Evolution of evolutionary mechanisms: A workshop held at Berlepsch Castle (Göttingen, West Germany), November, 1980

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There is almost no doubt that the strategies that underlie the process of organismic evolution are the result of mutation and selection, just as any biological structure. On a recent workshop at Berlepsch Castle this problem was discussed by evolutionary biologists, engineers, population geneticists and mathematicians. The meeting was organized by K. Gärtner and G. P. Wagner, Medical and Veterinary School of Hannover and Max-Planck-Institute of Biophysical Chemistry, Göttingen.

In his introductory lecture I. Rechenberg (Technical University, Berlin) summarized his extensive studies on the optimization of technical systems by his evolutionary strategy, a method for the optimization of complex technical systems by random mutation of parameters and selection of the best parameter combination[1]. Optimization is possible at a reasonable rate only if the evolutionary algorithm meets the following requirements: i) a stochastic continuity of the relation between the genetic changes and the phenotypic response, i.e. small changes in the genotype should on the average lead to small changes in the phenotype; ii) an optimal steplength of variability that allows a maximal speed of adaptation; iii) recombination; and iv) a "genetic gear" that relates the phenotypic response of functionally related characters to genetic changes. All these four properties contribute to a marked increase of the rate of adaptation and may correspond to four major steps in the evolution of evolutionary mechanisms.

The biological counterpart was discussed by R. Riedl (Univ. of Vienna) in his contribution on the evolution of morphological characters and epigenetic organization.[2] On the basis of the mode of typogenetic evolution, the existence of atavisms, the appearance of homeotic mutants, and the pattern of interspecific variability, Riedl showed how the macroevolutionary pattern of change may be explained by the evolutionary optimization of epigenetic organization, the "genetic gear" of Rechenberg. The importance of the evolutionary optimization of the epigenetic system was also emphasized by von der Malsburg (Max-Planck-Inst. f. Biophysical Chemistry, Göttingen). He pointed out that with reference to our knowledge of ontogenetic self-organization the possibility of gradual adaptation is not trivial. Therefore an epigenetic system that allows gradual adaptation has to be the product of evolutionary optimization.

Thus the basic contributions maintained the view of evolution as a gradual process but emphasized that the rate of change under environmental disturbances has to be subject to evolutionary adjustment by selection for rapid adaptation.

The influence of random disturbances of the selection process was then discussed. Prof. Pirchner (Technical Univ. Munich) reviewed the random-drift theories on the basis of S. Wright's ideas. K. Gärtner (Medical School, Hannover) reported about his experiments on intangible variance (i.e. non-heritable and non-environmental variation). It was shown that the amount of intangible variance of any particular quantitative character is the most important component of its variance. It has a distinct magnitude, specific for each character and determined before the third cleavage stage of an embryo. Intangible variance causes stochastic continuity of the phenotypic variance of quantitative characters.[4,5] The results emphasized the question of the evolutionary significance of this phenomenon. In this connection H. P. Schwefel discussed a model to explain how intangible variance can lead to increased speed of adaptation.

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This is, for instance, the case if the amount of intangible variance is correlated with higher mutation rate in the germline or a higher tendency to express genetic variability phenotypically.

A second approach for the empirical study of the evolution of evolutionary mechanisms was presented by G. P. Wagner. With regard to data on the evolution of lungfish and horses it was demonstrated that typogenetic evolution may be characterized by a peculiar kinetics and hence by a peculiar mechanism.[6]

Besides the problem of evolutionary optimization of the adaptability of morphological characters, three speakers considered the evolution of social behavior. C. Vogel (Univ. of Göttingen) gave a critical review of the concepts of sociobiology on the basis of his observations on the Hanuman Langur.[7] The dangers of a one-sided adaptationist view was demonstrated with regard to the sociobiological interpretation of "infant killing" and "infant transfer". As a speculative summary Vogel proposed the view of a close interrelationship between individuation and sociation in primate evolution.

Two approaches for the mathematical treatment of the evolution of social behavior were discussed. Hammerstein (Univ. of Bielefeld) discussed the game-theoretical approach on the basis of Maynard Smith's theory of evolutionary stable strategies, and Hofbauer (Univ. of Vienna) proposed an approach with the use of systems of differential equations.[8] In summary, it appeared that the evolution of social interaction did not contribute to an acceleration of genetic change.

In the final discussion the participants emphasized the importance of considering the evolution of evolutionary mechanisms as an integral part of organismic evolution.

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