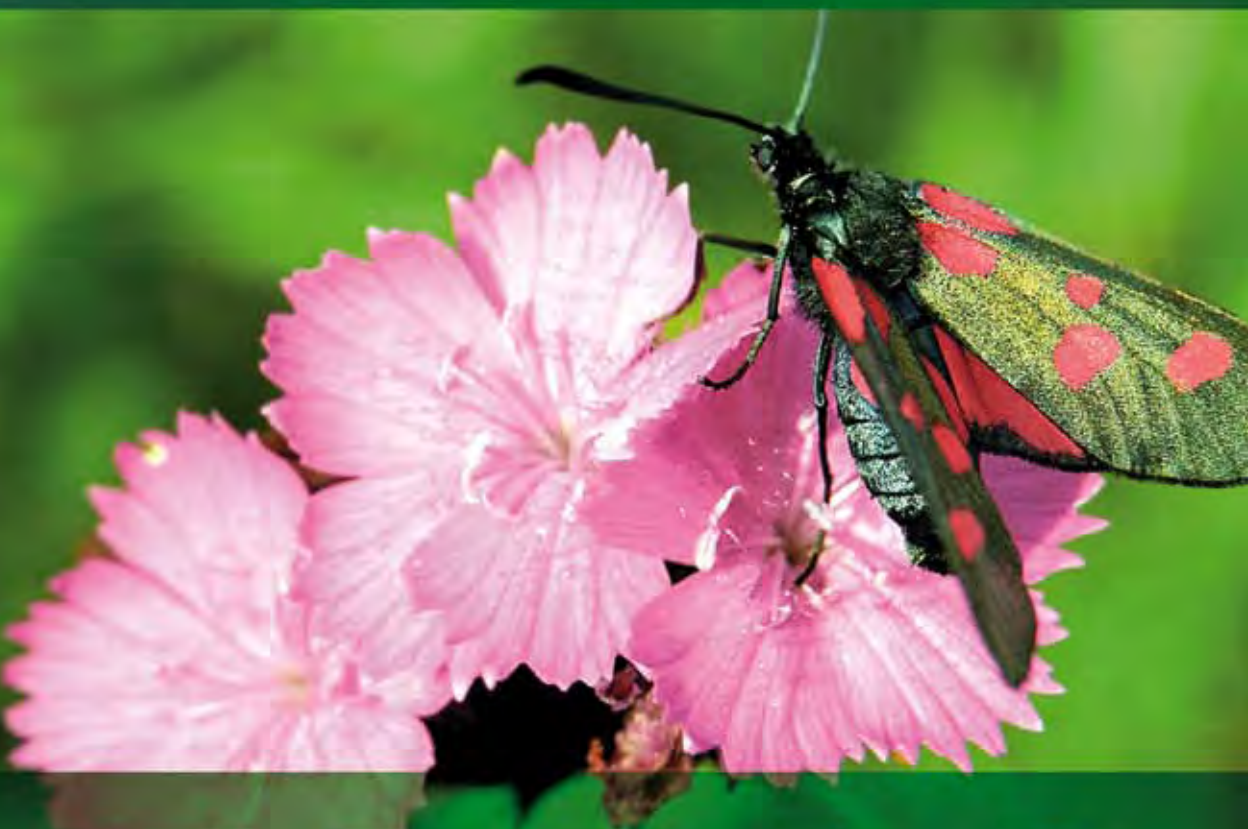
BIOLOGY CENTRE

of the Academy of Sciences
of the Czech Republic
České Budějovice



MISSION

The Biology Centre of the Academy of Sciences of the Czech Republic performs research and provides education in biological and ecological disciplines.

HEADQUARTER ADDRESS:

BRANIŠOVSKÁ 31, 370 05 ČESKÉ BUDĚJOVICE, CZECH REPUBLIC

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RESEARCH conducted at the Centre is predominantly ecological, with a certain representation of biomedicine and nanotechnology. The research involves collaboration across disciplines, use of diverse methodological approaches (molecular biology, genetics, taxonomy, field ecology, mathematical modelling, etc.), and the combination of analytical and holistic approaches to problem solving. Core facilities with shared equipment augment the output of all Centre's institutes.

EDUCATION is as important as the research. In collaboration with several universities, primarily the University of South Bohemia, the Centre tutors PhD students in animal physiology, developmental biology, ecology, entomology, genetics, molecular and cell biology and parasitology. Teaching and practical training of undergraduates is another important activity; about 80 staff members of Centre lecture at the University of South Bohemia, Charles University in Prague, Masaryk University in Brno, University of Veterinary and Pharmaceutical Sciences in Brno, and other places of higher education.

HISTORY AND STATUS

The Academy of Sciences of the Czech Republic (ASCR) is a research organization that harbours 53 institutes. A number of them were moved from Prague to the town of České Budějovice around 1985. In 2006, five institutes merged into the Biology Centre of the ASCR and by January 2007 received the status of a "public research institution" (abbreviated v.v.i. in Czech), which implies considerable freedom and responsibility of the management. The Institutes of Entomology, Plant Molecular Biology, and Parasitology occupy separate buildings on the main campus with the postal address Branišovská 31, and the Institutes of Hydrobiology and Soil Biology are located about 500 meters away at the address Na Sádkách 7.

INTERNATIONAL COLLABORATION

has a long tradition at all the Institutes that constitute the Centre, with associates located all around the globe. The Centre receives foreign PhD students and postdocs. All PhD students educated in the Centre are sent for postdoctoral stays abroad.

Several international scientific meetings are organized annually. The Central European Worskhop on Soil Zoology (April 17–20), and the meeting on Fish Stock Assessment Methods for Lakes and Reservoirs: Towards the True Picture of Fish Stock (September 11–15) were held in 2007.

PERIODICALS

The Centre publishes international periodicals European Journal of Entomology (IF= 0.782 in 2006) and Folia Parasitologica (IF= 1.511). These journals date back to 1903 and 1954, respectively. In addition, the staff of Biology Centre are on the editorial boards more than 20 international journals published abroad.

ORGANISATION CHART OF THE BIOLOGY CENTRE ASCR

Supervisory Board
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Chairman

BC Director
František Sehnal
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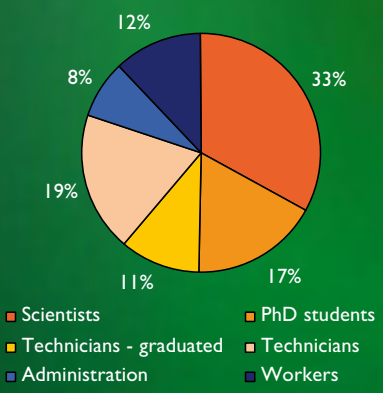
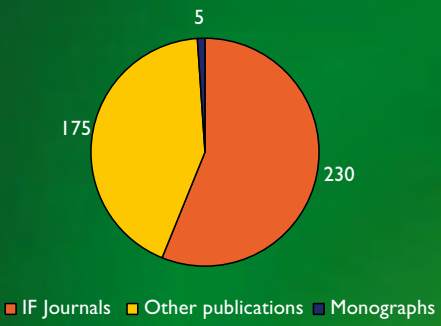
- Technical and Administrative Service
  Director Vít Našinec
- PROJECTED – Biotechnological Institute of Applied Ecology

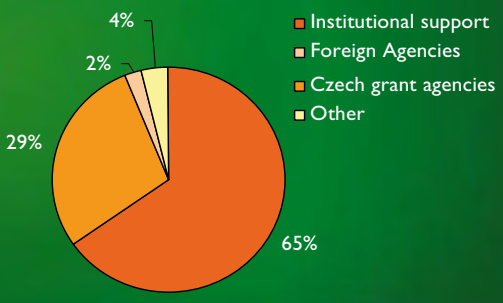
Staff - End of 2007



Scientific output in 2007



Financing - End of 2007



FINANCES

are primarily obtained from the state. More than a half is provided as institutional support and the rest from grants and contracts.

INSTITUTE OF ENTOMOLOGY

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(EUROPEAN JOURNAL OF ENTOMOLOGY):
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MISSION STATEMENT

The Institute carries on taxonomic, genetic, physiological, molecular and ecological investigations on a wide range of model insect species and model ecosystems.

GENERAL INFORMATION

The Institute was founded within the Czechoslovak Academy of Sciences in 1962 by a merger of a Laboratory of Entomology and the Department of Insect Pathology, which existed since 1953. The Institute expanded to five Departments scattered throughout Prague until 1985, when most of the staff moved to the present building in the town of České Budějovice. The Institute harbors the editorial office of the *European Journal of Entomology*.

The Institute originally focused on applied entomology and has generated more than 150 patents applicable in agriculture and forestry. They have been primarily concerned with production of bioagents for the pest control, introduction of pheromones for pest signalling, development and application of juvenile hormone analogues, etc. The discovery of the immunosuppressive cyclosporine was a very important side-product of research on entomopathogenic fungi. Other practical contributions were made in the area of nature conservation and environment protection.

The present staff of more than 100 (occupying 82 full-time positions) includes specialists ranging from molecular biologists to field ecologists. Research is supported by more than 30 grants and annual scientific output counts about 100 papers in renowned international journals (an interactive database of all publications is available on the Institute's webpage). Since 1962, the Institute has educated more than 140 PhDs and organised over 30 international meetings.

RESEARCH AREAS

1. **Mechanisms of morphogenesis**
   - chromosome structure and function, chromatin, sex chromosomes
   - regulation of gene expression and differentiation
   - transcription factors, hormone action
2. **Insect physiology and developmental biology**
   - regulation of development and metabolism
   - growth factors
   - analytical biochemistry
3. **Neurohumoral regulation of biorhythms and life cycles**
   - interactions between environmental factors and endogenous rhythms
   - molecular mechanisms of circadian rhythmicity
   - genetic control of biorhythms
   - mechanisms of insect adaptations to seasonal and long-term changes of climate
4. **Principles and mechanisms of biodiversity**
   - insect taxonomy
   - molecular evolution
   - evolutionary and population genetics
5. **The role of insects in the structure and function of selected ecosystems**
   - the structure of insect communities in natural Central European and tropical ecosystems
   - use of aquatic insects as bioindicators of environmental changes
   - mathematical modelling of ecological processes
6. **Biological control of insect pests and disease vectors**
   - genetic methods
   - biorational pesticides, pathogens, predators and parasitoids
   - environmental aspects of the use of genetically modified crops.

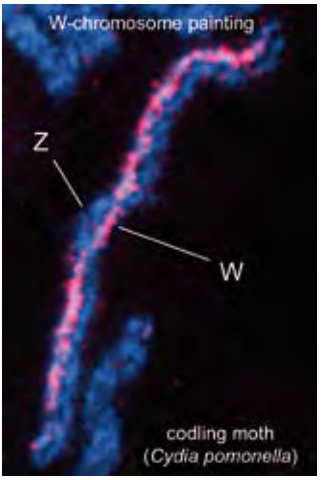
EXAMPLES OF THE RESULTS

Mechanisms of morphogenesis

A new universal method was developed to isolate the W-chromosome DNA in Lepidoptera by laser microdissection of the sex-chromatin bodies from female polyploid cells. The DNA was used to construct the first W chromosome-specific plasmid library and to prepare of W-chromosome

painting probes. Sequence analyses confirmed degeneration of the W chromosomes via accumulation of repetitive sequences and transposons (Fuková et al. 2007: *Chromosoma* 116, 135–145). Cross-hybridizations of the W-painting probes by Zoo-FISH revealed low similarity between the W chromosomes even in closely related species. These results support the hypothesis of the accelerated molecular divergence of the W chromosomes in the absence of meiotic recombination (Vítková et al. 2007: *Chromosome Res*. 15, 917–930).

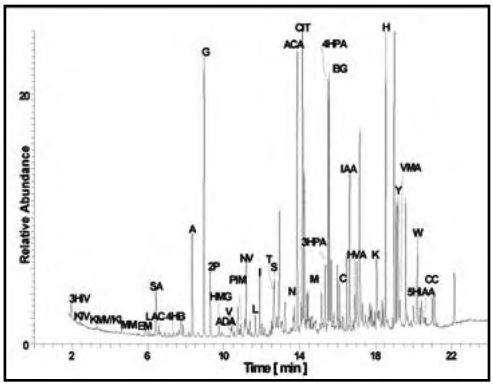
Insect physiology and developmental biology



Extracellular adenosine has been identified as an important signaling molecule that functions in mammals as a modulator of the stress and immune responses, nervous signaling and in oxygen tissue balance. Studies of extracellular adenosine signaling in *Drosophila s*howed that elevated levels of extracellular adenosine block cell growth and cause apoptosis in the Cl8+cell line cells. Defects in *Drosophila* adenosine deaminase ADGF-A, which elevate adenosine titer in the hemolymph, were lethal. This lethality could be partially rescued by a mutation in the adenosine receptor (Doležal et al. 2005: *PLoS Biol.* 3, e201) that activates both a cAMP and a calcium pathway (Doleželová et al. 2007: *Insect Biochem. Mol. Biol*. 37, 318–329).

Metamorphosis of a beetle, *Tribolium castaneum*, was used as a model in investigations aimed at elucidating the mode of action of the juvenile hormone (JH). The mechanism of JH control of metamorphosis has remained an enigma for seven decades. Breakthrough studies (Konopová & Jindra, 2007: *Proc. Natl. Acad. Sci. USA* 104, 10488–10493; Konopová & Jindra, 2008: *Development* 135, 559–568) on *Tribolium castaneum* have demonstrated for the first time the pivotal role of the Met (Methoprene-tolerant) protein as a putative JH receptor in the regulation of insect metamorphosis.

A comprehensive set of original methods has been developed for for the detection, identification and quantitative determination of biologically important compounds (polyols, lipids, amines, organic acids, small peptides and steroids) (Gäde et al. 2006: *Biochem. J.* 393, 705–713; Galis et al. 2006: *Plant J*. 46, 573–592; Hušek and Šimek 2006: *Curr. Pharm. Anal.* 2, 21–41).



Multicomplex GC/MS analysis of organic acids including amino acids in human urine. From Hušek P.: Quantitation of Amino Acids and Amines by Chromatography, In Molnar-Perl I, ed. (Elsevier, 2005). One-code abbreviations used for amino acids. Abbreviated carboxylic acids: 3HIV= ß-OH-isovaleric, KIV = ketoisovaleric, KMV = ketomethylvaleric, KIC = keto-isocaproic, MMA = methylmalonic, EMA = ethylmalonic, SA = succinic, LAC = lactic, 4HB = 4-hydroxybutyric, 2PB = 2-phenylbutyric= I.S., HMG = 3-hydro-xy-3-methylglutaric, ADA = adipic, NV = norvaline (I.S.), PIM = pimelic, ACA = aconitic, CIT= citric, 3HP = 3-hydro-xyphenylacetic, 4HP = 4-hydroxyp-henylacetic, BG = hippuric (benzoyl-glycine), IAA=indoleacetic, HVA = homovanilic, 5HIAA = 5-hhydroxy-indoleacetic, VMA = vanillomandelic.

Neurohumoral regulation of biorhythms and life cycles

A novel circadian clock mechanism underlying an intriguing sun compass navigation was discovered in the brain of the migratory monarch butterfly. It rests on a neural pathway that connects the circadian clock to polarized light input entering the brain (Šauman et al., 2005: *Neuron* 46, 457–465). The circadian clock protein CRY2 plays a dual role – as a core clock element and as an output that regulates circadian activity in the central complex, the likely site of the sun compass (Zhu et al., 2007: *PLoS Biol* 6, e4 0001–0018). The *period* clock gene seems to be involved in the regulation of adipokinetic hormone (AKH) synthesis (Kodrík et al., 2005: *Physiol. Entomol*. 30, 248–255) that plays a role in the activation of antioxidant mechanisms (Večeřa et al., 2007: *Comp. Biochem. Physiol.* 146, 336–342), such as in response to toxins produced by the genetically modified plants (Kodrík et al., 2007: *Peptides* 28, 974–980).

Principles and mechanisms of biodiversity

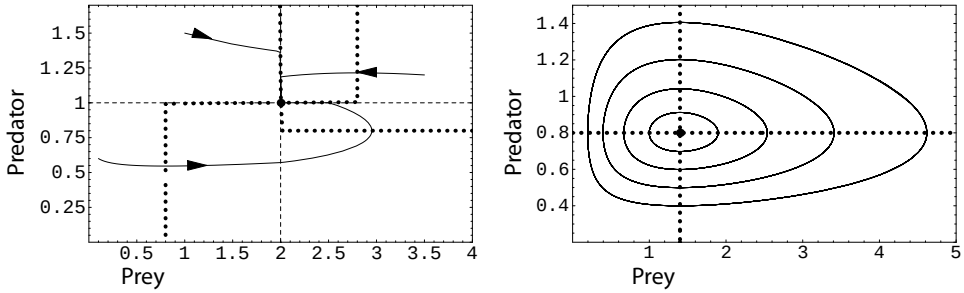
Insect taxonomy is studied using morphological, and recently also molecular, criteria. Comprehensive results of such studies are published as books.

- Several beetle families were revised by A. Bezděk in the Catalogue of Palaearctic Coleoptera. Volume 3. (Löbl I. & Smetana A., eds., 2006, Apollo Books, Stenstrup, 690 pp.).
- P. Starý summarized all data on Central European aphid parasitoids in "Aphid parasitoids of Czech Republic (Hymenoptera: Braconidae: Aphidiinae), 2006, Academia Praha, 430 pp.".
- Bauernfeind E. & Soldán T. wrote the first treatise of Europteran Ephemeroptera (The Mayflies of Europe, 2008, Apollo Books, Stenstrup, 400 pp).
- A book written by J. Holman "A Catalogue of Aphids and their Host Plants in the Palaearctic Region" to be published in 2008 by Springer includes 75,511 entries that encompass 3,706 aphid species, 11,131 host plant species, the biogeographic data, and exhaustive literature (2,287 references).

Foto: Caterpillar of *Coscinocera* sp. silkmoth feeding on Homalantus trees in New Guinea

The role of insects
in the structure and function of selected ecosystems

Research on aquatic insects as bioindicators of water quality has a 50-year history. A multivariate approach for assessing the ecological status of running waters in the Czech Republic is being developed within the EC Water Framework Directive (Kokeš et al., 2006: *Hydrobiologia* 566, 343–354). The role of insects in the structure and function of selected ecosystems is studied in respect to nature conservation in selected Central European and tropical ecosystems. Research in wetlands revealed that highly stenotopic tyrphobiontic beetles and moths are distributed according to a distinct ecological gradient between the bog margin and the bog centre (Bezděk et al., 2006: *Biodiver. Conserv.* 15, 395–409). The study of ecological and evolutionary mechanisms generating insect biodiversity contrasts plant-insect food webs of the temperate and tropical forests (Novotný et al., 2006: *Science* 313, 1115–1118) and focuses on the effects of forestry management on the endangered species (Beneš et al., 2006, *Forest Ecol. Manag.* 237, 353–365) and on large-scale distribution patterns in temperate (Konvička et al., 2006: *Global Ecol. Biogeogr.* 15, 82–92) and tropical (Novotný et al., 2007: *Nature* 448, 692–695) ecosystems. The increasing species richness of herbivorous insects from the temperate to the tropical zone is driven by a parallel trend of increasing plant diversity, while the number of herbivorous species per a plant species remains constant.



Panel A shows classical prey-predator population cycles. If both the predators and prey behave adaptively and maximize their fitness, the population cycles disappear and population dynamics are stabilized at an equilibrium (panel B). Dotted lines are isoclines. (Křivan 2007).

Ecological interactions are also studied by means of mathematical models. This work focuses mostly on the effect of animal foraging behavior on species persistence and stability (Abrams et al. 2007: *Am. Naturalist* 169, 505–518; Křivan 2007: *Am. Naturalist* 170, 771–782) and on the effects caused by low population numbers (Alee effect) on species survival (Berec et al. 2007: *Trends Ecol. & Evol*. 22, 185–191; Courchamp et al., 2008: *Allee effects in ecology and conservation,* Oxford University Press).

Biological control of insect pests and disease vectors

Behavioral ecological interactions are studied using an acarine system with sophisticated instrumentation and a mathematical apparatus (Škaloudová et al., 2007: *Anim. Behav*. 74, 813–821). Much scientific focus has been given to insect interaction with genetically modified crops, including unexpected side effects (Hussein et al., 2006: *J. Chem. Ecol.* 32, 1–13).

INSTITUTE OF HYDROBIOLOGY

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MISSION STATEMENT

The main aim of the Institute is research of biotic interrelations and their interaction with abiotic factors in lenitic water bodies, especially man-made reservoirs. An ecosystem-focused approach coupled with detailed investigations of selected processes involve multidisciplinary teamwork, relying on specialists in water chemistry, biochemistry, bacteriology, protozoology, algology, zooplanktonology and ichthyology. The participation of diverse specialists allows the study of trophic food chains with both principal approaches: bottom up and top down (feedback).

GENERAL INFORMATION

A hydrobiological research unit was created in the Czechoslovak Academy of Sciences in the early fifties. In 1953, it became part of the Institute of Biology. It was incorporated into several institutes after reorganization of the Institute of Biology, with the exception of the period 1967–1970, when the Hydrobiological Laboratory was recognised as an independent entity. Later it became part of the Institute of Entomology and Institute of Landscape Ecology. In 1981, the Laboratory was moved to České Budějovice and in 1990 it became an autonomous institute.

The Institute pursues several long-term projects focused on biological processes in reservoirs. One of the most important research subjects is eutrophication. Biotic interactions in the plankton community has been a main focus, including the microbial loop, mechanisms of influencing water blooms, phosphorus load and lake turnover. Another research subject is atmospheric acidification of mountain lakes. Long-term studies have been carried out on the changes in the ionic composition and biodiversity in rivers, lakes and reservoirs caused by acid rain and fertilization. A characteristic feature of these studies is a combination of experimental and field approaches. Long-term ecological research on diverse Czech reservoirs has allowed distinguishing phenomena occurring at different time-scales. Elucidation of the fundamental environmental functions of reservoirs provides basic information for water quality management.

The present staff of about 60 people occupies 31 assigned positions (some fellows and PhD students have only part-time employment and are dependent on grant support). All scientists of the Institute take part in the teaching programmes or student tutoring.

MAJOR RESEARCH AREAS

Department of Plankton and Fish Ecology

This department performs research on the role biotic communities play in the food web of reservoirs or lakes, including relationships with physical, chemical and human influence. Specifically, the department addresses quantitative and qualitative occurrence of different organisms in terms of time cycles and occupied niches. An emphasis is placed on biotic interactions (feeding, growth, mortality, predation and production) that contribute to the ecological success of reservoir species. Both bottom-up (from nutrients to fish) and top-down (cascading from fish to phytoplankton) approaches are followed. The long-term development of zooplankton and fish during reservoir maturation is also studied. The department carries out extensive field surveys and a number of defined laboratory experiments. Significant effort is dedicated to unbiased quantitative surweying of fish in large inland waters. The staff members are responsible for the regular monitoring of the Slapy and Římov reservoirs.

Department of Aquatic Microbial Ecology

The members of the department primarily deal with carbon and nutrient flows through microbial food webs in systems of different trophic status. The principal questions investigated are related to elucidating the major processes affecting: (i) bacterial growth (nutrient and substrate availability) and mortality rates (protistan bacterivory and viral lysis), (ii) decomposing processes in natural aquatic ecosystems, and (iii) factors shaping microbial community composition from the level of bacteria and protozoa to algae, (iv) the specific role of phytoplankton, especially autotrophic picoplankton in food webs, (v) formation of cyanobacterial blooms, and (vi) taxonomical composition and functioning of cyanobacterial and algal assemblages. Specific attention is given to assessment of bacterial production and protozoan grazing, bacterial utilization of phytoplankton exudates, extracellular enzyme activities of bacteria and algae and the overall carbon and phosphorus flows through differently structured microbial food webs.

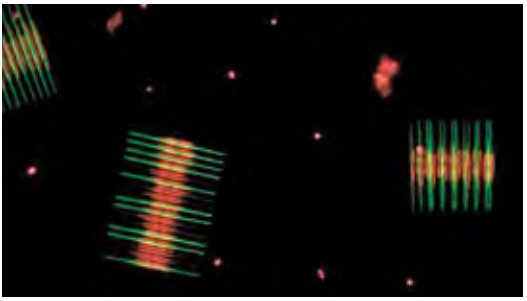
These ecological aspects and activities are studied in relationship to taxonomy, biology and ecology of the key microbial and algal species, or at least taxonomically well-defined microbial groups mediating these processes. To address these key questions, an approach combining experimental laboratory models (continuous and batch culture systems) and designed field studies is frequently applied.

Department of Hydrochemistry and Ecosystem Modelling
The department deals with complex aspects of water chemistry and element cycling in reservoir and lake ecosystems. The research is focused on (i) processes of eutrophication of aquatic ecosystem as a result of the interconnected effects of external and internal nutrient loading, together with the morphology and hydrodynamics of the water bodies; (ii) processes of acidification and recovery of mountain lakes and their catchments. Investigation of eutrophication and nutrient cycling in aquatic ecosystems has been accomplished mostly at reservoirs situated in the Vltava River basin. Long-term ecological monitoring is carried out at representatives of deep, stratified reservoirs (Slapy, Římov) and shallow reservoirs (Lipno, Jordán). Modelling approaches have been used in the identification of nutrient sources in catchment areas of reservoirs and in the studies of mixing processes in deep reservoirs.

UP: Římov Reservoir – intensively studied since its impoundment in 1979

Processes that control water composition in the entire catchment-lake ecosystem during acidification, recovery from acidification, and during changes of climate conditions , have been studied in the mountainous areas of the Czech and Slovak Republic, e.g. the Bohemian Forest and Tatra Mountains, respectively.
The response of these ecosystems has been studied by experimental and modelling methods.

Bosmina sp., a common cladoceran in lakes and reservoirs



Epifluorescence image of growing diatom colonies – silica uptake marked green

EXAMPLES OF RESULTS

Several important results are provided here as examples; comprehensive references can be found on the Institute's web page. Investigation of microbial communities in freshwater ecosystems revealed new insight into complex interactions using ribosomal RNA-targeted probes. Analysis of bacterial mortality caused by viral lysis and predation by heterotrophic nanoflagellates suggests both antagonistic and synergistic interactions between the two sources of bacterial mortality. Bacterivory by flagellates was associated with reductions in bacterial diversity and increases in viral production (Weinbauer et al., 2007: *Environm. Microbiol.* 9, 777–788; Šimek et al., 2007: *Environm. Microbiol*. 9, 789–800).

The palaeolimnological investigation of a 5 m long sediment core from Plešné Lake in the acidified Bohemian Forest has enabled the reconstruction of P cycling development in the lake from the Late Glacial period, about 14,000 years ago, to the present. A sequential fractionation analysis of P, Al, Fe, Ca, and Mg in the sediment core has shown a significant change in P cycling in the Late Glacial-to-Holocene transition period, when the watershed became forested and soil erosion decreased. While the Late Glacial sediment could release P due to its redox labile bonding to Fe, the highly organic Holocene sediment became a permanent P trap due to the role of $Al(OH)_3$. The ability of the sediment to immobilize P increased further during the anthropogenic acidification era because of elevated terrestrial export of ionic Al (Kopáček et al. 2007: *Limnol. Oceanogr.* 52, 1147–1155).

The application of sophisticated methods, such as echosounding, fry trawls and allozyme analysis, has contributed to revealing the role of vertical and horizontal gradients in pelagic communities of fish fry and zooplankton in large canyon-shaped reservoirs. The bathypelagic percid fry layer occurring in the Slapy and Orlík Reservoirs at depths of 6–17 meters was described in detail. Detailed analysis of the distribution of dominant plankton filtrators of the genus *Daphnia* and their hybrids was performed (Čech et al. 2007: *J. Fish Biol.*70, 141–154; Čech et al. 2007: *J. Fish Biol.* 70, 1109–1119; Seďa et al. 2007: *J. Plankton Res.*29, 619–628).

INSTITUTE OF PARASITOLOGY

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MISSION STATEMENT

The Institute of Parasitology performs research on human and animal parasites at the organismal, cellular and molecular levels. Its mission is to acquire, advance and disseminate knowledge of the biology and host relationships of parasitic protists and related eukaryotic microorganisms, helminths (parasitic worms) and arthropods. The Institute pursues this goal through research, education and other activities at both the national and international levels.

GENERAL INFORMATION

The Institute of Parasitology was established in Prague in 1962 and was relocated to České Budějovice in 1985. It is the principal institution in the Czech Republic devoted exclusively to parasitological research. The main research areas encompass protistology, helminthology and medical entomology, including studies on the causative agents of the infections transmitted by arthropods. The results contribute to the prevention and control of human and animal parasitic diseases and have also an impact on agriculture and fisheries.

The laboratories of the Institute of Parasitology are well equipped with instruments to perform a vast array of methods such as scanning and transmission electron microscopy, histology, biochemistry, molecular biology, phylogenetics, and tissue and cell cultures. Its facilities make it possible to study host-parasite interactions at the organismal, cellular and molecular levels. The Institute also possesses an Animal House Facility accredited for experiments with laboratory animals and maintains cultures of several parasitic protists, cell lines, ticks and mosquitoes. A large collection of type and voucher material (about 3,000 species of protists, helminths and parasitic arthropods) and a comprehensive parasitological library are the largest in the country. Scientists of the Institute provide expert opinions on parasites to the national and international agencies and the Institute offers postdoctoral residency training and international training courses in parasitology.

The Institute of Parasitology publishes of the international journal Folia Parasitologica. It is issued quarterly and publishes contributions from all branches of parasitology.


RESEARCH AREAS

Conducted research is focused on the taxonomy and biology of parasites as causative agents of diseases in man and animals. Priority research includes:

1. **Parasites of fish**
   - Morphology, molecular taxonomy and pathogenicity of amphizoic amoebae
   - Life cycles, ultrastructure and phylogeny of myxosporeans and microsporidia
   - Systematics, ultrastructure and biology of helminth parasites related to the aquatic environment
2. **Molecular biology of parasitic protists and nematodes**
   - Functional genomics of kinetoplastid flaggellate, especially Trypanosoma brucei
   - Secondary endosymbiosis and evolution of plastids
   - Genetic analysis of the nuclear receptor function in the model nematode Caenorhabditis elegans
3. **Biology of disease vectors: molecular interactions involved in pathogen transmission**
   - Immunology of host-vector interactions with respect to pathogen transmission
   - Molecular and cellular factors of pathogen transmission in ticks
   - Molecular ecology of Lyme borreliosis and tick borne encephalitis with respect to their antigenic structures and protein carbohydrate interactions
4. **Molecular taxonomy and phylogeny of parasites**
   - Phylogeny of parasitic protists, helminths and arthropods, and host-parasite coevolution
   - Parasite distribution and host specificity as the result of coevolutionary and host-switching events
   - Molecular phylogeny of the bacteria associated with blood-feeding arthropods
5. **Parasitic protists of man and animals with a special focus on opportunistic parasites**
   - Human parasites with special attention to emerging opportunistic parasites
   - Biology, pathogenicity and phylogenetic relationships of coccidia
   - Immune response against microsporidia

EXAMPLES OF RESULTS

Paraphyly of pseudophyllidean tapeworms (Cestoda): testing a hypothesis using morphological, life-cycle and sequence data.
Tapeworms (Cestoda) of the order Pseudophyllidea are parasites of marine fish and other vertebrates, including man (*Diphyllobothrium* and *Spirometra*) and freshwater fish in aquaculture. Phylogenetic relationships of tapeworms of this order were assessed using newly obtained morphological, ultrastructural, life-cycles and molecular data. Results have revealed that the order is composed of two phylogenetically unrelated groups, for which two new orders, Bothriocephalidea and Diphyllobothriidea, of these medically and veterinary important helminth parasites have been proposed. A complex revision of the order Bothriocephalidea, including amended diagnoses of all genera and keys to their identification, have been provided (Brabec et al., 2006: *Int. J. Parasitol.* 36, 1535–1541; Kuchta & Scholz, 2006: *J. Parasitol*. 92, 884–892; Škeříková et al., 2006: *Am. J. Trop. Med. Hyg*. 75, 307–310; Kuchta et al., 2008: *Int. J. Parasitol*. 38: 49–55).

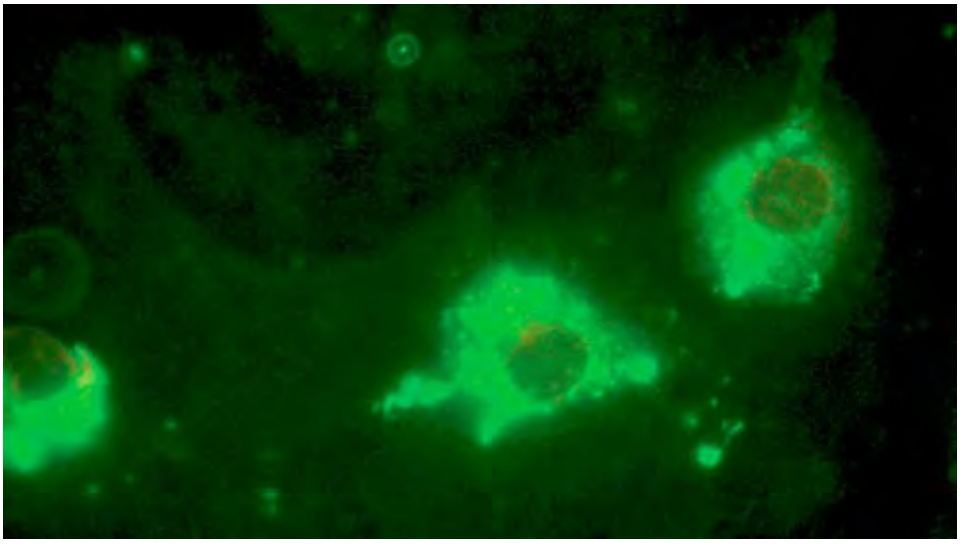
Evolutionary and geographical history of the *Leishmania donovani* complex with a revision of current taxonomy.
Visceral leishmaniasis, the most severe form of the disease that is lethal if untreated, is caused by species of the *Leishmania donovani* complex. These species are morphologically indistinguishable but have been identified by molecular methods, predominantly multilocus enzyme electrophoresis. Multifactorial genetic analysis was conducted that includes DNA sequences of protein-coding genes as well as noncoding segments, microsatellites, restriction-fragment length polymorphisms, and randomly amplified polymorphic DNAs, for a total of approximately 18,000 characters for each of 25 geographically representative strains. Genotype is strongly correlated with geographical origin, but not with current taxonomy or clinical signs. A new taxonomy, in which *Leishmania infantum* and *L. donovani* are the only recognized species of the *L. donovani* complex is proposed, and an evolutionary hypothesis for the origin and dispersal of the species is presented (Lukeš et al., 2007: *Proc. Natl. Acad. Sci. USA* 104, 9375–9380; Zemanová et al., 2007: *Int. J. Parasitol.* 37,149–160; Jirků et al., 2006: *Diagn. Microbiol. Infect. Dis*. 55, 75–79.).

Questing *Ixodes ricinus* female

Ixodes ricinus ticks

Lyme borreliosis: insights into tick-/host-borrelia relations

The ultrastructure and lectin characterization of granular salivary gland cells from *Ixodes ricinus* females was performed. The tick plasma lectin, Dorin M was cloned and sequenced. It was proposed that Dorin M may play a role in an innate immunity of the tick and also in pathogen transmission by this vector, possibly. The suppressive effect of tick saliva on borreliacidal activity of host complement and phagocytosis of Lyme disease spirochetes by macrophages was demonstrated. A tumour necrosis factor-inhibitory molecule was found in the saliva of *Ixodes ricinus* ticks (Vancová et al., 2006: *J. Parasitol*. 92, 431–440; Rego et al., 2006: *Insect Biochem. Mol. Biol*. 36, 291–299; Kýčková & Kopecký, 2006: *J. Med. Entomol*. 43, 1208–1214; Koník et al., 2006: *Parasite Immunol*. 28, 649–656.).



Interaction of Lyme disease sporochete *Borrelia burgdorferi* (green fluorescence) with mouse macrophages

INSTITUTE OF PLANT MOLECULAR BIOLOGY

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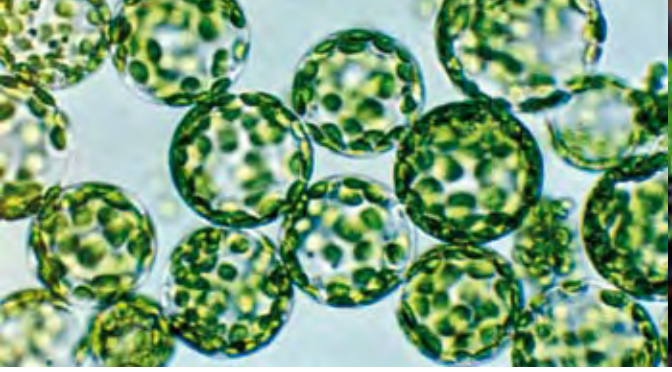
MISSION STATEMENT

Research activities range from plant molecular biology to ecological studies; the main topics include genetic engineering of plants, molecular genetics and diagnosis of plant viruses, viroids and phytoplasmas, and biophysics and physiology of photosynthesis.

GENERAL INFORMATION

The Institute of Plant Molecular Biology was founded in 1990 when several genetically oriented teams split from the Institute of Experimental Botany in Prague and moved to České Budějovice. The Institute is well equipped with instruments and facilities necessary for plant molecular biology, including air-conditioned greenhouses, climate chambers and rooms for plant tissue cultures. It is authorized to work with genetically modified organisms and quarantined plant pathogens. The Institute contributes significantly to national programs of plant biotechnology and provides expertise on the diagnosis of quarantined plant viruses to the Ministry of Agriculture and the State Phytosanitary Administration, and on genetically modified crops to the Ministry of the Environment.

An important part of the activities of the Institute is training in plant molecular biology and plant pathology, which is performed in close cooperation with the University of South Bohemia. In association with the Faculty of Science, Faculty of Agriculture and the Institute of Physical Biology, the Institute received accreditation for PhD programs in molecular biology, genetics and physiology, plant pathology and biophysics. Currently, the Institute hosts 38 Czech and foreign students, including 18 persuing a PhD. Nearly half of the scientist staff takes part in teaching classes. The University of South Bohemia, Charles University in Prague, and Palacký University in Olomouc are partners in joint research projects.




RESEARCH AREAS

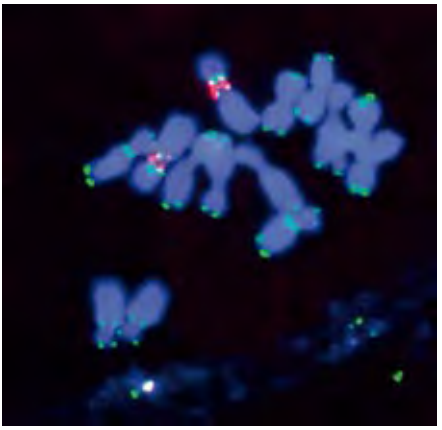
1. **Department of molecular cytogenetics**
   - Study of plant genome organisation at the chromosomal, subchromosomal and molecular levels, utilizing microsatellite mapping.
2. **Department of molecular genetics**
   - Research on plant nucleases, their function and potential utilization in medicine as an anticancer agent.
   - Functional genomics of hop, analysis of plant transcriptional factors in relation to metabolome regulation and analysis of mechanisms of gene silencing in relation to viroid propagation and pathogenesis.
3. **Department of gene manipulation**
   - Development of transgenic tissue lines of spruce showing high toxicity towards bark beetle species.
   - Study of the possibilities of human papillomavirus proteins production in transgenic potato and tomato plants.
4. **Department of plant virology**
   - Research on diseases caused by viruses, phytoplasmas and bacteria.
   - Development of molecular diagnostics, including those based on microarrays.
   - Focus on diseases of brassicas, legumes, small fruits and fruit trees that are difficult to diagnose.
5. **Department of photosynthesis**
   - Relationship in structure and function of photosynthetic membrane pigment-protein complexes.
   - Physiology, carbon discrimination and gas exchange in C3 and C4 plant metabolism.

EXAMPLES OF RESULTS

Plant genome organisation

The application of highly-parallel pyrosequencing (454-sequencing) and subsequent in-depth bioinformatics analysis of the resulting data allowed the sequence reconstruction and quantification of all major families of repetitive DNA in the pea (*Pisum sativum*). Compared to conventional methodologies used before, this approach proved to be much more efficient, providing comprehensive characterization of various repeats making up the majority

of nuclear DNA in complex higher plant genomes (Macas et al., 2007: *BMC genomics* 8, 427).



Distribution of repetitive DNA in pea

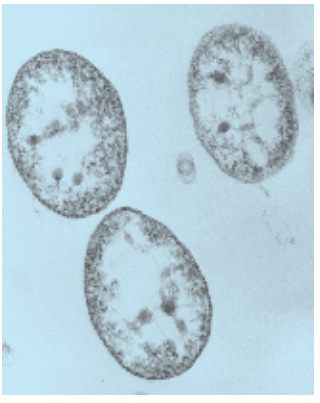
A family of recently discovered Ogre retroelements, which play a significant role in genome evolution of several taxa of higher plants, was investigated by computer-based analysis of their sequences retrieved from a range of species. Comparative analysis proved a common origin of Ogre-like elements from different species and allowed detailed characterization of their unusual features, including an extra ORF and intron sequences (Macas & Neuman, 2007: *Gene* 390, 108–116).

Molecular genetics

A new myb-like factor regulating biosynthesis of secondary metabolites in the hop was cloned. This transcription factor showed highest expression in maturing hop cones and colored petioles. Expressed as a transgene, it changes plant morphogenesis and production of medicinal prenylflavonids, depending on which N-terminal domain variant is present (Matoušek et al., 2007: *J. Agric. Food Chem*. 55, 7767–7776).

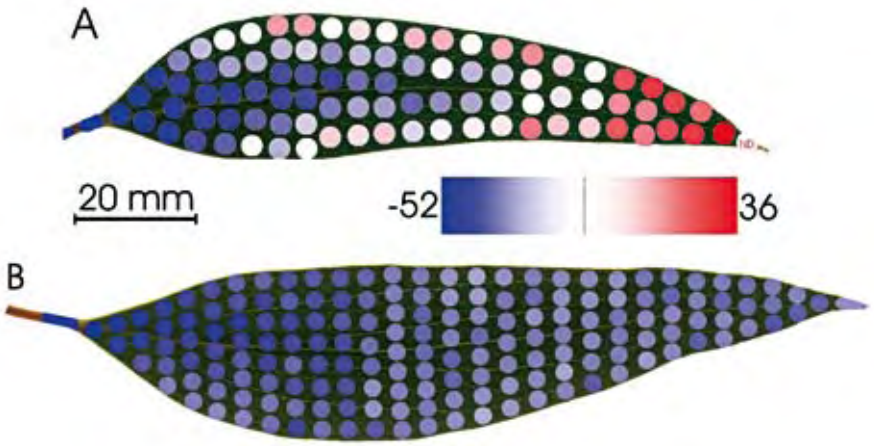
Virology

A few new microorganisms were described. For example the new Potato spindle tuber viroid strain was described showing extraordinary pathotoxicity. Its inoculation by a biolistic method causes a complete inhibition of plant growth and development. This toxicity was found to be accompanied by the accumulation of a high level of silencing RNAs and the induction of apoptotic nuclease in plant veinal tissues (Matoušek et al., 2007: *Biol. Chem.* 388, 1–13). Moreover, biolistic inoculation proved the transfer of two viroids, PSTVd and HSVd, to new host plants (Matoušek et al., 2007: *J. Virol.* 81, 11891–11899).



Isolated phytoplasmas infecting *Ribes*

A new potyvirus from *Daphne mezereum,* the Daphne mosaic virus (DapMV), was also described and its complete genome was sequenced (Fránová et al., 2006: *Arch. Virol*. 151**,** 793–801). Likewise phytoplasmas associated with the full blossom and blackcurrant reversion diseases in currants (*Ribes sp*.) were identified (Špak et al., 2007: Chapter 18, In: Characterization, Diagnosis and Management of Phytoplasmas, *Studium Press LLC*, Texas, USA, 387–397).



Spatial distribution of deuterium (delta D in parts per million relative to Vienna Standard Mean Ocean Water, V-SMOW) in the bulk leaf water of Eucalyptus pauciflora. **A** shows a leaf grown in dry (40% RH) and **B** in well watered and humid (80% RH) conditions.

Photosynthesis

Various aspects of photosynthesis are investigated in this department. An ultra-fast (femtosecond) transient absorption spectroscopy revealed several new and interesting aspects in a function of photosynthetic systems of different organisms. Application of this method on light-harvesting complexes from purple bacteria containing carotenoids with different conjugation length provided information about the role of the bacteriochlorophyll (BChl*a*) in a carotenoid-BChl*a* energy and electron transfer. We have observed BChl*a* as the electron acceptor in the process of charge separation between carotenoid and BChl*a*. In comparison to the efficiency of energy transfer, the charge separation is higher for carotenoids with shorter conjugation length (Polívka et al., 2007: J. Phys. Chem. B 111, 7422–7431).

The inner structure of pea chloroplasts was observed *in vivo* using fluorescence microscopy. Fluorescence emmision spectra were recorded to localise and identify granna and stroma lamela of the thylakoid membrane (Vácha et al., 2007: J. Lumin. 122–123, 301–303). We have shown that red alga *Cyanidium caldarium* contains higher-plant type photosystem I complexes and a cyanobacterial-type photosystem II. The proposed role of photosystem I PsaG and PsaH subunits as trimerisation site and an anchor for light harvesting complexes was refuted (Gardian et. al., 2007: Biochim. Biophys. Acta 1767, 725–731).

Distribution of stable isotopes of water in plant leaves reflects environmental conditions and water turnover. We designed a method visualizing the heterogenity of the isotope distribution and suggested a model predicting water isotopic enrichment throughout the leaf (Šantrůček et al., 2007: Plant Physiol. 143, 88–97).

Comprehensive references can be found on Institute web page.

INSTITUTE OF SOIL BIOLOGY

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MISSION STATEMENT

The Institute of Soil Biology is concerned with theoretical and practical problems of the maintenance and regeneration of soil fertility. The research is oriented on the structure and dynamics of soil organism communities in both natural and human-affected ecosystems, interactions among soil animals, microorganisms and abiotic factors in the formation of soil microstructure, nutrient cycling, and humus formation.

GENERAL INFORMATION

The Institute was established in 1986 from the Laboratory of Soil Biology, which had been a part of the former Institute of Landscape Ecology of the Czechoslovak Academy of Sciences since 1979. In 2006, the Institute joined the newly established Biology Centre. The staff includes 17 scientists and 25 technicians. In addition, nine doctoral and 18 masters and bachelors students participate in the Institute's research projects. Collaborating universities include the University of South Bohemia, Charles University in Prague, Masaryk University in Brno, Palacky University in Olomouc and universities based in Vienna, Budapest, Košice and Helsinki.

The Institute is involved in all the important fields of contemporary soil research, from the molecular to ecosystem levels, in order to elucidate relationships between the structure and function of the decomposer food web community and the role of soil biota in ecosystem functioning and services. The research teams focus in particular on the contribution of soil biota on soil functioning, human impacts on soil ecosystems and on the renewal of soil organism communities and soil processes in disturbed habitats. Variously managed grasslands, abandoned fields, post mining sites, caves and forests under natural and anthropogenic stresses are used as model ecosystems in long-term research. A broad interdisciplinarity approach, as seen in the close collaboration of microbiologists, zoologists and chemists, is an important facet of the Institute. The capacity to solve synecological problems at the lowest level is a special strength of Institute's contribution to soil biology research.

The Institute has contributed substantially to the development of soil biology as a distinct scientific discipline, which was incorporated into international scientific programmes such as SCOPE and IGBP, and those supported by NATO and UNESCO. The results of Institute research were important in formulating the ecotone concept, accepting the role of soil biota and their diversity in soil functioning, the development of general succession theory with soil as an integral part of ecosystem succession and the planning of international long-term global change studies. The contribution of the Institute to the taxonomy of soil fauna (especially Collembola, Protura, Diplura, Oribatida and Nematoda) is also appreciated world-wide. The Institute maintains several collections of viable microorganisms. The collection of microscopic filamentous fungi consists of more than 1000 strains of Zygomycotina, Ascomycotina and mitosporic fungi isolated from the soils, litter, caves, intestine and excrements of soil invertebrates. The collection of soil algae (Chlorophyta s.l., Xanthophyceae, Eustigmatophyceae) and cyanobacteria includes about 2500 strains isolated from the soils and aerophytic habitats of various ecosystems from diverse climatic and geographic zones. A collection of soil actinomycetes was established in 2006 with the focus on the producers of new manumycin-type compounds. All collections are used for scientific and educational purposes and are available for any collaborative research, including biotechnology use.

RESEARCH AREAS

- structure and dynamics of soil organism assemblages in natural and human affected habitats and their long-term changes
- interactions between soil animals and microorganisms and their effects on soil properties and processes
- enzyme and metabolic activity of soil microorganisms, ecophysiology of soil invertebrates, algae and cyanobacteria
- decomposition and mineralization of soil organic matter, soil microbial transformations of carbon, phosphorus and nitrogen in particular, including production of gaseous metabolites and their emission from soil
- taxonomy and biology of soil microorganisms and soil animals, e.g. actinomycetes, micromycetes, algae and cyanobacteria, rotifers, nematodes, earthworms, collembolans, oribatid mites, diplopods, terrestrial isopods, centipedes, ants and diptera larvae

EXAMPLES OF RESULTS

Soil sampling at a rehabilitated colliery spoil heap in Northwest Bohemia

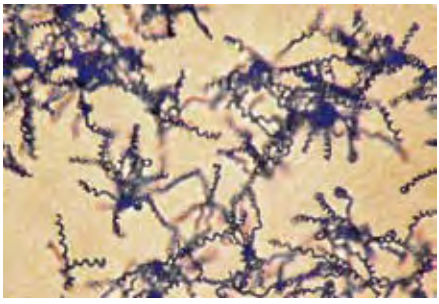
The study of soil organism succession and soil formation at post mining sites in Northwest Bohemia is a complex research project aiming to elucidate the role of soil biota in the gradual changes of the soil condition in sites that are reclaimed or still not restored (Frouz et al., 2006: *Appl. Soil Ecol.* 33, 308–320; Szili-Kovács & Elhottová, 2007: *Cereal Res. Communic.* 35, 1169–1172). Particular attention is given to interactions between the environment, plants and soil biota (Frouz & Nováková, 2005: Geoderma, 129, 54–64; Krištůfek et al., 2005: *Folia Microbiol.* 50, 427–435; Elhottová et al., 2006: *Leeuwenhoek Int. J. Gen. Mol. Microbiol*. 89, 459–463; Frouz et al., 2007: *Eur. J. Soil Biol.* 43, S184–S189). This research includes long-term monitoring of soil parameters at permanent sites, some of which have been studied for more than 15 years, as well as manipulation experiments (Frouz et al., 2007: *Appl. Soil Ecol.* 37, 72–80). The results contribute to the succession theory and have practical applications in restoration projects and reclamation technologies.

The study of linkage between structure, function and diversity of soil microbial communities and greenhouse gases emissions from upland pasture soil affected by cattle has been ongoing since 2001. In addition to research focused on the formation of important greenhouse gases (methane, nitrous oxide and carbon dioxide) in soils, and their emissions from the soils to the atmosphere (Šimek et al., 2006: *Agric. Ecosyst. Environm,* 112, 186–191; Hynšt et al., 2007: *Biol. Fertil. Soils* 43, 853–859; Hynšt et al., 2007: *Agric. Ecosyst. Environm,* 120, 269–279), the structural and functional diversity of soil microbial community has been studied, using lipidic biomarkers analyses and genomic methods. The special effort is focused on the study of the group Archaea and its contribution to greenhouse gas emissions (Radl et al., 2007: *Nature ISME J.* 1, 443–452).

Measurement of soil parameters of pasture soils

The effects of grassland restoration processes, i.e. transformation of recent arable land into grasslands, and the impact of successive management practices on soil fauna assemblages has been investigated in an ambitous field experiment. In this study, long-term observations have been made of different arrangements of sowing with a native seed mixture and leaving plots to spontaneous succession in mowed and grazed meadows of the White Carpathians. Animals typical for grassland biotopes appeared at sown plots as late as after the intense development of vegetation cover (Háněl & Čerevková, 2006: *Helminthologia* 43, 109–116; Stašiov et al., 2006: *Biológia* 61, 165–169). Comparing the data from mowed and grazed meadows, the effect of grazing on soil invertebrates was observed. Generally, grazing was connected with the occurrence of eurytopic species and the decrease of stenotopic species (Schlaghamerský et al., 2007: *Eur. J. Soil Biol,* 43, S72–S78).

Gene screening of actinomycetes producing new substances with potential therapeutic applications to modulate immune mechanisms have been performed**.** This project concentrates on the identification of new manumycin-type compounds producers by specific gene "screening" (van Elsas et al., 2007: *Nature ISME J.* 1, 204–214). This family of secondary metabolites exhibits attractive immunomodulatory and anti-inflammatory activities with low cytotoxicity and might be interesting candidates for future use in medicine. Possible new producers of manumycin-type secondary metabolites were characterized, identified and stored in a culture collection.



Representative of soil actinomycetes – Streptomyces sp.

BIOTECHNOLOGICAL INSTITUTE OF APPLIED ECOLOGY (PROJECTED)

The current institutes of the Biology Centre focus on basic biological research. Most of the generated results have so far only remote perspectives for practical applications. The Biology Centre intends to remain in the forefront of the conducted theoretical investigations and to promote practically targetted research as well. Plans have been prepared to construct a modern building for a new Institute of Ecological Biotechnologies, with aid of the European Union funds. It is envisioned that more than one hundred people will work in the new institute by 2013. Human resources will be drawn from the region, in particular among the graduates of the University of South Bohemia, but expert staff will be recruited worldwide, beginning in 2009.

Research conducted in the new Institute will focus on problems that are of particular importance for the region, but are also relevant for the whole Europe. Detailed plans for the following projects have already been defined:

Sanation and melioration of soils damaged by human activities

Quality assessment and improvement of fresh waters

Management of nutrient flow in river basins and other measures for the suppression of blue algae

Monitoring environmental changes and prognosis of their economic impact

Diagnostics of crops, ornamentals and other cultivated plants

Molecular diagnostics of plant diseases

Modern methods of plant protection: genetic engineering and use of bioagents

Exploitation of natural compounds and their recombinant derivatives

The safety of foods and fodder

Diagnosis and management of diseases transmitted by ticks

Control of mosquitoes and other disease vectors

Development of vaccines for the treatment of emerging diseases

Use of plants for the production of vaccines

Use of insect models to find inhibitors of human disease pathways

Design of the projected institute – Atelier A1, s. r. o. – České Budějovice

TECHNICAL AND ADMINISTRATIVE SERVICE

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The Joint Technical and Administrative Service was established in November 1990 as a partly independent unit that provides infrastructural services to the Institutes in České Budějovice. It became an organisational part of the Biology Centre as of 1 January 2006. Its responsibilities include dealing with labour law matters, salary/wage issues, accountancy, contacts with financial institutions, and the administration, maintenance and security of real property, investments, energy management and control and various technical services. The Technical and Administrative Service also operates a joint biological library, common lecture halls, catering and other activities.

Joint biological library (on the left)
Dining hall
and BC workshops (down)

ČESKÉ BUDĚJOVICE

The city of České Budějovice is the economic and cultural centre of the South Bohemian region, with a population of about a hundred thousand inhabitants. The town was founded in the year 1265 by King Přemysl Otakar II at the confluence of the two rivers Vltava and Malše. The rectangular ground plan of the medieval town with its main square, which is one hectare in area, is a wonderful example of medieval urbanism. The city is famous for its burgher houses, baroque town hall, Samson fountain and nice churches. The beauty of the city and the surroundings, with its attractive nature and other historical monuments, has led to the development of a significant tourism industry. The famous Budweiser Budvar brewery is one of the biggest companies in the town. The University of South Bohemia was established in the year 1991 and now has seven faculties. Together with the Biology Centre of the ASCR, these two institutions comprise the educational centre of the city.

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