The Gaia Hypothesis Revisited: Discoveries of some realistic selective pressures for altruistic species in ecological systems.

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The Daisyworld has been the unique theoretical support for the Gaia hypothesis, biotic homeostasis of the environment, since it was published almost 25 years ago. The Daisy world is inhabited by daisies of two different colors and the daisies control the temperature of the planet by reflecting or absorbing the solar radiation and thereby create more favorable or advert temperature to themselves. The Daisyworld has long been regarded as a metaphorical example of the Gaia hypothesis and many scientists have dismissed the idea of the Gaia hypothesis.

The present earth is inhibited with various organisms and not small number of them can alter the environment by releasing chemical substances. Here some new mechanisms will be presented by which those organisms can alter the environment only in a favorable direction to the whole biota. They are much more realistic than the Daisyworld, can readily be applied to the actual ecosystem in the earth and may provide a stronger support to the biotic homeostasis of the earth.

(I) Maintenance of environmental homeostasis by biota, selected non-locally by circulation and fluctuation mechanisms. (T. Akagi, Artificial Life, 12, 135-152, 2006)

The system considered consists of two environment-altering species and a resource circulating through the two species. In the system, fluctuation in the growth rate among species leads to selection of favorable species. The accompanying fluctuations in the quantity of resources, which return by circulation with a certain time lag, are likely to cause this selection.

(II) Daisyworld inhabited with daisies incorporating a seed size/number trade-off: The mechanism of negative feedback on selection from a standpoint of the competition theory. (M. Seto and T. Akagi, Journal of Theoretical Biology, 234, 167-172, 2005)

Unlike the original Daisyworld model, white and black daisies in our model incorporate a seeding/germination trade-off against bare ground area of the planet without assuming the local temperature reward. As a result, the planetary temperature is automatically regulated by the stable coexistence of the two species.

(III) A self-regulatory chemostat model with two species in trade-off for one resource (the 2:1 model). (M. Seto and T. Akagi, submitted). A self-regulatory chemostat model with two species in trade-off for two resource (the 2:2 model). (M. Seto and T. Akagi, submitted).

To two competing species with temperature affecting traits, trade-offs in their ability to utilize a nutrient (the 2:1 model) or two nutrients (the 2:2 model) are introduced. Chemostat systems are shown to yield the competitive coexistence of the two species as well as the regulation of temperature.