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Työn nimi -- Arbets titel			
The fractal dimension in multiscale biological systems.			
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<p>Biological systems are generally considered as complex, interactive systems with several spatiotemporal scales varying quantitatively and qualitatively between different levels of the system. The organic and inorganic components of a biological system have also simultaneously ordered, random and chaotic elements. These elements interconnect preserving some patterned structures and creating variation, and the dynamics of the system is often a combination of regular and irregular patterns and processes. The environment or matrix of biological systems is in most cases heterogenous or patchy in relation to the system units.</p> <p>Fractal geometry studies the structure of irregular sets or systems at different scales. A quantitative measure, the fractal dimension, can be used to measure the spatiotemporal fine structure of the system. In this study, I have analyzed the suitability of the fractal dimension concept to study the patterns and processes of a biological system. The work is based on central publications of fractal dimension theory, applications and biological system study and modelling. The main intrests of the study can be formulated to following intimately involved problems:</p> <ol style="list-style-type: none"> 1) What are the basic mathematical assumptions behind the concept of the fractal dimension and how can these properties be used to study biological systems and their spatiotemporal scales? 2) What does the fractal dimension tell about the nature and logic of the scales in a biological system ? 3) Does the fractal dimension characterize the complexity or information at different scales in a biological system? 4) Is the dimensional approach in general relevant for the study and analysis of biological systems ? <p>The fractal dimension concept describes the spatiotemporal fine structure of systems with self-similarity or scaling invariance, but its application can be broadened with some restrictions to systems with self-affinity and stochastic elements. The fractal dimension can be a measure for metric, correlational or information structures of a system, and be used in a wider context as a generalized dimension. The study of organism, border and surface structure, frequency distributions, point patterns and some power laws at different scales are examples of using the fractal dimension in biological pattern analysis. The temporal properties of the fractal dimension can be used in the general analysis of nonlinear dynamics, time-series and temporal dispersion or diffusion. If the spatial and temporal properties of the fractal dimension are connected, it can be used in relatively tightly integrated systems as in physiology, but also in more diffuse and complex processes as in population dynamics or in hierarchical systems of landscape ecology. Besides a geometrical description of biological systems at different scales, fractal geometry and dimension are tools for new ideas of complexity, determinism and chaos. Very complex structures and dynamics may be created by using simple, recursive algorithms revealing delicate lines between order and chaos in nature. Fractal geometry and its dimensions form an extensive basis to construct and compare different heterogenous and informational structures using modern computer image processing and analysing techniques.</p> <p>The basic properties of the fractal dimension can in many ways be seen applicable to hierarchical biological systems. When analyzing biological systems, the fractal dimension approach should, however, be properly restricted to relevant quantitatively comparable biological scales and be rather used as a relative measure of system properties and differences between systems than an absolute system 'megaparameter' or a sort of universal law or rule affecting the evolution of the system. The study of biological systems with complex dynamics and multiple scales should use information gained by several different measure procedures and use 'objective', more formal models as well as 'subjective', system specific models with special biological information.</p>			
Avainsanat -- Nyckelord			
Dimension, fractals, spatiotemporal scales, biological systems			
Säilytyspaikka -- Förvaringställe			
Eläintieteen laitoksen kirjasto			
Muuta tietoja -- Övriga uppgifter			