On analogy between ocean system and living system – A thermodynamic investigation -

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Both the ocean system and living systems seem to share a common feature, that is, the development of a circulatory structure. In this study, we discuss the analogy between the ocean circulation and living organisms and their evolution.

We have suggested that time evolution of the circulatory structure in the ocean system is associated with an increase in the entropy production rate, and supports the principle of maximum entropy production (MEP, Sawada, 1981) (Shimokawa and Ozawa, 2001, 2002). By producing the highly organized circulatory structure, the system succeeded in producing a higher rate of entropy production (Fig. 1a). The same should hold for the development of a living organism. Through the development of a system from a fertilized egg to an adult, a well-organized circulation of body fluids (i.e., blood) emerges. By using this circulating blood as a working substance, the living system attains higher exchange rates of heat and materials (e.g., oxygen and food) with its surroundings. The rate of entropy production is likely to be at its maximum in the living system's most mature state.

There is, however, a difference between an ocean system and a living system. The circulation of the former can last perpetually, provided that a temperature difference exists in the surrounding system. In contrast, life activity and its entropy production decrease with old age, ending in death. The existence of death seems to be an apparent contradiction to MEP, and it should be examined more carefully whether the conditions of MEP apply to the growth processes of individual organisms.

Let us consider the development of an internal structure of a species during a considerably long period of time, rather than that of an individual living system during that individual's short lifetime. The development of a structure in individuals of a species caused by differential reproduction processes on the geologic time scale is known as