Neural-Network-like Bio-Machinogenesis via Semeiogenesis : Origins of Genetic Codes and Other Semeiotic Systems

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Genetic codes were found to have emerged as semeiotic culture of hierarchical tRNA-riboorganismic society which had evolved in early intracellular micro-environment ("semeiotic culture theory" or "poly-tRNA theory" (Fig.1) on the origin of genetic codes). Well-made biomachines such as bee super-organism (= bee eusociety consisting of queens and workers), animal body (= super-organism consisting of germ-line and somatic-line unicell diploid animals), and genetic apparatus were found to have evolved by neural-network-like machinogenesis via queen-worker-like hierarchical sociogenesis (Fig. 2, I). Every of these socio-machinogenesis depends on the society's own specific semeiotic system which is considered to be the society's "semeiotic culture". Origins and evolution of cognitive and autopoietic characters of various biosystems were discussed, with special emphases on riboorganismic(RNA-), multi-cellular(animal-), and multi-individual (species-)societies, as well as on various semeiotic culture systems including genetic codes (Fig.1), bee-dance language (Fig.5), hormones (in multi-cellular society = animal body, etc.) and pheromones (in "specia" or iso-species society), and primate language systems. Unified theory for the evolution of general bio-systems was discussed from the aspect of (self-)learning neural network machine (NNwM), (Figs. 3, 4, 7). suggesting that every living system could be some type of learning NNwM from which life's active and autopoietic features would emerge

Poly-tRNA theory (Ohnishi, 1993, 1995 ; Ohnishi et al., 1999, 2000, 2001) has elucidated that earliest mRNA had evolved from some kinds of tRNA (such as an early tRNA-Gly), as can be elegantly explained by the poly-tRNA model in Fig.1. Some early tRNA (such as tRNA-Gly) interacted with 16 (presumptive) anticodon regions of the poly-tRNA(-transcript) (transcripted from early tRNA gene cluster comprising 16 tRNA genes and 3 ribosomal RNA genes as shown in Fiig. 1 [A]) , and helped the poly-tRNA make primitive peptide (such as trmD-peptide shown in Fig.1[B]). Base replacements suitable for making base-complementarities between (presumptive) codons on tRNA-Gly (= presumptive mRNA) and (presumptive) anticodons on the poly-tRNA woud been selected, having reslted in generating

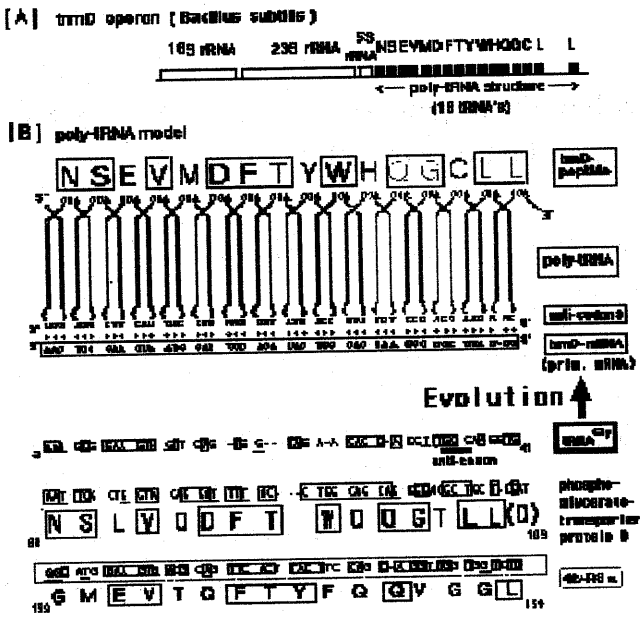

Fig.1. Poly-tRNA model for an early peptide-synthesizing RNA-machine. See text for details.

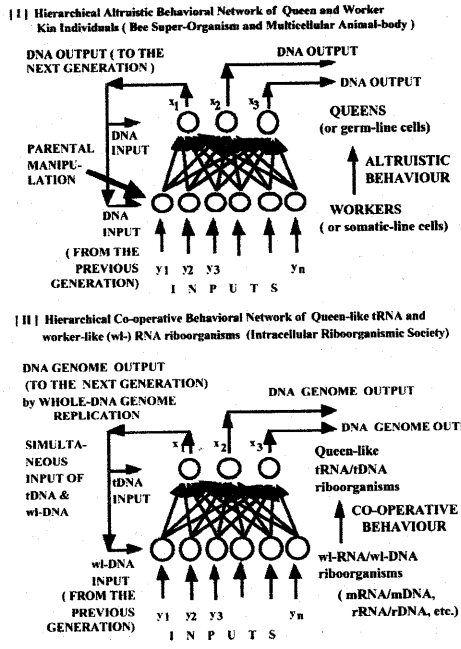

Fig.2. DNA information-flow in the hierarchical behavioral network in altruistic kin societies (Model I, bee-superorganism, multicellular animal body), and in an intracellular co-operative tRNA/tDNA ribo-organismic society.

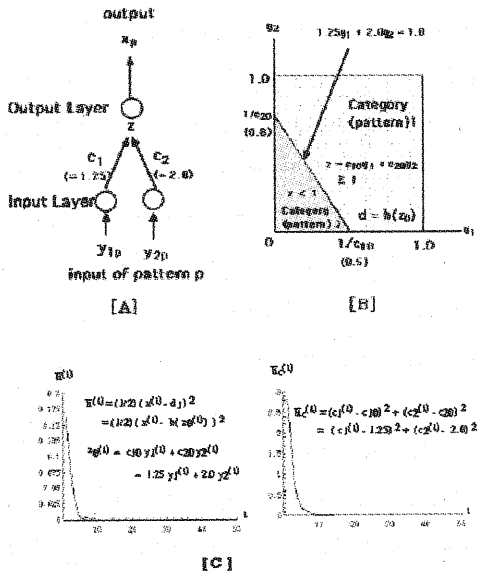

Fig.3. Simulation of learning process by a simplest 2-layered NNwM [A] based on back propagation method (BPM). Rapid learning was observed for discriminating pattern 1 (z < 1) and pattern 2 (z >= 1) of randomly selected data-sets (y1, y2) (See [B],[C]).

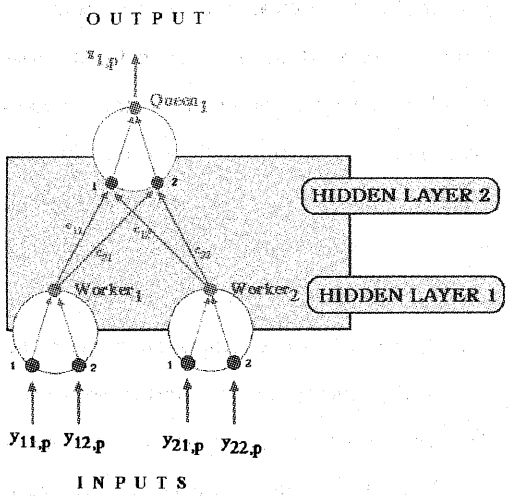

Fig.4. Hidden layers in a simple queen-worker-type 2-layered NNwM consisting of one queen and two workers. . Thus, this double-two-layered NNwM can discriminate non-linearly separable datasets. This scheme well explains the question why typical well-made biomachines (such as bee-superorganism, animal body and genetic apparatus) have had evolved as results of hierarchical sociogenesis of pre-existing "cognitive" bio-individuals (which had been themselves cognitive NNwMs).

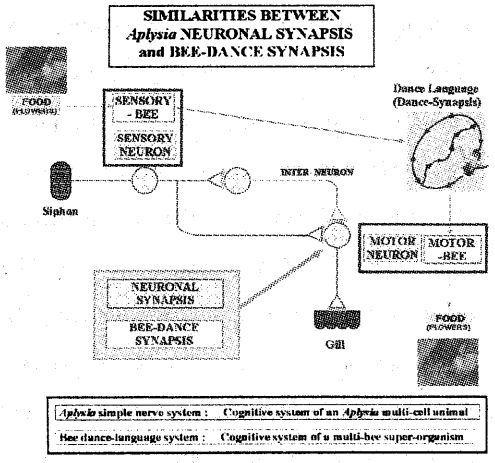

Fig. 5. Close similarities between the *Aplasya* simple nerve system and the bee dance-language system. This elucidates that the bee-dance system consisting of sensory-bees and motor-bees is a typical "sensory or nervous system (for finding foods) of the bee-superorganism (bee eusociety).

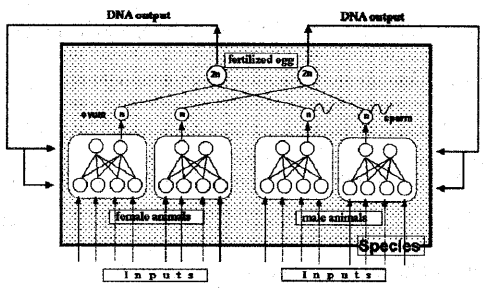

Fig. 6. Learning NNwM-structure of iso-specific society (specia) consisting of multicellulat diploid individuals of the same species. This suggests a logical basis for the real existing entity of the "species".

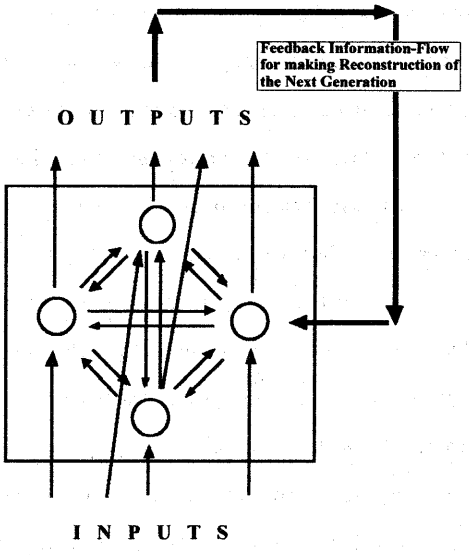

Fig. 7. Generalized scheme of (fully-)connected learning-NNwM as an autopoietic cognitive living system, suggesting that every living system would be cognitive. Note that some of final outputs (such as DNA information) remake the system of the next generation by feed-back mechanism. Genetic variations occurred in the previous generation are selected by the cognitive behavioral function of the next-generation system.

anticodon-codon base-complementarity. Further analyses revealed that early tRNA-ribozymes or tRNA-riboorganisms (which are replicable bio-individuals emerged in intracellular environment) would have associated to constitute a hierarchical co-operative society consisting of queen-like RNAs (tRNAs and worker-like (tRNA-derived) RNAs (mRNAs, ribosomal RNAs, etc.). Such hierarchical riboorganismic society has had converted to be well-made protein-synthesizing and genetic apparatus in modern cells.

This conclusion revealed logical similarities among the mechanisms of evolutionary emergences in several well-made biomachines. Both bee-superorganism (bee eu-society) and multicellular animal body are known to have evolved as hierarchical "kin" societies of "lower-level individuals (bees or unicell animals), where sterile workers (worker-bees or somatic-line worker-cells) behave altruistically to fertile queens (queen-bees or germ-line queen-cells) (Hamilton, 1964). This altruistic behavioral network constitutes a possible (at least) 2-layered learning NNwM in which workers are input-layer elements, and queens are output-layer elements which finally outputs DNA-sequence information to the next generation, resulted in remaking the next-generation NNwMs. Thus this eu-society works as a cognitive machine for using input information from environment (and also from inside the eusociety), and finally outputs more DNAs to the next generation. Protein-synthesizing and genetic apparatus is also queen-worker-like hierachical society and works a leaning NNwM (Fig2 II). In both of these NNwMs, mutations occurred in the previous generation were "actively" selected by the cooperative behaviours of workers or worker-like RNAs. In animal-body, somatic worker-cells behave to select better genes, and the same genes are inherited to the next generation by germ-line queen-cells, since queens and workers are clonal. This feed-back cycles can regenerate variations in so-called "connection weights" (in back propagation method) of the queen-worker-type 2-layered NNwM (Fig. 3), resulting in cognitive selection can occure because NNwMs possessing better connection weights will evolve better bio-machines. This selection would be made by the self-system if "teacher signals " are (possibly) possessed by the system. Even if NNwM is a simplest 2-layered machine, rapid learning in BPM-simulation (Fig.3) was observed. Hierarchical sociogenesis by pre-existing bio-individuals can possess hidden-layeres even in 2-layered machine (see Fig.4), which well explains why hierarchical sociogenesis tend to generate well-made machines. Further considerations revealed that bee-dance system is nerve-like sensory-motor system of bee-superorganism (Fig.5), iso-specific society would also work as a (self-)learning NNwM. General biosystem would be some kind of cognitive NNwM as shown in Fig.7.