DESCRIPTION FOR THE GENERAL PUBLIC

Theory of evolution created by Charles Darwin is one of the most important theories in the modern science. It affects distinct disciplines such as social sciences and even the philosophy. Evolutionary phenomena inspired computer scientists for the development of the optimization methods ,such as evolutionary and genetic algorithms, or machine learning techniques. On the other hand, in biology, methods taken from mathematics and physics are also used, Mathematical models and computer simulations are very useful tools for research. Important aspect of the explanation of the evolutionary phenomena observed in nature is the calculus of costs and benefits, resulting from analyzed trait or behavior. The investigated trait can be for example body size, allocation of energy between reproduction and immune response, but also mating strategies or evolutionary origins of altruistic behavior. Many situations observed in nature seems to be paradoxical. It is not easy to explain why predator species are less violent for themselves than herbivore rodents and why in most cases we observe even sex ratio. In the situations when verbal explanations don't lead to conclusions, mathematics may be helpful. One of the main tools used to solve problems of this type is evolutionary game theory. This discipline was established by John Maynard Smith, British evolutionary biologist and former aircraft engineer, by application of methods taken form economics, created by famous mathematician John von Neumann and the economist Oskar Morgenstern. Evolutionary game theory is relatively young discipline and is still in phase of intensive development. One of the related problems is the interpretation of the economical concepts in terms of population processes, which is related to the problem of definition of the Darwinian fitness. And here we approach the field of our project. This is continuation of the previous works on so called demographic games. In demographic approach to game theoretic models, the "currencies" in which "payoffs" of strategies are payed are fertility (measured as the number of produced offspring) and mortality (measured as the probability of death during the interaction described as the game round, such as fight between deers for the access for females). We want to investigate the impact of the delay of fertility "reward" caused by egg hatching time or pregnancy duration. To reach this goal we will combine game theoretic methods with tools for analysis of the delayed differential equations, which show that delays can induce oscillations of the population sizes, which are not present in the classic models. This will allow for analysis of the role of passive carriers (not playing the game) of the genes which will be expressed by their offspring (for example mothers carrying genes encoding behavior of their sons during mate competition). Another problem is the influence of the life cycle on selection of behavioral strategies. If an individual will die during conflict then he will not participate in other interactions anymore. Therefore mortality pressure is not only related to the particular encounter but it determines the chance for another encounter with different competitor. This will affect the age structure of the strategy carriers and can affect the outcomes of selection process. We want to analyze this influence. Last question that we want to investigate is the impact of the growth limiting mechanisms operating at the level of whole population on the mechanisms of selection of individual strategies. Which quantity is maximized by natural selection, instantaneous growth rate or maybe lifetime reproductive success? Or maybe different quantities are maximized during free growth of the population and at the stable population size? This is the question about so called measure of Darwinian fitness. How this affects the predictions of the stable population size? We expect that our research will increase the realism of the modeling methods used in evolutionary biology and contribute to exploration of the relationships between selection mechanisms, ecological factors and demography. Mathematical techniques and new modeling methods can be used in different scientific disciplines. They can be helpful in development of new more precise models of cancer dynamics (where evolutionary game theoretic methods are used nowadays) or in the modeling of social and economic phenomena. In this way biology will pay off the debt to economical sciences for borrowing the game theory.