宇宙での生命の起原と進化

山岸明彦
東京薬科大学
生命科学部

Are we alone in the universe?

生命は、宇宙で我々だけか？

アストロバイオロジー

- 天文学
- 惑星科学、地球物理学
- 地球化学、化学進化
- 地学的証拠
- 生化学的研究
- 熱水地帯の微生物生態
- 遺伝子の証拠、分子進化学
- 宇宙での微生物探査
- 知的生命体探査

何を検出して生物と言うか

- 生物の定義

  複製する:現場培養、現場観察

  境界を持つ:蛍光染色Live and dead

  代謝する:酵素活性染色

生命の定義と Darwinism

山岸明彦

生命と地球の歴史　磯崎・丸山

- ある種の境あるいはしきりをもって、周囲の外世界から独立した空間を保持する。
- 外界から物質やエネルギーを取り込んだり放出したりする代謝を行う
- 自己複製を行う（繁殖する）
- 世代交代を通して進化する

アストロバイオロジー　小林憲正

- 代謝をおこなう
- 自己複製を行う
- 外界との境界をもつ
- 進化（変異）する
- 　　（江上不二夫）

Darwin 1859, p 5

- As many more individuals of each species are born than can possibly survive; and as, consequently, there is a frequently recurring struggle for existence, it follows that any being, if it vary however slightly in any manner profitable to itself, under the complex and sometimes varying conditions of life, will have a better chance of surviving, and thus be naturally selected. From the strong principle of inheritance, any selected variety will tend to propagate its new and modified form.[Darwin 1859, p 5]

Darwinism
（ウォーレス現代生物学）

- 生物の多産
- 限られた資源
- 変異の存在
- 最適者の生存

- 自然選択

G. Joyce: Forward for Origins of Life (1993)

- There is no single definition that satisfies the entire scientific community.
- Exobiology Program with in the NASA
- *Life* is a self-sustained chemical system capable of undergoing Darwinian evolution.
- Darwinian evolution:
  - Self-reproduction,
  - Material community over an historical lineage,
  - Genetic variation,
  - Natural selection.

G. Joyce: Forward for Origins of Life (1993)

- *Life* is a self-sustained chemical system:
  - Living systems contain all the genetic information necessary for their own constant production (i.e., metabolism)

Definition of Life: PICERAS
Koshland 2002 Science 295: 2215-2216
Fundamental principles on which a living system is based.

- Program: recorded by DNA
- Improvisation:即興でやること: mutation
- Compartmentalization: maintain concentration
- Energy: movement of chemicals
- Regeneration: re-synthesis, cell division, birth
- Adaptability: respond immediately
- Seclusion: 隔離 of reactions, information's

Definition:

- Suppe 1977 The structure of Scientific Theories
  - Necessary conditions
  - Sufficient conditions
- Nietssche
  - There are concepts that can be defined, whereas others only have a history.

Maturana and Verela 1981, Autopoiesis and Cognition-the Realization of the Living

- Autopoietic system:
  - Entity defined by an internal processes of self-maintenance and self-generation.
  - the process whereby an organization produces itself. An autopoietic organization is an autonomous and self-maintaining unity which contains component-producing processes. The components, through their interaction, generate recursively the same network of processes which produced them. An autopoietic system is operationally closed and structurally state determined with no apparent inputs and outputs. A cell, an organism, and perhaps a corporation are examples of autopoietic systems.

A. Lazcano, 2008, Chemistry and Biodiversity, vol 5. 1-15

- Life could be defined as a self-sustaining chemical system that is capable of undergoing *Darwinian* evolution.
- The properties associated with living systems, such as replication, self-assemblage, or catalysis are also found in nonliving entities.

Pross, A. 2011 J. Systems Chem. 2, 1-14

- Toward a general theory of evolution: Extending Darwinian theory to inanimate matter
- 非生物的反応で競争選択されるシステムへDarwinismを拡張する。
- Dynamic kinetic stability (DKS)
- 川の水
- 生命はより大きなDKSへ向かう
- 予言不可能だが、合目的的（？山岸）

Pross, A. 2011 J. Systems Chem. 2, 1-14

- Toward a general theory of evolution: Extending Darwinian theory to inanimate matter
- Evolution: Certain oligomeric replicating systems, through a process of imperfect replication and on-going kinetic selection, will tend to evolve toward replicating systems of greater DKS.

Pross, A. 2011 J. Systems Chem. 2, 1-14

- Toward a general theory of evolution: Extending Darwinian theory to inanimate matter
- One whose replicating reaction would have been strictly governed by thermodynamic constraints, was transformed into a far from-equilibrium energy-gathering teleonomic replicating system. (Origin of Life)

生命の定義

- 無いという考えもある。歴史的に定義される。あるいは、説明される。
- NASAの定義と限界
- 日本での理解
- 現在も研究対象である。
- 生物はシステム：その要素は生きている
  - 次章参照
    - 自由エネルギー
    - 動的平衡

生命とは何か
（シュレディンガー）

- 負のエントロピー
- 自由エネルギー（第6章への注）

参考文献

- Joyce, G.F., 1993: Climbing Darwin's ladder, Curr. Biol. 3, 703-704.
- Daniel E. Koshland Jr., 2002: The Seven Pillars of Life, 295, 2215-2216
- Frederick Suppe , 1977: The Structure of scientific theories, University of Illinois Press
- Maturana, H. R. and F. J. Varela, 1981: Size constancy and accommodation. Perception 10: 707-709,
- A. Lazcano, 2008: What Is Life? A Brief Historical Overview, CHEMISTRY & BIODIVERSITY , 5, 1-15
- Pross, A. 2011: Toward a general theory of evolution: Extending Darwinian theory to inanimate matter, 2, 1-14