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THINKING and TEACHING SYSTEMICS : BIO-SYSTEMICS in Higher Education - A Multi-Trans-disciplinary WHOLENESS, - An HOLISTIC Point of View, - A "Viable SYSTEM" Modelling.

Pierre BRICAGE,

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THINKING and TEACHING SYSTEMICS : BIO-SYSTEMICS in Higher Education - A Multi-Trans-disciplinary "WHOLENESS", - An HOLISTIC-CYBERNETIC Point of View, - A "Viable SYSTEM" Modelling.

Pierre BRICAGE

Associate General Secretary of AFSCET
The French Association of Systemics and Cybernetics, Paris, France, Europe
http://www.afscet.asso.fr
Social & Health Sciences Engineering, Fac. of Sciences, University of Pau & Pays de l'Adour, 64000 Pau, France,
http://web.univ-pau.fr/~bricage/
bricagepierre@gmail.com

abstract

To survive the living systems must "to eat and not to be eaten". But, soon or late, every one is eaten **http://tinyurl.com/surviepbafscet**. The only way to soften partly the struggle for life is to enter into an Association for the Reciprocal and Mutual Sharing of Advantages and DisAdvantages (**ARMSADA**). A lichen which is both an organism and an ecosystem, a cell which is also an ecosystem and an endosyncenosis (Bricage 2002b, 2005b), both are ARMSADAs. Every ARMSADA emerges when the partners do lose simultaneously the capacity to kill the other one(s). In the new Wholeness, all that is an advantage for a partner is a disadvantage for all the other one) **http://tinyurl.com/pbsustdev**. The "parceners" are fused together "for the best and for the worst". The benefits are only for their Wholeness which expresses new emergent "capabilities" **http://tinyurl.com/andesymbiosis**.

We can not **promote innovative and unconventional global health, economical and social solutions** without the use of *applied software tools*. But words, concepts, paradigms, models and software tools, whatever they are helping to represent -chemical, physical, biological, mathematical or "universal" "objects"-, are only tools, not the reality. They are nothing without not only a comprehensive knowledge of biology, through systemics and cybernetic approaches, but the respect of ethical ecological-educational-sociological-economical-political objectives to cope with the diversity and the complexity of our nature and nurture. The university system -based on research and technological assessments- has won in terms of technological applications and in money-making, **BUT it has lost in terms of ethical value and education.** Knowledge and technology have prevailed but only for some people, not for all. Education has failed and humankind is losing in **its integration** into the earth organism. That is not the earth that is endangered but man species (Bricage 2006b, 2009b).

"Bayesian networks" tools are available for research and *"Vester Sensitivity Modelling" tools* for pragmatic and applied projects, but what we do need to do is not to make better researchers and money-makers (through the "take-make-waste but recycling" processes) -or better speakers or thinkers- **BUT first we need TEACHERS** to really allow the worldwide teaching of why and how man species MAY survive and in what manner and how we really CAN survive: between individualism and communism, ***"For a WHOLE to survive, each one of its parts MUST survive first."*** The systemic and cybernetic approach, through modelling, allows us to be **the actors of "what we know and how we know it and how we represent it**". That allows us not only to make predictions but also **to know "what we do not know yet" about reality**. Teaching is the action to promote operational practises. Teaching -thanks to the unity and the diversity of concepts and models- is also the way to balance and equilibrate theoretical fundamentals and applied research: teaching is a technology of transfer of technology (Bricage 2008a).

We NEED ways of thinking simplexity rather than complexity. We need to shift from seeing the world as "stock and flow" machines but as living ago-antagonist systems, with their robust rather than optimal strategies !

key words : advantage, disadvantage, association, breakage, cancer, cybernetics, danger, fractal (Hoverstadt 2009), governance, limits, living systems, metamorphosis, network, parceners, survival, systemics, threshold, Wholeness.

Key concepts : "capacity of hosting" (**HOSTING**), "capacity to be hosted" (**HOSTED**), contingency, endosyncenosis (**CENO**), ergodicity, modularity, percolation, systemic and cybernetic approach, trans-disciplinarity.

key paradigms : **ARMSADA**, ecoexotope (**ECO**), endophysiotope (**ENDO**).

key tools : *applied and expert softwares*, graphic semiology (Bertin 1967).

Introduction : *Man is not an exception*.

Look at Penguins walking on the ice-bank of the Antarctic Continent. They walk slowly. Yet they have no need to run because there is no danger for them here. And that is a great advantage because the Penguins' body is not built for running ! But there is nothing to eat on the ice-bank. That is a great disadvantage ! When it is very cold you need a great amount of food to survive. There is never advantages without disadvantages. Now look at Penguins swimming into the water of the Antarctic Ocean. They swim very fast because they have two reasons to do so. Firstly they must swim faster than the fishes. To survive they have to eat them. And there is a lot of fishes there and the Penguins' body is built to swim very fast. That is a great advantage. Secondly they must swim faster than the Killer Whales that are eating Penguins to survive too. Wherever the Penguins are there is never advantages without disadvantages. Indeed they will survive as long as they can transform disadvantages into advantages and prevent advantages from turning into disadvantages. There is no difference between a Penguin -a multi-cellular macroscopic organism- and an amoeba -a microscopic cell- that is million of million of million times smaller -in volume-. They both are predators and preys too, depending on the beings' surrounding they are living with. An Amoeba is a predator that eats bacteria -its preys-, like a Penguin eats fishes. But sometimes bacteria that were engulfed by the Amoeba are predators too and they do eat the eater. The advantage to be able to capture bacteria sometimes turns into a great disadvantage too. Man is not an exception. The Man species is eating ecosystems like the Amazon forest. But Man is also creating ecosystems like kitchen gardens, that he eats too. The Man's body is an ecosystem that is eaten too by flies, mosquitos, fleas... These tiny animals were eating the macro-scopic ones who were exterminated by the forest's destruction. The Man's body is also an ecosystem of survival for bacteria and viruses (like the flu ones). These invading Man living organisms were generated by the breeding of the animals, like pigs or chicken..., that Man eats. *Man is not an exception* (Bricage 1991a, 2000a).

There is **only a simple rule : *to survive that is "to eat and not to be eaten".***

I. Biology Thinking: A SYSTEMIC APPROACH. *"The building tools for building the model's steps".*

To model the relationship between predators and preys we need representations like diagrams, tables, charts, maps and curves (Bertin 1967). But we need systemic representations (Bricage 2006a & b) We need *drawing softwares*. We also need efficient paradigms to build models (Bricage 2002a, 2005a) and to test them. Thus we need also *mapping softwares* and *image analysing softwares* too.

1. T*he Gauge Invariance of Life* : a scaling invariance of 7 functional capacities (*Analysis*).

Every living systems, at the microscopic level of organisation (like a "cellular" organism) or at the macroscopic one (like a "multi-meta-cellular" organism) or at the telescopic one (like an ecosystem, which is a "multi-meta-((multi-meta)-cellular)" organism may be entirely defined with 7 functional characteristics that are mutually necessary and sufficient for its duration (Bricage 1991a, 2000a) and that are in interaction (Bricage 1991b, 2000b, 2002b). The capacity of moving matter and energy flows is the first requirement (1) before the capacity of mass growth (2). The matter and energy flows and the growth are controlled through the capacity to respond to stimulation (3). All of this is possible because the internal and the external parts of the system exhibit not only a correlated structural organisation (4) into the space, through the time, and into the action, but also a correlated functional one. And the external and internal parts are forever inseparable (like love-birds are). This is the capacity of integration (5). Soon or late during its life cycle a living system -whatever its level of organisation may be- expresses a capacity of movement (6). All these capacities are necessary for the survival and the survival has only one goal, the reproduction of the corresponding life form (7): the capacity to itself reproduce its self.

This is true at all the levels of organisation of the living systems. An atom or a stellar system has the same functional behaviour as has a bacterium (Bricage 2005a) or a cell (Bricage 2005b). These are living systems but at another scale of space and time (Bricage 2009b). A pebble on the soil is not alive, but it contains living atomic systems, and pebbles in the sky are parts of a stellar living system (Bricage 2009b, 2010a).

2. EcoExoTope & EndoPhysioTope: Integration (Ecology Governance Concepts).

A swarm of bees is not a population of individual organisms. The swarm, indeed, is an organism which regulates its internal temperature depending on the external one. Into the Whole (the swarm system), the actors (the bees) are in interaction. Only the swarm possesses the 7 characteristics of a living system. A single bee does not. But the bee is an actor of the survival of the endophysiotope (**ENDO**: internal, tope: space, physio: of functioning) of the swarm which in return protects the bee(s), but between some functional limits (of the endophysiotope, in brief ENDO) and some ecological limits (of the ecoexotope, in brief ECO).

A blood cell is a living system that is hosted into the living hosting system of our organism. The ENDO of the cell will survive as long as it can preserve its gauge invariance whatever are the changes of its ecoexotope (**ECO**: external, tope: space of, eco: inhabitation) of survival. Into our organism all the cells, like the swarm itself, all are functionally defined by their ENDO and their ECO. They both define the system as a whole (Bricage 2002a & b) and the interface of exchange between the endophysiotope (ENDO) and the ecoexotope (ECO). Each cell is a local actor. It is spatially, temporally and functionally integrated into its whole of survival, the global actor, the "multi-meta-cellular" organism (Bricage 2002b). To make models we need basic axioms and solid definitions, we need the design of new key words to represent new key concepts (**Tables 1 & 2**).

The ECO furnishes the ENDO a limited capacity of hosting (in brief **HOSTING**). And the ENDO expresses a limited capacity of being hosted (in brief **HOSTED**) by an ECO of hosting. The system is simultaneously: -the ENDO with its actors, -the ECO with its other actors, -the network of interactions inside the ENDO, -the network of interactions outside into the ECO, -the network of interactions from inside to outside and back (the network of the networks), and – the whole (Bricage 2002b, 2010b). The cell is the adjacent inferior level of organisation of that of the organism. And the ENDO of the organism is the ECO of survival of the cells. The organism, a System-Of-Systems, is integrated into a superior adjacent level of organisation, an ecosystem, which he/it shares with other organisms. When the ECO is changing, the ENDO must change too, in order to allow the survival of the Whole. Both together, ECO & ENDO are changing or no changing. That is the integration (Bricage 2000a & b).

3. EcoExoTope & EndoPhysioTope: Limitations (Ecology Governance Criteria).

In order to reproduce its life form a living system (a cell or a man) must first grow in mass. A critical mass, a quantitative threshold, must be attained before the acquisition of the capacity of reproduction that allows sometimes to grow in number. A lot of observations and measurements have shown that the HOSTING of the ECO is always the limiting factor of growth of the ENDO. All the water of the earth is limited, as well as a water drop is on a pebble. The solar energy captured by the earth is periodically (daily, annually) limited, depending on the latitude, the altitude and the season and, nowadays it depends greatly on the man industrial activities too.

The relationship is usually a linear one (Bricage 1984a & b) : **Table 3**.

A lot of experimentation and results have proved that the HOSTED of the ENDO is always correlated with the HOSTING of the ECO, but not in a linear manner. The percentage of germination of the seeds of *Hibiscus sabdariffa* (the bissap) obeys to a Gauss curve of the number of the sowed seeds density (Bricage 1980, 1984a). If the density is too low (below the threshold) no seed sprouts. The same happens if the density is to high. But there is always, whatever the genotype (the HOSTED of the ENDO) is, a peak of seed germination in between. And this optimum density value is always linearly depending on the HOSTING of the ECO (Bricage 1984a & b). The bissap is an annual plant (the periodic time of generation is equal to 1 year) and the regulation of the germination regulates the effective density of the new progeny that replaces each year the parental dead population. This regulation is the result of the existence of at least one (or two) violence biochemical substances, which indeed fix the HOSTED of the ENDO (Bricage 2000b & c, 2002a). If we artificially/technologically prevent its/their action(s) there is no regulation anymore. All the seeds sprout. But all the plants soon or late do die from the exhausting of the HOSTING of the ECO and if they do not die another type of regulation prevents the survivors to acquire the capacity of reproduction (**Figure 3**). All may survive but no one can survive its self (Bricage 1984a).

The interactions between the HOSTING and the HOSTED may locally control the fate of plant populations in a linear manner (Bricage 1984b) but, globally, in a non-linear one (Bricage 1991b). Frequently the relationship may be represented with an hyperbolic curve (Bricage 2006a & b, 2010a) : **Table 4**.

4. Associations for the Reciprocal & Mutual Sharing of Advantages & DisAdvantages (ARMSADA).

The lichens are ubiquitous widespread organisms. They survive in extremely hard ECOs. They are able to colonise ECOs where no other life form is able to survive. Why ? A lichen is a box that is built with the body of a species of an heterotrophic fungus. In the box is encased a population of photoautotrophic plant cells of an alga species. The two are inseparable. They cannot be cultivated separately. And if one dies so does the other one too. It is an ARMSADA, an association in which all that is an advantage for a partner is a disadvantage for the other one, and reciprocally. The fungus offers the alga the mineral nourishment and its ENDO as a home. It is a great advantage for the alga that is then protected against its predators and against the usual variations of the HOSTING of the ECO that would impair its survival if the alga was free. That is a great disadvantage for the fungus who must consume a part of its matter and energy -of its HOSTED- to allow the survival of the alga. But all that is an advantage must be paid with a disadvantage. Indeed the fungus with its filaments, soon or late, eats the alga cells, like the man species eats his domestic animals or cultivated plants. That is a great disadvantage for the alga and a great advantage for the fungus. All together are eating the matter and energy of the other one which furnishes an internal HOSTING for each one part besides the external HOSTING of the ECO of their Whole. Its is a mutual and reciprocal predator-prey balanced relationship. And into the Whole, each one -and the Whole- may survive only if the other one does survive first. Sometimes a third partner may enter the association, a nitrogen fixing bacterium. The Whole is an endosyncenosis (**CENO**: to meet and fuse, syn: into a system, endo: with a new internal structural and functional organisation) (Bricage 1998).

How can we simply represent that complexity ? Do all new living systems emerge from an ARMSADA ?

Into a plant cell, like into a lichen, a compartment -the chloroplast- is specialised in the fixation of the HOSTING of the ECO into organic matter. Another one -the mitochondrion- is specialised into the consumption of that organic matter. It is also a “predator-prey like” relationship. The mitochondrion eats the sugars that are synthesised by the chloroplast for the whole cell use. But doing so it produces wastes -water and carbon dioxide- that are the raw materials of the chloroplast's metabolism. It is ***a “take, make, waste” “but recycling”*** process. Inversely, the chloroplast's metabolism produces oxygen which is the raw material for the mitochondrion to use sugars. A third compartment -the peroxisome- recycles into water the toxic peroxide wastes which are produced by the mitochondria and chloroplasts together. A cell is made of compartments of Monera origins, the chloroplast, the mitochondrion, the peroxisome, that are juxtaposed to each other and encased into an other one, the hyaloplasm, also of Monera origin (Bricage 2005a & b). The eukaryotic cell also is an endosyncenosis (in brief CENO). It has emerged from a pre-requisite variety of previous pre-existing partners that were initially antagonistic ones (Bricage 2005b & c). It is a CENO, an ***-E pluribus unum-*** new System-Of-Systems that has emerged step by step towards the sprouting of an ARMSADA. All that is an advantage for a partner is a disadvantage for all the other ones, like the partners of the lichen, all are mutually fused -***for the best and for the worst***-. *“For a WHOLE to survive, each one of its parts MUST survive first.”* : -***Unus pro omnibus, omnes pro uno-***. What is the wastes for some is aliments for others, and reciprocally. Both all the products and by-products are shared mutually. It is through their mutual and reciprocal interactions that “the parceners” survive in a kind of half-autonomy that renders all more independent of the ECO that they would be if separately free: ***-In varietate concordia-***. All at once they are sharing both the internal dangers of their new ECO -the ENDO of the cell- and the external dangers of their ancient ECO -the ECO of the cell-. Being more and more dependent for their collective sharing of dangers and wastes of the cell's ENDO -through inter-recycling-, they become more and more independent of their ancient ECO which is still the ECO of their new Whole: the cell (Bricage 2002b, 2005b, 2008b, 2010b).

It is a resilient system that is ***sustainable for all the partners because it is sustained by each one.***

What are the signals and the constraints that lead individual systems to merge into a collective one ?

What sort of collective System-of-Systems is rising out ? And how does this Whole arise ? (**Figures 1 & 2**)

How can we represent it/he/she ? How can we model the system's behaviours ?

There is NO advantages WITHOUT dis-advantages.

First advantage :

For THE BEST: emerging of a new capacity of being hosted within ecoexotopes where there was for the endophysiotope, until then, no capacity of hosting.

Second advantage :

To a TALLER WHOLE: a jump in spatial scaling.
To a MORE DURABLE WHOLE: a jump in time scaling.

First disadvantage :

For the WORST: if one of the "parceners" dies, the other ones do so too.

Second disadvantage :

LOSS of previous properties: The new Whole is LESS than the sum of its parts.

The setting up of an ARMSADA allows "to survive" and "to re-produce its self" through the creation of a new system with an upper level of organisation.

BUT ONLY IF

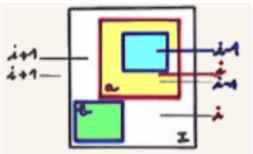
First requirement :

Each one's growth is limited by that of each others.

laws

Second requirement :

For ONE to survive, ALL the OTHER ONES MUST survive FIRST.
The mutual survival is depending on reciprocally shared restrictions.
All the partners MUST simultaneously lose the capacity of killing each other ones.



ecoEXOtope $_i$ = ENDOphysiotope $_{i+1}$
ecoEXOtope $_{i-1}$ = ENDOphysiotope $_i$
organism $_i$

Table 1. Laws of emergence and survival of "iterated systems" like the lichen -or cell- EndoSynCenosis.
The endophysiotope of a *i* level of organisation is the ecoexotope of previous adjacent *i-n* levels, whatever the ***i*** level is. The Whole is always less and more than the sum of its parts: because of the half-autonomy of the parceners, simultaneously abilities of the previous pre-requisite levels are lost and new are gained **http://tinyurl.com/anlea05pau** .

2 NEW WORDS: ECOEXOTOPE & ENDOPHYSIOTOPE

2 "TRIVIAL" CONCEPTS:
* TO SURVIVE IT IS "TO EAT" & "NOT TO BE EATEN"
* THERE ARE NEVER ADVANTAGES WITHOUT DISADVANTAGES

1 NEW PARADIGM:
ALL THE LIVING SYSTEMS MERGED FROM AN ARMSADA
ASSOCIATION for the RECIPROCAL and MUTUAL SHARING OF ADVANTAGES and DISADVANTAGES

2 "EVIDENT" FACTS: MODULARITY & ERGODICITY

2 NEW IDEAS:
* DANGERS HOSTED IN CELLS, ARE NECESSARY FOR THE SURVIVAL
* VIRUSES ARE REGULATORS & PROTECTORS OF LIFE THROUGH THEIR CONTROL OF THE CAPACITY OF HOSTING OF THE ECOEXOTOPES & OF THE CAPACITY OF TO BE HOSTED OF THE ENDOPHYSIOTOPES.

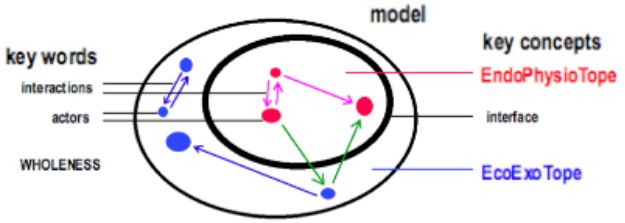


Table 2. The basic systemics principles for ecological governance and the design of curative vaccines.
(1) a pre-requisite variety (quality) and quantity of actors, (2) a requisite variety and quantity of their linkages (inter-dependence), to allow a requisite variety of a minimal amount of Wholes (3) : "between individuality and community".

5. Predictions and Applications to Social & Health Sciences (Sanitary Governance).

When a bacteriophage virus -an exogenous predator- invades the ENDO of a bacterium, the bacterium dies and a progeny of viruses is released from the eaten prey (probability 0.999). But, sometimes (probability 0.001), the infected bacterium is not lysed and a dynamic equilibrium is lasting a very long time -at the time scale of the bacterium life cycle-. During it the hosted virus and the hosting bacterium survive and reproduce all together -"*Unus pro omnibus, omnes pro uno*" and "*In varietate concordia*"- forming a new ENDO (**Figure 1**). But if an alteration of their common ECO of survival (outside the bacterium) or of the new ENDO of the (bacterium and phage) association -its inside, which is the ECO of survival of the "temperate" phage- arises, thus the bacterium is killed and a viral progeny is freed. The no-death of the virus triggers the death of the bacterium. The same is true for cells. It is now proved that viruses are involved in cancer emergence. When a virus enters a cell, usually the cell is eaten (probability 0.999999). But exceptionally, the no-death of the cell occurs (probability 0.000001). For the cell, to become cancerous is the only way "not-to-die"! The cancerous state can be triggered both with external invasion of viruses from the ECO or with internal evader viruses of the ENDO (because the genome of the cell is inhabited by endogenous "temperate virus-like" entities). The cancer cell is an injured cell that should have died but did not, and the cancer path was the only way it had to survive (Bricage 2008b). The no-death of the cancer cells lineage, soon or late, leads to the death of all the other non-cancerous cells, with the death of the organism. Cancer is a breaking of the cell's ARMSADA through an aggression that results in a lack of non-autonomy of cells through the de-controlled freeing of an ancient integrated virus. Too much individualism (the temporarily no-death of one cell) results, soon or late, in the death of the collectivity (the whole organism).

"anywhere, at any time, soon or late, integration in the best way of survival for all levels, at all levels"

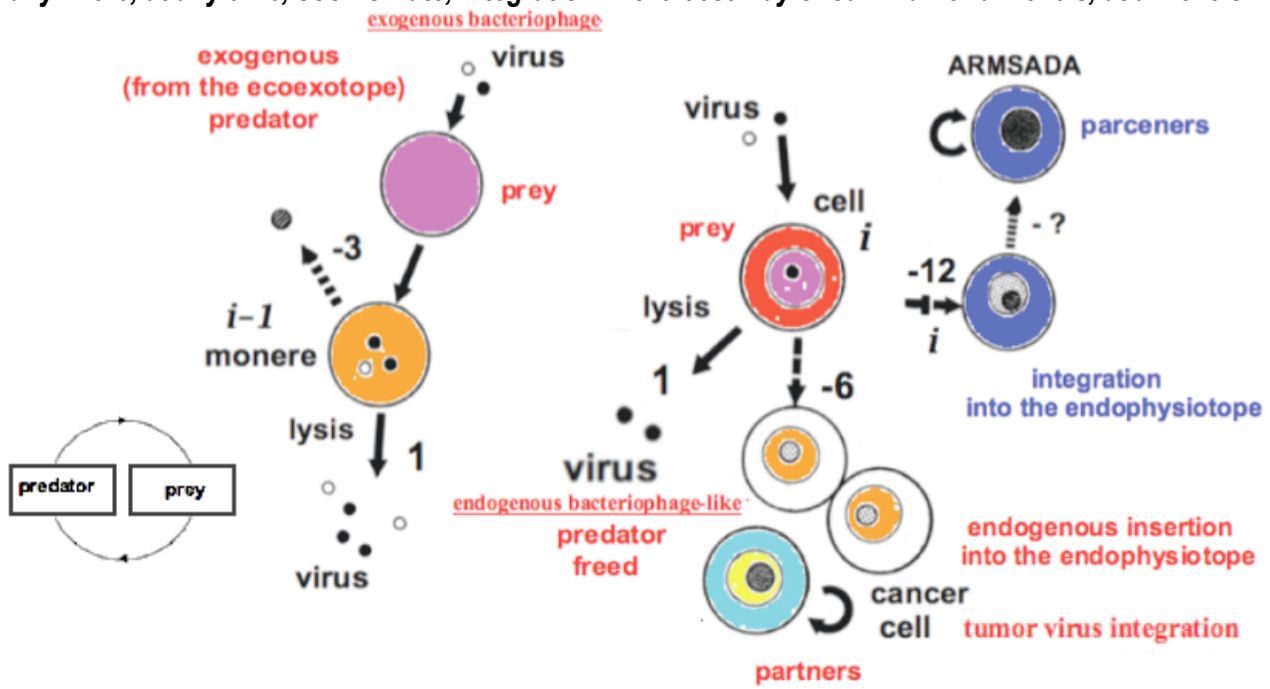


Figure 1. The end of the predator/prey virus/host arms race via an ARMSADA emergence.

At the level of organisation of the monera (***i-1***) an exogenous predator, a bacteriophage virus, lyses its hosting bacterium with a probability of quasi **1** (100%), Sometimes, with a probability of only **-3** (0.1%), it does not so -through the integration of the ENDO of the virus into the ENDO of the bacterium into an ARMSADA- . At the adjacent superior level (***i***) of the eukaryotic cell which is an endosyncenosis of monera, an exogenous or endogenous virus lyses its hosting cell with a probability of quasi **1** (100%), Sometimes it does not so, but with a probability of integration of only **-6** (1 per million), but the surviving cell becomes a cancer cell. With a probability maybe of -**12** (1 per million of million), the cell neither does die nor become cancerous, an ARMSADA emerges. We can design a cancer curative vaccine protocol based on the killing of cancer cells through the freeing of their endogenous viruses or a AIDS curative vaccine based on the integration of the HIV virus.

Dangers hosted in cells are necessary for their survival (Bricage 2008b). Endogenous viruses are regulators and protectors of life through their control of the HOSTING of the ECO and the HOSTED of the ENDO. The integration of a virus as a "parcener" into a cell is an impossible event (probability maybe of 0.000000000001). But, at the scale of the biological time -after billions of generations-, soon or late, it becomes certain. Protocols of making curative vaccines -HIV curative vaccine (Bricage 2005d & e) or cancer curative vaccine (Bricage 2008b)- have been proposed using that paradigm (**http://archives-ouvertes.fr/hal-00352578/fr**) (**Table 2**, **Figure 1**).

The functional interactive network of emerging of an ARMSADA is independent of the scaling dimensions and interactions (Bricage 2009b, 2010a). Can we simulate that with *Bayesian networks* ?

II. Biology Thinking: CYBERNETICS & MODELLING. ***"the managing tools for models managing".***

Fungi are peculiar organisms. They are more and less than a plant and an animal organism. They are both a plant and an animal, and not-a-plant and not-an-animal. It is not just co-operation or collectivism. It is a mutual and reciprocal dynamic performance management by the partners and by the wholeness too (**Figure 2**).

What are their laws of effective organisation ?

1. *The Systemics Constructal Law* (Interactions & Networks Modelling).

Whatever may be the level of organisation, each actor is acting not only on its ECO but also, directly or indirectly, on its ENDO. Every change of the ECO or of the ENDO is feeding back, directly or indirectly, changes of the ECO and the ENDO themselves. Every actor is acting not only on itself but also on its adjacent superior and inferior levels of organisation (Bricage 2001a). Every local or global changes results, soon or late, directly or indirectly, on other global or local changes (**Figure 2**).

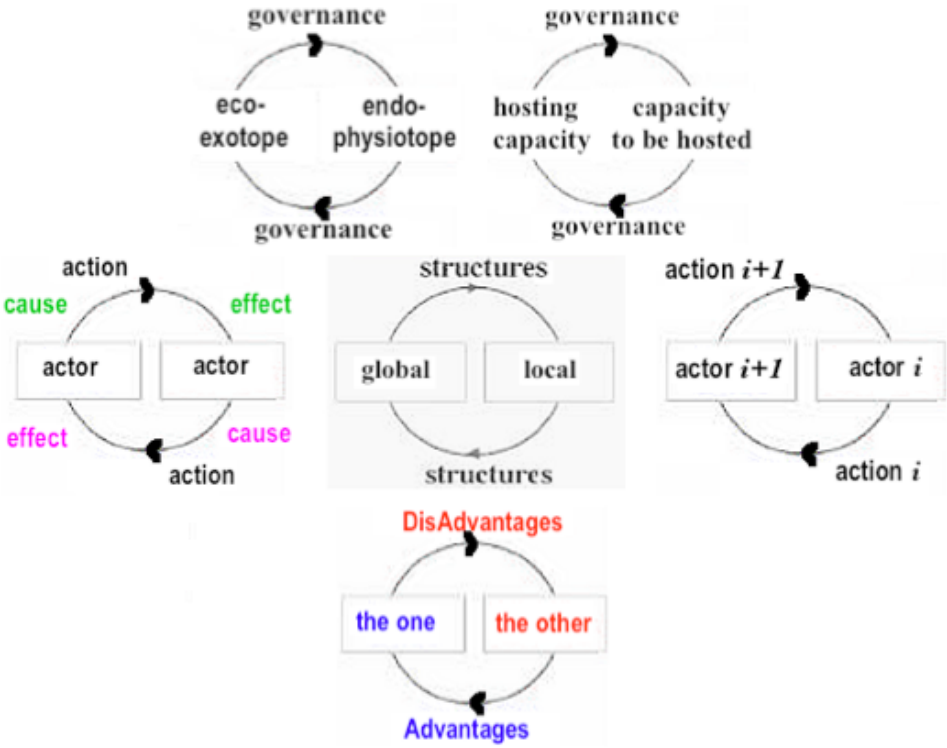


Figure 2. The systemics constructal law: ***"interaction is construction & construction is interaction".***

Feed-backs are rising from the emergence of a new system from previous ones. Feed-backs are inherent and inherited parts of the structural & functional organisation of a system. They can both maintain the system in a steady state or, through its mosaic transformation (Hoverstadt 2009), undergo either its change of nature or its death. It is the feedbacks sufficient requisite variety that allows the physiological limits of interaction between ENDO and ECO "to be maintained". When these limits are exceeded the network either changes or breaks down in a percolation manner (Bricage 2005f).

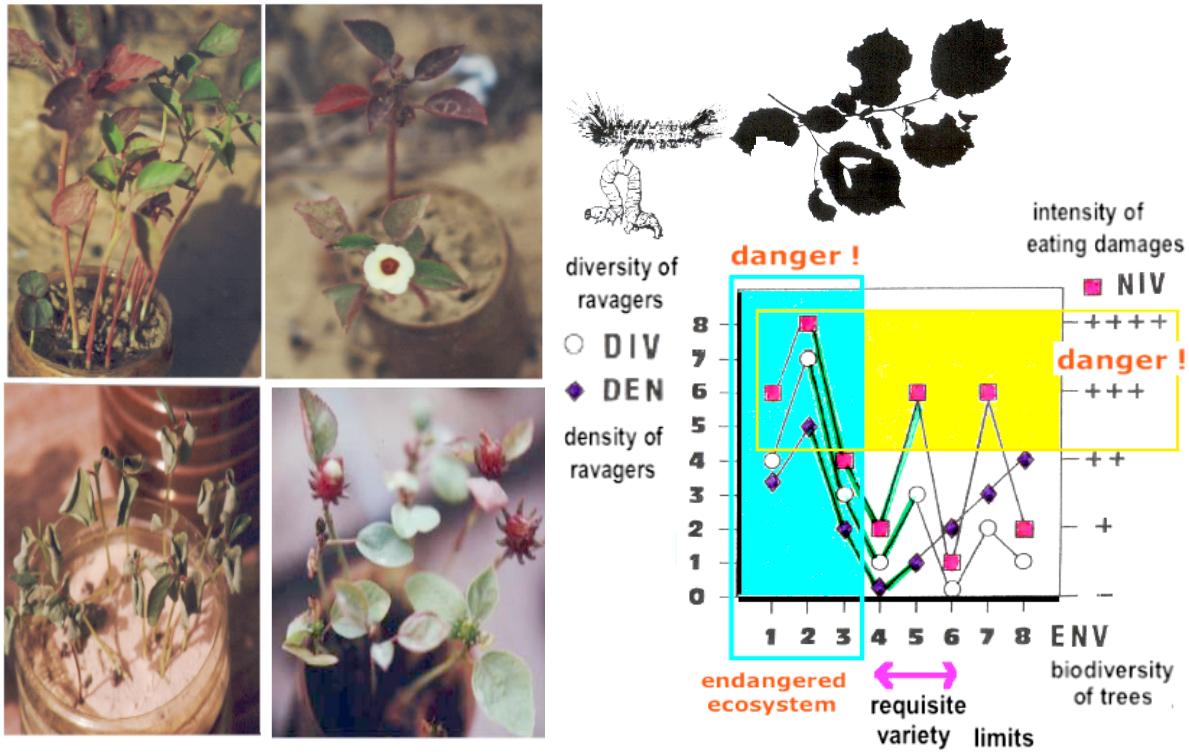
The management of the survival is about maintaining a pre-requisite qualitative and quantitative variety :

"Un peu de tout, plutôt que beaucoup de peu." **quality x quantity = constant** (Bricage 2006a). An exceeding quantity always results in losing quality. But quantity must increase to allow the emergence of new qualitative properties.

2. Ergodicity (modularity and fractal organisation & functioning) & Modelling (Evolution Laws).

Due to the fractal organisation of the living systems (Bricage 2001a), from the quantum of Planck to the whole Universe (Bricage 2009b), the actors, the actions and the pathways in which, and through which, they are taking place (Bricage 1985) are all made of juxtapositions and encasements of previous ones. The ways and the flows are juxtaposed and embedded like are the spaces and the time delays (Bricage 2010a).

To preserve the previous stages of diversity and to create some new ones, each life's form must be a guest and a host. He must simultaneously "be welcomed" -receiving a HOSTING from its ECO- and "welcome" -furnishing to other life's forms a HOSTING for their ENDO-. And HOSTED is the result of how is the management of these antagonistic necessities (**Figures 2 & 3**). How and why ***"emergency is required for emergence"*** ?



higher quantity
failing of HOSTING
no one survives

lower quantity
succeeding HOSTED
survival of the self

Hibiscus sabdariffa L. (bissap)

DIV & DENS **diversity** (quality) & **density** (quantity) of insects larvae, ravagers of the deciduous trees of a forest (wood of Pau, France), NIV rate of **injury of the eaten** leaves, depending on its biodiversity ENV

Figure 3. <u>The actors, the network(s) of interactions and the Whole(s)</u>.

At the level of a "multi-meta-cell life form" (the Hibiscus sabdariffa L. species)

- the actors : the ENDO of each one of the local organisms sharing the same ECO of survival and globally competing for the same food supply in a "field condition" (mono-specific population of an agro-system, ENV=1).
- the network of interactions (Figure 1, Table 2) : locally and globally interacting growth plant regulators, changing "take-make-waste-recycling" supplies exchanges between all the ENDO and their limited common ECO,
- the Whole : not the population but the life form (the species) and its ECO -of survival or not-.

At the level of a "multi-meta(multi-meta-cell) life form", an ecosystem (a temperate forest, a wild system, ENV=n)

- the actors : locally the ENDO of each ones of the local organisms ("statistically defined" by DEN, DIV and ENV) sharing the same ECO of survival, "*glocally*" the competitors in a same species (intra-competition) and the competitors between species (inter-competition), those which are eating or not and those which are eaten or not -food chains- (Bricage 2000b),
- the network of interactions : interacting growth plant regulators, changing take-make-waste-recycling exchanges of food supplies and defence substances between all the ENDO and their limited ECO, within and between populations,
- the Whole : the globally (inside limited) ENDO of the forest biosphere is an open system competing with other ecosystems (for example anthropic ones -agrosystems-) for the occupation of their (outside limited) common ECO.

2a. "**juxtaposition and encasement is the process of emergence".**

Whatever may be the level of organisation and the manner in which it is observed -with chemical, physical, biochemical, or biophysical tools- and represented -with mathematical or semiological tools- or simulated -with *software tools*-, it is not only actors but also dimensions that are juxtaposed and embedded. The "evolution tree" does not look like a tree but a coral, not only with diplo-tomic but multi-tomic fissions or sproutings and also with multiple fusions. The fissions increase the quantity of the actors that are juxtaposed and can be embedded in new potential associations. The fusions increase the quality of the new emergent actors. We need new mathematical tools and new softwares to represent and simulate such processes (Bricage 2010a).

2b. **"pre-requisite variety is the inevitable previous need before emergence".**

For example with the trees of a forest whom leaves are eaten by the larvae of butterflies (**Figure 3**), we may measure, with *form analysing and area measuring softwares*, the intensity in which the leaves of the trees are damaged -compared to control intact leaves- (Bricage 1991b). Using *multivariate analysis softwares* for the compilation of these measurements, we may prove, and represent with *graphing softwares*, how biodiversity is the "key-actor" of the survival of every ecosystem. The diversity of the preys (the trees) protects them against the injuries from the predators (the ravager insects). There are several steady states in which the damages of the leaves are reduced. And the increase of the plant species diversity (the increase of the juxtaposed actors) may, or may not, depending on the global ECO, decrease or increase their ENDO injury by the insects (Bricage & al. 1989). Before knowing the relationship between the actors we can not make any prediction of how the system may evolve. An ecosystem is an endosyncenosis, like a cell or a lichen is. Living systems are systems of systems that are juxtaposed and embedded, all are intrinsic puzzling endo-syn-cenoses (CENO) (Bricage 2009b).

3. Dimensions & Predictions (Mathematics Tools).

Whatever may be the level of organisation, ***i+j***, everywhere and at any time, each action of an ENDO is a response to a cause, the result of an effect, of an action, that is originating from the ECO of survival :
ENDOi = f(EXOi) so, with Y=ENDO and X=ECO, **Y=f(X)**, or from the ENDO itself, so **Y=g(Y)**, or from their interactions **Y=h(X,Y)**. But the same is true for the responses of the ECO itself, so **X=F(Y), X=G(X)** and **X=H(Y,X)** .

IF Y = K or X = K the WHOLE and the PARTS are independent
IF Y = K. X the WHOLE is LIMITED by the PARTS WHICH ARE LIMITING local ACTORS
X = K. Y the PARTS are LIMITED by the WHOLE WHICH IS A LIMITING global ACTOR

The HOSTING CAPACITY of the WHOLENESS IS LIMITED
BY THE CAPACITY OF TO BE HOSTED OF EACH PARTNER
WHOSE ENDOPHYSIOTOPES ARE SHARING THE SAME ECOEXOTOPE OF SURVIVAL

OFTEN *"The WHOLE IS GREATER THAN THE SUM OF ITS PARTS"* CONFUCIUS
BUT, IT MAY ALSO BE THE RIGHT SUM OF THE PARTS, AND
SOMETIMES IT MAY ALSO BE LESS THAN THE SUM OF THE PARTS,
THE MORE FREQUENTLY IT IS DIFFERENT FROM THE SUM !

THE WHOLE IS BOTH MORE AND LESS THAN THE SUM OF ITS PARTS. $aY + bX = c$

Table 3. The Wholeness and the parts (the simplest examples). (See for "a review" *In* Bricage 2010a).

Using the concept of percolation (Bricage 2005e & f) we can represent in a simple way "The forgotten Message of Ecology" (Bricage 2009a), the facts that "***Overexploited populations can collapse.***", that "***Keystone species may be essential to a community***." and that "***No population increases without limits***.". To model the "space-time-action field" (in brief STAF) of a system we need an "hyper-space" of at least 12 dimensions, with the 3 dimensions (3D) of "our" usual space (height, width and length), with the 7 dimensions of action (the 7 gauge invariance characteristics) and at least 2 dimensions of time (at least 1 ENDOgenous reference and at least 1 ECOgenous reference). But usually there are a lot of time dimensions because a lot of biological rhythms are juxtaposed and embedded like are the living being system-of-systems. At the cellular scale, periodic times of functioning are running at the millisecond, others at the second, but the generation time is counted in days.

To (partially) avoid the biases due to the encasements of the duration and the existence of time delays, we need to represent the living processes using the living clocks as references, but not our artificial time counters (Bricage 2009b, 2010a). To represent an interaction, which is an "instantaneous collision", between the STAF of a life form and that of another one, we need *multivariate analysis softwares* to project its trace in a 3D plan. In that plan, which is the plan of "Projection in the Simplest Picture way of a complex Process" (PSPP), the curves that represents the phenomenon are always conic sections (**Table 4**) or composition of conic sections. Why ?

THE USUAL TRAJECTORY OF THE WHOLE IN ITS SPACE-TIME-ACTION FIELD
IS ALWAYS A CONICAL ONE OR A "COMPOSITION" OF CONICAL ONES :

$$aX^2+2bXY+cY^2 = X(aX+bY)+Y(bX+cY) = K$$

THAT MEANS THAT THE WHOLE IS THE PRODUCT OF 2 "VECTORS"

FREQUENTLY THE WHOLE IS THE PRODUCT OF ITS PARTS $X.Y = K$

"hosting capacity of the whole"."capacity to be hosted" of a partner = K

WHEN IT IS AN ELLIPSE : $X^2 + Y^2 + 2XY = K$ THAT MEANS THAT $(X+Y)(X+Y) = K$

THE WHOLE IS THE SQUARE PRODUCT OF THE SUM !

The SUM OF THE DISTANCES FROM 2 FIXED POINTS IS A CONSTANT MP + MQ = a + b = K

THE SAME WITH A CIRCLE : $X^2 + Y^2 = K$ MEANS OM + OM = 2 R (with a = b)

WHEN IT IS AN HYPERBOLE : $X^2 - Y^2 = K$ (or XY = K) THAT MEANS THAT $(X+Y)(X-Y) = K$

The DIFFERENCE BETWEEN THE DISTANCES OF 2 POINTS IS A CONSTANT MP - MQ = a - b = K

THE WHOLE IS THE PRODUCT OF THE SUM WITH THE DIFFERENCE !

USUALLY THE WHOLE IS BOTH MORE AND LESS THAN THE PRODUCT OF ITS PARTS

THE SAME LAWS ARE IN ACTION INDEPENDENTLY OF THE SCALING INTERACTIONS

Table 4. The Whole properties are depending both from the sum and the difference of its parts.

More important will be the requisite variety of the parts more important may be their difference or their sum and more unexpected may be their emerging whole. But the fitting, between the parts into the ENDO or between the ENDO and the ECO (Bricage 2002a), is more and less adequate depending on the quality and the quantity of the parts (Figure 3).

III. Biology TEACHING: Epistemo-Praxeology. *"The operating tools for the operating ways".*

How may we operate "in an ARMSADAs making way" (Bricage 2003) for the maintain -of biological, chemical, social, economical- diversity and, simultaneously, for the emergence of both hyper-specialist and hyper-generalist people ? : ***"Une place pour chacun et chacun ayant sa place."*** (Bricage, 2001b)

We must promote the learning and teaching of SYSTEMICS knowledge and CYBERNETICS tools for all.

For doing so, whatever might be the "labyrinth" of formation of a future teacher (hyper-generalist), or engineer (both generalist and specialist) or researcher (hyper-specialist), in arts, in literature, in human sciences, in economics or in medicine or sciences, he/she should have passed - (1) at least one inevitable trans-disciplinary semester module of "the comprehensive learning of the systemics approach", at the beginning of its bachelor degree, still the university entry, and - (2) at least one inevitable semester module of "applied systemics and cybernetics", with computing and simulation, through the use of informatics tools, at the end of its bachelor degree.

And if he/she wants to be a teacher, in order to teach SYSTEMICS & CYBERNETICS, not only at the higher education level but also at the primary level of education, he/she should pass a Master degree with other general trans-disciplinary modules and specialised thematic applied modules.

1. Quality Control for *Accompaniment* (Computing Tools).

With *multivariate analysis softwares*, through *Factorial Analysis of Correspondences*, we can both identify qualitative critical variables or key actors and picture the links between all the interacting variables (Bricage 1988). We can make predictions about the future (in probability) of a decision or a behaviour (Bricage & al. 2007). We can built *expert software tools for quality control*. With *Component Principal Analysis* we can quantify the respective parts of each actor. Of course we need expert softwares tools to evaluate and control the accompaniment of the students and the co-ordination of the improvement of their formation (Bricage 1993, 2007).

Because there are too many linkages between the parts and because of their non-linear relationship, what we need is *semiology graphing tools* (Bertin 1967). But first we need *Data Bases interactive constructing tools*.

2. The "Experimental Design's Acquisition" physiological/cognitive window (Education Sciences).

In the way of a dynamic performance management the acquisition of the systemics approach methodology and of the cybernetics tools -for the comprehensive perception of Nature- must be done the soonest as possible.

2a. **"the sooner the better but not too soon", *"chaque chose en son temps"!***

The "reflex behaviour" of the scientific perception of Nature is passing through the acquisition of "the experimental methodology", which is a special way of qualitative and quantitative thinking. We can evaluate this acquisition, -through exercises of control of competencies-, using a 7 degrees grid that points the critical phases and the steps of the know-how of the experimental methodology (Bricage 2008a). We can compare the intensity of this behaviour acquisition, and its speed, between and within classes of students of different origins and different motivations. All the students having a scientific formation (with mathematics, physics, chemistry and biology) have no difficulty to acquire and apply in another context *the experimental methodology*. And they are the fastest. All the students having given up too soon these "hard sciences" will never acquire it. The sooner a student has deserted one or many of the scientific disciplines the slower he/she will later acquire it, if he/she does it eventually. This know-how knowledge acquisition, like other ones -for example the acquisition of every language-, obeys to a limiting strict window of age, there is a threshold and a plate: "not too aged is too soon, but too aged is too late..." ***"avant l'heure ce n'est pas l'heure, après l'heure ce n'est plus l'heure."*** The students of the classes for preparing competition entrance have the highest motivation and they are the fastest. The ones of the classes for preparing reorientation may have a so big motivation too but if they are too old they have overstep the limits of the physiological window in which their brain is able to learn the most efficiently this special way of thinking. Is not that a big disaster? So "the systemics approach" must be taught to young people that are still able to learn it efficiently.

2b. ***"une place pour chacun et chacun à sa place".***

The learning of a sufficient (quantity) variety (quality) of disciplines is a pre-requisite for the future learning of the knowledge and the ethical aspects of the systemics and cybernetics concepts and their easy future applied exploitation. But we must keep in mind (**Table 4**) that always "**quality x quantity = k**". We must propose different ways of learning (Bricage 2007) with a lot of facultative or compulsory modules, but the same unavoidable stages.

3. Cognition Technology & Knowledge Management (Communication Behaviour).

The use of the "High Tech" technology will be certainly useful for the perception, the expression, the representation and the acquisition of cognition. But a cognition technology is not only tools it is first an ethical point of view. What knowledge management for what to do ? The important learning point is to go from complexity towards simplexity. For example, the use of the simplex graphic methodology is a mean to represent, in probability, both the interactions between linear or non-linear complex behaviours and its evolution. It looks like "a balance with 4 plates" allowing to represent the evolution of a system towards its death, its loss or its increase in variety.

For a resilient future, how to make "systems thinking" becoming a main stream in society ?

Conclusion (*Synthesis*).
The emergent steps of the history of the Universe : *PhyloTagmoTaphology.*

The all local parts of THE Universe's System are living systems. A same law of growth, in mass or in number, with its balanced and breaking feedbacks is valid whatever the local organisation may be, at all the micro-, macro-, pico- or telo-scopic scale, from the quantum of Planck to the whole Universe itself (Bricage 2009b).

Due to his/her embedded levels of emergence (Bricage 2001b, 2009b) his/her evolution implies mosaic transformations, and ***"only instability, emergency, is an opportunity for emergence"***. But, only a sufficient "pre-requisite" variety -not only of tools, of knowledge or of paradigms-, but first of people is able to generate, soon or late, more and more post-potential varieties of structures of the ARMSADA type (Bricage 2003). The (transient) stability is limited in time. It is born from the instability, more and more, and it generates, more and more, the instability. At all the organisation levels of the Universe, the growth or the development of every living system are durable ***only if they are sustainable for their local partners and sustained by their local and global actions.***

So "strategic risks" is-it a chance ? What gain if any ? What chance ? What fate ?

We have flu maps and vaccines but we can not predict and prevent viruses emergence and people death.

"*There are never advantages without disadvantages*." And the greater are the advantages, the greater are the disadvantages. All local parts are in interaction with other inferior adjacent local ones and other superior adjacent local ones and with their whole too. There are never gains without costs.

The "true" symbiosis, **ARMSADA**, is not an association for reciprocal profits : **not** a "winner and winner" union (**http://www.afscet.asso.fr/Decision.pdf**) ! Indeed, to survive, and eventually to reproduce its life's form (to itself survive its self), an organism has **to turn disadvantages into advantages and to avoid that advantages turn to disadvantages** (**http://www.abbayeslaiques.asso.fr/SYSTEMIQUE.html**). The symbiosis is only an **A**ssociation for the **R**eciprocal and **M**utual **S**haring of **A**dvantages and of **D**is**A**dvantages between partners, that are **parceners** (**http://www.afscet.asso.fr/heritage.pdf**). The profits are only global, for their **new emergent wholeness** (**http://www.abbayeslaiques.asso.fr/ASSOCIATIF/AMSADAparadigm.PDF**). **At all the levels of organisation of the living systems**, only survive the Associations for the Reciprocal and Mutual Sharing of Advantages and of DisAdvantages. **The Man is not an exception** (**http://www.afscet.asso.fr/pbAnde03.pdf**).

An "eco**system**" -like a cell, or a lichen, or an atom, or a galaxy, or the whole Universe- always is an endo-syn-cenosis that has merged by the juxtaposition and encasement of parceners. A lichen (Bricage 1998, 2001a) or a cell (**http://tinyurl.com/pbcellorigin**, Bricage 2005c & d) or an atom, or a galaxy, all are CENO that are equally alive... and the Universe is too (Bricage 2009b **http://tinyurl.com/phylotagmotaphology**).

To study biology and to engineer an ethically reasonable biological technology we first need to have mastered informatics applied tools, applied mathematics tools, physics concepts and tools, chemistry concepts and tools. Biology is the trans-disciplinary knowledge domain of description and comprehension of THE System of the Universe and of the Nature and Nurture of Man species. Man is a prey & a predator, an ENDO & an ECO too.

There are two priorities for an university or an academic community: (1) to elaborate or to promote concepts -obviously transdisciplinary or new ones- and (2) to encourage and promote scientific research. The systemic and cybernetic approaches, through modelling, are particularly useful for that goal. We need to work as to that every people in the World can read and write **about how our organism -the earth- is functioning (with or without us)**. And so that "***there are never advantages without disadvantages***". And that "***everyone is both a winner and a loser***", depending on the space in which he is, and the time "of functioning" he is in. FIRST, we do not need better researchers BUT new teachers and a new mode of thinking and new applicators **in systems science**, ***in an epistemo-praxeological view and manner*** (Vallée 1995). T**o allow the teaching of the systems sciences everywhere**, we do need teachers for everybody, at every level and everywhere, to claim what earth -and solar system and so more else, **in an upwards scaling view**- is, and what earth -and cell system and so more else, **in a downwards scaling view**- also is (Bricage 2009b, 2010a). And when, why and how (**Tables 3 & 4**), "***a system is always more and less than the sum of its parts***". Why and how every system is an ARMSADA, and that we are only a tiny part (but maybe a useful key-actor) of our limited native world. We need next teachers not only at the higher education level but first at the basic education level "to create" people with an holistic point of view and able to allow -through the education of children and students- the emerging of resilient ways to accelerate, sustain and monitor new approaches of sanitation technology and the cure of biological-ecological-economical-sociological diseases without too injuries of our resilient planet (Bricage 2009a) through a ladder governance (Hoverstadt 2009). **Every good regulator of a system MUST be a model of the system** (The Conant-Ashby Theorem). We need Higher Education Teachers -and Thinkers- to form, worldwide, other Teachers.

A whole is durable only if it is sustainable for its parts and sustained by its parts. And the parts are durable only if they are sustained by their whole. ***"For a one to survive each one of all the others MUST survive first."***

The world greatest challenge is not health but education. Every life form has an equal value.

Evidently, biological models are key-actors of the reliance between the disciplines, because the biologists must explore life -through its diversity and unity- from the quantum of Planck to the whole Universe, because each biological system -whatever is its organisation level- is both more and less than the sum of its parts.

Before research, **teaching is the first step** to prepare minds .

-"*Le hasard (de la découverte) n'atteint que les esprits préparés.*" Louis PASTEUR-

bibliography

BERTIN J. (1967) Sémiologie Graphique. Les Diagrammes-Les Réseaux-Les Cartes. Gauthier-Villars, Paris, 431 p.

BRICAGE P. (1980) Étude des phénotypes pigmentaires du bissap, Hibiscus sabdariffa L., Malvacées. I. Biométrie de la productivité. Bull. IFAN A 42: 440-480.

BRICAGE P. (1984a) Étude des phénotypes pigmentaires du bissap, Hibiscus sabdariffa L., Malvacées. IV. Influence des phénotypes parentaux et des conditions stationnelles sur la germination et le développement des individus: compétition entre individus. Bull. IFAN A 46-1/2: 140-166.

BRICAGE P. (1984b) Lathyrus macrorhizus : influence des facteurs stationnels sur la floraison in situ. Can. J. Bot. 62: 241-245.

BRICAGE P. (1985) Multiple molecular steps and pathways of in situ anthocyanin biosynthesis in Lathyrus macrorhizus Wimm. I. The leaf steps and pathways. p. 106-107., II. The glycosylation-acylation network. p. 108-111., III. The end-products population pattern. p. 112-126. *1rst International Coll. Lathyrus, Chemical aspects, IBEAS, Pau, France*.

BRICAGE P. (1988) Action des micro-ondes (fréquences, intensités, durées) sur les systèmes biologiques : quels effets et quand ? *1er Congrès International Société de Chimie Biologique "Systèmes Énergétiques, Structure, Contrôle et Évolution", Bombannes, France*, 10 p.

BRICAGE P. (1991a) Les Caractéristiques des Organismes Vivants. Fac. Sci. Univ. Pau, 44 p.

BRICAGE P. (1991b) Évaluation des interactions entre les densité et diversité des chenilles de Lépidoptères et les diversité et degré de défoliation des feuillus d'un bois. Mesure de la polyphagie et prédiction des pullulations potentielles. Acta Entomologica Vasconae 2: 5-21.

BRICAGE P. (1993) Quelle pédagogie pour quelle formation ? Bull. A.E. E.N.S n° 2(1993), p. 45-71.

BRICAGE P. (1998) La Survie des Systèmes Vivants. *MCX20 "Prendre soin de l'homme" (atelier fondateur) Centre Hospitalier Général de Pau, France*, 3 p. **http://www.abbayeslaiques.asso.fr/BIOsystemique/PauMCX20.pdf**

BRICAGE P. (2000a) La Survie des Organismes Vivants., *Atelier AFSCET Systémique & Biologie, Fac. Médecine, Paris*, 44 p. **http://tinyurl.com/surviepbafscet**

BRICAGE P. (2000b) La nature de la violence dans la nature: Déterminismes écologique, physiologique et génétique de l'adaptation aux changements aux différents niveaux d'organisation des systèmes végétaux. *La Violence. Colloque AFSCET, Andé*, 7 p. **http://www.afscet.asso.fr/pbvioIW98.pdf**

BRICAGE P. (2000c) Systèmes biologiques : le "jeu" de la croissance et de la survie. Quelles règles ? Quelles décisions ? Quels bilans ?, *La décision systémique: du biologique au social." Atelier AFSCET, Institut International d'Administration Publique, Paris*, 6 p. **http://www.afscet.asso.fr/JdVie1.pdf**

BRICAGE P. (2001a) Pour survivre et se survivre, la vie est d'abord un flux, ergodique, fractal et contingent, vers des macro-états organisés de micro-états, à la suite de brisures de symétrie. *Atelier AFSCET "Systémique & Biologie", Institut International d'Administration Publique, Paris*, 11 p. **http://www.afscet.asso.fr/ergodiqW.pdf**

BRICAGE P. (2001b) Du biologique au social ? Un exemple d'intégration : les associations à avantages et inconvénients réciproques et partagés. En quoi un organisme est-il une association ? En quoi une association est-elle un organisme ? *Centenaire des Associations Loi 1901, Associations du champ social : instruments des politiques publiques et acteurs de transformation. Biarritz,* 18 p. **http://www.abbayeslaiques.asso.fr/SOCIOsystemique/associationsSocial.pdf**

BRICAGE P. (2002a) Héritage génétique, héritage épigénétique et héritage environnemental : de la bactérie à l'homme, le transformisme, une systémique du vivant., *L'évolution du vivant et du social: Analogies et différences. Colloque AFSCET Andé*, 20 p. **http://www.afscet.asso.fr/heritage.pdf**

BRICAGE P. (2002b) The Evolutionary Shuttle of the Living Systems., *5th European Systems Science Congress, Hersonissos*, Res.-Systemica 2: 6 p. **http://www.afscet.asso.fr/resSystemica/Crete02/Bricage.pdf**

BRICAGE P. (2003) La durabilité contractuelle du vivant. Seules survivent les Associations à avantages et inconvénients réciproques et partagés. *Atelier Développement durable, MCX33-APC, CIRESS Toulouse, Conseil Régional Midi-Pyrénées*, 3 p. *In* Anthropo-politique et gouvernance des systèmes complexes territoriaux. Presses de l'Université des Sciences Sociales de Toulouse, p. 111-117 (2005). **http://www.afscet.asso.fr/pagesperso/PBtlseMCX33.pdf**

BRICAGE P. (2005a) Le langage du vivant: plurilinguisme, transfrontaliérité et associativité., 9 p. *Congrès national ANLEA, Pau, France*, **http://tinyurl.com/anlea05pau**

BRICAGE P. (2005b) The Cell originated through Successive Outbreaks of Networking and Homing into Associations for the Mutual and Reciprocal Sharing of Advantages and of Disadvantages, between the Partners, with a Benefit only for their Wholeness., *6th European Systems Science Congress Proceedings, Paris, Workshop 1: Ago-Antagonism*. Res. Systemica 5: 11 p. **http://tinyurl.com/pbcellorigin**

BRICAGE P. (2005c) Les Associations à Avantages et Inconvénients Réciproques et Partagés. L'origine endosyncénotique de la cellule : avantages et inconvénients partagés entre partenaires indissociables et bénéfice global pour le nouveau tout émergeant., *6th European Systems Science Congress Proceedings, Paris, Workshop 1: Ago-Antagonism.* Additional Supplementary Files. 55 p. **http://tinyurl.com/cellreferences**

BRICAGE P. (2005d) The Metamorphoses of the Living Systems: The Associations for the Reciprocal and Mutual Sharing of Advantages and of Disadvantages. *6th European Systems Science Congress Proceedings, workshop 4: BioSystemics*. Res. Systemica 5: 10 p. **http://tinyurl.com/pbmeta1**

BRICAGE P. (2005e) Les Métamorphoses du Vivant : Les Associations à Avantages et Inconvénients Réciproques et Partagés. *6th European Systems Science Congress Proceedings, workshop 4: BioSystemics.* Additional Supplementary Files. 9 p. **http://tinyurl.com/HIVcurative**

BRICAGE P. (2005f) The Modelling of the Time Modularity of the Living Systems: the Time Delay, the Time Duration, the Time Lag and the Rhythms. La modélisation de la modularité temporelle du vivant : le tout est à la fois plus et moins que la somme de ses parties. *6th European Systems Science Congress Proceedings, workshop 19: Gouvernance sanitaire & sociale.* 10 p. **http://www.afscet.asso.fr/resSystemica/Paris05/bricage2.pdf**

BRICAGE P. (2006a) Danger des représentations non-systémiques. -1. Pouvoir de prédiction des représentations systémiques en Sciences de la Vie. 39 p. **http://www.afscet.asso.fr/pbAnde06txt.pdf** -2. MODÉLISATION : figures et références par mots clés. 21 p. **http://www.abbayeslaiques.asso.fr/BIOsystemique/bibliographie/pbAnde06fig.pdf** *Les représentations au crible de l'approche systémique. Journées annuelles AFSCET, Andé.*

BRICAGE P. (2006b) About the dangers of the use of non-systemics concepts & the testability of systemics designs through their predictions in the life sciences. Complementary Data. The Symbiosis: a unity through diversity partnership of mutual sharing of profits and of injuries., *Journées post-congrès de l'Union Européenne de Systémique. Journées annuelles de l'AFSCET, Andé.* 8 p. **http://tinyurl.com/andesymbiosis**

BRICAGE P. (2007) Quel enseignement supérieur & quel accompagnement pour quelles formations en sciences et technologies ? Bull. A.E. E.N.S., n° 1(2007), p. 78-91. **http://webcampus.univ-pau.fr/courses/CL50cd**

BRICAGE P. (2008a) La démarche scientifique expérimentale, un langage "systémique" : mise en évidence d'une phase critique d'apprentissage. *Systémique et langage. Journées Annuelles AFSCET, Andé*, 30 p. **http://www.afscet.asso.fr/Ande08/pbAnde08ExpSci.pdf**

BRICAGE P. (2008b) Cancer is a breaking of the cell's association for the reciprocal and mutual sharing of advantages and disadvantages through an aggression that results in a lack of non-autonomy. Complementary Data, Figures & References., Systemic Complexity: new prospects to complex system theory. *7th Congress of the Systems Science European Union, Lisbon*, Res. Systemica 7: 26 p. **http://tinyurl.com/pbcancerlisboa**

BRICAGE P. (2009a) Les conditions d'intégration de l'humanité au sein de la nature terrestre. The Forgotten Messages of Ecology and Governance. *"Essai de lecture systémique de la crise mondiale." Journées annuelles AFSCET, Andé*, 20 p. **http://www.afscet.asso.fr/crise/pbcrise.pdf**

BRICAGE P. (2009b) L'évolution créatrice: métamorphoses et phylotagmotaphologie du vivant. L'évolution du Vivant a une direction. Comment est-elle orientée ?, *Colloque "150 ans après Darwin, 70 ans après Teilhard: Lire l'évolution." Centre de Sèvres, Paris*, 109 p. **http://tinyurl.com/phylotagmotaphology**

BRICAGE P. (2010a) Sémiologique graphique de l'espace-temps-action du vivant : bilan épistémologique et praxéologique de sa modélisation systémique, co-déterminisme global, prédictibilité locale et imprédicativité glocale. L'approche systémique des lois systémiques du vivant "vivant". *Vers une nouvelle systémique, Andé, Journées annuelles AFSCET, Andé*, 34 p. **http://www.afscet.asso.fr/Ande10/pbETAvivant10.pdf**

BRICAGE P. (2010b) Associations for the Reciprocal and Mutual Sharing of Advantages and DisAdvantages. The way, to be resilient and self-sustainable, the living systems run through. *54th International Congress of the ISSS "Governance for a Resilient Planet" Waterloo, Canada*. 12 p. **http://journals.isss.org/index.php/proceedings54th/article/view/1491**

BRICAGE P. & al. (1989) Évaluation des cortèges des Lépidoptères défoliateurs d'un bois de feuillus (bois de Pau). *1er Coll. "Entomologie" Pays Basque (France & Espagne), Bayonne, France*, Ikartzaleak 13: 5-26.

BRICAGE P. (sous la dir. de) & al. (2007) Systémique & Accompagnement, AFSCET, Pau, 155 p. **http://halshs.archives-ouvertes.fr/halshs-00130212**

HOVERSTADT P. (2009) The Fractal Organization. J. Wiley & Sons Ltd, Chichester, England, 336 p.

VALLEE R. (1995) Cognition et système. Essai d'épistémo-praxéologie, L'Interdisciplinaire, Lyon-Limonest, 136 p.