

*Antsiferova O. A., Levitskiy A. D. Monitoring results of ferric and ferrous iron in soils of hilly-moraine plains*

The studies have been carried out in a typical arable agricultural landscape of the Sambian plain (Kaliningrad region). Four monitoring rounds have been conducted (November 2017, April, June, October 2018) in seasons with varying degrees of soil moisture. Dynamics of free iron in humus horizon (0–20 cm) in three groups of soils has been studied: brown soils on the tops of hills, gleyic brown soils on slopes, soddy-gley soils in depressions. Soils are drained with a system of clay drainage. The content of ferric ( $\text{Fe}_2\text{O}_3$ ) and ferrous ( $\text{FeO}$ ) iron has been determined in an extract of 0.1 n  $\text{H}_2\text{SO}_4$  by aspectrophotometric method using  $\alpha$ - $\alpha$ -dipyridyl indicator. The boundaries of the content of different forms of free iron in soils of different degrees of hydromorphism have been established. In brown soils on the tops of hills and slopes  $\text{Fe}_2\text{O}_3$  prevails over  $\text{FeO}$  in all seasons (autumn, spring, summer). In soddy-gley soils in November 2017 and April 2018, the reverse pattern was observed in most areas, and gleying was developing. A strong spatial variation of the amount of free iron in the depressions has been found due to local differences in wetting, granulometric composition and humus content. A significant correlation of field moisture and free iron has been revealed only for soddy-gley soils. Of all the studied soils, soddy-gley soils have showed the highest content of  $\text{FeO}$  (autumn 2017 and spring 2018) and the amount of  $\text{Fe}_2\text{O}_3 + \text{FeO}$ . This is a reflection of the features of their geochemical position in the landscape and water regime. Winter rape dies when the content of ferrous iron is about 40 mg per 100 g of soil in autumn and spring and in summer- more than 15–20. The  $\text{Fe}_2\text{O}_3/\text{FeO}$  index should be used in agroecological monitoring and examination of the reclamation state of drained soils, modeling and forecasting of mobile iron (extract 0.1n  $\text{H}_2\text{SO}_4$ ) in agricultural landscapes under different climatic scenarios.

*free (an extract of 0.1 n  $\text{H}_2\text{SO}_4$ ) ferric and ferrous iron, monitoring, brown soils, soddy-gley soils,  $\text{Fe}_2\text{O}_3/\text{FeO}$  index, winter rape, critical  $\text{FeO}$  content*

*Dubravin V. F., Kapustina M. V., Eroshenko D. V. Zoning of hydrochemical fields of the Baltic sea surface layer*

The study was based on the homogeneous long-term array of hydrological data, averaged over for 1950–2005. The data includes annual average values of Salinity (PSU),  $\text{O}_2$ ,  $\text{PO}_4$ ,  $\text{NH}_3$  and  $\text{NO}_3$  ( $\mu\text{mol}/\text{kg}$ ) on a regular grid  $1 \times 1^\circ$  [1]. The cluster analysis (modification by V. Ryakhovsky [2]), which was carried out in two variations: by five parameters (including salinity) and by four parameters (excluding salinity), allowed to distinguish six clusters (regions) in the surface layer of the Baltic Sea. Clusters 1–4 in both versions are quite similar: 1 – Gulf of Bothnia, 2 – the Gulf of Finland, 3 – Plume Area I (influenced by the Vistula, Daugava and Neva rivers), 4 – River Plume Area II (influence by the Oder, Neman and Pärnu rivers). Other regions differ: according to the first variant, cluster 5 is Main Area and 6 – Western Area, and according to the second variant, cluster 5 is Central and 6 – Southern. At the same time,

the Gulf of Bothnia region is characterized by lower phosphate values; Gulf of Finland – by low oxygen values; waters of the Vistula, Daugava and Neva rivers – by elevated levels of oxygen, phosphates and nitrates; the Oder, Neman and Pärnu rivers – by raised ammonium values; Western – by high salinity; South – by ammonium values in the range of  $0.37 \div 1.07 \mu\text{mol N/kg}$ . The calculations allow us to conclude that not only do common processes (atmospheric circulation, river runoff and water exchange with the North Sea) control the distribution of salinity, but also distribution of dissolved oxygen, phosphorus and nitrogen in the surface structural zone. It confirms the earlier conclusion, made in [3-5], but now with the quantitative estimates.

*salinity, hydrochemical parameters (oxygen, inorganic phosphorus, ammonium and nitrate nitrogen), surface structural zone, cluster and correlation analysis*

*Ljutikov A. A., Korolyov A. E., Ostroumova I. N. Cultivation of the larvae pikeperch (*Sander lucioperca*) and perch (*Perca fluviatilis*) on artificial diets*

This work presents the results of rearing of perch and pikeperch on artificial starter feeds from the first moment of feeding of larvae without using live food. The main components of feed were protein of microbial origin, protein hydrolysates of warm-blooded animals, fish and meat flour, wheat flour, phospholipids, premixes, physiologically active additives. The nutritional value of feeds was: protein 54.3–61.0%, fat 10.3–15.4%, nitrogen free extractives (NFE) – 6.4–14.4%. Larvae were grown in 8-liter Weiss incubatory device with an initial density of 75–100 individuals per liter, perch weighing 34 mg was transferred to a round pool with a density of 9 individuals per liter. The best results were obtained using feed containing protein of microbiological synthesis. The perch survival rate on such diet – 28.5% (age 56 days, weight 1194 mg), the pikeperch survival rate on such diet – 12.6% (age 34 days, weight 154 mg). The main share of the dead juveniles occurred in the period of full transition to exogenous nutrition. During the rearing, pikeperch was characterized by a high growth rate – the average daily increase in the first three weeks of the experiment was in the range of 21.7–24.5% (perch – 16.3%). The high sensitivity of the pikeperch larvae to the quality of starter feeds was established - according to the results of 21 days of using feeds with signs of oxidation, the larvae survival rate was 2.3%. In addition to low survival, about 75% of individuals had various skeletal deformities and a swim bladder that was not filled with gas. The results indicate the possibility of rearing early larvae of perch fish (Percidae) exclusively on artificial diets, provided that the quality of the feed used is controlled.

*pikeperch, *Sander lucioperca*, perch, *Perca fluviatilis*, larvae, artificial feed, industrial cultivation*

*Lvova E. E., Sukonnov A. V., Rozenshtein M. M., Sukonnova T. E. Methods of experimental evaluation of wear resistance of net fishing materials from mechanical wear factors*

In the process of harvesting, fishing gear are subject to various types of wear, namely chemical, biochemical and mechanical. The nature of chemical and biochemical

wear is well studied, which allows us to apply methods and ways to reduce them. The least studied and most aggressive is mechanical wear. Currently, there are no numerical values and methods for evaluating the parameters of wear resistance of fishing filamentous materials from the impact of mechanical wear factors in the domestic netting industry. At the same time, foreign manufacturers use such characteristics as resistance to abrasive friction, which allows for a better selection of materials, taking into account operating conditions of fishing gear. In this regard, the article considers the issue of creating a method for assessing the influence of factors that cause mechanical wear on the degree of strength loss of the fishing net strip. For the purpose of approbation of methodological support of researches, the description of the experimental equipment developed by authors has been carried out. A series of experimental works performed using methods of planning experiments, allowed us to establish general patterns of influence of factors of mechanical wear on the residual strength and the degree of strength loss of the mesh strip made of fishing polyamide threads of different diameters. Regression coefficients have been calculated and mathematical dependences of the residual strength of the fish and the degree of strength loss of the  $\beta$  polyamide fishing thread on the studied factors of mechanical wear have been obtained. The analysis of the obtained dependencies allowed us to assess the priority of the significance of the influence of the studied factors. The use of these dependencies will improve the quality of selected materials for the construction of fishing gear at the design stage, as well as to assess their durability during operation.

*fishing gear, mechanical wear, influencing factors, experimental data, assessment of regularities, degree of strength loss, fishing materials, net strips, priority of influence, practical application*

*Nedostup A. A., Razhev A. O. Revisiting the theory of electrodynamic similarity of commercial fishing mechanisms*

The main task of electrodynamic similarity of fishing mechanisms is to determine the power parameters of the elements of their design with different technical characteristics, which significantly complicates the theoretical analysis in the design. An important component of electrodynamic similarity consists in preserving physical nature of the original phenomena in a model made in sizes different from nature. In electrodynamic problems, it is required to ensure the coincidence of mechanical, electrical and electromagnetic processes-to determine the force parameters of interacting objects with each other and the medium in a dimensionless manner in order the values of these parameters will be independent of the size and speed of the object, density, viscosity of the medium and other values. In case of dynamic similarity in addition to scales of physical characteristic of hydrodynamics, soil-dynamics and tribologicals processes of fishing, at design stage of fishing mechanisms it is necessary to enter additional scales of the characteristics considering electrodynamic processes. In the article, the authors propose additional scales of similarity for electrodynamic characteristics, methods of their calculation and characteristics of their dependences on the geometric scale  $C_l$ . Full similarity of two objects of research is only possible with a large number of similarity criteria, which is achieved only in theory.

*electrodynamic similarity, fishing mechanisms, fishing gears*

*Burova N. V., Podkorytova A. V.* Physical and chemical characteristics of agar from red algae of the genus *Ahnfeltia* genus: recommendations for its application

The article is devoted to the study of the physicochemical characteristics of agar from underutilized valuable red algae *Ahnfeltia tobuchiensis* and *A. plicata* harvested during the 2016–2018 fishing seasons in order to assess the prospects of using this raw material in the production of hydrocolloids. Algae have been harvested by the method of active fishing in Peter the Great Bay (Sea of Japan), and also collected from storm deposits on the coasts of Lake Busse (Sakhalin Island), the Solovetskiy Islands and the Onega Bay (White Sea). According to the data obtained, the yield of natural agar from *A. tobuchiensis* is on average 3,9, from *A. plicata* – 9,0%, and the yield of alkali-modified agar from *Ahnfeltia* the Far Eastern fish basin and the White Sea basin is on average 10,7 and 19,7% respectively. The article presents the efficiency coefficients of sequential extractions, detailed data on the content of the agar fraction and impurities in crude extracts of *Ahnfeltia*, as well a correlation analysis characterizing the relationships between these fractions. We have studied such properties of the obtained hydrocolloids as strength, transparency, gelling and melting temperatures of agar gels, as well as the content of minerals (total ash) and nitrogen. Using Spearman's rank correlation coefficient, the relationships between the yield of agar and its physicochemical characteristics have been revealed. As a result of the carried out studies, it has been found that the alkali-modified agar obtained from *A. tobuchiensis* satisfies the requirements of Russian standards on food and microbiological agars, and drift algae ashore of *A. plicata* are of full value raw material for the production of top-grade food agar. The studies have shown the high quality of the polysaccharides obtained and the feasibility of using red algae of the *Ahnfeltia* genus obtained not only by the method of active fishing, but also from the storm deposits for the production of agars. The prospects for the practical application of the data presented in the development of import substitution programmes for gel forming polysaccharides are obvious.

*agarophytes, Ahnfeltia tobuchiensis, A. plicata, gel forming polysaccharides, agar, extracts, characterization of hydrogels, import substitution, correlation analysis*

*Makarov A. V., Maksimenko Yu. A., Dyachenko E. P.* Study of optical and thermoradiation characteristics of a foam solution of gelatin from fish processing waste

The optical and thermoradiation characteristics of the foamed gelatin solution from fish processing waste as an object of infrared (radiation) drying with bilateral energy supply have been experimentally and analytically studied. Calculation of the optical and thermal radiation characteristics of the test product has been carried out using the method of averaged optical and thermal radiation characteristics based on empirical data on the directional hemispherical thermal radiation characteristics  $R_\lambda$  and  $T_\lambda$  obtained on a PHOTON RT multifunction spectrophotometer. As a result of the research and calculations for a foamed gelatin solution, the dependences have been found of the coefficient of effective attenuation of the radiation flux as it propagates in the optically infinitely thick layer  $L$ ,  $m^{-1}$  and the distribution of the bulk density of the absorbed radiation energy over the depth of the optically thin layer  $W$ ,  $W/m^3$  on the product moisture  $w$ ,  $kg/kg$  and coordinates of the thickness of the foam layer  $x$ ,  $m$ . An

analysis has been made of the dependence of the distribution of the bulk density of the absorbed radiation energy over the depth of the optically thin layer on the coordinates of the layer thickness and product moisture. As a result of an experimental-analytical study of the optical and thermo-radiation characteristics of the foamed gelatin solution, taking into account the bulk density of the absorbed radiation energy along the depth of the layer, infrared emitters have been selected, their operating modes, including the optimal wavelength range  $\lambda$ ,  $\mu\text{m}$ , corresponding to the maximum radiation intensity and maximum transmittance of the product, as well as an optically thin layer  $h$ , m, the most rational for high-intensity drying.

*drying, gelatin, infrared energy supply, thermoradiation characteristics, optical characteristics, fish processing waste, foam*

*Maksimova S. N., Slutskaya T. N., Poleshchuk D. V., Poleshchuk V. I., Vereshchagina K. K. Prospects for the culinary products from the frozen pacific sardines (ivasi)*

Production of culinary products opens up great opportunities in solving the technological problems of using a variety of fish resources characterized by commercial value. The prospects of producing high-quality biologically valuable food products based on them by applying the principles of food combinatorics are considered. A possibility of producing culinary products from the frozen sardine of Pacific Ivasi is associated with technological features determined by both the chemical composition of the raw materials and the technological features of the production of frozen products. Studying the technological potential of the Pacific sardine (Ivasi) as a possible object for the production of culinary products, the studies of both the fractional composition of proteins and the rheological characteristics of muscle tissue have been carried out. It has been revealed that the most preferred raw material for the production of culinary products according to a number of investigated criteria is sardine with a high fat content. Moreover, in order to improve the emulsifying and rheological characteristics of the minced system, as well as to improve the organoleptic characteristics, it was proposed to introduce salmon and chitosan milk into the composition of the minced system. According to the results, the most rational was the ratio of fish (fatty) and milk – 3: 1 and the introduction of a low molecular weight water-soluble chitosan into the stuffing system in an amount of 1% by weight of the stuffing system. Studies of heat-treated forcemeat systems confirmed the previously put forward hypothesis about the advisability of introducing salmon and chitosan milk into the minced system. Based on the data obtained, it has been concluded that it is possible to use Pacific sardine (Ivasi) with a fat content of more than 20% as a raw material for the production of culinary products.

*Pacific sardine, frozen fish, chemical parameters, muscle tissue, reological characteristics, salmon milt, chitosan*

*Naumov V. A. Air temperature and humidity effect on the performance of water ring vacuum pumps*

Relatively low overall efficiency is the main disadvantage of water ring vacuum pumps (WRP). As a rule, manufacturers of WRP place in the open access experimental dependences of the pumping speed (flow) of air and the power expended on the suction pressure. But no firm provides information about the energy efficiency of the WRP. A method for comparing the WRP energy efficiency by calculating the isothermal efficiency based on mathematical modeling of load characteristics has been previously proposed. The test results of the WRP have been used only for pumping dry air. This article analyzes the load characteristics of different WRP manufacturers. It has confirmed an increase in the rate of pumping wet air compared to dry. At the same time, the maximum isothermal efficiency increases by only a few percent at a suction pressure  $P = 25\text{--}45$  kPa. It is shown that increase in the frequency of the shaft rotation may lead to some reduction isothermal efficiency. The dependences of the performance correction factor  $K$  on  $P$  under the same conditions (air 100% humidity with a temperature of 20 °C, water temperature 15 °C) are similar in almost all the models of studied WRP. The value of  $K$  does not exceed 1.2–1.3 up to  $P \geq 10$  kPa. The value of  $K$  close to two can only be obtained with extremely small pressure. In practice, WRP are not operated at such pressures due to low energy efficiency. The exception is “Samson” pumps test results. They show an increase in productivity by 34% already at  $P = 20$  kPa. The rate of WRP pumping increases with increasing temperature of moist air  $T$ . The correction factor of productivity reaches  $K = 2.5$  already at  $P = 15$  kPa, if  $T = 50$  °C. It is possible to choose the conditions for significant increase in the WRP capacity using moist air as the working fluid. At the same time, the increase in WRP energy efficiency will be small.

*water ring vacuum pumps, suction pressure, capacity, air temperature, humidity, energy efficiency*

*Nekrasova Yu. O., Mezenova O. Ya., Myorzal Y.-T., Kyun S. Biopotential of the seeds of siberian cedar pine and its changes during storage*

Siberian cedar pine seeds are a valuable source of biologically active substances. Pine nuts and their processed products are of scientific and practical interest for the creation of new functional food products. The object of the study was the seeds of Siberian cedar pine (*Pinus sibirica*), collected in different regions of Russia. Material for the study was collected in 2017 and 2018, a total of 7 samples were studied. Cedar oil was analyzed for changes in the content of vitamin E (alpha-, beta-, gamma- and delta-tocopherol), fatty acids, volatile substances, and peroxide value during storage. Vitamin E has antioxidant properties, so its content is a qualitative characteristic of the seed biopotential. Fatty acids, especially polyunsaturated ones, are easily oxidized, as a result of which the consumer properties of nuts and their nutritional value deteriorate. The fatty acid composition of lipids is also their qualitative characteristic and an indicator of storage stability. The peroxide value indicates the degree of oxidation of the fat fraction of the seeds. Volatile substances are formed during the oxidation of fatty acids, which indicates spoilage of seeds. The high-performance liquid chromatography method (HPLC) was used to determine the content of vitamin E. Fatty acids and volatile substances were identified by gas chromatography. The peroxide value of fat was determined by spectrophotometric analysis. The results show that during storage the

quality of pine nuts decreases, the content of vitamin E decreases, saturated fatty acids increase, and trans-fatty acids appear. Volatile substances are formed as a result of oxidation of mono- and polyunsaturated fatty acids. At the same time, seeds are better stored in cones and in vacuum packaging (production of Barnaul).

*cedar nuts, storage stability, vitamin E, fatty acid composition, peroxide value, HPLC, GC, spectrophotometry*

*Grigorovich L. M., Tulupov A. E.* Comparative evaluation of grain productivity of corn (*Zea mays* L.) hybrids in conditions of the Kaliningrad region

Production of food grain and forage for domestic animals in the result of corn cultivation solves many economic and social problems. The conformity of biological requirements with the soil - climatic regional conditions is a prerequisite for using corn as forage in the rapidly developing cattle breeding in the Kaliningrad region. The rise of corn productivity is conditioned by the usage of modern hybrids which are able to adapt to the vegetation conditions. Therefore the problem of scientific grounding for the choice of hybrids providing the high corn yield is urgent for agrarians and needs optimum solutions. The research of hybrid corn sorts and identification of the most productive ones to increase the grain gross product is of prior importance in the efficient functioning of agricultural enterprises. The aim of the research is to make a comparative evaluation of corn productivity in the agro-ecological conditions of the Kaliningrad region. The field experiments on early-ripe and moderate-ripe hybrids were made according to 'Methodology of state sort testing of agricultural crops.' The corn cultivation technology was intensive, being practiced in the region. Phenological observations of plant growing from emergence of seedlings stage (09 BBCH) to (65 BBCH) proved that all observed corn hybrids have reached full bloom in the optimum time and are able to crop before the vegetation period. It has been proved that in case when the grain moisture reaches 22%, the crop harvest amounts to 11.90 -16.15 t/ha. The comparative estimation of seed productivity has demonstrated formation of higher crop yield (13.23 – 16.15 t/ha) of hybrids having FAO from 200 to 400.

*Zea mays, hybrids, grain productivity, crop yield*

*Makarov B. I., Tereshchenko N. N., Rudmin M. A.* Evaluation of the efficiency of the use of glauconite as a fertilizer for spring grain

Intensification of the crop industry in Russia and the expansion of the area of cultivated land leads to a constantly growing demand for mineral fertilizers, as well as the search for alternative sources of the main biogenic elements of plant nutrition. The paper discusses the results of a series of model laboratory experiments aimed at assessment of perspectiveness of the use of Bakcharsky deposit glauconite as an alternative to phosphorus-potassium fertilizers in growing naked oat (*Avena sativa*) of the Tyumen variety in conditions of the Tyumen region. We have studied the effect of various doses of glauconite concentrate (equivalent to 30, 60 and 90 kg / ha), as well as different methods of its application: application to the soil as a fertilizer, presowing

treatment of seeds as a growth promoter. In addition to glauconite concentrate, the experiments evaluated the effectiveness of using its derivatives: glauconitolite, particle size fraction (125–500 microns) of glauconitolite, particle size fraction (125–500 microns) of glauconitic sandstone, and magnetic fraction (125–500 microns) of glauconitic sandstone. It has been established that introduction of glauconite concentrate at a dose of 60 kg / ha has the best stimulating effect on the growth and development of oat plants relative to the products studied, as well as the improvement of the agrochemical properties of the soil. Pre-sowing treatment of naked oat seeds with a glauconite water suspension had a positive effect on the germinating capacity and germinating power of the seeds. The results of the field and laboratory experiments allow us to conclude that the use of glauconite and glauconitic rocks of the Bakchar iron-ore deposit as a fertilizer for growing crops is fundamentally promising.

*glauconite, glauconitic rocks, potash fertilizers, naked oat, germinating capacity, germinating power, green mass*

*Zobov P. G., Dektyarev A. V., Morozov V. N. Comparatative analysis of the scanning of small-sized shipboard products of an engineering part with a complex internal structure using various models of 3D scanners*

Today, three-dimensional scanning is one of the most promising areas in the field of accurate measurements. At the same time, in the Russian Federation there is a clear need to improve the accuracy of manufacturing ship parts of the engineering part, which determines the relevance of work in this direction. For enterprises of the United Shipbuilding Corporation Group, a serious issue is selection of equipment that meets the tasks set. This paper discusses the scanning issues of small-sized shipboard products of the engineering part using the example of an element of a collapsible coupler having the largest overall size of 15 mm, a complex structure of the internal cavity, locking notches, as well as increased requirements for manufacturing accuracy. The experimental work on scanning has been preceded by a review of the types of 3D scanners with their division into groups according to their functionality and technology. Such a separation is based on two fundamental types of 3D scanners - laser and optical scanning systems, while the former are divided into equipment with and without reference marks; the resulting classification is further divided into types of performance - stationary, mobile and semi-mobile devices. A total of nine groups have been allocated. The experimental work itself has been carried out on several types of equipment with analysis and comparison of the data obtained. As a result, based on the experimental data, the optimal equipment for products of this kind has been selected. Also, to simplify the selection of the necessary equipment, the results of the studies have been presented visually in the form of a dependence diagram of the characteristics of the scanning equipment on design features with the division into groups and highlighting such parameters as universality, susceptibility to surface color, cost, mobility, and actual accuracy.

*3D-scanning, 3D-scanners, reverse engineering, engineering part, the product of the machine-building, shipbuilding, accuracy*



*Sutyryn V. I., Shinkarenko I. A.* Application of damping materials in the vibration control system of the ship mechanism

The task of protecting the crew and passengers from vibration and noise arising from the operation of ship mechanisms is, if possible, not to exceed the permissible values of vibration and noise levels. This can be achieved by using low-noise machines, auxiliary mechanisms and propellers; choosing the general arrangement of rooms on the ship at the maximum possible distance from sources of vibration and noise; installing vibration and noise sources so that less sound and vibrational energy is transmitted to the hull; applying sound-absorbing materials and devices in ship premises, etc. These activities relate to the acoustic design of ship structures. The most widely used methods of combating vibration are vibration isolation and vibration damping. The most effective is the optimal combined use of these two means of vibration protection in one oscillatory system. If the vibration isolation carried out by means of shock absorbers is effectively applied and can be calculated with sufficient accuracy, vibration damping is applied less widely and only in the form of coatings on foundation structures. In addition, vibration damping does not always give a positive effect. This paper explores the possibility of damping structures with bulk materials, as well as water. This type of damping of the structure, called shear, is easier and cheaper to implement, and it allows you to change the damping coefficient within certain limits. At the same time, such damping, as a rule, is nonlinear, practically cannot be accurately calculated, and requires experimental substantiation. The work describes the testing of an experimental method designed to determine the damping coefficient of bulk materials and liquids.

*vibration, damping, depreciation, resonance, vibration isolation, frequency analysis*

*Chureev E. A., Nikolaev I. I., Zlygostev D. V., Yakuta I. V.* Checking a SFB-type vessel for static impact of a tow rope

The article has checked the stability of a small fishing boat (SFB) of a new project under the action of a tow rope in accordance with the requirements of the Rules for the Classification and Construction of Ships (RCCS) of the Russian River Register. Verification calculations have showed that the maximum statical lever of the recovery moment of the vessel is two times less than the upsetting lever from action on the vessel of a statically stretched tow rope calculated in accordance with RCCS. The upsetting lever from the dynamic action on the tow rope is by an order smaller than the dynamical-stability lever of the vessel. Next, an experimental verification of the model «MRB707» (SFB) has been carried out on the effect of tugging of the towing rope in the experimental pool of the science-research center of shipbuilding (SRCS) of Kaliningrad State Technical University (KSTU). For the experiment, a model has selected on a scale of 1:5. The load case of the vessel has been the lowest metacentric height during operation. The model does not have a propeller screw and a rudder plate. With the help of a cable, the model gained the necessary speed, then the cable was released and the model lost its course. The cable at this moment began to stretch, it meant imitation of overtaking the towed vessel. As a result of the experiment, it has been established that the formulas of the Rules require adjustment. Under the static

action of the tow rope, the model deck does not enter the water, it enters the water at a towing speed of 7 knots, but at such a high speed towing is not performed.

*metacentric height, model experiment, inclining experiment, heeling moment, tow rope, stability*

*Mnatsakanyan A. G., Ogij O. G., Kharin A. G.* Current state and prospects of the labor market in the primary sector of Russian agriculture in terms of digitalization of the economy

Human capital determines the quality of the workforce and is a key factor in the development of the modern economy. The digital economy has special requirements for workers in all sectors and professions, including the agroindustrial sector. A primary agroindustrial sector, including agriculture, forestry and fisheries, is the least studied part of the Russian economy in terms of capabilities and features of the digitalization process. But this sector is on the verge of large-scale changes due to the transition to a digital economy. The main driving force behind these changes is people - workers, whose knowledge and labor skills largely determine the success of economic reforms. The purpose of this paper is to assess the current and future state of the labor market in the primary agroindustrial sector. We are consistently considering the development trends of the Russian primary agroindustrial sector, first of all, due to the “labor” factor. Then we analyze the state of the rural labor market, and its main features and key problems are revealed. In conclusion, we evaluate the current and future demand for agricultural specialists from the standpoint of the requirements for professional education. The result of our study is the conclusion that the rural labor market lacks for workers with knowledge and competencies for an innovative and digital economy. The methodological basis of this study is a system approach linking agricultural development trends with the current situation and labor market prospects. The information base of our study is normative documents, state statistics and materials from similar studies of other authors.

*agroindustrial sector, innovations, digital economy, labor market, labor force, vocational training system*

#### **KSTU News, № 57**

*Avdeeva E. V., Mazhuga E. V., Novozhilov O. A.* Smelt (*Osmerus eperlanus*) bacteria of various taxonomic groups

Smelt is a mass food object of the Kaliningrad region population. The studies of the microflora help to prevent infectious diseases of humans. It is necessary to control bacterization of smelt. We have studied the microflora of smelt *Osmerus eperlanus* (Linneus, 1758) over a five-year period (2014–2019). Totally 92 specimen of smelt from the river Neman and the river Matrosovka have been studied. Microbiological investigations have been performed by a standard method. We have studied the cultural, morphological and physiological and biochemical characteristics of bacteria. Determination

of bacteria has been carried out in 16 tests. Based on the totality of cultural, morphological and physiological and biochemical characteristics, bacteria have been determined to the genus and species using the Bergey Bacteria Detector. In the results, 41 species of bacteria, which belong to the genus *Acinetobacter*, *Aeromonas*, *Alcaligenes*, *Bacillus*, *Citrobacter*, *Enterobacter*, *Kurthia*, *Micrococcus*, *Escherichia*, *Plesiomonas*, *Pseudomonas*, *Renibacterium*, *Staphylococcus* and *Streptococcus*, *Escherichia*, *Plesiomonas*, *Pseudomonas*, *Renibacterium*, *Staphylococcus* and *Streptococcus* have been found in the smelt microflora. 13 species of opportunistic pathogenic bacteria have been identified that can cause diseases of the studied object under stress conditions. Smelt are also bacterized with 13 saprophytic bacteria. They are characteristic microflora for fish. We have found 15 species of sanitary bacteria. They have 2 types of bacteria of the *Escherichia coli* group. They testify to water pollution by household wastewater in the reservoir under study. The microflora of smelt from the mouth of the Neman River was not as diverse as the microflora of smelt from the Matrosovka River. The most bacterized organs of smelt are the heart, liver and spleen. The aim of this work is important, because smelt microflora has been studied for the first time.

*smelt, Osmerus eperlanus, river Matrosovka, river Neman, bacteria, pathogenic bacteria, microflora, fish, sowing, contamination, environment, saprophytic bacteria*

*Antsiferova O. A., Chiyanova O. Yu. Ecological assessment of chemical properties of soils of the seaside recreational zone in the urban village Yantarny*

The research has been carried out in a park recreation area, which is located along the abrasion coast of the Baltic sea in the urban village Yantarny of the Kaliningrad region. For soil diagnostics, sections with a depth of 150–250 cm have been laid. Soil samples have been taken from each horizon. pH, organic carbon content (with subsequent conversion to humus), mobile compounds of phosphorus, potassium, heavy metals (Cu, Zn, Pb, Cd, Ni, Cr(3+)), and the total amount of mercury have been defined in soil samples. The reaction of the medium in the soil profile is in the range from slightly acidic to neutral. In the soils of the North-Western part of M. Becker Park carbonate horizons at a depth of more than 80-100 cm have been discovered. The maximum amount of humus in soils is concentrated in a layer of 0–10 cm. On average, it is equal to  $3.30 \pm 0.10$  % (the range of variation is 3.00–4.45 %). These values are typical for forest soils on sandy loam and sand rocks in automorphic conditions of the region. Distribution of humus in the profile depends on the genesis and varies from sharply decreasing to evenly decreasing. Buried profiles of different preservation were found in four of the eight soils. The content of organic matter in humus horizons of buried soils varies from 1.19 to 3.99 %. The soils of the recreational zone contain a very high amount of mobile phosphorus (more than 250 mg/kg), both in humus horizons and in soil-forming rocks. This is due to the admixture of phosphorites and is a geochemical feature of the rocks of the Samland Peninsula. The maximum number of mobile potassium is contained in the humus horizon (100–278 mg/kg). The distribution of potassium in the profile is sharply decreasing. Soil-forming sand rocks have a very low content of mobile potassium. The amount of heavy metals (Cu, Zn, Pb, Cd, Ni, Cr (3+)) and gross mercury is below the maximum permissible concentrations.

*recreational zone, soils, pH, humus, distribution by profile, mobile forms of phosphorus, potassium, heavy metals, ecological assessment*

Maltseva I. S., Avdeeva E. V. Parasite cenosis of pike-perch (*Sander lucioperca*) of the Curonian lagoon

The parasitofauna of pike perch in the reservoirs of the Kaliningrad region has been studied fragmentarily and the data are outdated. To assess the ichthyopathological state of fish, constant monitoring of changes in the composition of the parasitofauna and infection rates is necessary. Four-year studies of the pike-perch parasitofauna living in the Russian part of the Curonian lagoon (Baltic sea) have been carried out. 18 species of parasitic organisms have been found in pike perch: myxosporidia *Myxobolus dispar*, microsporidia *Glugea luciopercae*, monogenea *Ancyrocephalus paradoxus*, cestodes *Triaenophorus nodulosus*, *Diphyllobothrium latum*, trematodes *Bunocotyle cingulate cortex*, *Diplostomum spathaceum*, *Tylodelphys clavata*, *Bunodera luciopercae*, *Azygia lucii*, *Ichthyocotylurus platycephalus*, *I. variegatus*, *Bucephalus polymorphus*, nematodes *Raphidascaris acus*, *Camallanus lacustris*, acanthocephala *Acanthocephalus lucii*, *Corynosoma strumosum*, parasitic crustaceans *Achtheres percarum*. Full parasitological analysis has been carried out according to the methodology developed by I.E.Bykhovskaya-Pavlovskaya. Parasites with a complex life cycle predominate in the pike-perch parasitocenosis. Number of parasite species with direct development cycle: 2016 (23.5 %), 2017 (26.6 %), 2018 (28.6 %), 2019 (26.6 %) – 4 species each year under study. Number of species with change of intermediate hosts: 2016 – 13 species (76.5 %); 2017 – 11 species (73.4 %); 2018 – 10 species (71.4 %); 2019 – 11 species (73.4 %). The increase in the infestation of pike-perch with the flukes may indicate the eutrophication process in the reservoir. During the four years of the study, there were significant differences in the composition of the parasitofauna and the extent of infection of certain species of parasitic organisms. The main path of infection – trophic. Representatives of the trematode class dominate in the pike perch parasitofauna of the Curonian lagoon (8 species). The highest extensity of invasion observed in monogenea *Ancyrocephalus paradoxus* (100 % in 2019), metacercariae trematodes *Ichthyocotylurus platycephalus* (100 % in 2019) and parasitic crustacea *Achtheres percarum* (100 % in 2016–2019).

*parasite cenosis, crustaceans, myxosporidia, trematodes, cestodes, nematodes, scrapers, pike perch, extensiveness of invasion*

Nedostup A. A., Razhev A. O., Khrustalyov E. I., Bedareva O. M. Revisiting the theory of thermodynamic similarity of recirculating aquaculture systems for growing aquatic organisms

The use of recirculating aquaculture systems (RAS) requires that they observe growing conditions close to the natural habitat of hydrobionts, including the temperature regime. The use of simulation and physical modeling for the calculation of the temperature field will allow optimization of technological processes, increase the productivity of RAS basins, increase productivity and reduce costs. The main task of the thermodynamic similarity of recirculating aquaculture systems is to determine the power and volumetric parameters of their structural elements having different technical characteristics, which significantly complicates theoretical analysis in the design of RAS. An important component of thermodynamic similarity is preservation of the

physical nature of the original phenomena in a model, executed in dimensions other than nature. In thermodynamic problems, it is required to ensure the coincidence of mechanical and thermal processes. It is necessary to characterize the interaction of the object and the medium with dimensionless quantities that would not depend on the absolute size of the object, temperature, its speed, density of the medium, viscosity of the liquid and other dimensional quantities. When designing RAS, the scale of the physical characteristics of the hydrodynamic processes occurring in the recirculating aquaculture system with dynamic similarity is not enough, as they do not take into account the thermodynamic processes occurring in the recirculating aquaculture system. In the article, the authors propose additional similarity scales for thermodynamic characteristic, give methods for their calculation and graphs of their dependences on the geometric scale  $C_l$ . It should be borne in mind that no matter how complete the list of similarity criteria is, ensuring complete similarity is fundamentally impossible, just as it is impossible to study any phenomena or processes in their entirety. Knowing the scale of  $C_l$ , it is possible to determine the scale effect.

*thermodynamic similarity, recirculating aquaculture system, RAS*

*Novikova S. I., Bedareva O. M., Gorshinina G. V., Troyan T. N.* Assessment of viability and stability of winter crops by conductometric method

The possibility of using the conductometric method to assess the winter hardiness of winter crops (winter wheat, winter rape) has been analyzed. The value of relative electrical conductivity shows the degree of cell damage and can serve as a criterion for the condition and viability of winter crops. It is defined in any phase of development as the ratio of the electrolyte output before boiling to its output after boiling and is expressed as a percentage. High electrical conductivity bears evidence of dying plant tissues, electrolytes leave dead cells. The dependence of the electrolyte yield from the die-cut tillering nodes of winter wheat and winter rapeseed and the root necks of winter rapeseed is shown in order to predict their overwintering. Prediction of the preservation of winter wheat is possible by the fact of accumulation in quantities of sugars and the calculation of a possible tolerance level at which negative temperature indicators can be obtained from the following data: the accumulation of 1.0 % sugar in plants (on absolutely dry matter) allows 1 °C of frosts to be transferred. According to the long-term studies of the Kaliningrad CAS, the presence of snow cover of more than 10 cm without waterlogging of the soil, the absence of alternating thaws and frosts with sugar content in tillering nodes – 20–25 %, in leaves – 17–18 % determines successful wintering of winter wheat. According to the results, 67 % of the examined samples of winter wheat were characterized by a high sugar content in tillering nodes and under the same weather conditions that are listed above for winter rape, they could withstand the air temperature of -31 °C, and 33 % of plants minus 20 °C. Sowing of winter rape passes under conditions of high temperature and lack of moisture. Winter wheat during certain periods of development also lacked moisture (September, October, May, June, July).

*Triticum durum L (winter wheat), Brassica napus oleifera Metzg (winter rape), electrical conductivity, electrolytes, sugar content, frost*

*Skuratov N. A., Sukonnov A. V., Sukonnova T. E.* Experimental research on the assessment of the influence of the ascending speed of the codends with a catch for various forms of slipways on the effort in the drawing end of the fishing winch

The work is devoted to the study of the physical process of drawing bags with catch using ship slipways. This is due to the identification of the reasons for the appearance of peak loads in the drawing end of the fishing winch when hauling codends with a catch, leading to damage to fishing gear, rupture of fishing gear, and deterioration of the quality of fishing objects. To solve the above problem, it is necessary to conduct experimental studies to establish the influence of factors characterizing the ship-trawl system on the process of hauling codends with a catch on the ship deck. The studies have been carried out on the installation, representing the model of the RTM-S fishing deck, made on a scale of 1:25 with various forms of surfaces of the slipway deck. The object of research was the model of a codend corresponding to a bag of a full-scale trawl (pr. V-408). The degree of filling of the model of the codend was 50%, which corresponds to 30 tons of a real bag. The following factors have been selected as influencing factors: the shape and angle of inclination of the slipway deck surface (as factors characterizing the hull of the vessel), as well as the sampling speed of the drawing end (as a factor characterizing the traction and speed parameters of fishing exhaust winch). The experiment has been conducted using experimental design methods. Therefore, we have varied the factors affecting the force in the fishing winch when drawing codends with a catch, and we have studied the effect of each factor. Based on the results of the studies, mathematical dependencies have been obtained that allowed us to draw conclusions about the degree of influence of the studied factors on the effort of hauling codends with a catch on the deck of a vessel.

*trawl, catch, slipway, model, experiment, factors, dependence, load reduction*

*Ageev O. V.* The approach to mathematical description of the profiles of the knives for fish processing equipment

The paper shows the necessity of developing a mathematical description of the profiles of knives for cutting fish. The methods of interpolation of the working tools trajectories in modern equipment with CNC have been analyzed. Taking into account the technology of manufacturing knives for analytical modeling of their profiles, it is proposed to use a third-order polynomial. A mathematical model defining the shape of the front curvilinear edge has been developed. The knife geometry is characterized by a half angle, a mating angle of the edges, the height of the chamfer and half-thickness of the blade. By changing the model parameters, the shapes of knives with concave, convex, concave-convex and convex-concave chamfers have been obtained. The model function is continuous up to and including the second derivative, which ensures the absence of ledges, kinks, and jumps in the curvature on the profile. In the section from the cutting edge to the lateral edge of the knife, the function has no more than one inflection point, which ensures the absence of local waviness on the chamfer. The conditions of monotony in the section from the knife edge to the transition point to the lateral edge have been determined. An expression for calculating the coordinates of the

inflection point of the specified function has been obtained. The developed mathematical description of the knife profile is the basis for setting optimization problems in order to determine the best knife geometry from the point of view of resource conservation. The presence of a mathematical model of the chamfer allows you to determine the optimal half angle of grinding according to the criterion of the minimum force of resistance to cutting. The opportunity to calculate the optimal half angle of sharpening, as well as the optimal half thickness of the knife, according to the criterion of the minimum deformation friction force, has been created. The proposed approach is used in the formulation and solution of variational problems to determine the type of analytical functions that determine the optimal profiles of cutting tools with minimal harmful resistances.

*fish, cutting, profile, chamfer, shape, knife, edge, model*

*Andreev M. P., Morozov I. O.* Influence of stabilizers of different nature on the rheological properties of the jelly products based on secondary raw materials

The paper substantiates the use of stabilizers for the jelly production from secondary raw fish materials. The expediency of using stabilizers is explained by the necessity to increase the strength characteristics of jelly food products based on secondary raw materials of aquatic biological resources. This is due to the insufficient collagen content in fish tissues which is necessary to obtain a product with desired strength properties. Raw materials for the jelly production were broths from Baltic cod and pike perch. The boiling time was 60 minutes with a hydraulic module 2. Optimal type of stabilizers and their concentrations were determined to improve the consistency of the finished jelly product. The influence and efficiency of the use of stabilizers of various natures on the rheological characteristics of a jelly product based on secondary raw materials was established. The complex food additives of various natures were used as stabilizers. These are alginates, gums, standardized carrageenan, and gelatin. The concentration ranged from 0.1 to 2.0%. The rheological characteristics of the investigated samples of jelly products from secondary raw materials have been determined. According to the results of a rheological research, the optimal types and concentration of complex stabilizers have been established for their use in the technology of jelly products from fish. The possibility of increasing the strength characteristics of the product by five times by the addition of stabilizers in minimal concentrations (0.1–0.5 %) has been experimentally established.

*complex stabilizer, jelly product, secondary raw materials, rheological characteristics, penetration number, deformation rate, yield value*

*Vorobyov V. I.* Use of fish scales for food purposes

A method for processing fish scales has been developed allowing to obtain functional drinks, as well as food additives. The method consists in the fact that fish scales, after washing with water, are subjected to heat treatment in liquids (85–100 degrees C) containing at least one type of organic acid (fruit, vegetable, berry juices, milk whey, etc.). The resulting mixture after heat treatment is fractionated into a liquid

part, which is cooled (functional drink) and a solid part (scales after heat treatment), which is dried and ground (food supplement). The chemical analysis (total, amino acid, toxic elements) of raw materials (pike perch scales, direct-pressed apple juice) and finished products (apple juice with scales thermo-hydrolysis products and food supplement) is presented. It has been determined that during heat treatment of flakes in a liquid, the mass fraction of protein in apple juice increased from less than 0.3% to 4.51 %, total ash from 0.2 % to 0.4 %, glycine from less than 0.25 % to 1.07 %, alanine from less than 0.25 % to 0.47 %, with a decrease in carbohydrates from 11.6 % to 8.1 %. The content of toxic elements in the food supplement did not exceed the maximum permissible concentrations for food and feed products, while the mass fraction of protein compared to the original scale decreased from 40.99 % to 30.87 %, and carbohydrates increased to 13.4 %. The involvement of underutilized fish collagen-containing raw materials (fish scales) in industrial production contributes to the expansion of the range of new collagen-containing food products, reduction of protein deficiency and environmental pollution.

*fish scales, fish collagen, functional drink, food additive, gelatin*

*Kazimirova E. A., Mezenova O. Ya., Shenderyuk V. I.* Research on the preparation and application of protein hydrolysate from residual brewer's yeast in cereal bar technology

We have studied the biopotential of the residual brewer's yeast and brewer pellet (waste from the brewing industry) to produce protein hydrolysates and their applications in technologies for cereal bars. The analysis has been conducted of scientific and technical literature on the use of secondary raw materials of brewing industries. General chemical composition of residual yeast and brewer pellets provided by the brewery "Redit" has been studied. The amino acid composition of protein has been analyzed and the biological value of brewer's yeast has been calculated. Enzymatic and high-temperature thermal methods of hydrolysis of residual brewer's yeast have been investigated. The nature of bitterness of brewer's yeast and the degree of its flavor release have been studied. The amount of bitterness in residual brewer's yeast has been determined depending on their washing with water. Dependences of influence of hop bitterness of brewer's yeast on the degree of their hydrolysis have been revealed. The rational technology of protein hydrolysate production using high-temperature hydrolysis has been experimentally established. Residual brewer's yeast is a source of many biologically active substances, primarily protein and essential amino acids, b vitamins and various macro - and micronutrients. Brewer pellets contain high amounts of fiber, protein, vitamin E and b vitamins, minerals and other biologically active substances. Rationality of the use of white yeast hydrolysate as a protein additive in the formulation of a cereal bar based on brewer pellets has been shown. General chemical composition of enriched cereal bars has been determined. The developed cereal bars have a higher nutritional value in terms of protein and dietary fiber and are recommended for use by all groups of the population, as well as for the prevention of diseases of the gastrointestinal tract.

*brewing waste, residual brewer's yeast, brewer pellet, protein hydrolysate, cereal bar, BAS*



Rykov A. I., Agafonova S. V. The use of seeds of white lupine (*Lupinus albus* L.) in the flour confectionery technology

The content of protein and essential amino acids in the kernel of white Lupin (*Lupinus albus* L.) has been studied. The high protein content at the level of 37.79 % and the number of all essential amino acids (g/100 g of protein) is the following: valine (1.75), isoleucine + leucine (2.36), lysine (1.85), methionine + cystine (0.82), threonine (1.75), tryptophan (0.32), phenylalanine + tyrosine (3.34). The biological value of lupine protein has been calculated, which amounted to 76.12 %. The formulation of waffle of increased biological value, including wheat flour, crushed lupine kernels, margarine, pasteurized cow's milk, egg melange, sugar, is presented. The amount of lupine additive introduced into sugar waffles (15 %) and the baking time of products (1.5 minutes) has been justified. The technological scheme of production of enriched waffles "Lupinovye", including such operations as preparation of lupine flour (soaking, peeling, drying, grinding lupine), flour bolting, formulation of a mixture followed by dough kneading, followed by baking waffles at a temperature of 200 °C. Before packaging and labeling, products are cooled and sold to the final market. The total chemical composition of enriched proteins containing 13.7% protein with a biological value of 73.46 was studied, as well as the increased content of essential amino acids (g / 100 g of protein): valine (1.55), isoleucine + leucine (2.36), lysine (2.03), methionine + cystine (1.43), threonine (1.35), tryptophan (0.42), phenylalanine + tyrosine (3.04). Drafts of technical conditions of TU 10.72.12-XXX-00471544-2019 and technological instructions for TU 10.72.12-XXX-00471544-2019 have been developed. The shelf life of waffles is 30 days at relative humidity of not more than 75 % and temperature (18±5) °C.

*lupine, vegetable protein, flour confectionery, sugar waffles, fortified food products*

Soklakov V. V., Rachkova N. A. Application of potentiometric titration in determination of peroxide value of the fat of aquatic organisms

Visual determination of the end of the titrimetric analysis is one of the factors that have contributed most of all to the uncertainty of this measurement method. That is the reason for searching other ways to determine the equivalence point. The peroxide number of the fat of aquatic organisms has been introduced as a safety parameter correlating with the content of cytotoxic products resulted from secondary oxidation, as well as one of the criteria permitting the use of the fat for medical, food, veterinary or technical purposes. The analysis of standardized and proposed in the scientific literature methods for determining the peroxide number in the food industry and pharmaceuticals has shown the possibility of using UV-, IR-Fourier and IR-ATR-spectroscopy, photometry and potentiometry along with titrimetry. The using of potentiometric indication during titration has been proposed as a method for routine determination of this parameter, modified in terms of instrument detection and available to the maximum number of users. Thus, in the Vilar method, standardized in GOST 7636, determination of the equivalence point has been carried out using a potentiometric indication by the jump of the redox potential or by the differential titration curve. To approbate the

proposed method, we have used samples of fats with different shelf life and oxidation state from freshwater and oceanic fish, including made out from frozen raw, as well as industrial products. The results of peroxide number comparative determination using a standardized technique and the proposed modified one showed no significant differences, taking into account the limit of repeatability established in GOST 7636. It may argue the validity of the potentiometric indication for the designated purpose. If it is difficult to determine the end point of titration on the titration curve, it is proposed to use a value of Eh 238 mV as a reference.

*peroxide value, fat of aquatic organisms, potentiometric method*

*Fatykhov Ju. A., Naumov V. A., Ageev O. V., Erlikhman V. N., Shashkov V. S.*

Mathematical simulation of fish vibroorientation process

Increasing the productivity of a number of fish processing machines is possible only by mechanizing the process of oriented fish loading. Of all known methods, the most widely used is the method of fish orientation in the horizontal vibration plane. The method is based on the physical difference due to the characteristics of the skin and scaly cover of fish sliding friction coefficients. When orienting fish head-first, the friction coefficients are less than their values when moving the tail forward, which allows for a steady forward movement of the fish head-first. The aim of the study is to establish by mathematical modeling methods the dynamics of the relative movement of fish on a horizontal vibration plane depending on the kinematic parameters of vibration and the nonlinearity of the friction coefficients of the fish movement in their different orientations. The objects of the research are Atlantic mackerel and horse-mackerel. The solution of the differential equation of the relative motion on vibration plane has been done by the numerical method. Reference points that set the function of the dependence of the friction coefficients on the speed at different orientations of the fish have been set using experimental data. It has been found that at circular speed of vibration plane  $\omega=25,0 \text{ s}^{-1}$ , speed of the relative moving of fish makes  $W_{cp}=0,07 \text{ m/s}$ , that corresponds to the capacity requirement of a loading device. Thus fish accomplishes a complete cycle with the stages of motion a head and tail forward with two brief stops. Amplitude of vibrations of the vibration plane substantially influences intensification of the process, but for the examined types of fish its rational value makes  $A=10 \text{ mm}$ . The determinative of the process is a difference between the coefficients of friction during their orientation by a head and tail forward, but speeds of fish sliding must not exceed a critical value equal  $W_{kp}=0,5 \text{ m/s}$ . For other types of fish the rational values of parameters of vibroorientation are set coming from the data of experimental array of friction descriptions.

*vibration plane, fish, mathematical modeling, numerical method, coefficient of friction*

*Duong Van Thanh, Ivanov V. P. Mathematical model and results of optimization research for the characteristics of rsw-type fishing vessels by permanent dimension method*

The main direction of the conducted research is optimization choice of the characteristics of RWS type fishing vessels which has been carried out as part of formed methodology for the tasks of replenishing the fishing fleet with the purpose of subsequent effective use in the specified technical-economic conditions (TEC) of operation. In this article, the operational efficiency is shown of combining the advantages of the RSW method of fish storage and processing on board. An important additional condition for achieving that efficiency is to ensure an optimized balance of the technical characteristics of vessels (capacity, productivity of fish processing equipment, the sea endurance by fuel) and the TEC of their operation (the state of fishing area, limit storage time for refrigerated products, as well as a price and cost index). The statement of the optimization problem is given, the features of the developed mathematical model of the vessel with its software are shown, a significant amount of optimization studies is performed, their results are presented. A well-reasoned interpretation of the results of analysis and generalizations have confirmed the operability of the developed apparatus for optimizing the characteristics of RSW fishing vessel, which is available and convenient to use, and has showed its capabilities. The performed research cycle completes the formation of a methodology for optimizing the characteristics for a relatively new and developing concept of universal medium-tonnage RSW fishing vessel, combining the advantages of the RSW method of fish storage and processing (cutting and/or freezing) with subsequent storage in dried tanks. The methodology is intended to solve the problems of the development of marine fisheries for Vietnam, and may be for number countries of other regions as well.

*medium-tonnage RSW type fishing vessels, operational efficiency, methodology of technical and economic analysis, mathematical modeling of the vessel, optimization of vessel characteristics, results of optimization research*

*Pakhnutov I. A. Numerical MinMax-optimization*

The paper discusses a type of gradient descent minimization method for functions and functionals weakly differentiable, as well as descent direction and  $\varepsilon$ -possible directions computation (concurrently a simple algorithm for solution of homogeneous linear inequalities is presented). Examples of explicit computations for a sort of functions and functionals are given. It is shown that a reasonable choice of sequence  $\varepsilon \rightarrow 0$  renders quite plausible results.

*weak gradient, optimization, discrete approximation*

*N. I. Buyankin, O. M. Bedareva, I. A. Volkova.* Phenological rhythms of millet crops development in the conditions of the Kaliningrad region

In the conditions of rational fodder production, expanding the range of fodder crops has a great importance. The study of adaptive capabilities, taking into account the biological characteristics of species adapted to the agro-climatic conditions of the region, will expand the range of highly productive crops used in the system of green and raw conveyors, when the productivity of meadows and pastures is very low. The article presents the results of an agroecological test in the conditions of the Kaliningrad region of millet clan varieties: paiza or Japanese Millet (*Echinochloa frumentacea* Link), mohar or italian bristle (*Setaria italica* L.), chumiza (*Setaria italica* subsp. *maxima* L.). Their high productivity, exceptional drought tolerance, undemanding soil fertility and nutritional advantages put millet crops among the most promising forage ones. Good leafiness that does not turn yellow until the end of the growing season allows the phytomass to be used not only as hay and haylage, but also for preparing silage. To increase protein yield, paiza can be used in componential crops. In order to determine seed and feed productivity, as well as to study the correspondence of edaphotopic conditions to the objects of study; morphometric parameters of crops and phenological rhythms of their development have been estimated. During carrying out phenological observations, the optimal timing of harvest ripeness has been determined. For the first time in the Kaliningrad region, annual fodder crops (paiza, mogar, chumiza) have been studied, their seed and fodder productivity has been evaluated, the most valuable plant species (varieties) were identified. A complete phenological rhythm of the development of the research objects most resistant to the environmental conditions of the region is presented.

*feed, annual crops, paiza, Japanese millet, mohar, chumiza, green mass, variety, bioecological features, growth phases, phenology, productivity*

*A. A. Gusev, D. O. Guseva, L. V. Rudinskaya, E. N. Naumenko.* Polychaetes (Polychaeta; Annelida) of the Kaliningrad region and the history of their study

The polychaetes fauna of the Baltic Sea is quite rich, but it is characterized by a sharp decrease in the number of species from the southwest to the northeast in a changing salinity gradient. In the waters of the Kaliningrad region, 14 species of polychaetes were found out of 333 found in the Baltic Sea: *Hediste diversicolor* (O. F. Müller, 1776), *Bylgides sarsi* (Kinberg in Malmgren, 1866), *Boccardiella ligerica* (Ferronière, 1898), *Marenzelleria arctia* (Chamberlin, 1920), *Marenzelleria neglecta* Sikorski & Bick, 2004, *Marenzelleria viridis* (Verrill, 1873), *Polydora ciliata* (Johnston, 1838), *Pygospio elegans* Claparède, 1863, *Streblospio shrubsolii* (Buchanan, 1890), *Fabricia stellaris* (Müller, 1774), *Manayunkia aestuarina* (Bourne, 1883), *Laonome xeprovala* Bick & Bastrop, in Bick et al., 2018, *Alkmaria romijni* Horst, 1919, and *Scoloplos armiger* (Müller, 1776). In the south-eastern part of the Baltic Sea, 12 species have been recorded, and 9 species- in the Vistula (Kaliningrad) Lagoon. Polychaetes have not been found in the Russian part of the Curonian Lagoon. The paper

presents main results of research on the species composition of polychaetes and their ecology in the South-Eastern Baltic and the Vistula Lagoon. Based on the literature data, the author describes the history of the study and first registration of polychaetes in the water bodies of the Kaliningrad region, starting from the middle XIX century to the present. We can assume that the south-eastern part of the Baltic Sea will soon be penetrated or have already been penetrated by polychaetes *L. xeprovala*. Another important habitat factor that causes a low number of polychaetes species in the study area can be considered a deficit of oxygen in the deep water, which is usually tolerated by a small number of species. Based on the analysis of records of polychaetes in the south-eastern part of the Baltic sea, we may suggest a future likely discovery of five species of polychaetes after a great inflows of the North Sea waters: *Terebellides stroemii* Sars, 1835, *Nephtys ciliata* (Müller, 1788), *Ampharete baltica* Eliason, 1955, *Spirorbis* (*Spirorbis*) *spirorbis* (Linnaeus, 1758), and *Aricidea* (*Strelzovia*) *suecica* Eliason, 1920.

*Polychaeta, species composition, South-Eastern Baltic, Vistula and Curonian Lagoons, Kaliningrad region, history of study*

*P. V. Nosenkov, A. A. Nedostup, V. A. Naumov.* Experimental research on the breaking tension and relative elongation of fishing rope-thread products with various tear speed and length of the samples

The article is devoted to an experimental study of the main physical and mechanical properties of fishing filamentous materials, in particular, tensile strength and elongation. The experiments were carried out on thread-rope fishing twisted products used for the construction of industrial fishing tools, in particular polypropylene and polyester. These tests allowed us to study the material to determine not just strength and elongation, but also to determine the dependences of the behavior of a given material under load at different loading speeds, as well as the length of samples of these materials. Studies of behavioral characteristics were carried out not only on materials in a dry state, but also on a wet one, which made it possible to approach the determination of physical and mechanical properties during direct operation of fishing gear (for example, such as a trawl) in an aqueous medium. Experimental studies were carried out on the basis of the laboratory of fishing materials of the Department of Commercial Fisheries of the FSBEI of HE "Dalrybvtuz", using the modern universal table-type tensile testing machine Shimadzu Autograph AGS-X10 with software. To hold the samples in a tensile testing machine, snail-type fastenings were used. All experiments were performed in accordance with standard research methods for determining the breaking load and elongation of fishing materials. The results of the experimental data were mathematically related to the construction of graphical dependencies in the MathCad environment. The developed dependencies allow not only to visually trace the behavioral characteristics of the tested samples, but also to determine the physical and mechanical properties of rope- threadlike products made from these materials.

*rope-thread products, breaking tension, elongation, experiments, dependencies, mathematical processing, graphics*

*A. M. Tortsev, I. I. Studyonov, D. V. Chupov. Regulatory activities of Atlantic salmon fishery in the North Dvina river*

Fishery is an important element of the economic, social and cultural development of coastal communities. At the same time, fisheries management measures should be applied to conserve fish resources. Analysis of the instruments used to regulate the fishery of Atlantic salmon and the development of measures for their further improvement by the example of the North Dvina River Delta in the Arkhangelsk region is the purpose of the study. Regulation of salmon fishery is based on the biological, economic and legal instruments. This is aimed at limiting and stimulating economic activity. However, in recent years there has been a decrease in salmon catch. The transparency and openness of the salmon fishery is highly questionable. At the same time, there is a discrepancy in the data of salmon catch between scientific fishery and commercial fishery. At present, it is advisable to use an additional tool for regulating salmon fishery in the local territory in the form of establishing standards for the type, quantity and size of fishery gear that are used for salmon fishery. Long-term statistics on salmon catches and state monitoring of fishing effort are the basis of this fishing regulation tool. Introduction of the tool into the practice of state organizations allows for the increase in the transparency of salmon fishery and the reliability of catch information, as well as for regulation of the economic component of fishery. This reduces the anthropogenic pressure on the salmon population and prevents the decrease in stocks.

*Atlantic salmon, regulation of fishery, North Dvina river*

*N. N. Chukalova, N. Yu. Kirilyuk, V. V. Shenderyuk. Microbiological assessment of the Vistula (Kaliningrad) Lagoon water quality*

The microbiological assessment of water quality in the Russian part of the Vistula (Kaliningrad) Lagoon was taken for the first time in 2018. The total number of mesophilic (TM) and psychrophilic (TP) heterotrophic bacteria, indices of the total coliform (TC), faecal coliform (FC), faecal streptococci (FS), *Staphylococcus aureus* (SA), well as self-purification (SP) index, FC/FC ratio and occurrence of the pathogenic bacteria (*Salmonella*, *Shigella* genera) and *Pseudomonas aeruginosa* were studied by standard methods. Mean values of the mesophilic and psychrophilic heterotrophic bacteria was  $9.4 \times 10^4$  and  $4.8 \times 10^5$  cfu/ml accordingly. In the aquatory of the waterbody the TM and TP ranged insignificantly. A strong correlation between water temperature and TP was revealed ( $r= 0.98$ ,  $p= 0.95$ ). Mean values of TP differed significantly in summer and autumn as compared with spring ( $p= 0.99$ ). Self-purification index ranged from 0.2 to 207.1. The amount of SP and water temperature correlated negatively ( $r= -0.6$ ). Indices of bacterial contaminants increased acceptable level for total coliforms in 2.2 times, faecal coliforms – in 1.2 times, faecal streptococci- in 8.2 times. The highest value of TC was revealed in the mouth of the Pregola River (Kaliningrad hydrologic region) and in the central hydrological region near the border with Poland. The average count of the TC and TP correlated significantly ( $r= 0.62$ ,  $p= 0.95$ ). The FS index in the Vistula (Kaliningrad) Lagoon aquatory varied from 81.9 to 1100 cfu/100

ml. Low value of the faecal contamination factor (FC/FS ratio) characterized the origin of the bacterial pollution as predominantly animal-borne contamination. Based on the results of our investigations, the water in the Russian part of the Vistula (Kaliningrad) Lagoon can be characterized as beta-mezosaprobic and alfa-mezosaprobic polluted of 3-4 category of cleanness.

*Vistula Lagoon, Kaliningrad Lagoon, Baltic Sea, bacteria, pollution, sanitary significant microorganisms*

V. I. Vorobyov. Using fish skin with scales for food purposes

A method for producing collagen-containing food products has been developed that allows one to obtain functional drinks, dessert products and collagen-containing food additives with a high content of calcium. The method consists in cleaning and washing with water fish skin with scales, its subsequent processing in a mixer with the addition of baking salt, baking soda and ice, fractionation of the resulting mixture onto fish skin cleared of scales and a mixture of scales and skin. Both fractions are separately subjected to heat treatment in liquids (85-100 degrees C) containing organic acids (juice, whey). The mixture of scales with skin fractionated after heat treatment is homogenized, dried and ground (food supplement). The heat-treated fractionated fish skin is homogenized and used as a functional food base / additive to produce dessert products such as mousse, yogurt, jelly, etc. The liquids remaining after heat treatment are cooled (functional drinks). The chemical analysis (general, amino acid) of raw materials (zander skin without scales, direct-pressed apple juice) and finished products (apple juice with skin thermo-hydrolysis products, dried food base / additive) is presented. It has been determined that during heat treatment of fish skin in a liquid, the mass fraction of protein in apple juice increased from less than 0.3% to 1.79%, total ash from 0.2% to 0.5%, glycine from less than 0.25% to 0.4%, with a decrease in carbohydrates from 11.6% to 9.3%. The mass fraction of protein of heat-treated fish skin, compared with the feedstock, decreased from 88.87% to 70.78%, and carbohydrates increased to 13.0%. The developed method for processing fish skin with scales contributes to the expansion of the range of new functional food products.

*fish skin, fish collagen, food supplement, functional drink, gelatin*

O. V. Zinina, O. P. Neverova, A. V. Khitsenko. Production and analysis of caciotta cheese from goat milk, enriched with dietary fibers

Goat milk is one of the best types of dairy raw materials for the production of specialized products due to its high biological value and hypoallergenic properties. Manufacturing technology of Caciotta cheese from goat milk with the addition of dietary fiber in the amount of 1, 3 and 5 % by weight of the raw material has been considered. The organoleptic and physico-chemical indicators of goat milk, as well as its cheese suitability, have been determined. The results of the study showed that the original goat milk conforms the requirements of GOST 32940-2014 and is cheese-suitable. The sequence of technological steps for the production of Caciotta cheese enriched with dietary fiber is presented. The dietary fibers were introduced to milk at the initial stage before milk fermentation with homogenization to reveal the properties of dietary fiber and the uniformity of their distribution. The results of the studies of the

Caciotta cheese samples showed that with an increase in the content of citrus dietary fiber, the fat content decreases from 52.46 % in the control sample to 50.08 in a sample with 5 % dietary fiber; the moisture content increases from 53.92 % in the control sample to 56.82 – in the sample with 5 % dietary fiber. The results of the descriptor analysis showed that with an increase in the content of dietary fiber, the sour-milk smell and taste become less pronounced, the citrus smell and taste prevail, while the consistency becomes more dense and elastic. The sample with the citrus dietary fiber in amount of 3 % has the most harmonious organoleptic properties. The yield of cheese ranged from 1280 g of the control sample, to 1530 g of the experimental sample with the addition of dietary fiber in amount of 5 % from 10 L of milk. Thus, according to the results of study, it can be concluded that citrus dietary fiber can be added to goat cheese to produce a novel product in terms of its organoleptic properties, increase in its yield, and also enrich the cheese with a functional ingredient.

*goat milk, Caciotta cheese, quality indicators, product yield, dietary fiber*

*V. A. Naumov, D. L. Alshevskiy, Yu. N. Korzhavina.* Influence of technological factors on strength characteristics of fish imitation lard

In Russia, not only the consumption of lard as an independent product (salted, smoked), but also a number of products obtained with its addition are highly popular. For example, lard can be used for the manufacture of sausages, deli meats, canned goods, semi-finished products and other products. However, recently there has been an increase in the number of people who, for a number of reasons (religious, health problems, taste preferences, etc.), reduce or even exclude products of animal origin from their diet. Currently, a number of enterprises have begun to use various technologies of imitation lard. As a result, it became possible to obtain a product that is similar in appearance, consistency and color to pork lard. Such a replacement will reduce the cost of finished products and may lead to improved functional and technological properties. Imitation lard has high adhesion with minced flesh, it is tightly held in the structure of the product, and its technology is easily reproduced in a production environment. There is a known technology of imitation lard based on vegetable oils or raw materials of animal origin (chicken skin, beef fat), but obtained imitation lard does not always go with fish raw materials. In this paper, we propose a method for producing fish imitation lard based on fat-containing fish waste. The aim of the work is to study the strength of the emulsion. Based on the results of an experimental study, a contour plot of the strength of the imitation lard depending on time and concentration has been constructed; it is shown that empirical coefficients depend on the MITPRO concentration.

*fat deposits, fish oil, imitation lard*

*O. P. Chernega, O. V. Kazimirchenko.* Improvement of sour white cabbage technology with the application of lactic-acid bacteria

Vegetable crops take a significant part in the human diet which is confirmed by consumer market analysis. The technology of vegetables fermentation and in particular white cabbage is one of the most traditional and slightly variable technologies.



Fermentation of sour white cabbage is a complex microbiological process that depends on some factors. To improve the quality of this type of product some changes may be introduced into fermentation technology. However the improvement of any technology is possible if the patterns are mastered, essence of the process is studied and the optimal conditions are revealed which allow optimizing technological processes. A deep study of factors including microbiological ones affecting changes in the structure of pickled cabbage and the speed of organoleptic properties formation allow us to improve the classic technology. The purpose of this research is to improve the technology of white cabbage fermentation using the microbiological culture of lactic acid bacteria *Lactobacillus plantarum* which play a significant role in lactic acid fermentation processes. It has been shown that the addition of lactic acid bacteria reduces duration of the cabbage fermentation process, accelerates organoleptic properties formation and maximally preserves vitamin activity of the starting materials. Sanitary indicative and pathogenic bacteria have not been revealed.

*sour white cabbage, lactic acid fermentation, microbiological indicators, acidity, salinity, vitamin C, spoilage microorganisms, organoleptic indicators*

*N. V. Yartseva, N. V. Dolganova, N. D. Aisungurov.* Effect of washing on the quality and storage time of minced pond fish

In modern conditions, one of the most important goals of the processing industry can be considered the solution of the complex task of satisfying the needs of each individual in food products, taking into account his physiology by providing the necessary quality indicators, in particular, their biological value and environmental cleanliness. In recent years, the number of people using ready-made meals and semi-finished products, including fish, has increased. Fish raw materials have high nutritional value and taste, but with all the advantages of fish over other products of animal origin, its consumption in the country, including in the Astrakhan region, is very low. This is due to the low solvency of the population, which forces processors and producers to find opportunities to reduce the cost of manufactured fish products. At the same time, when the fish stocks of inland waters are in critical condition, aquaculture is a promising direction for the development of fisheries. Particular attention in this aspect is paid to the rational processing of aquatic organisms with high biological value. The results of modern scientific research and the analysis of industrial production experience prove the economic feasibility of processing fish raw materials for minced meat, that is, create new generation products that meet the changing requirements of consumers. Integrated processing of fish pond raw materials for minced meat will allow the maximum use of the edible part of fish in the production of a number of molded products, and inedible - to send to the production of feed and technical products. The paper considers a change in organoleptic, structural-mechanical, physico-chemical and microbiological quality indicators of washed and unwashed minced meat products from pond fish raw materials, in particular silver carp, carp and grass carp. In the process of cold storage, the optimal shelf life of the washed minced meat from pond fish has been established.

*washed minced pond fish, carp, grass carp, silver carp, cold storage, storage time, organoleptic characteristics, physico-chemical indicators, microbiological indicators*

*O. A. Antsiferova, D. N. Safonova. Seasonal dynamics of productive moisture in sod-podzolic soils on lake-glacial clays*

The research was conducted in 2019 at a key site in the Chernyakhovskiy district of the Kaliningrad region. We studied the soils and reserves of productive moisture in the humus horizon (0–20 cm) and the 0–100 cm layer under perennial grasses on a seeded hayfield. Within the lake-glacial lowland plain, soils formed on carbonate heavy clays are common. The factors of differentiation of the soil cover are the relief and power of the clay layer. The main difference between the soils is the degree of gleyization. Deep-gleyed sod-podzolic soil with a clay layer thickness of 77–115 cm is located at the elevation of the relief. The field is dominated by a reduced flat relief. Such areas are occupied by surface-and profile-gleyed sod-podzolic soil with a 150 m layer thickness of heavy clay. Monitoring of productive moisture reserves was carried out on two soil areas that differ in the degree of hydromorphism. By the beginning of the resumption of vegetation of perennial grasses, the moisture reserves in both soils were satisfactory in the 0–20 cm layer and good in the meter thickness. The dynamics of moisture reserves is related to the characteristics of water consumption of herbs. The humus horizon of soils is characterized by sharp fluctuations in moistening. Statistical analysis did not reveal significant differences between soils in moisture reserves over the entire observation period in layers 0–20 cm and 0–100 cm. However, there was a tendency for more contrasting moisture and desiccation of the soil with a more powerful clay layer. The reserves of productive moisture in the studied soils under the prevailing agrometeorological conditions were sufficient to ensure a high yield of two mows. Late dates for the first production mowing are undesirable, because soil moisture is consumed unproductively.

*sod-podzolic gleyed soils, lake-glacial calcareous clay, monitoring of the reserves of productive moisture, perennial grasses*

V. I. Panasin, *D. A. Rymarenko, K. V. Deputatov, M. I. Wikhman. Soil-geochemical aspects of zinc distribution in soil-forming rocks and soil-ground waters of agricultural landscapes of the Kaliningrad region*

Soil-forming rocks are of glacial origin. Five genetic groups of soil-forming rocks have been identified. The most widespread are washed moraine deposits. In glacial rocks, such minerals as quartz, hydrosludes and feldspar are predominant; in water-glacial and ancient alluvial – minerals of the silica group. Zinc-bearing minerals are found in soil-forming rocks in trace amounts, and in general their number is much lower than in soil-forming rocks of the non-Chernozem zone of Russia. In the soil-forming rocks of the region, zinc is in a dispersed state. It has been established that the zinc content depends on a number of physical properties of rocks, and the amount of zinc in humus-accumulative horizons of soils of agricultural lands is mainly determined by the zinc content in soil-forming rocks. Concentration of zinc in soil and groundwater is largely inherited from its content in soil-forming rocks. The low content of zinc in soil-forming rocks causes a deficiency of this trace element in the soils of the region. The content of zinc in soil and groundwater has been determined. According to the concentration of this trace element in soil and groundwater, the territory of the region is

divided into four provinces. The maximum zinc content has been observed in the groundwater of the Eastern zone, where heavy rocks with a carbonate horizon close to the daily surface prevail. The lower zinc content is typical for the soil and groundwater of the Western part of the region, where deeply leached rocks of sandy, sandy loam and light-loamy granulometric composition prevail. Soil- ground waters of the Slavskiy district are characterized by low zinc content.

*soil-forming rocks, soil-ground water, total zinc content*

*P. R. Grishin, S. V. Dyatchenko, V. A. Korobchinskiy, A. A. Nedostup.* Mathematical modelling when determining basic elements and characteristics of fishery vessels

The paper shows the relevance of creating a new methodological support for determining basic elements and characteristics of fishing vessels in order to reduce the design time and improve the quality of design work. A quantitative assessment of economic and technical indicators characterizing the operational efficiency of a fishing vessel obliges a designer to comprehensively solve a problem of determining the optimal elements and characteristics of the vessel, taking into account dominant factors. To determine the optimal elements and characteristics of a fishing vessel and reduce the time for design work, modern software products are currently being used that allow systematic studies of seaworthiness, strength and vibration characteristics, as well as the determination of relevant indicators of economic efficiency. The effectiveness of the use of software products in the design of marine objects depends on the designer's qualifications, capabilities of the software products and the available methodological support. Currently available methodological support for the design of fishing vessels does not allow solving problems in the required volumes. A new algorithm and corresponding mathematical models for the design of modern fishing vessels are proposed. The accumulated database of the main elements and characteristics of various types of fishing vessels allowed us to proceed to the development of new methodological support for creating design solutions using 3D modeling. The developed methodological apparatus uses: methods of variations and successive approximations; an electronic database of the main elements and characteristics of fishing vessels; created 2D and 3D models of the body shape; curves of elements of a theoretical drawing; 2D and 3D models of architectural and structural design of energy, hydrodynamic and mining-technological complexes for typical projects of a fishing vessel.

*shipbuilding, fishing vessels, algorithm, mathematical model, basic elements, vessel characteristics, 2D and 3D modeling*

*D. A. Romanyuta.* Comparison of methods for designing vessels from composite materials in accordance with the requirements of the rules of classification societies of different countries. Part 1

The article presents examples of the use of composite materials in the shipbuilding industry. Methods of designing ships from composite materials in accordance with the requirements of the Rules of the Russian (sea and river), Polish, Indian and Korean shipping registers are considered. A brief analysis is made of the

content and the main highlighted ideas of the Rules. The requirements in terms of calculating the overall strength of the hull, in terms of the general approach to the choice of bond sizes, permitted materials, the required characteristics of the materials used and other input data necessary for the design of the composite hull structure are analyzed in more detail. An analysis of the requirements showed that the design techniques for ships of different countries are radically different from each other and can show completely different results, with the same design object. Among the Rules considered in the article, the requirements of the Russian River Register, regarding the design of fiberglass vessels, turned out to be the most concise and incomplete. From the point of view of calculating the total strength of ships, the requirements of the Rules of the Korean Register of Shipping are the simplest of those considered. This is due to the fact that calculation requires the least amount of source data available at the earliest stages of design. From the point of view of choosing the sizes of connections, the requirements of the Rules of the Korean Register of Shipping are simpler than others, due to the smaller amount of required data and a more understandable approach to design. This approach operates with formulas that are justified from the point of view of strength calculation and does not depend to a large extent on the process and method of manufacturing sheet structures (as in the Rules of the Polish Register) or on any empirical dependencies (Rules of the Russian Maritime Register).

*composite materials, design methodology, ship design, general strength, register, classification society, fiberglass*

*Yu. N. Slastikhin, A. N. Chernega. Experimental study of oil drying processes*

The article considers an experimental study of oil drying. Presence of water in cooling oil leads to increase of its corrosion effect on metals. The appearance of even traces of water in the oil increases the corrosion rate by more than 20 times. One of the main reasons for the water cut of the freon system is the supply of non-quality refrigerants and oils containing a lot of water. In order to prevent the freon system from watering down, it is necessary to strictly check the oils filled in the refrigeration units for moisture. The most available method in ship conditions is to determine the availability of water using the ships integrated laboratory "SKLAMT-1" with simple equipment. If moisture is detected in oil, it must be dried. To separate water from oils in ship conditions, an experimental plant was created, consisting of a single-stage refrigerating machine VF-3M, as a consumer of cold used a heat-insulated vessel with a capacity of 10 liters, filled with a oil-water mixture, inside the vessel there is a coil (evaporator) cooling the oil-water mixture. Separation of water from oil-water mixture is carried out in three ways: upholding of oil-water mix; freezing of water without preliminary settling of stock-and-water mixture; freezing of water with preliminary settling of oil-water mixture. The temperature of the cooled oil was kept constant  $T_m = -20$  deg C. Samples of the oil-water mixture were taken hourly in three sections of the vessel (bottom, middle, top). Water content in samples of oil-water mixture by Dean-Stark method was found by GOST 2477-65. Analysis of the results of the experimental data has showed that separation of water from oil in the range of positive temperatures by a method of sedimentation is quite effective. Cooling of the water-oil mixture to negative temperatures leads to precipitation of moisture into the lower part of

the vessel at the initial moment of time due to difference of density and difference of partial pressures of water sludge, and then water sludge is frozen within 2–5 hours of plant operation.

*separation of water from oil, experimental study, methods of determining the presence of water in oil*

A. Ya. Yafasov, N. A. Kostrikova. Problems of transformation of social and economic systems in postCOVID-19 economy

It is shown that turbulence in socio-economic systems that has arisen since the beginning of 2020 is fundamentally different from the previously encountered metamorphoses, requiring a revision of approaches to sustainable development and management of socio-economic systems at all levels – local, regional, sectoral, and state and transnational. For the first time, the primary cause of metamorphosis was human morbidity, which affects the homeostasis of society and the stability of the economy, the speed of spread of COVID-19, different manifestations in different countries depending on the culture and education of society, the state of medicine and the structure of GDP and other factors. It has been established that metamorphosis occurs by creating a new digital infrastructure of socio-economic systems based on a radical revision of established dogmas in the economy and society, in relation to the natural environment. It is shown that it lags behind the metamorphosis of the real economy, which has been taking place since the beginning of the 21st century due to the development of nano-, bio-, info-, cognitive, socio-, additive technologies, genetics and robotics, sensorics and distributed energy and their transition to the category of emergent. A condition for a successful metamorphosis with the transition to sustainable development is the preservation of the best traditions of culture and the creation of integrated intelligent management systems in socio-economic systems.

*socio-economic systems, sustainable development, digital economy, situational centers, homeostasis, metamorphosis, convergent interaction, emergent technologies*

#### **KSTU News, № 59**

D. G. Gogolev, T. V. Bukanova, S. V. Aleksandrov. Regional correction of algorithms for chlorophyll «a» concentration retrieval from VIIRS and OLCI radiometers satellite data of in the south-eastern part of the baltic sea

The work is devoted to the assessment of accuracy of chlorophyll “a” concentration retrieval from satellite data of visible range in the surface layer of the south-eastern Baltic Sea. Values of chlorophyll “a” concentration collected in the marine expeditions of 2019 and calculated using the novel satellite radiometers: VIIRS installed on the Suomi-NPP and NOAA-20 satellites, and OLCI working on the SENTINEL-3A and 3B satellites were compared. Comparison of traditional ship measurements and state-of-the-art satellite technique allowed estimating the errors of chlorophyll “a” concentration calculation using standard satellite data processing algorithms: the OCI algorithm for VIIRS radiometer data and the algorithm using a neural network for OLCI radiometer data. Verification of satellite data processed by

standard algorithms showed a weak connection with field data and corresponding errors: the determination coefficient was 0.3 and the regression error was 2.51 mg/m<sup>3</sup> for the OCI algorithm applied for VIIRS radiometer data and the determination coefficient was 0.06 and the regression error was 1.65 mg/m<sup>3</sup> for the algorithm using a neural network applied for OLCI radiometer data. Correction of standard algorithms by regression equations was proposed, and provided the smallest errors in calculating the chlorophyll “a” concentration in the study area using satellite data and improved the fit between ship and satellite data. The highest accuracy of concentration of chlorophyll “a” calculation for the south-eastern Baltic Sea is provided by OLCI satellite radiometer with the proposed regional correction: the regression error is 1.1 mg/m<sup>3</sup>, the determination coefficient is 0.3.

*chlorophyll «a» concentration, satellite data of visible range, regional algorithms, the Baltic Sea*

*Ju. A. Gorbunova, E. E. Esiukova. Emissions of macroalgae and seagrass in the Russian part of the South-East Baltic sea coast*

Emission of macroalgae and seagrass is a natural process on the Baltic seashore. However its amount and features are largely preconditioned by the sea waters eutrophication. Macroalgae emissions can accumulate litter and pollutants (macro/meso/microplastics, petroleum hydrocarbons, heavy metals, etc.). They are mediators that accelerate the transit of these substances from the sea to the coast and back. Emissions on the beaches worsen their recreational attractiveness. At the same time, emissions of macroalgae and seagrass can serve as a valuable raw material, the industrial use of which requires an assessment and forecast of possible volumes of emission. Observations of the features and spatial distribution of macroalgae and seagrass emissions were carried out in the Russian part of the south-east Baltic sea coast in January 2017 - May 2020. Distribution of the emissions was characterized by significant spatial and temporal variability. The largest macroalgae accumulations were local and mainly near the coastline protrusions as capes (natural) and breakwaters, slipways, groins (man-made). Large amounts of emissions were observed on the northern coast of the Sambia Peninsula (patches up to 1,5 km long, at times up to 12–20 m wide, at the sea face up to 60–100 cm high), in contrast to the western coast and Curonian and Vistula spits especially from late autumn till early spring when Radophyta is a main biomass in emissions. Chlorophyta and Phaeophyta were in a large amount in summer. The appearance and residence time of emissions was due to hydrometeorological conditions. Usually the largest amount of macroalgae was after storms. The residence time of macroalgae on the beach varied greatly and was often limited to a few days. Further transformation of emissions could take place in several ways – by flushing back into the sea (most often), by burial under a layer of sand or small pebbles, and by wind dispersal along the beach.

*macroalgae, seagrass, macroalgae emissions, coastal zone, sea coast, hydrometeorological conditions, Baltic Sea*

A. V. Granin, F. M. Shakirova, Yu. A. Severov, M. A. Gorshkov, A. E. Kalaida, O. K. Anokhina, I. R. Shakirov, Yu. S. Utyamyshcheva. Structure of the sterlet population (*Acipenser ruthenus* L.) of the Kuibyshev reservoir based on materials of 2012–2019

The article presents data from long-term studies of the population of sterlet in the Kuibyshev reservoir and the changes that have occurred in its structure. Biological indicators of the Kuibyshev reservoir sterlet of recent decades are analyzed, compared to those of previous years of research. The study of the sterlet catch in the Kuibyshev reservoir revealed, what is compared to the data from previous years, the commercial catch of it has significantly decreased. Sterlet is the object of poaching and is rarely given up at reception points. The basis of the number of catches in 2012–2019 in the Volga, Kama and Volga-Kama ples, as well as throughout the reservoir, were fish with an absolute length of 30–45 cm. Fish with a commercial length of 42 cm (absolute length of 47–48 cm) or more accounted for 4 % of the total sample size. Our catches are dominated by sterlet weighing 150–300 g. The absence of fish older than 10 years of age was noted, increase in linear size in 3–5-year-olds and numerical predominance of females over males. According to size and weight indicators, fish have sexual dimorphism. It is revealed that females of sterlet of the Volga reach of Kuybyshev water reservoir, those who are at the II fat stage of puberty, grow more intensively than females with no fat deposition in the gonads. The materials obtained in the course of research are of great practical significance for the rational use of fisheries and environmental significance for existing biodiversity. The research results allow us to assess the current state of the sterlet population as one of the most valuable representatives of the Volga sturgeon family and its reservoirs.

*sterlet, Kuibyshev reservoir, age structure, size and weight indicators, sexual structure*

V. F. Dubravin, M. V. Kapustina. Zoning of hydrochemical fields of the Baltic sea deep layer

Average annual values of salinity (S, PSU), dissolved oxygen (O<sub>2</sub>), phosphates (PO<sub>4</sub>), ammonium nitrogen (NH<sub>3</sub>) and nitrates (NO<sub>3</sub>) (μmol/kg), averaged for 1950–2005 on a regular grid of one degree [1], are divided into clusters. The cluster analysis (modification by V. Ryakhovsky [2]), has been carried out in two variations: by five parameters (including salinity, 1<sup>st</sup> variation) and by four parameters (excluding salinity, 2<sup>nd</sup> variation). It allowed us to distinguish five and four clusters (regions) in the deep layer (at salinity maximum layer S<sub>max</sub>) of the Baltic Sea, according to the 1<sup>st</sup> and 2<sup>nd</sup> variants of the analysis, respectively. Clusters 1–4 in both versions are quite similar: 1 – Aland, 2 – Marginal, 3 – Main Area, 4 – Gotland-Finland. Fifth cluster – Western – distinguish according to the 1<sup>st</sup> variant of the analysis, while in the 2<sup>nd</sup> variant it goes to the 3<sup>rd</sup> cluster. Aland cluster is characterized by high values of phosphates and ammonium; Marginal – by low phosphate values; Gotland-Finland – by lowered values of nitrates; Western (according to the 1<sup>st</sup> variant) – by high salinity values; Main Area cluster allocated on a leftover basis. The paper presents the results of the correlation analysis performed for the clusters. The calculations allow us to conclude that stratification of the Baltic Sea and water exchange with the North Sea control the

distribution of salinity and dissolved oxygen, phosphorus and nitrogen in the deep layer. The results of this study and the one carried out earlier for the surface layer [3] confirms the conclusion, made in [4-6], but now with the quantitative estimates.

*salinity, dissolved oxygen, phosphate, ammonium nitrogen, nitrates, deep structural zone, cluster analysis, correlation analysis*

*N. A. Dyakova, S. P. Gaponov, A. I. Slivkin. Ecological and hygienic assessment of soil condition of the anthropogenic ecosystems of the Voronezh region*

Today heavy metals are one of the most dangerous pollutants of objects of a surrounding medium owing to their migration on biological chains. The research was aimed at studying of ecological-hygienic condition of the upper layers of soils of urbo- and agroecosystems of the Voronezh region. 51 points of exemplars of upper layers of soils in areas, various in terms of anthropogenic influence, have been chosen in the region. The content of the main heavy metals has been studied in the analyzed examples: lead, mercury, cadmium, arsenic, cobalt, nickel, chrome, zinc, copper. Territories have been identified where upper layers of soils are polluted with these or those elements, and also facilities used for economic activities in the region doing the greatest harm to the environment have been shown. 18 examples of soils do not conform to the requirements of the standard documentation on the content of heavy metals. At the same time the industrial enterprises LLC Bormash and JSC Minudobrenie, combined heat and power plant of "VOGRES" and also automobile route M4 and the railroad have the greatest negative impact on the condition of upper layers of soils of the region. At the general wellbeing of bigger number of the explored soils on the maintenance of separate elements, calculation of a total indicator of pollution allowed us to draw a conclusion that only 10 exemplars which have been collected in Elan-Koleno, Nizhnednevitk, the Novovoronezh and also exemplars collected in Olkhovatsky, Gribovsky, Hokholsky, New Khopyor, Repyevsky, Vorobyevsky districts and at a distance of more than 100 m from not high-speed automobile road in Bogucharsky district demonstrate tolerable rate of pollution. At the same time the clearest soils of the region can be considered soils near the Novovoronezh, the settlement of Elan-Koleno, in the New Khopyor and Bogucharsky districts.

*Voronezh region, lead, mercury, cadmium, arsenic, cobalt, nickel, chrome, zinc, copper, soil, index of pollution*

*E. A. Lozitskaya, O. S. Bugranova, O. V. Kazimirchenko, N. A. Tsupikova. Assessment of the ecological condition of the Karpovskoe lake in 2019*

The Karpovskoye lake is a small reservoir of Kaliningrad, which is actively used for recreation. Small water bodies are most vulnerable to pollution and within a short period of time may lose their self-purification capacity. The purpose of this paper is to assess the ecological condition of the Karpovskoe lake by hydrochemical, hydrological, microbiological and hydrobiological parameters. The hydrochemical parameters of the lake, with the exception of the total iron, corresponded to the values of fishery standards. High content of the total iron in the lake water above the standards is typical



for the surface waters in the Kaliningrad region. The number of saprophytic bacteria in water increased by the summer-autumn season, which is associated with a growth in water temperature in summer to an average of 22-26 °C and an increase in destructive processes in the autumn season. Aerobic bacteria predominated in the bacterioplankton of the lake, development of which was determined by the presence in the water of readily available organic matter, a sufficient amount of oxygen, and a favorable pH of the environment. No pathogenic bacteria dangerous to human health have been found in the microflora of water. According to taxonomic indicators, the algoflora of the lake was characterized as «green-euglen-diatom-blue-green», which is typical for many urbanized reservoirs. Quantitatively, algae from the Cyanoprokaryota division prevailed with the dominance of *Limnothrix redekei* and *Planktothrix agardhii*. Algae vegetation throughout the entire period contributed to the maintenance of consistently high oxygen content and possibly influenced the decrease in the content of nutrients in the water. The results of the comprehensive analysis showed that The Karpovskoe lake is  $\beta$ -mesosaprobic, which corresponds to the eutrophic level.

*the Karpovskoe lake, ecological assessment, algological analysis, microbiological analysis, hydrochemical characteristics*

V. A. Naumov, A. A. Zemlyanov. Calculation of water-fish mixture unsteady inflow into the working tank of the vacuum fish pump unit

Vacuum fish pumping units provide the least damage to fishing objects in comparison with other means of mechanization of overload. Therefore, at present they are widely used in fisheries. However, vacuum fish pumps have a serious drawback. The efficiency is much lower than, for example, in case of centrifugal fish pumps. Researches of vacuum fish-pumping units of the last years are directed on increase of their power efficiency. Earlier in the published works of the author, the first phase of the suction stage - pumping air from the working chamber using a vacuum pump-has been investigated. The present article offers a mathematical model of the second phase of the first stage of operation of a vacuum fish pump unit – suction of water with fish in the working capacity. The Cauchy problem of unsteady inflow of water-sample mixture is solved by numerical method. It is established that the similarity criteria of the problem are: the ratio of initial pressure in working tank to atmospheric pressure, dimensionless height of liquid rise, the generalized coefficient of hydraulic resistance of the pipeline, the ratio of the volume of the piping and working tank. The unsteady nature of the flow is due to a decrease in the pressure drop in the suction process. If it is not taken into account, then with a decrease in the volume of the working capacity and an increase in the length of the suction pipeline, the calculation error can reach 20 %. The proposed method of calculation allows us to determine at the given values of similarity criteria, what volume of water-sample mixture will be pumped into the working tank in one cycle, what useful work will be done at the same time. This is necessary to assess the energy efficiency of the vacuum fish-pumping unit.

*vacuum fish pumps, suction stage, mathematical model, calculation method, liquid flow, pressure, useful work*

A. I. Nikitenko, D. V. Artemenkov, V. A. Belayev. Specific features of length-weight characteristics of some pelagic and demersal fish species of the Central Eastern Atlantic

The Central-Eastern Atlantic (CEA) is one of the most bioproductive areas of the world's oceans, especially in the Canary upwelling area. At present, the main commercial fishing activities are carried out with the aid of active fishing gear – pelagic trawls. The study presents the parameters of Length-Weight Relationships (LWR) of some pelagic and bottom fish species of the Central-Eastern Atlantic. The data obtained in the course of expedition research were used for studying of small pelagic fish in 2004-2017. Six species showed isometric growth, four species showed positive allometric growth, and two species showed negative allometric growth. The comparison showed that the types of growth by b parameter in fish differed significantly for the same species from different locations. These differences may be related to differences in the physiological state of fish in different seasons of the year, or to differences in prevailing environmental conditions, the degree of fullness of the stomach, gonad maturity, gender and the presence of diseases, and the characteristics of the sample, such as size ranges, the number of selected individuals. The results of this study can be useful for determining the trend of allometric growth depending on the state of the number of main commercial and by-catch fish species in fisheries management. In addition, the LWR parameters presented here for the first time for the species *M. Senegalensis*, *T. trecae* and *B. brama* caught in CEA can serve as a starting material for comparison with future studies conducted in this area. Mesopelagic and epipelagic fish included in this study have a more rounded shape, while bottom fish have a more elongated shape.

*Central-East Atlantic, LWR, length, weight, pelagic, epipelagic, mesopelagic, bottom*

G. V. Alekseev, O. A. Egorova, A. G. Leu, I. P. Yukhnik. Modeling of the temperature pattern of a starch- or pectin-containing raw materials bulk in the presence of internal self-heating

This article is devoted to determining temperature distribution by volume of the embankment of food, starch or pectin-containing raw materials during storage in specialized silos. The object of research was the boundary conditions for storage under conditions that are most appropriate for real conditions with active ventilation. Despite the importance of solving issues related to the prediction of the formation of heat-moisture fields during storage of the studied embankments and the changes in the technological properties of the raw materials that depend on them, currently available mathematical descriptions of these conjugate phenomena are not enough. This is due to the complexity and poorly studied processes of storing food embankments at both the micro and macro levels. Such masses are a system with distributed parameters. A significant feature that largely affects the studied temperature distributions is the possibility of new internal sources of heat and moisture appearing in food bulks of this type. Formation of such sources in some cases is based on the effect of "self-heating", which appears due to biological processes occurring in mounds, such as "breathing" of individual elements of the bulk, such as inside stored grain mass. In this regard,

possibility of predicting the fields of heat and moisture content depends, on the one hand, on the completeness of the necessary information about the humidity and temperature of the components of the mass at the initial moment, and on the other hand, on the reliability of the mathematical model, which is capable of setting boundary conditions based on this information and thermophysical constants, describe the real processes of heat transfer in the embankment. The relevance of the article lies in the fact that the analysis of the nature of the features of heat and mass transfer in the discrete embankment of a food product can be carried out only on the basis of the formed analytical models.

*heat-moisture fields, technological properties of raw materials, conjugate phenomena, distributed-parameter system, temperature pattern forecasting, mathematical model, boundary conditions, thermophysical constants, heat transfer processes*

*M. N. Alshevskaya, O. V. Anistratova, I. I. Sviridenko.* Formulation of a semi-finished product from poultry meat enriched with vegetable components

The aim of the work was to develop a recipe for semi-finished poultry meat, as well as to refine the parameters of the production process. The necessity of expanding the assortment of semi-finished products from poultry meat has been substantiated. A marketing analysis has been carried out of consumer preferences in Kaliningrad and the region. The choice of vegetable components of the sauce for the injection of semi-finished poultry meat products has been justified. The ingredients of the oil-vegetable sauce have determined based on the percentage of weight loss of the finished product. The necessity of adding a structurant to the formulation of the oil-vegetable sauce has been presented. A formulation of the oil-vegetable sauce has been developed, which will improve the organoleptic and physico-chemical properties of semi-finished poultry meat. The effect of salt and temperature on the rheological properties of oil-vegetable sauce has been studied, the optimum temperature of the sauce for injection of broiler chicken fillet in the production of semi-finished products from poultry meat has been established, the optimum temperature has been justified, which retains all the functional and technological properties of the oil-vegetable sauce with the addition of xanthan gum, and also will not affect the microbiological parameters of the sauce. Based on the studies, a production flow chart has been developed. The shelf life of chicken semi-finished product enriched with plant components is set to be 60 days. The new semi-finished recipe satisfies consumers' taste preferences, and is also a dish of high nutritional value.

*semi-finished product from poultry meat, injection, structure-forming agent, viscosity, product, formulation, oil-vegetable sauce*

*V. I. Vorobyov, E. V. Nizhnikova.* The use of fish scales for cosmetic purposes

The paper proposes two methods for processing epidermis of aquatic organisms (fish scales, skin with scales), which make it possible to obtain products for various purposes, including a cosmetic scrub made from fish scales having an attractive appearance, with a natural hue range and a smell of natural origin (without fish smell).

The essence of the methods consists in the preliminary cleaning of the scales from various impurities of organic origin, followed by its thermal treatment in liquid (85–100 degrees C). The liquid used is vegetable, fruit, berry juices and whey containing various organic acids (malic, lactic, etc.). The heat-treated scales are separated from the liquid; if necessary, they are mixed with components of plant origin (cereals, herbal preparations), dried, crushed and fractionated to obtain cosmetic scrub fractions of varying degrees of dispersion. The paper presents organoleptic characteristics and chemical composition (total, amino acid, heavy metals) of raw materials (fish scales) and finished products (cosmetic scrub). It has been found that, during the process of thermal hydrolysis of pike perch scales (*Sander lucioperca*) in a liquid (apple juice), its mass fraction of protein decreases from 40.99 to 30.87 %, calcium – from 21.28 to 17.20 %, phosphorus – from 8.60 to 5.40 %, with an increase in carbohydrates to 13.4 % (due to the components of the juice transferred to fish scales in the process of its thermal hydrolysis). It has been shown that with an increase in the duration of thermal hydrolysis of fish scales, its stiffness decreases (it is rubbed by the fingers) and the content of smaller fractions (abrasive) increases during its grinding and separation.

*human skin, fish scales, collagen-containing products, cosmetic scrub, abrasive*

V. S. Kazakova, E. S. Zemlyakova. High temperature hydrolysis of fish integumentary tissues in the Kaliningrad region

Pike perch is one of the local fish species in the Kaliningrad region. After cutting fish on a fillet, as a type of food waste, skin forms. The purpose of the study was to study the physicochemical properties of the integumentary tissues of pike perch in various periods of fishing and to show the possibility of their use as raw materials for high-temperature hydrolysis. Determination of physical and chemical parameters has been carried out in accordance with GOST 7636-85 “Fish, marine mammals, marine invertebrates and their processed products. Methods of analysis” with the establishment of mass fractions of water, protein, fat and ash. Evaluation of the indicators has been carried out on raw materials selected from the September and November 2019 catch. The hydrolysis has been carried out using autoclaving at a temperature of 130 ° C under a pressure of 0.25 MPa for 60 minutes, at a stirrer rotation speed of 60 rpm. As a result of temperature exposure, three fractions were obtained: upper (water-soluble) and lower (sedimentary) and fat (traces). The physicochemical composition of the obtained fractions has been estimated with the determination of the mass fraction of water, protein, fat, ash. An organoleptic evaluation of the obtained fractions has been carried out before drying and grinding, and after. It has been noted that during the hydrolysis of bone, cartilage tissue with muscle contraction, etc. three fractions are formed: sedimentary, containing insoluble particles, water-soluble and fatty. Due to the low lipid content in the feedstock, the last fraction has not been formed during the thermolysis (traces) and, accordingly, the physicochemical composition of this fraction was not evaluated. The prospect is the possibility of obtaining and using compositions from the integumentary tissue of pike perch as enriching additives in the technology of functional food products, since hydrolyzed fish skin is a source of easily digestible protein and its structural components, minerals, and some glycosaminoglycans.

*Pike perch cover tissues, physical and chemical parameters, high -temperature hydrolysis, water- soluble fraction, functional products*

*A. V. Makeeva, N. Yu. Klyuchko. Assessment of the chemical and biological value of river perch (Perca fluviatilis) in the Kaliningrad region*

The volume of the raw material base of the internal reservoirs of the Russian Federation is estimated at 5 million tons of aquatic biological resources. This can increase the pace of development of the fishing industry and increase the production of fish food products. A promising object of internal reservoirs of the Kaliningrad region is the river perch *Perca fluviatilis*, the main volume of which is caught in the Curonian and Kaliningrad bays. Despite the rich chemical composition, lack of muscle bones, decent taste, good yield of fillet (36-51%), this type of fish can be rarely found on the shelves of the city; mainly it is presented in the form of dried or smoked products. Studies have shown that river bass (*Perca fluviatilis*) is a source of complete protein, fat and minerals. According to the mass fraction of protein, river perch belongs to the group of protein fish (15-20%), and the fat content is low or medium-fat, making it possible to use it in dietary nutrition. A high content of macronutrients was also noted, namely potassium (191.90 mg%), phosphorus (190.00 mg%), sodium (67.10 mg%), from microelements - copper, zinc, and manganese. According to the fatty acid composition, the lipids of river perch differ in the predominance of polyunsaturated acids over monounsaturated ones. There is also a high content of vital essential acids – linoleic (9.5%), gamma-linolenic (2.5%) and partially essential – eicosapentaenoic (12.6%), docosahexaenoic (2.1%). The calculated coefficient of biological significance was 0.39%, and the coefficient of efficiency of polyunsaturated fatty acid metabolism was 0.16. According to the research results, river perch (*Perca fluviatilis*) can be recommended as the main raw material for expanding the range of fish products.

*river perch, Kaliningrad region, chemical composition, fatty acid composition, mineral composition*

*O. A. Antsiferova, D. I. Yusupova. Structural state of sod-podzolic gleyed soils on haymaking within the Lava-Pregol lowland*

The research was conducted in 2019 at a key site in the Chernyakhovskiy district of the Kaliningrad region. The soils on the lake-glacial Lava-Pregol lowland within the studied haymaking area were formed on heavy carbonate clays, sometimes covered with low-power medium loam. The soil cover consists of a combination of sod-podzolic gleyed soils. Soils are gleyed with depth, the degree of expressiveness of signs of podzolization, granulometric composition of humus horizon. On the rise, the soil is medium-loamy in a layer of 0–20 cm, deeper clay, signs of gley with 50 cm. On a typical lowered flat area, the soil is heavy loam and clay surface- and profile-gleyed with a pronounced podzol horizon. The increase in the degree of hydromorphism is associated with greater soil moisture. The structure of both studied soils is lumpy and is assessed as poor in spring and autumn, and unsatisfactory in summer. The structural coefficient for the three monitoring rounds on both soils was less than 0.67. The range

of seasonal variation in the content of the amount of agronomically valuable aggregates (10–0.25 mm) according to dry fractionation data is 17–24 %. Water quality of aggregates during the growing season (April – October) varies from bad to excellent. Differences in the structural state between deep-gleyed and surface-gleyed soils are insignificant according to dry fractionation data. A significant difference is observed in the beginning of April in the degree of water resistance of the structure. Deep-gleyed soil on the rise in the early spring period contains more water-bearing aggregates. There is a strong tendency to increase the water strength of the structure in the surface-gleyed soil in the summer-autumn period due to the deposition of amorphous iron hydroxides on the faces of aggregates.

*sod-podzolic gleyed soils, structural state, water stability of aggregates, seasonal variation in aggregate composition, perennial grasses*

*E. A. Kalinina, Ju. A. Balabay. Influence of biofungicides on economic productivity of winter garlic (*Allium sativum* L.)*

The growing demand of the population for vegetable crops creates the need to expand the area of their cultivation and obtain products in large volumes. In Russia, the area of winter garlic crops is very small and accounts for about 0,3 % of the total area occupied by vegetable crops. In addition, the low yield of this crop is due to the lack of quality planting material. Growth regulators and biofungicides are used in cultivation techniques for widespread introduction into production and obtaining high and stable yields of winter garlic. The article presents the results of the processing of crops of winter garlic biologicals fungicidal activity of Fitosporin-M and Rizoplane. The research object was a zoned variety of winter garlic Gribovsky. When cultivating winter garlic, the main technological methods were used, mineral and organic fertilizers were used. The condition of plants was assessed after the overwintering period and in the subsequent periods of development - from germination to maturation. Special attention was paid to the condition and development of plants after overwintering. According to the appropriate methods, the yield, the proportion of plants affected by bacterial and fungal diseases, economic and biochemical parameters (diameter, weight of bulbs, number of teeth, dry matter and nitrate content) were evaluated. Reliability of the results was evaluated using mathematical statistics. Based on the results of the research, conclusions were made and the importance of processing winter garlic with biofungicides was emphasized.

*garlic (*Allium sativum* L.), biofungicides, economic productivity, biological yield, Phytosporin-M, Rizoplan*

*E. V. Mazur, I. A. Shinkarenko, V. I. Sutyryn, N. L. Velikanov. Vibration diagnostics of anti-friction bearings of the ship propeller shaft*

The paper presents the results of measurements and processing of vibration signals from the anti-friction bearings of the propeller shaft. A comparative assessment has been conducted of the effectiveness of vibration methods for detecting local defects in the anti-friction bearings. The information content and reliability of the assessment of

the applied methods has been evaluated by assessing the obtained values of the defective bearing in comparison with the corrected one. The results of the vibration measurements of the ship anti-friction bearings have been analyzed and studied in terms of their suitability for assessing the technical condition. It has been shown that, in order to obtain an unambiguous assessment of the state of the bearing, the vibrodiagnostics of the bearing assembly must be performed by several methods. Using the studied bearings as an example, it has been found that, in the case of a pulsed non-periodic vibration signal, the statistical parameters of vibration are most applicable for assessing the state. The probability of error is shown with sufficient evidence if, in defining defects, only one of the considered methods is used. The work additionally demonstrates the results of the use of multichannel methods of recording and processing a signal to localize a bearing defect and clarify its nature. The method of ordinal analysis with the construction of the spectrogram of the signal has revealed diagnostic information about the contacting elements in the bearing. Using the method of synchronous accumulation of the temporal implementation of the signal, as well as constructing the envelope of the signal with the display on the polar graphs, it was possible to bind the observed defects to a specific angular sector of the bearing. The results obtained are of high practical value, since determination of the technical condition of anti-friction bearings installed on low-speed ship shafts is a serious problem, and modern methods of vibration diagnostics are not yet widely applied in practice.

*vibration diagnostics, anti-friction bearings, kurtosis method, vibration spectrum*

#### **KSTU News, № 60**

*Aleksandrov S. V., Stashko A. V. Spatial distribution and seasonal dynamics of nutrients in the Vistula lagoon in 2019*

Research of the nutrients (ammonium nitrogen, nitrite nitrogen, nitrate nitrogen, phosphorus of phosphates) was carried out in the Russian part of the Vistula Lagoon in 2019 as a part of the monitoring of aquatic biological resources conducted by AtlantNIRO. The analysis allowed considering seasonal dynamics and spatial distribution and comparing with long-term data (2010-2016) before the commissioning of modern treatment facilities. Seasonal dynamics of the mineral phosphorus and various forms of mineral nitrogen in 2019 corresponded to long-term patterns. The spring maximum was mainly associated with the input of nutrients as a result of freshet. With the beginning of phytoplankton development, their concentrations in the water significantly decreased. Minimum concentrations of mineral phosphorus, nitrates and nitrites were observed in July during the algae bloom. The spatial distribution of nutrients was characterized by the absence of stable differences between regions throughout the year. Only in some months their concentrations in the eastern region and the Primorsky Bay were 2-3 times higher, which is similar to long-term data and this is due to the flow of the Pregol river. Analysis of the long-term data showed that in 2019, after commissioning of modern treatment facilities, there was no local increase in certain areas due to the influx of polluted waters, but the concentrations of mineral forms of nitrogen and phosphorus in the entire Russian water area remained at the same level. In particular, high concentrations of mineral phosphorus remain, especially in

summer. The long-term supply of large amount of nutrients with river and wastewaters, as well as primary production in the eutrophic lagoon led to the accumulation of phosphorus in the reservoir. As a result, the commissioning of treatment facilities cannot have a rapid effect on reducing the level of eutrophication of the Vistula Lagoon.

*nutrients, chlorophyll, treatment facilities, Vistula Lagoon*

*Burbakh A. S., Shibaev S. V.* Research results of spawning migration of european smelt (*Osmerus eperlanus eperlanus* L.) in the Deima river of the Curonian lagoon basin (Kaliningrad region)

The most important places for the fishing of smelt are Curonian Lagoon, the Neman River and the Matrosovka River, while fishing in the rivers and in the lagoon is organized differently. In the lagoon fishing is traditionally carried out with stationary net, and in rivers with beach seines, moreover, the brigades have the opportunity to move with the fish. The existing scheme of location of fishing brigades the last years turns out to be ineffective, and therefore it becomes necessary to expand the geography of smelt fishing. It is possible, both through the organization of fishing upstream in the Neman River, and through the development of new reservoirs, where smelt go for spawning and where is intensive angling. In 2020 the first fishing was organized on the Deima River, which had its own characteristics due to the morphological characteristics of the channel. Smelt go in the Deima River somewhat later than in the main commercial waterbodies, because it is far from the Klaipeda Strait, through which fish enter the Curonian Lagoon from the Baltic Sea. It allows to extend the period of active fishing. The size structure of all three commercial stocks is similar, the only thing that distinguishes the Neman River is the presence of a resident form of dwarf smelt. Fishing on the Deima River in 2020 was effective, the average catch per one draught was 25 kg, without by-catch of dwarf smelt or other fish species.

*Curonian lagoon, Neman River, Matrosovka River, Deima River, commercial yields, European smelt, size structure*

*Lyutikov A. A., Shumilina A. K., Vylka M. M.* Substitution of fish meal and fish oil with vegetable protein and oil in starter feeds for whitefish

The results of growing muksun larvae from the beginning of feeding up to 130 mg on experimental starter artificial feed indicate the possibility of cultivating this species on diets in which fish meal and fish oil can be partially or completely substituted for components of vegetable origin - soybean meal and linseed oil. After 38 days of the study, juveniles receiving experimental feed had a similar survival rate and average individual weight with the control group – 81–82 % versus 79 % and 136–142 mg versus 133 mg (coefficient of variation 21 %), respectively. In most cases, the biochemical and hematological parameters of all juveniles grown in the experiment had similar values and were within the norm, which indicates a good physiological state of the larvae. Analysis of the fatty acid composition of the feed showed that the substitution of half of the fish meal for soy protein did not significantly affect the lipid composition of the artificial diet, which was comparable to the composition of the



control feed. Complete substitution of fish meal with soybean meal, and fish oil with linseed oil, significantly changed the content of fatty acids, reducing the concentration of n-3 in the experimental feed to 1 %. Despite this, the reared juveniles were characterized by a similar (or higher) content of essential fatty acids with the control juveniles. Thus, the amount of linolenic acid in the experimental larvae relative to the control larvae was 2.7 versus 1.2 %, eicosapentaenoic acid – 0.94 versus 1.4 %, docosahexaenoic acid – 5.0 versus 3.2 %, linoleic acid – 19.2 versus 18.5 %, arachidonic – 2.2 versus 1.1 %, respectively. Thus, the relatively high values of n-3 and n-6 essential fatty acids in the lipids of muksun juveniles reared on a feed poor in these acids indicates the ability of whitefish larvae to convert highly unsaturated fatty acids.

*whitefish, starter feeds, linseed oil, soy protein, fatty acids*

*Minina L. M., Minin A. E.* Refining the areas of the Gorky and Cheboksarsky reservoirs based on earth remote sensing data

Estimation of the abundance, state of stocks, as well as the development of the total allowable catch and the recommended catch of aquatic biological resources requires knowledge of the exact values of the water area of the studied water bodies. This study is devoted to the Gorky and Cheboksary reservoirs, located on the Volga river. The purpose of the study is to clarify the areas of these reservoirs using satellite images. Based on the results of decoding satellite images from Landsat satellites for the period from 1997 to 2020 and digitizing the boundaries of the reservoirs, 23 variants of the Gorky area and 28 variants of the area of the Cheboksary reservoir were established at different water levels. Based on these measurements, formulas have been obtained for the dependence of the areas of the Gorky and Cheboksary reservoirs on the water level in them, which make it possible to determine the area of these water bodies by the known water level (the coefficient of determination is 0,79 for the Gorky reservoir, 0,96- for the Cheboksary reservoir). According to calculations, the area of the Gorky reservoir at a normal headwater level (84 m) is 144,8 thousand hectares, the Cheboksary reservoir at the normal headwater level (63 m) – 102,1 thousand hectares, the area of the Oka river, located in the zone of wedging out of the backwater of the Cheboksary hydroelectric power station – about 2,5 thousand hectares. It was revealed that the area of the water area of the Cheboksary reservoir is characterized by greater variability depending on the water level than that of the Gorky reservoir, which is probably due to the high coefficient of water exchange of the Cheboksary reservoir. The seasonal dynamics of the areas of the studied reservoirs is analyzed. Clarification of the areas of the Gorky and Cheboksary reservoirs using geoinformation systems made it possible to conduct a more accurate assessment of the number of aquatic biological resources and develop correct recommendations for forecasting catches in these reservoirs.

*Gorky reservoir, Cheboksary reservoir, reservoir area, seasonal dynamics of areas, Earth remote sensing data, satellite images*

*Ageev O. V., Naumov V. A., Fatykhov Ju. A.* Mathematical simulation of the process of muscle fiber destruction during fish cutting

The paper shows the relevance of mathematical simulation of modes of muscle fiber destruction during fish cutting. The muscle tissue of raw materials has been described by the Maxwell-Thomson viscoelastic rheological model. Two modes of the material fiber breaking have been determined – viscous laceration and elastic tear. Viscous laceration provides a high quality of cut surface. A complex of mathematical models that allow calculating the time intervals for the onset of viscous laceration and elastic tear depending on the structural and rheological properties of muscle tissue and the rate of its deformation by the cutting organ, has been obtained. Models have been developed that describe the mode of fiber destruction, which is characterized by an impact deformation of the material. The simulation results show that with an increase in the dimensionless speed, the quality of the cut surface first increases due to a reduction in the viscous laceration time, and then, when the characteristic value is reached and the further increase in the speed, the cut quality deteriorates due to the onset of elastic tear of fiber. It has been found that an increase in the measure of material elasticity, an increase in the dimensionless cutting speed, and also a change in the dimensionless criteria of material strength lead to a decrease in the quality of the cut surface. It is shown that with an increase in the magnitude of the impact relative deformation, the time interval of viscous laceration decreases nonmonotonically and tends to zero. It has been determined that with an increase in the Young's and retarded elastic modules of the material, the time interval for the onset of viscous laceration decreases significantly. With an increase in the coefficient of dynamic viscosity of muscle tissue, viscous laceration occurs later. With the values of the strength criteria equal to 3; long modulus of elasticity equal 63158 N / m<sup>2</sup>; measures of elasticity 3, 5, 8, 12, the values of the characteristic dimensionless speed are 0.095, 0.055, 0.032, 0.021, while the values of the dimensionless time interval corresponding to the change in the destruction mode from viscous laceration to elastic tear are 10, 20, 30, 45, respectively.

*fish, fiber, muscle tissue, cutting, destruction, knife, edge, rheology, viscoelasticity*

*Vorobyov V. I.* Processing of the cover tissue of hydrobionts in organic liquids of natural origin

The influence of the temperature regimes of processing the integumentary tissues of fish (skin and scales of pike perch) in directly squeezed apple juice was investigated. The general chemical and amino acid composition of the feedstock (apple juice, fish skin and scales) and the obtained thermally processed products (juice-containing collagen drinks, powder of scales, skin) was determined. It was shown that after heat treatment in apple juice (110 deg C, P = 0.11 MPa) of purified fish skin, the mass fraction of protein in the obtained juice-containing collagen drink increased from 0.3 % to 4.1 % (in 13, 7 times), dry matter from 9.5 % to 11.4 %, with a decrease in ash from 0.3 to 0.2 % and carbohydrates from 8.9 % to 7.1 %. The mass fraction of glycine in the resulting drink increased by more than 12.4 times, and proline by 13.1 times (the main amino acids of collagen proteins). With a similar processing of peeled scales, the mass fraction of protein in the resulting drink increased from 0.3 % to 2.0 % (6.7 times), dry matter from 9.5 % to 10.5 %, ash from 0.3 up to 0.5 %, glycine more than 7.0 times,

proline by 7.1 times, with a decrease in carbohydrates from 8.9 % to 8.0 %. The thermally treated scales (powder) obtained after fractionation, drying and grinding had a significant decrease in the mass fraction of protein from 42.0 % to 26.4 % (1.6 times) with an increase in carbohydrates to 16, 1 %, as evidenced by a change in the color of the scale powder (light brown). A comparative amino acid analysis of sterilized (110 deg C) and pasteurized (95 deg C) beverages obtained under similar conditions showed a significant effect of the processing temperature on the increase in the mass fraction of glycine, proline, alanine, valine, arginine, and serine in the liquid.

*directly squeezed apple juice, fish skin and scales, juice-containing collagen drink, fish collagen, fish integumentary tissues*

*Guzhova V. F., Shumanov V. A., Shumanova M. V., Chernova A. V. Study of diffusion properties when dry salting baltic herring with salt enriched with phytocomponents of garlic*

The salting process is the traditional and most expedient process of technological processing for fish of the herring family. Within the framework of the presented work, the process of dry salting of herring was investigated. The diffusion coefficients of the salt are determined by the method of photon correlation spectroscopy. When salting, two types of salt were used: table salt and salt enriched with phytocomponents of garlic. It was shown that the diffusion coefficients of salt enriched with phytocomponents of garlic are an order of magnitude higher than the diffusion coefficients of table salt. The intensity of the diffusing substances of the salt enriched with phytocomponents of garlic was also 1.5 times higher throughout the experiment; however, when the depth of 4 mm was reached, the intensity of light scattering in both samples leveled off. An increase in the diffusion coefficient indicates that the salting process is intensified, since salt, being a carrier of phytocomponents, penetrates into the tissues of herring, and, as a result, phytocomponents that are enriched with salt also penetrate into the tissues of fish. The high value of the intensity of light scattering in the samples of herring with salt enriched with phytocomponents of garlic indicates that "clusters" of salt with water are more actively formed, which means that the water-holding capacity increases, which is confirmed by previous studies. In this case, we can say that salt enriched with phytocomponents of garlic serves as a complex barrier in the technology of aquatic organisms, since it has a high diffusion coefficient, and besides this, antimicrobial and antioxidant properties, which will have a positive effect on the quality of the finished product, as well as on its safety.

*salting, salt, herring, phytocomponents, garlic, diffusion coefficient, scattering intensity, Rayleigh scattering, photon correlation spectroscopy*

*Makeeva A. V., Klyuchko N. Yu. Research on recipe of mold frozen semi-manufactured goods improving from river perch *Perca fluviatilis* with increased biological value*

An urgent direction of research is the expansion of the assortment of molded frozen semi-finished products due to the use of fish from inland water bodies of the country, the inclusion of plant ingredients in the formulation to ensure balance, as well

as the increase of the functional and technological properties of the product through the use of non-traditional structure formers. Based on chemical analysis, the muscle tissue of the river perch (*Perca fluviatilis*) in terms of protein content belongs to the group of protein fish (17.3%), and in terms of fat content to medium-fat fish (2.6%). The studies carried out made it possible to detect all essential amino acids in the muscle tissue of the river perch (*Perca fluviatilis*), calculate their rates (114.8 - 206.1%) and biological value (60.9%), which makes it possible to use it on a large scale in production purposes. Based on the analysis of the chemical, mineral, vitamin composition, as well as the functional and technological properties and prevalence, a selection of herbal ingredients was made, included in the formulation of molded semi-finished products from river perch of increased biological value - apple cake, flax seeds, kale collard ... Studies on the content of vitamin C have confirmed its large amount in kale (17.16%), and among apple pomace obtained from different varieties of apples, the largest amount falls on the variety "Antonovka" (3.52%), which was chosen for the recipe. With the help of mathematical planning of the experiment, the optimal values of the production process of molded semi-finished products were established: the mass of apple cake is 11 g per 100 g of the product, and the mass of swollen flax seeds is 7 g per 100 g of the product. The average organoleptic assessment score was 15.27 points, which indicates an "excellent" category in accordance with the developed differentiated quality level. The constructed profiles of taste and consistency characterize the finished product in more detail.

*molded fish semi-finished product, river perch, chemical composition, amino acid composition, mathematical modeling*

*Naumov V. A.* Influence of rotor frequency of water ring compressor machines on air pumping

The ability of water-ring compressor machines (WCM) to operate both in the vacuum pump mode and in the blower mode is one of their important advantages. Manufacturers publish the results of WCM tests in the public domain. The dependences of the air pumping rate and the power consumed on the pressure in the working chamber are available to researchers in both of these modes. The method for modeling the load characteristics of WCM based on test results was developed earlier at Kaliningrad State Technical University (KSTU). The load characteristics were used to calculate the pressure dynamics in the working chamber when pumping air using the WCM. The noticeable effect of the leakage coefficient on the process parameters was found. All these studies were performed at a fixed rotation frequency of the WCR. Modern WCM allows you to operate them in a wide frequency range. The analysis of the influence of the WCM rotor speed on the air supply and power consumed is performed in the article. Regression dependences of supply and power on pressure at different frequencies were found. The parameters of these dependencies are determined from a small number of experimental points. Their numerical values should be considered estimates. Additional experimental studies are required over a wide frequency range to clarify these values. The Cauchy problem for the pressure in the working chamber was formulated and solved numerically. The minimum pressure in the working chamber does not depend on the increase in the speed of rotation in the vacuum

pump mode. The maximum pressure in compressor mode increases with increasing frequency. The air pumping speed increases in both modes. The time to reach the set pressure in the working chamber decreases, and the mechanical work spent increases. A large amount of mechanical energy is required to pump air into the working chambers of a larger volume.

*water-ring compressor machines, capacity, power consumed, pressure, rotor frequency*

*Sereda N. A., Fedorov S. V.* Search for the coupler curve type in the basic mechanisms of food machines operating at variable power loads

The article analyzes the structures of two basic mechanisms operating under variable power loads. There is a known mechanism in which the maximum power load occurs at the end of the forward stroke, while at the beginning of the reverse stroke there is an increased value of the power load. This value decreases towards the end of the return stroke. This mechanism is used in food machines for fractionating lumpy materials. The working body of such a mechanism is connected with a connecting rod, on which a tray is fixed for placing lumpy materials on it. There is a basic mechanism with a characteristic maximum force loading in the middle of the working stroke interval. Note that in such a mechanism at the beginning of the working stroke, the value of the power load is higher than at the end of this stroke. The named mechanism works as part of a food machine jaw crusher. In this case, the working body can be associated with a connecting rod or a rocker arm. Both basic mechanisms are crank-yoke mechanisms containing two structural groups. The subject of the research is the view of the connecting rod curve of the two basic mechanisms. A graphic-analytical method for constructing a connecting rod curve is proposed – the trajectory of a characteristic point located on the connecting rod. This method is based on determining the length of the segment and the angle of its inclination to the center-to-center distance of the base mechanism. The mentioned segment connects the point on the connecting rod with the articulated fixed support of the basic mechanism. The named support is a hinged connection of the rocker arm with the rack. Dependences are proposed for determining the length of a segment and the angle of inclination of this segment to the center-to-center distance of the mechanism in an analytical form. These dependences are obtained as a function of the crank angle of the basic mechanism and a number of geometric parameters. In the future, the construction and analysis of the type of the connecting rod curve of the basic mechanism is carried out. It is shown that the connecting rod of the basic mechanism for fractionation of lumpy materials moves back and forth over most of the kinematic cycle interval.

*basic mechanism, power load, articulated four-link system, connecting rod curve, graphic-analytical method, construction algorithm*

*Lyubina O. S., Gvozdareva M. A., Grechukhina L. G., Melnikova A. V., Shakirova F. M.* Seasonal dynamics of quantitative indicators of plankton communities in the Volga-Kama reach of the Kuibyshev reservoir

The paper presents investigation results of the seasonal dynamic of the number and biomass for phytoplankton and zooplankton in the Mesha Bay (Kuibyshev reservoir) according to the data from 2019. Distribution of these parameters in shallow-water and deep-water areas have been analyzed. Phytoplankton included 153 taxa from 8 groups, the species diversity base formed by green algae and diatoms. The average microalgae abundance during the investigation period was 3700 mln.cl/m<sup>3</sup>, biomass – 3.65 g/m<sup>3</sup>. The blue-green *Planktothrix agardhii* (Gomont) Anagnostidis & Komárek, 1988 made the largest contribution to the total microalgae activity at all stations. The zooplankton fauna included 65 species, where rotifers diversity was the highest. Quantitative zooplankton parameters turned out to be 343.4 thousand specimen/m<sup>3</sup> – in abundance, 1.56 g/m<sup>3</sup> – in biomass. The Rotifera dominated by abundance in the shallow-water and deep-water areas, but the highest biomass was found for crustaceans. Monitoring of the Mesha bay showed the presence of two peaks for abundance and biomass of phytoplankton – in spring (May) and autumn (September), while for the zooplankton- only one peak in the spring period (May). According to the presented data, it is obvious that in the coastal zone of the Mesha Bay phytoplankton and zooplankton abundance and biomass is much higher than that in the deep-water zone. Shape of seasonal dynamic curves of planktonic communities was similar for the whole bay and for separated areas. Correlation of phytoplankton and zooplankton abundance is tighter in the deep-water zone and biomass – in the coastal zone.

*phytoplankton, zooplankton, abundance, biomass, seasonal dynamic, Mesha Bay, Kuibyshev reservoir*

*Sudnik S. A., Poddueva E. A.* Biology of the crab *Seulocia vittata* (Stimpson, 1858) (Crustacea: Brachyura: Leucosiidae) of the South China sea

*Seulocia vittata* (Stimpson, 1858) – a species of purse crabs in the coastal waters of the Indian Ocean and of the western part of the Pacific Ocean. This benthos eating predator, due to its massiveness, should have a significant effect on hydrocenoses. Despite the small size of the crab, it is actively harvested by a coastal (handicraft) fishery. There is some information about distribution of the species and notes on the morphometry and linear growth of males. New information was obtained on the sex structure, size composition, reproduction of the crab *S. vittata* in Nha Trang Bay in February 2014. Sex ratio in the sample was close to equal, total body length of males and females was comparable (32,3–42.9 mm and 29,5–43,3 mm, respectively), in the width of the carapace: with the dominance of both sex individuals of similar size (about 19 mm), larger females were found. Weight growth of individuals was ahead of linear growth. The maturity size (carapace width), obtained by two methods, was 19–22 mm for males, less than 16 mm-for females. February is the time of active spawning of

crabs; sizes of ripe oocytes were 0,22x0,24 mm, gonadosomatic index in prespawning females, on average- 5,4 %. The fecundity reached 2014 eggs with their sizes of 0,2x0,3 mm. The spawning season was long timed; females were able to produce more than two clutches of eggs per year. The main features of reproduction of *S. vittata* in Nha Trang Bay were similar to these in another species of purse crabs – *Lyphira perplexa* Galil, 2009. The frequency of occurrence of «shell disease» signs – 3,3 %.

*purse crabs, Seulocia vittata, the South China sea, sizes, reproduction, maturity, fecundity, sizes of ripe oocytes, eggs sizes*

*Tylik K. V. Hydroecological features of the Krasnaya river – nature landmark of the Kaliningrad region hydrological profile*

Hydroecological features of the Krasnaya River are caused by both natural conditions and the level of anthropogenic impacts. The phase of spring floods, relatively low summer-winter and winter low-water periods with periodic floods stand out in the water regime of the river quite clearly. According to long-term average data, flood occurs in early March and ends in late April. In water-rich years, the highest flood discharges in April can exceed the average values by 2–2,5 times. Seasonal and longitudinal dynamics of the flow velocity is the dominant factor in the formation of biotopes and biocenoses in different parts of the river, since this indicator varies most strongly. The maximum current velocity exceeding 0,7 m/s during the spring flood is characteristic of the areas with the greatest slope of the bottom in the area of vil. Tokarevka. The water temperature at the mouth of the river as a whole is 2,5 °C higher than in the upper reaches in different phases of the water regime. During the spring flood season, at a high flow rate and turbulence of the water flow, homooxygenia was observed not only in vertical density, but also along the longitudinal section of the river. The maximum values of the concentration of oxygen dissolved in water in the annual cycle can occur in the summer low water (13.5 ml/dm<sup>3</sup>, 130 % saturation). This is probably due to its intensive production as a result of photosynthetic activity of hydrobionts. The Krasnaya River overgrows moderately during the growing season. Intensity and degree of overgrowing range from very weak to medium. Overall hydroecological situation of the Pissa River basin, to which the Krasnaya River belongs, on the basis of indirect indicators of natural, anthropogenic impacts, the state of the waters, adjusted for the natural and economic features of the Kaliningrad region, has been assessed as satisfactory.

*Krasnaya River, hydroecological features, water regime, flood, water flow, homooxygenia*

*Vorobyov V. I., Nizhnikova E. V. Processing of acid apple juices promoting import substitution of juice-containing products*

The use of processing methods (thermal hydrolysis) of directly squeezed fruit juice obtained from apples of Russian varieties (having a sour taste) with collagen-containing fish raw materials (fish skin and pike-perch scales) is substantiated to obtain juice-containing drinks containing products of hydrolysis of fish collagen and having a

good taste without adding (blending) sweet imported juices, as well as sugar, sweeteners and sweeteners. The general chemical composition, organoleptic indicators are presented, the mass fraction of malic acid, calcium, phosphorus, as well as pH, Brix index, sugar-acid index of apple juice and juice drinks obtained on its basis are determined. It was determined that during thermal hydrolysis of apple juice with fish skin ( $t = 110^{\circ}\text{C}$ ,  $P = 0,11 \text{ MPa}$ ), an increase in the mass fraction of protein (from 0,3 to 4,1 %) of calcium (from 0,011 to 0,018 %), phosphorus (from 0,011 to 0,015%), as well as pH (from 3,9 to 4,2), sugar-acid index (from 11,35 to 16,09 %) and a decrease in the mass fraction of carbohydrates (from 8,9 to 7,1 %) and malic acid (0,96 to 0,87 %) of the obtained juice drinks in comparison with the original apple juice. Under similar conditions, during the hydrolysis of apple juice with fish scales, an increase in the mass fraction of protein (from 0,3 to 2,0 %) of calcium (from 0.011 to 0.085%), phosphorus (from 0.011 to 0,048 %), as well as pH (from 3, 9 to 5,0), sugar-acid index (from 11,35 to 19,44 %) and a decrease in the mass fraction of carbohydrates (from 8,9 to 8,0 %) and malic acid (from 0,96 to 0,54 %).

*apple juice, apple acid, fish skin and scales, thermal hydrolysis, fish collagen hydrolysis products, sugar-acid index*

*Naumov V. A. Changing performance and energy efficiency of the vacuum fish-pump system with increasing rotor speed*

Vacuum fish-pump units (VFU) provide the least damage to the fish when it is moved. Most modern VFUs are designed on the basis of water-ring compressor machines (VCM). VCM can operate smoothly in difficult conditions, including on fishing vessels. Samson Pumps (Denmark) has been supplying the Ocean Master series of VCM since 2019. The ability to change the rotor speed (RS) is one of the features of this series. Earlier, Kaliningrad State Technical University (KSTU) developed a method for mathematical modeling of the operational stages of the VRU. The effect of changing the PMR was studied only on air pumping (the first phase of the VFU operation). The change in productivity and energy efficiency with an increase in RS over the entire cycle of the VFU has been studied in this article on the example of the KS625 VCM. The necessary additions, taking into account the change in the RS, were made to the mathematical model of the work of the VFU. An increase in the RS leads to a greater pressure drop. Therefore, a larger volume of the water-sample mixture is pumped into the tank in one cycle of the VFU operation. The consumption of the water mixture during the first stage increases, but not as much as during the second stage. The increase in RS has almost no effect on the duration of the first stage, while the duration of the second stage is significantly reduced. Since the duration of the VFU cycle decreases, and the volume of the mixture pumped in one cycle increases, the average performance of the VFU increases. The efficiency of the VFU changes slightly with the growth of the RS while the energy intensity indicator is noticeably deteriorating. Operation of the VFU at high speeds of the VCM should be recommended only if it is necessary to quickly empty the container with the water mixture (for example, when unloading fishing vessels). It is advisable to reduce rotation speed of the VCM rotor during long-term operation of the VFU. This will reduce energy costs for pumping the water mixture.



*vacuum fish-pump units, water-ring compressor machines, performance, power consumed, rotor speed*

*Orlov I. O., Zemlyakova E. S. Study of the process of enzymatic hydrolysis of the support-skeleton and integumentary tissues of hydrobionts*

In the conditions of the modern rhythm of life, a problem of increasing the number of people with diseases of diarthrosis and cartilage is particularly acute. To carry out preventive measures and reduce the occurrence of acute diseases, experts recommend the use of dietary supplements and preparations containing natural components of cartilage tissue-glycosaminoglycans. Such substances are also called chondroprotectors or substances that have a chondroprotective effect. One of the most effective ways to obtain such substances is enzymatic hydrolysis of raw materials rich in glycosaminoglycans (GaG). Such a source is traditionally the tissue of cattle. However, to increase economic efficiency, a promising raw material is the secondary raw material of hydrobionts. A number of studies confirm that chondroitin sulfate (which is part of the GaG complex) obtained from raw materials of hydrobionts is closer to human in its structure. Thus, chondroitin-6-sulfate predominates in hydrobionts, which differs in its sulfation pattern from chondroitin-4-sulfate. The target composition obtained in the process of enzymatic hydrolysis is a complex of easily digestible substances, including sulfated glycosaminoglycans (sGAG), when using walleye tissues, the total proportion of sGAG obtained after fermentation was 3.3 %, pollock tissues – 2.8 % in terms of dry matter. In the process of hydrolysis, such indicators as formol-titrated nitrogen (FTN), the degree of hydrolysis, the accumulation of dry substances and the accumulation of sulfated glycosaminoglycans were studied. The study of these indicators allows not only to more accurately assess the state of the process, but also to optimize the hydrolysis parameters themselves to achieve high yield indicators of the target substance.

*enzymatic hydrolysis and its parameters, secondary raw materials of hydrobionts, chondroprotectors, sulfated glycosaminoglycans, papain*

*Kovalchuk L. I., Tkachenko K. S. Functional diagnostics of the exhaust gas path of the turbo-charged main marine diesel engines by means of invariant standards*

Diagnostic standards can be formed only in the presence of quantitative features that make it possible to control changes in the properties of operators and form the structure of the standard. In this regard, quantitative assessment of the degree of linear dependence of operators and the impact on the results of measurement and calculation errors is of particular importance. The article considers a method for constructing invariant standards for functional diagnostics of the exhaust gas path of turbo-charged main marine diesel engines. The most objective basic data are bench tests of the engine according to a series of load characteristics for verification of the algorithm. An example of building standards for a specific engine has been implemented. Theoretical prerequisites have been established, allowing, in a certain case, to form quantitative structures that establish patterns of change in the parameters of the working process of a marine diesel engine in various operating modes. The structure of invariant standards

makes it possible to establish the presence of this type of data, as well as to reduce the number of computational operations and to minimize the error of the initial data on the parameters of the standard. It has been determined that by solving the system of equations, it is possible to determine the parameters of the reference when using an identical amount of initial data and known structure of the diagnostic standard. From the given systems of equations, it is clear that they are unstable from the point of view of their solutions, since the parameters of the standard change significantly even with insignificant fluctuations in the initial data. This article presents one of the possible options for the numerical assessment of the influence of errors in the initial data on the parameters of invariant diagnostic standards when implementing various computational algorithms.

*main marine diesel engine, exhaust gas path, invariant standards, functional diagnostics*

*Artamonov D. A., Myslitskaya N. A., Tsibulnikova A. V., Samusev I. G., Bryukhanov V. V. Optical emission spectra of bismuth oxide and ytterbium oxide under IR-excitation conditions*

This paper presents the results of studying the reflection spectra of bismuth oxide powders  $\text{Bi}_2\text{O}_3$  and a mixture of bismuth and ytterbium oxides  $\text{Bi}_2\text{O}_3 / \text{Yb}_2\text{O}_3$ . A technique for preparing samples of oxide powders from metals, and the results of spectral ellipsometric and luminescence measurements are described. The dependence of the change in the reflection coefficient in a  $\text{Bi}_2\text{O}_3$  medium in the presence of  $\text{Yb}_2\text{O}_3$  has been established. The values of the optical characteristics of the reflection coefficients of p- and s-polarized light for  $\text{Bi}_2\text{O}_3$  and  $\text{Bi}_2\text{O}_3 / \text{Yb}_2\text{O}_3$  are obtained. At a wavelength  $\lambda = 590$  nm, a sample containing ytterbium oxide has reflection coefficients  $R_p = 0,321$  and  $R_s = 0,331$ . The reflection coefficients for the bismuth oxide sample without the addition of ytterbium oxide are  $R_p = 0,223$  and  $R_s = 0,220$ . The IR Stokes and anti-Stokes upconversion red luminescence spectra of the samples have been obtained upon excitation in the IR range. An increase in the luminescence intensity of bismuth ions, distributed in the crystal lattice of the oxide in the presence of ytterbium ions, at a wavelength of 640 nm was recorded, which is explained by the transfer of energy between the energy levels of the ions. The intensity of upconversion luminescence depends nonlinearly on the power of the exciting IR radiation of the semiconductor laser. Numerical modeling of this dependence has been carried out within the framework of exponential and quadratic models

*reflection spectra, reflection coefficient, emission, light polarization, ellipsometry, IR-excitation, upconversion luminescence*

*Zhukova N. A., Tristanov A. B., Tin Tun Aun, Aung Myo Thaw. On the problem of data collection in the network of the internet of things with a dynamic structure*

Data collection is the process of receiving data from end devices and presenting it in a form that allows them to be processed. When collecting data in the Internet of Things (IoT) systems, it is necessary to take into account a number of requirements that we define in this article. The authors have analyzed the data collection technologies in

the IoT systems. The existing models of data collection and IoT system architecture have been considered in detail. Requirements for systems with complex structure have been presented; assessment of the compliance of the existing models of data collection with the requirements of the mobile IoT systems is given. Attention is paid to technologies and methods of ensuring security in data collection and processing. Separately, the issues of the performance of IoT networks have been considered. The analytical review of the existing data collection models presented in the paper allowed us to demonstrate the lack of developments that meet the requirements for data collection in mobile IOT networks. Based on the analysis of the existing models and data collection technologies, it has been concluded which data collection technologies will allow implementing the collection that meets the stated requirements.

*Internet of Things, security of data collection, transmission and storage, Fog computing, energy efficiency in data collection, delays in data collection, mobile networks*

*Yafasov A. Ya., Merkulov A. A., Maitakov F. G.* The role of digital transformation in the diversification of the fish industry on the example of organizing personalized meals in the region

The article is part of the concept of creating a digital platform model of a unified communication environment for the fishing industry of the region. The use of digital technologies changes the innovation process, largely eliminating the problem of coordination of participants, providing risk assessment at each stage of R&D and the subsequent stage of product commercialization. The paper shows potential opportunities for diversifying the economy of the regional fishing industry by expanding the scope of activities – by creating a regional personalized catering system based on local agricultural products and seafood using the digital platform «Nutrition XXI Century». The digital platform enables creation of a consumer-oriented ecosystem of many independent participants in the regional FoodNetRegion market. Every resident of the region, a legal entity, can join the regional ecosystem FoodNetRegion and become a participant in any role – the author of new recipes, culinary specialist, product manufacturer, marketer, logistician, carrier, etc. The new ecosystem takes into account the developed dietary recommendations for different groups of the population and individuals. The digital platform «Nutrition XXI Century» allows you to get new quality: a system of social catering – personalized nutritious food at the price of mass products. According to the estimates, this can give an increase in the regional GDP of the industry by 2.7 times. The payback period for the social catering system is no more than one year.

*fish industry, digital platform, ecosystem, aquatic biological resources, personalized nutrition, communication environment*

## **KSTU News, № 62**

*Beraki T., Shibaev S. V., Gulyugin S. Yu.* Age and growth of the blue shark *prionace glauca* in the eastern atlantic ocean

Проведено исследование возраста и роста выборки из 292 экз. синей акулы *Prionace glauca* (Linnaeus, 1758) длиной ( $TL$ ) от 151 до 305 см, отловленных в Центральной части Атлантического океана в районе Западной Африки в период с 1980 по 1982-е годы. Возраст определен по позвонкам. Пары полос роста (полупрозрачные и непрозрачные полосы) подсчитывали на изображениях, сфотографированных с окрашенных целых позвонков, с использованием цифрового микроскопа Digi Score II. Количество полос колебалось от 3 до 12 для самцов и от 4 до 13 – для самок. Параметры роста функции фон Берталанфи рассчитывались с помощью программ FISAT, функции решения Microsoft Excel и уравнения Форда - УолФорда (Ford – Walford) на основе наблюдаемых данных и обратных расчислений. Получены следующие числовые значения:  $K= 0,1$ ,  $L_{\infty} = 386,4$  см и  $t_0 = -1,35$  года для самцов и  $K = 0,12$ ,  $L_{\infty} = 355$  см и  $t_0 = -1,02$  года для самок. По оценкам, продолжительность жизни акулы составляет не менее 23,7 и 28,3 года для самцов и самок соответственно. Естественная смертность оценена в  $0,15 \text{ год}^{-1}$  и  $0,18 \text{ год}^{-1}$  для самцов и самок рыб соответственно.

*Prionace glauca, Восточная Атлантика, максимальный возраст и рост, уравнение Берталанфи*

*Nasenkov P. V., Nedostup A. A., Dolin G. M. Experimental studies of the Poisson coefficient of threadlike fishing materials*

The present work is devoted to an experimental study of the determination of Poisson's ratio for fishing threadlike materials. Poisson's ratio for fishing threadlike products plays an important role, because with its help, it is possible to track the behavioral changes in the physical and mechanical properties of the material, which is under constant variable loads, which as a result affects the performance and efficiency of the industrial fishing tool in the fishery. Studies on the determination of Poisson's ratio for many isotropic materials, such as metal, stone, glass, are well known and easily determined due to the structure of these materials. Anisotropic materials, which include filamentary fishing products, are very often unstable in their structure, which leads to both negative values of the coefficient and positive ones. Experiments to determine Poisson's ratio have been carried out on threadlike fishing twists used for the construction of commercial fishing tools, in particular on polyamide threads. A technique has been developed that allows you to determine the values of this coefficient with an accuracy of more than 90%. Experimental studies were carried out in the laboratory for the examination of fishing materials of the department of commercial fishing of FSEI HE "KSTU". The results of the obtained experiments have been analyzed and mathematically processed with the construction of graphical dependencies in the MathCad environment. The presented dependences made it possible to visually trace the behavior of the change in the value of Poisson's ratio depending on the change in the load on the material. The obtained material makes one think about the values of Poisson's ratio for fishing thread-like products and its influence on the basic properties and characteristics of commercial fishing tools in general.

*Poisson's ratio, fishing threadlike products, physical and mechanical properties, diameter, elongation, strength, experiments, dependencies, mathematical processing, graphs*

*Tsupikova N. A., Menshenin A. S., Aldushin A. V. Morphometric characteristics of the Schönflies pond (Kaliningrad)*

The paper presents the study results of one of the artificial reservoirs in Kaliningrad – the Schönflies Pond, located in the southern part of the city. It is an important recreational impoundment in which swimming is allowed. In 2018, the Department of Ichthyology and Ecology of KSTU carried out a hydroacoustic survey using the ASKOR data collection software-hardware complex, which allowed, in real time, joint recording of the current depth and the geographical coordinates of the investigated bottom. Initial processing of the field measurement results was performed using MS Excel spreadsheets, Golden Software Surfer and ArcGis geoinformation systems. The maps of the bottom relief in 2D and 3D have been plotted for the first time; the boundaries of the catchment basin have been shown. During the subsequent analysis of the results obtained, the main morphometric parameters of the Schönflies pond have been determined, such as the water surface area, shape of the reservoir basin and volume of water mass enclosed therein, length of the contour line, maximum length and width, depth (average and maximum), tortuosity of coastline, coefficient of openness, as well as the water catchment area and specific water intake. Following the calculation results, the Schönflies Pond can be defined as a medium sized water reservoir with 9.1 hectares of surface area and with an average depth of 3.1 m. Its coast line has a shape close to triangle. The pond has a complex bottom relief, with a sharp increase in depth in the northern and northeastern parts, where the steepness of the underwater coastal slope reaches 30°. The drainage area is not large and amounts to approximately 7.3 hectares which is typical for quarry reservoirs of the Kaliningrad region.

*morphometric characteristics, bathymetry, water catchment area, Schönflies Pond*

*Tsupikova N. A., Sevostianova E. A. Some hydrological and hydrochemical peculiarities and problems of small urban ponds on the example of the Poplavok pond*

The paper considers the role of small water bodies in the life of urban ecosystems and their importance for modern cities. Changes in the chemical composition of the water of the Poplavok pond due to the recent clean-out, anthropogenic influences and natural factors are assessed based upon the data of monthly hydrological and hydrochemical observations and additional studies within the period from February 2015 to November 2017. Comparison of the pond with other water reservoirs of the similar purpose in Kaliningrad in terms of morphometric and hydrochemical parameters showed that the Poplavok pond is one of the typical artificial reservoirs of Kaliningrad; its hydrological and hydrochemical regime significantly depends on weather conditions and performed water control and water economic practice. A feature of the artificial reservoirs of the city of Kaliningrad is their small size and slow natural water exchange, which is one of the most important hydrological and hydroecological characteristics. These small water reservoirs of Kaliningrad are dynamically passive water areas with a simplified structure and reduced stability of in-water body processes. As a result, there is a tendency in ponds to significantly

accelerated eutrophication in comparison with natural water bodies and “water blooming”. Rejuvenation of ponds and extension of their life cycle is possible by cleaning the bed and reconstruction of the reservoir. The result of such rejuvenation is studied in the article using the example of the Poplavok pond. After reclamation, the reservoir underwent a recovery period, and by 2016 many indicators had reached the permissible level. These features of the formation of a closed system of the pond don't contribute to the rapid renewal of the waters or their self-purification, which leads to a gradual decrease in water quality as a result of the rapid accumulation of organic material even after reclamation, which was observed in the Poplavok pond in 2017. For this type of ecosystems a constant monitoring of their condition and timely intervention to maintain or improve their ecological state are recommended.

*small city ponds, the Poplavok pond, hydrochemical characteristics, ecological state, monitoring*

Ageev O. V., Naumov V. A., Fatykhov Ju. A., Samoylova N. V. An approach to calculation of specific work of material damage during fish cutting

The paper shows the relevance of the development of a complex of mathematical models that allows calculating the specific work when cutting fish in order to determine the coefficient of efficiency of an elementary knife. An expression has been obtained for calculating the dimensionless specific work of muscle fibers destruction. A model for calculating this value for elastic fiber tear with a high deformation rate has been formulated. The specific work of viscous laceration at high cutting speed has been determined. A mathematical model for calculating the dimensionless specific work required for elastic fiber tear at not very high speeds has been obtained. The dimensionless specific work of viscous laceration of the fiber at not very low speeds has been calculated. The dependences of the dimensionless specific works of elastic tear and viscous laceration on the dimensionless strain rate have been determined by a numerical method. It has been found that with an increase in the dimensionless velocity, there is a nonlinear increase in the dimensionless specific work of viscous laceration. When the maximum value of the dimensionless specific fracture work, corresponding to the characteristic dimensionless speed, is reached, the viscous laceration changes to elastic fiber tear. In this case, with a further increase in the dimensionless velocity, the dimensionless specific work of elastic fracture changes nonmonotonically. With the values of measures of elasticity 3; 5; 8; 12 the maximum values of the specific work of destruction are 0.0694; 0.0417; 0.0262; 0.0173 and are achieved with a characteristic dimensionless speed values of 0.0982; 0.0549; 0.0331; 0.0218, while the minimum values of the dimensionless specific work of elastic tear are 0.05761; 0.02714; 0.01279; 0.00641 and are reached at dimensionless speed values of 0.248; 0.217; 0.187; 0.161 respectively. With an increase in measures of elasticity of the material, the maximum value of the dimensionless specific work of destruction and the minimum value of the work of elastic tear reduce significantly. Also, with an increase in measures of elasticity, the value of the characteristic dimensionless speed, at which a viscous laceration is replaced by an elastic tear, decreases.

*fish, fiber, muscle tissue, cutting, damage, knife, work, rheology, viscoelasticity*

Vorobyov V. I., Nizhnikova E. V. Obtaining collagen and hydroxyapatite fractions from fish scales

A method for obtaining collagen and hydroxyapatite fractions from fish scales has been developed. The method consists in the following: fish scales are washed with water and treated twice in a solution containing edible salt and baking soda, then scales are dried with hot air (up to 80 °C) until the mass fraction of moisture is not more than 10%, then it is crushed in a high-speed grinder (grinding duration 0.1-5 minutes, 36000 r/min) with simultaneous or subsequent separation of the resulting mixture into at least two fractions: fibrous collagen and hydroxyapatite powder. It has been experimentally determined that collagen tissue, dried and crushed in its natural state, has the smallest particle size in the range of 0.1 mm (100 microns) and more, while the particles look like fiber fragments. Partially denatured collagen tissue can be crushed into much smaller spherical particles (less than 0.1mm). The general chemical composition (including calcium and phosphorus) of the obtained fractions of fish scales of pike perch and sazan is presented. It has been determined that the mass fraction of the yield of crushed and separated fish scales fractions depends on the type of raw material, its chemical composition, as well as on the duration of the grinding process. It has been revealed that with a decrease in the particle size of the resulting fractions, mass fraction (%) of calcium in them and, accordingly, the bulk density, increase. The work also shows that the main component of the fibrous fraction (particle size 2.5 mm and more) is protein (collagen) mass fraction, which is more than 70%, and powder (particle size 0.1 and less)- ash (hydroxyapatite) with mass fraction of over 62%.

*fish scales, fish collagen, hydroxyapatite, technical filler, food additive*

Karneeva F. S., Al'shevskaya M. N., Anistratova O. V. Improving the recipe of Atlantic Herring preserves in a mayonnaise-jelly filling

Salted fish products and preserves from Atlantic herring are the traditional food in our country. The filling in the preserves can make up to 35% of the total mass in a liquid state and as a rule people do not eat it. The shelf life of preserves depends on the storage conditions. In retail chains, such a product is stored at temperatures of +5+20C. The development of a filling recipe that is harmoniously combined in taste with salted fish, a dense consistency for preserves with conditionally positive storage temperatures is relevant. To solve this problem gelatin was chosen as a structure-forming agent. The basis for the development of the recipe was mayonnaise filling with the addition of components such as tomato paste and garlic. The study of the influence of the acidic environment formed as a result of the tomato paste on the strength of the filling revealed a decrease in strength with an increase in the content of tomato paste. The mass fraction of gelatin in the formulation of 3.5% is justified, which makes it possible to form a strong jelly during the storage of preserves at conditionally positive temperatures. The tasting evaluation of preserves allowed us to determine the optimal content of tomato paste in the product which is 10%. The shelf life of the products is justified in 15 days. During this time, no sanitary-indicative, conditionally pathogenic and pathogenic microorganisms were detected. The CMAFAnM index did not exceed the value of 2 \*

105 CFU / g. The total acidity of the product during the shelf life changed slightly and remained within the standard values. A recipe and technological scheme of preserves in mayonnaise-jelly filling with the addition of tomato paste and garlic, a draft of technical documentation have been developed.

*preserves, Atlantic herring, mayonnaise-jelly filling, filling strength, shelf life*

*Koshkina A., Alshevskiy D. L. Technological improvement of apple cider recipe using wild fruits and berries of the Kaliningrad region*

Processing of regional fruits and berries into alcoholic beverages in order to preserve them for a longer period and increase the gastronomic variety is a traditional practice. Humanity has been developing the production of wines and low-alcohol fruit wine drinks. With the development of the mankind, different types of fruit and berry bases have become common to certain territories, depending on the natural and climatic conditions and labor costs for cultivation. As a result, today in each climatic zone a specific set of varieties and types of cultivated crops has been formed – this is where the "alcohol belts" concept takes its beginning. Winemaking culture varies in southern Europe quite dramatically, while central Europe predominantly processes apples into wine and cider. Within the scope of this research, several experimental recipes for apple cider have been developed using wild fruits and berries, namely briar, sea buckthorn and viburnum. Special indicators were established to confirm that the final product can be considered "cider", such as acidity, alcohol and sugar content. Strength of some compositions reached 8-9%, while the permitted GOST 31820 was 6% [2]. Acidity was within acceptable range: at least 4 g / dm<sup>3</sup>, and in terms of sugar content, the values range from 5.8 Brix to 24.8 Brix, the lower values appeared to be common for samples with added sea buckthorn, high values were mostly seen in samples with viburnum syrup in their composition. To assess organoleptic characteristics, a 50-point system was used. In the end, samples with a high percentage of viburnum and briar syrup (50 and 75%) have scored the highest - an average of 47 points, and the sample with a low content of sea buckthorn syrup in the composition (25%) scored 43 points.

*apples, cider, viburnum, sandthorn, briar, titrated acid, alcohol content, sugar content, recipe, brewing*

*Stepanova K. A., Baydalina L. S. Safety assessment of meat pate enriched with protein-mineral complex from hot-smoked secondary fish raw material*

The paper considers a possibility of implementing a partially waste-free technology for the production of canned food "Sprats in oil" on the basis of fish processing enterprises in Kaliningrad. It shows efficiency and safety of the use of the protein-mineral complex (PMC), produced by hydrothermolysis of the hot smoked head sprat, for the enrichment of meat products. Functionality of PMC has been determined by the content of calcium. The content of calcium and phosphorus in PMC is 6.5 and 4 %, respectively. The content of calcium and phosphorus and their ratio in meat pate, enriched with a mineral complex of a protein-mineral complex have been calculated. Introduction of this additive into meat products in the amount of 5 % provides an increase in the calcium content in them (37 % of the daily intake in terms of 100 g of



product) and provides an optimal ratio of calcium and phosphorus for absorption by the body. Safety of the enriched meat pate has been proven in terms of benzo(a)pyrene content, which is standardized in smoked products. A recommendation has been given for the maximum permissible level of benzo(a)pyrene in PMC – no more than 0.016 mg / kg. The shelf life of pate in a package with low barrier properties, taking into account the reserve coefficient, was 12 days at a storage temperature of  $(4\pm 2)$  °C. There has been no significant effect of PMC on the change in microbial contamination and, accordingly, the shelf life of experimental pate samples in comparison with control samples. Recommendations are given for a possible increase in the shelf life of the pate. A high probability of non-compliance of meat raw materials with microbiological standards has been found, which must be given serious attention when organizing manufacturing of meat products.

*protein-mineral complex, calcium, phosphorus, meat pate, benzo(a)pyrene, microbiological indicators, safety*

*Beley V. F., Korotkikh K. V.* Assessment of the operating modes of a ship service diesel generator based on capability diagram

An analysis of the operating modes of ship's electric power plants shows that they often operate with large reactive loads, which leads to a decrease in the active power of synchronous generators, and operation of auxiliary marine diesel engines at fractional loads, which is characterized by increased specific fuel consumption. A qualitative assessment of the operating modes of ship service diesel generators is based on an examination of the capability diagram, which represents the dependence of the available active power on the reactive power. On the example of the diesel electric-power generator of the sail training barque "Kruzenshtern", calculation of the available power of the synchronous generator for various operating modes is shown. Construction of the capability diagram is based on the analysis of the characteristics and technical data of the synchronous generator and auxiliary diesel, taking into account a number of power limitation zones: limitation on the heating of the field winding and stator winding of the marine synchronous generator; power limitation according to the technical capabilities of the auxiliary diesel; under the conditions of ensuring static stability when operating in under-excitation mode and limitation on the minimum permissible excitation current. Based on the analysis of the constructed capability diagram, the operating range for the active and reactive power of the ship's synchronous generator is shown; angular and synchronizing characteristics are plotted for each of the limiting points of the capability diagram. As a result, based on the study of a complex of interrelated solutions: the capability diagrams, vector diagrams, angular and synchronizing characteristics of the synchronous generator and the technical parameters of the auxiliary diesel engine, an assessment of the operating modes of marine diesel generators is given, which can be used at the design and operation stages of ship's electric power plant.

*ship's electric power plant, diesel-generator, active and reactive power, voltage, current, capability diagram*

*Kolotev D. A., Sukonnov A. V.* Experimental study on the estimation of the effect of cyclic loads on the fishing thread strength

Among the various ways to increase the efficiency of fishing, an important role is given to increasing the wear resistance of fishing filamentous materials that are used in the process of building fishing tools. It is known that in the course of operation, various factors influence fishing gear, one of which is cyclic loading. The work is devoted to an experimental study of the effect of cyclic loading on the residual strength of fishing filamentous materials, on examples of fishing polyamide filaments. In the course of the work, a review and analysis of methods for studying the effect of cyclic loading on the strength of materials in the field of clothing production and in the construction sector were carried out. These methods, which are used in these industries, cannot be fully applied in the field of industrial fishing due to the specifics of fishing materials: the structure of the material, the type of raw materials in the manufacture, the type of twist. To determine the effect of cyclic loading on the residual strength of fishing filamentous materials, an experimental setup and a test procedure for fishing filaments were developed. Also, the experimental setup developed by the authors was designed and equipped with the necessary measuring equipment. The studied factors affecting the strength of the fishing thread and the range of their changes were determined, taking into account the methods from neighboring production areas. The method of experiment planning is applied and a matrix for a three-factor experiment at two levels is compiled. The mathematical dependence of the residual strength of the thread on the operating factors, namely, the diameter of the thread, the number of loading cycles and the lengthening of the thread, was obtained.

*cyclic loading, matrix, wear, commercial fisheries, diameter, nylon, the experimental setup*

*Sudnik S. A., Egorova Yu. E.* Biology of the shrimp *Palaemon elegans rathke*, 1836 (Decapoda: Caridea: Palaemonidae) of the South-Eastern Baltic sea

Stone shrimp *Palaemon elegans* Rathke, 1836 – is a widespread invasive species, polyphagous benthophage, that is important in fish nutrition, and in some countries it is a fishing object. After introduction in the Baltic Sea, it has successfully acclimatized and spread widely, displacing the native palemon shrimps species. There is a lack of knowledge about *P. elegans* biology of marine settlements off the coast of the Kaliningrad region. New data on the sizes, sex, weight characteristics and reproduction of *P. elegans* in the coastal zone of the South-Eastern Baltic have been obtained. The sex ratio more often approached equal, the total body length was 9.8–50.0 mm with a carapace length of 4.0–11.6 mm; the maximum female sizes were larger than male sizes. The shrimp body weight was 0.04–1.37 g; the weight growth was somewhat ahead of the linear one. The first mating could take place when the female carapace length was up to 5 mm; having sizes of 4–9 mm, they matured and spawned for the first time, laying up to 1500 eggs with sizes of 0.45–0.58 x 0.50–0.60 mm, bearing embryos.

During the first half of embryogenesis, an increase in the egg volume was observed; on average by 1.4 times; no significant embryos loss was found. During the spawning season (May – early September) females can spawn at least twice. Analysis of sex, size and reproductive parameters in shrimp from three marine settlements showed their sufficient uniformity. Comparison of the results with those obtained for shrimp from the Kaliningrad Bay allowed us to assume that its marine and bay settlements are part of the same *Palaemon elegans* population in the waters of the Kaliningrad region.

*shrimp, Palaemon elegans, Baltic, sizes, sex ratio, body weight, reproduction, maturation, fertility, egg sizes*

*Troyan T. N., Bedareva O. M., Gaimanova A. A., Karachinova L.V.* Progressive development of price ecosystems of forage purposes in conditions of the North-Western region

The raw material base of feed production is different in global and regional conditions. The main emphasis is on the caloric content and cost of feed. The indicator when choosing a crop for the production of plant raw materials is both its quantitative and qualitative assessment. Increasing the production of food crops grown on land is a difficult task due to the high risks of agro-climatic conditions in the formation of yields, as well as competition for limited land and water resources. Land-based aquaculture plays an important role in ensuring food security. In this regard, the study of the raw feed base for the purposes of fish farming is relevant in the modern world. The paper studies the question of the possibility of using perennial grasses as a feed component of fish compound feeds. As a result of the research, the growth dynamics has been found of perennial grasses in meadow phytocenoses. A graphical interpretation of the bleed cycles and mowing cycles is performed. The period of ripeness of herbs is determined. Depending on the growth rate of meadow phytocenosis, the cyclical growth of perennial grasses of cereal-legume botanical composition is presented. There has been a decrease in the gross yield correlating with the rhythms of growth and development during the growing season, which is associated with a decrease in the production process of plants in the second half. Elements of mineral nutrition play an important role in the management system of forage lands. To increase environmental plasticity and stress resistance, potash and phosphorus fertilizers are introduced into the food system during the most critical periods of the development of perennial plants. Additional phosphorus and potassium fertilizers at the end of the growing season increase the stability of grasses in winter.

*vegetable raw materials, compound feed, perennial grasses, meadow phytocenosis, pasture, haymaking, growth, dynamics, grazing cycle, haymaking cycle*

*Alshevskaya M. N., Anistratova O. V., Baranauskas V. A.* Improvement of the production technology of whole piece meat products from pork using bamboo fiber

Development of recipes for meat products and technological parameters of their production, which allows for an increase in their yield and reduction of the cost price, is an urgent area of research. To solve this problem, food additives (phosphates, modified starches, carrageenan, etc.) are widely used, which increase moisture-retaining ability of muscle tissue proteins and change viscosity of muscle juice during heat treatment of a meat product. The use of dietary fiber in the formulation of meat products will not only solve the technological problem of increasing the yield of the finished product, but also improve its nutritional value. The paper shows the possibility of using bamboo fiber as a food additive to increase the yield of the finished meat product and improve its quality characteristics, as well as the possibility of reducing the mass fraction of phosphates in the production of whole meat products from pork. The optimal parameters for injecting pork ham have been established (pressure of 2.8 bar at a step speed of 30 rpm), optimal modes of massaging (5 hours of total working time, at 7 revolutions per minute and 10 minutes of rest) and heat treatment (drying 1.5 hours at a temperature of 55 +2 °C, smoking 45 minutes) have been worked out and selected ( at a temperature of 65 +2 °C, cooking at a temperature of 84+2 °C for 80 minutes). The shelf life of smoked-boiled ham has been established according to microbiological and organoleptic indicators. The results of studies formed the basis for the recipe of the meat product "Smoked-boiled Ham" with addition of bamboo fiber. Technical documentation projects and a technological scheme of production have been developed.

*bamboo fibers, polyphosphates, food additives, injection, massaging, heat treatment*

*Vinokur M. L. Using antarctic krill (*Euphausia superba*) hydrolysate in imitated mince technology*

The article gives an assessment of the possibility of obtaining imitated raw-frozen minced krill using a hydrolyzate. Manifestation of cryoprotective properties of krill hydrolyzate has been investigated. The hydrolyzate has been obtained as a result of partial hydrolysis of krill with protosubtilin G3x during the production of krill meal. A mixture of sucrose and sorbitol (1:1) was used as a reference for comparing cryoprotective properties. Saika mince was chosen as the basis. The influence of the amount of added dry krill hydrolyzate on the formation of organoleptic properties imitating minced krill has been studied. The amount of krill hydrolysate added to the saika mince corresponded to 1, 2, 3, 4, 5 and 6 %. The most rational dosage of dry hydrolyzate, which makes it possible to create a product that imitates krill mince and sufficiently stabilizes the mince, was 4% of the mince mass. We also studied the effect of adding a hydrolyzate in the amount of 4% on such indicators characterizing the quality of mince as water-holding capacity and the amount of moisture lost during heat treatment. The use of a hydrolyzate made it possible to significantly increase the water-holding capacity of minced meat and reduce the amount of water lost during heat treatment. In comparison with a mixture of sucrose and sorbitol, krill hydrolyzate had a more pronounced stabilizing effect on both indicators, but the ability of minced meat to bind water during heat treatment has improved to a greater extent. The above positive effect of the krill hydrolyzate on the quality of mince was observed both immediately after freezing and after three months of storage.

*antarctic krill, krill hydrolysate, raw-frozen mince, cryoprotector, water- holding capacity, imitated mince, amount of moisture lost during heat treatment*

Vorobyov V. I., Chernega O. P., Titova I. M. Influence of processing methods on qualitative and quantitative indicators of boiled shrimp

A study of the qualitative and quantitative indicators of whole cooked shrimp (*Litopenaeus Vannamei*) has been carried out, aimed at finding technological solutions in order to reduce mass losses in the production of whole cooked-frozen shrimp, depending on the methods of its processing. When obtaining boiled shrimp, defrosting of frozen raw materials was carried out in water with air bubbling (control) and aqueous solutions of salt with food additives phosphatex (0.5 % by weight of raw materials), as well as a mixture (phosphatex (0.5 %) and protepsin (1.0 %)) within 3 hours. Some of the frozen raw materials were thermostated (33 °C) in an aqueous solution (phosphatex (0.5 %) and protepsin (1.0 %)) for 2 hours. It was experimentally determined that a slight decrease in the mass fraction of protein in shrimp meat when it is processed with a mixture (phosphatex and protepsin) during defrosting and thermostating (from 19.36% (control) to 19.26 % and 18.80 %, respectively) and phosphorus (from 0.562 % to 0.445 % and 0.392 %), with an increase in the mass of boiled shrimp (by 1–2 %) from the initial raw material. Treating shrimp shell with a mixture (phosphatex and protepsin) significantly influenced the change in the mass fraction: an increase in chitin from 5.2 % (control) to 7.1 % (defrosting) and 11.2 % (thermostating); ash reduction from 7.7 % (control) to 5.47 % (defrosting) and 2.66 % (thermostating); a decrease in protein from 14.02 % (control) to 13.86 % (defrosting) and 13.32 % (thermostating). The addition of edible salt and a change in the concentration of food additives used during the defrosting of frozen raw materials within 30 minutes contributed to an increase in the mass of whole boiled shrimp (by 12.7 %) when using a mixture (1.0 % edible salt and 1.25 % phosphatex) in comparison with the feedstock.

*whole boiled shrimp (Litopenaeus vannamei), phosphatex, protepsin, shrimp shell, chitin, food supplement*

Makeeva A. V., Klyuchko N. Yu. Assessment of the nutritional value of molded frozen semi-finished products from river perch (*Perca fluviatilis*), enriched with components of vegetable raw materials

Currently, Russian fishing industry is moving forward and is strengthening both on the territory of its state and abroad. All this makes the use of aquatic biological resources, especially underutilized ones, promising for the development of new technologies or products. The urgency of increasing the production of minced molded products today is due to the unsaturation of the market with these types of products. This is due to the presence on the market of products that do not respond or do not fully meet the quality requirements imposed by consumers for the biological and energy value of the product, the naturalness of the ingredients, taste properties, shelf life and other parameters. In this paper, studies have been conducted to improve the recipe of molded semi-finished ice cream from river perch of increased biological value. Based

on the previously obtained data on the assessment of the biopotential of the main raw material – river perch of the *Perca fluviatilis* species – and enriching components (apple cake, flax seeds, Kale leaf cabbage), a technology for a functional frozen semi– finished fish product "Okunek" cutlets is proposed. The finished product has attractive organoleptic characteristics: the taste and smell are characterized by a moderate intensity of the taste and aroma of cabbage, pronounced fishy and barely perceptible shades of apple and flax seeds. For enriched cutlets, the general chemical, amino acid and mineral compositions have been determined. The level of functionality of the semi-finished product is determined by the content of functional ingredients - fiber, vitamin C and minerals: potassium, phosphorus, sodium, magnesium, iron, manganese, copper, chromium. The safety of the enriched product has been determined from the point of view of the presence of pathogenic and conditionally pathogenic microflora. The peculiarities of changes in microbiological parameters during storage have been investigated, and the guaranteed shelf life of products has been established. The analysis of the content of vitamin C in the finished product after freezing, as well as when frying in vegetable oil and steaming has been carried out.

*molded fish semi-finished product, river perch, chemical composition, amino acid composition, functional product*

*Naumov V. A., Levicheva O. I. Evaluation of the centrifugal pumps energy efficiency for the food industry*

A large number of publications are devoted to the development and improvement of methods for hydraulic calculation of technological pipelines in the food industry. However, the authors of publications often use the nominal values of the parameters of pumps in their calculations. Load characteristics, as a rule, are not taken into account. For example, the change in the pump efficiency is not taken into account when the diameter of the process pipeline increases. Food centrifugal pumps (FCP) are most widely used for transporting low-viscosity liquids (milk, juices, wine, etc.). They have high reliability, good performance and energy efficiency. Manufacturers of FCP place in the open access (technical documentation, Internet resources) the dependences of the head, the power consumed and the efficiency on the flow rate of the liquid. Analytical expressions for the load characteristics of food pumps are obtained in the article. They are necessary for computer modeling. The check showed that some manufacturers overestimate the efficiency in the technical documentation. Therefore, the efficiency must be recalculated based on the test results. It is shown that the value of specific energy costs continues to decrease with an increase in the supply above the nominal, while the efficiency worsens. In this case, the feed should not go beyond the right border of the working area. The characteristics of FCP are calculated in the first approximation when pumping concentrated apple juice at the point with the highest efficiency. The coefficient of kinematic viscosity of the juice at a temperature of 20°C is almost 16 times greater than that of water. The estimates showed that the flow rate and head of the FCP decreases by only 3%, the efficiency decreases by about 17%. Energy costs for pumping one liter of liquid increase by more than 40%. The formation of a database of load characteristics of food pumps from different manufacturers seems promising. They can be used for hydraulic calculations of technological pipelines. At

the same time, it is necessary to experimentally verify the effect of the viscosity of food liquids on the load characteristics of centrifugal pumps, including energy efficiency indicators.

*centrifugal pumps, load characteristics, liquid consumption, head, power, efficiency, specific energy costs, food liquids*

*Beley V. F., Brizhak R. O.* Theoretical analysis of electromagnetic interference due to the operation of electrical equipment of ship power plants and their elements

The paper presents the main terms and definitions in the field of electromagnetic compatibility (EMC) and electromagnetic interference. On the example of the ship of project 488, the elements of the electromagnetic environment of the ship power plant and its elements are shown. The paper considers the requirements for ensuring EMC and indicators of the quality of electricity, regulated by the Rules for the Classification and Construction of Sea-Going Ships and standards for the quality of electricity in general purpose systems. It is shown that requirements established by the power quality standards are the levels of electromagnetic compatibility for conducted electromagnetic interference, subject to which the EMC of electrical equipment of ship power plants and their elements is ensured. A theoretical analysis of electromagnetic interference caused by the operation of power ship electrical equipment is given: higher harmonics of voltage and current, voltage fluctuations and flicker, dips and overvoltages. It is shown that nonlinear elements emit higher current harmonics into the electrical network during operation. As a result, the voltage in the network will be determined by: the voltage supplied from the supply network and the sum of voltage drops from the entire spectrum of higher harmonics of the current of the nonlinear element. Electromechanical processes at the time of starting electric drives based on asynchronous motors are considered and it is shown that along with nonlinear elements they are mostly the main sources of conducted electromagnetic interference in the ship electrical power system. At the moment of starting the electric drive, the current is practically inductive, which causes an increase in the voltage drop in the supply lines, and leads to a decrease in the resulting field of the synchronous generator due to an increase in the longitudinal component of the armature response, and, accordingly, to a decrease in the voltage at the terminals of the diesel generator. In order to assess the recommendations for reducing the level of electromagnetic interference caused by the operation of the shipboard power electrical equipment, a laboratory model with the sources of this interference has been created.

*ship power plant, electromagnetic compatibility and interference, power quality, electrical equipment, voltage, current*

*Pritykin A. I.* Elasto-plastic deformation of the board assemblies under different loading

The paper presents the results of deformation of board assemblies with regular located frames and one stringer under action of distributed ice loads and mooring loads in open sea. Investigations were performed by numerical methods using program complex ANSYS and using the program specially elaborated by the author. At present,

literature lacks data that allows for evaluation of stress state of grillage neither in elastic nor in elasto-plastic stage of loading. Available theoretical solutions relate basically to calculation of grillages under universally distributed load on the whole area of grillage plating, although most part of residual deformations are caused with ice loads or by mooring loads, acting on limited areas. The paper considers the character of deformations of ties of grillages and appearance of plastic hinge under different scheme of action of loads on grillages. The diagram of loading is represented in a bilinear form with modulus of strengthening in 100 times less the modulus of elasticity. Real board grillage of Oden-type icebreaker under ice pressure at level of board stringer has been considered. It has been found that most loaded zones of frames are their support sections. Because of big width of associated plate, the shell plating near the contour of grillage practically never turns to plastic condition. The only weak place of plating is their deformation under mooring at open sea, which results in appearance of corrugation. Performed calculations allow us to evaluate order of deflections under elasto-plastic deformations of grillages which is impossible to calculate analytically.

*grillage, frames, stringer, ice load, mooring load, plastic hinge, limit load, FEM*

#### **KSTU News, № 64**

*Kudryavtseva E. A., Bukanova T. V., Aleksandrov S. V. Modelling the primary production in the South-Eastern Baltic sea*

Field measurements conducted in the coastal zone of the Russian sector of the Baltic Sea south-eastern part from April 2008 to April 2009 allowed to describe patterns of seasonal distribution of the chlorophyll *a* concentration (Chl) and primary production (PP) of phytoplankton in the water column under environmental conditions. It is shown that the vertical distribution of Chl is determined by its concentration in the surface layer and hydrophysical conditions, while the vertical distribution of PP performs a decreasing function of depth and light. In late spring-early summer, when the growth of phytoplankton is limited by nutrients, the subsurface maximum of Chl can be observed; as a result, contribution of this layer to the integral PP increases. Indicators of phytoplankton productivity in the coastal zone have been calculated depending on the trophic state of waters (oligotrophic, mesotrophic, eutrophic). Significant variations of Chl (1.2–19.8 mg·m<sup>-3</sup>) and PP (40–2153 mgC·m<sup>-2</sup>·day<sup>-1</sup>) values are observed from the oligotrophic level in the winter period (December-March) to eutrophic level in spring (April) and summer during maximum phytoplankton growth. The analysis has been conducted of the well-known algorithms for calculating PP, proposed for the Baltic Sea, including the equations for detecting the dependence of photosynthesis on the light, presented by J. Still, T. Platt, and A. Jassby–T. Platt. The equations of T. Platt and A. Yassby–T. Platt provided a better correspondence of the PP values calculated for different depths to the data of field measurements of PP at these depths, and J. Still's equation better reproduced the average value of water column PP.

*primary production, chlorophyll "a", vertical distribution, light curves, Baltic Sea, MODIS*



*Lamba S. A., Shibaev S. V., Fedorov L. S. Fisheries evolution and development perspectives in the South sea region (EEZ Angola)*

The paper provides a general description of fishing in the economic zone of Angola and its evolution since 1960. It describes the features of the organization of fishing in the exclusive economic zone of Angola during the period of fishing mainly by USSR and then the formation of national fishing. It is shown that the fishing sector of Angola is of significant importance for the country's economy and accounts for about 4.6% of the country's gross domestic product in 2011. Until the end of the war in 2002, Angola's fishing sector was the third largest economic sector after oil and diamond mining. The total catch reached 500 thousand tons, but due to a decrease in the volume of aquatic biological resources, it decreased. However, it still remains a very important sector for the national economy and an important source of livelihood for the population and food supply for the country. Currently the total catch is estimated in the range of 220-290 thousand tons; the national fleet can provide up to 40 thousand tons. The characteristics of the size composition of the main pelagic fish species and information on the dynamics of their catch on the shelf of Angola are given. The main objects of the fishery are small pelagic species (species of the genera *Trachurus*, *Sardinella*, *Scomber*), as well as dimesal species (*Serranidae*, *Scianidae*, *Sparidae*, *Merlucciidae*, *Pomadasyidae*). A characteristic of the types of fishery is given, which include purse seine fishing, bottom and pelagic trawling, as well as artisanal fishery.

*aquatic bioresources, oceanic fisheries, the state of fishing for aquatic bioresources in the Angolan region, scientific and exploratory research*

*Prozorkevich D. V. A stochastic-statistical approach in long-term forecasting of the national catch*

Practical activities of research institutes of the Federal Agency for Fishery and other research organizations often involves the necessity to prepare forecasts of a possible national catch for extended time-periods. Different institutions require these forecasts for their business planning and other activities. Generally, accuracy of these deterministic forecasts is low. Moreover, catches of some commercial species are determined by not only biological parameters, but also management decisions that may result in unpredictable consequences. This paper considers the possibility to prepare a long-term forecast of the national catches of commercial species, which depends not only on the state of stocks, but also on economic and political factors. This forecast involves a stochastic-statistical approach that is based on a long-term series of observations over fisheries taking into account some patterns and assumptions. The paper includes analysis of some possible factors that can have a direct impact on sizes of catches and the relation between them. Modelling is based on the Monte-Carlo method and is performed using software designed to assess possible risks when input parameters are uncertain. The result is the most likely scenario for the development of fisheries, indicating the range of forecast uncertainty. As a test example, a long-term forecast for the Russian catch of NA blue whiting (*Micromesistius poutassou*) up to

2042 was made. For this fish species, the Russian catch sizes may comprise at least 86 000 tons in the long-term. Similar assessments can be made for other commercial species.

*forecast, stock, total allowable catch (TAC), probability, blue whiting*

*Alexandrov N. K., Chernega O. P.* Study of storage stability of products made of collagen hydrolyzate

The paper presents the results of microbiological studies of poultry offals (chicken feet and heads) and collagen hydrolysate (CH) stored at low temperatures (chilled ( $4\pm 2$  °C) and frozen (minus 18 °C) form). The CH has been studied according to the indicators by which gelled poultry products are evaluated. Safety of raw materials (poultry offals) in accordance with regulatory requirements has been confirmed. Safety of CH in terms of pathogenic and presumptive pathogenic microorganisms has been confirmed as well. The paper also describes a change in the number of mesophilic aerobes and facultative anaerobes in CH in the process of storage. The CH products (HP) have been obtained, namely CH lyophilisate and CH that was dried at 50 °C (DCH). It has been found that the moisture content in the CH is  $90.1 \pm 0.1\%$ , in the DCH it is  $10.7 \pm 1.2\%$ , in the lyophilisate it's  $11.1 \pm 0.3\%$ . The water activity has been determined: for the CH it is more than 0.95, for the lyophilisate it is  $0.36 \pm 0.15$ , for DCH  $0.32 \pm 0.14$ . With the use of organoleptic methods it has been found that chilled form of CH has signs of spoilage on the 10th day of storage, and the frozen form has them on 72th day of storage. The strength of CH increased during storage at low temperatures. On the basis of the research, the recommended shelf life for chilled ( $4\pm 2$  °C storage) CH is 7 days, for frozen (minus 18 °C storage)- it's 60 days. The paper also presents a variant of HP use as an additive to sause. The dosage of 2% HP in the sauce produces a jelly, which confirms the gelling agent properties of the HP.

*collagen hydrolysate, shelf life, microbiological, organoleptic and rheological researches*

*Andriukhin A. V., Andreev M. P., Galdukevich V. A.* Improving the technology of antarctic krill (*Euphausia superba*) complex processing

The paper presents data on change of chemical composition, content of deproteinized shell and output of mince and shell-containing wastes at press-separation of Antarctic krill depending on degree of pressing of belt of perforated drum of press-separator with diameter of holes 3 mm. Taking into account the obtained data, the necessary condition for sequential use of two press separators with different diameters of holes of the working drum for mince production with acceptable qualitative parameters has been revealed. Change of formol-titrated nitrogen and non-protein nitrogen content during preliminary enzymatic hydrolysis of biological liquid isolated from whole crude krill during centrifugation is shown. Chemical composition of biological fluid (juice) formed during centrifugation has been investigated. A clear dependence of the use of krill mince on the production of molded, culinary products or stuffed products has been determined, depending on the water-holding capacity. The use

of additives made it possible to slow down the hydrolysis of krill mince lipids, which was expressed in lower values of the acid number throughout the shelf life. Preliminary enzymatic treatment made it possible to increase the yield of the lipid fraction by more than 20% and intensify the process of destruction of protein substances. The paper also shows a change in the quality of krill mince during refrigeration storage using vacuum packaging and stabilizing additives. Maintaining water-retaining capacity above 60% for 120 days when using food additives will expand the range of products relative to mince without using additives. Introduction of food additives in a certain amount from the mass of krill mince makes it possible to slow down dynamics of decrease of quality indices of krill mince during refrigeration storage.

*antarctic krill, krill oil, raw-frozen minced meat, press separation, shell-containing waste, enzymatic treatment, deproteinized shell*

Vorobyov V. I., Kazimirchenko O. V., Nizhnikova E. V. Chemical and microbiological parameters of fish skin and scales in processing and obtaining new food products

A method is proposed for processing fish skin with scales in order to obtain food additives and drinks enriched with collagen and its hydrolysis products. It has been determined that as a result of thermal hydrolysis (100 deg C for 2 minutes) fish scales in apple juice (mass fraction of protein – 0.1%, carbohydrates – 11.8%, ash – 0.46%, phosphorus – 0.11%, calcium – traces) and subsequent fractionation of the mixture, the resulting juice drink enriched with collagen hydrolysis products has the following chemical composition: protein – 1.12%, carbohydrates – 10.7%, ash – 0.69%, phosphorus – 0.18%, calcium – 0.02%. Partially hydrolyzed, swollen and crushed in apple juice (ratio 1:3 by weight, duration of hydrolysis – 48 hours at 4 deg C) fish skin (semi-finished product) was mixed and homogenized at a ratio of 1:5 with apple-pear juice, acquiring puree-like consistency with protein content: 1.86%, carbohydrates – 8.2%, ash – 0.54%, phosphorus – 0.26%, calcium – 0.01%. Microbiological tests of fruit juices, skin and scales of pike perch showed compliance with the standardized indicators. Samples of apple-pear juice had the highest microbiological stability during cold storage. Composition of the microflora of fruit juices was formed by spore and non-spore rod-shaped bacteria, at the final stages of storage – yeast and mold fungi, microflora of the skin and scales – coccal bacteria. Indicators of bacterial contamination of samples of fortified drinks, semi-finished products, puree based on apple juice and experimental mixed samples with the addition of orange juice at the background points were insignificant (on average,  $8.2 \times 10^2$  CFU / cm<sup>3</sup>), by the end of the shelf life, they naturally increased. The microflora of samples of enriched drinks was formed by non-spore sticks of *Pseudomonas putida*, *Bacillus subtilis* alone; in samples with lower pH values, acid-fast bacteria *Streptococcus sp.*, *Micrococcus candidus* dominated.

*fish collagen, fish skin, fish scales, apple juice, hydrolysis, microbiological analysis of skin and scale samples, enriched drink*

Mastyugin Yu. V., Alshevskiy D. L., Korzhavina Yu. N., Koshkina A. Substantiation of the method for separating the skin surface of the beaver tail from its lipid-protein part

Despite of the hunting permission and partial processing of their meat by private farms for sausages or other meat products, the number of animals is growing rapidly, and at the same time the amount of waste after meat processing that has nutritional value is increasing. The present study provides a rationale for the technology of applying an enzyme to the tail to simplify separation of the skin from the lipoprotein part. The optimal concentration of the enzyme, the fermenting time, temperature and duration of heat treatment have been analyzed as well. The enzyme application effect together with such catalysts as citric acid and salt on the beaver tails, resulted in weight, skin thickness and density change. The amount of dry solids passing into the solution after treatment has been also taken into account. During the experiment, it has been found that all fermented samples gain weight by 23% from the initial one. According to the results, the most successful patterns are the samples that get 4 points using citric acid and 0.1% enzyme solution and the sample that get 5 points with a high concentration of the enzyme 0.55 % and two catalysts. The experiment showed that an enzyme-treated tail samples, combined with heat treatment, gave a good result and greatly simplified the separation of inedible skin from the fatty part of the tail.

*beaver meat, beaver tail, enzyme preparations, lipoprotein part*

*Rachkova N. A., Soklakov V. V., Vorotnikov B. Yu. Approaches to solving the problem of determining the sufficiency of marine placental collagen purification*

Implementation of a unique method for producing marine placental collagen in the pilot operation conditions required a serious analysis of methods for assessing the parameters of individual technological stages. The main processes determining the quality of the finished product are separation of water-, salt- and alkali-soluble proteins in combination with the removal of lipids. To control the manufacturing process in the framework of in-process monitoring, it has been proposed to use an assessment of the dynamics of protein accumulation in extractants and the residual lipid content in the collagen. The analysis of standardized methods for determining the mass fractions of protein and fat used in food and pharmaceutical industries has shown a theoretical possibility of using the colorimetric method with a biuretic reagent and the gravimetric modified Soxhlet method, respectively, for technological purposes. Measurement of the protein content allowed for justification of a method for determining the duration of the extraction process under specific temperature conditions. The necessary and sufficient conditions are formulated as boundary factors in determining of this parameter. It has been proposed to consider the residual amounts of non-collagen proteins in the finished product as a technically difficult-to-remove impurity. The appliance of a widely used procedure for the quantitative determination of lipids with modern laboratory equipment suitable for production laboratories equipping, together with the analysis of other available standardized procedures, revealed a problem associated with the lack of an acceptable method due to the content of the measured component in the analyzed matrix at a level below reliable results. As a solution, it has been proposed to fix the value of remaining lipid content in product specification at the level of twice the repeatability limit of the most accurate available measurement procedure.

*marine placental collagen, parameters of technological process, quality determination of proteins, quality determination of lipids*

*Romanyuta D. A.* Influence of the character of load distribution from the wheel on the structure of trailer ships according to the requirements of the Russian River Register

The article analyzes the shape of the imprint and the nature of the pressure distribution over the contact patch from the wheels on rolling ships, required by the Rules of the Russian River Register (RRR). It has been found that the rectangular shape of the contact patch from the wheel prescribed by the RRR in most cases corresponds to real conditions. Distribution of uniform pressures along the length of the imprint of the wheel does not correspond to the actual picture, but in the direction of the width it is permissible. A formula is presented that describes a certain parabolic function and displays the form of non-uniform pressure along the contact patch. Using the specialized software complex FEMAP with NX NASTRAN, the finite element method was used to assess the stress-strain state of the floors of two trailer ships from the impact of the wheels of a truck and a car. The calculation was carried out taking into account two types of loads: with a uniform and parabolic nature of the pressure distribution along the contact patch. The peak value of the pressure with a parabolic shape turned out to be 1.5 times higher than with a uniform one. The difference in the results of the strength analysis for the maximum displacements and stresses in the beams was about 3%. At the same time, the highest stress values in the flooring, with different forms of pressure distribution over the wheel imprint, differ by 10–11%. The use of the proposed formula, which describes the parabolic nature of the load along the length of the contact patch, can be essential in determining the dimensions of the wheel imprint, the value of the maximum stress in the flooring, and the value of the admissible residual deflection of the flooring, in accordance with the requirements of the RRR Rules.

*trailer ship, contact patch, wheel print, pressure distribution, register, finite element method, Femap*

*Volkova L. Yu., Dorosh K. S., Zakirov S. R., Mishin O. D.* Calculation studies of fuel equipment for marine diesels

The paper presents a method and calculation of the cyclic fuel delivery, plunger pairs of high-pressure pumps and nozzle holes of fuel oil atomizers for low-speed marine two-stroke diesel MAN B&W engines with a cylinder capacity from 1310 to 4880 kW. It is shown that for the given power range of marine diesel engines, cyclic delivery at the nominal mode varies from 31 to 188 cm<sup>3</sup>, a plunger diameter - from 44 to 80 mm, and holes diameter- from 0.58 to 1.1 mm. It has been found that for MAN B&W 6S50MC diesel engine, with a constant cyclic fuel supply by one nozzle (18500 mm<sup>3</sup>) at injection duration (0.039 s), an increase in the average pressure in front of the nozzle holes from 30 to 100 MPa makes it possible to reduce the nozzle holes diameter from 0.75 to 0.55 mm, while reducing the average diameter of the sprayed fuel from 49 to 36 microns. Calculations have been performed of the fuel flame, the length of which depends on the nozzle hole diameter; of the speed and time of the fuel expiration, of the density and Weber criteria. Its self-ignition delay period has been found. It depends on the pressure and temperature of the air in the combustion chamber, the average speed of

the piston and the excess air coefficient. It is proposed that the time the fuel flame travels from the nozzle opening to the wall of the combustion chamber should be coordinated and approximately equal to the delay time of the fuel self-ignition. The proposed method of calculating fuel delivery, a plunger pair of the high-pressure pump, nozzle holes diameter of the nozzle sprayer, fuel atomization fineness, a fuel flame length, and a delay period of self-ignition can be useful in improving and developing new designs of the fuel equipment of marine diesel engines

*high-pressure pump, nozzle, cyclic delivery, diameter of nozzle and atomized fuel, torch, self-ignition*

## **KSTU News, № 65**

*Avdeeva E. V., Moiseeva A. I.* Microbiocenosis of carp (*Cyprinus carpio*) of the educational and experimental farm of KSTU (Kaliningrad region) for the three-year period from 2018 to 2020

Increasing fish farm productivity criteria with the help of various intensification measures (feeding fish, fertilizing ponds, increased stocking densities) leads to the emergence of fish infectious diseases. Educational and experimental farm is a multi-level pond farm that contains spawning, nursery and feeding ponds. It is used for commercial carp cultivation. On its territory, amateur fishing is also carried out. While studying pond economy, most frequently we register diseases of a bacterial nature. Test material has been carps of different ages. The primary bacteriological sowing has been carried out according to the method generally accepted in ichthyopathology. Microorganisms have been identified to genus and species with the help of a combination of cultural, morphological and physiological & biochemical signs using the Bergey bacterial manual. Microbial pathogenicity has been identified on the basis of proteolytic activity. The species composition of the carp microflora of the educational and experimental economy of Kaliningrad State Technical University in the period from 2018 to 2020 has been studied. As a result of microbiological analysis, groups of sanitary-indicative, saprophytic and opportunistic microorganisms have been identified. Isolation from the blood and parenchymal organs of bacteria of the genus *Pseudomonas* and *Aeromonas*, which can serve as virulent agents, indicates a possibility of carp infection due to the cultivation technology violation. When bacterial infections in pond farming happen, the economic damage can be significant, and treatment can be very expensive. Opportunistic bacteria that colonize pond farm carp can become virulent and provoke occurrence of epizootic process if fish resistance weakens and stressful conditions for the fish occur. Bacterial epizootics develop very quickly and can cause death of the entire fish stock in a pond farm. Therefore, any disease is better to prevent than to cure. But in order to develop preventive measures, it is necessary to constantly monitor the causative agents of various bacterial diseases in the pond economy.

*microbiocenosis, contamination, carp, educational and experimental farm*

*Antsiferova O. A., Yusupova D. I., Safonova D. N.* Influence of environmental conditions on the composition of mesofauna and the number of earthworms in the soils of agrophytocenoses of the Kaliningrad region

The article is devoted to identification of the biodiversity of *Lumbricidae* in drained cultivated soils of varying degrees of gleying. The studies were carried out in 2020–2021 in the hay field in the Chernyakhovsky district of the Kaliningrad region (Lava-Pregolskaya lowland) and in the arable field of the Zelenogradsk district (Sambian plain). Representatives of *Annelida* and *Mollusca* types in the mesofauna of soils have a similar share, Nematoda species predominate. Representatives of eight main classes of the *Arthropoda* type are found in all soils. A neutral reaction in Sod-podzolic soils (Aric, Siltic, Drainic) in haymaking is favorable for earthworms (115–159 pcs/m<sup>2</sup>), and increased acidity in gley Cambisols (Aric, Loamic, Drainic) under barley culture negatively affects their numbers (on average 58 pcs/m<sup>2</sup>). Gleysols (Aric, Siltic, Drainic) with a period of surface flooding contain an average of 95 worms per 1 m<sup>2</sup>. In catenas, there is an increase in the number of earthworms from elevated and less moistened areas to lowered and more moistened soils. *Dendrodrilus rubidus f. tenuis*, *Octolasia lacteum*, *Lumbricus rubellus*, *Aporrectodea caliginosa*, *Lumbricus castaneus*, rarely *Eiseniella tetraedra* were found in Gleyic Albeluvisols (Aric, Siltic, Drainic) in the hay field. *Aporrectodea caliginosa*, *Lumbricus rubellus* predominate in arable Cambisols (Aric, Loamic, Drainic). The largest number of earthworms is usually concentrated in a layer of 0–10 cm. But in the Cambisols in June, this layer dries up and seasonal migration of worms to a depth of 10–20 cm is observed. Such a type of earthworms as *Octolasion lacteum* is an indicator of soils with a close occurrence of carbonates (CaCO<sub>3</sub>), and *Eiseniella tetraedra* occurs mainly in soils with a period of surface flooding.

*mesofauna of soils, earthworms, soil and ecological conditions, haymaking, arable field*

*Vorobyov V. I., Chernega O. P., Sadovaya A. V.* Influence of a fish collagen fiber additive on the qualitative indicators of wheat dumpling dough

A possibility of using a collagen fiber fraction (CFF) obtained from fish scales as an additive in the test dumpling shell (based on wheat flour) has been studied. General chemical composition (including calcium and phosphorus) of the additive obtained from pikeperch and carp scales is presented, where the content of moisture is 5.1%; protein – 76.3%; fat – 1.4%; total ash – 17.2%; calcium – 5.1%, and phosphorus – 3.9%. Test samples have been obtained, with the addition of various concentrations (1%, 2%, 4%, 6%, 8%, 10%) of CFF, from which test dumplings have been prepared, stored at -18°C for 2–x months. It has been found that the test dumpling shells with the addition of CFF had an increased mass fraction of moisture compared to the control (without additive) before cooking and a smaller weight gain after cooking (in the range of adding the additive to the dough from 1 to 8%). It has been noted that with an increase in the mass fraction of the CFF additive in the test dumpling shell, the mass

yield of the boiled product increases. It has been found that inclusion of CFF in the recipe of the test dumpling shell in the amount of 2–3% is optimal. Experimental samples of dumplings stuffed with pollock with CFF additives in the dough in an amount of 2% and 3% have been made, and the general chemical composition of the boiled test shell and the finished product has been determined. It was found that when cooking in water, dumplings with CFF additives also had a smaller weight gain compared to the control. Addition of CFF to the test dumpling shell contributed to the improvement of its organoleptic characteristics (rich taste and soft texture), as well as to an increase in the mass fraction of protein in the casing.

*collagen fiber fraction, fish scales, fish dumplings, test dumpling shell*

*Nugmanov A. Kh.-Kh., Meshcheryakova G. S., Lebedev V. A., Aleksanyan I. Yu., Adzhey D. Y.* Thermodynamic analysis of the static patterns of moisture absorption by a biopolymer based on its hygroscopic characteristics

Currently, the world community is seriously concerned about the rapid and unpredictable growth in the use of synthetic food packaging, which leads to a constant accumulation of non-biodegradable waste, the disposal of which is difficult and expensive. This determines the rationality of replacing such packaging materials with biodegradable edible films, in particular, based on pectin substances of natural origin, which are natural structure-forming agents obtained from non-recyclable waste during the processing of plant materials. In this aspect, it is interesting to use watermelon peels, a significant part of the harvest of which does not reach the consumer due to its insufficient condition or simply remains in the fields unharvested. Moreover, the watermelon rind contains up to 13,4 % of pectin substances, 8,1 % of which are protopectin, which determines the strength parameters of berry tissue. To solve the problems posed in the work, in particular, the choice of rational operating parameters and modeling of drying, a study of its statics has been carried out by determining the hygroscopic characteristics and thermodynamic regularities of moisture absorption by pectin gel from a watermelon rind, which made it possible to determine the binding energy of moisture with a dry residue and, as a consequence, in fully assess the energy consumption during the procedure of its dehydration, as well as recommend the final rational moisture content of the finished product as a result of the drying process for its long-term preservation during its use and storage and, in addition, determine the appropriate environmental parameters that need to be maintained in commercial, industrial and warehouse premises.

*watermelon raw materials, rind, pectin extracts, protective film, hygroscopic parameters, static laws, thermodynamic analysis, drying.*

*Rachkova N. A., Soklakov V. V., Vorotnikov B. Yu.* Bioecological potential of marine placental collagen in cosmetology

The projected growth of fish products will entail an increase in the volume of unused waste, which protein part is significantly represented by collagen. The global market for this product is expected to double in 10 years in financial terms, while



marine collagen has an advantage over the collagen of terrestrial animals due to its low immunogenicity, absence of associated zoonotic diseases and religious restrictions on its consumption, as well as low cost. As a result of comparing the most widely produced type I collagen with the type V collagen we obtained, a suggestion has been made about the unique characteristics of the supramolecular structure of the latter, due to the cyclical development of placental tissues. An overview is given of various technologies for the production of fibrillating and network-forming marine collagens, which do not cover processing of secondary placental raw materials. A generalized functional scheme for the production of soluble collagen has been proposed. And when one specifies it for a particular technology, it is necessary to take into account physico-chemical characteristics of the raw material and the specific type of the extracted protein. The existing directions of the collagen use in the cosmetic industry have been considered, associated with its biocompatibility, biodegradability, biomimetic and hemostatic properties. Among the spectrum of possible cosmetic preparations, anti-aging protection, softening and increasing the elasticity of the skin, analgesic and regenerating effect, protection from UV radiation, restoration of the hair structure and strengthening of the nail bed have been noted. Samples of commercial forms of cosmetics based on the marine placental collagen and other native components of roe extracted from secondary raw materials have been proposed. The volunteers did not have any negative effects after using the cosmetic preparations developed by us. A synergistic effect is predicted with the joint use of collagen types I and V. The ecological aspect of the production of marine placental collagen has been mentioned.

*marine placental collagen, collagen structure, technology of marine collagen, cosmetics industry*

*Sereda N. A., Fedorov S. V. Method for determining reactions in pairs of single-moving mechanisms of a technological machine*

Analysis of graphoanalytical and analytical methods for determining reactions in kinematic pairs of single-moving mechanisms has been carried out. The graphoanalytical method is characterized by clarity. Its application involves repeated reproduction of a number of actions. Analytical methods are based on the compilation of equilibrium equations for a single link or for a structural group of the mechanism. These methods are used, as a rule, to assess the effect of the useful resistance force and the change in the transmission angle on the values of reactions in pairs of single-moving mechanisms. In order to evaluate the effects of the gravity forces of the links and the variation of the transmission angle on the values of forces in pairs of a single-moving mechanism, a method for determining reactions in such pairs has been developed. The practical application of the method involves the synchronous use of AutoCAD and Mathcad programs. The difference between the method and the well-known graphoanalytical method is as follows. A polygon of forces is not constructed for the L.V. Assur structural group, angles are measured directly on this group. So, the angles between the lines of gravity of the connecting rod, rocker arm and the direction of the tangential components of the reactions in the crank-connecting rod and rocker-rack pairs are measured, respectively. In relation to the structural group of M. Z. Kolovsky, a triangle of forces is constructed and the value of the angle between the line of gravity of the

crank and the direction of the full reaction in the crank-connecting rod pair is set. The total reactions in pairs of a single-moving mechanism are maximal in the position when the transmission angle is minimal. In this position of the mechanism, the crank continues the line of centers. The reaction in the connecting rod-rocker pair, unlike the forces in other pairs, increases both with an increase in the transmission angle and with its decrease.

*graphoanalytical method, analytical method, reaction, kinematic pair, single-moving mechanism, angle of transmission, gravity of links*

*Babintsev A. Yu., Sukonnov A. V.* Study of the interconnections of technical features of commercial fishing vessel complexes with the characteristics of trawlers

Trawl fishing vessels for working with fishing gear have fishing schemes, which include commercial winches and cable-net drums. When designing the hulls of fishing vessels, appropriate techniques are used. In turn, there are no methods to develop fishing schemes and complexes with various types of fishing, which leads to a low level of mechanization of operations and, as a result, to significant production costs. For this reason, schemes and complexes in industrial fishing are often designed with overestimated capacities and mass-dimensional characteristics. This circumstance ultimately affects profitability of trawlers and fish products cost. In most cases, development of fishing complexes for trawlers is carried out according to the prototype, taking into account their size. In accordance with the foregoing, this work is devoted to establishing links between the energy characteristics of fishing equipment and vessel parameters, in order to obtain initial data for the development of methods for designing complexes and schemes. To solve this problem, a review and analysis of fishing schemes for fishing trawlers with main engine powers from 44 kW to 5300 kW has been carried out. The main factor of the analysis was comparison of the given power parameters of fishing winches and power characteristics of fishing vessels. Based on the results of the study, the dependences of the power characteristics on the power of the power plants of the trawlers have been established analytically. Regressions are presented in the form of graphs and written by mathematical formulas, for which their adequacy has been checked. The results of the study will find application in the development of fishing complexes for fishing vessels.

*trawl complex, wire winch, power of propulsion system, fishing scheme, dependence*

*Zobov P. G., Dektyarev A. V., Kazachenko K. V., Morozov V. N.* Study of physical and mechanical properties of samples obtained by SLM technology. Part 1. Strength limit

Additive technologies are currently being actively implemented at the enterprises of the shipbuilding industry. After the successful testing of fused deposition modeling (FDM), stereolithography (SLA) and multi jet modeling (MJM) technologies in terms of prototyping and production of polymer products, the general vector of development seeks to master the technologies of metal printing of blanks and finished parts. Work in this direction is being carried out at a number of enterprises and the most

popular technologies in this aspect are selective laser melting (SLM), wire arc additive manufacturing (WAAM) and high-speed direct laser deposition (HSDL). At the moment, the interest of a number of shipbuilding companies is the possibility of producing blanks for parts according to castings drawings using the SLM technology. However, it should be noted that in the literature there are conflicting data on the properties of the samples obtained, in particular, regarding the presence of anisotropy of strength characteristics and the compliance of geometric deviations with existing standards. It is interesting in this regard to manufacture products of complex geometry from stainless steels, which can be used in the manufacture of levers, forks, housings of special equipment, as well as supercavitating screws and elements of hydrofoil consoles for small vessels. This paper describes the physico-mechanical characteristics and geometric deviations of samples obtained by the SLM technology on a Laser Cusing M2 setup made of 316L stainless steel. Specific ideas are given about the anisotropy of strength properties and the compliance of the geometry of the samples with the requirements for the manufactured products. The presented materials can serve as a starting point for carrying out strength calculations of products, taking into account some specifics of additive technologies and, in particular, the SLM process.

*additive technologies, 3D printing, shipbuilding, 316L, SLM, selective laser melting, strength, physical and mechanical characteristics*

*Kazmin S. A., Korableva M. S., Lobanov A. V., Timofeev O. Ya. Features of the classification of vessels of the oil and gas field fleet*

Classification of vessels is carried out on various grounds: depending on their purpose, dimensions, deadweight, operational restrictions, principles of buoyancy, transported goods and methods of their handling. Vessels of the oil and gas fleet traditionally belong to the group of vessels of the "technical fleet", designed to ensure the development of offshore fields on the continental shelf, to perform underwater technical, downhole, construction and installation, pipe-laying and cable-laying works, as well as other tasks related to the operation of oil and gas facilities. The continental shelf is the most accessible part of the World Ocean and is the zone of the most active human activity in the development of various resources. Development of the World Ocean is aimed at solving three main problems that are of paramount importance for the further global development of mankind: an increase in the volume of extraction of mineral raw materials, use of ocean energy, provision of food and accommodation of the population. The article examines the various views of modern society on the classification of ships and ocean engineering facilities, with the help of which a set of measures aimed at the development, construction and operation of various energy facilities of the continental shelf is implemented. In particular, the article analyzes the classification principles of the Russian Maritime Register of Shipping, the Norwegian DNV (Det Norske Veritas), as well as classification approaches used by oil and gas companies and brokers (on the example of Rystad Energy, Norway). In addition, the article in the form of tables and diagrams presents generalized data on the classification of the oil and gas fleet used in various periods in the domestic oil and gas industry.

*classification, oil and gas field, vessel, support, technical fleet, classification society*

*Yafasov A. Ya.* Updating the Marinet Roadmap in modern conditions

The aim of the work is to analyze a Roadmap of the Marinet track of the National Technology Initiative and develop proposals for its updating in the context of the new situation in the world - bifurcation of the world system caused by the economic war between developed Western countries, with the United States ahead of the game, and Russia. The Marinet road map has been analyzed, the necessity of including production technologies for deep processing of marine bioproducts, recycling, accelerated development of domestic fishing shipbuilding, equipment and materials, aqua and mariculture, renewable marine energy with simultaneous accelerated digitalization of the marine economy has been substantiated. Digitalization of the maritime economy should be carried out by creating independent digital ecosystems using domestic digital platforms and software products, the element base of microelectronics, sensors and computer technology, expanding and improving training of digital economy personnel. Digital ecosystems, going beyond the maritime economy and spreading to other industries, ensure the implementation of the “strategy of adjacent synergistic development”. It is shown that the focus of development should be the classical innovative model of the economy with the priority of developing new production technologies, relying on internal sources of investment in production, modernizing public-private partnerships and training systems for professional personnel in the digital economy. Creation of digital system designers and development of algorithms that ensure rapid construction and congruent restructuring of digital ecosystems, depending on changes in the internal and external environment, will ensure the accelerated digitalization of the Russian economy, its digital and technological sovereignty. For the coastal regions of the country, the need for the synchronous development of agro-industrial and fishery complexes, public catering enterprises in the concept of a full-cycle bioeconomy is shown. The use of digital platforms significantly reduces food prices, increases food security and sustainability of regional development.

*bifurcation of the world system, Marinet, digital economy, production development, digital platform, innovation, circular economy, digital economy personnel*