The problem of animal reproduction from the positions of some theoretical biology areas

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Abstract. Various theoretical propositions about the nature of living matter and its characteristics such as free energy , the basic process , biophysical potential, their place in the development of an organism and arising from these theories possible applications to livestock . Specific data of own experiments and researches by various authors on the quality of the offspring of different animal species under the influence of stress factors on parental forms are given. A hypothesis about the increase of the biophysical potential of generative cells under the influence of stress factors and manifestations of heterosis effect not only due to heterozygosity of hybrid organisms, but also - due to most of their biophysical potential inherent in the formation of gametes is proposed.
[Bekenev V.A., Muratov A.A. **The problem of animal reproduction from the positions of some theoretical biology areas.** *Life Sci J* 2014;11(9s):151-155] (ISSN:1097-8135). http://www.lifesciencesite.com. 28

Keywords: aging, the basic process, free energy, viability, topcrosses, stress, biophysical potential

There are often problems during the reproduction of faming animals, consisting in declining of potency, fertility, prolificacy, viability of descendants, reduction economic use terms, etc.

Creation of optimal conditions for the development of organisms and obtaining high productivity is possible only on the assumption of right idea of biological essence and characteristics of living matter. Its features are adaptive animal reactions to the action of environmental factors.

There is a number of theories about the essence of life. One of them that provokes increasingly growing interest of scientistsin recent years is E.S.Bauer'*sprinciple sustainable disequilibrium* [1], which states: "All and only living systems have never been in equilibriumand execute, due to its free energy, permanent work against equilibriumrequired by the laws of physics and chemistry onthe external conditions existing. "According to Bauer, a living organism extracts matter and energyat the expense of own resources, due to energy fund called by him *free energy*. Thanks to this supply of *free energy*, the organism is capable to extract the potential energy from the food that absorbs and to convert into energy with the help of which does work to improve energy fund.

Free energy refers to excess of energy, generated in a living system as a result of itsactivated nonequilibrium state of the molecules compared to the unexcited state of equilibrium. The part of free energy, the living creature possesses in the result of its nonequilibrium state, is the potential of the living substance, or called by Voeikov V.L., biophysical potential [2] Determination of living matter essence, given by E.S.Bauer, is accepted and supported by prominent contemporary researchers of philosophical [3,4] and biological trend.

In thermodynamic theories of living systems' existence nonequilibrium states in open biological systems are called stationary states, which are close in meaning to the concept of basal metabolism [5-9]. According to Prigogine's theory, the permanent process of deceleration of entropy production of organisms [reducing external dissipation function], the process of approaching the current stationary state to the final stationary state of system, i.e. to the death. The deference from the Bauer's theory is that the self-organization of bio system is mandatory, it is not due to the intrinsic activity of a living organism [2].

Exceptionally important phenomenon appears in the process of individual development, which is called "basic process". It is concluded in the process of organism development and senescence under the influence of environmental factor potential, at the same time the free energy, which the living matter possesses, in consequence of nonequilibrium structure, decreases, and in its generative cells – abruptly increases. It means, there is a period of such deviation from the stationary state, when the nonequilibrium thermodynamic systems, absorbing the matter and energy form the environment, can make the qualitative leap to the complication. Herewith the new organism begins its development with the high level of specific heat production, generative cell at the expense of structural energy of dying cells obtains potential to convert the interlinked energy of food into *free energy*, which is capable to do work.

The basic process supposes the possibility to each living system repeatedly "rejuvenate" and marsh

again into the development phase on retention of high vitality. It also allows save permanent viability of living systems, in spite of individual's death.

According to Zotin A.I. [9] theory during the oogenesis, when gamete is still the part of the parent organism, the process of rejuvenation of the system descends, and there is the aging process at all other stages of the organism's life. In which connection, it is proved that the period of rejuvenation of living systems is accounted for the early phases of oogenesis long before the fertilization or the embryos' birth [9-11]. This corresponds to some scientists' opinion that the aging begins at the early stages of embryonic development.

Speed of the aging process is the greatest at the early stages of development, then slows down. The measurement of heat corresponds to this, the former decreases with age per unit weight. In numerous studies referenced by A.I. Zotin, it is shown that the rejuvenation of the living system, which occurs during the growth of small oocytes, is quite long and is about 10-15% of the lifetime.

It is believed that the increase of the free energy level of germ cells occurs due to the energy of coupled processes which take place in senescent cells of the maternal organism. Free energy determines "total number of calories, which can be converted throughout its life by the body" [5] i.e. - its viability. So, one of the main causes of dying of some fish species after spawning; colors - after flowering is, apparently, the potential drop of somatic cells of the maternal organism and the formation of new germ cells with high energy potential due to its structural energy, i.e. energy, which is in an excited state. The ATP content can be served as biochemical indicator of structural energy.

The above-stated physical processes, characterizing the energy exchange in the organism, can have not only theoretical but also practical significance. They lead to the understanding of various aspects of animal adaptation towards environmental conditions; to the different perceiving the essence of reproductive function; as well as to the better understanding the essence of general biological phenomena such as heterosis and inbreeding depression, to the developing theoretically-grounded promising approaches for solving applied problems of biology and animal husbandry and etc.

Reduced adaptation leads to greater susceptibility to stress, illness, and reduced viability. Consequently, the organism of animals, especially of reproductive groups, should not just be in the auspicious conditions, but also have systematic, optimal loads, requiring the mobilization of neuroendocrine systems. Experiments and practice show the positive effect of the forced movement of semen and health, being evidence that the adaptation level of the animals using physical exercise is maintained within normal limits. [12-18]

However, the data obtained in different observations and experiments allow to formulate certain theoretical regulations and to answer many specific questions.

Fertility, animal live weight at the birth and their viability are obviously determined to a considerable degree with the development of ovules, i.e. that dependents on the level of accumulated free energy by it [and by spermatozoon]. It is interesting that the addition of ATP in sperm does not increase the energy status of the spermatozoa, and does not increase their mobility which shows the endogenous nature of energy reserve in it, accumulated during the gestation period.

At the same time the level of antioxidantive activity [AOA] of blood and sperm, which can be just the supportive source of certain level of free energy and energy potential of organism cells, influences the level of reproduction. Thus, in our researches during the mating of breeding pig, with high level of antioxidant activity [SH- group] in the red cells of blood, and bucks, with high level of this indicant in spermatozoa; prolificacy and the nest weight were significantly higher than at their low level of both parents.

In sperm cells, characterized by an extremely high rate of metabolism, especially many free radicals develop. In the female genital tract their level for some unknown reasons is reduced, and spermatozoa sort of rejuvenate.

According to our data, under the influence of various anti-stress medication [vitamins C and E , eleutherococcus extract, etc.] in the red blood of piglings the increase of antioxidant activity as well as peroxidation is observed, but the processes of accumulation of antioxidants prevail over free radical reactions, which increases the life activity of animals. There is also high correlation between the intensity of peroxidation processes and indicators of sperm AOA. However, during the formation of the zygote free radicals in the female genital tract, neutralize, and the AOA retains its high status, that was achieved as a result of increased metabolism. That is, free energy of a new organism is at high level, giving the best opportunity for its further development.

The role and nature of the main process, i.e. the formation of the preparatory potential of embryonic cells, is closely related to the rate of individual development of organisms. There are individuals exposed to stress, i.e. being in the excited state of structures of the body, perceiving external, in a sense its damaging signal. Germ cell of such individual acquires the ability to extract energy from

the environment and thereby improve their biophysical potential [2]. A good example is a technological method as senication - spraying plants with bath of highly concentrated fertilizers, in order to accelerate ripening. This increases the flow of nutrients from leaves, germination of theobtained seeds increases by 5-10 % [19]. A similar pattern is observed during the close breeding. Inbreeding in pure breeding leads to the fact that the normal range of reaction of the animals as contrasted to crossing of different breeds and lines become narrower, they are easier subjected to stress. They have more often broken borders of physiological adaptations. For example, the excitation threshold of inbred pigs during the stimulation of electric shock is significantly lower than mongrel. [20].

Interestingly, the heterosis effect is stronger when parents are under stress conditions of development. In experiments on quails under the influence of stress factor, which was thiouracilas food additive, males with better reproductive capacity are succeeded at selection on growth rate than males, whose parents were in normal environmental conditions [21].

During the cultivating of tenebrionid beetles in stressful conditions, caused by lack of yeast in nutritional yeast milieu, leading to a sharp decrease of lysine and other essential amino acids in feed, the heterosis by weight of larvae was 42.4% compared with 12.6% for the normal environment [22].

We can say that animals which are stressed and also inbred the level of live material nonequilibrium is supported more stressful which tends to higher energy metabolism, fast deterioration and senescence.

Consequently, stressed organisms produce more outer work the main process proceeds more intensive i.e. the process of increasing of generative cells potential on account of fast decreasing of somatic cells potential. As a result their generative cells are probably more fortified by energy substances and have a great biophysical potential in comparison with organisms which are within optimal environment. Analogical regularity is specified for inbred organisms whereas senescence speed as well as stressed organisms proceeds faster [23-28].

As it is paradoxical in terms of the inbred depression development there are considerable evidences that the germ cells of inbred individuals have higher biophysical potential in spite of decreasing potential of somatic cells. So, the inbred chicken in comparison with outbred the main important parts of eggs quantitatively are not reduced [dry weight of the yolk, nutritive value, content of essential amino acids] or even increased [yolk oil, the quantity of dry substances and yolk lipids]. [26,27].

The sperm of inbred bulls tends to increase of biophysical potential expressing in their best survival ability besides the tighter inbreeding the higher survival, which leads to improvement of inseminate ability of bulls' sperm, taken in tight inbreeding. Inbred bulls excel their outbred half-brothers with activity of frozen-thawed sperm in 0, 06-0, 15 points and its inseminate ability in 1, 8-4, 4 %. In our earlier researches inbred boars have the advantage over outbred with multiple fetation of wombs which were paired with them.

First generation hybrids have a greater growth rate and lifetime, make less outer work against the balance in force of its heterozygosity and wider reaction norm, than inbred or stressedones. It is known that concentrative gradient of potassium ions and natrium on both sides of cell membrane is a factor determining the size of membrane potential. In a special experiment we determined the correlation of potassium and natrium in erythrocytes and plasma of pigs with a different degree of their parents' relations. Thereby, the largest difference [in many cases highly authentic] correlating these elements between erythrocytes and plasma presents among hybrid pigs and the least among inbred ones. Outbred animals take a middle place in that condition. Potential middle sizes of erythrocytes for tested animals are counted. Outbred pigs of large white breed potential amounts to 115,7 milevolt, inbred pigs of large white breed potential -112,0, hybrid crossed with landras breed - 121,9, outbred landras breed - 116,7 milevolt.

Therefore, erythrocytes of hybrid pigs have the greatest potential and the least – inbred ones.

Hereof, this suggests that potassium natrium pump of erythrocyte membrane more effectively functioned among hybrid pigs in comparison with outbred and moreover with inbred ones.

These results according with statistics Shahbazov V.G. compared the differences of potential between core and cytoplasm, cell and environment found that heterotic plants are described with a higher difference.

As intensive development phases in ontogenesis of hybrid individuals pass slower than of inbred ones [23,24] so the potential of somatic cells reduces slowly.

We can assume that as a result each hybrid elementary cell gets lower first potential as a consequence of heteroticattenuation in spite of probability of heterozygous forms excision. Probably, therefore stock-breeders attempts to fasten the heterosis in several generations do not lead to desired result. For pure breeding and line crossing the ambient pressure is approximately equalas the rate of reaction of organisms to the impact of external environment is the same. Therefore, despite the

heterozygosity in case of line crossing which is not supported by high energy potential, heterosis fixing does not happen.

We suppose that the positive effect of topcrossis conditioned by not only more valuable inheritance of inbred producers. Inbred animals unlike outbred or hybrid are more homozygous have narrow norm of reaction to the impact of environmental factors differ by increased rate of individual development and senescence. All this leads to the formation of a higher potential of biophysical inbred producers gametes better providing fertilization and implementation of genetic information by animal yield. We believe that the phenomenon of heterosis is connected not only to the genetic information [overdominance , etc.], as interpreted in the majority of studies but also with the amount of free energy source forms gametes that is with their initial potential.

According to our hypothesis the scheme of potential formation of generative cells can be represented as follows [Fig 1]. On pure-bred organisms [1 x 1; 2 x 2] effect of the environment as a result of their more narrow reaction norm is stronger than crossbred [heterozygous]. Their curve of specific heat production during the ontogenesis under the influence of stressful factors looks sharper. Therefore, it makes the body to devote more energy to the potential of germ cells [as if squeezing of somatic cells]. As a result the hybrids generative cells [1 x 2] are enriched as genetic information and energy they are fully manifested by heterosis effect.

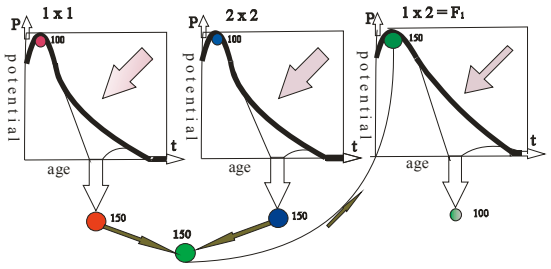

Fig. 1 The scheme of potential formation of generative cells under the influence of genetic features of hybrid and inbred organisms development and pressure of environmental factors

Notes.

- 1, 2 - different species [species], 1x2 - hybrids

- curves - the dynamics of change in heat during ontogenesis in the original forms, and in hybrids

- 100, 150 - conventional units of biophysical potential of germ cells at the time of fertilization

- Purple arrow - pressure of external factors on individual development

Heterotic organisms curve [1 x 2] energy exchange in ontogeny is more slightly sloping since external environment has a weak influence on them. Their energy potential generated proportionally to the speed of ontogeny is smaller than in inbred organisms stronger to the influence of environmental factors. As a result - subsequent generation' sheterosis is not shown.

State positions characterizing the energy exchange in the organism leads to a different understanding of various aspects of animal adaptation to environmental conditions. A prospective way to improve animal reproduction may be an influence leading to an intensification of metabolism and energy increasing the level of adaptation including the work of the natural hormonal regulators of reproduction in maturing germ cells. It is ought to use the moderate physiological stress not depleting adaptive features but creating the energetic conditions to include the main process , i.e. the formation of the initial potential of the free energy of germ cells. They are the manifestations of heterosis condition in crossbreeding.

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5/29/2014