An attempt to define the ecological concept of refugia using basic system deliberation

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ABSTRACT. Hypothetical concept of refugia was analysed from viewpoint of worse / better life conditions, nutrient potential, existence of potential niches, life strategies, bounded / diffuse nature, and possible permeability of boundaries.

KEYWORDS: refugia, biological crises.

Introduction

The problem of refugia attracts considerable interest among ecologists engaged in the investigation of biocrises. Assumed capacity of refugia to accept some taxa during the crisis as well as to release them after the crisis indicates that refugia mean something other than simple relicts of the previous thrifty ecosystems. In this manner they also differ from biologically defined shelters or refuges.

Refugia conditions

(1) Refugia conditions (Cr) are fairly different from those that dominate diversified ecosystems before the first crisis. These differences include, for example: (i) strongly decreased primary input of solar energy, (ii) marginal temperature, (iii) marginal chemical conditions or (iv) effective barriers. In terms of formerly thrifty ecosystem conditions (Cth), the refugia conditions look worse. Precisely defined, Cr need not be worse or better but should simply be different from Cth.

(2) The ultimate conditions (Cu) encompass the absolute limits of organic adaptive capability (from the perspective of construction, physiology, behaviour...). For example, although we know that the hippopotamus cannot live in boiling water, the prediction of Cu is inevitably a more complicated task. As visible from (1) and (2), the refugia conditions cannot be equal to conditions occupied by thrifty systems and, withal, they cannot be also equal to ultimate conditions Cu. Therefore, $Cu \neq Cr \neq Cth$.

(3) However, refugia conditions cannot be worse for individuals if they are to survive after escaping from previously flourishing systems. Commonly but not always, escaping is equal to extinction in the previously occupied ecosystem. These new conditions must be better, at least in survival probability (nutrition and reproduction) than conditions in the previously occupied ecosystem. Usually, the total sum of utilisable biologic nutrients in Cr (Crn) is the same or greater than was accessible in Cth (Cthn). Simultaneously, Crn is probably the same or greater than in Cu (Cun). From (3), the utilisable nutrient potential in refugia could be favourable. $Cun \leq Crn \geq Cthn$.

(4) The existence of 'potential niches' is important (= the ease of new niche introduction). Some scenarios can be realised; for example: (i) the conditions close to Cu limits, see (1 and 2), (ii) the prevailing supertramp strategies of inhabitants = jumping from place to place, a reflection of several situations, (iii) the prevailing low metabolic spectrum of organisms, mainly omnivores, (iv) moderately high to high intensities of stress and microenvironment movement. The old concept of open niches, although also puzzling in its details, can be easily used as a factor favouring abnormal immigration or flows during times of large crises. We must distinguish promising and almost inaccessible niches. The first can be included in Cr but surely they are absolutely minimised in Cu. Open space for expansion is almost inaccessible in Cu (Cus), less is in Cr (Crs) and the minimum is in Cth (Cths). Thus $Cus > Crs > Cths$.

(5) A refugium is a situation where survival probability is increased. These situations include: (i) organism strategies that can be activated in a crisis (e.g., an active strategy), and (ii) the marginal bioarea is adjacent to Cr, allowing passive diffusion. Some characteristics aid in overcoming the crisis. They are, for example: (i) less nutrient requirements and / or less selectivity of nutrient sources; (ii) short reproduction, so-called r-strategy, some uniform populations of small organisms are called disaster populations. Briefly we can say that some organisms are successful in crisis environments.

(6) Success of Cr inhabitants depends on the capacity to migrate, survive and then emigrate to other regions.

(7) Are the refugia physically outlined or not? When they lack any physical boundaries, they are part of the internal exchange within the system. Such phenomena are to be conceptualised separately and they need another label. The concept of refugia can be effective only when a real system of natural refugia can be demonstrated. In our opinion this is a crucial point of refugia discussions. However, Cu is quite strictly outlined and boundaries of thrifty systems are usually also well expressed. So we can easily deduce, from (1) and (2), $Cu \neq Cr \neq Cth$, and that refugia are outlined.

(8) Permeability of Cr-Cth margins fluctuated: At least in some intervals of crises, refugia were open so that organisms could attempt some massive colonisations. Controversely, if highly diversified systems begin to develop a dense network of specialists (between the crises), the margins of dense multi-component structures may represent some barriers against a recurrent infiltration. In this case, the refugia look like temporal traps. This assumption also substantiates recent thinking about the system identity of refugia. From the stand-point of refuge quality, two types of refugia can be distinguished: large and stable reservoirs, e.g. the deep ocean (stable refugia) and zonal and quickly changing boundaries of systems (stationary refugia).