

Newsletter of the Russian Society of Nematologists

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AKHATOVA F.S. & FAKHRULLIN R.F. Comparative characterisation of the cuticles of free-living nematodes by dark-field and atomic force microscopy.

Different nematodes have similar anatomy and morphology. However, significant differences related to the habitat of the species may occur. To compare the cuticle of different nematodes, we chose free-living nematodes: *C. elegans* living in moist, organic-rich soil, and *T. aceti*, living in strongly acidic vinegar environment. Dark-field images and spectral data were obtained using CytoViva[®] hyperspectral unit. AFM images were taken using Dimension FastScan and Dimension Icon microscopes operating in PeakForce Tapping mode. Analysis of spectral data of cuticles suggests that their chemical compositions are very similar. Process of cuticle biosynthesis in free-living nematodes may be identical. AFM data demonstrate the similarity of ultrastructural parameters (width of rings and grooves depth) of epicuticula. The periodicity and size of the rings can be rather conservative traits, even in systematically distant species. Although the width of the rings and the depth of the furrows in two species were practically the same, both species differed significantly in the morphology of the rings and furrows. In *C. elegans*, regularly repeating parallel grooves were detected, whereas in *T. aceti*, less regular and unmatched grooves forming a kind of ‘fingerprints’ were detected. Cuticles of these species differed significantly in their mechanical characteristics, peculiarities in the distribution of hard and soft areas, and in their adhesive properties. Probably the differences related to the different habitats of nematodes. AFM surface characterisation methods can be applied to the study of surfaces of free-living and parasitic nematodes (Support: RSF 20-13-00247). – Kazan (Volga Region) Federal University, Kazan, 420008, Russia; e-mail: akhatovaf@gmail.com.

ARBUZOVA E.N., IVANOV A.V. & CHALKIN A.A. Analysis of the efficiency of different methods of DNA isolation of the pinewood nematode *Bursaphelenchus xylophilus*.

For accurate identification of molecular genetic studies, it is necessary to obtain high quality and pure DNA. Nucleic acid samples often contain contaminants of proteins and other substances. This reduces the efficiency of PCR and subsequent sequencing. Therefore, a particularly important step in molecular genetic studies of nematodes is DNA isolation. The main aim of this work was to perform an initial assessment of the quantity and quality of DNA isolated from nematodes of the genus *Bursaphelenchus* using different commercial kits with different principles of method: DNA-Extran-2 kit, “Syntol” (treatment of the sample with proteinase K, followed by removal of proteins without extraction with organic solvents, to determine their efficiency); Proba-RAPID, “DNA-Technology” (express method of lysis of cells and viral particles with neutralisation of inhibitors); QIAamp DNA Mini Kit, “Qiagen” (enzymatic lysis of the sample on spin columns with silica gel membrane) and mechanical cell lysis (pestle rubbing) in TE-buffer. The quality of isolated DNA was determined by the absorbance ratio at 260 nm and 280 nm wavelengths. The value of the index during extraction with the Extran-2 DNA kit was close to the optimal one and varied in the range of 1.7-2.15. The lowest values were observed when using the RAPID test kit (1.07-1.11), which may indicate a high content of contaminating products. The effect of the quality of isolated DNA on the identification of *B. xylophilus* was determined by PCR-flash using test systems of “Agrodiagnostica”. Our results confirm that, the most effective kit to obtain the required amount of high-quality DNA of the pinewood nematode *B. xylophilus* is the DNA kit Extran-2, “Syntol”. – All-Russian Plant Quarantine Centre, Moscow Region, Bykovo, 140150, Russia; e-mail: pazhitnovaece@mail.ru.

BORETS L.S.¹, PRONKINA N.V.² & POLYAKOVA T.A.² Paratenic host of *Contracaecum radiatum* (Linstow, 1907) Baylis, 1920 (Nematoda: Anisakidae) in Antarctic basin.

The mature nematodes of the genus *Contracaecum* Railliet & Henry, 1912 (Anisakidae) parasitise in the alimentary tract of mammals and birds. Their juvenile stages can be found in the muscles and body cavity of fishes. The

identification of *Contracaecum* juvenile stages is hampered by the scarcity of morphological features. During the 79th cruise of the research vessel 'Mstislav Keldysh' in February-March 2020, eight specimens of immature anisakid nematodes were collected in the Antarctic Sound from Antarctic silverfish *Pleuragramma antarcticum* (Nototheniidae). Four fishes out of 15 ones dissected contained nematode juveniles. The morphological examination of these juveniles did not provide secure identification up to species level, with *Contracaecum osculatum* and *C. radiatum* as the closest species. The sequence of the large ribosomal subunit (LSU rDNA) of these juveniles was amplified and sequenced. BLAST-search for obtained 717 bp long LSU rDNA sequence demonstrated 100% similarity with the deposited (AF226577) sequence of *Contracaecum radiatum* from an Antarctic Weddell seal – *Leptonychotes weddelli*. Previously another fish species was reported as an intermediate host for *C. radiatum* – dusky rock cod *Trematomus newnesi*. Our data expand the information on the paratenic hosts and occurrence of *C. radiatum* in the Antarctic (Support: RSF 19-74-2014; State Assignment AAAA-A19-119100290162-0). – ¹A.N. Severtsov Institute of Ecology and Evolution, RAS, Moscow, 119071, Russia; e-mail: ludokromashka@yandex.ru; ²A.O.Kovalevsky Institute of Biology of the Southern Seas, RAS, Sevastopol, 299011, Russia; e-mail: natalya-pronkina@yandex.ru, polyakov-acant@yandex.ru.

EFEYKIN B.D., IVANOVA E.S. & SPIRIDONOV S.E. Mitochondrial gene arrangement and phylogenetic relationships of three taxa of the parasitic nematodes of invertebrates.

The order Rhabditida (subclass Secernentea in older classifications) includes numerous groups of parasitic nematodes. The evolutionary origin of these taxa of parasites is an intriguing problem of the nematode evolution. Earlier phylogenies of higher taxa of nematodes were mainly inferred from the analyses of 18S rDNA. Such an analysis, being informative for some groups, proved to be not sufficient to resolve the relationships in the phylogenetic tree of Rhabditida. Several complete mitochondrial genomes of nematodes of the order Rhabditida have been published over the past decade. A comparison of the gene arrangement (GA) in such a circular genome was proposed as an additional source of phylogenetic 'signal' (see Sultana *et al.*, 2013). Primarily a limited number of GA types was reported for nematodes of the order Rhabditida, but the latest publication (Kim *et al.*, 2020) revealed significantly higher diversity. Thus, the mitochondrial genome of nematodes of the genus *Heth* (infraorder Rhigonematomorpha according to De Ley & Blaxter, 2002) was obtained with NGS approach. Also, the mitochondrial genome of *Rhigonema thysanopora* from this infraorder was published. The GA of *Heth* nematodes differed significantly from *Rhigonema* and resembled GA of ascaridids and spirurids. Analysis of GA in nematodes of the Thelastomatidae family (*Leidynema appendiculata* and *Blatticola blattae* from cockroaches), and Chitwoodiellidae family (representatives of the genus *Singhiella* from mole-crickets) enabled the evaluation of phylogenetic hypotheses for the infraorder Oxyuridomorpha. It appeared that GA in the two studied cockroach nematodes significantly differed, with GA of *Blatticola* nematodes from the German cockroach being similar to that in the human pinworm *Enterobius vermicularis* (family Oxyuridae). The GA of the *Singhiella* was significantly different from that of the thelastomatids. Analysis of the mitochondrial genome of the nematode *Synoeceema hirsutum* (family Ungellidae, Drilonematomorpha) from earthworms revealed distant similarity with *Acrobeloides varius* (Cephalobidae, Cephalobomorpha). – A.N. Severtsov Institute of Ecology and Evolution, RAS, Moscow, 119071, Russia; e-mail: s_e_spiridonov@rambler.ru.

EFREMOVA A.D. & SPIRIDONOV S.E. The comparison of different methods of steinernematid infective juvenile recovery stimulation.

The use of the entomopathogenic nematodes of the family Steinernematidae for the control of insect pests demands the release of significant amounts of these nematodes into the agricultural soil. Such inundation approach requires the use of the methods of mass propagation of these nematodes on artificial media. Despite the development of nematode breeding technologies, some problems hamper the wider application of these technologies. The need to stimulate the recovery of Steinernematidae invasive juveniles from the non-feeding third stage (so-called 'Dauer larva') is between these technological problems. Nutrient media for the cultivation of steinernematids are quite affordable, but the simple introduction of invasive juveniles into these media does not secure further development to adult breeding stages. A comparison was made between three methods to stimulate the recovery of invasive juveniles of *Steinernema feltiae* from the state of the 'Dauer larva'. Juveniles were surface sterilised with a 0.1% solution of merthiolate in autoclaved tap water. Nematodes were placed 1) on the surface of Lurie agar with 2-day-old colonies of bacteria of the genus *Xenorhabdus bovienii*; 2) on the surface of Lurie agar with an evaporated precipitate of an ethanol extract of a wax moth tissues homogenate (incubation of wax moth tissues for 48 hours in 70% ethanol, then evaporation of the extract to a viscous precipitate that does not contain alcohol); 3) on the surface of agar containing 10% (by weight) of wax moth tissue homogenate. Only the third method provided a reliable recovery of invasive juveniles to feeding. Two-three days after nematode release onto agar with homogenate numerous adult, sexually mature males and female were observed.

An increase in the yield of adult nematodes was achieved by applying a 1-2-day suspension of *X. bovienii* in the Lurie broth over the agar surface (two days before the addition of nematodes). Adult nematodes *S. feltiae*, transferred to a liquid nutrient medium (directly in fragments of Lurie agar) successfully developed and consumed the medium completely within 21-28 days with formation of new invasive juveniles. – **A.N. Severtsov Institute of Ecology and Evolution, RAS, Moscow, 119071, Russia; e-mail: s_e_spiridonov@rambler.ru.**

FADEEVA N.P.¹, MIKHAILOVA E.R.^{1, 2}, SEMENCHENKO A.A.¹ & MORDUKHOVICH V.V.^{1, 2} New species genus *Desmodora* de Man, 1889 (Nematoda: Desmodoridae) from the hydrothermal vent communities of the Piip volcano (south-west Bering Sea).

Species of the marine nematode genus *Desmodora* have been found to dominate (up to 78%) in the nematode fauna from the vent communities of submarine Piip volcano, Bering Sea. This paper has addressed such a taxonomic problem sibling species genus *Desmodora*, and attempts a solution based on morphological and genetic characters. They are very common in the marine environment. The genus *Desmodora* de Man, 1889 has had a number of taxonomic revisions. The morphological characteristics and molecular genetic data of desmodorid specimens from different habitats of submarine Piip volcano were studied and five species of the genus *Desmodora* have been described: *D. hydrotherma*, *D. calyptogena*, *D. spongina*, *D. paraspongina* and *D. beringiana*. These sibling species are similar in morphological characteristics, but they are reproductively isolated. Spatial distribution from habitats of submarine Piip volcano of the described species was analysed (Support: RFBR 20-04-00919-a). – ¹**Far Eastern Federal University, Vladivostok, 690600, Russia; e-mail: nfadeeva2006@yandex.ru;** ²**A.V. Zhirmunsky National Scientific Center of Marine Biology, FEB RAS, Vladivostok, 690041, Russia.**

FAKHRULLIN R. Round worms serve as potent *in vivo* models around the clock.

Nematodes, represented mostly (but not limited to) by the world-famous *Caenorhabditis elegans*, have secured a prominent and irreplaceable position as laboratory animals, taking part in a tremendous number of *in vivo* studies as versatile multicellular models. In this talk, several recent advances in the application of nematodes as model organisms will be covered. Apart from ubiquitous *C. elegans*, a less popular nematode, *Turbatrix aceti*, has been recently re-introduced into biomedical research. First, the technical aspects of imaging of various nanoscale and microscale particles, such as engineered peptide nanoparticles, nanoclays (including drug-loaded nanocontainers) and plasmonic nanoparticles, will be covered. Next, the talk will focus on the use of free-living nematodes as models for detection of emerging pollutants, including nanoplastics and fly ash particles. Finally, a recent technology on directed modification of nematode intestines with a completely uncharacteristic microbiota (oil-degrading marine bacteria *Alcanivorax borkumensis*) will be highlighted. This technology allows to induce free-living soil nematodes to eat and digest crude oil, which makes them perspective bacteria delivery vectors and tiny oil degradation factories to tackle oil and oil-products spills (Support: Russian Federation Presidential Grant MD-2153.2020.3). – **Kazan (Volga Region) Federal University, Kazan, 420008, Russia; e-mail: kazanbio@gmail.com.**

FEDYAEVA M.A.^{1, 2} & TCHESUNOV A.V.² Stoma and gut ultrastructure of four free-living nematode species belong to four different feeding types.

Nematode stomas vary broadly in shape, but the gut structure looks the same. Here, we want to show variety of gut ultrastructure in species of feeding types according to Wieser (1953). The species are *Oxystomina* sp. (selective deposit feeder with a tiny stoma), *Paramonhystera filamentosa* (non-selective deposit feeder with a medium-sized unarmed stoma), *Paracanthonchus caecus* (epigrowth feeder with medium-sized stoma armed with tooth, denticles and other sclerotised structures) and *Halichoanolaimus robustus* (predator with a large stoma equipped with teeth). All these species consume their food in different ways. While *Oxystomina* sp., *P. filamentosa* and *H. robustus* swallow their food, *P. caecus* crushes it. As a result, some species swallow liquid matter whereas other species feed on coarse food. Due to this difference, we can see various gut structure. *Oxystomina* sp. and *P. caecus* gut cells have not sparse located microvilli and amorphous extracellular layer (glycocalyx). *P. filamentosa* and *H. robustus* gut cells have thick multilayered glycocalyx (as protection from coarse food) and closely located microvillie. In conclusion, there is no direct link between feeding type and gut structure, but we can relate the last one with feeding manner and consistency of swallowing food (Support: RFBR 20-54-56038-a). – ¹**Lomonosov Moscow State University Marine Research Centre, Moscow, 119992, Russia; e-mail: mariaf92@mail.ru;** ²**Biological Faculty, Lomonosov Moscow State University, Moscow, 119991, Russia; e-mail: avtchesunov@yandex.ru.**

GORELYSHEVA D.I.^{1,2} & BALAKIREV A.E.^{1,2} Diversity of rictulariid nematodes from small mammals in Vietnam and the first record of *Pterygodermatites nycticebi* (Monnig 1920) from tree shrew *Tupaia* sp. (Scadentia: Tupaiidae).

Small mammals from Vietnam (Thanh Hoa and Thua Thien – Hue province) were infected by three species of *Pterygodermatites*. We found *Tupaia belangery* and *T. chinensis* (Scadentia: Tupaiidae) infected by *Pterygodermatites nycticebi* Monnig 1920; *Niviventer indochinicus* and *Leopoldamys revertens* (Rodentia: Muridae) infected by *Pterygodermatites whartoni* Hoeppli 1928, and *Callosciurus finlaysonii* (Sciuridae) infected by *Pterygodermatites* sp. Molecular data for these parasitic species was obtained. The monophyly of subgenera *Mesopectines* and *Paucipectines* was not confirmed in our analysis. Moreover, the study provides the first record on *Pterygodermatites nycticebi*, which is considered to be a dangerous parasite of primates from tree shrews (Scadentia: Tupaiidae). Previously, *Nycticebus coucang* was considered to be a native host of *P. nycticebi*, but it seems that the actual range of hosts in wildlife is wider. Intraspecific variation was observed for *P. nycticebi* using SEM and molecular analysis. – ¹A.N. Severtsov Institute of Ecology and Evolution, RAS, Moscow, 119071, Russia; e-mail: sweetcourseee@gmail.com; ²Joint Russian-Vietnamese Tropical Research and Technological Centre, No 63, Nguyen Van Huyen, Nghia Do, Cau Giay, Hanoi, Vietnam.

IVANOV A.V., SUDARIKOVA S.V. & KHUDYAKOVA E.A. PCR diagnostics to enhance detection of *Heterodera glycines* Ichinohe.

The article provides general information about the soybean cyst nematode *Heterodera glycines*: spread, symptoms, morphological characters and the development cycle. Soy is a valuable ingredient of food and forage, a major component of many pharmaceuticals and cosmetics. This culture's popularity is mainly accounted for by high protein concentration in beans (about 40% of the seed mass on average), and a fairly high yield. The total area of soybeans cultivation in the world in 2020 amounted to 127.98 million ha, the world production reached 366.7 million tons. Over 80% of the world soybeans production is concentrated in three countries: Brazil, the USA, and Argentina. In 2020, Russia's proportion of the soybean production in the world accounted for about 1.3%. *Heterodera glycines* Ichinohe, 1952, is the soybean cyst nematode, which causes great damage to the soybean and other Fabaceae crops. Ten percent of the world's agricultural soybean production is lost because of the soybean cyst nematode, which amounts to 1/3 of the losses caused by pests and diseases. The development cycle of *H. glycines* is common for all cyst nematode species. The diagnosis of *H. glycines* is based on morphological and molecular methods. Molecular methods are becoming more important as *Heterodera* spp. nematode cysts are quite often detected on regulated products. Morphologically they are quite similar, e.g. nematodes belonging to one group. In this case, conducting research by the morphological method can be difficult. The aim of the research was testing and optimising sample preparation methods and classic PCR methods with available commercial kits for the effective identification of soybean cyst nematode, including the use of specific primers. Currently, Russian companies offer a wide range of reagents for DNA extraction and amplification. For example, Syntol (Russia) offers a kit for the isolation of nucleic acids from animal tissues DNA-Extran-2. Basic kits for carrying out amplification, containing all the necessary components, with the exception of species-specific oligonucleotides, are offered by Syntol, Evrogen (Russia), AgroDiagnostica, Dialat Ltd. (Russia). Species-specific oligonucleotides are produced by Biotechindustria (Lumiprobe), Evrogen and Syntol. – All-Russian Plant Quarantine Centre, Moscow Region, Bykovo, 140150, Russia; e-mail: tonijons8@mail.ru.

IVANOVA E.S.¹ & MAZAKINA V.V.^{1,2} An alien slug *Arion vulgaris* Moquin-Tandon, 1855 in Moscow parks and its susceptibility to nematodes.

Snails and slugs inhabited green areas of Moscow city were collected and examined on the presence of gastropod-associated nematodes and trematodes. In several locations, the alien slug species and a recent newcomer *Arion vulgaris* was predominant gastropod species showing the typical synanthropic (antropohore) behaviour. The mitochondrial markers for the three Moscow populations of slugs were obtained and predictably, confirmed that slug populations inhabited Moscow parks represent haplotypes of Western origin in accordance with Zajac *et al.* (2020) which have shown that the spatial pattern of genetic diversity in Eastern Europe reflects the recent invasion of *A. vulgaris*. At least three established populations of *Arion vulgaris* were discovered in Moscow parks. Of all fifteen gastropod species examined, *A. vulgaris* was the only species infected by the nematode *Alloionema appendiculatum* Schneider, 1859, an obligate parasite of molluscs. ITS sequences of *A. appendiculatum* obtained from 3 populations of infected slugs were identical to those from Western and Central Europe. This suggests that nematodes travelled with their hosts rather than were brought with soil or slugs were infected in their new habitat. As a generalist nematode parasite of land gastropods, *A. appendiculatum* has a wide host range including species common in the European part of Russia. Its complex life cycle includes a free-living stage in soil which offers a source of infection for other susceptible gastropod species but the capacity of *A.*

appendiculatum to change hosts in local conditions needs to be further examined. In our study, prevalence of invasion by *A. appendiculatum* was higher in the long-established populations of *A. vulgaris* than in relatively young ones which indicates that co-invasive parasites of an alien slug show a spreading potential. High probability of the further expansion of *A. vulgaris* in Moscow can be expected, first, due to the dispersal of slugs from infested territories to surrounding suitable areas and second, due to new deliveries with imported plants. The particular susceptibility and tolerance of *A. vulgaris* to nematodes in our study is in accordance with data of Ross *et al.* (2016, 2017), Antzée-Hyllseth *et al.* (2020), and Filipiak (2020) while in contradiction with the enemy release hypothesis (Torchin *et al.*, 2003). No parasites dangerous for humans or animals were found in the study (Support: RFBR 20-04-00910-a). – ¹A.N. Severtsov Institute of Ecology and Evolution, RAS, Moscow, 119071, Russia; e-mail: elena_s_ivanova@rambler.ru; ²Biological Faculty, Lomonosov Moscow State University, Moscow, 119991, Russia.

KALINKINA D.S., MATVEEVA E.M. & SUSHCHUK A.A. Soil nematode community patterns of natural forests and under introduced trees in North-West of Russia.

Introduction of tree species in new areas influences on soil biota, including nematodes. Indirect influence exhibits in the variation of microclimatic characteristics of nematode habitats and further restructuring of their communities. Negative consequence (as direct influence) of plant introduction is dispersal of dangerous plant parasite species in native biocenoses. Such changes in soil nematode communities, as supposed, will be different in dependence on tree species, conditions of growth (introduction, natural biocenoses). To check this hypothesis, nematode fauna was compared in deciduous (from 54° to 61° N) and coniferous forests (from 61° to 64° N) and under introduced trees (from 61° to 67° N) of some botanical gardens; and *Pinus sibirica* and *Tilia cordata* were chosen as model objects. Soil samples were collected by multiple injections under tree crowns. Nematode extraction and fixation, preparation of temporary microslides and identification were performed according to generally accepted methods. Results showed that the taxonomic diversity of nematodes under introduced *T. cordata* considerably decreased (25-29 taxa) compared to native deciduous linden forests (40-48) and, in the contrary, slightly increased under introduced *P. sibirica* (25-32) compared with coniferous pine (*Pinus* sp.) forests (22-30 taxa). Diversity of plant parasites (Pp) under introduced trees had no differences as compared with ones in natural biocenoses for *T. cordata*, or increased for *P. sibirica*. Pp species rare in native forests were found under introduced trees (*Nagelus leptus*). Nematode abundance did not differ between trees and was lower compared to natural forests. There were noted the changes in eco-trophic structure of nematode communities under introduced trees: share of Pp and fungivorous nematodes increased, and share of omnivorous and bacterivorous nematodes decreased in the community. Thus, the results indicated distinctive characteristics of nematode communities under introduced trees and did not show significant differences depending on tree species (Support: State Order 0218-2019-0075). – Institute of Biology, Karelian Research Centre, RAS, Petrozavodsk, 185910, Russia; e-mail: kalinkinads@gmail.com.

KHUSAINOV R.V. Fauna of root-knot nematodes (Tylenchida: Meloidogynidae) of open ground in the Central-European part of Russia.

Investigations of fauna of root-knot nematodes were carried in the Central-European part of Russia in 2016-2019. The soil samples were collected from fields of various vegetable and legume crop as well as potatoes in the territory of twelve regions. Three species were found (*M. ardenensis*, *M. hapla* and *M. incognita*). *M. ardenensis* detected in sites of fields bordering the woodland belt in the rhizosphere of weeds in Moscow and Kaluga regions. *M. hapla* was found in the rhizosphere of different plants in the territory of ten regions. This species was found on potato in Lipetsk and Bryansk regions (to 18 juveniles (100 cm³ soil)⁻¹) and on cabbage in Moscow region (to 36 juveniles (100 cm³ soil)⁻¹). It was found on carrot in Tver, Moscow, Tula, Lipetsk and Bryansk regions (22-520 specimens (100 cm³ soil)⁻¹). Lesions of meloidoginosis with a high degree of plant infection were recorded. Carrot roots have the 5th level of infestation with formation over-galls (Lipetsk region). Quantity of female was 5-12 specimens on one over-gall. Also this species was found on legumes crop in Yaroslavl, Moscow, Vladimir, Kaluga, Orel and Bryansk regions, on soybean in Kursk region and on peas in Tver and Moscow region (to 42 specimens (100 cm³ soil)⁻¹). *M. hapla* was represented by two subspecies, which differed in the presence of males in populations and the level of gallogenesis. *M. incognita* was found on legumes crop in the territory of Moscow and Ryazan regions (16-48 juveniles (100 cm³ soil)⁻¹) (Support: RFBR 19-516-6001). – A.N. Severtsov Institute of Ecology and Evolution, RAS, Moscow, 119071, Russia; e-mail: ren_khusainov@yahoo.com.

KONRAT A.N., NOVIK T.S. & SHESTEPEROV A.A. Possibility of application of pharmaiod for soil disinfection from phytoparasitic nematodes.

In vitro experiments it had been shown that liquid agent pharmaiod at dose levels over 0.1% killed saprobic (*Caenorhabditis elegans*, *Pelodera* sp., *Turbatrix aceti*) and parasitic nematodes (*Ditylenchus dipsaci* and *Meloidogyne incognita*). Nematodes didn't survive such treatment and following washing with water became yellow or brown. At dose level of 0.001% the agent reduced alive nematode number: *C. elegans* by 92.2%, *T. aceti* by 88%, *Pelodera* sp. 69%, and it had no effects on stem nematodes at that dose. Using three pharmaiod doses (0.1; 0.01; 0.001%) for treatment of soil infected with root-knot nematode larvae it had been found that the agent didn't have a significant effect on the quantitative and qualitative composition of nematodes compared with the control, including root-knot nematode larvae. Liquid Pharmaiod at dose level of 0.001% reduced *Meloidogyne* infection in root system (biological efficiency – 56%) and stimulated plant growth. In a vegetation experiment aimed to study the agent effects on number of golden potato nematode larvae, liquid pharmaiod at dose levels of 0.5 and 0.1% was phytotoxic: the tubers died. The agent had no phytotoxic effect on potato plants and significantly reduced the female number in roots at a dose level of 0.01% (biological efficiency – 96%). Soil treatment with 0.01% liquid pharmaiod reduced the number of golden potato nematode larvae, but didn't affect the number of nematodes attributed to other ecological groups (Support: Program of Fundamental Scientific Research of the State Academies of Sciences FNSE-2019-0009). – **Federal Scientific Centre VIEV, RAS, Moscow, 117218, Russia; e-mail: Alenakonrat@vniigis.ru.**

KULINICH O.A.^{1,2}, CHALKIN A.A.¹, RYASKIN D.I.¹, PETROV A.V.¹, ARBUZOVA E.N.¹, KOZYREVA N.I.^{1,2} & RYSS A.Yu.³ Bark beetles as potential vectors of the pinewood nematode *Bursaphelenchus xylophilus* (Steiner & Bührer) Nickle in Russia.

The pinewood nematode *Bursaphelenchus xylophilus* (PWN) is a dangerous pest; it causes pine wilt disease. Survey (2000-2021) did not detect the PWN in the Russian Federation. The Pest Risk Analysis showed that a part of Russian territory is favourable for the PWN adaptation (Kulinich *et al.*, 1995). The PWN is widespread in Japan, Taiwan, China, and the Republic of Korea, from where it can be introduced to the Russian area by insects (vector). The life cycle of PWN is closely associated with the longhorn beetles *Monochamus* spp., which transmit the nematodes from infected trees to healthy ones. The main phytosanitary measures carried out for the localisation and elimination of *B. xylophilus* outbreaks (in Portugal, Spain, Japan, China) are aimed at the destruction of longhorn beetles of the genus *Monochamus*, as the PWN vectors. Studies in Portugal, the USA and Japan have detected the PWN in bark beetles (*Ips acuminatus*, *I. mansfeldi*, *Dendroctonus frontalis*, *Tomicus piniperda*, *Hylastes ater*, *Hylurgus ligniperda*, *Orthotomicus erosus*, *Pityogenes bidentatus*) but the transfer of nematodes by these beetles is considered to be occasional. The specificity of nematodes and these beetles as vectors has not been studied. Studies on the possible transmission by bark beetles of the genus *Ips*, as the most widespread bark beetles in Russia, were initiated by the authors on the basis of All-Russian Plant Quarantine Centre (Support: RFBR 20-04-00569-a). – ¹All-Russian Plant Quarantine Centre, Moscow Region, Bykovo, 140150, Russia; ²A.N. Severtsov Institute of Ecology and Evolution, RAS, Moscow, 119071, Russia; e-mail: okulinich@mail.ru; ³Zoological Institute, RAS, Saint Petersburg, 199034, Russia.

KURNOSOVA O.P. Trichinella-host interaction and infection intensity: does pregnancy and colostrum bodies have a role to play.

In this study, intensity of the infection with *Trichinella spiralis* muscle larvae and levels of specific IgG were evaluated during experimental infection of pregnant rats and their offspring. The study results showed no significant differences in intensity of the infection with *Trichinella* muscle larvae at different infective doses in pregnant and non-pregnant rats. However, the levels of specific IgG in the blood of rats infected during pregnancy were higher as compared to infected non-pregnant rats, which may be explained by immunity response switching to the B-cell type in pregnant animals. *Trichinella*-specific IgG were not detected in the blood of newborn animals who had not received maternal antibodies with milk, while on the 15th to 31st days of age the IgG were detected in low titres. The level of specific IgG in the offspring obtained from infected mothers was not higher compared to the controls. The average number of muscle larvae was 2, 6 and 8 times less compared to the controls while infection intensity was 2536, 1384 and 6293 larvae per animal, and 5714, 8320 and 50266 larvae per animal in the control group of animals when infected on the 15th, 21st and 24th days of age, respectively. When infected on the 31st to 39th days of age, no difference in the infection intensity was found compared to the control offspring. In general, individual infection intensity and titres of specific IgG varied in the test groups. It is possible that maternal antibodies that were transferred to the offspring in low titres were able to induce a stronger immune response in infected infant rats compared to the control, and to reduce intensity of the infection with *Trichinella spiralis* muscle larvae in early age. – **Federal Scientific Centre VIEV, RAS, Moscow, 117218, Russia; e-mail: 916952522@mail.ru.**

KUZNETSOV D.N.¹, SERYODKIN I.V.² & MAKSIMOVA D.A.³ Study of the species composition of gastrointestinal nematodes parasitising sika deer and manchurian deer in the Russian Far East.

Three sika deer (*Cervus nippon*) and five Manchurian deer (*Cervus elaphus xanthopygus*) from Primorsky Krai (46°10' N, 137°20' E) were studied by the method of partial helminthological necropsy in the period of 2011-2019. The content of abomasum and intestinal tract was examined in each animal. All of the studied sika deer appeared to be infected with Trichostrongylidae nematodes, and the intensity of infection ranged from 43 to 272 nematodes. *Spiculopteragia asymmetrica* (including the minor morph – “*Spiculopteragia quadrispiculata*”) was detected in all of the studied sika deer. Trichostrongylidae nematodes were also detected in four of the five studied Manchurian deer. The intensity of infection ranged from two to 191 nematodes. All of the nematodes found in Manchurian deer were determined as *Spiculopteragia spiculoptera*. In addition, a small number of trematodes *Dicrocoelium dendriticum* was found in the thin intestines of two Manchurian deer as well. A comparison with the literature data shows a wide variability of the species diversity of the gastrointestinal nematodes parasitising *C. nippon* and *C. elaphus*, depending on the study region. In the studied area, the population density of ungulates is low due to anthropogenic influence. Moreover, the habitats of *C. nippon*, *C. elaphus* and other ruminants are separated due to the fact that they prefer different biotopes. Thus, the low level of species diversity of helminths recorded in this study is probably due to the minimisation of interspecific contacts among ruminants in this region. – ¹A.N. Severtsov Institute of Ecology and Evolution, RAS, Moscow, 119071, Russia; e-mail: dkuznetsov@mail.ru; ²Pacific Geographical Institute, FEB RAS, Vladivostok, 690041, Russia; e-mail: seryodkinivan@inbox.ru; ³Land of the Leopard National Park, Vladivostok, 690068, Russia; e-mail: dmaksimova.tig@yandex.ru.

LOGINOVA O.A. Morphological anomalies in juveniles of zooparasitic nematodes of the Strongylida order.

During routine analyses of faeces of agricultural herbivores from the Leningrad Region, carried out in 2018-2021 at the Laboratory for the Study of Parasitic Diseases, St. Petersburg State University of Veterinary Medicine (St. Petersburg, Russia) and at the Centre of Parasitology, A.N. Severtsov Institute of Ecology and Evolution, RAS (Moscow, Russia) using Wajda, Polyakov, Baermann-Orlov and Shilnikov-Shcherbovich techniques, larval stages of nematodes with morphological anomalies were found. Thus, L3 of *Strongylus equinus* with an asymmetric bifurcation at the tail end of its sheath was obtained in 2018 from the faeces of a domestic horse (*Equus ferus caballus*). L1 of *Elaphostrongylus rangiferi* with abnormal body thickenings were obtained from faeces of domesticated reindeer (*Rangifer tarandus tarandus*). We have been observing single spherical thickenings in the region of the pump chamber – the border of the esophagus and intestines in larvae from the particular male for three years. Yet, in 2021, a larva with a swelling at the caudal end (replacing the tail spike and dorsal spine) was found in the material from him, and larvae with multiple swellings along its body were found in the material from the female. Freezing and subsequent defrosting of larvae do not cause the formation of the described swellings. The effect of regular deworming of reindeer remains controversial given the adult parasites localisation. These anomalies had no effect on the locomotor abilities of the larvae throughout the observation. Though it requires long-term experiments aimed, in particular, at studying the invasive ability of the affected larvae. – A.N. Severtsov Institute of Ecology and Evolution, RAS, Moscow, 119071, Russia; e-mail: loginova_spb@bk.ru.

LYCHAGINA S.V.¹, TABOLIN S.B.^{1,2} & VOLKOVA M.V.³ Plant-parasitic nematodes from the rhizosphere of grapevines in the Bakhchisarai district of Crimea.

One of the main branches of agriculture in the Republic of Crimea is viticulture. In 2020, the total area of vineyards in the republic was about 19 thousand hectares, 16 thousand of which was fruit-bearing. However, the yield from these vineyards remains very low. In 2020, the average yield in Crimea was about 56 centers per hectare, while the normal yield from the specialised plantations of industrial vineyards is considered to be 120-150 centers per hectare. It is known that plant-parasitic nematodes can seriously reduce the yield of grapes and even cause the death of individual plants. Despite this, data on the species composition of plant-parasitic nematodes and their distribution in vineyards of Crimea are very limited. During routine nematological surveys conducted in 2016-2020 in the Bakhchisarai district of Crimean peninsula, the most frequently encountered species were *Criconemoides informis* (Micoletzky, 1922) Luc & Raski, 1981, *C. morgensis* (Hofmänner, 1914) Taylor, 1936, *Nagelus leptus* (Allen, 1955) Siddiqi, 1979, *Helicotylenchus digonicus* Perry, 1959, *H. vulgaris* Yuen, 1964, *Paratylenchus microdorus* Andrassy, 1959, *Pratylenchus neglectus* (Rensch 1924) Chitwood & Oteifa 1952, *Pratylenchoides crenicauda* Winslow, 1958, *Tylenchorhynchus dubius* (Bütschli, 1873) Filipjev, 1936, *Xiphinema ingens* Luc & Dalmasso, 1964, *X. pachtaicum* (Tulaganov, 1938) Kirjanova, 1951, *X. simile* Lamberti, Choleva & Agostinelli, 1983, *Zygotylenchus guevarai* (Tobar Jiménez, 1963) Braun et Loof, 1966 (Support: Program of Fundamental Scientific Research of the State Academies of Sciences FNSE-2019-0009). – ¹Federal Scientific Centre VIEV, RAS, Moscow, 117218, Russia; e-mail: lychagina-

svetlana@rambler.ru; ²A.N. Severtsov Institute of Ecology and Evolution, RAS, Moscow, 119071, Russia; ³All-Russian National Research Institute Viticulture and Winemaking “Magarach”, RAS, Yalta, 298600, Russia.

MOKIEVSKY V.O.¹, KONLAR' D.V.¹, TCHESUNOV A.V.² & NGUYEN DINH TU.³ Free-living nematodes of the intertidal zone of Condao islands (Vietnam).

Condao islands are the archipelago lie *ca* 100 km of the South Vietnam. Human impact on marine ecosystems was restricted here since long ago till recently. All the intertidal communities look rather intact. Nematodes were collected there in several locations on two islands; each set of samples includes one taken from the rhizosphere of dominated mangrove trees and the next from outside the mangroves, on the bare calcareous sand on reef-flat. Local species diversity was estimated in each location to test the hypothesis of the reduction of species number in insular ecosystems. Second set of tests was provided to evaluate the differences between nematodes assemblages in vicinity of mangrove roots and outside. The results of this test highlight the role of mangroves and their roots as a structuring factor for the communities of free-living nematodes. For the first time species diversity and communities composition was described for the islands of the region. Species diversity of the free-living nematodes was comparable with the figures obtained in the same habitats of the mainland. The commonalities in species composition were found in mangroves and reef-flat sediments; several genera (*Ptycholaimellus*, *Tereshellingia*, *Anoplostoma*) and families, such as Desmodoridae and Stilbonematidae, are typical form mangrove rhizosphere and assume to be mangrove-associated (Support: RFBR 21-54-54006-a). – ¹P.P. Shirshov Institute of Oceanology, RAS, Moscow, 117997, Russia; e-mail: vadim@ocean.ru; ²Biological Faculty, Lomonosov Moscow State University, Moscow, 119991, Russia; ³Institute of Ecology and Biological Resources, VAST, Hanoi, Vietnam.

MOKIEVSKY V.O.¹ & TCHESUNOV A.V.² Free-living nematodes in mangroves: diversity and spatial structure of the communities along the gradient from Vietnam to the Persian Gulf.

Mangrove trees and their roots are assuming to be one of the most important factors to structure the life on the intertidal zone of tropical seas. Nematodes diversity, species composition and the structure of the communities are affected greatly by mangrove vegetation. Species composition of the assemblages reflects mainly the type of root system of different mangrove species and therefore should depend on mangrove species diversity and composition both in local and geographical scales. Sharp gradient of the diversity of mangrove species occurs from Indo-West Pacific to the East and to the West. Here we are comparing our own and literature data on the taxonomic composition of free-living nematodes in mangrove areas of the region. Mangroves of the South Vietnam are rich by species; about 38-39 species are reported from there. In Persian Gulf, the diversity of mangroves is reduced to a single species. India and West coast of Africa keep the intermediate position in terms of mangrove diversity. Taxonomic composition and diversity patterns are compared along this gradient to test in which extend diversity of mangroves does affect species diversity and composition of associated fauna (Support: RFBR 21-54-54006-a; RFBR 20-54-56038-a). – ¹P.P. Shirshov Institute of Oceanology, RAS, Moscow, 117997, Russia; e-mail: vadim@ocean.ru; ²Biological Faculty, Lomonosov Moscow State University, Moscow, 119991, Russia.

MORDUKHOVICH, V.V.^{1,2} & ZOGRAF J.K.¹ New finding of Ironidae (Nematoda: Enoplida) from Piip submarine volcano, the Bering Sea.

During the study of the nematofauna from the Piip submarine volcano (the Bering Sea) the very long free-living nematodes representatives of the family Ironidae were found. *Piipironus* gen. nov. shows all main characters of subfamily Thalassironinae but differs from all known ironids in the form of the amphid (spiral vs pocket-like) and the simultaneous presence of papilliform and tubular supplements. Supplementary copulatory organs usually take the form of tubules or papillae, both types are found together only in several genera and have never been described before for family Ironidae. The combination of papilliform precloacal supplements and the pair of tubular postcloacal supplements described for *Piipironus grandis* gen. et sp. nov. is unique among nematodes. The question of the true diversity of marine nematodes has been raised many times. The study of the nematofauna of the Piip submarine volcano began quite recently and *Piipironus* is the second new genus of nematodes described from here from one sample of bottom sediments. This can be taken as one of the examples of the hyper-high diversity of marine nematodes (Support: RFBR 20-04-00919-a). – ¹A.V. Zhirmunsky National Scientific Center of Marine Biology, FEB RAS, Vladivostok, 690041, Russia; e-mail: vvmora@mail.ru; ²Far Eastern Federal University, Vladivostok, 690600, Russia.

NAUMOVA T.V.¹ & GAGARIN V.G.² Deep-sea fauna of free-living nematodes of Lake Baikal.

The nematode fauna of Lake Baikal consists of 120 species from 32 genera, 16 families and 8 orders based on the authors' material and published information. The Lake Baikal nematode fauna has a high degree of endemism (75% of

the total number). In total, 37 species were found at depths over 250 m, of which 17 species are confined only to the abyssal zone and are not found in other depth zones. Of these, 31 species are endemic to the lake, 5 Palearctic (for most of the range – the Siberian subregion of the Palaearctic) and 1 cosmopolitan. The average number of worms within the depths from 225 to 1,465 m is 551 ind. (m⁻²). The exceptions are areas of natural outcrops of oil and gas, which occur at the bottom in the form of solid gas hydrates, and are discharged by bubbles into the water column. In such areas, the number of nematodes can reach >15 thousand ind. (m⁻²) (Support: State Project 121032300180-7). – **'Limnological Institute, SB RAS, Irkutsk, 664033, Russia; e-mail: tvnaum@lin.irk.ru; ¹I.D. Papanin Institute for Biology of Inland Waters, RAS, Yaroslavl Region, Borok, 152742, Russia; e-mail: gagarin@ibiw.ru.**

NTIDI K.N.¹, M. DANEEL^{2, 3} & FOURIE H.³ Identification of nematode pests in South African potato production areas and evaluation of sustainable management strategies.

Potato (*Solanum tuberosum*) is a staple food and an economically important crop for many countries. In South Africa, the commodity contributes 3% of the total gross production value of the country's agriculture. However, the production of potato is adversely affected by infection of plant-parasitic nematodes, particularly root-knot nematodes (*Meloidogyne* spp.). Nematicides are commonly used to control these pests, but due to the withdrawal of effective traditional products such as aldicarb and methyl bromide, nematode control has become more challenging. Hence, proper management of nematode pests is crucial to reduce their population build-ups and to enable the continued sustainability of the potato industry with good quality produce. The main aim of this research is to assist potato producers in South Africa to sustainably produce the crop in the presence of reduced population densities of nematode pests by i) identifying the *Meloidogyne* and *Pratylenchus* species found in potato farming areas and ii) to determine the host status of cover crops against *Meloidogyne* spp. (*M. enterolobii*, *M. incognita* and *M. javanica*) and *Pratylenchus* spp. (*P. brachyurus* and *P. penetrans*). The SCAR-PCR analysis of root-knot nematode females from 31 potato fields situated in the Free State province revealed the presence of *M. incognita* and *M. javanica*, while the former two species and *M. enterolobii*, were species identified from fields in the Limpopo and Mpumalanga provinces. Analyses of D2-D3 sequences and BLAST for lesion nematode identification revealed the presence of *P. parazeae* from samples collected in the North West province, while *P. bolivianus* was found in the Kwa-Zulu Natal, Free State, Mpumalanga and North West provinces. Glasshouse evaluation for summer cover crops showed that 'Pearler Hybrid Babala', 'Turfsaver RTF', 'Tiffany Teff', 'Commander Chicory', 'Tolgar Rhodes grass', 'Captain CSP plantain' were classified as poor hosts for both *Pratylenchus* spp., while initial results of winter cover crops indicated that 'Balo Phacelia', 'Esterosa Saia oats', 'Exito - Japanese oats', 'Iris white mustard', 'Velencia radish', 'Tajuna fodder radish', 'Scala brown mustard', *Tagetes patula* and 'Cordoba radish' were poor hosts for both *Pratylenchus* spp. (Support: SA(NRF)/Russia (RFBR) Joint Science and Technology Research Collaboration 118912). – **¹Agricultural Research Council – Grain Crops, Potchefstroom, 2520, South Africa; ²Agricultural Research Council – Tropical & Subtropical Crops, Mbombela, 1200, South Africa; ³North-West University, Potchefstroom, 2520, South Africa.**

ODOEVSKAYA I.M.¹, KUDRYASHOVA I.B.², KURNOSOVA O.P.¹, KACHURINA L.I.¹, REKSTINA V.V.², ZIGANSHIN R.H.³ & KALEBINA T.S.² The spectrum of excretory-secretory proteins of *Trichinella nativa* involved in the interaction of L1 larvae with the host muscle cells.

Trichinella nativa (Britov & Boev, 1972) is widely distributed among wildlife in the Holarctic region of the globe and is characterised by low reproductive potential, severe clinical manifestations of trichinosis disease and high resistance to prolonged freezing. More than 700 isolates originating from terrestrial and marine carnivores inhabiting arctic and subarctic areas have been identified as *T. nativa* (Pozio, 2016). *Trichinella* excretory-secretory (E-S) proteins are the determining factor of virulence because they interact directly with the host immune system during invasion and have pronounced strain specificity. A wide variety of adaptive reactions of *Trichinella* genus during the development of the parasite-host relationships is ensured by proteolytic enzymes and other protein molecules contained in the E-S products of *Trichinella*. However, fundamental data on composition of E-S proteins of the species *T. nativa* widespread in natural biocenosis are practically absent so far. Larvae of *T. nativa* strain ISS 7635 isolated from muscles of *Ursus arctos* L., 1758 were passaged on white mice. Invasive larvae were isolated from mouse muscles by proteolysis in artificial gastric juice, and then cultured in DMEM medium for 24, 48 and 72 h. The resulting E-S products were analysed by tandem mass spectrometry coupled to high-performance liquid chromatography (LC-MS/MS). Common proteins reliably determined by four or more unique peptides and present at all three culturing stages were selected from the E-S products. A total of 86 proteins, both with known and unidentified functions were revealed, apparently reflecting the bulk of the spectrum of proteins involved in parasite-host interactions. All of these proteins have posttranslational modifications. Judging by the ratio of the number of peptides detected for one of the revealed transmembrane serine proteinases (75) and actin (37), and considering the unique peptides determined for these two

proteins (74 and 9, respectively), their presence in E-S products was not caused by larval death and lysis but rather by secretion by the living larvae, probably as part of transport vesicles. The possible role of a number of identified proteins in the interaction of muscle larvae with host cells is discussed (Support: Program of Fundamental Scientific Research of the State Academies of Sciences FNSE-2019-0009; 121032300088-6 without attracting additional sources of funding). – ¹Federal Scientific Centre VIEV, RAS, Moscow, 117218, Russia; e-mail: odoevskayaim@rambler.ru; ²Biological Faculty, Lomonosov Moscow State University, Moscow, 119234, Russia; ³Shemyakin-Ovchinnikov Institute of Bioorganic Chemistry, RAS, Moscow, 117997, Russia.

PELGUNOV A.N.¹, KURNOSOVA O.P.², KACHURINA L.I.² & ODOEVSKAYA I.M.² Study of the effect of microwave radiation on *Trichinella nativa* (Britov et Boev, 1972) larvae in the muscle tissue of the brown bear.

Trichinellosis is a helminthic disease caused by the L1 larvae of nematodes of the genus *Trichinella*, which parasitise in muscle tissue. Trichinellosis pathogens are registered in many countries of the world. *Trichinella* nematodes can parasitise in three classes of vertebrates – mammals, birds and reptiles. According to epidemiological investigations, the main source of *Trichinella* infestation in most cases in Russia was contaminated meat of wild game animals: brown bear *Ursus arctos* L., 1758, badger *Meles meles* L., 1758, wild boar *Sus scrofa* L., 1758. On the territory of the Arctic seashore infestation occurs through consumption of meat of sea mammals: seals (family *Phocidae* Gray, 1821), walrus (family *Odobenidae* Allen, 1880). Our investigations were aimed at studying the effect of microwave radiation on the viability of *Trichinella* larvae in the meat of brown bear spontaneously infected with *T. nativa* (ISS 7635) under standard technology of cooking meat products in a microwave oven. The degree of destructive changes in encapsulated muscle larvae of *T. nativa* under microwave radiation is directly proportional to the exposure time. When exposed to microwave radiation for 5 min, denaturation of collagen in the capsule and lysis of digestive cells in larvae occur. Maximum time exposure for 15 min causes pronounced destructive changes in the body of *Trichinella* larvae. The dead larvae became susceptible to staining with methylene blue. The staining was diffuse, indicating deep destructive changes in larval tissues. Studies have shown that structural changes in the body of larvae occur not only due to heating of the surrounding muscle tissue, but also due to the emergence of a thermal effect as a result of the oscillatory motion of molecules within the larvae themselves. It was shown that the effect of microwave radiation on biological objects is determined by the amount of penetrating and absorbed by them electromagnetic energy (EMR). The effectiveness of EMR for the elimination of invasive *Trichinella* larvae in the meat of brown bear spontaneously infected with *T. nativa* as a result of treatment in a microwave oven was confirmed by the absence of parasites in a bioassay on Syrian hamsters (Support: Program of Fundamental Scientific Research of the State Academies of Sciences FNSE-2019-0009 without attracting additional sources of funding). – ¹A.N. Severtsov Institute of Ecology and Evolution, RAS, Moscow, 119071, Russia; e-mail: apelgunov@list.ru; ²Federal Scientific Centre VIEV, RAS, Moscow, 117218, Russia.

POLYANINA K.S. & RYSS A.Yu. A model of the ontogenesis and population dynamics of saproxylic nematodes (on *Panagrolaimus detritophagus*).

The saproxylic bacterial feeder *Panagrolaimus detritophagus* inhabits tree bark, the nematodes are vectored by the longhorn beetles *Monochamus galloprovincialis*. The study carried out *in vitro* was aimed to *i)* identify the main parameters of the *P. detritophagus* ontogenesis, *ii)* to build a model of population dynamics with analytical links of ontogenetic parameters for the time-dependent phases of population cycle; *iii)* to identify the number of generations and the final population structure when food resources are exhausted. Fifty active mature adults were inoculated on 2% potato-glucose agar at 21-23 (22)°C. Mean individual development time was: from egg to J2 1-2 days, to J3 3-4 days, to J4 4-7 days; to adults (G, generation) 7 (6-8) days. It was revealed that the population cycle *in vitro* is equal to 4 generations. At the end of the population cycle, 90% of the population consists of the diapausing J3 juveniles. In the growth phase of the population the proportion of eggs exceeds the proportion of other stages of the development cycle: 39 ± 11% for 7 days; and 53 ± 10% for 21 days. The mean female oviposition rate is 4.5 ± 1.3 eggs (day)⁻¹, of which only 56 ± 12% of eggs proceed to immediate development; the remaining arrested eggs developed later. It is concluded that there are two diapausing stages: eggs and the dormant J3, at the beginning and at the end of the population cycle, respectively. Formulas for the exponential growth for number of females and the total nematode population were developed (Support: RFBR 20-34-90101-Aspiranty (Biodel parameters); State Assignment AAAA-A19-119020690109-2 (nematode cultures of the ZIN RAS research collections)). – Zoological Institute, RAS, Saint Petersburg, 199034, Russia; e-mail: Kristina.Polyanina@zin.ru; nema@zin.ru.

PORTNOVA D.A.¹, KIYASHKO S.I.², SAULENKO A.A.^{2, 3} & MORDUKHOVICH V.V.^{2, 3} Free-living nematode communities at cold seeps of the Bering Sea.

Underwater degassing areas together account for more than 10% of the world's oceans, they are marked from littoral to hadal, in a wide range of geological conditions. According to current data, chemosynthetic production provides nutrition for a variety of bottom and plankt. Recently discovered methane seeps on the Koryak slope of the Bering Sea at depths 400-700 m are the northernmost chemosynthetic habitats ($\approx 61^\circ\text{N}$) known to date in the Pacific. The aims of this study are to describe the nematode community composition at methane seeps and adjacent area, and to study the contribution of products of chemosynthetic origin to the nematode diet. A total of 17 major meiofaunal taxa, excluding copepod nauplii, were recorded in the methane seeps: Nematoda, Copepoda, Polychaeta, Hydrozoa, Ostracoda, Priapulida, Kinorhycha, Bivalvia, Acarina, Ophiuroidea, Gastrotricha, Cumacea, Kamptozoa, Nemertea, Caudofoveata, Isopoda with a strong dominance of Nematoda (more than 88% of total abundance). Meiofaunal abundances ranged between from 347 ind. (10 cm^{-2}) (seep) and 5561 ind. (10 cm^{-2}) (periphery sediment). There were significant differences in the abundance of nematodes at different locations. The density of nematodes ranged from 336 ind. (10 cm^{-2}) (seep) to 5506 ind. (10 cm^{-2}) (periphery sediments). A total of 78 nematode genera were identified. Nematode dominant genus was *Daptonema*, subdominant genus was *Sabatieria*. Similarity and diversity analyses are done to compare the different locations. A wide range of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values was found, with $\delta^{13}\text{C}$ values ranging from -31.9 to -20.2‰ and $\delta^{15}\text{N}$ values ranging from 7.2 to 11.2‰. The depleted isotopic signatures suggest that chemosynthetically derived organic matter is an important carbon source for nematodes at seeps and is also included in the diet of organisms from the periphery of seeps (Support: RFBR 20-04-00919-a). – ¹P.P. Shirshov Institute of Oceanology, RAS, Moscow, 117997, Russia; e-mail: daria.portnova@gmail.com; ²A.V. Zhirmunsky National Scientific Center of Marine Biology, FEB RAS, Vladivostok, 690041, Russia; ³Far Eastern Federal University, Vladivostok, 690600, Russia.

POPOVA E.N.¹ & POPOV I.O.² Influence of the water regime on the complexes of soil nematodes in the Moscow Region.

To identify the features of soil nematode complexes, the Moscow region soils with different water regimes (peat-bog, alluvial, bog-podzolic, sod-podzolic and podzolic) were examined. The greatest genera diversity and abundance of soil nematodes was noted in humus-peat bog lowland soils (34 genera, up to 1380 individuals/100 ml of soil), characterised by a moderately close occurrence of groundwater, good but not excessive moisture and the thickness of the humus-peat horizon. The poorest nematode numbers and genera diversity occurred in peat-gley soils with excessive moisture. To characterise the complexes of soil nematodes, the classification of P.I. Nesterov (1977) was used. For podzolic and soddy-podzolic soils with deep groundwater, a litter forest-shrub biocenotic nematode complex with a predominance of polyphages from the order Dorylaimida, a moderate amount of plectids, cephalobids, and phytohelminths of non-specific pathogenic effect was typical. The litter of podzolic soils also contained a saprophage-humus complex (a significant predominance of bacterio/saprophage nematodes). A combination of saprophagous-humus and meadow-bog (the presence of chromadorids, enoplids and a small number of phytoparasitic nematodes) nematode complexes was noted in lowland bog peat-gley soils. In the bog-podzolic soils, the meadow-bog biocenotic complex of nematodes prevailed. After cultivation, phytoparasitic nematodes began to dominate in all these soils, and the nematode complex of drained peat-bog soils became close to litter forest-shrub one. Soil nematodes of alluvial soils had no analogue in the classification of Nesterov and were characterised by a high number and diversity of much nematode groups: polyphagous, phytophagous, bacterio/saprophagous and mycophagous, and in some cases predatory (Support: State Order 0148-2019-0007). – ¹Institute of Geography, RAS, Moscow, 119017, Russia; e-mail: en_popova@mail.ru; ²Yu.A. Izrael Institute of Global Climate and Ecology, Moscow, 107258, Russia; e-mail: igor_o_popov@mail.ru.

ROMASHOV B.V.^{1,2} & ROMASHOVA N.B.¹ Respiratory nematodes of canids (Canidae) in the Voronezh Reserve.

Three species of canids (Canidae) are recorded in the Voronezh Reserve: red fox (*Vulpes vulpes*) and wolf (*Canis lupus*) are native species, and raccoon dog (*Nyctereutes procyonoides*) is an introduced species. *V. vulpes* is the most numerous carnivorous species in the Voronezh Reserve. Nematological material was collected by the method of complete helminthological autopsies from 20 foxes and 3 wolves in 2011-2020. These are animals that died on the roads or as a result of poaching. We have studied the species diversity of nematodes parasitising in the respiratory organs of Canidae – lungs, trachea and nasal sinuses and determined the levels of infection. The levels of infestation with nematodes were indicated: the prevalence of infection (E, %), the intensity of infection (I, sp.), and the index of abundance (M, sp.). Prevalence of infection is not calculated for the wolf because of the small number of studies. Three

species respiratory nematodes were recorded in the canids – *Eucoleus aerophilus*, *E. boehmi* (fam. Capillariidae), and *Crenosoma vulpis* (fam. Crenosomatidae). *E. aerophilus* was noted in the trachea and large bronchi of red fox and wolf. We identified two local morphs of *E. aerophilus trachea* and *E. aerophilus bronchi* based on morphological characteristics and localisation features. Infection rates in red fox for *E. aerophilus trachea*: E = 80.0, I = 7.4, M = 5.9, for the wolf: I = 4.0, M = 1.3. Infection rates in red fox for *E. aerophilus bronchi*: E = 75.0, I = 2.9, M = 2.2, for wolf: I = 4.0, M = 1.3. We believe that these local morphs, when examined in detail, can be regarded as valid species. *E. boehmi* species localised in the nasal sinuses. Infection of red fox with *E. boehmi*: E = 20.0, I = 1.8, M = 0.4, wolf infection: I = 8.0, M = 2.7. The wolf is an obligate host. *C. vulpis* species localised in the large bronchi. Infection of red fox with *C. vulpis*: E = 55.0, I = 32.2, M = 17.7, wolf infection: I = 11.0, M = 7.3. The red fox is an obligate host *C. vulpis*. – ¹Voronezh State Nature Biosphere Reserve, Voronezh, 394080, Russia; ²Voronezh State Agrarian University n.a. Emperor Peter the Great, Voronezh, 394087, Russia; e-mail: bvrom@rambler.ru.

RYSS A.Yu. Plant nematology research in eastern and Nordic Europe and Russia, 2010-2021.

A review is based on the analysis of 100 publications (2010-2021) from 18 countries: Scandinavia (3 countries), Baltics (3), Central region (5), Black Sea region (4), Caucasus (2) and Russia. The most economically important PPN genera were identified by a global survey and listed by the EPPO: *Bursaphelenchus* (conifers), *Meloidogyne* (vegetable crops), *Globodera* (potatoes), *Heterodera* (cereals, sugar beet), *Ditylenchus* (potato, bulbs and others) are the agricultural pests for many European countries. Virus vectors *Longidorus*, *Trichodorus* (berries) and *Xiphinema* (grapevine). Migratory endoparasites *Pratylenchus* spp. and *Hirschmaniella*, the leaf and bud nematodes *Aphelenchoides* are economically important for the South of Europe. PCR diagnostics are used in many countries. The Multiplex Real-Time PCR methods actively developed in Czech Republic and applied in other countries. Pest Risk Modeling for forest pests is used in Norway and Russia. The management strategies are: crop rotation (many countries), automated environmentally safe fumigation with EDN, HCN, and biocontrol application (Czech Republic), selection of crops' resistance (Russia); biocontrol in glasshouses using vermicompost, nematophagous fungi and nematicidal plants (Czech Republic, Slovakia, Russia). The fundamental studies include biodiversity and bioindicators analysis, integrated taxonomy (10 countries), molecular phylogeny (Poland, Belarus, Bulgaria, Georgia and Russia); analytical phylogeography and reconstruction of pest origin centers (Bulgaria and Russia); interspecific hybridization (Poland); relationships of virus-vector nematodes and viruses (Poland, Czech Republic, Romania, Bulgaria, Russia) and HPR genetics (Russia). For Russia and Southern countries, the publications in international teams are typical; Czech Republic leads in the development of applied technology tools (Support: RFBR 20-04-00569-a; State Assignment AAAA-A19-119020690109-2 (literature database)). – Zoological Institute, RAS, Saint Petersburg, 199034, Russia; e-mail: nema@zin.ru.

RYSS A.Yu. & PETROV A.A. Muscles of the copulatory organs are markers of the Nematoda phylogeny.

The research provides detailed nomenclature of the muscles of the genital structures of the *Bursaphelenchus mucronatus* and one cephalobid species studied using confocal microscopy. The genital structures have evolved following the 'key and lock' correspondence between male and female organs. The male caudal muscles of Cephalodidae (*Chiloplacus* sp.) are identical to those of *Caenorhabditis elegans* (Rhabditidae) and this muscle pattern seems to be the ancestral state for the order Rhabditidae. Analysis of muscular patterns indicates that the gubernaculum has probably fused with spicules in the Aphelenchoididae evolution. The pattern of caudal muscles in males and vulval muscles in females can be used as the significant markers for phylogenetic reconstruction and natural classification of the order Rhabditida (Support: RFBR 20-04-00569-a; State Assignments AAAA-A19-119020690109-2 and AAAA-A19-119020690076-7). – Zoological Institute, RAS, Saint Petersburg, 199034, Russia; e-mail: nema@zin.ru.

SHESTEPEROV A.A. Evolution of epiphytoses of infections (*Anguina* spp.) of cereals.

The evolution of plants, including the family of cereals, is associated with birds and mammals, which play a large role in the spread of seeds. The appearance in the process of evolution of galls formed as a result of the vital activity of *Anguina* spp. in various organs of cereal plants resembles the process of existence of seeds of flowering plants. Like seeds, galls are resting structures with a tough shell that helps *Anguina* spp. survive in adverse conditions. Like seeds, Galls usually have the same modes of distribution that have evolved over the course of evolution: wind, water, animals, and birds. *Anguina* spp. form galls, similar to cereal seeds. In the epiphytosome: plant + phytoparasite + herbivore, in biogeocenosis one herbivore species is replaced by another and displaces it in the competitive struggle. However, due to its peculiarities, this species does not spread seeds and galls well. Different microorganisms adapt to each type of animal, including those 'useful' for each type of epiphytosis. The bacteria *Rathayibacter tritici*, *R. xicus* colonised the galls and caused the death of herbivorous mammals. Herbivores stopped eating cereal seeds with galls, which grain-

eaters began to use, and as a result ‘sow’ seeds and galls in characteristic and other biogeocenoses. As a result of coevolution, epiphytosis with the inclusion of toxic microorganisms reached a higher level. *Anguina* spp. epiphytoses in a particular biogeocenosis are determined by historically established interspecies relationships and characteristics of the coalition, including host plants, *Anguina* spp. species, ‘beneficial’ bacteria, herbivores, and birds (Support: Program of Fundamental Scientific Research of the State Academies of Sciences FNSE-2019-0009). – **Federal Scientific Centre VIEV, RAS, Moscow, 117218, Russia; e-mail: aleks.6perov@yandex.ru.**

SHESTEPEROV A.A.¹, LYCHAGINA S.V.¹, GRIBOEDOVA O.G.¹, ZEIRUK V.N.² & BELOV G.L.² Field evaluation of 50 potato varieties to the resistance to tuberous nematode *Ditylenchus destructor*.

In 2020, an experiment was conducted to assess the resistance to tuberous nematode and *Ditylenchus destructor* of 50 potato varieties on an artificial invasive background, in triplicate. The degree of infection of each sample was determined by the ratio of the infected in points (from 1 to 3). After storage, the infection manifested itself in all varieties, but to a different extent. 19 varieties were severely affected by *Ditylenchus* (3 points): Labella, Innovator, Sirenevyy Tuman, Krasavchik, Varyag, Golubizna, Signal, Nadezhda, Lorkh, Favorite, Lux, Fritella, Meteor, Start, Lukyanovskiy, Vostorg, Bravo, Vega, Berkut, Patriot, Prince. 18 varieties were assigned to point 2. Weakly infected varieties (1 point): Belarus, Gulliver, Debut, Kolobok. The degree of reproduction by the tuber nematode in the tubers affected by ditylenchiasis of each accession was determined in points. More than 100 specimens of nematodes per 1 square centimeter were found in 25 varieties. In 20 cultivars, the number of tuberous nematodes ranged from 25 to 100 specimens. In 5 varieties (Kolobok, Kupets, Belorus, Bryansk delicacy, Mechta), the number of ditylenchs was less than 25 specimens per 1 square centimeter. As a result of the assessment of 50 potato cultivars for susceptibility to tuberous nematode, it was found that all tested potato cultivars were affected by *Ditylenchus* and infected with *Ditylenchus destructor* nematodes to one degree or another. Potato varieties resistant to tuberous nematode have not been identified (Support: Program of Fundamental Scientific Research of the State Academies of Sciences FNSE-2019-0009). – ¹**Federal Scientific Centre VIEV, RAS, Moscow, 117218, Russia; e-mail: lychagina-svetlana@rambler.ru;** ²**Lorch Russian Potato Research Centre, Moscow Region, Lyubertsy, 140051, Russia.**

SINKEVICH O.V.¹, LYABZINA S.N.² & HUDYAKOVA E.A.³ Phytoparasitic nematodes on garden strawberry plantations in Karelia.

The intensive development of peasant farms engaged in the cultivation of garden strawberries in the Republic of Karelia has increased the area of this crop. The lack of domestic planting material responsive to the needs of farmers shifted producers’ attention to imported material. Purchased seedlings grown using frigo technology are kept and sold in a leafless state in frozen form. These seedlings are convenient for transportation and planting, but disease and pest control is very difficult. Inspectors of the Rosselkhoz nadzor and specialists from the Karelian branch of the All-Russian Institute of Plant Quarantine, VNIKR tested the imported planting material of garden strawberries and 3-year-old plantings. As a result of the research identified two types of plant-parasitic nematodes. Northern root-knot nematode *Meloidogyne hapla* was found and identified on planting material from the Netherlands. It is reproducing and developing outside the greenhouses in temperate climate, where it may cause significant economic damage. More than 550 host plant species are known in the world. The strawberry leaf nematode *Aphelenchoides fragariae* was found on plants imported from The Netherlands. Nematodes of the genus *Aphelenchoides* have a high occurrence on the territory of the Republic of Karelia, however, there are no data on the detection of *A. fragariae*. Nematode *A. fragariae* may cause significant economic losses, especially in humid years. There are about 300 species, which damage garden strawberries. Taking into account the cases of detection of previously unregistered nematode species, it is necessary to conduct regular studies to prevent an introduction of the imported species in ecosystems of the region. – ¹**Karelian Branch of “VNIKR”, Petrozavodsk, 185033, Russia; e-mail: ovbio@mail.ru;** ²**PetrGU, Petrozavodsk, 185031, Russia; e-mail: slyabzina@petsu.ru;** ³**All-Russian Plant Quarantine Centre, Moscow Region, Bykovo, 140150, Russia; e-mail: hudyakova.elena@vniikr.ru.**

STAROSTINA E.S.¹ & SHESTEPEROV A.A.² Computer experiments based on dialogue models for forecasting the population density of *Globodera rostochiensis* in the soil after cultivation of innovative crops of susceptible to and *Globodera*-resistant potato varieties grown in fields of different types of crop rotations (*Globodera rostochiensis*, computer experiments, forecasting).

Computer experiments on predictive dialogue models were carried out on the dynamics of the density of the golden potato nematode population (hereinafter – the GPNP) in the soil after growing susceptible and *Globodera*-resistant potato varieties in the fields of the 11-field of crop rotation. While comparing the data obtained on the computer model and the original data, a sufficiently high reliability is shown (correlation coefficient R = 0.95). While carrying out

computer experiments on the model for predicting the density of the golden potato nematode population in the soil after growing susceptible potato varieties, it was found out that it is not led to the complete destruction of the GPNP in the soil during the process of growing these potato varieties (even in spite of unfavourable conditions). While growing nematode-resistant and susceptible varieties of potatoes in different ratios (1:4 ... 4:1), a direct dependency has been defined: as more of the nematode-resistant varieties amounts in the crop rotation, the less of the GPNP is in the soil. The efficiency of cultivation of nematode-resistant varieties in decreasing the density of the GPNP in the fields of 11-field crop rotation in favourable, unfavourable and average long-term conditions for growing crops is shown. Based on a random number generator, conditions (favourable, unfavourable, average annual) were selected for growing a specific agricultural crop and potatoes set on computer modeling (Support: Program of Fundamental Scientific Research of the State Academies of Sciences FNSE-2019-0009). – ¹Russian State Agrarian University – Moscow Timiryazev Agricultural Academy, Moscow, 127550, Russia; e-mail: eliz.starostina@yandex.ru; ²Federal Scientific Centre VIEV, RAS, Moscow, 117218, Russia; e-mail: aleks.6perov@yandex.ru.

SNEZHKO I.O.¹, KISELEV S.M.² & SPIRIDONOV S.E.³ The finding of a new species of the genus *Leidynema* in *Elliptorhina chopardi* and *Diploptera punctata* cockroaches.

Collections of live animal cultures in zoos are an interesting object for parasitological research, including the study of the parasitic nematodes of tropical and subtropical insects. In 2020-2021, parasitic nematodes of the hindgut of cockroaches from the insectarium of the Yaroslavl Zoo were studied. Representatives of 12 species of cockroaches were dissected, including several species studied for the first time. The species identification was based on morphological characters, and on the analysis of the partial (732 base pairs – bp) sequence of the D2-D3 segment of the large ribosome subunit (LSU rDNA). Analysis of these nucleotide sequences showed that nematodes from the hindgut of cockroaches of the species *Elliptorhina chopardi* and *Diploptera punctata* form a separate group in the phylogenetic tree of the genus *Leidynema* with a 100% support level. The closest taxon to this group was *L. portentosae* from the Madagascar hissing cockroach *Gromphadorhina portentosa*. The level of nucleotide differences between nematodes from the two species of cockroaches from the Yaroslavl Zoo and this species from the Madagascar cockroach is 6% (41 bp). The level of nucleotide differences between such morphologically distinct species as *L. appendiculata* and *L. portentosae* is about 9%. The difference between nematodes parasitising in cockroaches *Elliptorhina chopardi* and *Diploptera punctata* from *L. appendiculata* is 10% (71-72 bp). The study of nematodes from these two cockroach species in a scanning electron microscope revealed morphological differences: the presence of special longitudinal ribs on the first 15-16 cuticle annuli of males and postlocal median depression on the tail end of the male. The combination of morphological characters and nucleotide differences indicates that most probably new species of the genus *Leidynema* was found in the hind gut of these two cockroach species. – ¹Russian State Agrarian University – Moscow Timiryazev Agricultural Academy, Moscow, 127550, Russia; ²Yaroslavl Zoo, Yaroslavl, 150007, Russia; ³A.N. Severtsov Institute of Ecology and Evolution, RAS, Moscow, 119071, Russia; e-mail: s_e_spiridonov@rambler.ru.

SUDARIKOVA S.V.¹, LIMANTSEVA L.A.² & KHUDYAKOVA E.A.¹ Optimisation of molecular methods for identification of the potato tuber nematode *Ditylenchus destructor* in laboratory diagnostics.

The potato tube nematode *Ditylenchus destructor* causes great damage to the crop of potatoes, vegetables, legumes and ornamental crops. This species is quite common in domestic and imported planting material, and its identification is important for exported products or seed products within the country. The PCR test with universal and species-specific primers based on BTC1 and 5.8S rDNA, proposed by A. Jeszke *et al.* (2013) was tested, optimised and recommended for laboratory diagnostics to identify *D. destructor*. The test allows you to identify all *D. destructor* haplotypes. Its applicability was assessed with a positive result. The studied populations from the Moscow, Ryazan, Tula, and Oryol regions showed that *D. destructor* belongs to haplotype E (209 bp). As a result of the PCR-RFLP performed according to Wendt *et al.* (1993) determined the size of the fragments of restriction analysis of this haplotype E for the TaqI enzyme – 550, 190, and 95 bp, for TruI – 500 and 300 bp. – ¹All-Russian Plant Quarantine Centre, Moscow Region, Bykovo, 140150, Russia; e-mail: sudarikovah@mail.ru; ²A.N. Severtsov Institute of Ecology and Evolution, RAS, Moscow, 119071, Russia; e-mail: lutik47@yandex.ru.

SUSHCHUK A.A., MATVEEVA E.M., KALINKINA D.S. & YURKEVICH M.G. Soil nematodes of different types of biocenoses in the Republic of Altai.

The first data on soil nematodes of different biocenoses on the territory of Republic of Altai have been presented. The results showed that the highest value of nematode taxonomic diversity was found in larch forest, and lowest one – in steppe biocenoses. Nematode's population density and biomass were similarly high values in the forest soil, and

significantly exceeded the values in the steppe. There were revealed differences in the eco-trophic structure of soil nematode communities between biocenoses. In the pine forest with *Pinus sibirica* bacterial feeders and nematodes associated with plants prevailed in the soil, which is typical for various types of pine forests; in larch forest – bacterial feeders, plant parasites and fungal feeders dominated. Nematode community in steppe soils had specific features and differed markedly from those in forest biocenoses: the community structure was incomplete with the dominance of fungal feeders and omnivores. On the base of ecological indices (Structure index SI, Enrichment index EI) calculated for nematode communities and described the food web state, the soil ecosystems of forest biocenoses were assessed as undisturbed with complex food webs and a moderate level of soil organic matter enrichment. The steppe biocenosis formed by *Stipa splendens*, on the contrary, was characterized by SI and EI values indicating a simplified and unstable food web associated with degraded soil ecosystems under the influence of unfavorable environmental factors (climatic or anthropogenic). This fact exhibits the possible effect of extreme conditions formed in the steppe of the Kosh-Agach region (50°00' N, 88°39' E) on soil nematodes (Support: State Order 0218-2019-0075). – **Institute of Biology, Karelian Research Centre, RAS, Petrozavodsk, 185910, Russia; e-mail: anna_sushchuk@mail.ru.**

SUSHCHUK A.A., MATVEEVA E.M. & KALINKINA D.S. Soil nematode communities of the European part of Russia: latitudinal aspect.

Patterns of spatial distribution and changes in the structure of soil nematode communities in the latitudinal-zonal aspect were investigated on the European part of Russia. The studies were carried out in the tundra, taiga, mixed and broadleaved forests, steppe regions of the Central Black Earth Region (CBR) and Crimea's mountainous regions. The highest nematode numbers were observed in coniferous forests, mainly in spruce, regardless of their geographical location; the lowest one – in the tundra and some broadleaved forests. The highest values of nematode biomass were also revealed in spruce forests; a high biomass was also found for the nematode communities in the virgin steppe of CBR; the lowest biomass was observed in tundra and Crimea's mountainous regions. An analysis of the nematode taxonomic diversity showed that broadleaved forests were distinguished by the largest number of identified taxa; the nematode diversity was also high in grassy plant communities (steppe, meadow as an example of the azonal community). Low diversity was found in the tundra and coniferous forests. Bacterial feeders were prevailed in eco-trophic structure of soil nematode communities of the most of biocenoses. As a subdominant group in nematode communities was fungal feeders (mainly in coniferous forests) or nematodes associated with plants (in tundra and broadleaved forests). A high abundance of omnivores (tundra, broadleaved forest, steppe) and plant parasites (meadows, broadleaved forest) was revealed in some biocenoses. It was shown that enrichment (EI) and channel (CI) indices are related to the biocenose type. In deciduous forests, steppes and meadows nematode communities were characterised by higher EI and lower CI values in compared with tundra and coniferous forests (Support: State Order 0218-2019-0075). – **Institute of Biology, Karelian Research Centre, RAS, Petrozavodsk, 185910, Russia; e-mail: anna_sushchuk@mail.ru.**

TREBUKHOVA Yu.A.¹, PAVLYUK O.N.¹, ZOGRAF J.K.¹ & NGUYEN DINH TU². Species composition and seasonal changes of nematode communities in tropical *Halophila ovalis* meadows in Tien Yen Estuary (South China Sea, Vietnam).

This study investigated the seasonal changes of the nematode community (densities, species, trophic groups) inhabiting rhizomes of tropical *Halophila ovalis* seagrass meadows within Tien Yen District of Quang Ninh Province, Vietnam. Sampling was conducted in 2015, in April (dry season) and October (rainy season) on intertidal mud flats at the Ha Dong (HD), Con Mat (CM) and Cua Song (CS) sites. Seagrasses were manually collected, the rhizomes were cut in by 10×10×10 cm frame and were washed gently with estuary water and were sieved through sieves with 1000 µm and 32 µm mesh sizes to remove the sediment. At each site three stations and triplicate samples were randomly taken for nematode communities. Nematodes were extracted by decantation and Ludox extraction. From each sample, all individuals were picked out. A total of 49 nematode species were identified at the sites, belonging to 31 genera and 16 families; overall, the nematode densities and the number of species were recorded to be lower than expected. In April, we identified 26 species and it was lower than on the close lying sediments, free from seagrass. The nematode densities and distribution were not similar in all stations and show significant differences between replicates and stations (ANOVA). One-way ANOSIM test for the densities of the nematode communities in the seagrass meadows of the areas showed significant differences between season ($R = 0.519$, $P < 0.01$) and between stations ($R = 0.963$, $P < 0.01$). The HD sites were dominated by two genera: *Sphaerolaimus* (37%) with 4 species, the most important one was the highly abundant *Sphaerolaimus ganymede*, and *Sabatieria*, with high values for *Sabatieria doancanhi* (11%). At CS and CM sites the species composition was similar, dominated by species of the genus *Sphaerolaimus*, dominated by *S. ganymede* (14%) and also strongly contributed by *Microlaimus orientalis* (8.7%) and *Desmoscolex* sp. (8.7%). The marked

changes in communities occurred between April and October, multidimensional scaling (nMDS) and dendrogram showed high dissimilarity in species distribution. The species diversity at all stations decreased in October almost three times. HD site had high values for representatives of the families Linchomoidae, dominated by *Terschillingia longicaudata* (27%), and Comesomatidae, dominated by *S. doancanhi* (22%). CS site had high values for *Daptonema brevisetosum* (18.5%) and *S. doancanhi* (18.5%). CM site had high values for *Dorylaimopsis halongensis* (40%). There has also been a change in the composition of the trophic groups: overall, predators and omnivorous, probably indicating a wide variety of food source availability, were highly found in April at all stations (36-50%), whereas in October most study sites were dominated by non-selective deposit feeders (44-63%) and epistrate-feeders (29-40%), while predators accounted for 7-27% only. The main factor responsible for seasonal changes of nematode community in intertidal zone of Tien Yen estuary is the precipitation (heavy rainfall) that leads to changes in sediment composition, salinity and other factors. – ¹A.V. Zhirmunsky National Scientific Centre of Marine Biology, FEB RAS, Vladivostok, 690041, Russia; e-mail: trebukhova@gmail.com; ²Institute of Ecology and Biological Resources, VAST, Hanoi, Vietnam.

TSKITISHVILI E.^{1,2}, JGENTI L.³ & LOMIDZE N.² Seasonal fluctuation in nematode population associated with potato.

Soil abiotic factors like temperature and moisture are the important determining factors for the community composition of nematodes and are considered to assess their effects upon the population of soil nematodes. A study on the seasonal fluctuation of nematode population was conducted during full vegetation periods (from April to October) at 25 cm soil depth in potato fields at Tetrtskaro (Eastern Georgia). The soil samples were also tested before planting (in March) and after harvest (in November). In total, 400 samples were analysed during the study. 56 nematode genera and 65 species were recorded. In fauna, prevail predatory species, namely the representatives of the order Mononchida and Dorylaimida that inhabit the soils of almost all natural and agroecosystems. Twenty-one percent were plant-parasites, 25% were bacteriovores, 23% were omnivores and about 7% were fungivores. *Ditylenchus destructor* was the most prevalent plant-parasitic nematode in studied ecosystems. It was observed that seasonal fluctuations have a direct effect on the nematode population. The largest nematode population was recorded in July when the percent soil moisture was high and the smallest in October, when the soil temperature and humidity index began to decline. This reveals a direct effect of these two climatic factors of soil on the population of nematodes. The soil pH also affected indirectly the nematode population densities. Support: Ministry of Science and Education of Georgia. Project: Georgia's Natural and Agricultural Ecosystems: Animal Diversity, Monitoring, Biocontrol. – ¹Institute of Zoology, Ilia State University, Tbilisi, 0162, Georgia; e-mail: eka.tskitishvili@iliauni.edu.ge; ²Georgian Technical University, Tbilisi, 0192, Georgia; ³Batumi Rustaveli State University, Batumi, 6010, Georgia.

TSVETKOV I.N.¹, BUGMYRIN S.V.², TRANBENKOVA N.A.³ & SPIRIDONOV S.E.⁴ Molecular identification and haplotype diversity of *Skrjabinigylus* Petrov, 1927 (Nematoda, Metastrongyloidea) in the Russian Federation.

Mature *Skrjabinigylus* spp. nematodes were obtained from frontal sinuses of the infected mustelids in Pskov and Kamchatka regions and Republic of Karelia. The sequences of the D2-D3 expansion segment of the sequence of large ribosomal subunit were obtained with primers D2A-D3B (Nunn, 1992). Two partial sequences of the mitochondrial *CoxI* gene were obtained with primers JB3_F-JB7GED_R (Bowles *et al.*, 1992) and COI_F1-COI_R2 (Kanzaki & Futai, 2002). In LSU rDNA tree, all the specimens from Pskov region and Republic of Karelia are forming single group with high level of bootstrap support. The differences in LSU rDNA between Kamchatka specimens and *S. chitwoodorum* from the skunk (USA) are on the level of 7%, what exceeds the differences between *S. chitwoodorum* and *S. petrovi* (4%). In the tree inferred from *CoxI* mtDNA tree (primers COI1/r2) *Skrjabinigylus* specimens from Pskov region of Russia are forming the clade with the *CoxI* sequence of the *S. petrovi* from Germany, when *S. nasicola* sequences are forming separate clade (both with 100% bootstrap support). Kamchatka specimens of *Skrjabinigylus* are in the basal position in this tree, not clustering with *S. petrovi* or *S. nasicola* clades (*CoxI* mtDNA sequences for *S. chitwoodorum* are absent). The sequences of *S. petrovi* specimens obtained with JB-primers demonstrated the presence of two subclades: a sample from Karelian mink is clustering with the sample from stone marten from Pskov region, when sample from Karelian stone marten forms a clade with those from polecat of Pskov region. It was concluded that *Skrjabinigylus* specimens from Pskov region are closer to *S. petrowi* in the sequences of *CoxI* mt DNA, even though demonstrating some morphological similarity to *S. nasicola*. *Skrjabinigylus* specimens from Kamchatka are not identical to *S. chitwoodorum* and differ from *Skrjabinigylus* specimens from European part of Russia (both *S. petrowi* and *S. nasicola*) (Support: RFBR 19-34-50081-mol_nr). – ¹State Agricultural Academy of Velikie Luki, Pskov Region, Velikie Luki, 182112, Russia; e-mail: tsvetkov-iliya@yandex.ru; ²Institute of Biology, Karelian Research Centre, RAS, Petrozavodsk, 185910, Russia; ³Kamchatka Branch of the Pacific Institute of Geography, FEB RAS,

Petropavlovsk-Kamchatskii, 683000, Russia; ⁴A.N. Severtsov Institute of Ecology and Evolution, RAS, Moscow, 119071, Russia.

VARLAMOVA A.I.¹, ARKHIPOV I.A.¹, KHALIKOV S.S.², ARISOV M.V.¹ & ABRAMOV V.E.¹ Influence of the supramolecular delivery system of fenbendazole on its physicochemical properties, metabolism and biological activity.

The mechanochemical technology of modification of the anthelmintic drug fenbendazole with polyvinylpyrrolidone polymer is a promising direction in the development of more effective drugs for the successful treatment of nematodes and cestodes of animals. The resulting solid dispersion of fenbendazole forms supramolecular complexes in water (SMCF). The physicochemical properties of the obtained substance were investigated by the method of X-ray analysis, electronic scanning microscopy, granulometric analysis, high-performance liquid chromatography. The biological activity of SMCF was studied on the laboratory model of *Trichinella spiralis* infection of mice and on sheep naturally infected with gastrointestinal strongylates. The pharmacokinetic profile and tissue residue depletion of fenbendazole and its metabolites in the body of sheep after SMCF administration in a reduced dose were studied by HPLC-MS/MS. Mechanochemical treatment of fenbendazole and polyvinylpyrrolidone was processed in a ball drum mill for 4 h at 60 rpm in a ratio 1:9. As the result it was revealed the loss of crystallinity of the substance up to the formation of amorphous phases, the solubility in water increased by 2.8 times, the particle size reduced to 1-10 µm, and the formation of aggregates of irregular shape was detected, which indicates the interaction of fenbendazole substance and polyvinylpyrrolidone. Thus, fenbendazole is evenly located on the surface and in the pores of PVP that changes the medicinal properties and delivers the drug through cells membranes. The rate of absorption and entry of fenbendazole and its metabolites into the blood after SMCF administration was in 2.3 times higher than the basic drug. A significant increase in the concentration of FBZ and its metabolites in the organs and tissues of sheep was registered that determined an increase of biological activity. The anthelmintic efficacy of SMCF against *T. spiralis* infection increased 4-fold and 3-fold against gastrointestinal strongylates of sheep (Support: Ministry of Science and Higher Education of the Russian Federation). – ¹Federal Scientific Centre VIEV, RAS, Moscow, 117218, Russia; e-mail: arsphoeb@mail.ru; ²A.N. Nesmeyanov Institute of Organoelement Compounds, RAS, Moscow, 119991, Russia.

YUSHIN V.V.¹, GLIZNUTSA L.A.¹ & RYSS A.Yu.² Obligate bacterial endosymbionts in nematodes: overview and the case of *Bursaphelenchus mucronatus* (Aphelenchoidea: Aphelenchoididae).

Considering their ubiquity and enormous diversity only relatively few bacterial endosymbioses have been described in nematodes compared with arthropods. The bacterial-nematode mutualism occurs between the endosymbiont, *Wolbachia* and members of the Onchocercidae family of filarial nematodes, including medically important parasites of humans and animals. *Photorhabdus* and *Xenorhabdus* are genera of Gram-negative bacteria that in addition to being pathogenic to insect larvae also have mutualistic interactions with nematodes from the genera *Heterorhabditis* and *Steinernema* respectively. Endosymbionts are rare in plant-parasitic nematodes (PPN); only about 50 species are known to host endosymbionts, excluding extracellular and pathogenic microbes. The Gram-negative intracellular bacteria belonging to the Verrucomicrobia were found to be localised primarily in the ovaries, eggs and intestine of ectoparasitic nematode species belonging to the *X. americanum*-group. Several intracellular endosymbiont bacteria of different groups have been found in plant-parasitic nematodes, including: ‘*Candidatus Cardinium hertigii*’ from cyst (*Globodera*, *Heterodera*) and lesion (*Pratylenchus*) nematodes. Endophytic bacteria belonging to *Stenotrophomonas* and *Ewingella* were found in intestines of *Bursaphelenchus xylophilus* and *B. mucronatus* by transmission electron microscope (TEM) observations. These intracellular bacteria did not impact on pathogenicity of the host nematode and had potential roles in nematode development and virulence. New TEM observations show tissue localisation and ultrastructural morphology of intracellular bacterial symbiont found in *B. mucronatus*. Close association of this symbiont with spermatocytes, spermatid and immature spermatozoa of male and mature spermatozoa from female spermatheca supposes the rare case of ‘intrasperm’ vertical symbiont transmission (Support: RFBR 20-04-00569-a). – ¹A.V. Zhirmunsky National Scientific Center of Marine Biology, FEB RAS, Vladivostok, 690041, Russia; e-mail: vvyushin@yandex.ru; ²Zoological Institute, RAS, Saint Petersburg, 199034, Russia.

YAKOVLEVA G.A. & LEBEDEVA D.I. Nematodes of some birds of Anatidae in Karelia.

Lake Ladoga is the largest water body in Europe, being located on the East Atlantic flyway. Numerous lakes and wetlands in the Ladoga drainage basin for seasonal stopover and breeding of many waterfowl species. The anatids is the most abundant and diverse group. There are a few data on parasites of some birds of Anatidae in Northwest Russia. Therefore, any information about their parasites is very important. The material for the study included birds taken from the south-eastern coast of Lake Ladoga (61°12' N, 32°54' E) during autumn hunting seasons in 2011-2014. Nematode

infection was studied in 18 specimens of 8 species of Anatidae: 6 greater ducks, 4 long-tailed ducks, two specimens of common scoters and tufted ducks, one specimen of velvet duck, garganey, pintail and northern shoveler. The examined birds hosted 7 nematode species: *Amidostomum acutum*, *Capillaria anatis*, *Echinuria uncinata*, *Epomidiostomum uncinatum*, *Eucoleus contortus*, *Streptocara crassicauda*, *Tetrameres fassisipina*. The species *T. fassisipina* was found in 6 studies bird species, *i.e.* greater and tufted ducks, long-tailed duck, common scoter, velvet duck, pintail. The species *T. fassisipina* and *S. crassicauda* possess a complex life cycle involving aquatic invertebrates, *Daphnia* and Amphipoda. The other nematodes have a direct life cycle. All the retrieved nematodes are typical and frequent parasites of Anatidae, and were located in their usual sites in the host organism (Support: State Order 0218-2019-0075). – **Institute of Biology, Karelian Research Centre, RAS, Petrozavodsk, 185910, Russia; e-mail: galina_il87@mail.ru.**

ZAKHAROVA V.V.¹, SHESTEPEROV A.A.¹ & KOLESOVA E.A.² Computer experiments on dialog models to predict population density of the nematode *Globodera rostchiensis* in soil after cultivation of susceptible and nematode-resistant potato varieties of different ripeness groups.

Computer modeling of forecasting the dynamics of population density of golden potato cyst nematode (PDPCN) in the soil showed that when growing nematode-resistant varieties of different ripeness groups under average annual growing conditions, it was found that 8-9 years were necessary for the destruction of golden potato cyst nematode (PCN) larvae in the soil for early- and mid-late varieties. When growing medium-early and medium-late varieties under the same conditions – 7 years is enough to kill them. This pattern was confirmed under favourable and unfavourable potato growing conditions. Computer experiments on cultivation of susceptible potato varieties at the initial population density of the golden potato cyst nematode (PDPCN) 10 eggs and golden potato cyst nematode (PCN) larvae in 100 cm³ in the soil, the maximum population density of the golden potato cyst nematode (PDPCN), under favourable cultivation conditions for early-, mid-late and late-maturing varieties is 3 years, mid-late – 4 years, mid-maturing – 5 years. With medium-long growing conditions for varieties of all ripeness groups, 5-7 years are enough until the maximum density of the golden potato nematode is reached (Support: Program of Fundamental Scientific Research of the State Academies of Sciences FNSE-2019-0009). – **¹Federal Scientific Centre VIEV, RAS, Moscow, 117218, Russia; e-mail: aleks.6perov@yandex.ru; ²Russian State Agrarian Correspondence University, Moscow Region, Balashikha, 143907, Russia.**

ZOGRAF J.K.¹, SEMENCHENKO A.S.² & MORDUKHOVICH V.V.^{1,2} Marimermithida (Nematoda) of the Far Eastern deep-waters: an integrative taxonomy and phylogeny.

Marimermithid nematodes are parasites of invertebrates mainly found in deep-sea environments. Their morphology is quite primitive and combines features usual for free-living nematodes (presence of cephalic sensitive organs, cylindrical pharynx, small cardia with a triradial internal lumen) and parasites (alimentary tract often devoid of rectum, anus and caudal glands, hypodermal chords are hypertrophied, female genital system adapted to facilitated production of a large number of eggs). Although the first marimermithids were described relatively long ago, they are rarely found, little-known and poorly studied. Probable they are the only group of nematodes of the order rank that has not yet been subjected to molecular taxonomic study. Recently representatives of the order Marimermithida were discovered in Kuril-Kamchatka trench at depths of 5000 m. One species belonging to the genus *Aborjina* was new to science and characterised by the presence of two circles of cephalic papillae (6+ (6+4)), eight hypodermal chords, and paired spicules without gubernaculum. According to *SSU* rDNA and *LSU* rDNA sequences described species occupies position among Leptosomatidae group that was previously shown for juvenile marimermithids with 100% similarity to that of *Leptosomatides* sp. (Dr. Alyeshin, personal communication) (Support: The Grant of the Ministry of Science and Education, Russian Federation, 13.1902.21.0012, agreement 075-15-2020-796). – **¹A.V. Zhirmunsky National Scientific Center of Marine Biology, FEB RAS, Vladivostok, 690041, Russia; e-mail: zojulia@yandex.ru; ²Far Eastern Federal University, Vladivostok, 690600, Russia.**