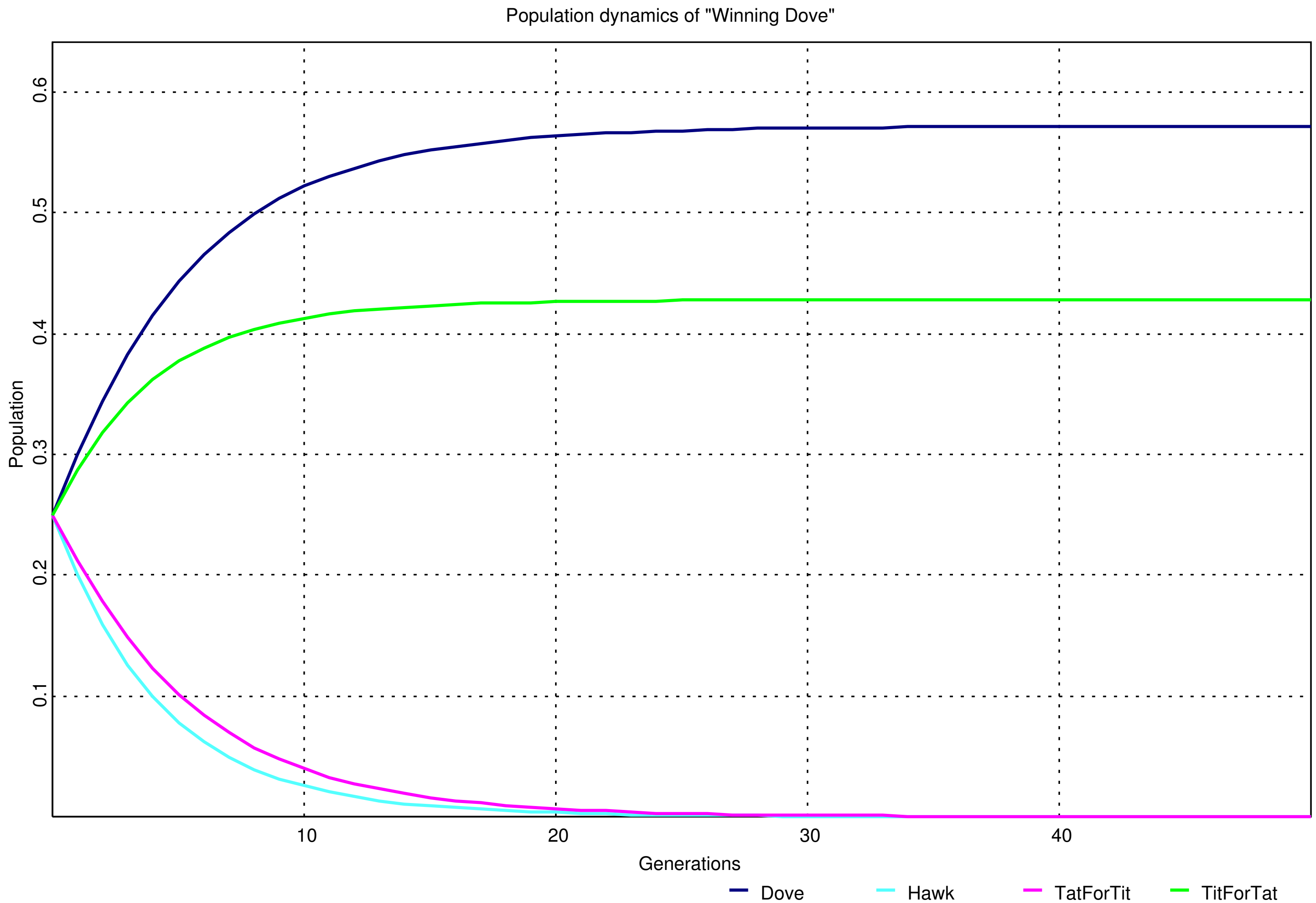

Figure 4.16: If the reciprocal strategies in the simulation are of conflicting types (like *Tit for Tat* and *Tat for Tit*) then “naive” or genuine altruists like *Dove* can become the “laughing third” and win the evolutionary race. (This simulation uses the payoff paramters T=5, R=4, P=1, S=0.)

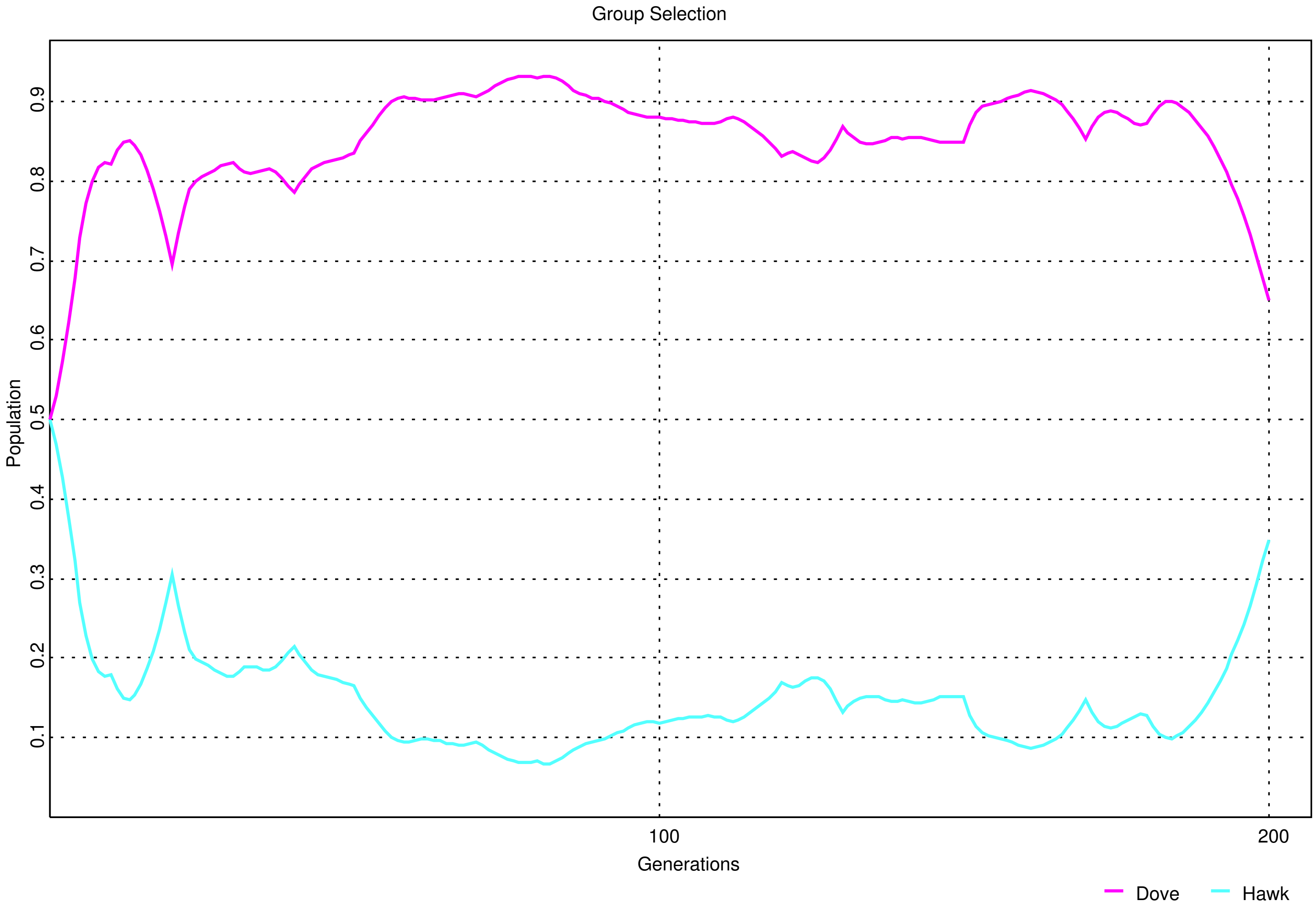

Figure 4.17: In a group selection model even genuine altruism can be a successful strategy. For this simulation of group selection the population was divided into 25 demes which are reshaped randomly every 10 generations.

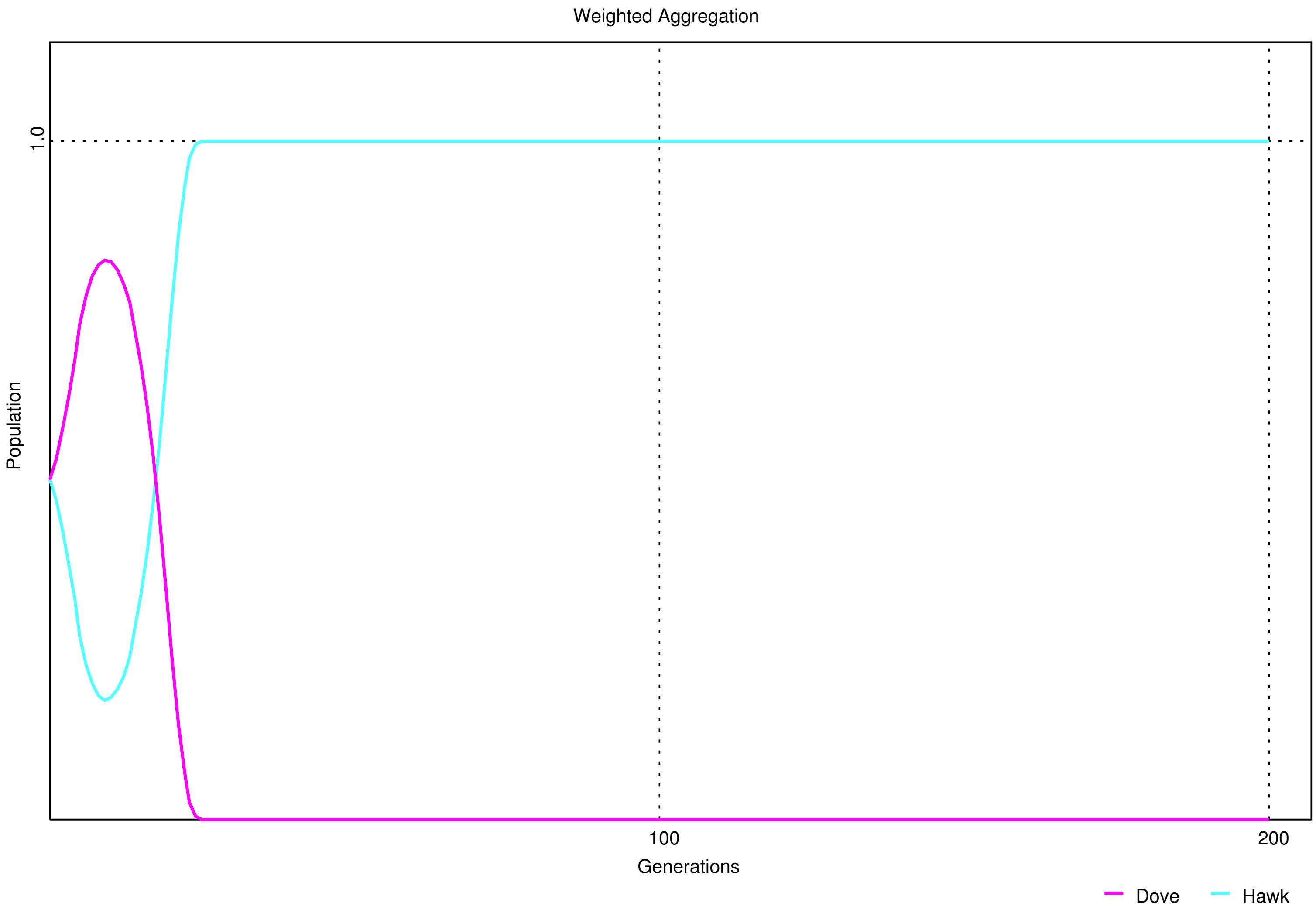

Figure 4.18: If the demes are completely isolated, any group selection effect remains transitory. Again, the population was divided into 25 demes in this simulation (with every deme containing at least some members of each species). But this time the demes were never reshaped.

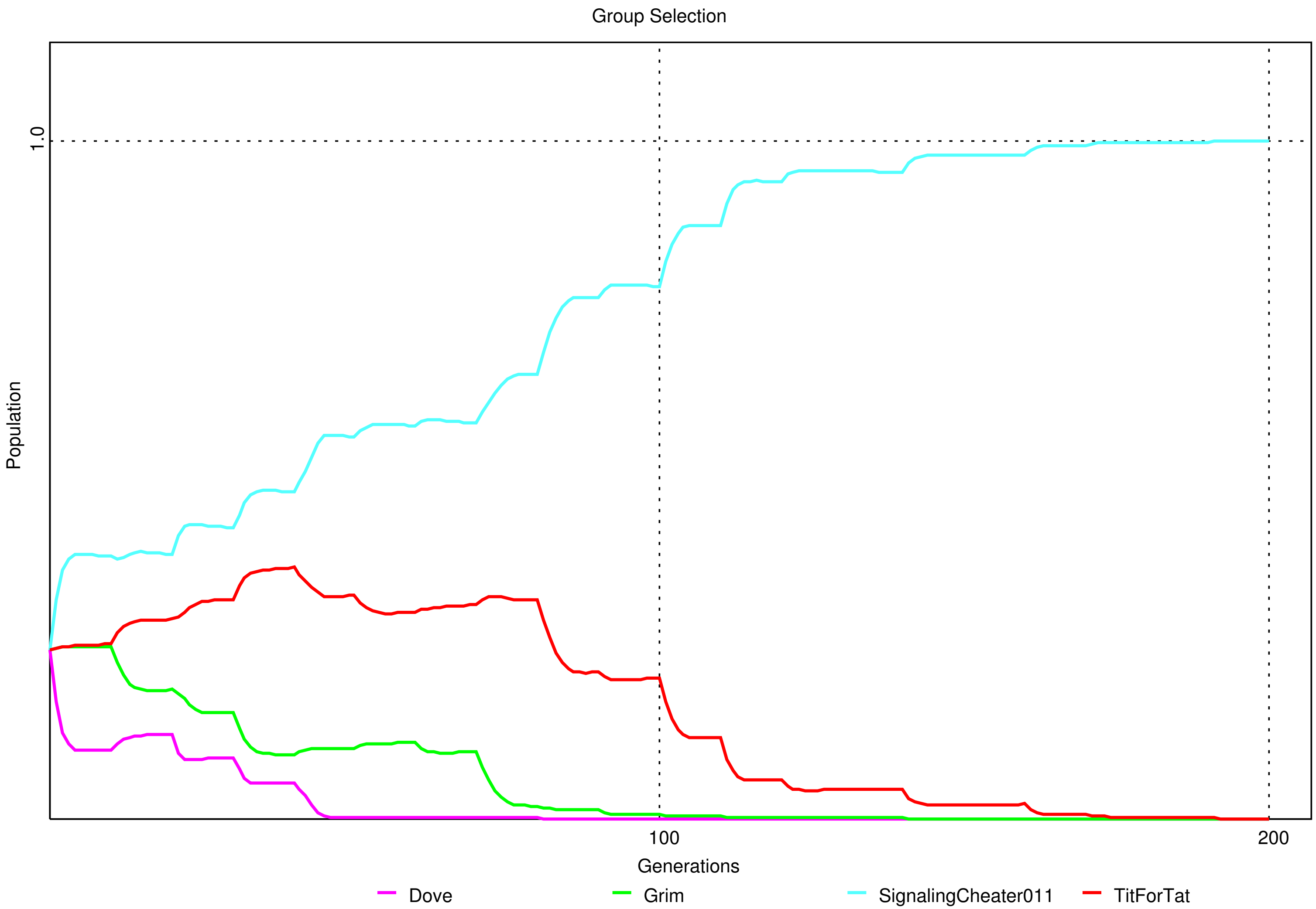

Figure 4.19: Under certain conditions group selection can work against the evolution of altruism. To produce this result the payoff parameters have been set to T=5.9, R=3, P=1, S=0. The population was divided into 10 demes which contain either one, two or three strategies and which were reshaped every 10 rounds.

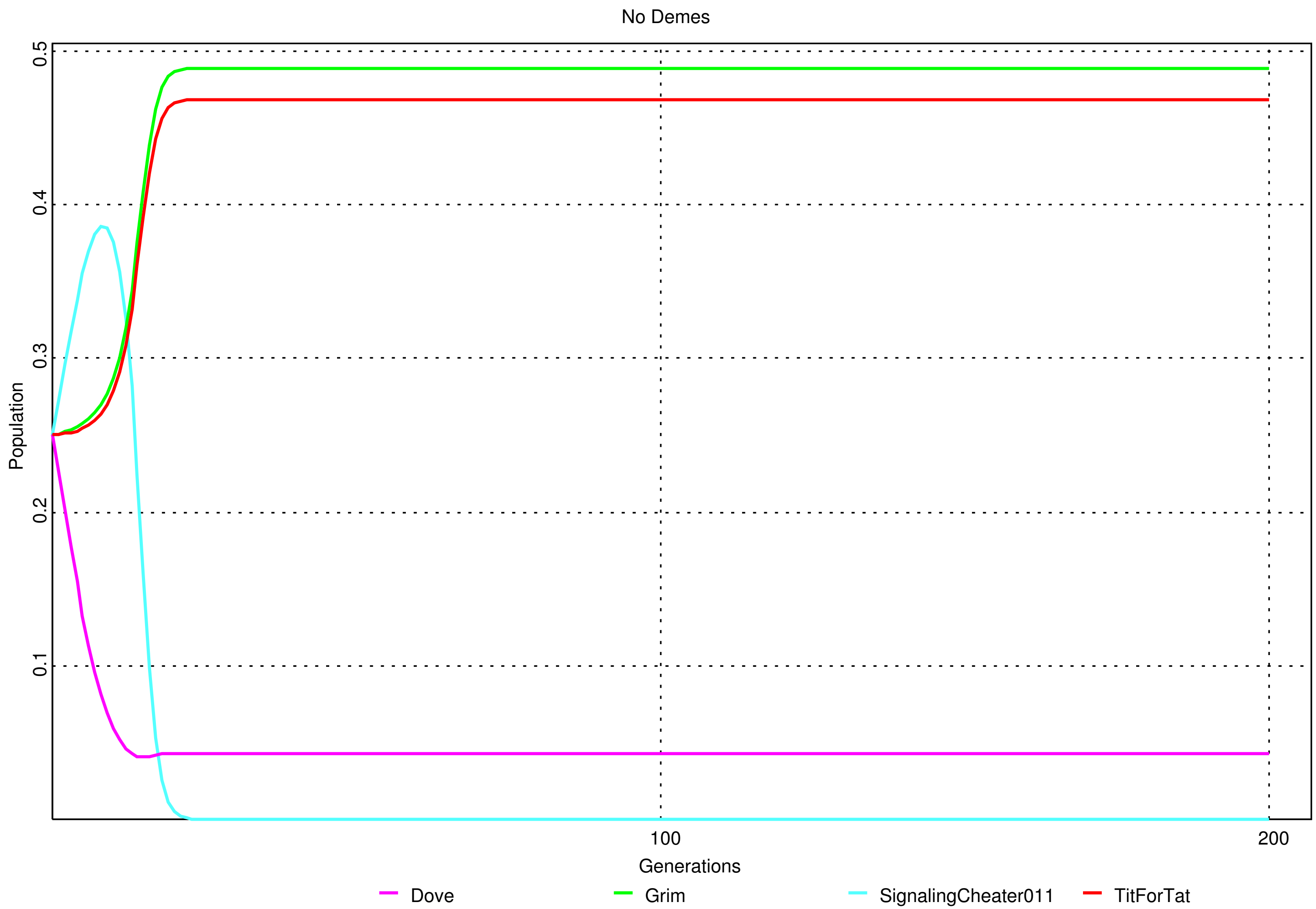

Figure 4.20: The same configuration as in figure 4.19, only without group selection. This time the altruistic strategies fare much better.

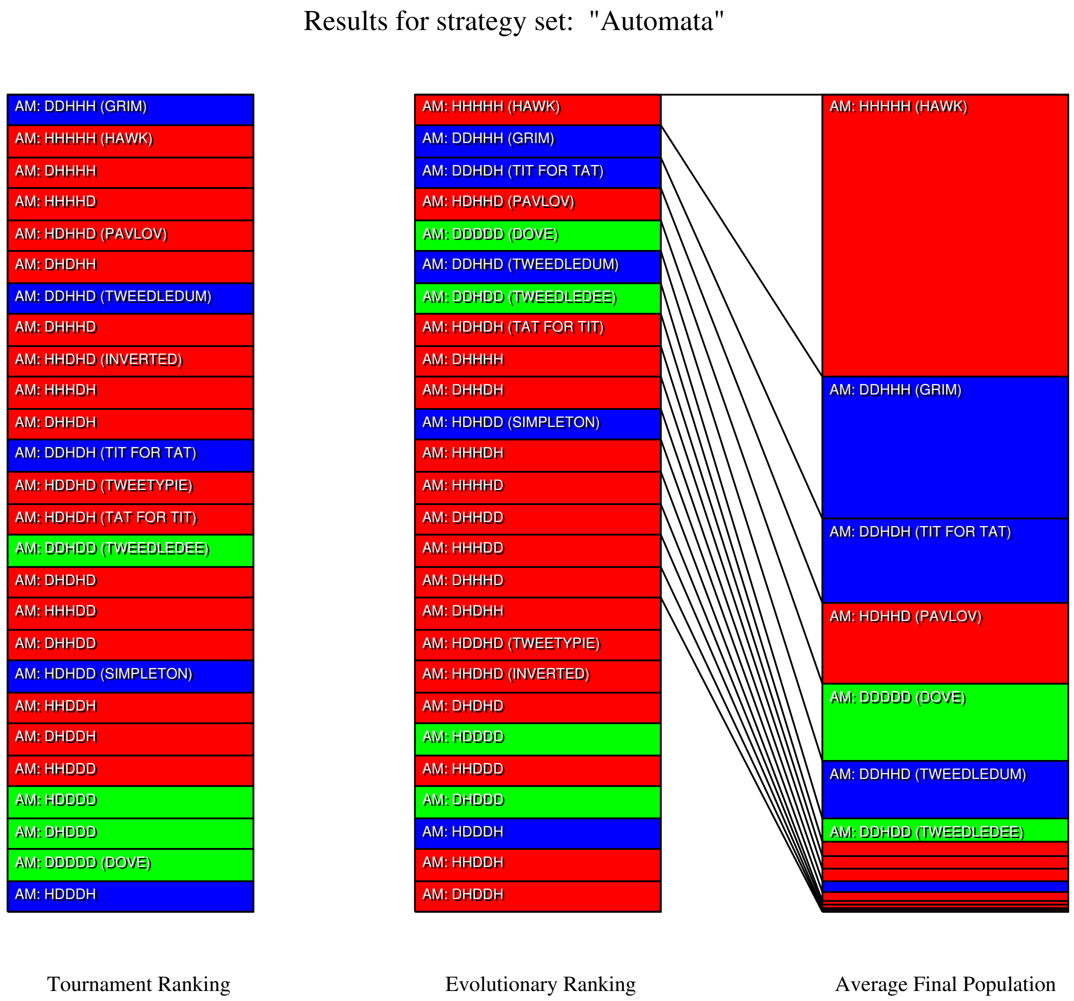

Figure 8.3: The aggregated results of all simulations of the "big series" using *Automata* strategies.

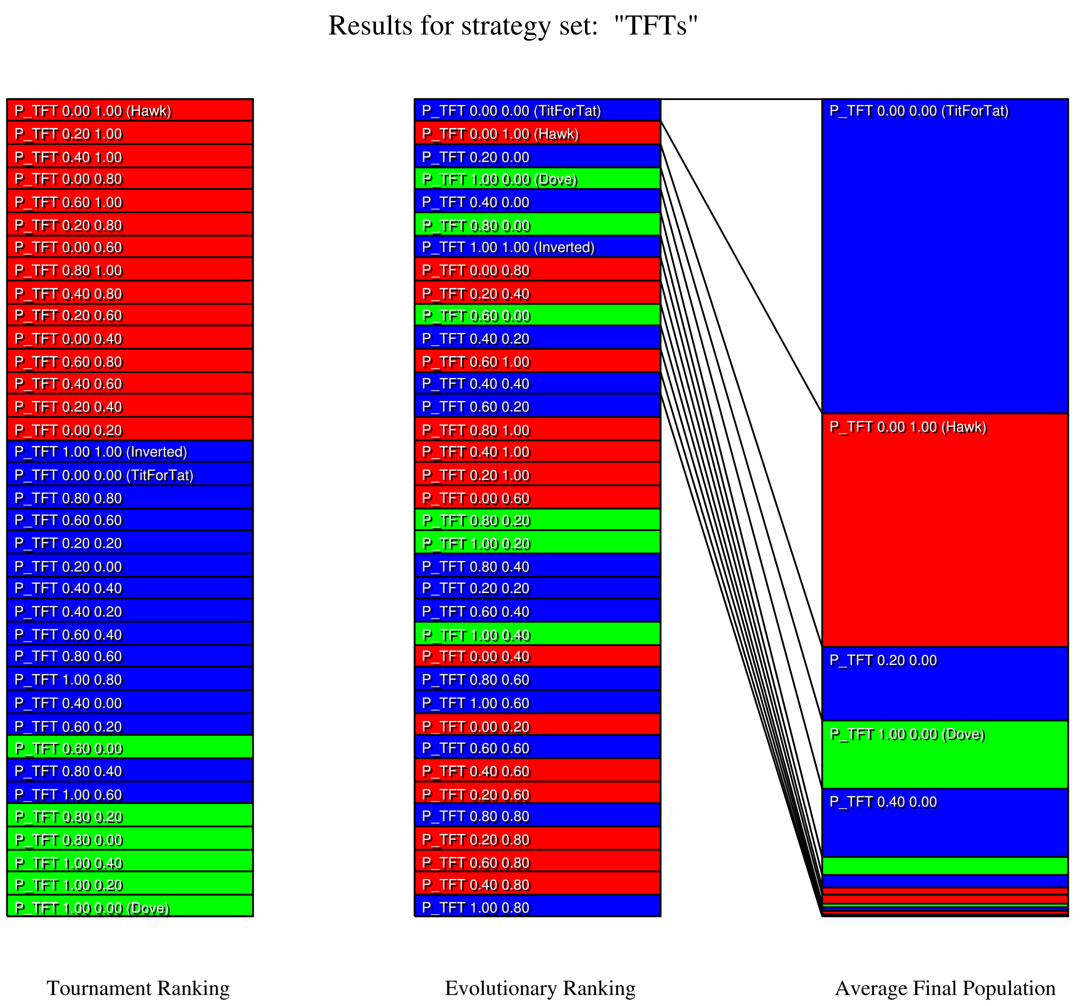

Figure 8.4: The aggregated results of all simulations of the “big series” using *Parameterized Tit for Tat* strategies.

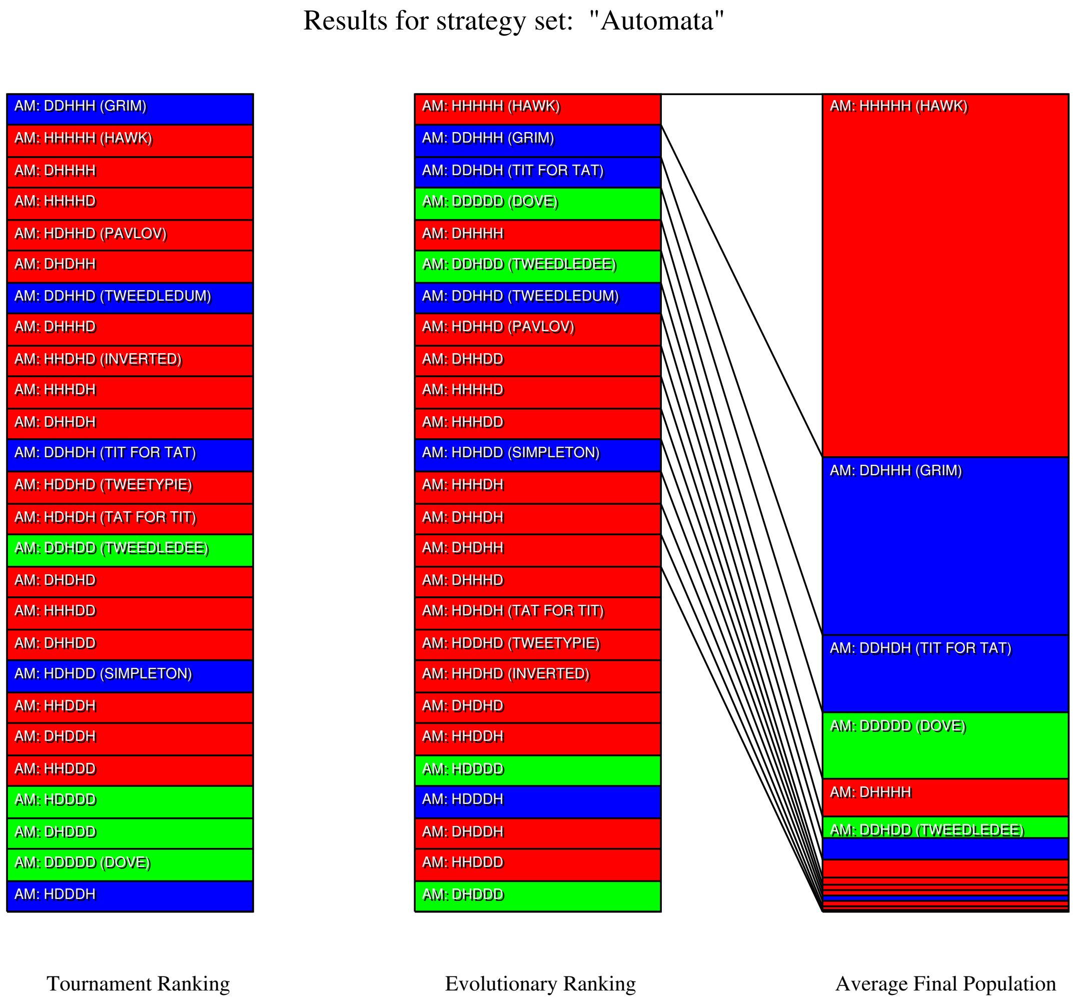

Figure 8.5: The aggregated results of those simulations of the “big series” for which the correlation value was 0%.

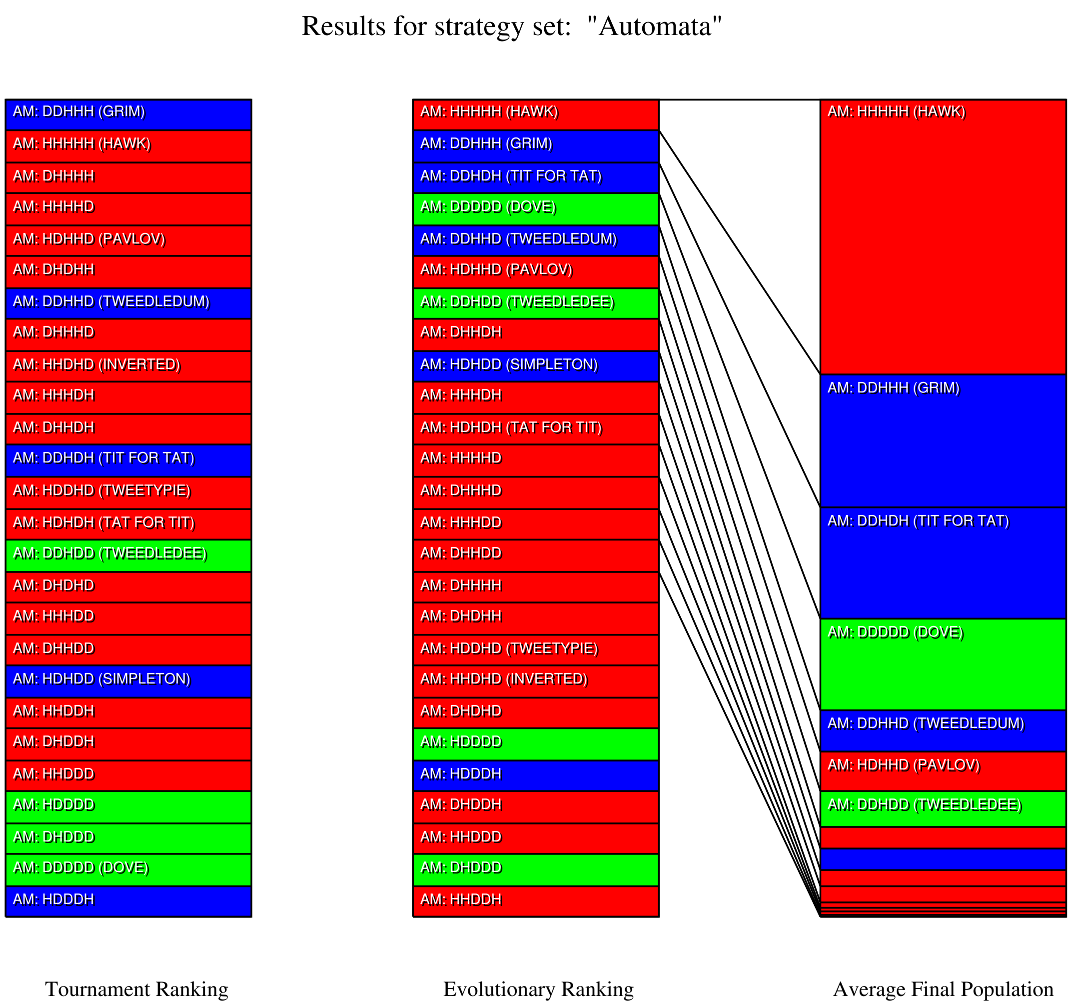

Figure 8.6: The aggregated results of those simulations of the “big series” for which the correlation value was 10%.

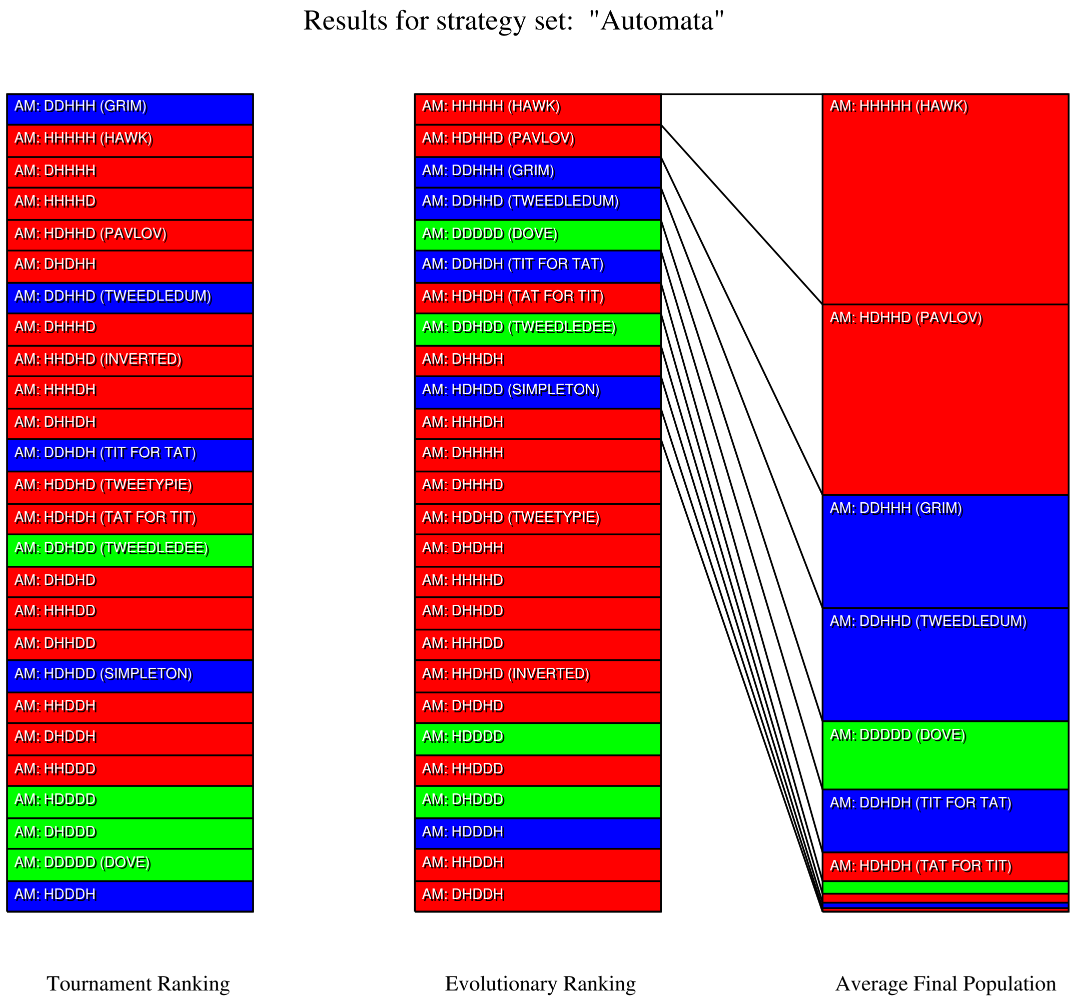

Figure 8.7: The aggregated results of those simulations of the "big series" for which the correlation value was 20%.

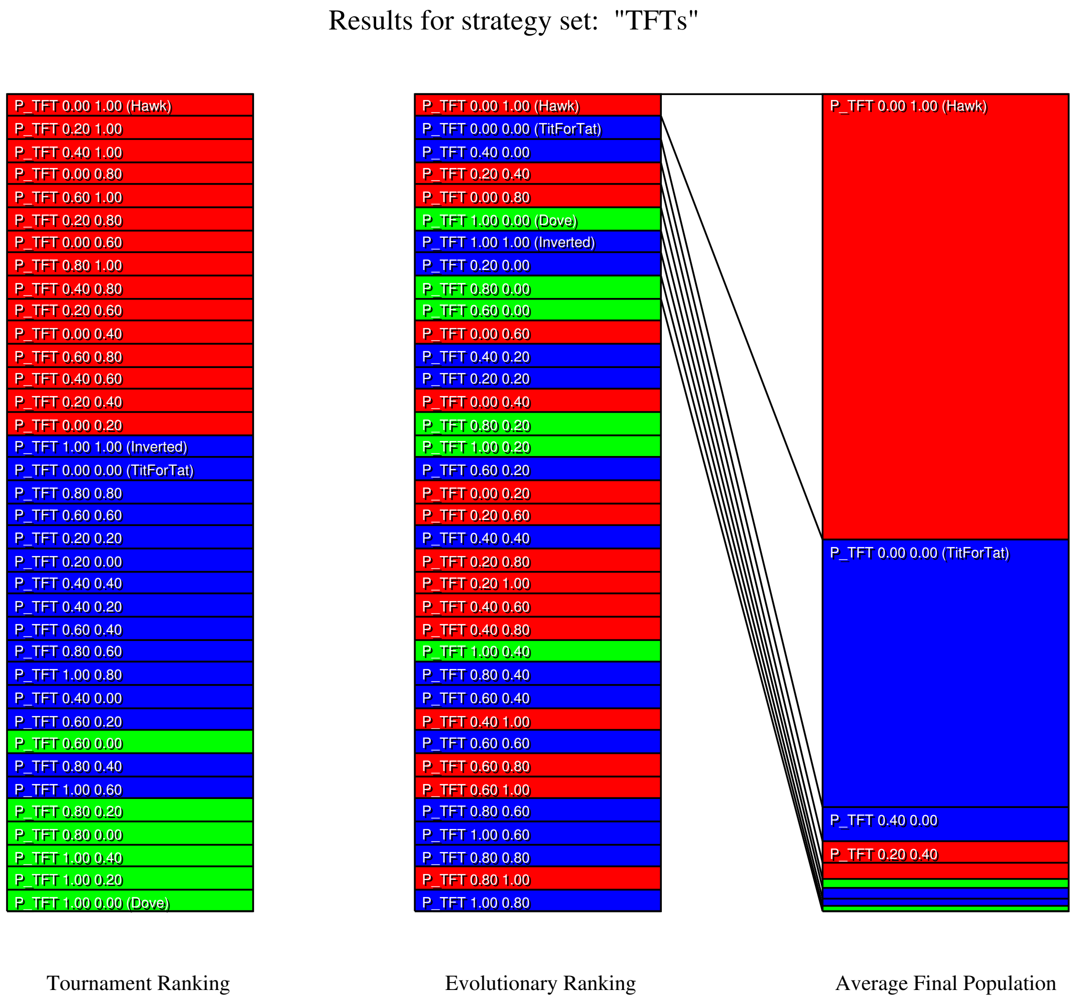

Figure 8.8: The aggregated results of those simulations of the "big series" for which the correlation value was 0%.

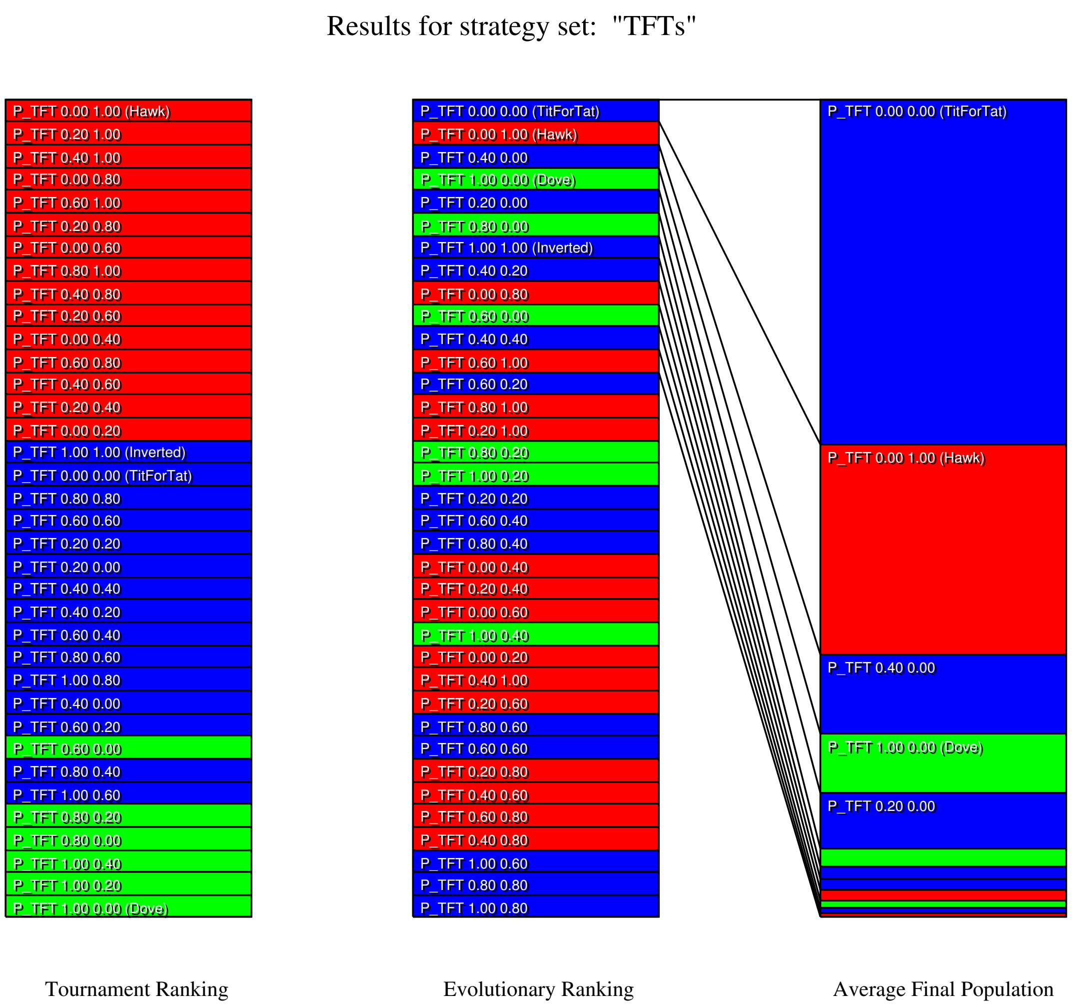

Figure 8.9: The aggregated results of those simulations of the “big series” for which the correlation value was 10%.

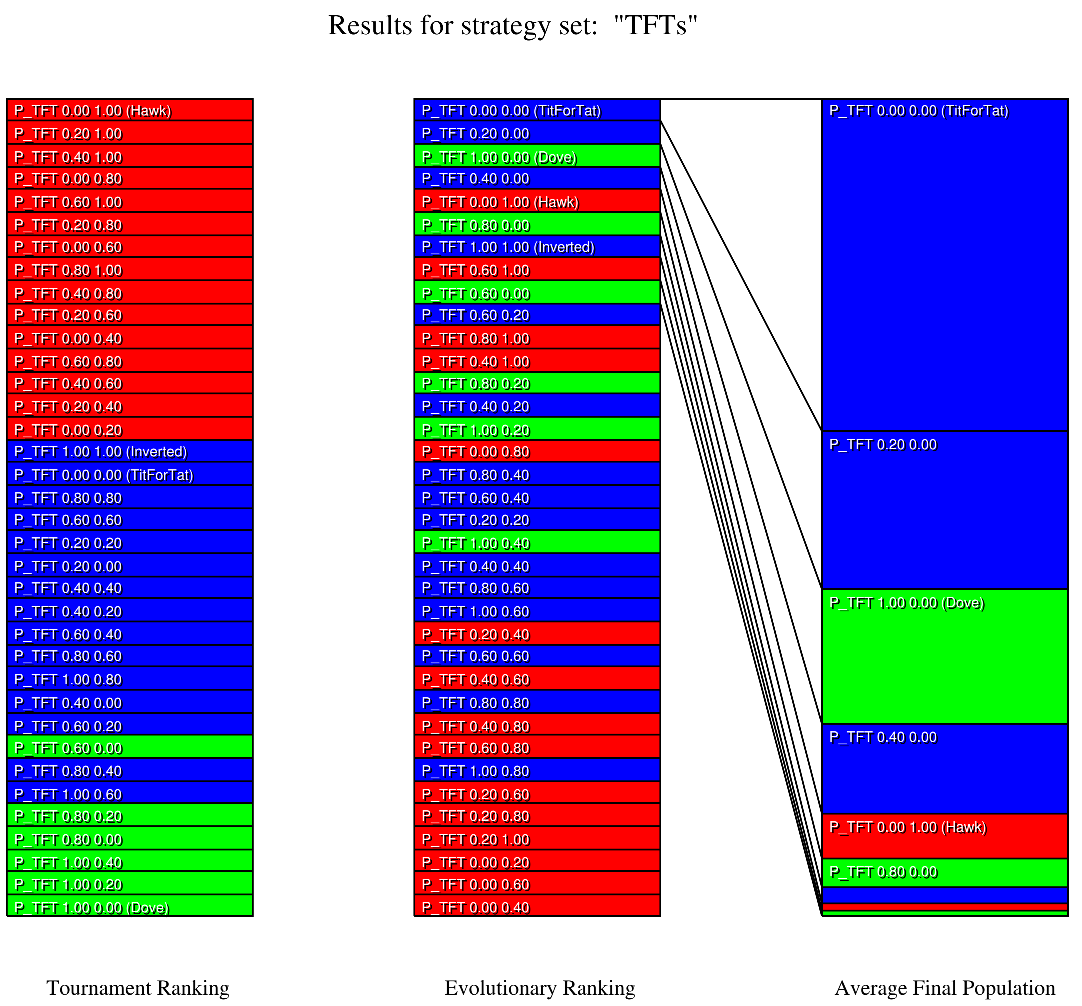

Figure 8.10: The aggregated results of those simulations of the “big series” for which the correlation value was 20%.

Results for strategy set: "Automata"

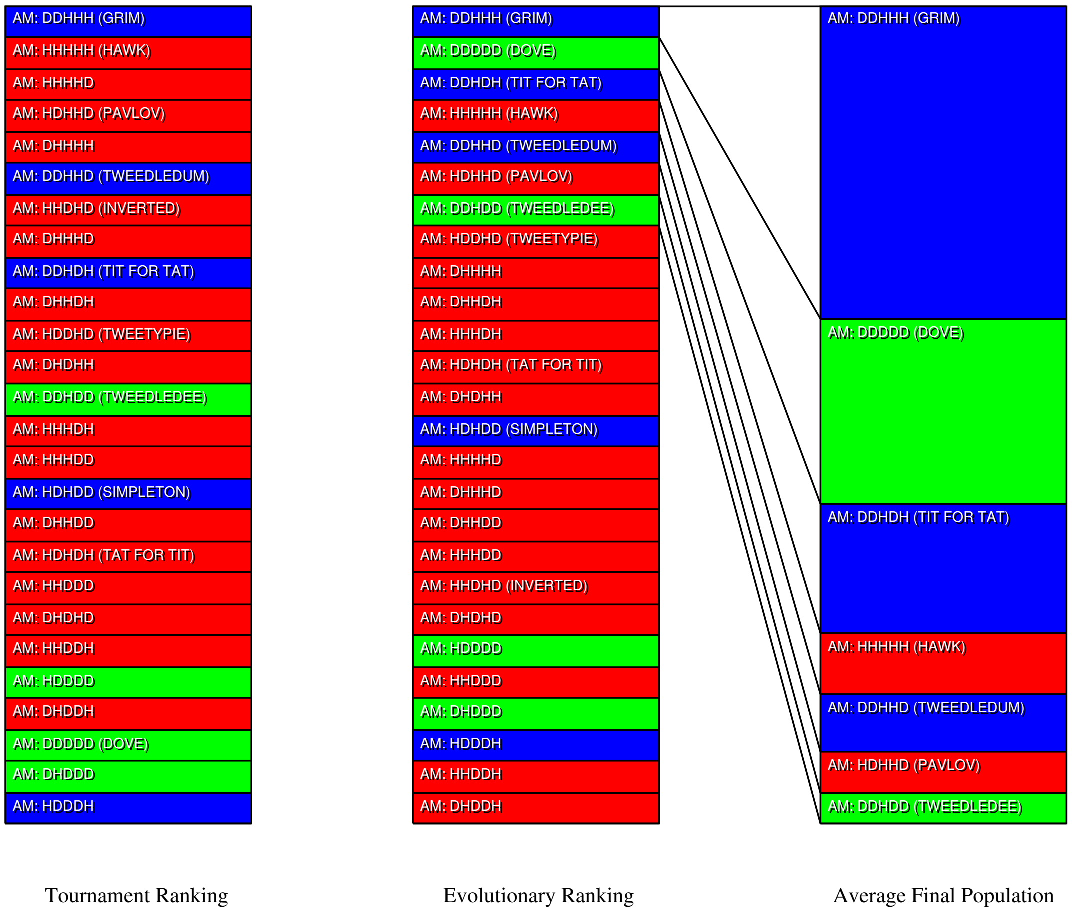

Figure 8.11: The aggregated results of those simulations of the "big series" for which the game noise was 0%.

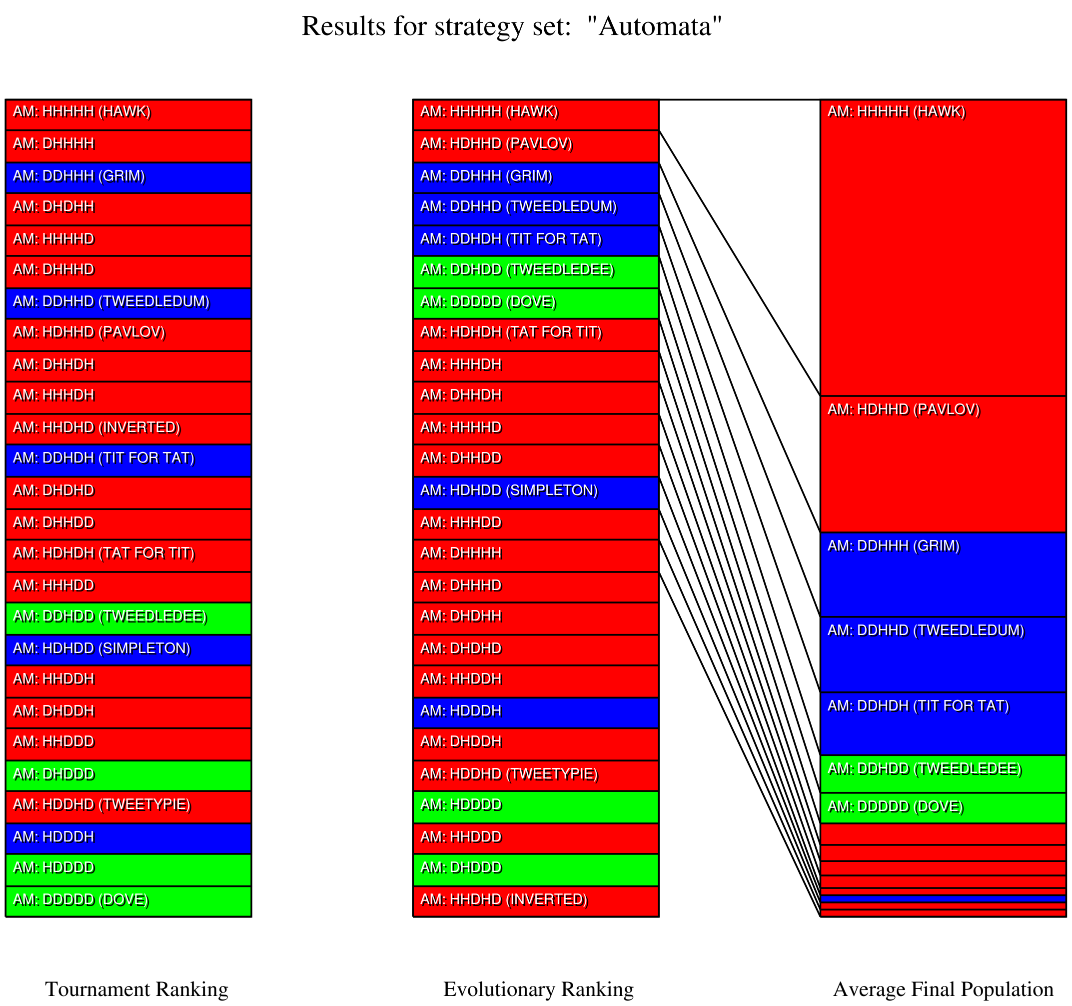

Figure 8.12: The aggregated results of those simulations of the “big series” for which the game noise was 5%.

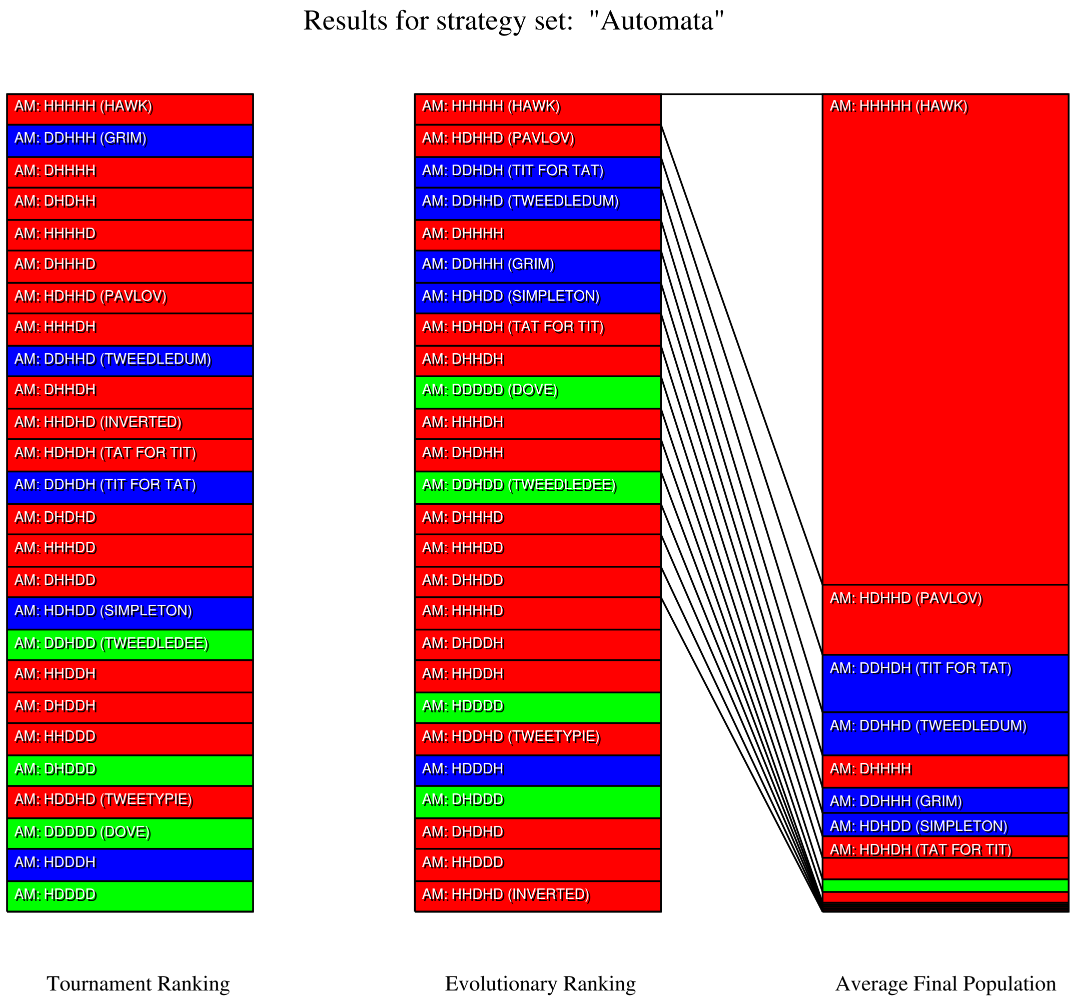

Figure 8.13: The aggregated results of those simulations of the "big series" for which the game noise was 10%.

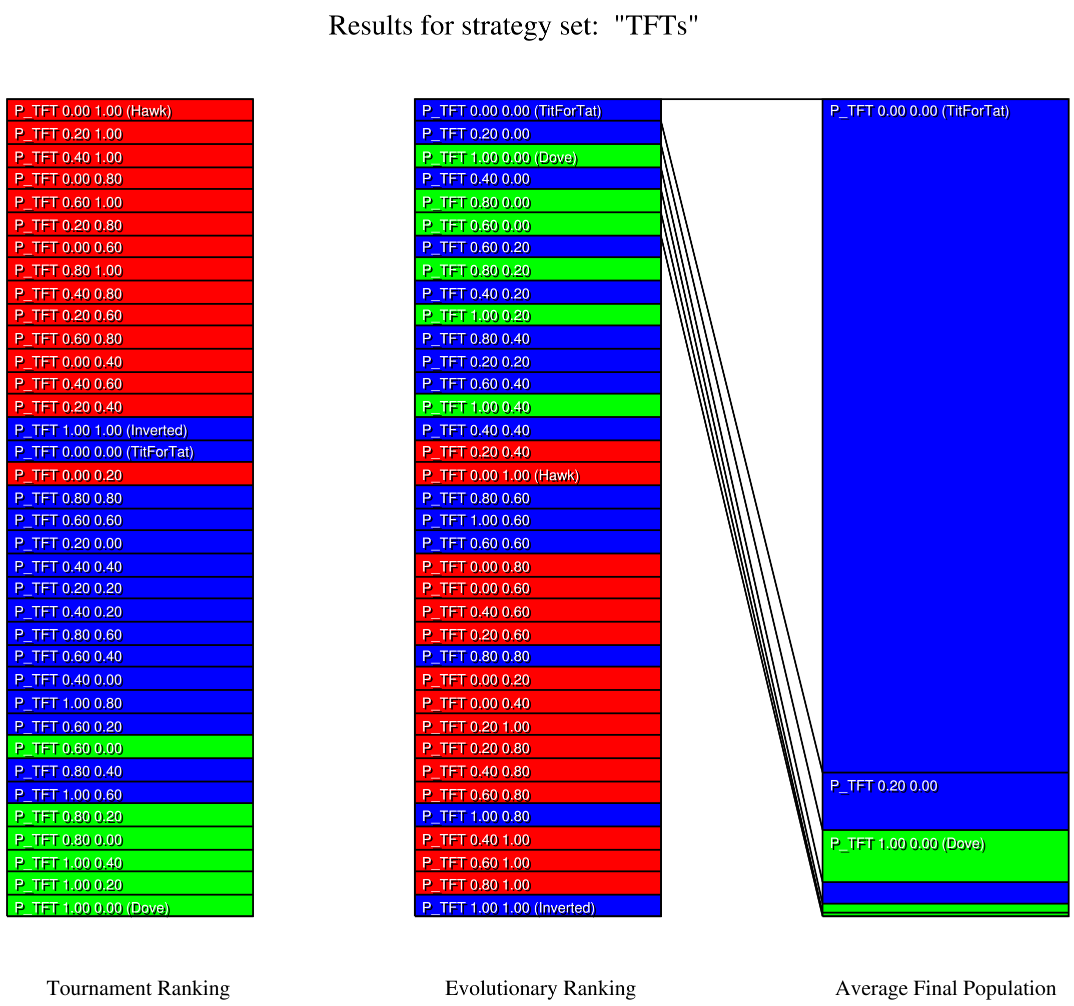

Figure 8.14: The aggregated results of those simulations of the “big series” for which the game noise was 0%.

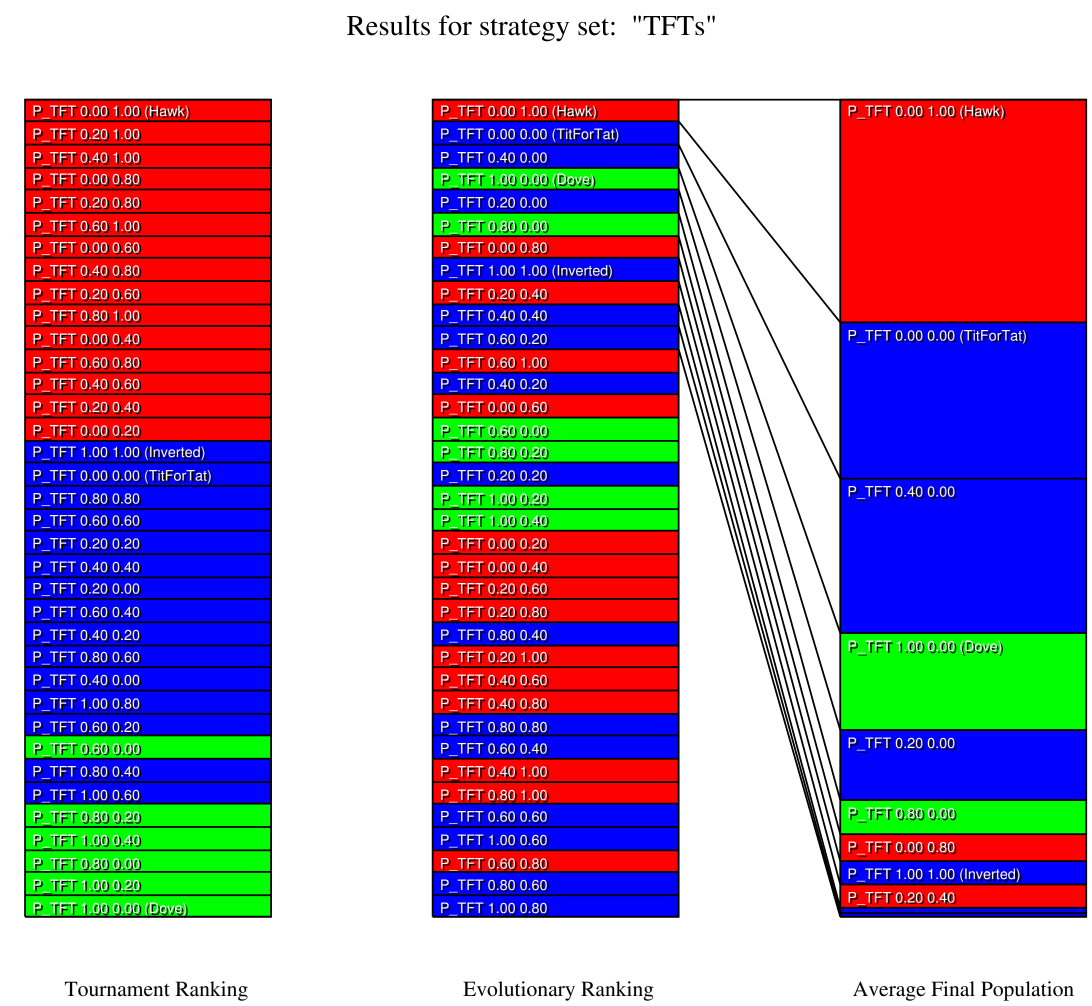

Figure 8.15: The aggregated results of those simulations of the "big series" for which the game noise was 5%.

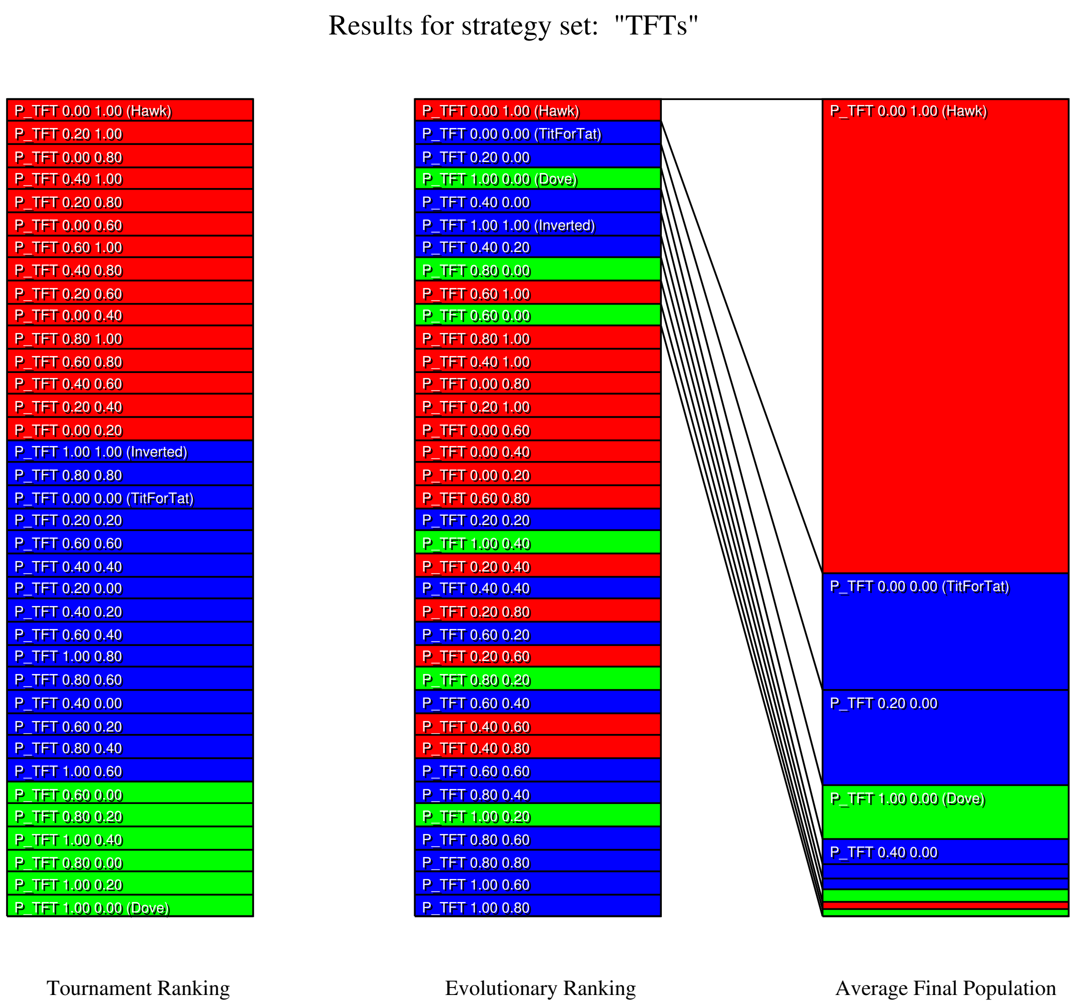

Figure 8.16: The aggregated results of those simulations of the “big series” for which the game noise was 10%.

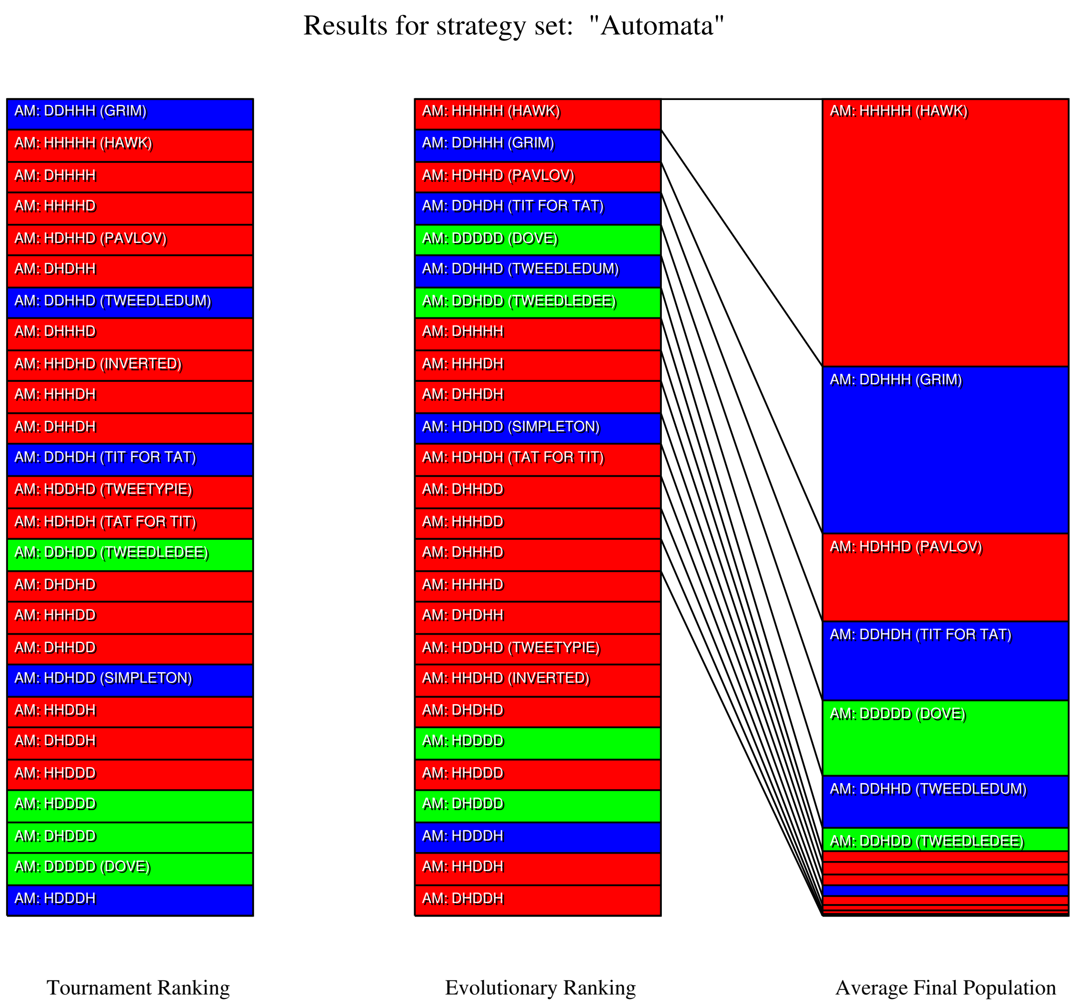

Figure 8.17: The aggregated results of those simulations of the “big series” for which the evolutionary noise was 0%.

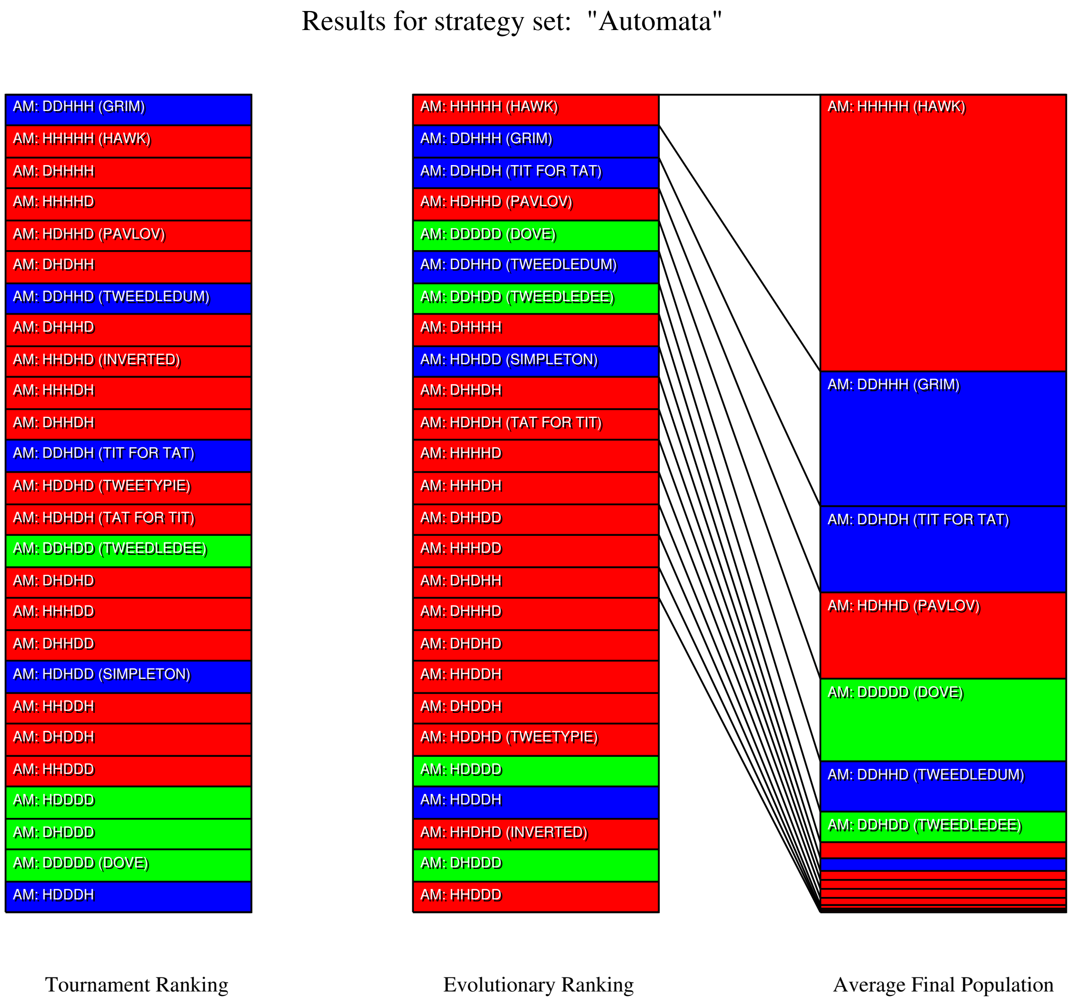

Figure 8.18: The aggregated results of those simulations of the "big series" for which the evolutionary noise was 5%.

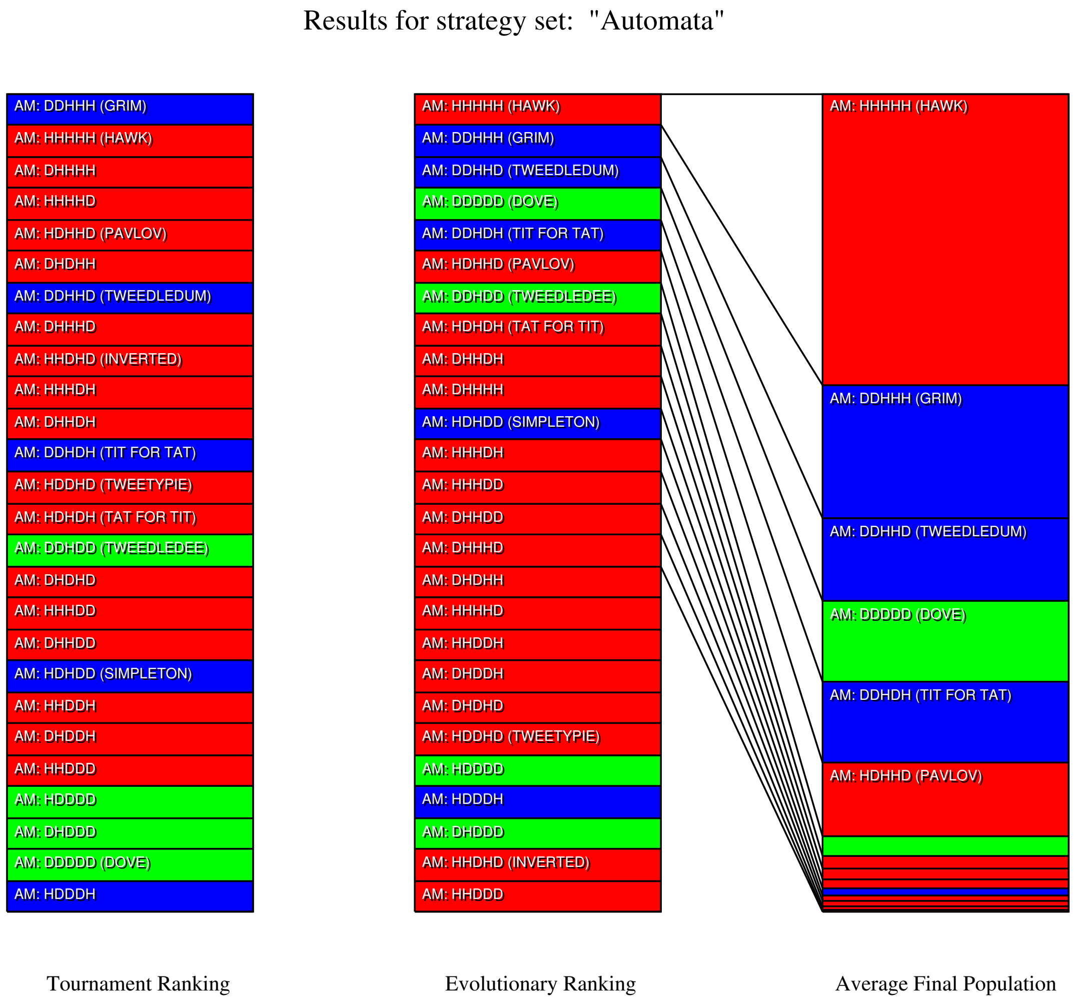

Figure 8.19: The aggregated results of those simulations of the “big series” for which the evolutionary noise was 10%.

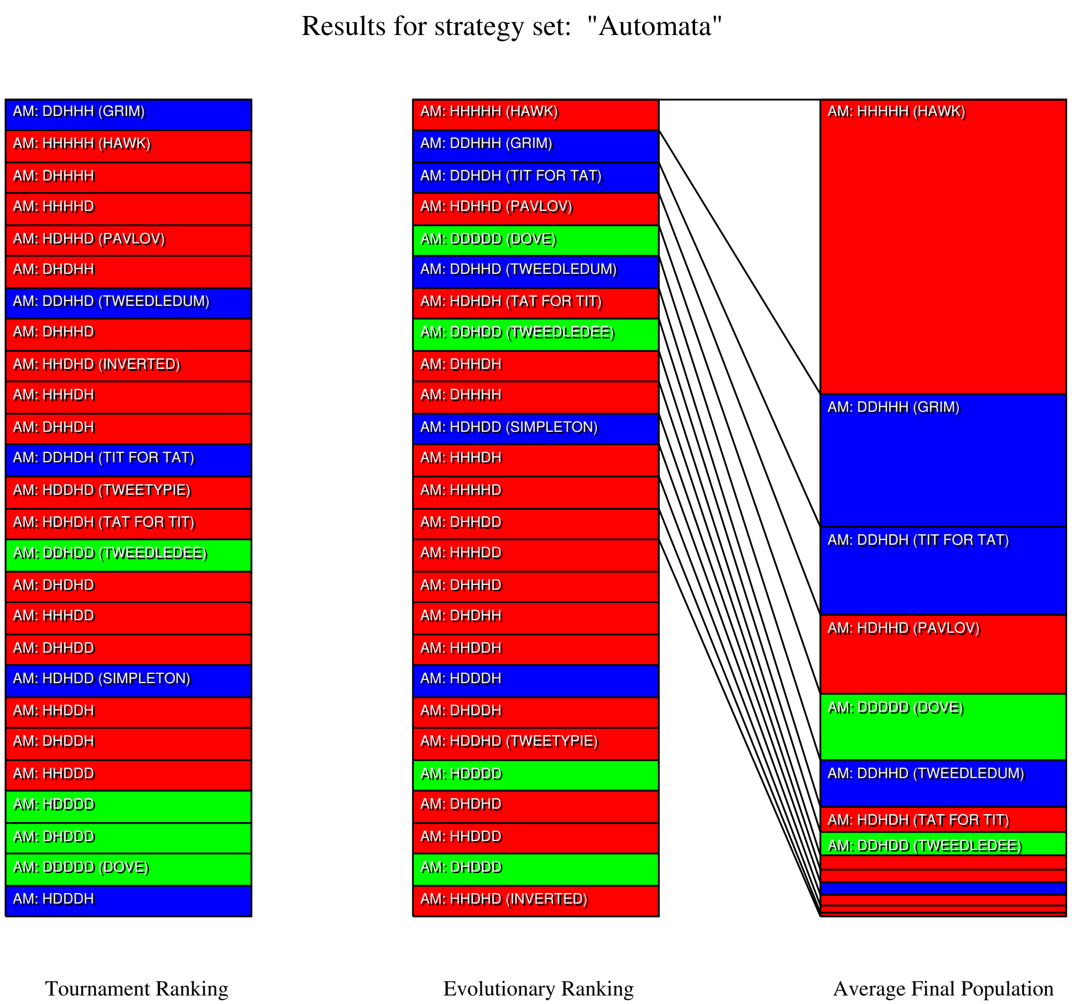

Figure 8.20: The aggregated results of those simulations of the "big series" for which the evolutionary noise was 15%.

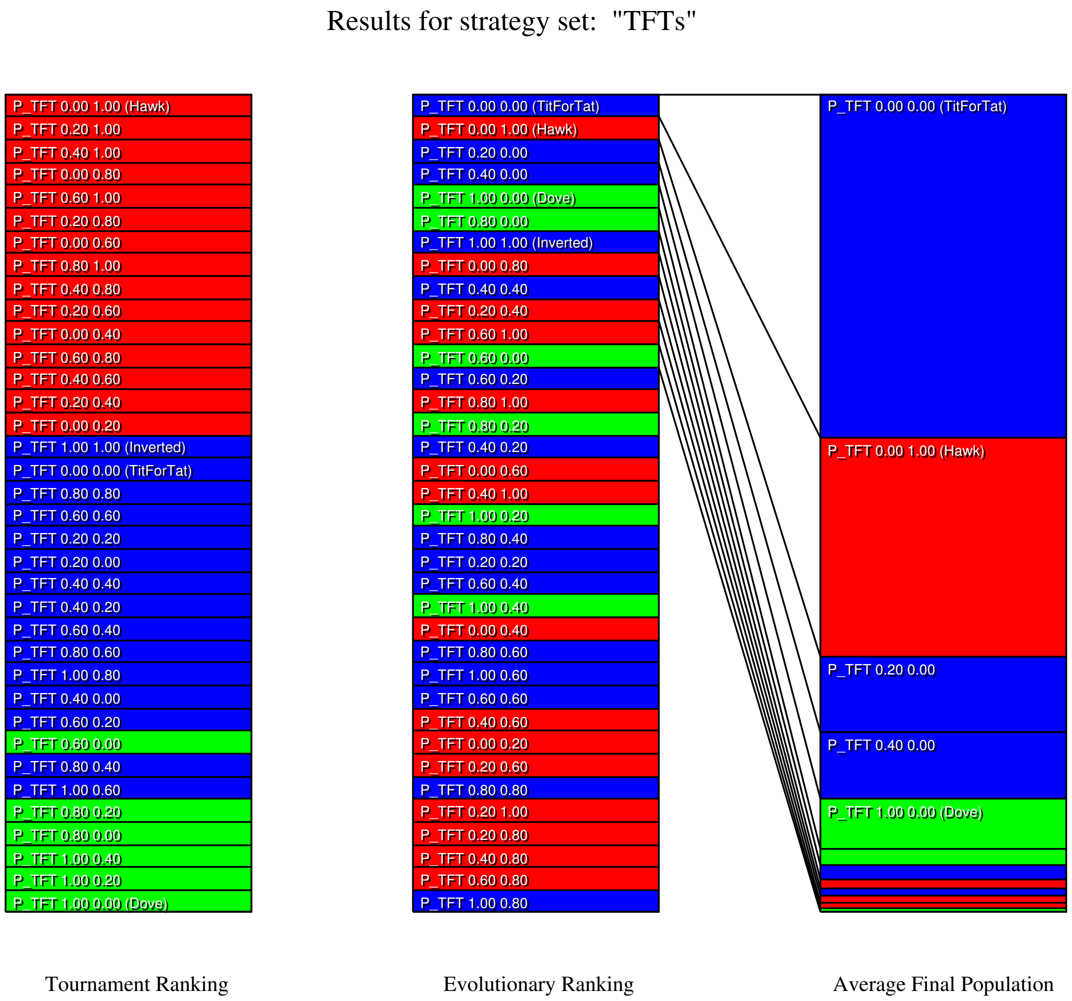

Figure 8.21: The aggregated results of those simulations of the “big series” for which the evolutionary noise was 0%.

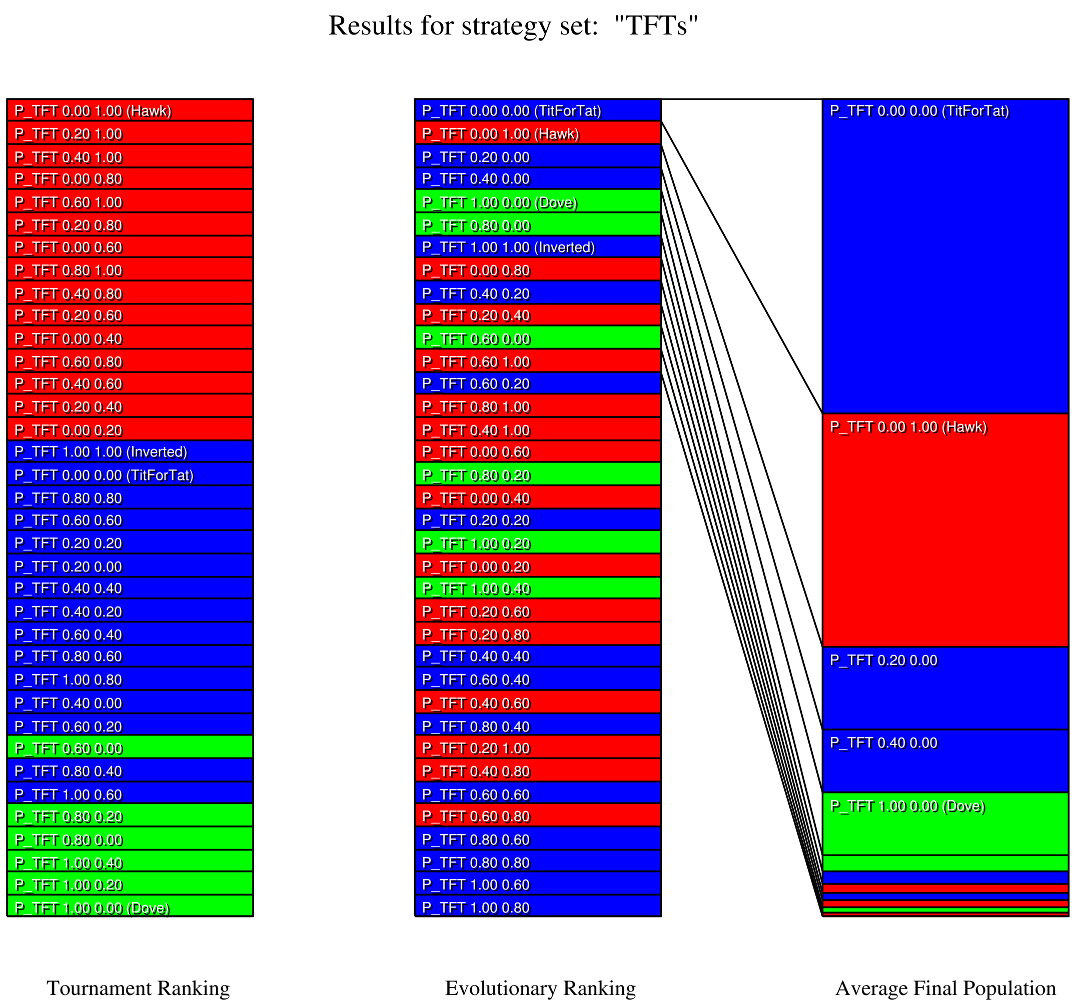

Figure 8.22: The aggregated results of those simulations of the “big series” for which the evolutionary noise was 5%.

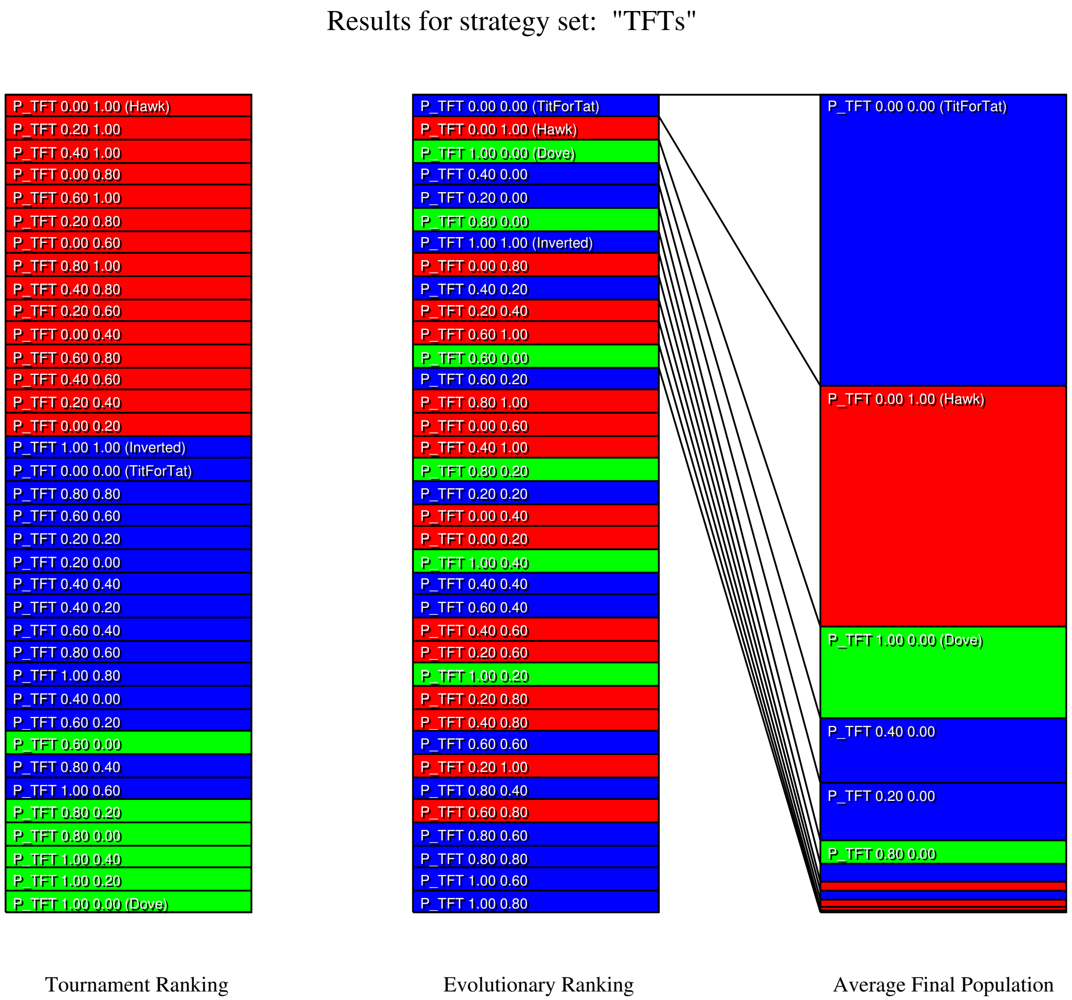

Figure 8.23: The aggregated results of those simulations of the "big series" for which the evolutionary noise was 10%.

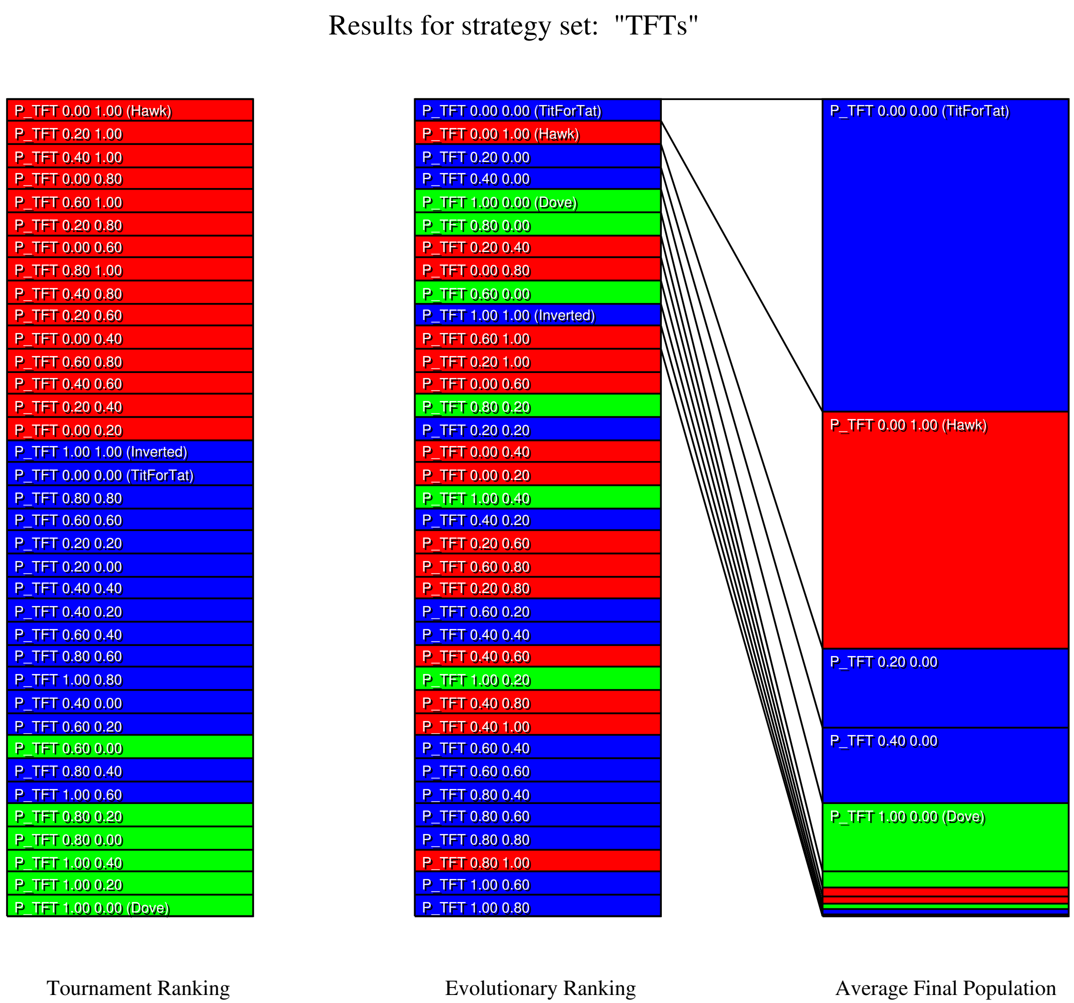

Figure 8.24: The aggregated results of those simulations of the "big series" for which the evolutionary noise was 15%.

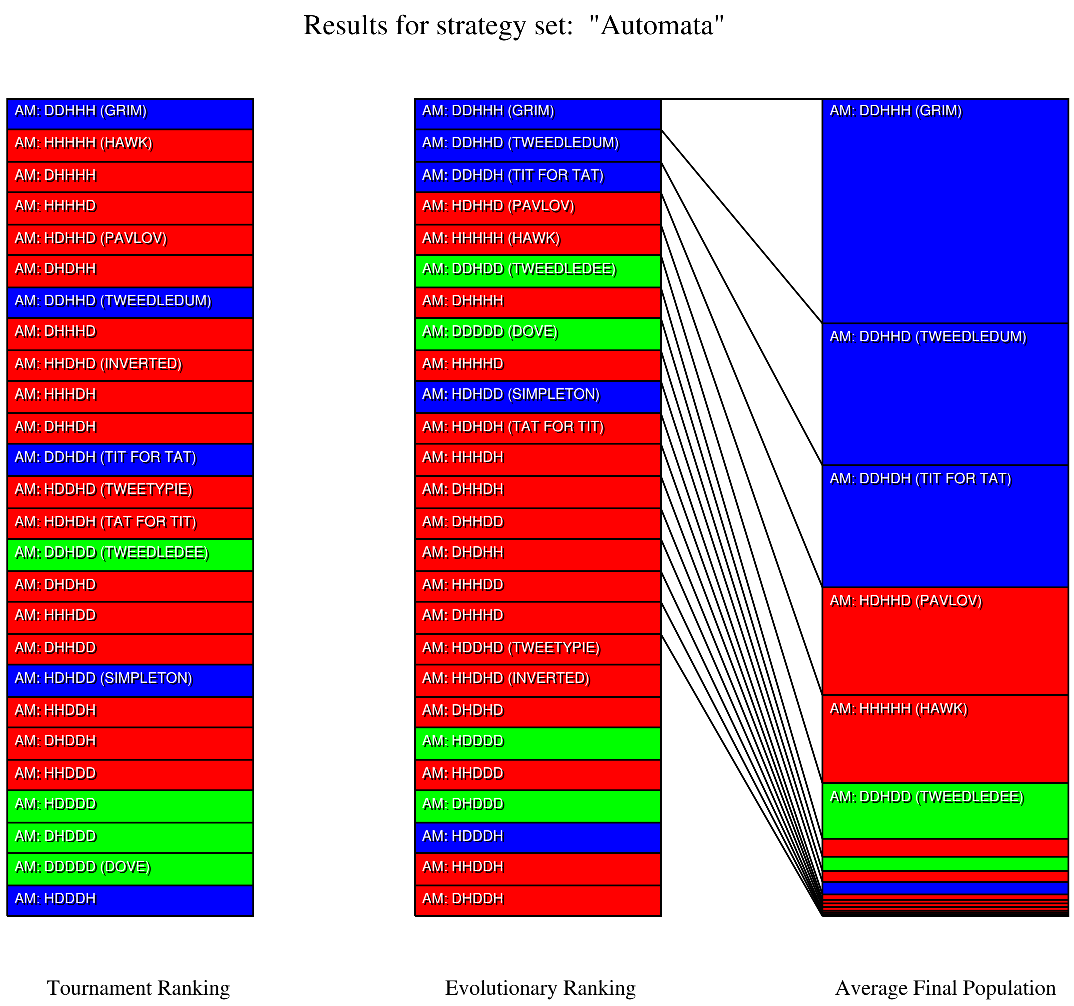

Figure 8.25: The aggregated results of those simulations of the "big series" for which degenerative mutations were turned off.

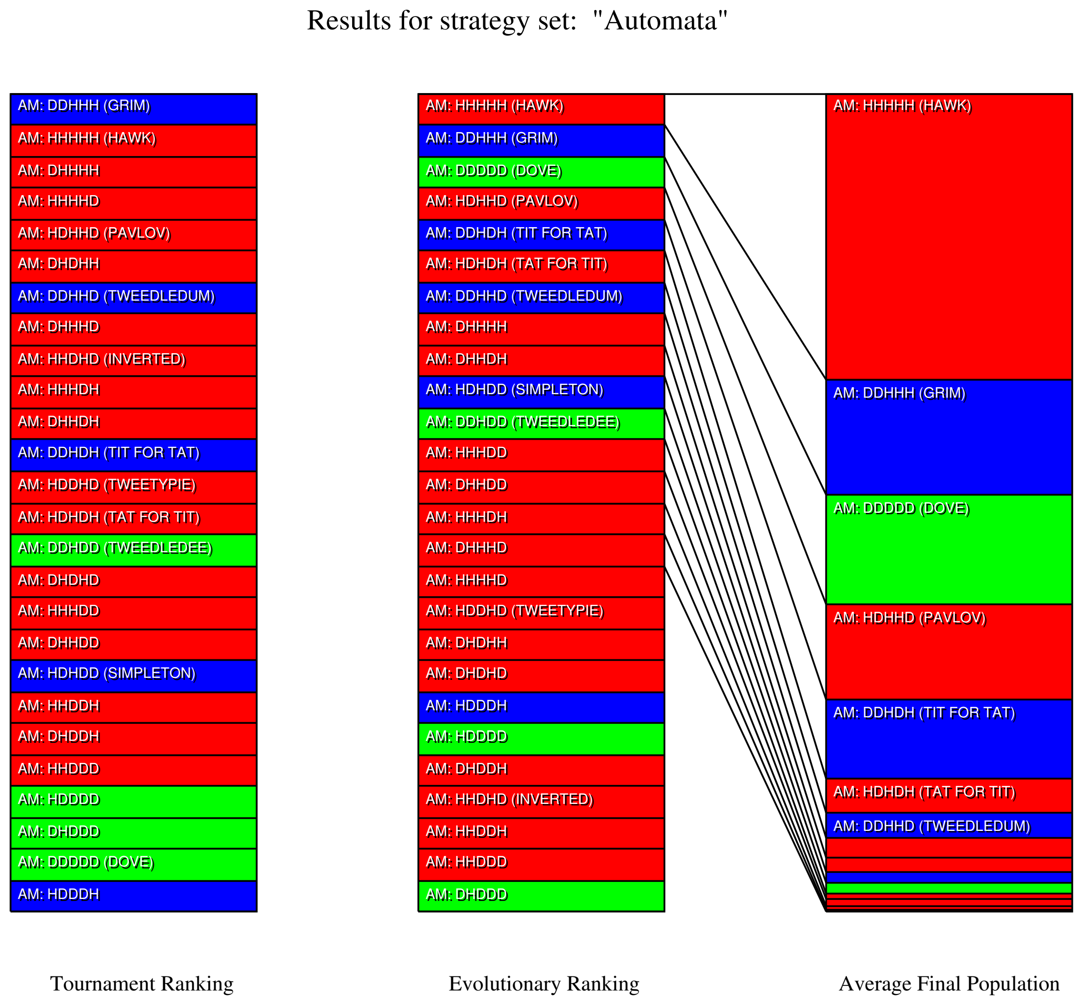

Figure 8.26: The aggregated results of those simulations of the “big series” for which 1% of the strategies degenerated in every new generation either to *Dove* or to *Hawk* (depending on whether the strategy was more cooperative or more defective before).

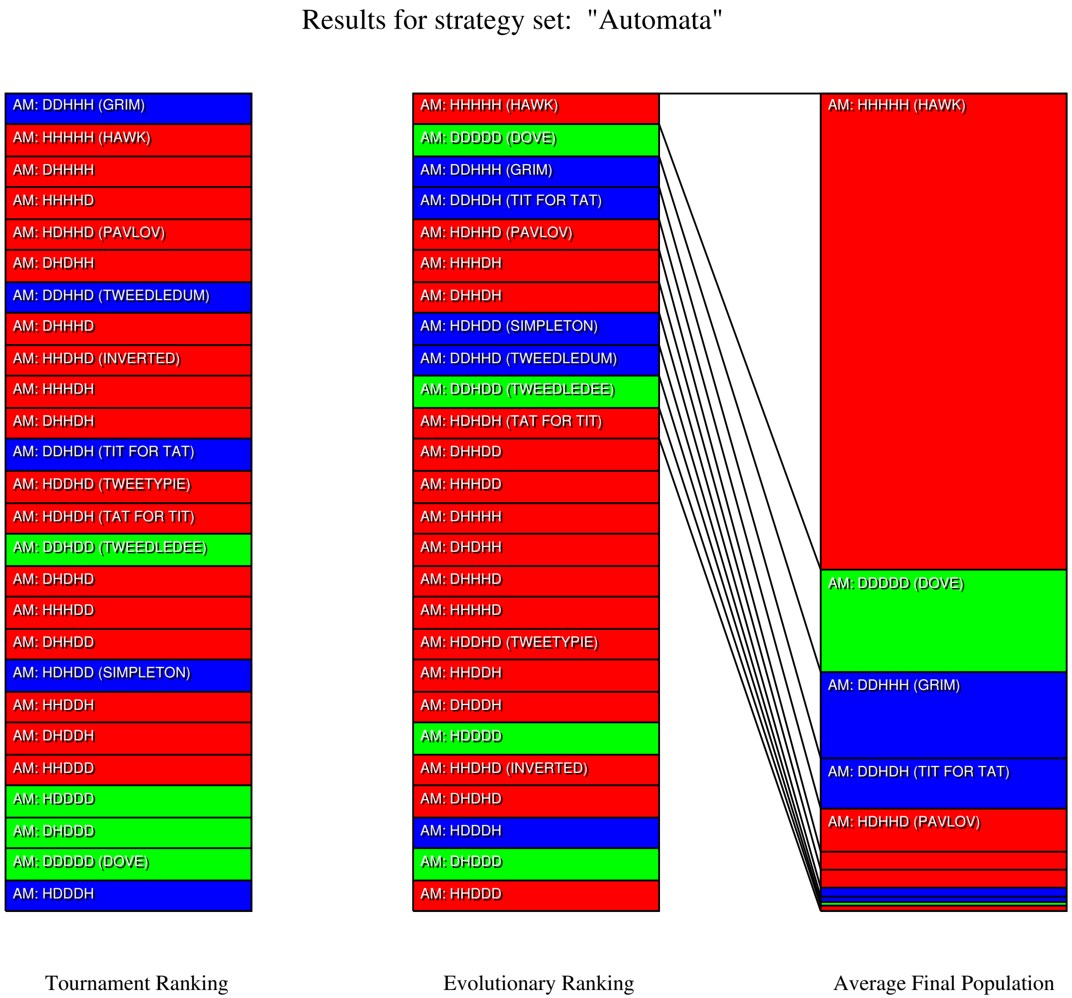

Figure 8.27: The aggregated results of those simulations of the “big series” for which 5% of the strategies degenerated in every new generation either to *Dove* or to *Hawk* (depending on whether the strategy was more cooperative or more defective before).

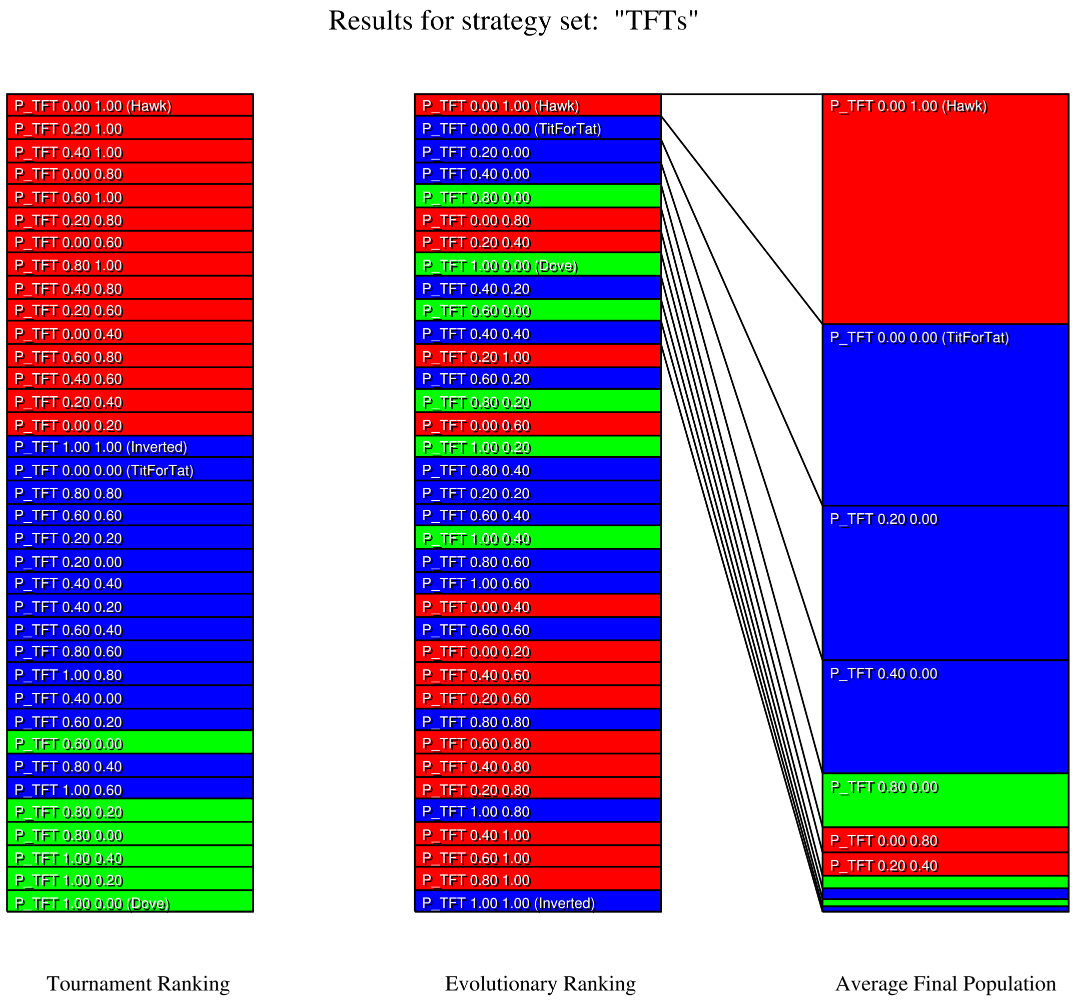

Figure 8.28: The aggregated results of those simulations of the "big series" for which degenerative mutations were turned off.

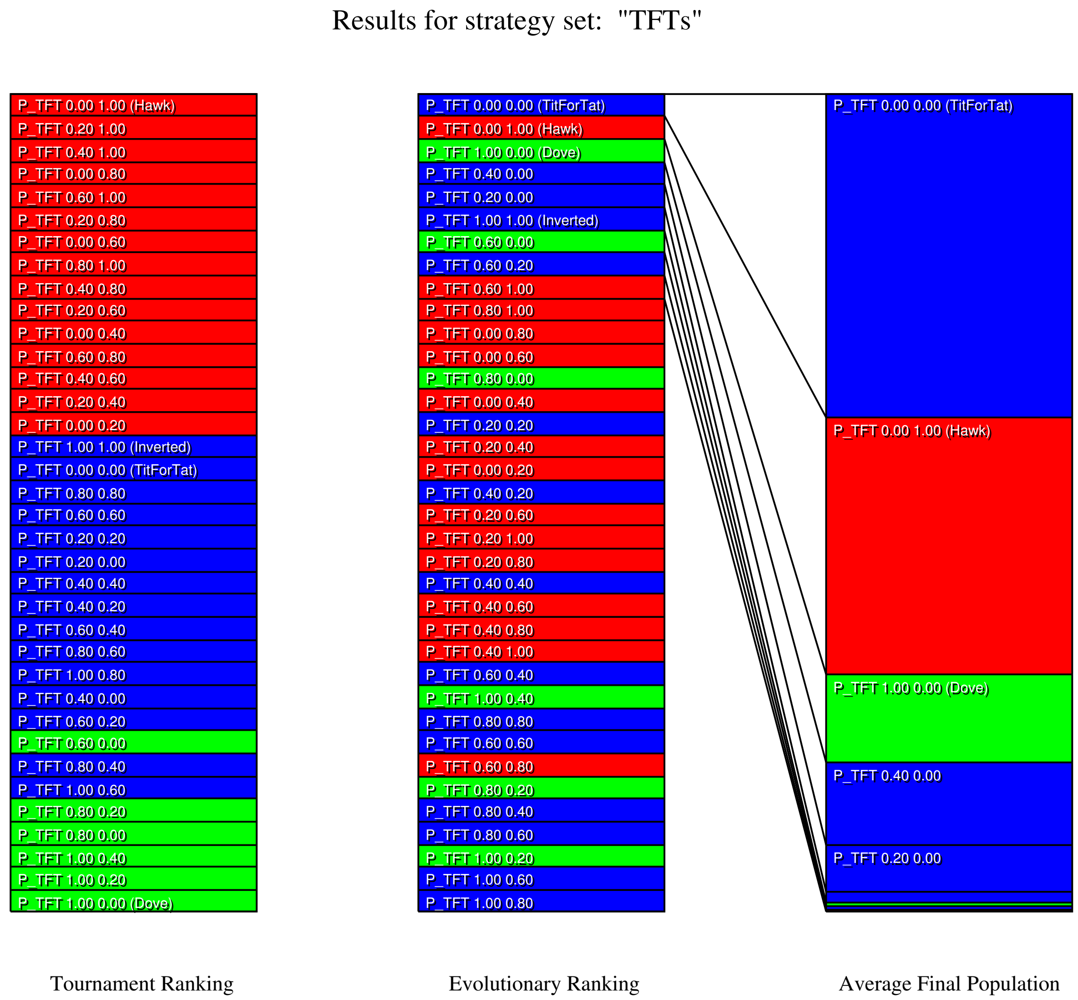

Figure 8.29: The aggregated results of those simulations of the “big series” for which 1% of the strategies degenerated in every new generation either to *Dove* or to *Hawk* (depending on whether the strategy was more cooperative or more defective before).

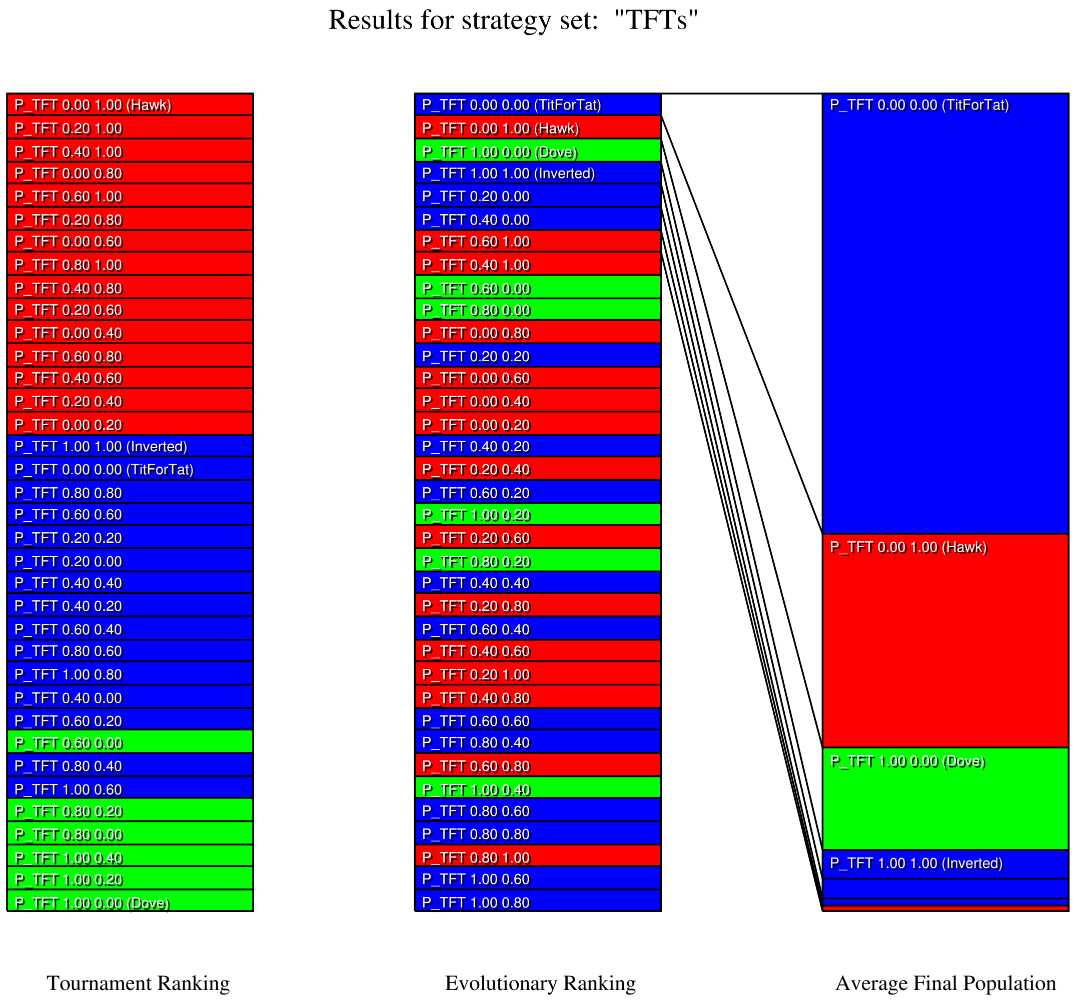

Figure 8.30: The aggregated results of those simulations of the "big series" for which 5% of the strategies degenerated in every new generation either to *Dove* or to *Hawk* (depending on whether the strategy was more cooperative or more defective before).

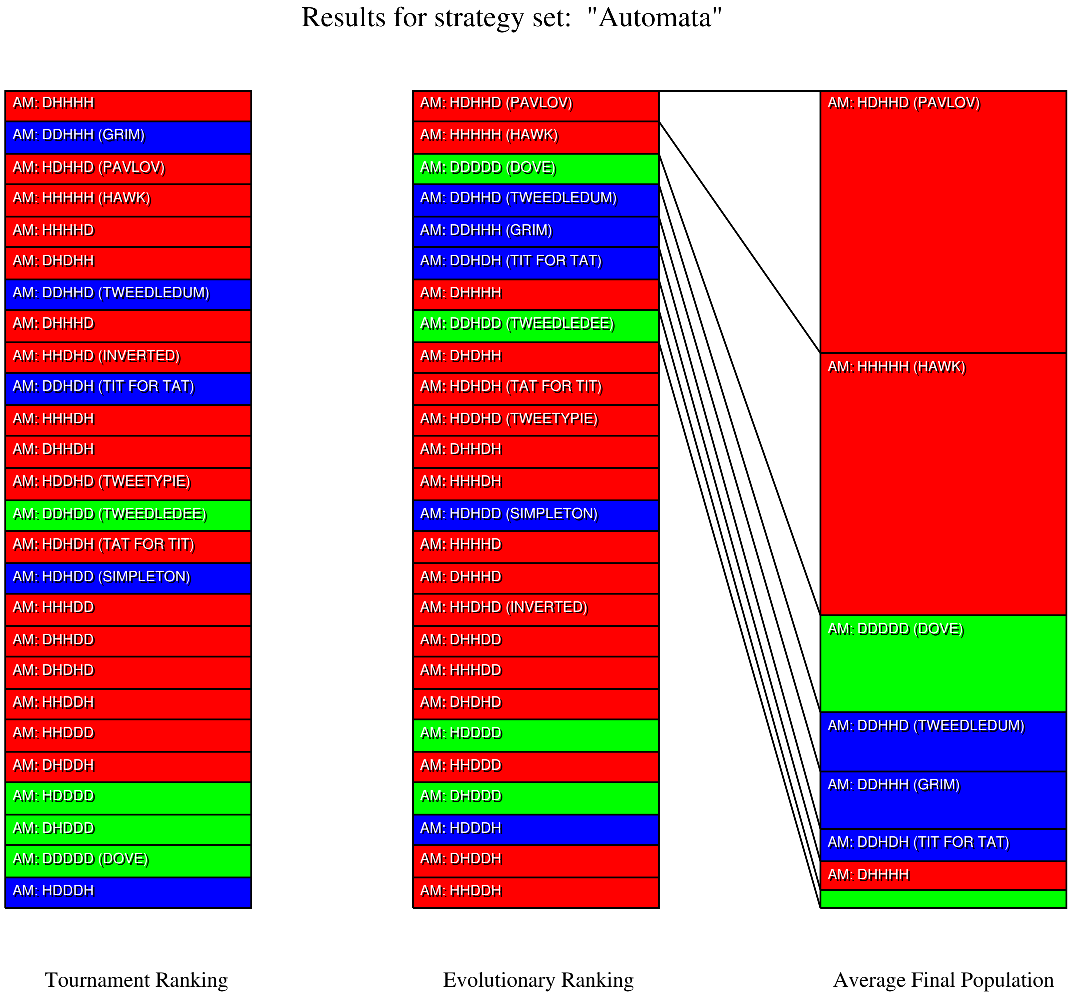

Figure 8.31: The aggregated results of the simulations of the “big series” with the payoff parameters T=3.5, R=3, P=1, S=0.

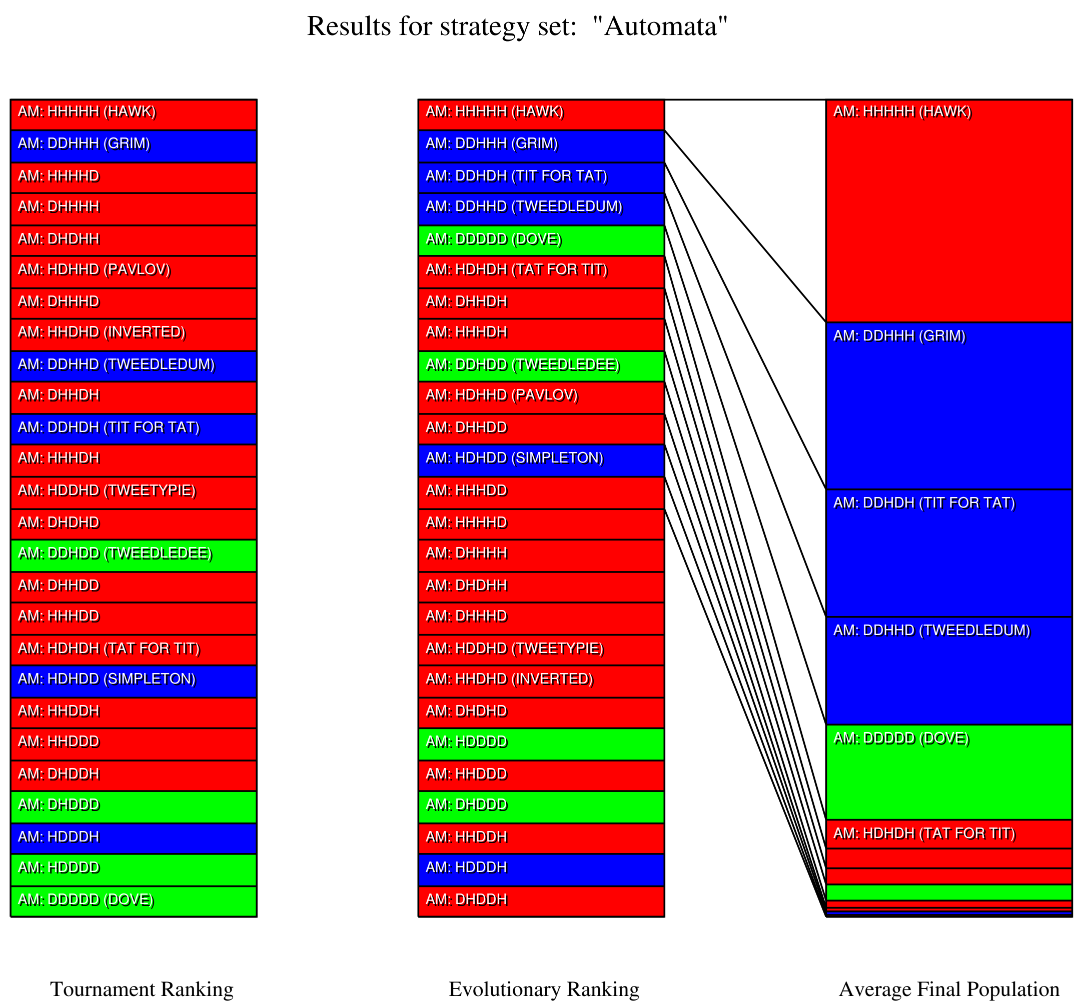

Figure 8.32: The aggregated results of the simulations of the “big series” with the payoff parameters T=5, R=3, P=1, S=0.

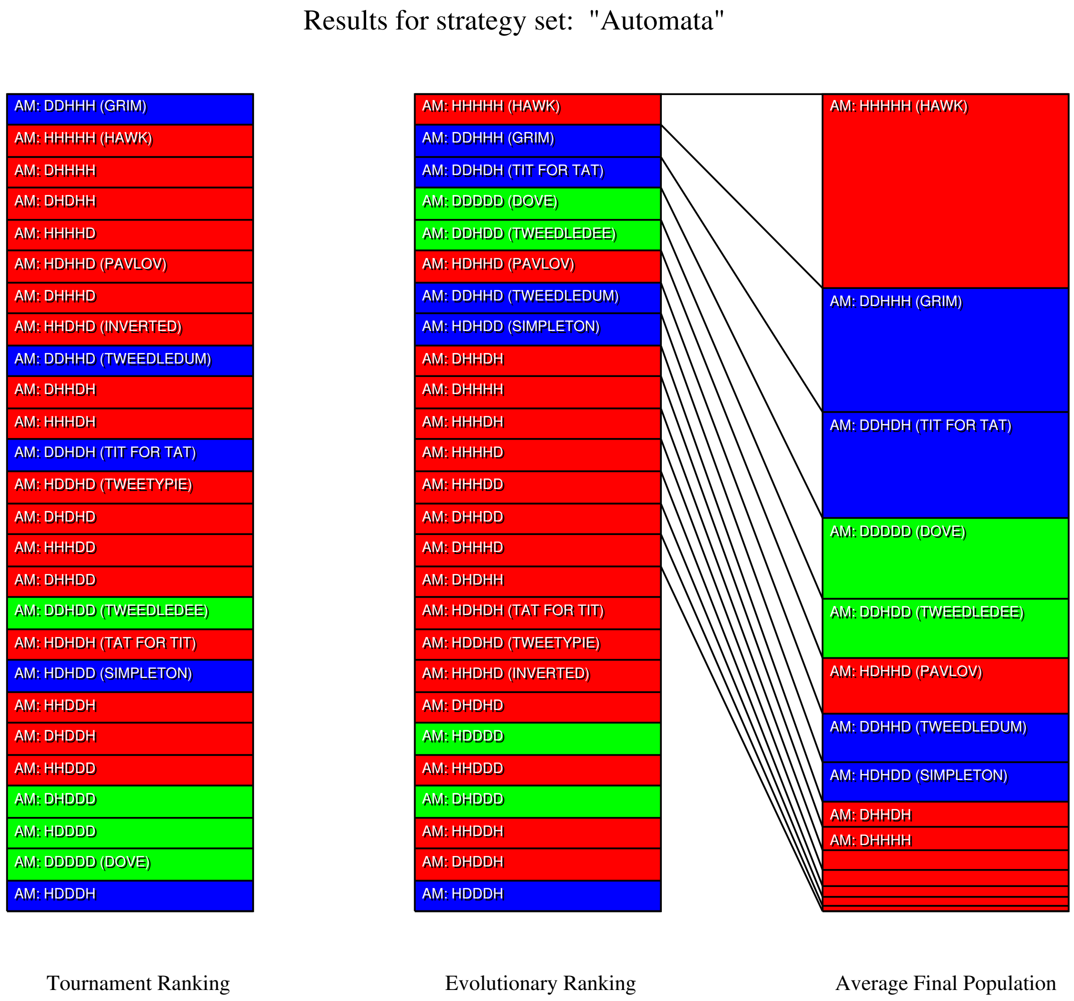

Figure 8.33: The aggregated results of the simulations of the “big series” with the payoff parameters T=5.5, R=3, P=1, S=0.

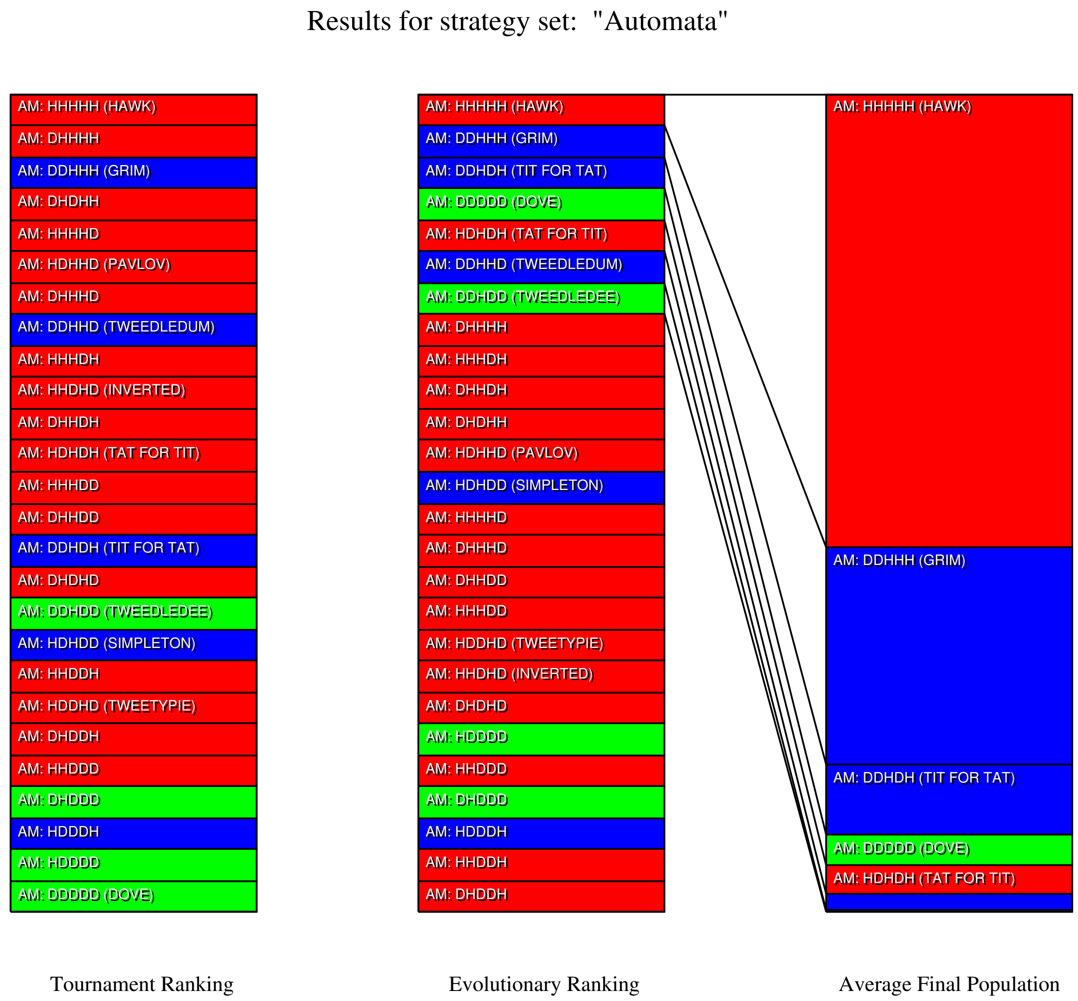

Figure 8.34: The aggregated results of the simulations of the “big series” with the payoff parameters T=5, R=3, P=2, S=0.

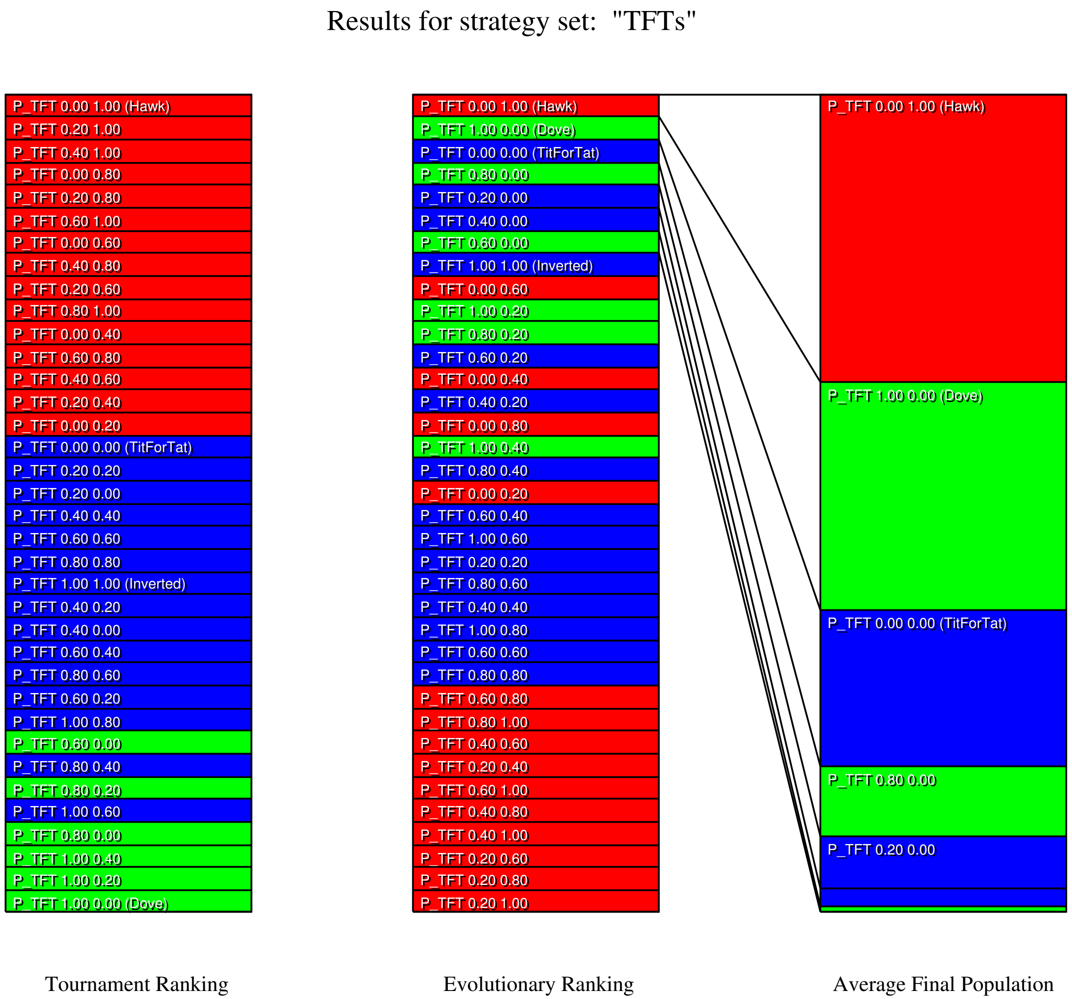

Figure 8.35: The aggregated results of the simulations of the “big series” with the payoff parameters T=3.5, R=3, P=1, S=0.

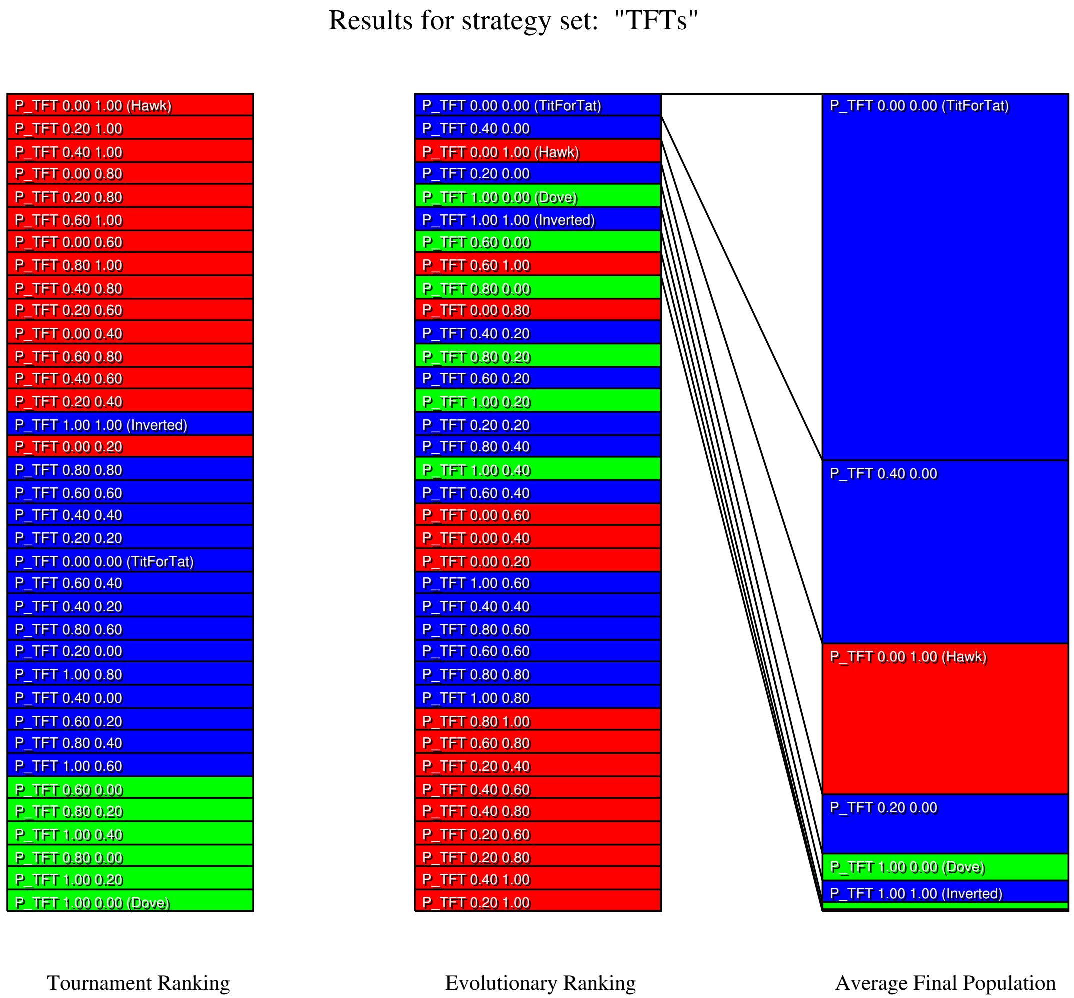

Figure 8.36: The aggregated results of the simulations of the “big series” with the payoff parameters T=5, R=3, P=1, S=0.

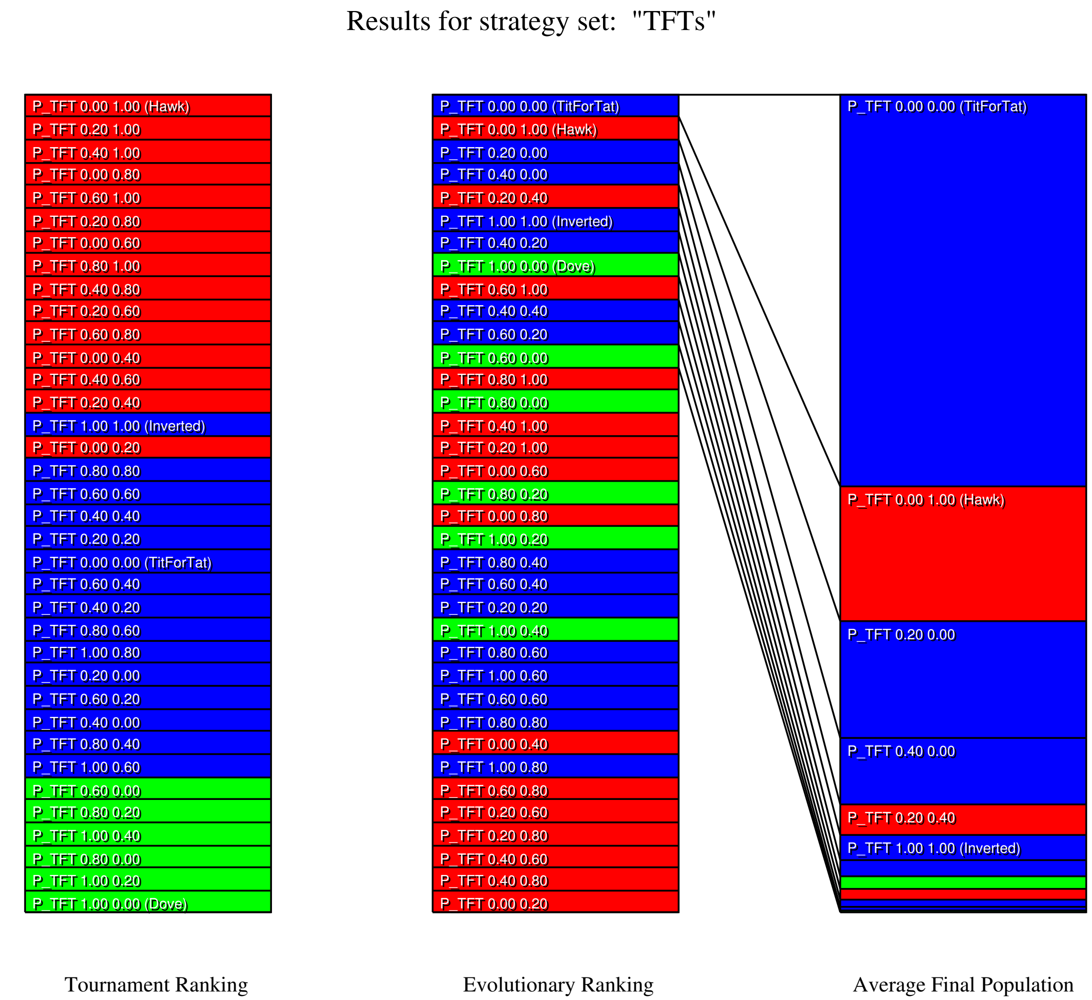

Figure 8.37: The aggregated results of the simulations of the “big series” with the payoff parameters T=5.5, R=3, P=1, S=0.

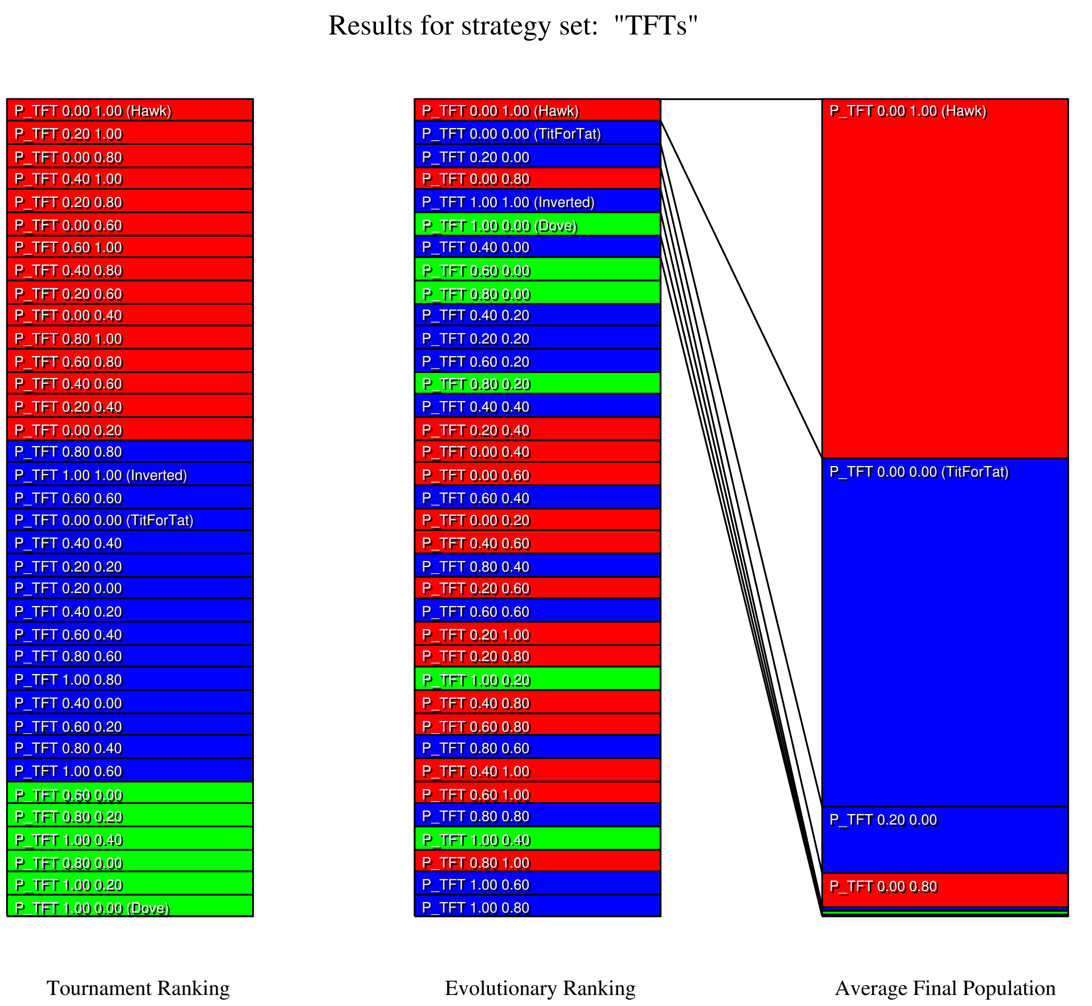

Figure 8.38: The aggregated results of the simulations of the "big series" with the payoff parameters T=5, R=3, P=2, S=0.

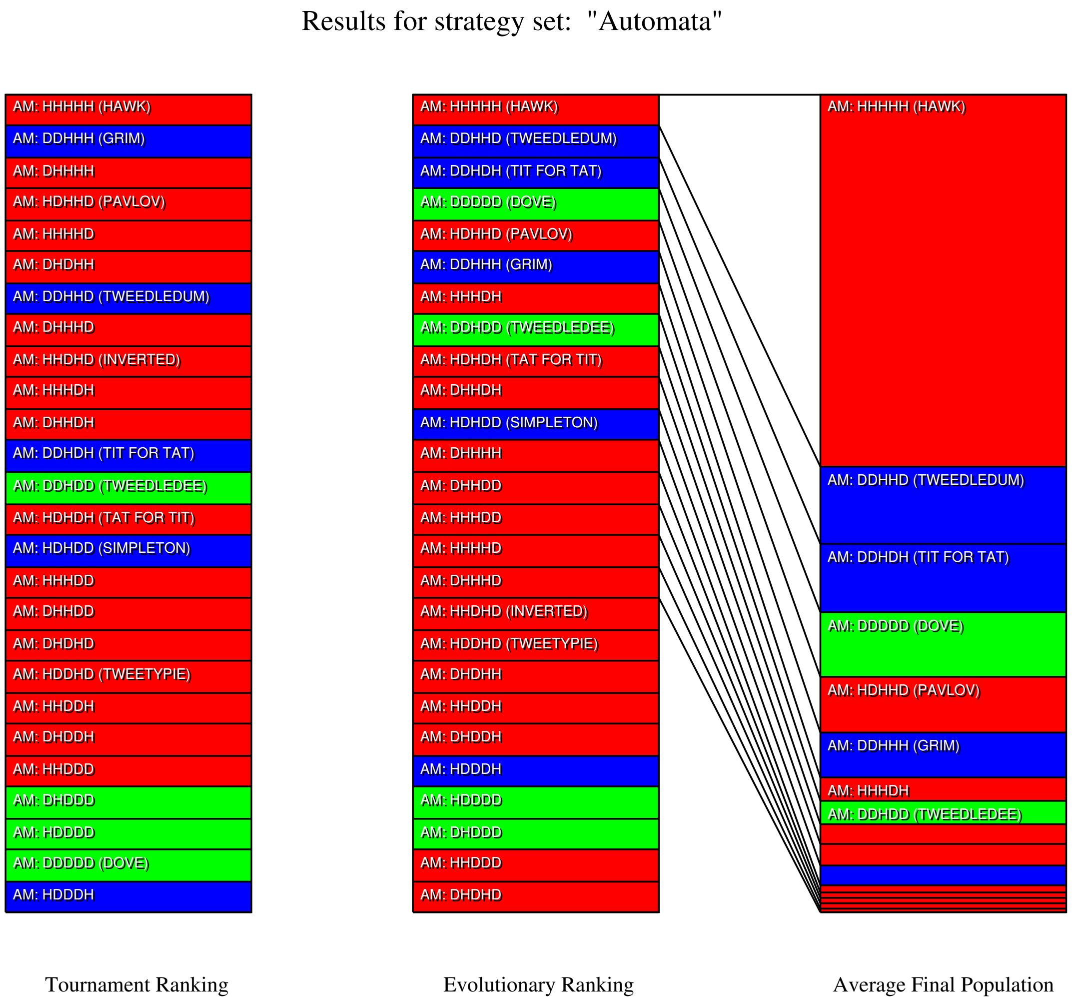

Figure 8.39: The aggregated results of all simulations of the "Monte Carlo series" using *Automata* strategies.

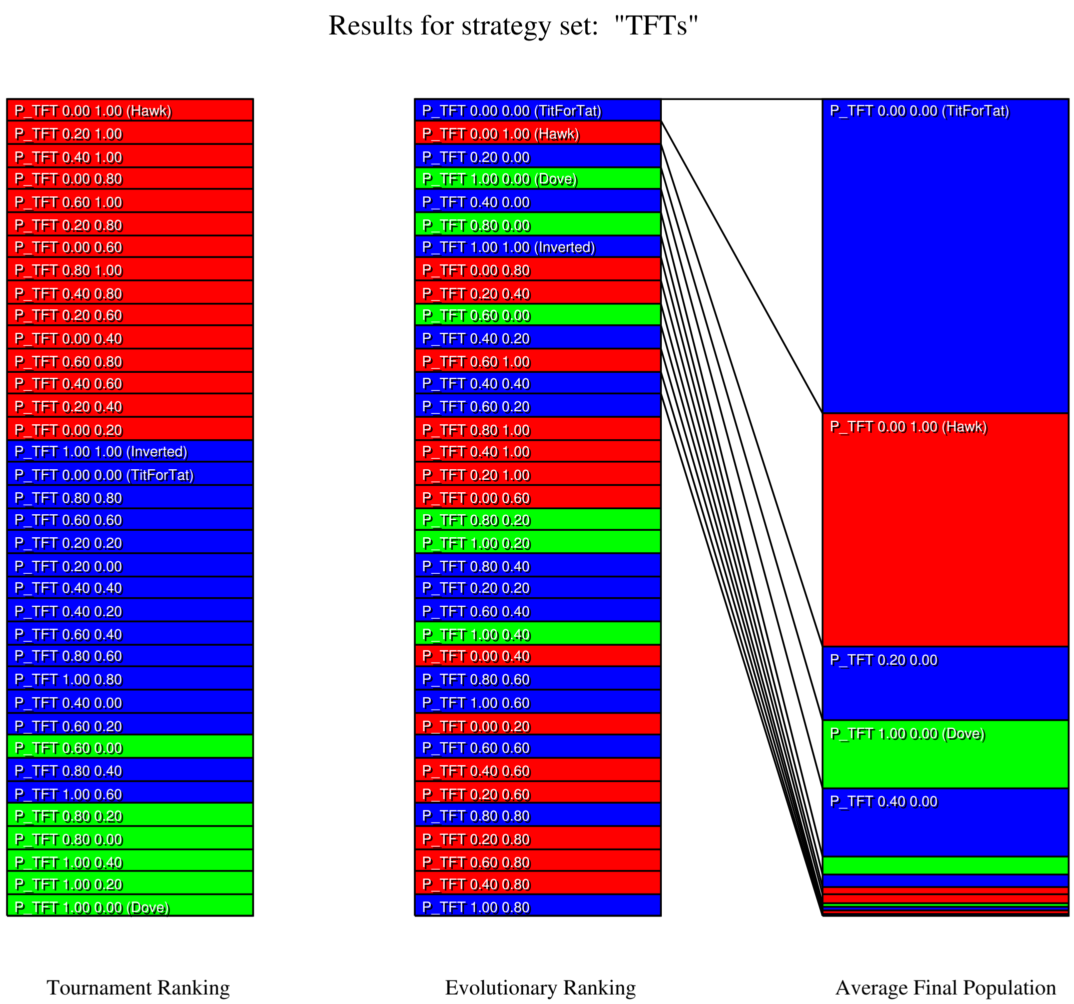

Figure 8.40: The aggregated results of all simulations of the "Monte Carlo series" using *Parameterized Tit for Tat* strategies.

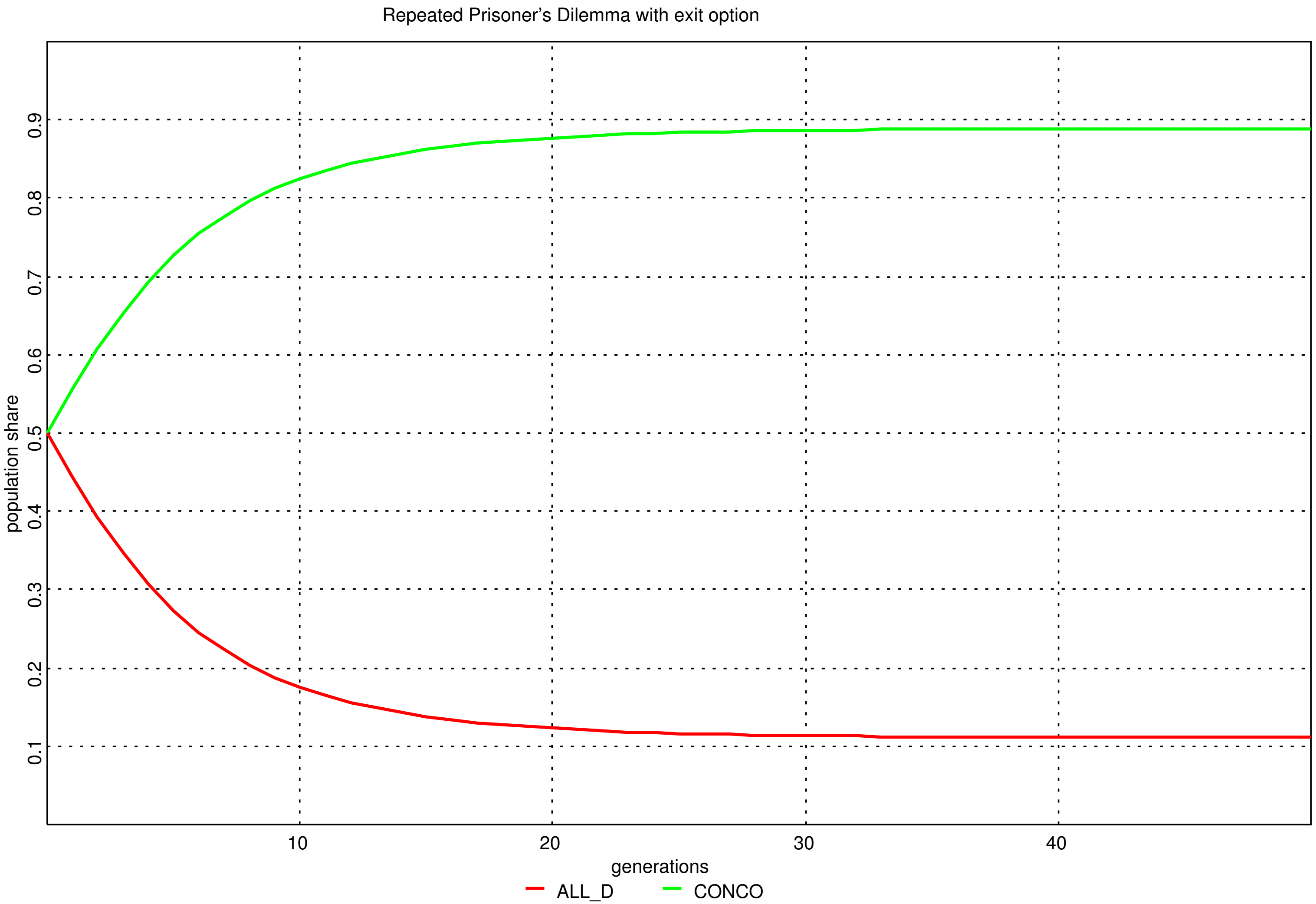

Figure 8.41: As this simulation following Schüßler (Schüßler, 1990) shows, cooperation may even evolve an "anonymous markets".

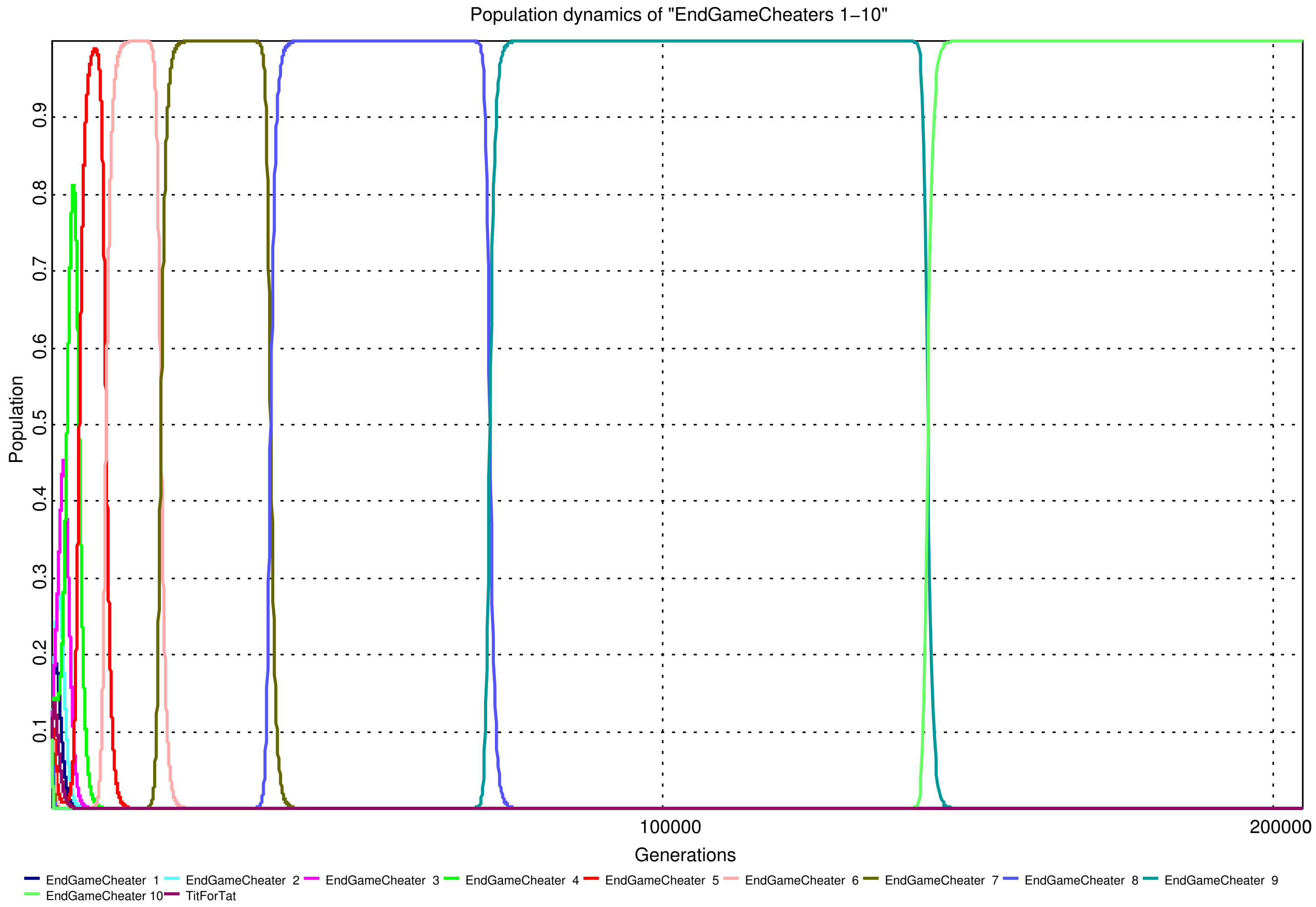

Figure 8.42: End game cheating as an evolutionary process: It takes more than 100,000 generations until it pays to cheat in the last ten rounds of a 200 round reiterated Prisoner's Dilemma.

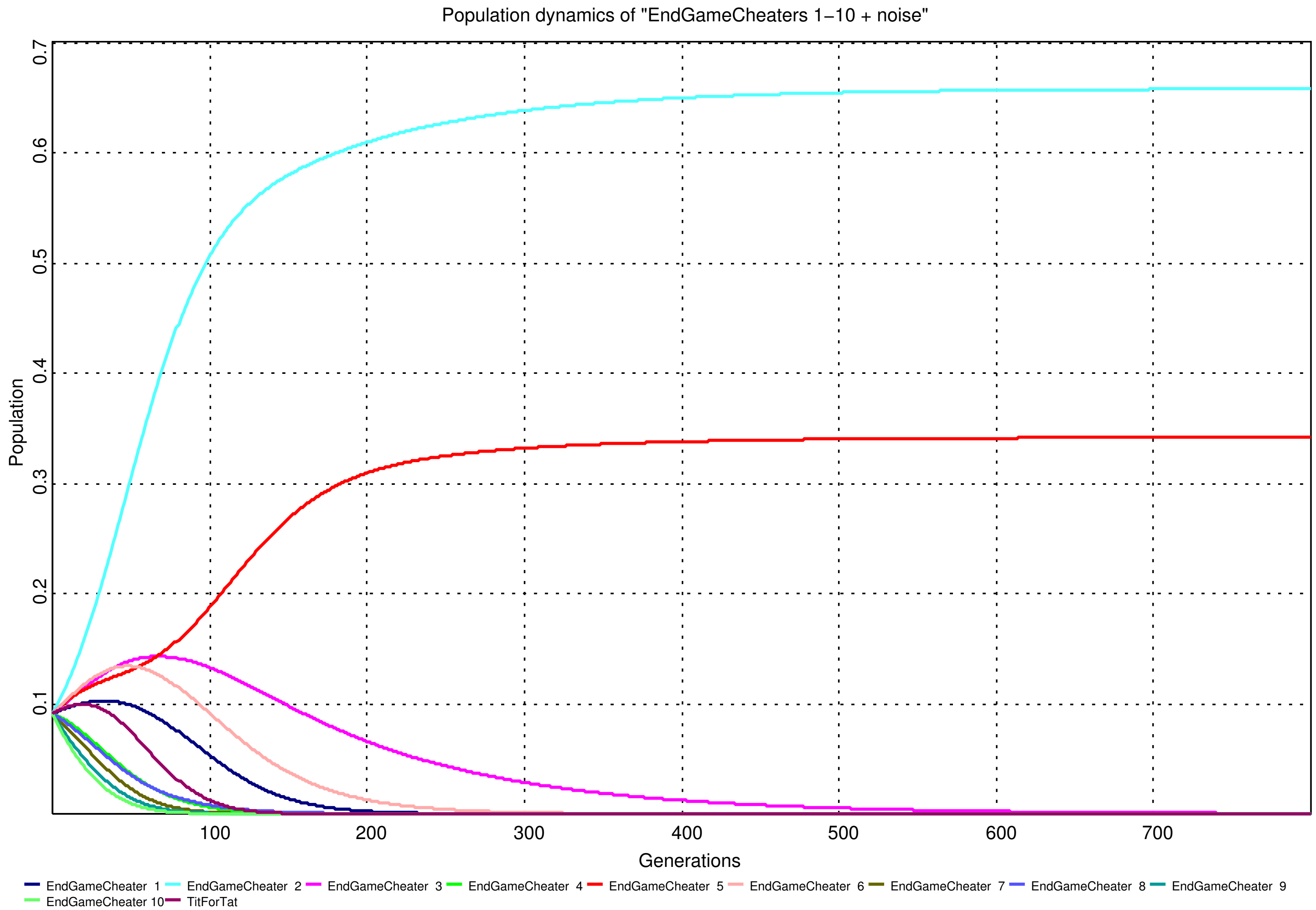

Figure 8.43: End game cheating is already stopped short when there is a slight amount of game noise (1%).