

Evolutionary Significance of Symbiosis in Ecosystem Development

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Symbiosis –an introduction

The term ‘symbiosis’ was first coined by Anton de Bary in the mid-19th century as ‘the living together of different species’. Symbioses are prolonged associations between organisms often widely separated phylogenetically. Temporarily or for a longer time and at least one of the organisms benefits from the relationship. Symbiosis established due to direct transmission and re-infection. Symbiosis functions in nutrition, protection, space and is selective driver for evolution. Symbiosis varies with respect to: Degree of intimacy (ectosymbiosis vs. endosymbiosis), the balance of advantage (mutualism vs. parasitism) and the extent of dependence (facultative vs. obligate symbiosis).

Symbiosis - A driving force in evolution

Microbial symbionts play such an important role in the lives of their eukaryotic hosts, why should they not also play a role in the evolution of these higher organisms? Symbiotic relationships are recognized as an important selective force behind evolution. Interdependent coevolution took place in many species. Over many generations, the organisms came to depend more on the symbiosis as natural selection favored those traits. Thus symbiosis became the sole source of the food, shelter, enzyme or whatever else the symbiotes derived from one another.

Landmarks in Earth history

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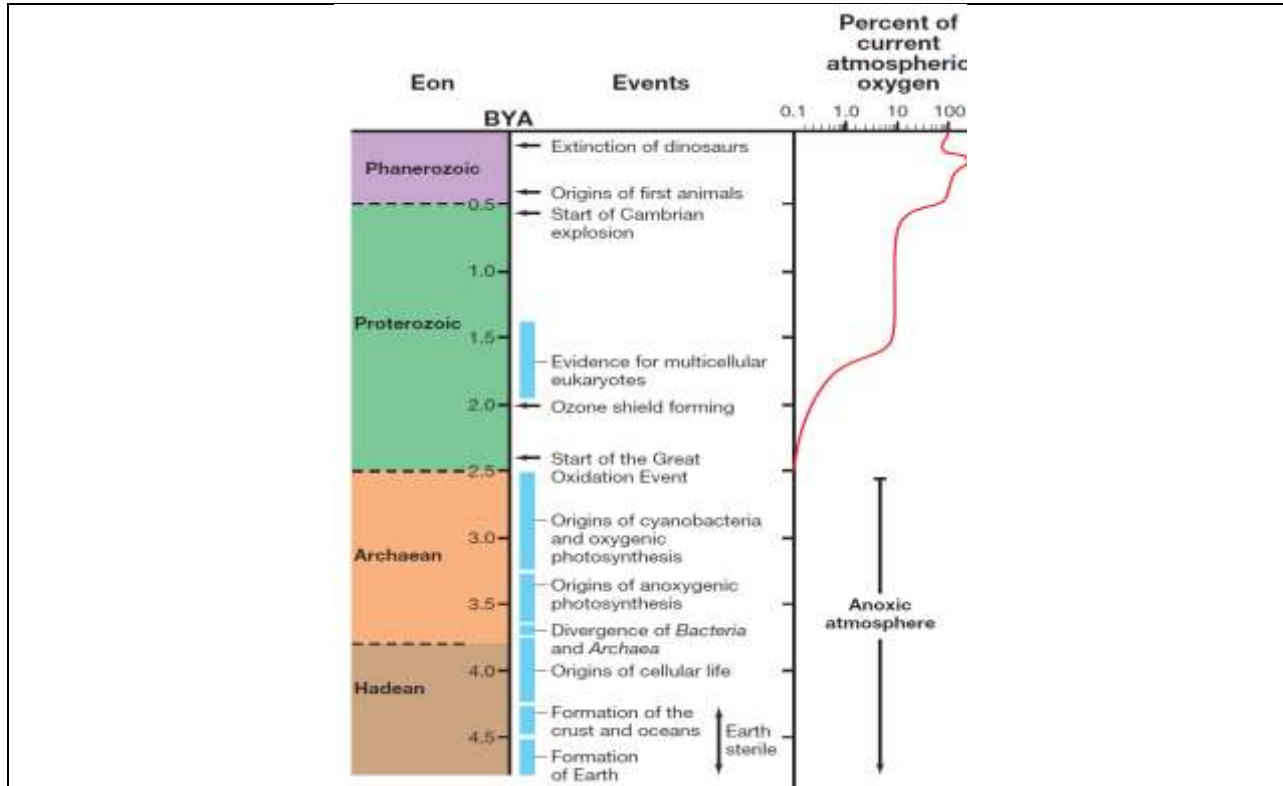


Fig 1: Evolutionary landmarks since earth formation [5.]

Darwin's theory of evolution

Charles Darwin formulated the scientific theory of evolution by natural selection. He states that all species of organisms arise and develop through the natural selection of small, inherited variations that increase the individual's ability to compete, survive, and reproduce. The biologist Lynn Margulis considers Darwin's notion of evolution, driven by competition, to be incomplete and contends that symbiosis, a major driving force based on cooperation, interaction, and mutual dependence among organisms behind evolution. Evolution of all eukaryotic species is believed to have resulted from a symbiosis between various sorts of bacteria (endosymbiotic theory).

Black Queen Hypothesis

Loss of gene result in the evolution of mutual dependence in microbial communities for lost metabolic functions. It is also the basis of some laboratory grown coculture with one or more other species from their environment (Fig 2).

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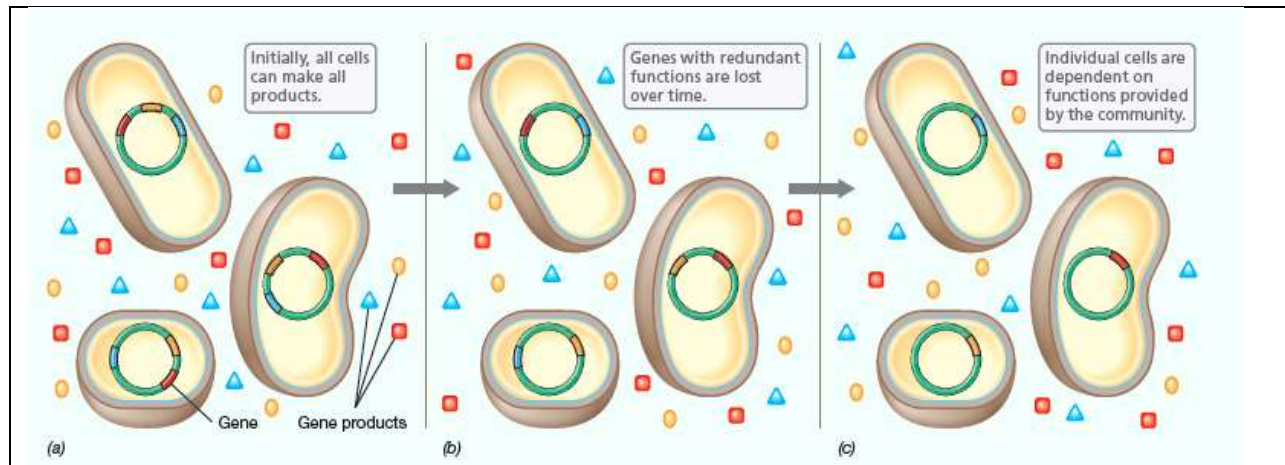


Fig 2: Black queen hypothesis: Role of symbiosis in evolution

Landmarks in Symbiosis concept

Symbiosis has been the one of the important driving force in the evolution. Fig shows the some landmarks of the evolution with the symbiosis (Fig 3).

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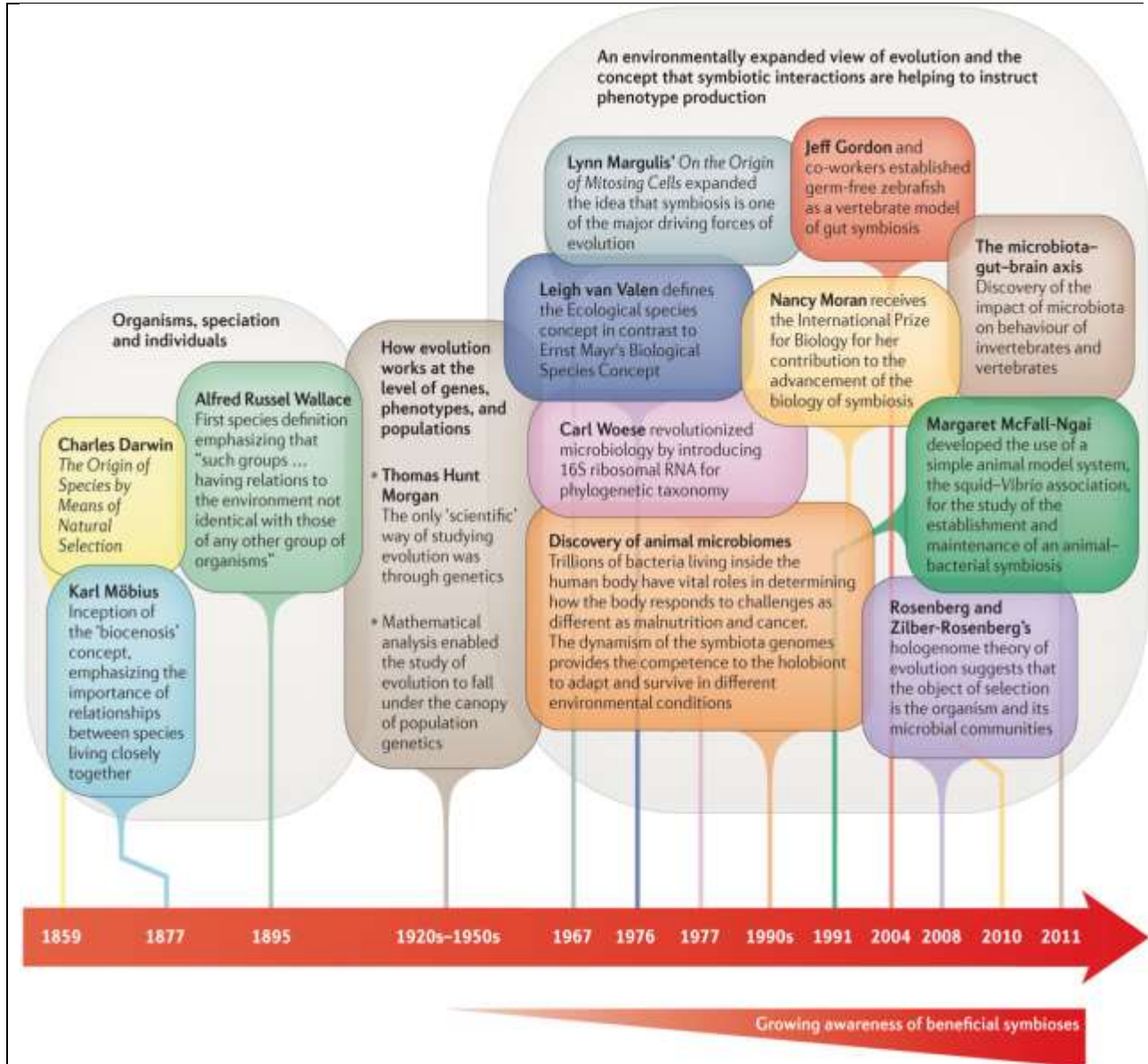


Fig 3: Successive progression of the symbiosis concept.

Forms of Symbiosis

Symbiosis is the type of association between organisms either positive or negative [10]. Symbiosis can be divided into different associations like mutualism, commensalism and parasitism.

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MUTUALISM	COMMENSALISM	PARASITISM
<ul style="list-style-type: none">• Parasite removal for food• Swap nutrients• Dual protection	<ul style="list-style-type: none">• Safe housing• Transportation (i.e. safe travel to food sources)• Use discarded material• Temporarily attaches to another	<ul style="list-style-type: none">• Host (term for party that is harmed)• Parasite (term for party that benefits)• Drains resources from host• Can kill host• May depend on host surviving• Transfer disease• Physically attached to host

During periods of rapid changes in the environment, the diverse microbial symbiont community can aid the holobiont in surviving, multiplying and buying the time necessary for the host genome to evolve. Both host and symbiont genomes must be transmitted with accuracy from one generation to the next during course of evolution. The symbiosis between some plant species and nitrogen-fixing nodule bacteria is one of the most relevant cooperative relationships in the world. The association of microorganisms with hosts can take many different forms. Some may be transitory and have little effect on adaptation or evolution of the holobiont.

Many have long lasting interaction such as:

- Plant microbe interaction among nitrogen fixing species
- The human gut microbiota,
- Rumen system
- Lichens

Conclusion

Symbiosis is a worldwide phenomenon operating throughout animal, plant and microbial systems. Interdependence of one organism over other could have evolved the life on Earth. The cross-feeding of essential small molecules among microbes is a way of their living especially in mat ecosystems. All three domains of life archaea, bacteria and eukarya might have evolved in mat ecosystems. Symbiosis is not only an ancient phenomenon but also a selective advantage for organism to coevolve

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