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**ORIGINAL PAPER**

# Elements of Somatic Ecology and their Evolutive Significances

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**Abstract.** *By analysing the organisms from an ecological point of view, we find that most (all pluricellular organisms and unicellular eukaryotic ones) have the body formed of their own cells and microorganisms that populate it as living medium. These do not represent a single individuality but a complex ecological system, formed of different beings that are interested in making a unitary and functional whole. Both eukaryotic cells and pluricellular organisms provide to microorganisms, and not only, a multitude of habitats in which they carry on their existence. According to Lynn Margulis' endosymbiotic theory (1981), eukaryotic cells provide ideal living medium to some prokaryotic cells, which populate them endosymbiotically under the form of cellular organelles. The study of these life medium is related to what we call "Somatic Ecology", a term introduced by Leo Buss (1987), by which a new branch of Ecology appears. The somatic ecology concept offers a new perspective on knowledge of our evolutionary and functional structure and in ecosystems protection and biomes that make up our organism.*

**Keywords**: Somatic Ecology, biosken, ecosystem, biome, probiotic relationships, germ-free organisms.

## 1. Introduction

The analysis o four organisms, from a Somatic Ecology point of view, opens us a universe that we have not seen it before or even suspected it. It is about the fact that an impressive number of microorganisms that live not only in our body but in certain habitats, populate it during our common development and maintain it in operational conditions as long as possible, generating, over our existence, thousands of generations without affecting our health, but rather contributing to its maintenance.

Data that have led to concept of somatic ecology have accumulated over time.

D.C. Savage (1978) stated that "animals exist as complex organic units composed of animal and microbial cells which interact". Savage's statements have remained without echo at that time because they were not fully understood.

G. Zarnea (1994) believes that "a microorganism can be autochthonous for a certain habitat and allochthonous for another one, which transits it". So, according to G. Zarnea's thinking some microbiota can be considered as being own to

organism, so native, while others are foreign to organism that is allochthonous, going through organism accidently, or interested, in case of parasitic species.
Also, Zarnea (1994) believes that "the gastrointestinal ecosystem is an open complex, integrated and composed of interacting units which contain many habitats for microorganisms".
The suggestion that gastrointestinal system can be considered as an ecosystem perfectly functional for autochthonous microbiota can be considered as a huge step for drawing concept of Somatic Ecology. Andrei Popovici Bâznoşanu (1937, 1969) defined biosken as being the smallest type of possible ecosystem (a leaf on which aphids are found, which are controlled by different species of ants, parasitoid and predatory insects); Bogdan Stugren (1975) nominated the following types of bioskens, which are perfectly integrated into the concept of Somatic Ecology:

-Backs of cattle infected by dipterans;

-Erythrocytes of turtles are occupied by hemi-gregarines;

-Human body cells are parasitized by viruses forming intraorganismic bioskens.

It is known the fact that Beklemişev N. (1952) defined consortium as a group of beings around an individual organism, which they depend on both tropho-ecologically and topographically (an isolated tree populated by phytophagous species that depend one to each other in their existence). W. Tischler (1955) uses term biochorion, which can be considered synonymous with that of consortium.
What interests us as the fact that, for explanation of these terms examples are also given, related to what we call "somatic ecology":

-Bogdan Stugren (1975) considers that several bioskens may constitute a consortium.

-W. Tischler (1955) considers that a field mouse with its ectoparasites and helminths are forming a consortium.

Such accumulations permitted to Leo Buss (1987) to prove scientifically a new direction in ecological research, which he called it SOMATIC ECOLOGY in order to detect interrelations that are established between an organism and many species of microorganisms that populate it.
In order to study thoroughly the concept of Somatic Ecology, it is necessary to appeal, not only to ecological thinking, but also to that biosemiotic one and to remember a much neglected biological phenomenon, the **symbiotic mutualism**.

## 2. Habitats offered by the digestive tractus to autochthonous microorganisms

The digestive tractus the system of organs by which the animal organism makes the exchange of matter and energy with environment. Through digestive tractus, assimilation of external environment is achieved, or what we call transformation of external environment into internal one.

The digestive tractus consists of compartments essentially differed among them, structurally and functionally. Each compartment (oral cavity, stomach, small intestine and large intestine) offer living conditions form any commensal, symbiotic species and even parasites; each represents a characteristic biotope, populated by a complex of species which form particular biocoenoses. So, each compartment may be considered an ecosystem (bucal, gastric, intestinal, etc.) and all these ecosystems, by their characteristics and connections, can form a true biome – **the digestive biome.**

## 3. Ecosystem– the bucal cavity

The biotope of this ecosystem consists of bucal mucous membrane, tongue and teeth, to which secretions of salivary glands that open in bucal cavity are added.

We do not insist, but we must remember that biotope, bucal cavity, offer particular conditions of temperature, moisture, pH (ranging between 6 and 7, the average being 6.8), aqueous and mucus secretion of salivary glands (Mustaţă Gh., Mustaţă G.-T., 2001). Salivary glands secrete lysozyme too, which has bactericidal action; it does not kill bacteria, but it does not permit their exponential growth.

Dozens of species of bacteria that belong to category of allochthonous microbiota are installed in bucal cavity, but also dozens of pathogenic species that belong to allochthonous microbiota.

Very characteristic bioskens are formed in bucal cavity;-such as those formed by dental plates (Mustaţă Gh., Mustaţă G.-T., 2001; Mustaţă Gh., 2010).

The dental plate bioskenis an ecosystem made at the level of a tooth. On dental plate, a multitude of bacteria species are fixed which interact among them.

The bacteria are fixed to a thin pellicle of mucin (a component of salivary secretion) together with they form a biofilm (organic film).The bacteria cover as a paving thin layer of mucin. There appears a competition for space among bacteria species that are fixed on dental plate. The first bacteria that initiate colonies are *Streptococcus cricetus* and *Actinomyces viscosus*. These are aerobic species. If mucin layer thickens, then two floors of the biological film are differentiated: one aerobic on surface and a second one anaerobic in depth. Inside of anaerobic layer, *Bacteroides gingivalis* and *Actinomyces naeslundii* are installed (Fig. 1).

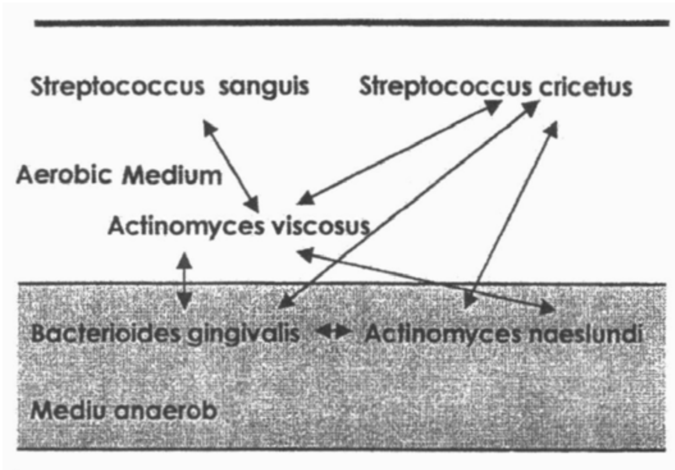


**Figure 1.** Microbiota from the biosken – dental plate.

If biological film is entirely occupied by autochthonous bacteria, then, some parasitic bacteria cannot fix passing through bucal cavity. Of course, we have to wash our teeth, not to facilitate formation of anaerobic layer, which gives an unpleasant odour too. But, if we have proposed ourselves to eliminate all the bacteria in bucal cavity, leaving it germ-free (free of germs), then, we have put these organisms in danger, because some pathogenic bacteria could fix and they would cause us great troubles. We wash our teeth, but we do not plan to eliminate 99% of bacteria, as they state us precisely in some commercial advertisements.
If a dental plate is a biosken, then we can consider that all dental plates form a biochorion or micrococenosis. To these ecosystems formed by bucal mucous membrane and lingual mucous membrane are added, so that we can speak of a major ecosystem – the bucal cavity.

**4. The gastric ecosystem**

Inside of stomach, living conditions offered to microorganisms are totally different from those in bucal cavity. Firstly, hydrochloric acids highly concentrated, providing a pH of 1.5-2, with a strong antimicrobial activity. Acid-tolerant microorganisms are installed in gastric cavity.
**The gastric mucous membrane biosken** has a characteristic structure (Fig. 2). Papering gastric mucous membrane, autochthonous microbiota protects it against pathogenic bacteria.

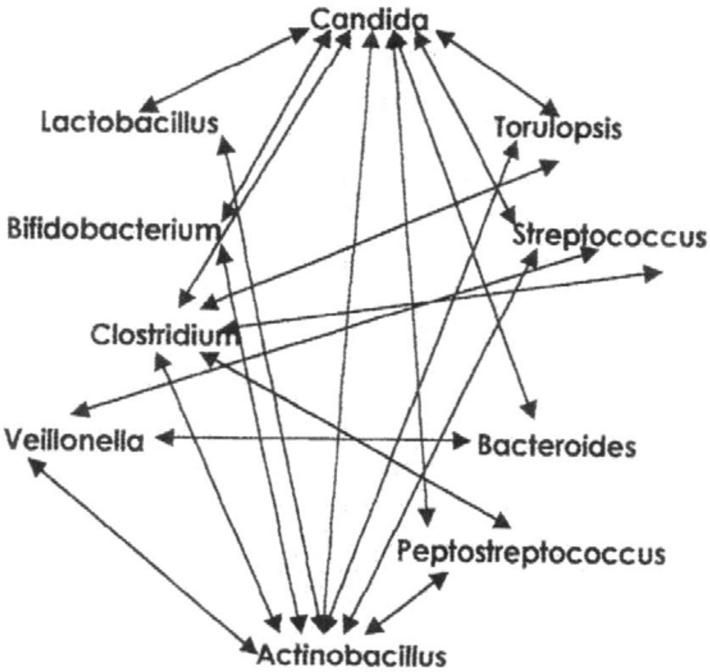


**Figure 2.** Bacteria installed on the gastric mucous membrane and in lumen

**The small intestine ecosystem** (duodenum, jejunum and ileum) offer different conditions in its three compartments. The pH is alkaline in small intestine (it ranges from 7.1 to 8.5), and instead of hydrochloric acid, biliary acids have antimicrobial activity. The gall does not permit exponential growth of bacteria. The biosken of small intestine is also characteristic (Fig. 3). The microbiota of small intestine is very important for organism health. In case it is affected by some antibiotics or by some troubles, then, small intestine is exposed to parasitic bacteria attack (Mustaţă Gh., Mustaţă G.T., 2001; Mustaţă Gh., Mariana Mustaţă, 2006).

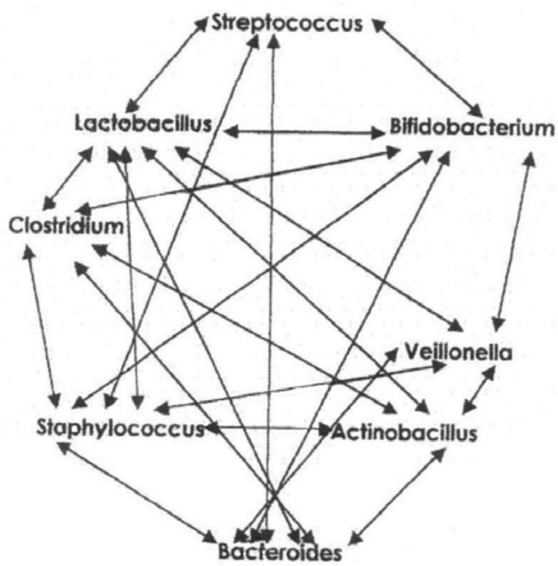


**Figure 3.** Bacteria installed in intestine

The large intestine ecosystem (colon) is the most favourable for some microorganisms installation. This is due to lack of a secretion with antimicrobial action. In ascending colon and in the first half of the transverse colon fermentation microbiota is installed, which is aerobic or facultative anaerobic and which determines digestion of decompose carbohydrates into other segments of digestive tract.

In the second half of transverse colon and in descending colon putrefaction microbiota is installed, which causes proteins decomposition. The microbiota of colon is essential for organism health as it finalizes digestion of complex carbohydrates and proteins and it synthesizes some vitamins necessary for organism: vitamins B complex, vitamin K, folic acid, nicotinic acid, etc.

If antibiotics are taken without accompanying them with vitamins B complex or yogurt to make a re–sowing with bacteria, then organism is in dangerous a result of action of pathogenic bacteria.

Biosken of human colon is formed of more than 400 species of microorganisms belonging to 40 genera (Fig. 4). The number of bacteria reaches 1x $10^{11}$/g in a carnivorous animal; bacteria may represent 40-50% from faeces weight.

We deduce from here that ecosystems of digestive tube are very different structurally and functionally. These have, however, some common characteristics, which determine us to consider that digestive tract functions as a unitary biome – **digestive biome,** etc. If we accept existence of digestive biome then we can also accept other types of biomes specific to organism: respiratory, circulatory (internal medium, reproductive, integrator, etc). All these biomes are in close interrelations forming a single structural and functional whole – homosphere, comparable to biosphere.

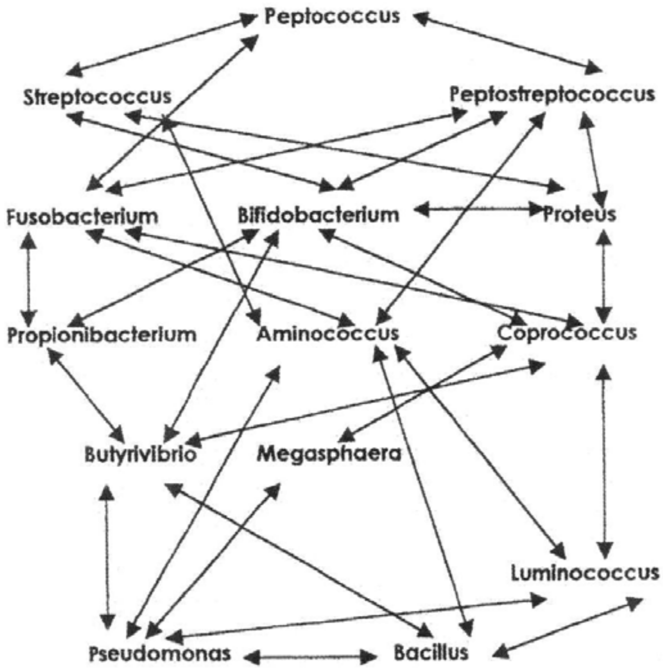


**Figure 4.** Some types of bacteria which populate human colon

We realise from those presented that we, as individuals, do not live alone; our organism is built from its own cells and from cells of microorganisms that populate different organs, forming together complex biocoenoses. We, through our particular structure, offer favourable living conditions for other beings, with whom we have associated, having a common evolution. These beings are interested to tone up and strength in our organism to ensure an existence as long as possible to habitats they populate, so necessary for their existence.
We can realize following types of digestive tract structure in these animals during their evolution, vertebrates were strongly influenced by communities of microorganisms populating them. Digestive tract betrays, through its structure and functionality, footprint left by relationships established with autochthonous microbiota. Based on these relationships, we distinguish several types of digestive tube:

-carnivorous and omnivorous type with a simple stomach (Fig. 5);
-ruminanth erbivorous type (camel, sheep, cattle, etc.), with stomach formed of 4 compartments (Fig. 6);
-non-ruminanth erbivorous type (horse, rabbit, elephant, etc.) with hypertrophied caecum (Fig. 7).

Based the investigations on digestive tube structure from some vertebrates, we realize that they have not evolved in isolation, but they have had a coevolution with autochthonous microbiota, which led to building of a certain type of digestive tube.

As a matter of fact, we cannot speak of isolated organisms, of germ-free organisms (gnotobiotic, axenic).

Each organism is more or less integrated in the environment, and in its turn, it represents a complex life medium, which hosts different communities of organisms that ensure their existence.

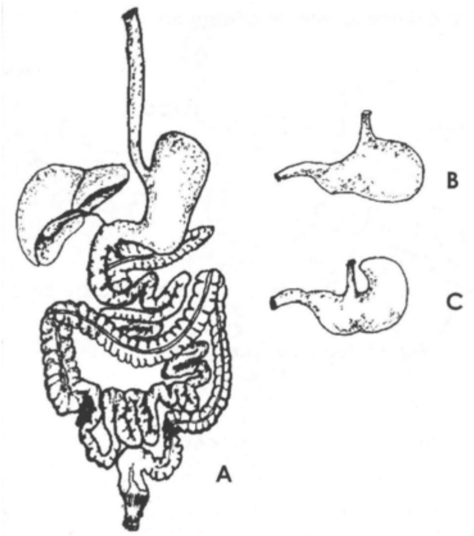


**Figure 5.** Right digestive tube: A - at human; B - at dog; C - at *Mus musculus*

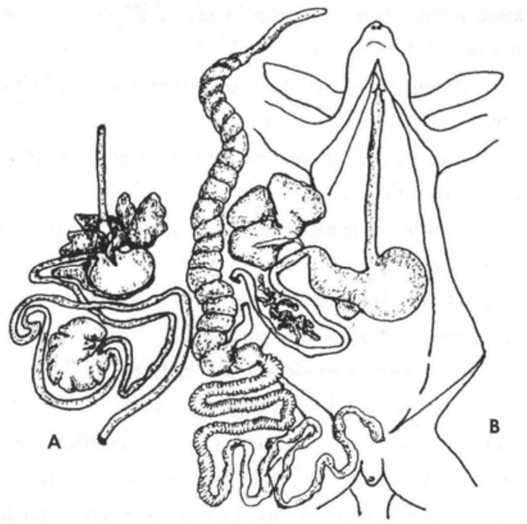


**Figure 7.** Digestive tube of caecal type: A - at rat; B - at rabbit.

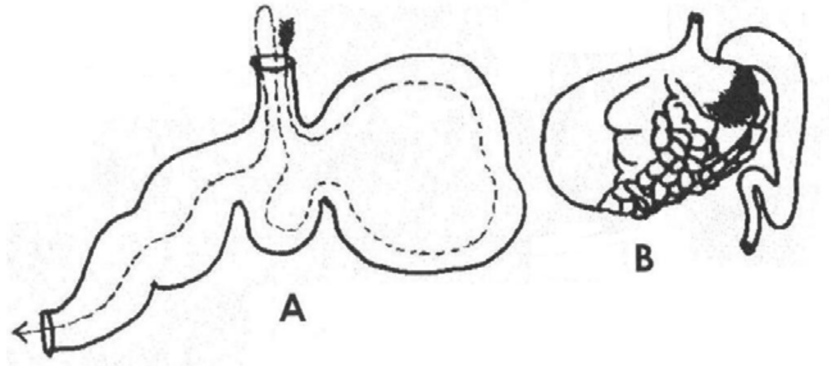


**Figure 6.** Digestive tube of ruminant type: A - at sheep, B - at camel

Modern research has demonstrated that there are germ-free organisms (gnotobiotic, axenic), and if they are obtained artificially, they present certain characteristics (Savage, 1978):

-organs which come in intimate and continuous contact with microorganisms or with antigens resulting from their secretions (liver, the small intestine, lymphatic ganglia, and so on) are smaller than at normal animals;

-at rodents, caecum reaches up to25-30% of body weight;

-crop, large intestine and even the bones are smaller in axenic chickens than in those normal ones;

-dejections are lacked of fermentations and putrefactions and they do not have a faecal or ammoniac smell.

Axenic animals cannot live if they do not get sowings with autochthonous bacteria. If they get such sowings, they come back to normal.

## 5. Sowing of foetus with autochthonous microbiota

At birth, the child could be considered germ-free. But, after the birth, it takes place the sowing of body with different species of bacteria. In Fig. 8, we can observe succession of bacteria which install into foetus and their definitive stabilization. It is particularly interesting competition of autochthonous bacteria and mode in which they are installed in new-born colon (Fig.9).

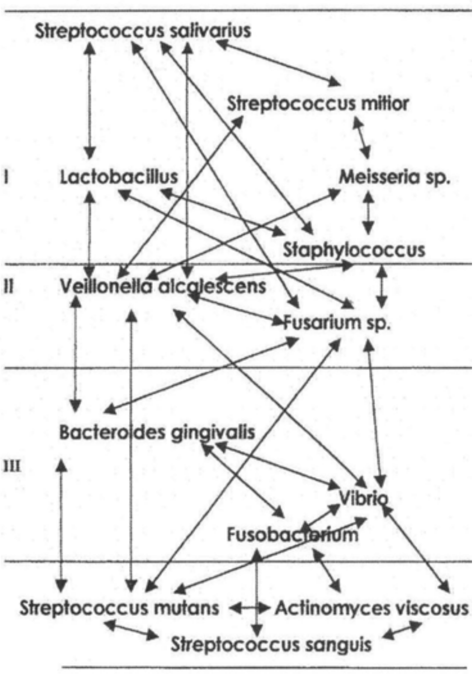


Figure 8. Succession of bacteria in foetus and its definitive installation

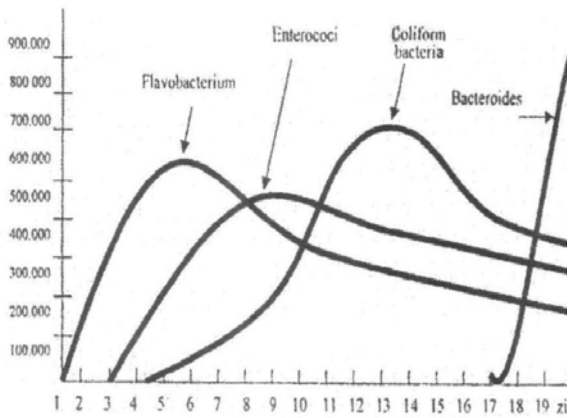


**Figure 9.** Installation and evolution of different types of bacteria in colon.

## 6. Probiotic relations

Probiotic relations are established between autochthonous microbiota and organism are essential for their cohabitation.

From the moment when microorganisms have occupied a certain habitat in our body, it is natural that they do not affect habitat and maintain it as long as possible in functional state, in health state, not to put in danger their own existence.

Among species that populate organism of a vertebrate one can put into evidence some relationships of probiotic type. Substances produced by a microorganism favour growth of another organism.

Any living organism that added to food, affects beneficially host-organism through improvement of balance of microorganisms in digestive system, has a probiotic action.

Probiotic preparations, which are introduced in food, can contain *Lactobacillus bulgaricus, L. acidophilus, L. helveticus, L. lactis, L. salivarius, L. plantarum, Streptococcus thermophilus*, etc. Probiotic organisms must have certain characteristics:

- lack of pathogenicity and toxicity;
- capacity to survive in the intestinal medium;
- to have beneficial effects on the host;
- to be economically accessible;
- to be stable for long periods.

The effects of the probiotic species action facilitate our understanding of their cohabitation with host:

- production of metabolites with antimicrobial action;
- competition for nutrients;
- prevention of colonization of pathogenic bacteria through competition, through the sites of adhesion on epithelia;
- modification of microorganims metabolism by increasing the activity of some enzymes or the diminution of others;
- stimulation of immunity by increasing the macrophages immunity;

- effects of probiotic organisms seem to suggest the idea that some species of microorganisms become somewhat essential to host.

We do not have to understand that host cannot survive without certain microorganisms but, to consider that some probiotic species positively influencing host organism, namely:

- they can stimulate the growth of animals by improving the food conversion and offer protection against intestinal infections;
- they replace antibiotics and synthetic chemical additives in animal farm;

- they attenuate the lactose intolerance phenomena caused by congenital deficiency of β-galactosidase by increasing of this enzyme.

*Lactobacillus* has anticancer effects, among which:

- inhibition of tumour cells growth;
- suppression of bacteria that produce enzymes responsible for carcinogenic substances from in offensive complexes;
- they determine suppression of nitroreductases involved in nitroso-aminases synthesis.

If animal comes in contact, naturally, with environmental microorganisms, a complete, normal microbiota is installed in host body, which ensures protection against pathogenic microorganisms

On the contrary, if new-born animal is maintained in germ-free state, it has certain difficulties in what concerns protection against pathogenic species. If new-born animal is placed in contact with different probiotic species, then it becomes resistant to attacks of pathogenic species.

The Somatic Ecology allows us to see the world as a single whole, in which each being dependents on all other beings and of whole formed by biosphere (life). Thus, we discover that digestive tract a particular complex ecological system being essential in connection with external environment. As a matter of fact, Michael Gershon (1998), from University of Colombia, considers it as being the Second Brain.

The community of microorganisms in digestive tube leaves its mark on entire functioning of body. The illness and organism health, if they do not have an origin totally digestive, they have at least one component related to function of digestive system.

The enteric nervous system with its neurotransmitters dominates body influencing a multitude of biological processes.

Modern research tends to demonstrate that, to a large extent, problems both of “head” and “psyche” are actually digestive problems.

Michael Gershon focused our attention on gastrointestinal tract as an autonomic nervous system, being only formation of body that can function on its own account.

Enteric nervous system functions too, if the vagus nerve is sectioned. As a matter of fact, it is considered that 90-95% of fibres of vagus nerve transmit information from digestive tube to brain and not inversely.

It is, of course, a too big boldness, but if today one can speak about an intelligence of living and about body intelligence, why not, we can speak too about a digestive tract intelligence ?

It is assumed that through vagus nerve, gastrointestinal tract can influence both memory and learning capacity and good mood.

The second our brain seems to recognize the food in take, that it receives them or not, that it decides to process them or not: it is that which informs brain on general state, warning it that it cannot accept a nutriment or another.
Modern research points out that osteoporosis, Parkinson disease, certain psychiatric disorders (anxiety, sleep disturbances, permanent fatigue and some memory problems) may have their origin in some dysfunctions of digestive tube.
Michael Gershon (1998) links functionality of digestive tract to microbiota that populates it. This could control, in some persons, installation of obesity, diabetes, autism and other unsuspected disorders. As arguments in support of this idea and that of our second brain, it is insisted on fact that 90-95% of serotonin secreted in our organism comes from digestive tube: serotonin has a vital importance in organism functioning.
The digestive tube was likened by ancient philosophers with plant roots, organs that anchor them in the soil and that establish connection with external world. Let's do not consider that this is a naive thinking; the digestive tractus not just "a pipe" through which food passes, so, through which external environment and internal medium penetrate; it is a living plant that anchors organism in environment, ensuring good functioning of all the organs.
Digestive tube, together with microbiota that populate it ensures health and body functionality; it keeps it in an optimum shape making possible an intellectual, creative and practical activity.

**Conclusions**

The unicellular eukaryotic organisms and all the pluricellular organisms do not live alone; they ensure habitats in which countless species of microbiota carry on their existence. We can affirm that pluricellular organisms have body built from cell body's and microorganism cells that populate them.
Starting from here, it was felt need to study organisms as complex living medium, being individualized a new branch of **Ecology** as a science – **SOMATIC ECOLOGY**. The substantiation of this direction of research belongs to Leo Buss (1987).
The Somatic Ecology concept facilitates understanding of organisms as a universe composed of its own cells and microbiota cells that populate them.
The pluricellular organism offers to microorganisms a multitude of habitats in which they find their optimal living medium. These act beneficially on host being concerned about its health. It is not about altruism, but about host health insurance to be able to facilitate their existence. The established relationships represent a symbiotic mutualism.
It is necessary to understand that organisms have not evolved in isolation but they had a coevolution with microorganisms that populated their habitats and with which they have established close interrelations.

In this present paper, we present evidences which demonstrate that eukaryotes and pluricellular organisms have bodies built from cell body's and microbiotic cells that are associated with.

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