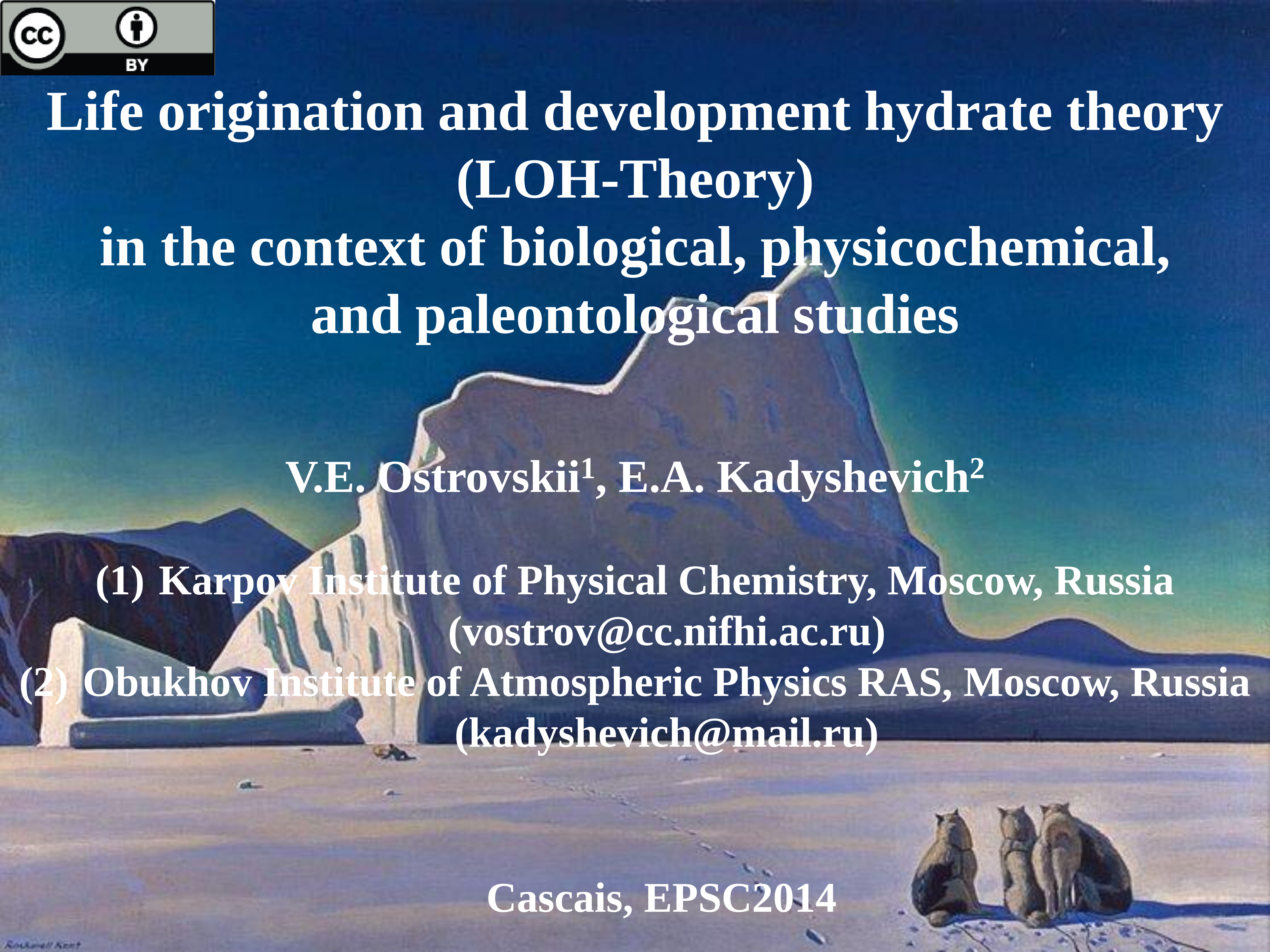
Life origination and development hydrate theory (LOH-Theory) in the context of biological, physicochemical, and paleontological studies



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I. Introduction: Principles

According to V.L. Ginzburg, Nobel Prize Laureate in Physics (2003), explanation of the life origination mechanism is one of the three “great problems” for the XXI century.

There are “ …three great problems for the modern physics…”

(1) The problem of the entropy increase, irreversibility, and “arrow of time”;

(1) The problem of interpretation of nonrelativistic quantum mechanics and of the possibilities to obtain a new knowledge about the field of its applicability;

(3) The problem on the possibility of explanation of the life and thinking “bearing on the physics only”.

(Ginzburg V.L., Nobel-prize Lecture, 2003)

The principal features of natural phenomena [1]

(1) Regularity and inevitability: natural phenomena arise and develop as a result of regular inevitable chemical and physical interactions, which are governed by universal physical and chemical laws.

(2) Thermodynamical directedness: natural processes are directed progressively to a free-energy decrease in each Universal sub-system that can be approximately considered as the isolated one.

(3) Laconism of instrumentation (the Occam-Newton-Russell principle): “Nature is simple and doesn’t luxuriate in excesses”.

(4) Gradual development : Nature makes no jumps (*Nature non facit saltus*, in Latin).

(5) Repeatability and individual features: Nature created many similar but somewhat differing events and no unique phenomena without close analogues.

(6) The unity of the event point: separation of an event into several sub-events proceeding in different points with subsequent interaction between the sub-events decreases the probability of the resulted event, because it decreases many-fold the degree of repetition of the event as a whole.

(7) Random phenomena doesn't just happen in Nature; if a phenomenon seems to be random, an expansion of the spatial and time framework of observations is capable of revealing its necessity.

Just as a result of the thermodynamically-caused directedness of the natural phenomena and processes, researchers are principally capable of mental doubling back the way the nature went and, thus, of revealing the main milestones in Nature’s movement.

A naturalist must search for a “hook” in the environment in order to catch on it and, having the thermodynamic laws as the guiding thread, to guess the logics used by Nature in its temporal transformations. [2]

History confirms K. Popper’s conclusion that the adequacy of the general understanding of natural phenomena is not progressive but makes zigzags and develops on the basis of the trial and error procedure as “…science is fallible, because science is human” [3].

Zigzags are capable of leading the scientific community away from the adequate knowledge and can be in progress during active work of two or three generations of researchers.

Even a proof, which, as it might seem, is entirely constructed on factual knowledges, is not guaranteed against the possibility to be disproved. By K. Popper, “…though we may seek for truth, and though we may even find truth (as I believe we do in very many cases), we can never be quite certain that we have found it. There is always a possibility of error; though in the case of some logical and mathematical proofs, this possibility may be considered slight.”[3]

There is an opinion that experiments are criterions of the verity.
But this opinion is correct by no means always.
The arrangement, technique, interpretation of experiments, etc. may be incorrect.

II. Formulation of the
Hydrate Theory of Living Matter Origination
(LOH-Theory)

II.1. Preliminary notions

How mach plant and animal species had created Nature?

Today, about 1.6 million animal species [4] and about 0.3 million plant species exist on the Earth, and descriptions of earlier unknown species appear each day in the literature.

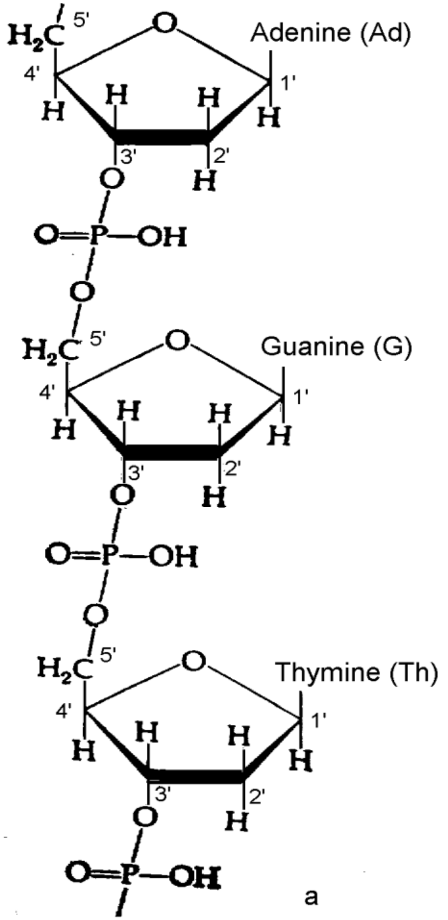
A multitude of deleted species were specified by paleontologists.
The common number of the species that were created by Nature is about 3 million.
The mysterious species diversity and mechanism of life origination are always in the human highlight.

Life, what is this?

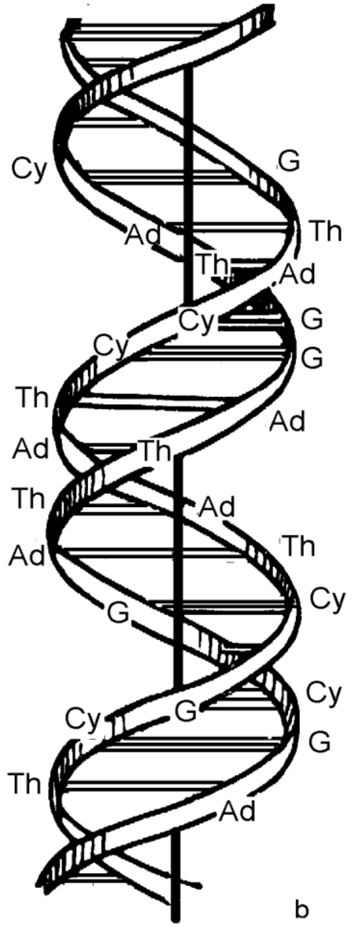
Replicating DNA is the necessary and sufficient sign of life

We associate living matter origination with the appearance of DNA- and RNA-like molecules and try to reveal the simplest and, therefore, most realistic way by which Nature went.

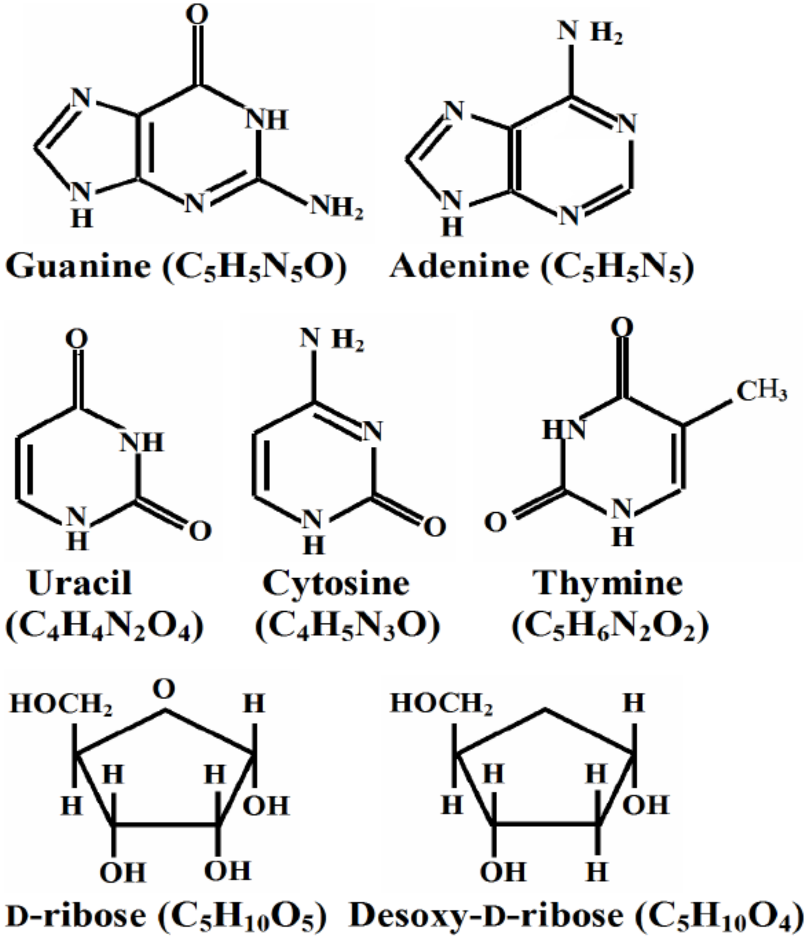
Fragment of the helix DNA



Fragment of the double-helix DNA



N-bases and riboses



Just the gas-hydrate structure is the living matter cradle.

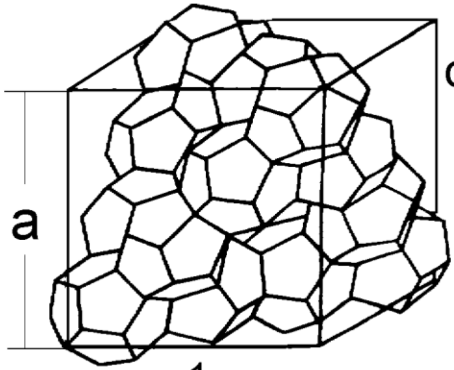
The capability for hydrate formation is a fundamental property of water molecules.

Hydrate structure consists of a honeycomb-like matrix which is built from H_2O molecules (host) and of some molecules or atomic groups (guests) housed within the matrix cavities.

Principal conditions for the gas-hydrate formation:

(1) size correlation between the guest and hydrate cavities;

(2) rather low temperatures.

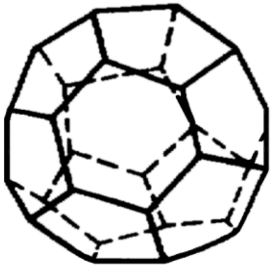


1

Examples
of hydrates of structure II:

$C_4H_4O{\cdot}17H_2O$; $(CH_2)_4O{\cdot}17H_2O$;
$CH_3Cl{\cdot}17H_2O$; $C_3H_6{\cdot}17H_2O$;
$(CH_2)_4O{\cdot}2H_2S{\cdot}17H_2O$
$C_3H_8{\cdot}2CH_4{\cdot}17H_2O$

2



3

Hydrate structure II (1) includes:

small cavities, d = 0.48 nm (2) and

large cavities, d = 0.69 nm (3).

Lattice sites are O-atoms of waters;

lattice edges are the sums of

intra-water O–H valence bonds and

inter-water O····H hydrogen bonds.

II.2. Hydrate theory of living matter origination

According to the LOH-Theory,

Nucleosides formed under ground or under seabed within the methane-hydrate structure;

N-bases housed within the large cavities, and riboses and phosphate groups housed within the small cavities.

Nucleosides (N-bases and riboses) formed by the reaction

$(NO_3^- + CH_4)$

as a result of the diffusion of NO_3^- -ions from the environment into the hydrate structure and then the

PO_4^{3-} -ions

diffused into the hydrate structure,

joined the nucleosides each to other through phosphodiester bridges and formed molecules of primary DNA and RNA.

Thermodynamic calculations showed that all these reactions require no external energy.

The reaction of CH_4 with NO_3^- -ions was discovered by M.I. Konovalov in 1888;

it is known as Konovalov's reaction [5]

At about 273 К,

i.e. just under the conditions when CH_4-hydrate exists,

this reaction is capable of forming cyclic compounds.

Methane reacts with NO_3^- -ions much slower than other methane hydrocarbons, but

Nature is never in a hurry.

Steadily, the H_2O concentration increased as a result of these reactions and of H_2O diffusion from outside and a semi-liquid structured super-cytoplasm formed.

The primary cells arose in this super-cytoplasm.

Just the occurrence of the hydrate matrix limited the subsequent increasing of the side groups of N-bases and ribose radicals and provided reproduction of the structural elements of the DNA molecules.

Low temperature in the underground and underseabed “incubators” (CH_4-hydrate exists at 280±20 K under the CH_4 pressure) provided the slowness of the reactions and the thermodynamic front.

Each reaction proceeded step by step and each step began after termination of the previous one with a progressive decrease in the free energy of the system.

The stability of the temperature and pressure under the ground and seabed favored the thermodynamic-front occurrence and the formation of DNA molecules and cells.

Living matter originated at the Earth repeatedly in different periods of the Earth's history, when its origination was favored by the ambient conditions.

In each such a period, living matter originated in a number of localizations.

In each localization, a great number of similar but different DNAs and a great number of different protocells formed.

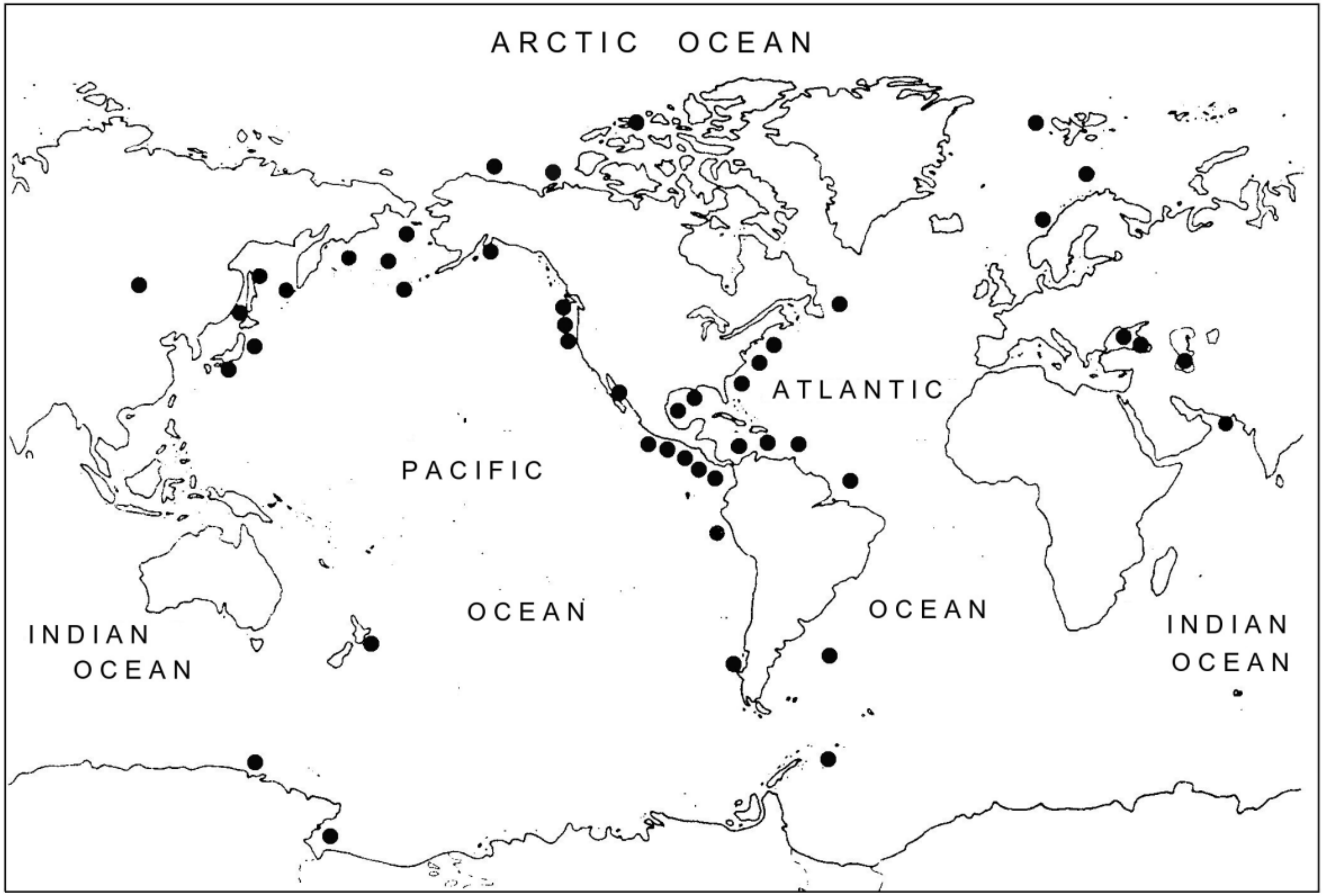
All these give a new approach to the problem of the species diversity in its Darwinian interpretation.

**As the biota expanded,
some big cells,
in which the newly formed DNAs sorbed water quickly,
“sucked” small cells in,
hydrolyzed their DNAs up to nucleotides
and used this material for their extended reproduction.
These “organisms-killers” were the first “animals”.
Their small “victims” used the mineral “food”,
i.e., remained “plants”.**

**Possibly,
differentiation of the primary living issues into animals and plants was dependent on the DNA concentration within the maternal hydrate matrixes
before their liquation and within the semi-liquid super-soap that formed after the hydrate-matrix liquation.
This “nutritional revolution” accelerated extended reproduction of the animals,
because they constructed their DNAs from the prefabricated nucleotides but didn’t synthesized them from minerals.**

The theory gives the new approach to the species diversity problem:
living matter appeared naturally and repeatedly
but not transformed and expanded
from a simple entity accidentally formed.
According to the theory,
just the DNA transformations represent life in its pure form and
the protein production proceeds as a result of side processes that
accompany the DNA transformations .
The protein formation processes are of principal importance for any
organism; moreover,
no multicellular organism exists without protein,
however, the life as a natural phenomenon is determined by DNAs.
Accumulation of protein in the cellular protoplasm and on DNAs
leads to a deceleration in the DNA replication, “tiredness”, and
“senescence” of cells and to termination of their reproduction.
Mitosis of eukaryotic cells terminates after 50–60 division [6, 7].
Basing on these notions, we formulated a new approach to the
optimal nutrition and life prolongation problems [8].

II.3. Sources for the living matter syntheses



A great number of CH_4-hydrate deposits are over the globe.

The points mark the main underseabed CH_4-hydrate deposits.

In the vicinities of some of them, deposits of niter occur (e.g., along the Eastern coast of America).

Localizations of phosphates are in many regions.

E.g., there are no doubts in the mineral origin of apatite:

$Ca_5Y(PO_4)_3$ (Y = F, Cl, or OH) [9].

Phosphate ions are dissolved in different water basins.

Phosphates might fell to the Earth during its formation or after that.

In the period of young-planet cooling, phosphorus could be oxidized by water by the reaction:

$P_4 + 16\ H_2O \rightarrow 4\ H_3PO_4 + 10\ H_2 + 1306$ kJ [9].

The solubility of phosphates in water at 293 K is about 3 mg/l;

in the ocean water, the N, P, and C content is (mg/l):

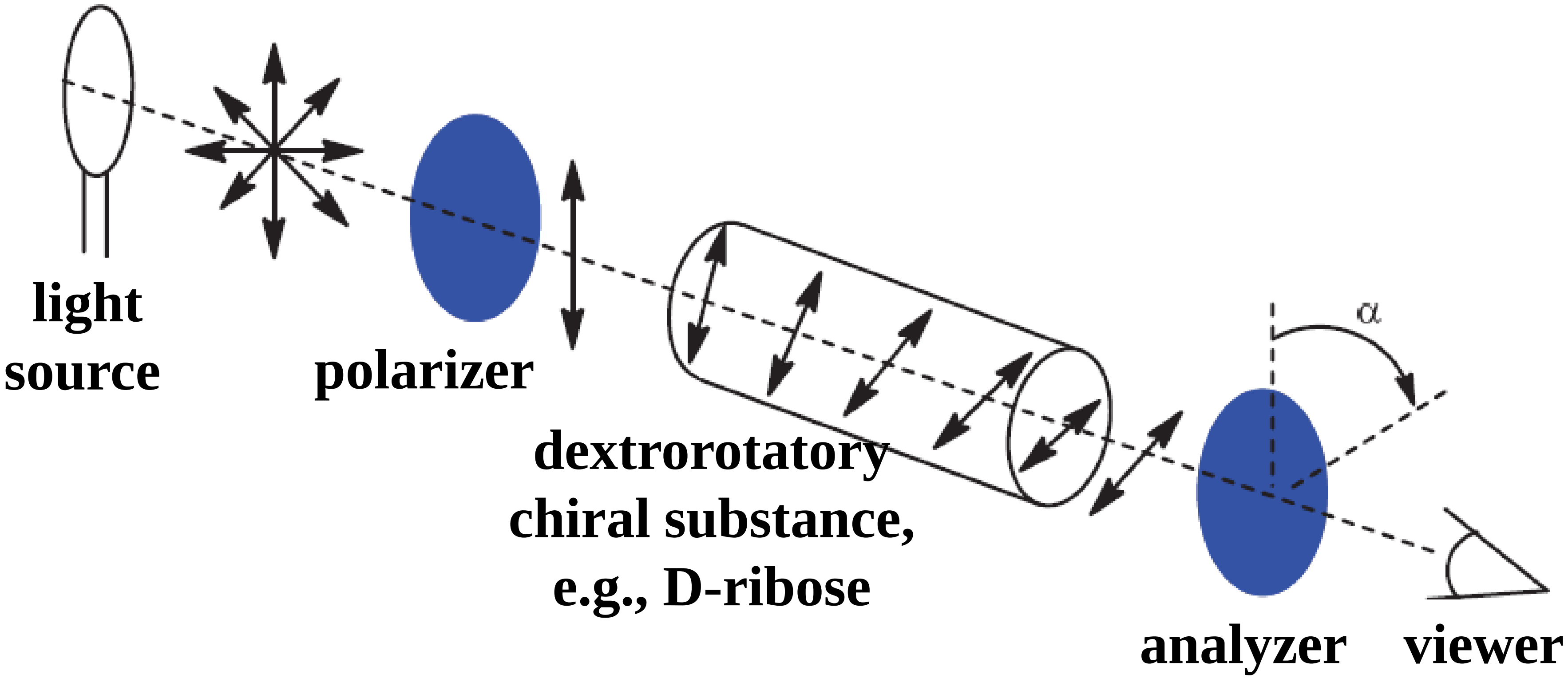
15.5, 0.088 and 28.0, respectively [10].

At a depth of 70 m, the phosphate concentration in the world ocean is as low as 0.02 mg/l [11].

The lowness of the phosphate concentration in the ocean water column explains the extremely small population of the ocean depths [12].

II.4. The DNA monochirality phenomenon nature

Illustration of linearly-polarized light plane rotation (α is the rotation angle)



light source

polarizer

dextrorotatory chiral substance, e.g., D-ribose

analyzer

viewer

DNA and RNA molecules rotate the linearly-polarized light plane as it is shown in the figure, and this phenomenon was not explained, although many researchers tried to do this [12].

Below, we give the explanation of the DNA monochirality [13, 14].

There are three questions
that are usually under consideration,
when discussing the DNA monochirality nature.

(1) What step of the DNA chemical formation is responsible for the DNA monochirality?

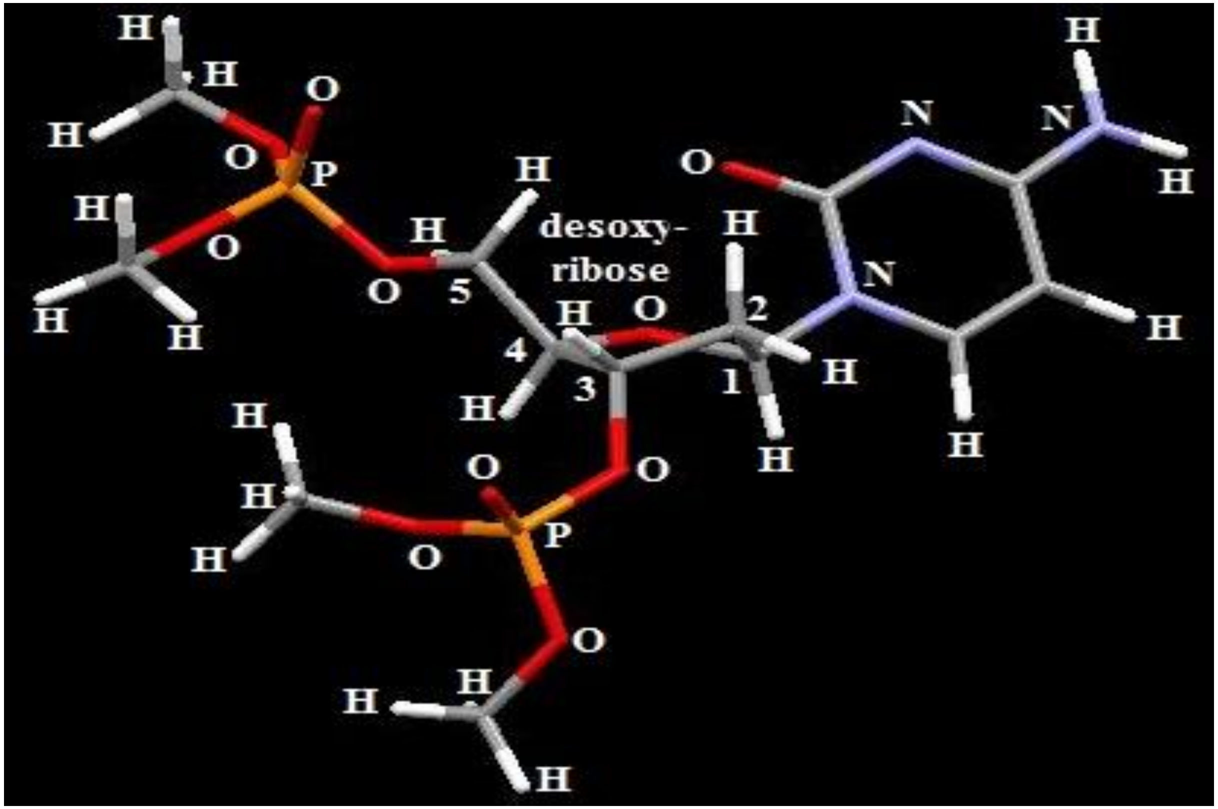
(2) What is the mechanism of the DNA monochirality origination?

(3) How did Nature choose D-riboses
from their mixture with L-riboses?

In the context of our theory,
question (3) has no grounds,
because the DNA formation process proceeds step by step up to formation of nucleosides
without formation of riboses as such and not the ribose but each nucleoside as a whole imposes the monochiral structure on DNA.

The following figure counts in favor of this conclusion.
To answer two other questions,
we addressed ourselves to the results published in [15, 16].

3D-simulated 4-radical complex within the CH_4-hydrate structure.



The ribose-like rings that are located between phospho-diester groups and N-bases

are somewhat twisted

as compared to the actual ribose ring and

the like-ribose-ring side $HOCH_2$- groups

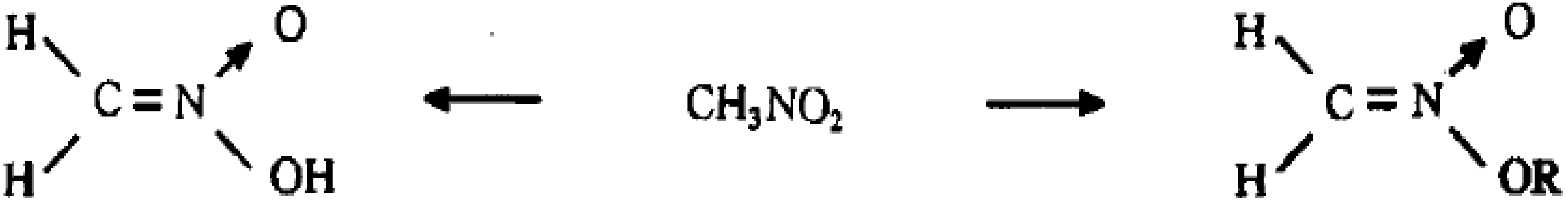
differ in their structure

from that of ribose [17, 18].

According to our theory,
the natural DNA synthesis begins from
CH_4 interaction with NO_3^--ions.

Meanwhile, it is confirmed [15] that
Konovalov’s reaction gives CH_3NO_2 at ambient temperature
and it is shown that
CH_3NO_2 is capable of transforming to different cyclic substances,
CH_3NO_2 is monochiral, and
its derivatives inherit its monochirality with formation of enatiopure substances [16].

The authors of [15] suggest that CH_3NO_2 transforms as below



with formation of reactive unstable nitronate groups, which contain the chiral N-atoms.

Apparently, there are sufficient grounds to state that just
the CH_3NO_2 formation step, i.e., the first step of the DNA formation,
is responsible for the DNA monochirality.

As a result of the chirality of N-atoms in the reactive form of the source nitro-methane,
all its derivatives, including any nucleotide as a whole,
are monochiral.

From the above-given figure containing the 3D-simulated 4-radical DNA fragment, it is seen that
some C-atoms of any ribose-like radical entering into nucleotides
are, apparently, chiral,
because nucleotides have no symmetry planes, inversion centers, and mirror-rotational axes.

Each nucleotide represents a multicentered chiral molecule, and
the DNA monochirality
is the complicated sum of the monochiralities of all its nucleotides.

It is well known that,

though the dextrorotatory and levorotatory enantiomers of any

substance are thermodynamically equivalent,

chiral substances may reveal monochirality, because, for

a substance,

the rates of formation of enantiomers of opposite signs and

the potential barriers of their formation

are usually different and

the potential barrier for

mutual transformation of enantiomers to one another

may be significant [19, 20].

III. The discoveries that triggered the living-matter origination concept

The Living Matter Origination Hydrate Theory is based on the following three our discoveries:

(1) The sizes of the large and of the small cavities of the CH_4-hydrate structure coincide completely with the sizes of N-base-radicals and with the sizes of ribose- and phospho-diester-radicals, respectively.

(2) At around 280 K, the structures similar to that of gas-hydrate are capable of forming in undisturbed highly-concentrated semi-liquid water/functional-polymer systems, including DNA and RNA.

(3) To synthesize DNAs, RNAs, cells, poly-saccharides (intercellular fastening material), collagen and ossein (proteins of the osseous tissue) and other components of living issues within CH_4-hydrate structure, only two additional substances niter, and apatite (with minor admixtures of some metals) are necessary and sufficient, and these substance are capable of reacting with CH_4 under the conditions when CH_4-hydrate is stable.

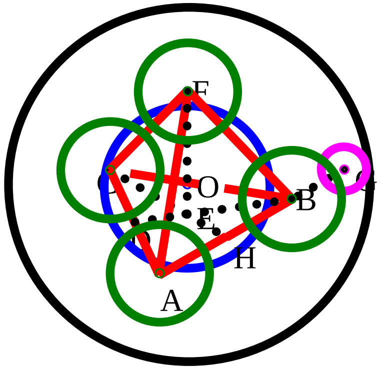
III.1. Discovery 1: the size compatibility between the DNA and gas-hydrate structures

At the early step of the theory development, the size compatibility was stated on the basis of the following two-dimensional consideration.

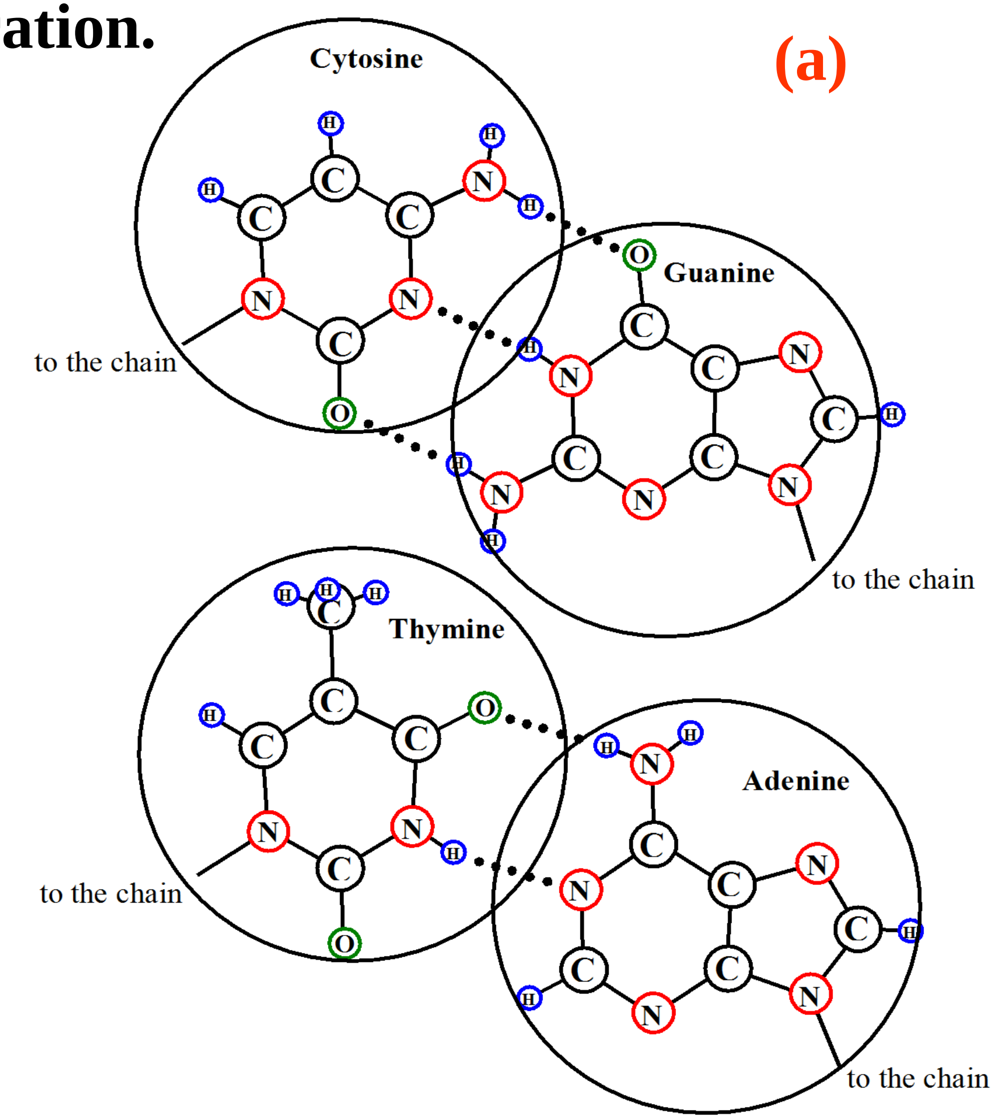
All the sizes are given in the same scale.

The circles correspond to sizes of large (a) and small (b) hydrate cavities.

(b)

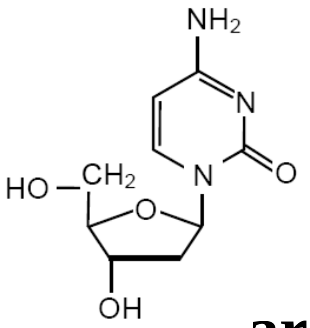


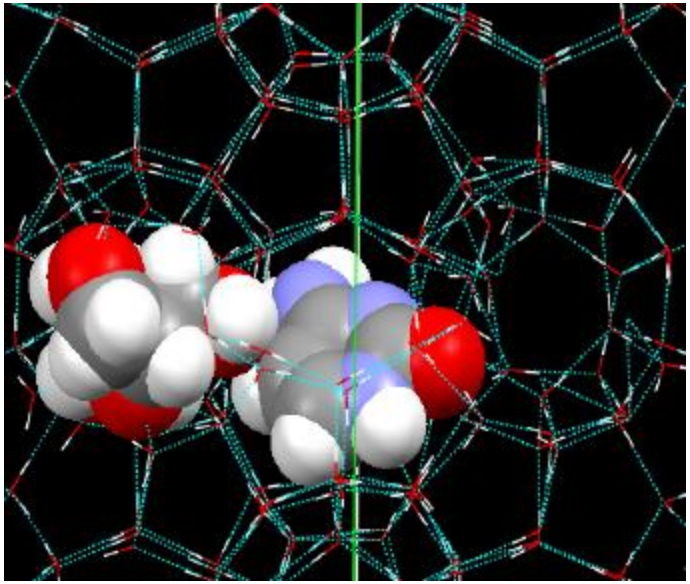
The large cavities are as if “moulds” for N-bases, and the small cavities are as if “moulds” for phosphate groups and riboses.

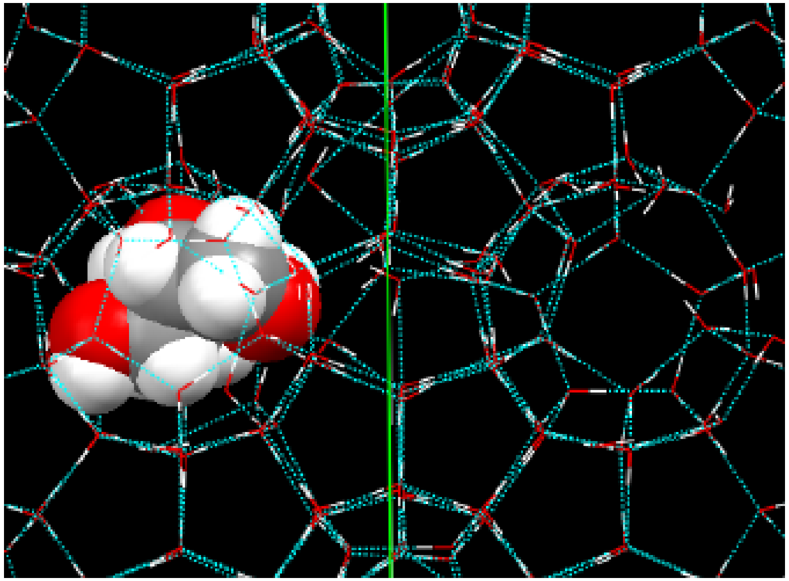


Recently, Discovery 1 was confirmed by 3D simulation.

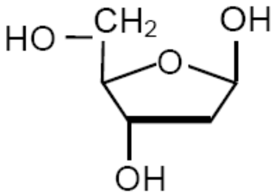
Below, cytosine/desoxy-ribose (left) and desoxy-ribose (right) DNA fragments are arranged in the gas-hydrate structure II within neighboring large and small hydrate cavities and within a small hydrate cavity, respectively .







The C, N, O, and H atoms are given as the grey, violet, red, and white ones.



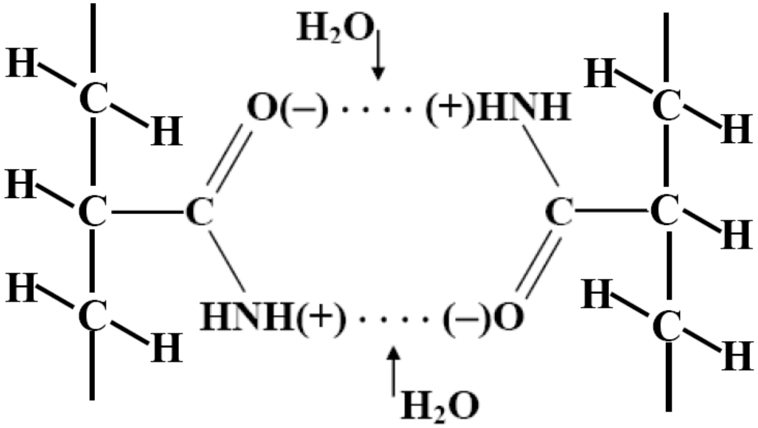
Each cavity is conserved, and there is no volume for additional atoms.

The details of 3D simulation are given in [18].

III.2. Discovery 2: gas-hydrate structure formation in highly concentrated semi-liquid H_2O/DNA systems

DNA–DNA and PAA–PAA pair interactions are similar, because they are caused by the hydrogen $NH_2^{+}\cdots{}^{-}O$ bonds.

Polyacrylamide (PAA) – H_2O interaction



To understand the H_2O effect on the DNA–DNA binding,

we studied H_2O sorption by PAA.

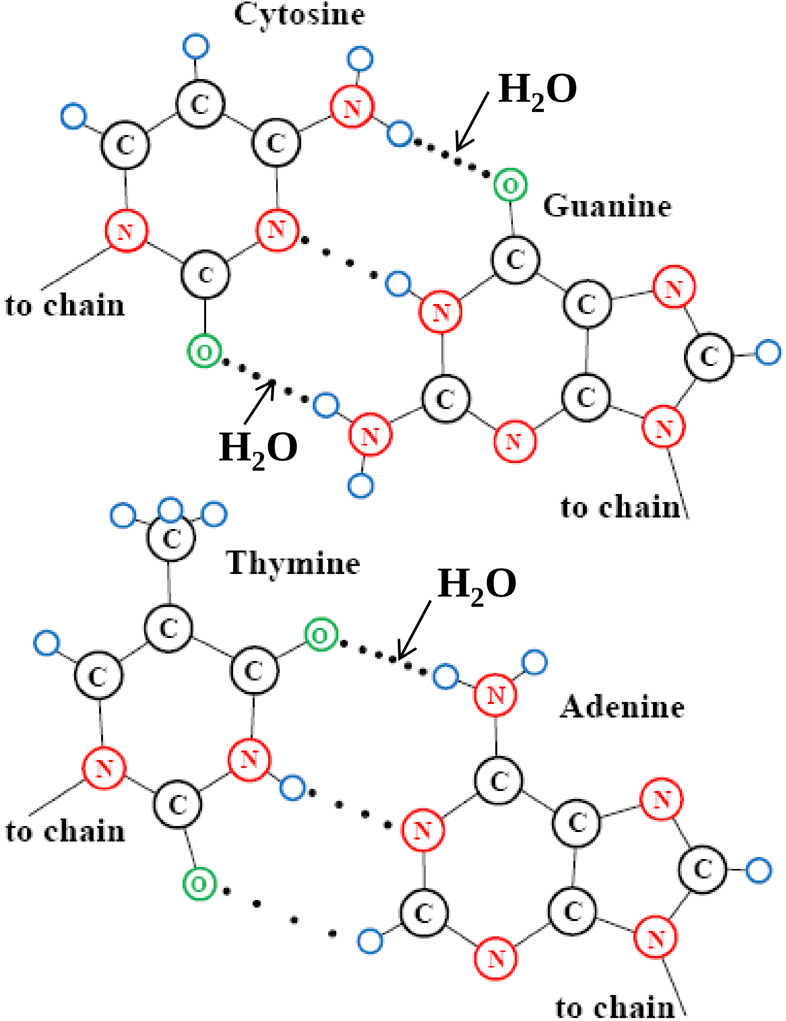
Studies of H_2O sorption by DNA double helixes

are inapplicable for this aim,

because riboses and phosphate groups also sorb water.

Detailed justification is given in [21].

DNA double-helix – H_2O interaction



The next slide contains the results of studies of the
PAA–H_2O system at about 290 K with different techniques:

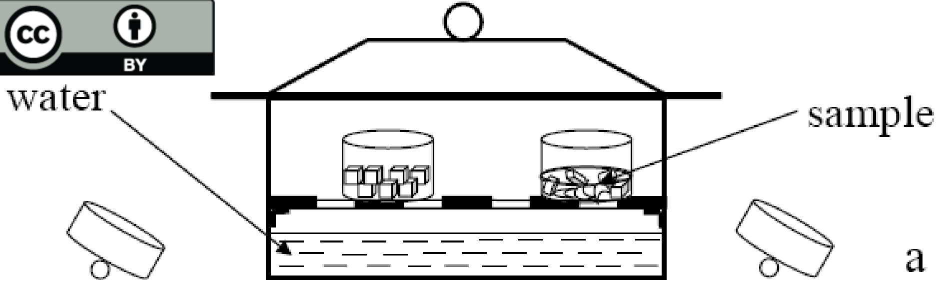
(1) H_2O-vapor sorption by PAA from the air of 100% humidity;
at about $n(H_2O)/n(AG) = 17 \div 18$ (17 H_2O mols per one amido-group)
saturation of the system is observed;

(2) H_2O-vapor desorption from the diluted PAA–H_2O system
into a trap cooled down to 77 K with desorption rate measurements;
the minimal desorption rate is observed at $n(H_2O)/n(AG) = 16 \div 17$;

(3) H_2O-vapor portion-by-portion sorption and desorption
in the PAA–H_2O system with calorimetric measurements
of the differential heats of H_2O sorption by PAA;
the differential heat of H_2O desorption from the diluted system
is equal to the heat of H_2O condensation at the surface of pure H_2O
up to $n(H_2O)/n(AG) = 17$
and varies in a complicated manner at $n(H_2O)/n(AG) < 17$;

(4) H_2O-vapor sorption by glycine from the air of 100% humidity;
the H_2O sorption rate begins to decrease at $n(H_2O)/n(AG) > 17$.

The repeatedly reproduced stoichiometry $n(H_2O)/n(AG) = 17$ proves
that the gas-hydrate H_2O matrix forms around AGs in the highly
concentrated H_2O–AG systems (details are in [2, 22]).


water
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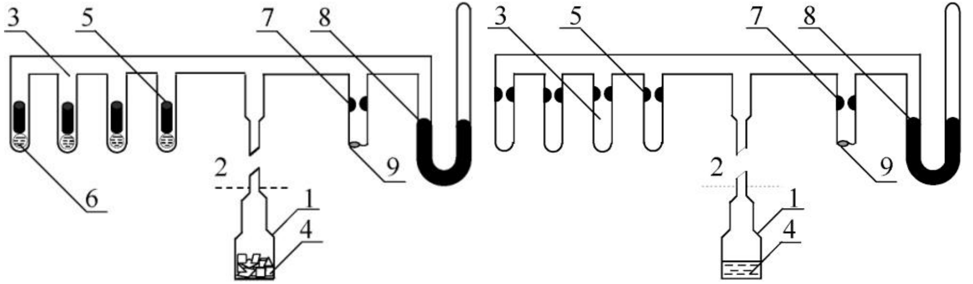
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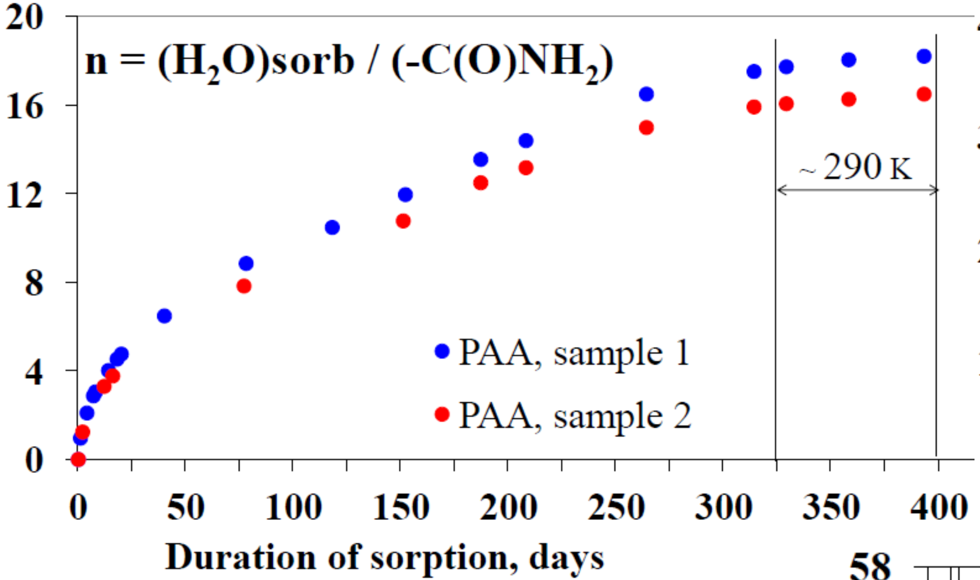
n = (H2O)sorb / (-C(O)NH2)
~ 290 K
● PAA, sample 1
● PAA, sample 2
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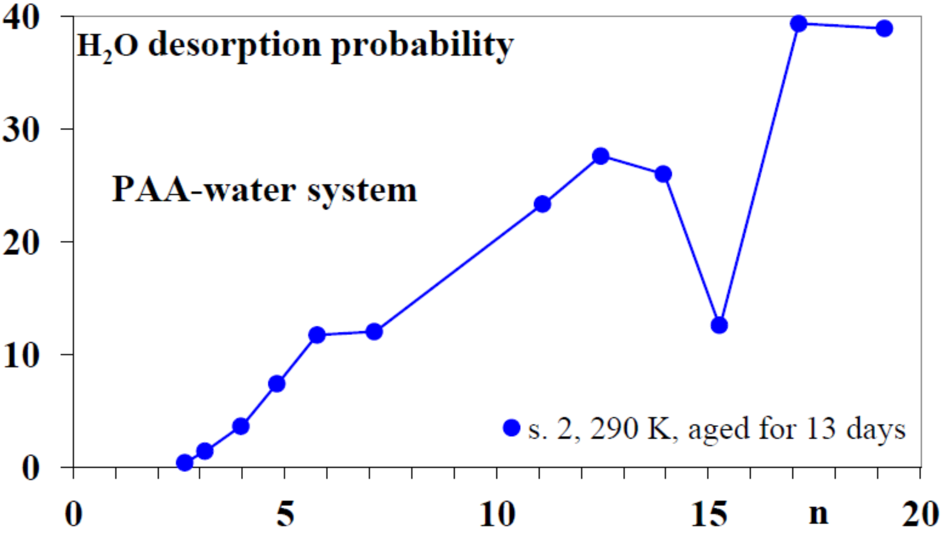
400
Duration of sorption, days


H2O desorption probability
PAA-water system
● s. 2, 290 K, aged for 13 days
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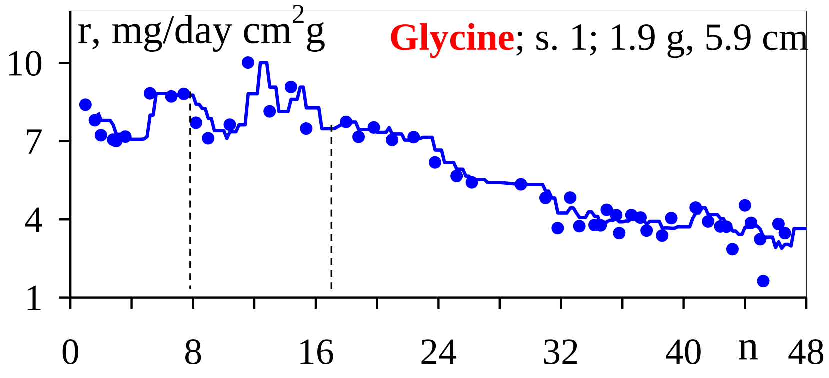
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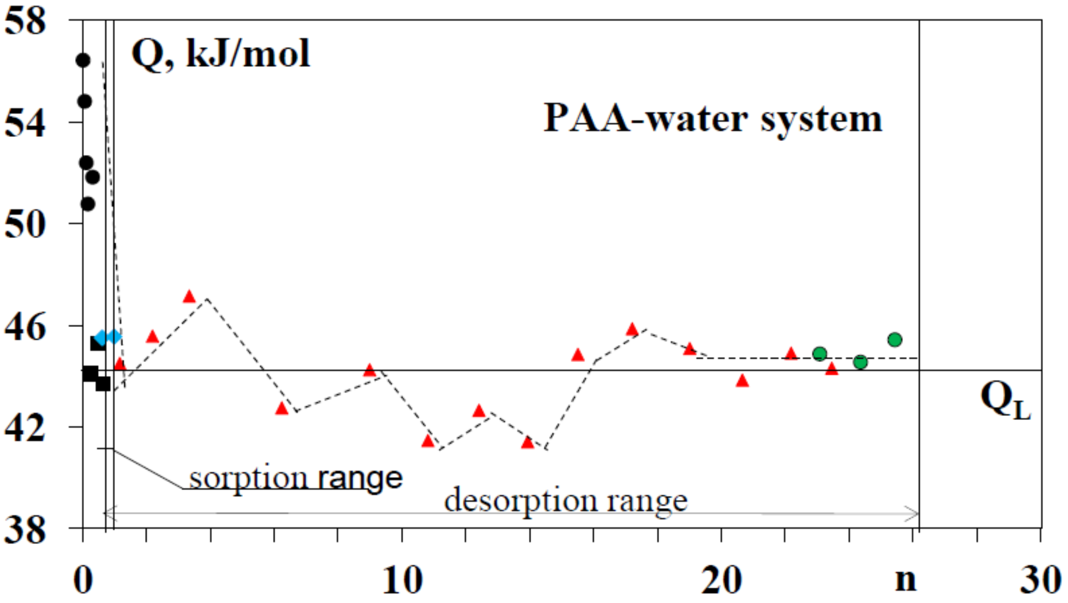
Q, kJ/mol
PAA-water system
QL
sorption range
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38
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III.3. Discovery 3: the minerals necessary and sufficient for origination of DNA and cells

Three widely distributed minerals,
CH_4, niter, and apatite
(with minor admixtures of some metals),
are necessary and sufficient
to form
DNAs, RNAs, cells,
poly-saccharides (intercellular fastening material), collagen,
ossein (proteins of the osseous tissue),
and other components of living issues.

Below, we will confirm this statement by the examples of the equations of the synthesis of the full set of N-bases and riboses that is necessary and sufficient for synthesizing different DNAs.

The possibility of synthesizing of DNAs on the basis of these precursors is obvious,
because the polycondensation reactions
are thermodynamically possible due to water production in the course of their proceeding.

III.3. Discovery 3: the minerals necessary and sufficient for origination of DNA and cells.

Different DNAs, cells, and tissues of living organisms
can be produced
on the basis of the internal energy of the source substances
from only one triad of mineral molecules,
namely, from
saturated hydrocarbon (methane, ethane, or propane), niter, and phosphate
(with minor additions of some metals) [23].

In nature,
the collision of more than three molecules
specified in their chemical composition
is of low probability and is impossible in practice.

(Below, we consider CH_4 as the source component for living matter origination, because its deposits are significantly more abundant than those of other two hydrocarbons.)

The individual N-bases and riboses can be spontaneously produced from CH_4 and niter

with a significant decrease in the free energy of the system.

Therewith, O_2 and N_2 emit to the atmosphere.

Cumulative producing of the stoichiometric set of N-bases and riboses,

which is necessary for the subsequent synthesis of different DNAs,

can also proceed spontaneously with the side evolution of O_2 and N_2.

Formation of the DNA precursors leads to the enrichment of the atmosphere with O_2 and N_2.

The following slides show the stoichiometry of the reactions and the standard variations in the thermodynamic functions characteristic for these reactions.

Stoichiomtry of the syntheses of quartets of N-bases and of riboses necessary for the subsequent formation of

DNA (1) and RNA (2)

$$28.2\ KNO_3 + 39\ CH_4 = \qquad (1)$$

$$= C_5H_6N_2O_2\ (Th) + C_4H_5N_3O\ (Cy) + C_5H_5N_5O\ (G) + C_5H_5N_5\ (Ad) +$$

$$+ 4\ C_5H_{10}O_4\ (DDR) +$$

$$+ 28.2\ KOH + 33.4\ H_2O + 6.6\ N_2 + 1.5\ O_2;$$

$$29.4\ KNO_3 + 38\ CH_4 = \qquad (2)$$

$$= C_4H_4N_2O_2\ (U) + C_4H_5N_3O\ (Cy) + C_5H_5N_5O\ (G) + C_5H_5N_5\ (Ad) +$$

$$+ 4\ C_5H_{10}O_5\ (DR) +$$

$$+ 29.4\ KOH + 31.8\ H_2O + 7.2\ N_2 + 1.5\ O_2$$

Thermodynamic calculations show the possibility of these reactions.

Syntheses of individual N-bases and ribose (as examples)

$$3\ KNO_3(cr) + 4\ CH_4(g) =$$

$$= C_4H_5N_3O(cr)\ (Cy) + 3\ KOH(cr) + 4\ H_2O\ (lq) + 0.5\ O_2\ (g) + 858.0\ kJ;$$

$$\Delta G^0 = -743.5\ kJ$$

$$5\ KNO_3(cr) + 5\ CH_4(g) =$$

$$= C_5H_5N_5(cr)\ (Ad) + 5\ KOH(cr) + 5\ H_2O(lq) + 2.5\ O_2(g) + 613.1\ kJ;$$

$$\Delta G^0 = -557.3\ kJ$$

$$4\ KNO_3(cr) + 5\ CH_4(g) =$$

$$= C_5H_{10}O_5(cr)(DR) + 4\ KOH(cr) + 3\ H_2O(lq) + 2\ N_2(g) + 1258\ kJ;$$

$$\Delta G^0 = -1145\ kJ$$

Thermodynamic calculations show the possibility of these reactions.

Changes in the enthalpy $\Delta_i(\Delta_f H_j^0)$, entropy $\Delta_i S_j^0$, and Gibbs free energy $\Delta_i G^0$ in the reactions of Cy, G, Ad, or U formation from CH_4 and KNO_3

(i) Reaction	$\Delta_i(\Delta_f H_j^0)$ kJ/mol	$\Delta_i S_j^0$ J/mol K	$\Delta_i G^0$ kJ/mol
$2\ KNO_3(cr) + 5\ CH_4(g) + 2\ O_2(g) = C_5N_2O_2H_6(cr) + 6\ H_2O(lq) + 2\ KOH(cr)$	−1666	−869.6	−1407
$3\ KNO_3(cr) + 4\ CH_4(g) = C_4N_3OH_5(cr) + 4\ H_2O(lq) + 3\ KOH(cr) + 0.5\ O_2(g)$	−858.0	−384.0	−743.5
$5\ KNO_3(cr) + 5\ CH_4(g) = C_5N_5OH_5(cr) + 5\ H_2O(lq) + 5\ KOH(cr) + 2\ O_2(g)$	−893.0	−281.4	−809.0
$5\ KNO_3(cr) + 5\ CH_4(g) = C_5N_5H_5(cr) + 5\ H_2O(lq) + 5\ KOH(cr) + 2.5\ O_2(g)$	−613.1	−187.1	−557.3
$2\ KNO_3(cr) + 4\ CH_4(g) + 1.5O_2(g) = C_4N_2O_2H_4(cr) + 5\ H_2O(lq) + 2\ KOH(cr)$	−1421	−682.9	−1218

Conclusion: each N-base can be produced within the hydrate structure from methane and niter.

O_2 emits to the atmosphere!

Changes in the enthalpy $\Delta_i(\Delta_f H_j^0)$, entropy $\Delta_i S_j^0$ and Gibbs free energy $\Delta_i G^0$ in the reactions of Cy, G, Ad, U, and D-рибозы from hydrocarbons and KNO_3

Reaction	$\Delta_i(\Delta_f H_j^0)$ kJ/mol	$\Delta_i S_j^0$ J/mol K	$\Delta_i G^0$ kJ/mol
$28.2\ KNO_3(cr) + 38\ CH_4(g) = C_4H_4N_2O_2(cr) + C_4H_5N_3O(cr) +$ $+ C_5H_5N_5O(cr) + C_5H_5N_5(cr) + 4\ C_5H_{10}O_5(cr) +$ $+ 28.2\ KOH(cr) + 32.4\ H_2O(lq) + 6.6\ N_2(g)$	–9410	–3787	–8281
$20.6\ KNO_3(cr) + 19 C_2H_6(g) = C_4H_4N_2O_2(cr) + C_4H_5N_3O(cr) +$ $+ C_5H_5N_5O(cr) + C_5H_5N_5(cr) + 4\ C_5H_{10}O_5(cr) +$ $+ 20.6\ KOH(cr) + 17.2\ H_2O(lq) + 2.8\ N_2(g)$	–6832	–2442	–6104
$18.06(6)\ KNO_3(cr) + 12.6(6)\ C_3H_8(g) = C_4H_4N_2O_2(cr) +$ $+ C_4H_5N_3O(cr) + C_5H_5N_5O(cr) + C_5H_5N_5(cr) +$ $+4\ C_5H_{10}O_5(cr) + 18.06(6) KOH(cr) + 12.13(3)\ H_2O(lq) +$ $+ 1.53(3)\ N_2(g)$	–5840	–1970	–5253

Conclusion: the reactions are thermodynamically possible.

N_2 emits to the atmosphere!

IV. Logical conclusions, theories, and observational facts that count in favor of the Life Origination Hydrate Theory

Underseabed and underground prokaryotes

Huge colonies of prokaryotes are discovered in the underseabed soil over the Pacific Ocean open area and Central America coastline under the H_2O column from 427 to 5086 m [24]. The underseabed soil was drilled to a depth of 400 m. It is stated that the concentration of living organisms in the soil samples is rather high and doesn’t depend on the depth of drilling. In the soil depth, no other source of carbon but CH_4-hydrate was discovered.
These bacteria are found near the American continent with its large niter deposits

Analogous phenomenon [25] of the existence of the active bacterial life was discovered in Siberia in CH_4-containing underground layers when drilling down to 6820 m; the rate of biomass formation is estimated as 1–10 ton per year at 1 km^2 of the Earth’s surface.

Apparently, these observation count in favor of origination of these bacteria on the basis of CH_4-hydrate.

Nitrogen in methane-hydrate localizations

Gas sampled from some CH_4-hydrate localizations contains significant amounts of N_2 in mixtures with small amounts of O_2:

4% of N_2 and 0.005% of O_2 [26],
11.4% of N_2 and 0.2% of O_2 [27].

The N_2 to O_2 ratio is much higher than that in the atmosphere; it is evident that the samples could not have been contaminated by atmospheric nitrogen during their collection and storage.

Potential sources of elemental N_2 in the Earth's crust are few.

It is quite possible that nitrogen (together with O_2) is produced by the reduction of CH_4 by niter in the deposits of CH_4-hydrates as a result of the reactions which lead to formation of nucleosides.

The gas-hydrate structure as the unique substance capable of explaining the DNA form

Up to now,
no cause capable of explaining the DNA chemical and structural composition
(including the regularity of the arrangement of its structural elements, size limitation of its fragments, etc.)
was revealed,
in spite of the fact that
the DNA chemical and geometrical structure and its fundamental significance for the origination and development of living matter were discovered more than 60 years ago.

Apparently,
the gas-hydrate structure is the unique mineral cradle for DNA birth and replication
and only its occurrence is capable of providing the living-matter existence.

The triad of source components as the most laconic and, thus, most probable set of the substances used by Nature

According to I. Newton,
“Nature is simple and doesn’t luxuriate in excesses”,
and, therefore,
the most laconic mode
for explaining a natural phenomenon
has the highest chance to be correct.
Three mineral components,
this is the minimal number of mineral components sufficient for syntheses of DNA and other biologically active substances.

In nature,
only one such a triad of minerals exists
(methane hydrocarbon, niter, and phosphate),
and just it was specified and used in this theory
as the source of living matter origination.

The possibility of our explanation of the phenomenon of nucleoside monochirality as the fact that counts in favor of the LOH-Theory

The phenomenon of
monochirality of DNAs and, in particular, of nucleosides
could not be explained realistically for a long time.

It is first explained realistically
by us on the basis of the LOH-Theory
(and its daughter MRH-Theory [2, 28, 29]),
according to which
nucleosides originated and are reproduced
as the comprehensive whole and
within the mineral gas-hydrate matrix and
that the natural DNA synthesis starts from the reaction $(CH_4+NO_3^-)$.

The applicability of the LOH-Theory for explanation of the phenomenon that couldn’t be explained earlier counts in favor of the Theory.

The agreement between the LOH-Theory and results of paleontological studies

In the line diagram given below,
the eons of the Earth’s history are marked
in such a form as they are considered by the present paleontologists
from the eon of Earth’s formation as a planet of the Solar System
(at the left)
up to our historical period (at the right).
In this diagram,
the approximate time (Gya) that responds to the emergence of
the Earth’s simplest monocellular living matter, of
the multicellular organisms and to
the so-called Kembrian explosion
when a multitude of species of multicellular animals and plants,
rather close to the present ones in their functional organizations,
is marked.
The age of the remains of the ancient organisms
is determined by the radiological methods.

There were three periods when the living matter development started and there were three periods when the atmospheric oxygen content increased.

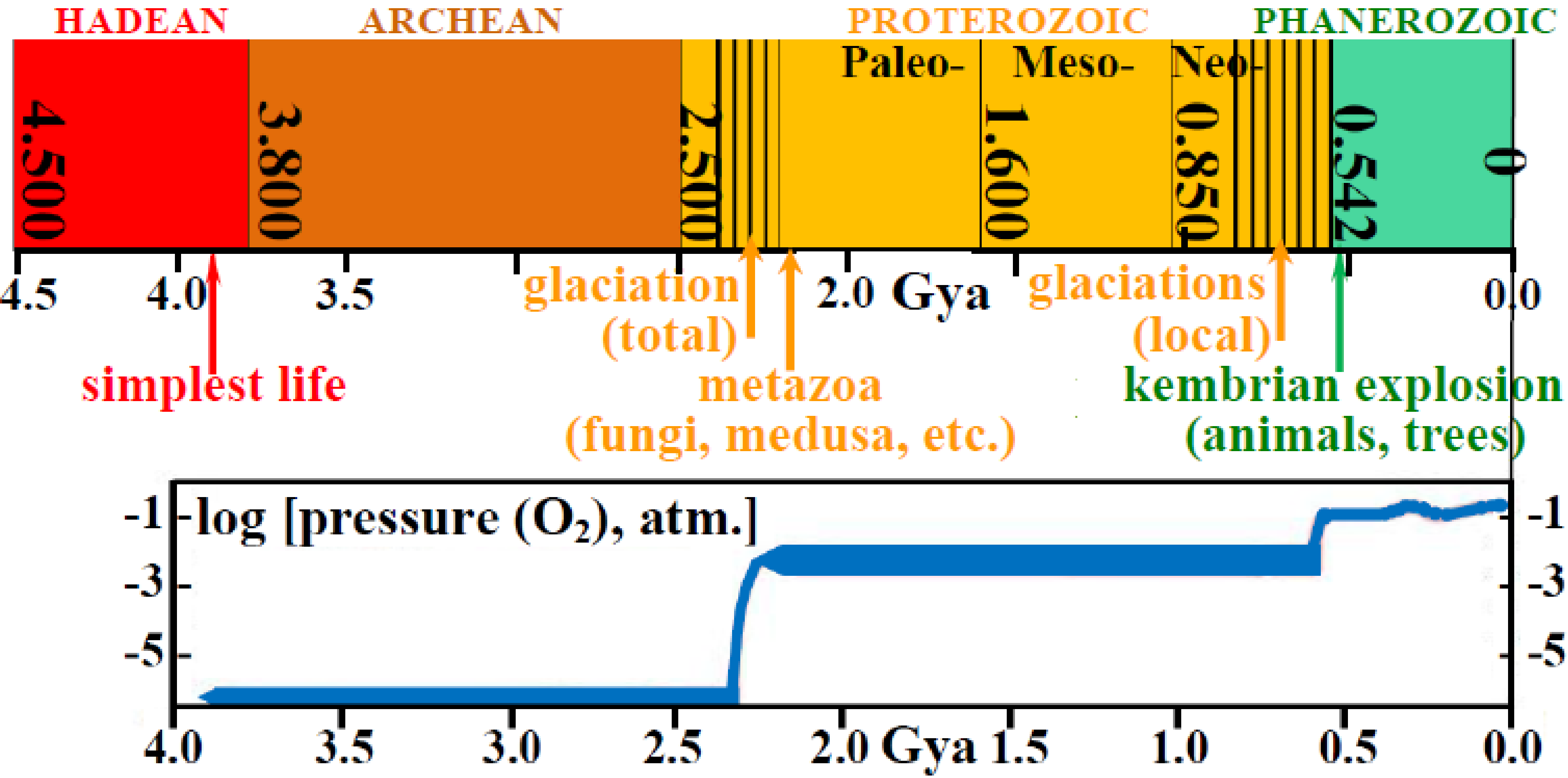
It is important that multitudes of new species had appeared at the ends of boulder-periods and that the steps in the oxygen content and the steps in the species diversification coincided in time.

How's that?

A logical deduction could be drown that just some peculiarities in the solar activity are accountable for the Earth’s boulder-periods. Indeed, all natural events are interconnected and the explanations of any global event should be searched among the events of a greater scale.

Neither the available cosmological hypothesis nor hypothesis of stellar transformations is capable of answering this question, but our LOH-Theory explains the relation between the periods of termination of glaciations and periods of emergence of new species.

Milestones of the Earth's history [30, 31]



Thus, Zak's linear diagram generalizes the available paleontological information on the temporal connection between the post-glacial periods in the Earth's history and the periods of massaged flora and fauna distribution over the Earth or over its separated regions.

The explosive living matter expansion proceeded late in cold periods, about (Gya) 3.9 (after the faint Sun period), 2.1, and 0.542.

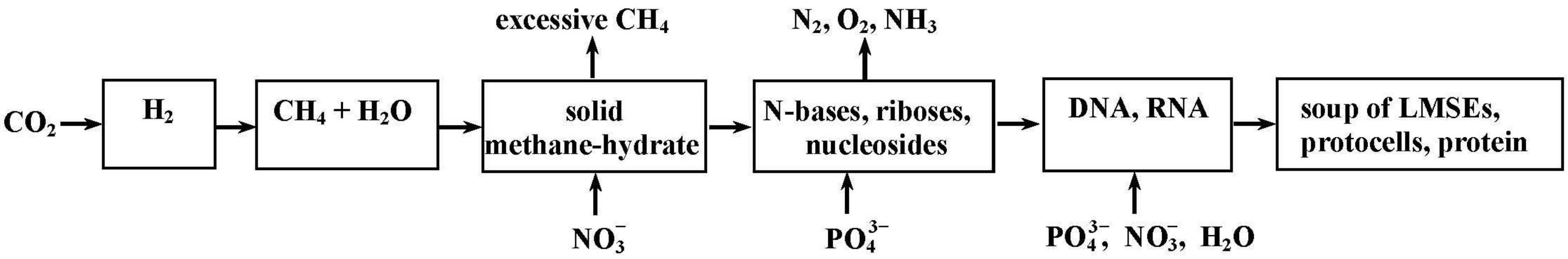
Just late in the cold periods, the conditions arose when the CH_4-hydrate localizations were rather close to the Earth's surface and the temperature was sufficiently high for a rather long time to unbrake the DNA formation processes that were "frozen" earlier.

In the course of each interglacial Earth’s history period favorable for syntheses of the DNA precursors, DNAs, and cells and for development of plant and animal organisms, the diversity and multiplicity of the living species were caused by the following main factors:

1. **the quantity of the DNA modifications that were produced within each natural “incubator”;**
2. **the quantity of “incubators”;**
3. **the survival of the organisms and DNA modifications that existed during the previous favorable periods;**
4. **variability of DNAs under the effect of the natural selection.**

Sequence of the processes of living matter origination

(rectangles symbolize underground or underseabed voids)



Living matter origination requires no external energy.

General conclusions on the living matter origination at the Earth:

(1) DNAs and cellular life had originated from simplest organic and inorganic minerals as the inevitable product of the atomistic world;

(2) DNAs and primary proto-cells had originated under the ground and seabed within localizations of CH_4 (or C_2H_6, or C_3H_8) gas-hydrate honeycomb structures from hydrocarbon, niter, and phosphate;

(3) The life origination process requires no external energy;

(4) Stable undisturbed conditions favored living matter origination;

(5) Living matter originated repeatedly in the historical periods when its origination was favored with the ambient conditions;

(6) In each appropriate period, living matter originated in a number of localizations;

(7) The reacting systems transformed from the minerals to DNAs and proto-cells so slowly that they passed step by step all possible states in the direction of gradual decrease in the Gibbs free energy; i.e., just the thermodynamic front governed their transformations;

(8) In each localization, a set of different DNAs and different proto-cells originated and gave start to development of a set of different multi-cellular organisms;

(9) The present species diversity is caused by:

(a) the spatial and temporal repeatability of the living matter origination processes under similar but not identical ambient conditions,
(b) multiplicity of the DNA and proto-cell forms in each event of living matter origination in each favorable historical period,
(c) variations in the parameters of the native medium,
(d) intraspecific variations,
(e) interspecific variations.

(10) The LOH-Theory correlates well with a number of available paleontological data.

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