September 4-8, the 3rd International Symposium "Life Sciences" took place in the G.B. Elyakov Pacific Institute of Bioorganic Chemistry, Far-Eastern Branch of the Russian Academy of Sciences (PIBOC FEB RAS). Scientists from Germany, the Republic of Korea, China and Taiwan, as well as members of scientific organizations from Moscow, Krasnoyarsk, Novosibirsk, were invited to participate in the Symposium. A total of 55 oral presentations and 26 poster presentations were made on research in various fields of the science of wildlife, in particular, biologically active compounds of natural origin. Representatives of the sponsors – "General Electric" and "Shimadzu", who made presentations on their activities and presented an exhibition of their products, took part in the Symposium. The preparation of the Symposium was partially funded by the RFBR (project No. 18-04-20060) and the FANO RF, as well as the endowment fund PIBOC FEB RAS.

As part of the Symposium, the accompanying symposium "KORUS-2018" was also held, which was attended by leading scholars from several universities of the Republic of Korea: Adju University (Suwon), Catholic University of Daegu, Injo University, Kosin University and Pusan and National University (Pusan), Catholic University (Seoul). This symposium is held regularly in order to summarize the results of joint Russian-Korean research.

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VALENTIN STONIK

Some Results of International Collaboration of G.B. Elyakov Pacific Institute of Bioorganic Chemistry of the Far-Eastern Branch of the Russian Academy of Sciences

During its more than fifty years history the G.B. Elyakov Pacific Institute of Bioorganic Chemistry (PIBOC) was successfully collaborating with many scientific organizations. Some examples of this cooperation and their scientific significance are discussed in this paper.

In the next 2019, 55 years from the day of the foundation of our institute will be celebrated. Decision of the Council of Ministers of the Soviet Union about organization of Institute of Biologically Active Substances of the Siberian Branch of Academy of Sciences of the USSR (now Pacific Institute of Bioorganic Chemistry, PIBOC) in Vladivostok was made on Octobers, 3, 1963. President of the Academy of Sciences of the USSR, Academician Mstislav Keldysh had signed Resolution No. 79 on the establishment of this Institute on March 6, 1964. Georgy Elyakov, 35-year-old scientist, candidate of chemical sciences, graduate of the Moscow State University became director of this new Institute. After the defense of the master's thesis

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he did some work in the Central Research Military-Technical Institute and from 1959 worked in the Department of physiology and biochemistry of the Far-Eastern Filial Branch of Academy of Sciences of the USSR, passing on Far East of Russia a way from a senior scientific researcher to the Director of Institute (1964-2001), Academician (1987), Chairman of the Presidium of the Far Eastern Branch (FEB) and Vice-president of the Russian Academy of Sciences (RAS) (1990-2001).

I was fortunate enough to be the second Director of PIBOC of the next period from 2001 to 2017.

Collaboration with Japan

In the first years of its existence, the main activity of our Institute was related to the studies on biologically active substances from the Far-Eastern terrestrial plants, including the famous ginseng. At that time the Institute collaborated with not only Soviet scientific organizations, primarily the Institute of Chemistry of Natural Compounds (now M.M Shemyakin and Ju. A. Ovchinnikov Institute of Bioorganic Chemistry RAS) and the N.D. Zelinsky Institute of Organic Chemistry RAS, but also with Japanese scientific groups headed by Prof. Shoji Shibata and Osamu Tanaka at the Tokyo University and University of Hiroshima, respectively. Since the first isolation of six panaxosides (ginsenosides) from *P. ginseng* in the 1960s by the scientists of our Institute [6], plenty of ginsenosides have been isolated and identified from different species belonging to the genus *Panax*. Currently, more than a dozen plants have been recognized as members of the genus *Panax.* Some of them have common names, which stem from their places of origin: *P. ginseng*, *P. japonicus*, *P. notoginseng*, *P. quinquefolius*, and *P. vietnamensis* are also called Korean ginseng, Japanese ginseng, Chinese ginseng, American ginseng, and Vietnamese ginseng, respectively. Creative competition of Japanese and Soviet chemists from PIBOC led to the establishment of structures of a large series of triterpene glycosides responsible for the biological activity of extracts from ginseng [7, 24, 32] (Figure 1). This had contributed to the widespread use of ginseng extracts in medicine and other fields. Totally, >6,000 articles regarding the traditional uses, chemical structures of constituents, and biological and pharmacological effects of ginseng have been published since W. Petkov reported the pharmacological properties of extracts of the Far-Eastern species *P. ginseng* for the first time in the 1950s [21].

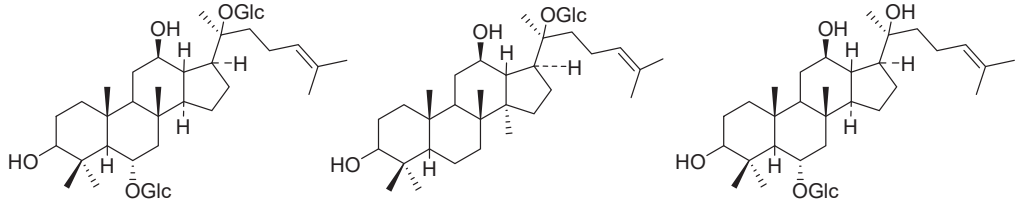

Figure 1. Structures of some ginsenosides from *Panax ginseng*

Many years later joint studies with Japanese microbiologists were initiated with participation of Dr. Naito Tanaka from Tokyo University of Agriculture, see for example [23].

Collaboration with Australia

In the beginning the seventies PIBOC has started the studies on marine natural products. These studies are now developing in many countries. They resulted in discovery of new classes of natural products and creation of new drugs against dangerous diseases. More than 30,000 new natural compounds (low molecular weight compounds and biopolymers), described in approximately 10,000 scientific articles were isolated by natural products chemists

from marine macro- and microorganisms during all the period of the studies. Discovery of new marine bioactive compounds has opened new directions of bioregulation in living organisms, stimulated the development of physicochemical methods to establish very complicated chemical structures of biomolecules. Modern techniques to separate complex mixtures of natural products existing in nature were appeared. New chemical reactions and reagents were elaborated to decide problems concerning total synthesis of natural compounds of particular interest.

Marine expeditions and Marine Experimental Station of our Institute, created on the shore of Trinity Bay 100 km southward of Vladivostok played an important role in the development of this scientific direction. During numerous marine expeditions in different geographic areas of Indian, Pacific and Atlantic oceans many groups of scientists from USA, Australia, Socialistic Republic of Vietnam, Republic of Korea and other countries were participating in joint studies onboard of the research vessel "Akademik Oparin". Scientific cooperation continued after the return of these scientists in their home countries. This led to a number of joint publications and fairly visible scientific discoveries.

For example, a potent antitumor agent was discovered together with Australian scientists from an ascidian, collected in the Great Barrier Reef area. During several years Drs Sergei Fedoreev and Vyacheslav Novikov from PIBOC together with Australian scientists Peter Murphy and Rick Willis from Australian Institute of Marine Science (Townsville) had been studying this new marine alkaloid named as polycarpin (Figure 2). Biotesting in the National Cancer Institute (USA) showed a potent cytotoxicity of this alkaloid against tumor cells as well as the capability to inhibit reverse transcriptase, a key enzyme in the search for antiviral compounds. Polycarpin as well as its derivatives and analogs were synthesized [22]. Up to now some obtained derivatives belonging to this series retain to be good model compounds to develop a leader compound and create new anticancer and/or antiviral drugs on their basis.

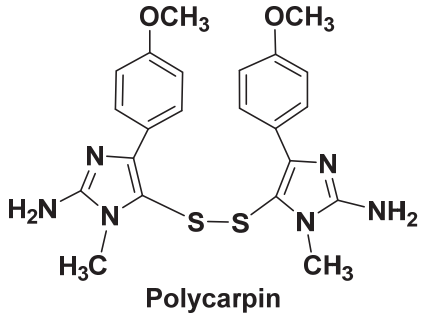

Figure 2. Structure of polycarpin

An outstanding Australian scientist Professor Joe Baker (1926-2017) was supporting the collaboration and brotherhood between PIBOC and Australian scientists quite a perceptible time. Professor J. Baker was an inspirational leader of the Australian marine science community. After his academic career in chemistry at James Cook University and following leadership of the Roche Research Institute of Marine Pharmacology Prof. J. Baker founded marine biodiversity research at the Australian Institute of Marine Science (AIMS) in Townsville. As a result, AIMS has contributed significantly to the growth of aquaculture industry in Queensland and several highly active natural compounds from sponges and ascidians were discovered.

Marine microbiology is another scientific field of joint interest of Russian and Australian scientists. The corresponding studies were activated after migration of Professor Elena Ivanova from PIBOC to Swinburne University of Technology in Melbourne. Many new species of marine bacteria were discovered in result of joint efforts and their properties described in a series of scientific articles. For example, in one of recent papers a novel species of gram-negative, non-pigmented, motile bacteria *Thalassospira australica* was described on the basis of phylogenetic and genomic analysis and analysis of physiological and biochemical properties of two strains isolated from a sea water sample collected at St. Kilda Beach, Port Philip Bay, Victoria, Australia. A study, based on a 16S rRNA gene sequencing, indicated that strains NP 3b2(T) and H 94 belong to the genus *Thalassospira*. The sequence similarity of the 16S rRNA gene between the two new isolates is 99.8 % and between these strains and all known validly named *Thalassospira* species was found to be in the range of 95-99.4 % [9].

Last years, Professor Elena Ivanova is also well known in the scientific world by the studies on interaction of different natural surfaces with bacteria. For example, when incubated on cicada wings, *Pseudomonas aeruginosa* cells are not repelled; instead they are penetrated by the nanopillar arrays present on the wing surface, resulting in bacterial cell death. Therefore, Cicada wings are effective antibacterial, as opposed to antibiofouling, surfaces.

Collaboration with USA

Active collaboration with American scientists was initiated after the visit of American scientist, novelist and playwright professor Carl Djerassi (1923-2015) into our Institute and its Marine Station in 1989. C. Djerassi is well known as an outstanding scientist who made a great contribution into the wide application of mass-spectrometry and circular dichroism spectroscopy in organic chemistry. In addition, he is best known for his contribution to the development of oral contraceptive pills for the birth control and as developer first antihistamines. In that time C. Djerassi was studying the biosynthesis of unusual sterols in marine organisms and particularly in sponges and sea cucumbers. Together with scientists from PIBOC, he and his collaborators from Stanford University have published a paper concerning unusual sterols from the sea cucumber *Eupentacta fraudatrix* (Figure 3) and their biosynthesis [16]. This paper was cited more than 40 times and stimulated further studies on biosynthesis of marine steroids.

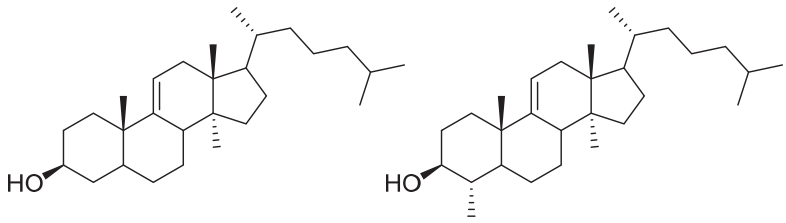

Figure 3. Unusual methyl sterols from the sea cucumber *Eupentacta fraudatrix*

An important example of USA-Russia collaboration was concerned the studies on marine natural products possessing cancer-preventive activities. The corresponding project was carried out together with scientists from the Hormel Institute of University of Minnesota (Prof. Zigang Dong) in the beginning of 21st century. During several years Dr. Sergei Fedorov had been studying cancer-preventive properties of several marine natural products isolated in PIBOC using different cancer and normal cellular lines in the Hormel Institute. These studies have led to several joint patents and publications, for example [8]. Moreover, similar studies were continuing at PIBOC after returning Dr. S. Fedorov to our Institute.

Long-term collaboration with Professor Ted Molinski (now working at the Scripps Institute of Oceanography, San Diego) on structures and properties of new marine natural products has led to the development of a new approach to the determination of absolute configurations of asymmetric centers in very complicated natural compounds [18].

Dr. Valery Voinov, one of main our specialists in mass-spectrometry, last years is working at the Department of Chemistry, Oregon State University together with Professor Duglas Borofski. In cooperation with our Institute, this group carry out very important studies concerning the development of electron capture dissociation (ECD), a mass-spectrometric method that has come to be regarded as a potentially powerful tool for elucidating protein structures. They demonstrated that a radio-frequency-free electromagnetostatic cell could be retrofitted into a triple quad mass spectrometer to allow electron-capture dissociation without the aid of cooling gas or phase-specific electron injection into the cell. It may be concluded that their recent attempts to optimize ECD for protein analysis were very successful, see, for example [31].

Collaboration with Socialistic Republic of Vietnam.

The joint studies on marine natural products with Vietnamese scientists were based on marine expeditions in Vietnamese waters on board of the research vessel "Akademik Oparin" and activated after 2004. Although the first Russian-Vietnamese marine expedition using research vessel "Akademik Oparin" was organized by PIBOC more than 30 years ago, in 1987 (September 30 – November 29), only after 2004 such expeditions became systematic and many dozens of Vietnamese scientists took part in them. In fact, such expeditions had been operating in Vietnamese waters from December, 24 through February, 3, 2004; from May, 04 through June 18, 2007; in November-December, 2016; and in July-August, 2018. Vietnamese participants of our expeditions represented several scientific organizations belonging to Academy of Science and Technology of Vietnam, namely Institute of Oceanography (Nha Trang), Institute of Chemistry of Natural Products (Hanoi), Institute of Marine Biochemistry (Hanoi), Nhatrang Institute of Technology Research and Application, Institute of Marine Environment and Resources (Haiphong).

A number of new bioactive marine natural products were discovered (for examples, see [12] and Figure 4) as well as many new strains of marine microorganisms were collected for joint studies. Moreover, scientists from PIBOC (Prof. Valery Mikhailov, Drs Tatyana Kuznetsova, Mikhail Kusaikin, Mikhail Pivkin, Alla Kicha, Natalia Ivanchina, Sergei Fedoreev, Natalia Mischenko and others) visited Vietnamese Institutes, particularly Institute of Chemistry of Natural Products (Hanoi) and Institute of Technology Research and Application (Nha Trang), to carry out joint investigations on marine microorganisms, polysaccharides such as fucoidans from brown algae, enzymes from Vietnamese mollusks, steroid glycosides from starfish, and quinoid pigments from sea urchins. As result, fucoidans from Vietnamese algae have found a wide application in Medicine of Vietnam. An own collection of marine microorganisms was created in this country and species identification of marine fungi from this collection was carried out by Dr. M. Pivkin. The Collection of Marine Microorganisms of PIBOC was replenished with many new species of marine bacteria and fungi.

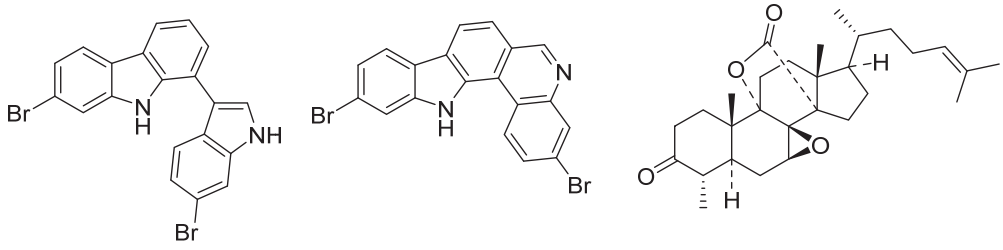

Figure 4. Structure of some natural products from a sponge *Penares* sp.

President of Vietnam Academy of Science and Technology (VAST) Prof. Chau Van Minh has played an important role in the development of this Russian-Vietnamese cooperation in Marine Sciences. He is also coauthor of several joint publications (for example [14, 15]) with scientists from PIBOC. Professor Chau Van Minh was born in 1961 in one of the Northern Vietnamese provinces. In 1985, he graduated M. V. Lomonosov Moscow State University, in 1993 received PhD level in Chemistry from the same University. Chau Van Minh is full professor in chemistry, having more than 150 articles published in International and Vietnamese scientific journals. As President of VAST, he is responsible person in Vietnam for scientific strategy and development of important projects, planning-financial activities, organizational and administrative activities, international cooperation management and inspection.

Collaboration with Republic of Korea

Very active collaboration was organized between PIBOC and several Universities from the Republic of Korea. Numerous low molecular weight and biopolymer natural compounds, discovered in our Institute became a good basis for the development of modern studies on their molecular mechanisms of action in the Republic of Korea.

Many years fucoidans and algal polysaccharides as well as bioactive glycosides from sea cucumbers are attracting a great attention in Asian countries as immunomodulators and anticancer agents. Studies on different fucoidans including those obtained from our Institute were carried out in Dong-A University School of Medicine, Busan, by Professor Jong Young Kwak. He was the Director of Immune-network Pioneer Research Center, sponsored as one of the Pioneer Research Center Program by the National Research Foundation of Korea. Taking into attention results of more than fifteen scientific articles published together with Russian scientists, Prof. J. Kwak was elected as Doctor Honoris Causa in the Russian Academy of Science in 2012. He was appointed as Professor at Department of Pharmacology, Ajou University School of Medicine, Korea from 2015 and continued scientific contacts with PIBOC.

As an example of joint studies with his group, action of fucoidans on dendritic cells may be mentioned. Dendritic cells are the most potent antigen-presenting cells for naive T cells. It was shown that scavenger receptor class A type I and type II (SR-A) are expressed by peripheral blood and monocyte-derived dendritic cells. The binding of anti–SR-A antibody to these cells was lower in the presence of fucoidan, which is an SR-A agonist [11].

Studies on anticancer properties of fucoidans from some brown algae have been carried by Dr. Svetlana Ermakova and Professor Tatyana Zviagintseva with their students in collaboration with College of Pharmacy, Chosun University, Gwangju. The inhibitory effects of *Costaria costata* fucoidan were examined on UVB-induced matrix metalloprotein-1 promoter, mRNA, and protein expression in vitro using the immortalized human keratinocyte (HaCaT) cell line. Pretreatment with fucoidan significantly inhibited this enzyme expression compared to UVB irradiation alone. Therefore, this fucoidan may be a potential therapeutic agent to prevent and treat skin photoaging [19].

Professor Joo-In Park from the same Dong-A University has carried out several very impressive studies on sea cucumber glycosides isolated at PIBOC as potent antileukemic agents.Acute myeloid leukemia is a disorder exhibiting the accumulation of immature myeloid progenitors in the bone marrow and peripheral blood. Standard antileukemic healing requires intensive combination chemotherapy, often leading to significant treatment-related toxicity. Low toxic marine secondary metabolites, inducing the generation of ceramide in leukemic cells are new anticancer agents to improve the therapy of leukemia. The antitumor activity, related to ceramide metabolism, of some marine metabolites, including stichoposides extracted from sea cucumbers of the family Stichopodiidae, was recently reviewed in a joint Korean-Russian paper [17]. Very potent antileukemic activity *in vivo* was reported for a series of glycosides, including holotoxin A_1 from the sea cucumber *Apostichopus japonicus* [28].

Impressive results were obtained in result of joint studies on pigments from sea urchins, particularly echinochrome A, an active substance of medical drugs belonging to the series “Gistochrome” (Figure 5). Two drug forms, so-called “Gistochrome for ophthalmology” and “Gistochrome for cardiology” have been permitted for application and industrial production in the Russian Federation. Echinochrome A was reported to have antioxidant properties and a cardio protective effect against ischemia reperfusion injury. Together with Korean scientists from Jnje University, Busan (Laboratory of Professor Jin Han), its potent effects on mitochondrial activities and metabolisms in heart tissues were established. Actually, this natural product enhances the mitochondrial biogenesis and oxidative phosphorylation in rat cardio myoblast H9c2 cells, increases the mitochondrial mass, level of oxidative phosphorylation, and mitochondrial biogenesis regulatory gene expression. The treatment with echinochrome A did not induce cytotoxicity, but enhanced oxygen consumption rate and other mitochondrial functions [10].

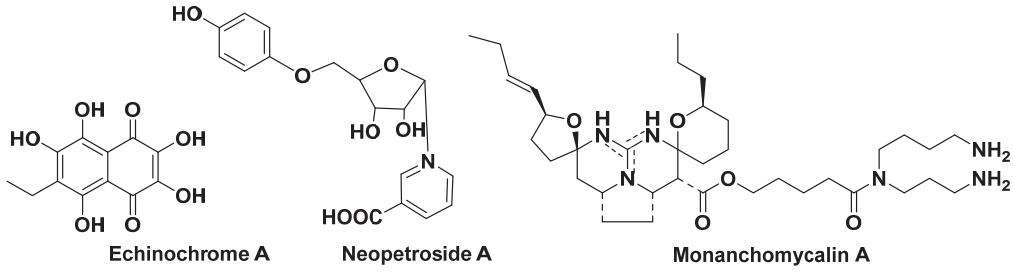

Figure 5. Some natural compounds, studied together with Korean scientists

Moreover, joint studies with this Korean group have shown that male Sprague-Dawley rats after administration of echinochrome A [0.1 mg/kg, daily 30 min before each exercise training (swimming)] increased the exercise capacity significantly higher compared to control groups. The rats carried out more work and were capable to more enduring swimming. There were no significant changes in the plasma lipids among the experimental and control groups. However, the muscle mitochondria content was greater in echinochrome treated groups. These findings show that this natural product enhances exercise capacity, which is associated with an increase in skeletal muscle mitochondrial content [26].

It is of particular interest that another natural product, so-called neopetroside A, an unusual riboside (Figure 5) isolated at PIBOC from the sponge *Neopetrosia* sp. was also shown by the group of Professor Jin Han to possess stimulatory action on mitochondrial functions in cardiomyocytes [25].

A long-term collaboration with group from the Marine natural products laboratory (Dr. Hyi-Seung Lee) of Korea Ocean Research and Development Institute led to structure elucidation of a series of new marine alkaloids from Pacific sponges, see, for example, studies on monanchomycalins (Figure 5) [17].

Joint studies in the field of marine microbiology between PIBOC and Republic of Korea were started in the beginning of the 1990s. Now Korea Research Institute of Bioscience and Biotechnology, namely its Biological Resource Center is one of the main our partners for these studies. For example, very recently a gram-stain-negative, rod-shaped, yellow-pigmented bacterium, designated strain 10Alg 139 (T) and isolated from the Pacific red alga *Ahnfeltia tobuchiensis*, was investigated. The phylogenetic analysis based on 16S rRNA gene sequences showed that the novel strain belonged to the genus *Polaribacter*. This new isolate and the type strains of recognized species of the genus *Polaribacter* were readily distinguished based on a number of phenotypic characteristics. A combination of the genotypic and phenotypic data showed that this bacterium represents a novel species of the genus *Polaribacter*, named as *Polaribacter staleyi* sp. nov. [20]

Collaboration with People's Republic of China

Dr. Li Wei finished post-graduate studies at PIBOC in the end of 1990s under the leadership of Prof. P.A. Lukyanov and last years was working at Dalian Ocean University. During long-term studies on lectins from marine invertebrates and algae his group collaborates with Laboratory of Chemistry of Noninfectious Immunity of PIBOC. Very recently together with scientists from several scientific organizations of Taiwan (such as Institute of Biological Chemistry, Taiwan National University and others) they reported the space structure and functions of a lectin from the sea mollusk *Crenomytilus grayanus* (CGL) collected from the sublittoral zone of Peter the Great Bay of the Sea of Japan. The crystal structure of this lectin was solved to a resolution of 1.08 angstrom, revealing a beta-trefoil fold that dimerizes into a dumbbell-shaped quaternary structure. CGL is capable to bind globotriose on the surface of breast cancer cells, leading to cell death. These findings suggest the use of this lectin in cancer diagnosis and treatment [13].

Another point of the Russian-Chinese cooperation is the Biology Institute of Shandong Academy of Science. Drs. Mikhail Kusaikin, Svetlana Ermakova, and collaborators from the Laboratory of Enzyme Chemistry of PIBOC together with Chinese scientists recently studied water-soluble polysaccharides from two specimens of brown alga *Sargassum muticum*, which synthesized heterogeneous sulfated fucoidans. Two of three fucoidan fractions from this alga collected in April 2014 contained mannogalactofucans, one - galactofucan (Fuc-Gal, 2:1). The alga specimen collected in June 2015 afforded two galactofucans of different structures (Fuc-Gal, 1:1 and 3:1). Studies on the antitumor activity of the obtained fucoidans and their modified derivatives showed a lack of cytotoxicity and the manifestation of activity against DLD-1 human colon carcinoma cells [30]. This collaboration concerned also anti-radiation properties of some algal polysaccharides.

Collaboration with Germany.

Joint studies with German scientists on marine bioactive compounds, possessing by immunomodulatory and anticancer properties are an important part of international scientific collaboration of our Institute. It is well known that spleen is a prime organ, in which immuno-stimulation takes place in mammalians. Proteome analysis was used by Drs Dmitry Aminin and Pavel Dmitrenok in joint studies with Proteome Center Rostock at University of Rostock (Germany) with participation of Oregon State University (USA) to investigate the elicited effects on mouse splenocytes upon exposure to sea cucumber triterpene glycosides cucumarioside A2-2 and frondoside A (Figure 6) . These compounds have been used to *in vitro* stimulate primary splenocyte cultures. Differential protein expression was monitored by 2D gel analysis and proteins in spots of interest were identified by MALDI ToF MS and nano LC-ESI Q-ToF MS/MS, respectively. Approximately thirty protein spots were differentially expressed. Prime examples of differentially expressed proteins were NSFL1 cofactor p47 and hnRNP K (down-regulated), as well as Septin-2, NADH dehydrogenase (ubiquinone) iron-sulfur protein 3, and GRB2-related adaptor protein 2 (up-regulated). Together with results from proliferation and cell adhesion assays, these data showed that cellular proliferation is stimulated by the studied triterpene glycosides. The studied triterpene glycosides were proposed to express their immunostimulatory effects by enhancing the natural cellular defense barrier that is necessary to fight pathogens and for which lymphocytes and splenocytes have to be recruited constantly [1].

Joint studies with Laboratory of Experimental Oncology, University Medical Center Hamburg Eppendorf, which is one of the largest hospitals in Germany, were very productive

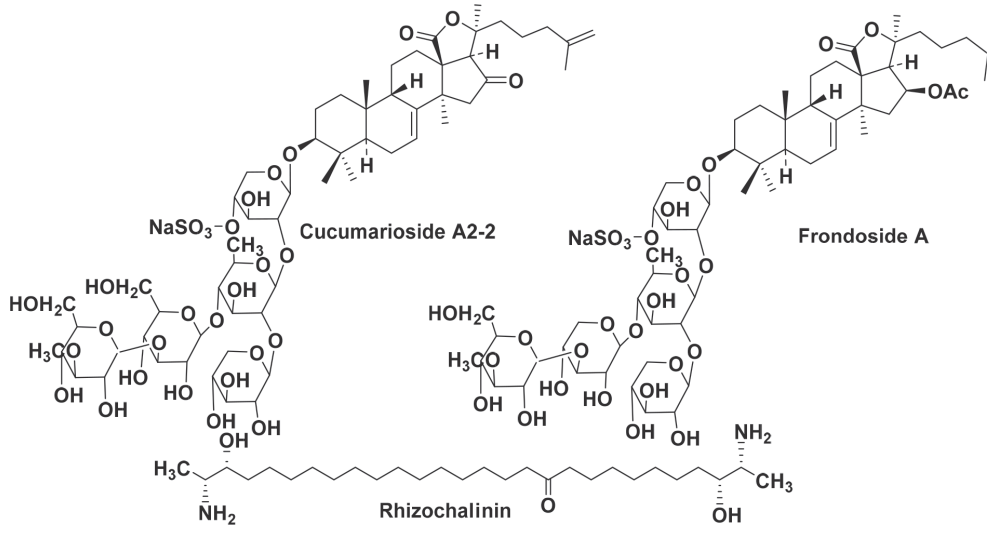

Figure 6. Structures of some marine metabolites studied together with German scientists

as result of post-graduate studies of Drs. Sergei Dyshlovoy and Ekaterina Menchinskaya in this Center. A series exceeding a dozen of joint articles in high level scientific journals was published. As a very recent example, the investigation of anticancer properties of rhizochalinin (Figure 6), obtained at PIBOC from bipolar lipid rhizochalin, which was also discovered by our scientists, may be mentioned. Rhizochalinin (Rhiz) shows promising *in vitro* and *in vivo* activities in human castration-resistant prostate cancer. A global proteome screening approach was applied to investigate molecular targets and biological processes affected by Rhiz in this model system. Bioinformatical analysis of the obtained data predicted an antimigratory effect of Rhiz on cancer cells. Validation of proteins involved in the cancer-associated processes, including cell migration and invasion, revealed down regulation of specific isoforms of stathmin and LASP1, as well as up regulation of Grp75, keratin 81, and precursor IL-1 beta by Rhiz. A combination of Rhiz with MEK/ERK inhibitors PD98059 (non-ATP competitive MEK1 inhibitor) and FR180204 (ATP-competitive ERK1/2 inhibitor) resulted in synergistic anticancer effects [5].

Collaboration with Italy

Institute of Biomolecular Chemistry in Napoly (Italy) elaborates similar scientific directions when compared with PIBOC. Long-term collaboration with scientists from this Institute included exchange of scientists and joint studies on some marine biological objects collected in the Mediterranean Sea. For example, triterpene glycosides of three species of the Mediterranean Sea cucumbers *Holothuria polii, Holothuria tubulosa*, and *Holothuria* sp. were studied. Three new monosulfated biosides, holothurins B_2, B_3, and B_4, along with the previously known holothurins A and B were isolated from the sea cucumber *H. polii*. Triterpene glycosides belonging to holothurin A and B groups were found in *H. tubulosa*, while only one individual glycoside, holothurin A, was isolated from *Holothuria* sp. The significance of holothurins as chemotaxonomic markers of the animals belonging to the genus *Holothuria* was confirmed [29].

Collaboration with France

Joint studies with the Station Biologique, Roscoff, France are connected with the establishment of the structure of hybrid algal polysaccharides carrageenans with the help of specific enzymes - carrageenases. The French side provided carrageenases and carried out partial enzymatic hydrolysis of polysaccharides. From the Russian side, carrageenans of the hybrid structure were obtained and structures of the products of enzymatic hydrolysis were established. In addition, within the frameworks of this cooperation, a search for bacterial strains, potential producers of enzymes capable of cleavage of carrageenans having a hybrid structure was carried out [3].

Collaboration with Poland

In the frameworks of agreement on scientific cooperation between PIBOC (Dr. Irina Ermak and collaborators) and the Ya. Kochanowski University, Kielce, Poland (Dr. Wieslaw *Kaca***)** the interaction of the well-known polysaccharide chitosan with bacterial lipopolysaccharides of various structures was studied. A corresponding joint project was successfully developed. The Polish side provided samples of endotoxins of wild and mutant strains of bacteria of the genus *Proteus* and their structural components. The parameters of their binding with chitosans of different molecular weights were determined. The acute toxicity of the complexes obtained was determined [4].

The inhibitory effects of natural polysaccharides (carrageenans and chitosans) on the immunobiological properties of endotoxic lipopolysaccharides of bacteria belonging to the genus *Proteus* were established [2]

International Life Science symposiums

A great contribution in the development of international contacts of PIBOC was made by International Symposiums on Life Sciences which took a place in Vladivostok. **The First International Symposium on Life Sciences** was held from 2 to 7 September, 2008. About 70 its participants represented seven countries, including Poland, Germany, Republic of Korea, Socialistic Republic of Vietnam, People's Republic of China, France and Russian Federation. Scientists from PIBOC, A.V. Zhirmunski Institute of Marine Biology FEB RAS, N.D. Zelinsky Institute of Organic Chemistry RAS, Far Eastern State University, G.M. Somov Institute of Epidemiology and Microbiology SB MAS, Institute of Automation and Control Processes FEB RAS, Far-Eastern State Technical University, Seaside Research Veterinary Station, Vladivostok were among Russian participants. About 30% participants were young scientists and post-graduate students. Fifteen plenary lectures, 25 oral, and 20 poster presentations were delivered.

The lecture "Structure and biosynthesis of carrageenan: the main component of red algal cell wall structures" by professor William Helbert from University Piere and Marie Curie-CNRS, Station Biologique, Roscoff, France, stimulated the following joint studies on these polysaccharides in the both countries France and Russia.

The presentation "Studies on chemical constituents of Vietnamese starfish *Anthenea pentagonala*" by scientists from the Professor Pham Quoc Long Laboratory of Institute of Natural Products Chemistry VAST (Vietnam) demonstrated a great interest of Vietnamese scientists to bioactive compounds from marine invertebrates. The corresponding joint studies are continuing more than last 10 years.

Professor Jong-Young Kwak (Dong A-University, Republic of Korea) in his lecture"Antitumor and immunomodulating effects of fucoidan" reported very interesting results, which were later described in several joint publications.

An excellent presentation "Metabolites – the chemical language of microbe" was presented by Professor Hartmut Laatsch from the Department of Organic and Biomolecular Chemistry, University of Göttingen, Göttingen, Germany. He said "We just begin to understand this language of nature and try to compile the vocabulary and to decipher the grammar. Natural products are weapons and defense systems, attractants or repellents, or just communication signals, which are important for the survival of species. Also, resistance development of bacteria against antibiotics is such a logical and unavoidable reply on environmental effects, which we can only overcome by a better understanding of the 'microbial conversation'."

The Second International Symposium on Life Sciences was held from 4 to 9 September, 2013, and attracted more than 80 participants from the same countries and Thailand, delivered 10 plenary lectures, 39 oral and 28 poster presentations.

Before the beginning of the symposium, the Chairman of the Presidium of Far Eastern Branch RAS, Academician Valentin Sergienko and Chief Scientific Secretary of the Presidium, Corresponding Member of RAS Vuacheslav Bogatov wished the symposium participants fruitful work. Valentin Sergienko has noted: "It is symbolic that the symposium is held on the eve of the 50th anniversary of the PIBOC and the 85th anniversary of its founder and long-time leader, Academician Georgy Elyakov, who laid the foundations of the scientific directions, which will be discussed at this conference. These scientific directions have not lost their relevance up to now".

In her lecture, Dr. Min Qu (Dalian Ocean University) reported how, using the model of toxic hepatitis, the favorable effects of low molecular weight lipopeptides, obtained from the giant Chinese salamander mucus were established. The corresponding studies have opened up prospects for the development of new therapeutic drugs for the treatment of viral and toxic hepatitis and cirrhosis of the liver. These and other investigations of Chinese biochemists from Dalian were then continued in collaboration with Professor Pavel Lukyanov and his collaborators from PIBOC.

The lecture of Dr. Andrei Imbs from A.V. Zhirmunsky Institute of Marine Biology FEB RAS was devoted to the Russian-Vietnamese studies on distribution and biosynthesis of coral lipids, which participate in most of the biochemical and physiological processes of these marine animals.

The lecture of Professor Rita Bernhardt (Saarland University, Saarbrucken, Germany) was about the structural studies on cytochromes P450, key enzymes of biosynthesis of steroid hormones and in detoxification of xenobiotics, including drugs. They are widely used in the pharmaceutical industry for the production of steroid hormones and their modified analogues. Bioinformatic studies of Professor Bernhardt can be the basis for the creation of mutant forms of the corresponding proteins with enhanced enzymatic activity, which is of great importance for increasing the yield and quality of artificially produced steroids.

The studies, presented at the symposium by Professor Narongsaka Chayabutra (Institute of the Memory of Queen Sayyawabhi, Bangkok, Thailand) were of considerable practical interest. They were devoted to the molecular mechanisms underlying the development of renal failure in human poisoning with the poison of the Viper Russell (*Dabola siamensis*), widespread in Thailand.

During the breaks between the sessions, the symposium participants got acquainted with the research work in PIBOC, discussed plans for future joint studies. In his closing speech, the Chairman of the Organizing committee of the symposium, the Director of PIBOC, Academician Valentin Stonik noted that the reports presented at the forum demonstrated the high scientific potential of research conducted by scientists from different countries in the field of chemistry of marine natural compounds, biochemistry and biotechnology.

The Third International Symposium on Life Sciences of this series was held from 4 to 8, 2018. Communications of all the participants of this scientific meeting are published in this Issue of the scientific journal "Herald of the Far-Eastern Branch of the Russian Academy of Science". It is hoped that they will be of interest and useful to those who are involved in research in the field of bioorganic chemistry, biochemistry, molecular biology and biotechnology.

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