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Aspects of the biodiversity and taxonomy of earthworms on the 5th international oligochaete taxonomy meeting

The scientific works of 4th International Oligochaeta Taxonomy Meetings are presented. Modern methods of gathering and the account, taxonomy and the genetic analysis of different species of earthworms are resulted. Problems of systematisation of group are described. New methods of phylogenetic constructions are characterised. The basic of ecological researches in the biodiversity of oligochaetes analyzed in various regions of the world. The life forms informations is given in the aspects of modern ekologo-physiological researches.

Key words: Oligochaeta, taxonomy, distribution, earthworms, soil, natural commodity, ecosystems, species., scientific, fauna.

Oligochaeta (few-bristled worms) is an extremely important taxonomic group in aquatic and terrestrial ecosystems. The class *Oligochaeta* (phylum *Annelida*) was traditionally separated into Microdriles (small oligochaetes living in sea and fresh water and in wet soil) and Megadriles (often large oligochaetes, living mostly in terrestrial soil, a few are however semi-aquatic or aquatic). Though, one should keep in mind that nowadays Microdriles are considered as a paraphyletic assemblage whereas Megadriles are regarded as perhaps a monophyletic group [1].

To the layman the best known oligochaete group are earthworms that were one of the first animal group colonizing humus soils at the end of Palaeozoic (250 MYA), and Charles Darwin undeniably contributed to their fame with his famous book The Formation of Vegetable Mould through the Action of Worms with Observations on their Habits, which became a best-seller in that time. In contrast to other *Oligochaeta*, the important role of earthworms has been recognized from the dawn of human history till present. They were known, for millennia, as important factors of soil fertility and it is no coincidence that in 350 B.C.E.Aristotle in his Historia Animalium described them as earth's guts. In fact, the number of casts was used as an estimator of soil fertility by tribesmen in the Sahara region as reported by Howard (1945). Earthworms have been also used in early medicine, as documented by Pliny the Elder (77) in his Natural History. Rather surprisingly, they have also been used as a model of scientific explanation of our world. For instance, Aristotle mentioned them as an example to support his — today rejected — theory of abiogenesis and believed — wrongly — that eels originated from earthworms [2].

In spite of the importance of oligochaetes, there are presently some serious deficiencies in the knowledge about their taxonomy, distribution, biology and ecology, in comparison with mammals, birds, lizards and other organismal groups. One way to bridge this gap is to bring together scientists working on the subject with the aim to speed up information about the progress in their work, exchange ideas and encourage them to cooperate. This is the basic idea behind the organization of the International Oligochaeta Taxonomy Meetings (IOTM). So far, four successful meetings took place. The 1st IOTM was organized by Ana G.Moreno in Madrid, Spain, the 2nd IOTM by Victor V.Pop in Cluj-Napoca, Romania, the 3rd IOTM by Tomáš Pavlíček and Patricia Cardet in Platres, Cyprus, and the 4th IOTM by Tomáš Pavlíček, Patricia Cardet and Yüksel Coskun in Diyarbakır, Turkey (Fig.). Traditionally, the meetings concentrate mainly on Oligochaete taxonomy and phylogeny, but also discuss different aspects from other scientific fields, e.g. earthworm ecology, faunistics and phylogeography as well as new methods of their study. The 5th International Oligochaete Taxonomy Meeting was continue in the best tradition of the previous four meetings and took place in Beatenberg in Switzerland, from April 11th to April 15th, 2011.

The value of soil and soil fauna in balance and preservation of ecosistems. For example Blakemore R.J (Tokyo, Japan) writes that earthworms are a surprisingly diverse and important group of organisms. This is what Darwin explained to us in his 1881 treatise, the culmination of 40 yrs of his work, on Vegetable Mould and Worms where once again he showed, as with Evolution via Natural Selection, how small, constant changes produce profound effects on all entwined Nature.

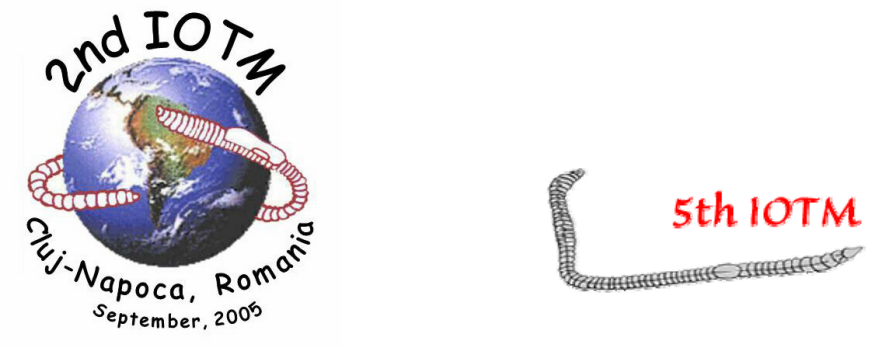

Figure. The emblems of the International oligochaeta taxonomy meetings

The importance of Earthworms relates to their intimate and synonymous/eponymous relationship with the earthen soil and plants that grow from it.

Soil is the most important and precious natural commodity on the Earth. All terrestrial life is built upon its foundation from healthy organic soil, so too are river, lake and coastal marine ecosystems (the deep ocean is a mostly devoid desert with only a few biodiverse «oases» hotspots). A 10-yr $300m marine consensus resulted in the abysmally small total of just 250,000 marine species in total — about 10 % of the current global total.

The United Nations FAO provides that 99.6 % of all human food and fibre comes from the land, despite this more resources are directed to aquatic and in particular marine research then into soil. There is not a single SOIL ECOLOGY INSTITUTE anywhere in the world in contrast to the myriad marine laboratories or space observatories. Thus Science journal was justified to title a special issue: «Soil — the Final Frontier.

The aim is to present how Earthworms are Ancient («Bioneers» to the land some 500–750 m yrs ago, with claimed origins ca. 1 billion yrs), Diverse (ca. 10,000 currently named species cf. 13,000 mainly marine Polychaetes), and crucially Important to Ecosystem services and food-chains which all Life on Earth, including ourselves, depend. In 1802 Lamarck named them *Annelidés* — the ringed ones — and they truly are the humble but accomplished Lords of the Ring. A proposal is presented to justify support for crucial earthworm eco-taxonomy as a 'Sea Change' for soil research.

E.Havlicek (Switzerland) asks: «Do really politicians need earthworms?» Whereas water and air have been receiving ongoing care and attention from scientific institutions and from legislative management for last decades, soils and their inhabitants, until recently, did not benefit from such interest. Doubtlessly, they are now recognized for their high biodiversity but in fact, the soil biology is still widely unknown. Moreover, the fact is that soils are not only a milieu for living organisms, they are also formed by these organisms and without their presence soils cannot develop. Determining and monitoring soil biodiversity is far from completion; nevertheless, in order to achieve soil protection goals at policy level, bioindicators such as earthworm diversity or microbial respiration — even imperfect — are being implemented. The choice of accurate tools is challenging because beside biological parameters, socioeconomic factors, such as effectiveness, inexpensiveness, or capacity to provide information, are to be considered.

The way leading from fundamental science to implementation is still not completely cleared, particularly in the soil biota domain. Reasons can be found out in the lack of scientific knowledge but also in the multifunctional use of soils that leads to divergent interest related either to soil quantity or to soil quality.

Choosing to host the 5th IOTM in the Alps had a symbolic meaning. The Alps constitute one of the European hotspots of the origin of earthworm biodiversity.

Earthworm biodiversity is the traditional theme of meeting. First recorded earthworms from the Mouteh Wildlife Refuge (Iran) by Ghayoumi R. has shown earthworms belong to three genera from the family *Lumbricidae* (Rafinesque-Schmaltz 1815), and include the following five species: *Aporrectodea caliginosa* (Savigny 1826), A. *rosea* (Savigny 1826), *Dendrobaena hortensis* (Michaelsen 1890), D.*veneta* (Rosa 1886), *Eiseniella tetraedra* (Savigny 1826).

Species richness and zoogeographic affinities of earthworms in Iran has been investigated by Ezzatpanah S., Latif R. and Malek M. The earthworm fauna of Iran is poorly known. So far, recorded are 18 species, 11 genera and two families (Lumbricidae and Megascolecidae). Out of all recorded species 61 % (11 species) are introduced and 39 % (seven species) could be autochthonous: *Aporrectodea jassyensis*, *Dendrobaena byblica complex*, D. *schmidti*, D. *veneta*, *Helodrilus patriarchalis*, *Healyella syriaca* and *Perelia*

kaznakovi. Native worms are found only in the narrow geographical region north of Elburz and Zagros Mountains. After uplifting, the mountain ranges have served as a natural geographic barrier preventing migration of the natives to the internal parts of Iran. The most speciose area in Iran located in the North West of the country might have earthworm exchange with Anatolia. A comparison of native species shows a high faunal (more than 85 %) similarity between Iran and Anatolia.

Biodiversity of earthworms in French Guiana described by Pablicek T. and Csuzdi Cs. The taxonomic diversity of earthworms in Eastern Amazonia is almost unknown. In humid tropical French Guiana (83,534 km²) 17 identified earthworm species have been recorded of which more than 50 % are introduced. Apart from one larger earthworm sample collected in French Guiana at the first half of 20th century all literature records are limited to description of one or a few species. They have described (in press) one new genus comprising three species. Two of them are new to science and were collected at the Nouragues Natural Reserve. The third species known from northern Brazil was accommodated in the genus Andiorrhinus before it was transferred to the new genus. Regarding of the genus Martiodrilus the revision of the collected samples provides evidence about the presence of two species recorded earlier (M. *duodenarius* (Michaelsen, 1918), M. *tenkatei* (Horst, 1887)); one species firstly recorded in F.Guiana (M. helleri (Michaelsen, 1918) and two species new to science.

Brown and others have resulted work examples of the Latin American Meetings on Oligochaete Ecology and Taxonomy (ELAETAO) on earthworm and enchytraeid research in Latin America. Topics included the diversity and distribution of native and exotic earthworm species in all Latin American countries, the use of oligochaetes as bioindicators, oligochaete genetics and phylogeny, various aspects of vermiculture, earthworm and enchytraeid sampling methods, and ecology and biology of invasive species, among others.

Earthworm biodiversity in Brazil studied by Brown G.G. and James S.W. The majority *Oligochaete* belong to *Glossoscolecidae* (66 %), *Ocnerodrilidae* (15 %) and *Acanthodrilidae* (8 %). Most native species show restricted distributions and high endemicity, while exotic species have extensively colonized disturbed habitats. *Pontoscolex corethrurus* (Müller, 1857), probably native to N Brazil, is a peregrine invasive throughout the rest of the country and is the most abundant and well-known Brazilian earthworm. More than 50 species of large (>30 cm length, >1cm diam.) earthworms (minhocuçus) inhabit Brazilian soils.

Studies of the effects of native and exotic species on soils, ecosystem function and biodiversity are needed, considering the extent of invasion, and increasing human pressure on land use and natural resources. Nevertheless, this is hampered by the lack of knowledge of their biology and ecology as well as the lack of trained taxonomists and earthworm researchers in Brazil.

Four Latin American Meetings on Oligochaete Ecology and Taxonomy have been held since 2003: ELAETAO 1 (Londrina, Brazil, Dec. 2003), ELAETAO 2 (San Juan, Puerto Rico, Nov. 2005), ELAETAO3 (Curtiba, Brazil, Dec. 2007) and ELAETAO4 (Curitiba, Oct. 2010). These unique fora brought together >80 researchers, students and technicians from >12 countries and resulted in several important publications (3 special journal issues and one book), helping to synthesize the work performed in the Americas.

An annotated check list of the Romanian earthworm fauna (*Oligochaeta*, *Lumbricidae* was made by Pop V.V.1, Pop A.A. and Csuzdi Cs. The earthworm fauna of Romania is quite well known due to the investigations conducted by several prominent specialists, starting with Örley (1885), Michaelsen (1891, 1903), Černosvitov (1932) and especially Victor Pop (1938–1964). Twenty five species were recorded from this territory before the beginning of Pop's research. Pop's (1949) publishing of the first comprehensive check list of the Romanian lumbricids raised the number of taxa to 47, to which three other species were added in 1964 and 1965 and thus raising the number of earthworm species recorded in Romania to 50. In the last 45 years, due to the continuous researches by Victor V.Pop, András Zicsi and Csaba Csuzdi the list of the lumbricid taxa recorded in Romania reached 75A thorough re-examination of the material kept in Victor Pop's earthworm collections in the Zoological Muzeum of the Babes-Bolyai University, Cluj-Napoca, as well as in the V.V.Pop's earthworm collection at the Biological Research Institute in Cluj-Napoca resulted in the removal of several ambiguous species from the list of the Romanian earthworm fauna which now contains 72 valid earthworm taxa.

It is important to put attention not only to the high number of lumbricid species, but also to the high number of endemic taxa. Thus, in Romania from the 72 taxa recorded 26 are endemics. This number is exceptionally high comparing to those of the whole Carpathian Basin (97 species, 39 endemics). The majority of endemic species were recoded from the Carpathian Mountains, and especially from the Apuseni Mountains.

The biogeographic structure of the Romanian earthworm fauna include Dacian endemics (15), Carpathian endemics (9), Moesian endemics (2), Central European (8), Transaegean (6), Moesian (6), Balkanic (3) peregrine (14) and other minor elements.

About new endemic earthworm from New Zealand with a very restricted distribution informed Boyer S., Wratten S.D., Bowie M. More than sixty years after the work of Ken Lee, who listed 173 earthworm species endemic to New Zealand, recent studies have revealed that the diversity of New Zealand earthworms has been largely underestimated. Maoridrilus otamahu was named after the maori name of this small island of volcanic origin that lies in Lyttleton harbour, between Christchurch and Banks Peninsula on the East Coast of New Zealand's South Island.

Biodiversity of earthworms in the Diyarbakır region (Upper Mesopotamia), Eastern Turkey described by Coskun Y.1, Pavlicek T. and Csuzdi Cs. Only 11 species of earthworms are recorded so far in the Diyarbakır region. This represents 14 % of the earthworm species richness known in the East Mediterranean region. The recorded species belong to two families (*Lumbricidae* and *Acanthodrilidae*) and are to be found also in other regions of Turkey and in the Levant. However, Eisenia n. sp. and Dendrobaena n. sp., currently under description, indicate a possible presence of local endemics as well.

In sediments of the river Alster in Hamburg Graefe U. and Beylich A. have found a large population of a curious earthworm which we could identify as *Sparganophilus tamesis Benham*, 1892, hitherto unknown from Germany. After the first description from England the species was described several times under different names from North and Central America (Smith 1895, Eisen 1896) and from France (Tétry 1934). The synonymy of these species was repeatedly reviewed (e.g. Cernosvitov 1945, Jamieson 1971). *Sparganophilus langi Bouché & Qiu*, 1998, from Switzerland (Lake Geneva) is probably also a junior synonym of *Sparganophilus tamesis*. Its description as new species is apparently due to a misleading characterization of S. tamesis in the key given by Reynolds (1980).

The role of earthworms as bioindicators. For example many knowledge gaps remain about the ecological impact of restorations on the terrestrial biota and more particularly on soil fauna. The focus here is on earthworms. In flood prone areas, earthworms have evolved different strategies to cope with inundated soils. However, little is known about their diversity and ecology in floodplains and even less on the impact of floodplain restoration on earthworms and the degree to which they may be useful as indicators of restoration success. The work of Laboratory Soil and Vegetation, (Switzerland) has aims at 1) characterising the patterns of earthworm density, biomass, species richness, diversity and community structure in a restored floodplain 2) assessing the relationships between these variables and spatial structural and functional variables and 3) decoupling and comparing the three components of earthworms diversity: «taxonomic», functional, and genetic.

A vibrational (Fourier transform infrared (FTIR)) spectroscopic method was used by Gobi M. and Gunasekaran P. (India) for the structural and compositional analysis of earthworm Eisenia fetida to monitor metal binding and its further transformations in live cells. The FTIR analyses of metals digested by E. fetida will be useful to study the impact of the heavy metal stress on worm metabolism. In our experiment, the epigeic earthworm E. fetida was exposed to 100, 75, 50, 30, 25, 15 and 5 % of automobile service station waste mud. Metabolic response after exposure to each concentration level of the waste mud was assessed by the FTIR on 10 animals with three replicates. The peaks at 1045 cm−1, 1080 cm−1, 1236 cm−1 and 1650 cm−1 represented the overall susceptibility of nucleotides, phospholipids, DNA and RNA to the present metals.

As a matter of fact, structure of nucleic acids and proteins was modified due to heavy metal accumulation. Heavy metals accumulation in the worms was measured and as expected lead, zinc and copper accumulation increased in the treated grou.

Earthworm communities were an indicator of river restoration success, the case of Emme river (canton Bern, Switzerland). Moreira N. and others shown earthworms play a key role in the functioning of soil ecosystem. They suppose that their communities may reflect the restored fluvial functioning. The aim of this study was to describe earthworm communities and to use them as indicators of restoration evaluation. These data will be compared to data obtained in a near natural system in order to evaluate the progress of this site towards a more natural fluvial functioning.

The effects of farming practices on earthworm dynamics in olive groves of central Greecs estimated by *Solomou* A., *Sfougaris* A. and *Vavoulidou* C. The highest estimated earthworm biomass and density of earthworms were estimated in the organic olive groves and the lowest one in the conventional olive groves ($p < 0.05$). The highest species richness was recorded in the organic olive groves. Six species were recorded in total, all of them were present in organic olive groves: *Octodrilus complanatus*, O. *croaticus*, *Dendrobaena*

byblica, D. *veneta*, *Aporrectodea caliginosa* and *Microscoles phosphoreus*. Conversely, at the conventional olive groves were present only four species and missing were D. *veneta*, and M. *phosphoreus*. The most abundant species were the following: O. *complanatus*, D. *veneta* and D. *byblica*. It can be concluded that biomass, population density and species diversity in earthworms may be considered as sensitive indicators of management practices, because these variables were influenced by farming system, i.e. higher in the organic olive groves than in the conventional ones.

Morphology contribution to species distinction and phylogenetic interspecific relationship focusing on Lumbricidae family. In many researches it is necessary to summarize the anatomy morphology and molecular data on both, try to find a place for species among the taxa. Most of the available taxonomic classifications of lumbricids are based on morphological studies. The use of an automatic classification based on morphological characters could make the taxonomy work easier.

The aim of researchers from France and China Briard C. and Qiu J.P. is to develop automatic classification techniques by using statistical processing and compare to the traditional classification. Species biological traits are extracted from the «Lombricien2000» database of the CNUSC (INRA, Montpellier, France) which contains all the data generated by the studies of M.B.Bouché since the 60s. Based on the morphological study of French lumbricids by Bouché (1972) and completed by Qiu (1998), 210 characters are available for each species described.The quantitative and qualitative morphological characters of all the Lumbricidae species and subspecies were analysed by using statistical processing as: the Multiple Correspondence analysis to study the contribution of morphological characteristics to separate species and the HierarchicalAscendant Classification and the maximum of parsimony to define interspecific relationships. By quantitative analysis of the differences existed between species, the characters diversity and the species differentiation direction in Lumbricidae is illustrated.

Eisenia lucens (Waga, 1857) and *Eisenia spelaea* (Rosa, 1901): are they really different species, wrote *Szederjesi* T. and *Csuzdi Cs*. (Hungary). *Eisenia lucens* (Waga, 1857) is a Central European earthworm species with montane distribution. Its range stretches from the Pyrenees through the Alps and the Carpathian Mts. to the Balkan Peninsula. In Hungary it occurs in the higher region of the Northern Hills, usually under the bark of fallen trees.

Eisenia spelaea (Rosa, 1901) also possesses a Central European distribution, it occurs from the Alps to the Balkan Peninsula. In Hungary it is found only alongside the Western border region usually living in the detritus of small streams. However, sometimes it can also be found in decaying wood or even in soil as well.

The strong similarity of both taxa makes it difficult to morphologically distinguish them. The only slight morphological differences are in the colouration and opening of the spermathecae. However both characters mentioned are very difficult to recognize properly on preserved material. There is another — biochemical — difference between the two species, namely the presence of bioluminescence in case of E. *lucens*.

The above mentioned difficulties in identifying the two species result in two problems. On the one hand, a larger part of the distributional data of each species is ambiguous; on the other hand from time to time the validity of the two species is questioned.

They tried to answer this question using the BAR code sequences (Cytochrome c oxidase subunit I) obtained from different E. *spelaea* and E. *lucens* (bioluminescing) specimens collected in different part of the Carpathian Basin.

The first results show high genetic differentiation between E. *spelaea* and E. *lucens* which seems to corroborate the validity of the two species. The E. *spelaea* specimens examined proved to be quite homogeneous genetically; however E. *lucens* possesses two highly divergent clade

Can earthworms provide the evidence of continental drift? Megascolecidae is a large family of earthworms which has native representatives in Australia, New Zealand, Southeast and East Asia, and North America. The most ancient lineages of the family showing a Gondwanan distribution have been used as evidence of the continental drift occurrence.

Members of the Pheretima group (e.g. Amynthas) are widely distributed around the tropics. Hainan Island is such a typical resource-rich tropical region that makes it one of the most significant areas for the scientific research in China. Zhao Q., Sun J., Jiang J. and others studied the lineages of earthworms present there and investigate whether they can provide the evidence of continental drift occurence between China mainland and Hainan Island. This phylogenetic study on earthworms in Hainan Island based on the morphological characters. They chosed 47 earthworm species in the family Megascolecidae in Hainan Island, comprising 42 and 5 species in the genera Amynthas and Metaphire respectively. Meanwhile, another 4 species from Guangdong province had been also selected. The phylogeny tree will be drawn by the method of Ag-

glomerative Hierarchical Clustering (AHC), after Multiple Correspondence Analysis (MCA) is applied to analyze the phylogenetic relationship among 47 earthworm species based on 19 morphological characters.

Results discussed in two parts: The first part dealed with the distribution of the species and answer the following question: Do all these species with the close relationship distribute in the adjacent regions? The second part dealed with the use of the gathered data as the evidence for occurrence of continental drift between China mainland and Hainan Island.

Earthworm taxonomy needs DNA barcoding now. In recent years, the concept of DNA barcoding has attracted the attention and research efforts of earthworm taxonomists. The numbers of DNA barcode papers and sequences of earthworms have grown exponentially. However, with the numbers of barcode records accumulating in GenBank and the Barcode of Life Data Systems (BOLD), challenges regarding species delimitation, undescribed species diversity, and morphology-based species identification have emerged.

Chang C.-H., Chih W.-J., Shen H.-P. and others presented a summary of Taiwanese earthworm studies based on 8122 specimens deposited at the National Taiwan University (NTU), and 751 barcode records from specimens deposited at NTU and Taiwan Endemic Species Research Institute. The results indicated that both the DNA barcode-only approach and an approach that combines taxonomy and parataxonomy overestimate species diversity. In many cases, species delimitation based on both morphology and DNA barcodes is still difficult due to the high variations in not only morphology but also the barcode sequences. They further argued that the current earthworm DNA barcoding approaches are biased towards collecting specimens and barcode records without sufficient involvement of taxonomists and taxonomic expertise. While the barcode records from the claimed new species become publicly available, the «new» species in the specimen jars remain associated with only a temporary name or identifying number, undescribed, and unnamed. In addition, the correctness of names in the database relies almost entirely on the sequence provider without any quality control, which may make the database unreliable as a species identification platform. Therefore, authors suggest that in order to make earthworm species identification using DNA barcodes practically applicable, earthworm taxonomists need to be more actively involved in the DNA barcoding studies and taxonomy needs to become a more significant part in the barcoding procedure.

The other example: is the Nicodrilus genus (Bouché, 1972) really one genus? Phylogenetic study based on morphological and molecular characters of some *Aporrectodea* and *Allolobophora* species (*Oligochaeta*, *Lumbricidae*).

The Nicodrilus genus defined by Bouché (1972) is not known by all of taxonomists and not accepted in the nomenclature according to ICZN; Aporrectodea term is used. However, according to *Bouché*, *Aporrectodea* and *Allolobophora* genera are not homogeneous and are supposed as polyphyletic genera. The aim is to study the phylogenetic structure of «Nicodrilus genus» in order to verify its cladistic nature and its taxonomical validity. In this work, we thus focus on species belonging to the *Aporrectodea* and *Allolobophora* genera. First, we use data stored in «Lombricien2000» database, representing the earthworm taxa collected and the morphological characteristics described by Bouché (1972) and Qiu (1998) for each species. Species life history traits are included among morphological characteristics (e.g. clitellum, puberculum and pores position, Morren's gland, body size…). Then, authors pursue a molecular approach on individuals sampled in France. Molecular phylogenetic analyses are based on the sequences of nuclear and mitochondrial gene regions and performed with maximum likelihood and bayesian inference. Statistical processings are realized on morphological data to compare information from molecular and morphological data to build phylogenetic relationship. Results will be discussed to define *Nicodrilus*, as described by *Bouché*, as a true genus (as a monophyletic one) or distributed into existing groups as *Aporrectodea* and *Allolobophora*.

The second example: estimation of time when a branching event recorded on a phylogenetic tree took place is easy under the assumption of constant substitution rate (strict molecular clock). As a matter of fact, the substitution rates are heterogeneous among lineages and clades, i.e., among species and populations. In such a scenario dating might still be possible by means of a relaxed molecular clock model if relevant sequences of fossil DNA and/or calibration points (e.g., fossil records) are available. Unfortunately, this is not often the case in earthworms which are soft-bodied organisms. Hadid Y. and Pavlicek T. explored whether in earthworms correcting the substitution rate for differences in body mass and in temperature of their environment could help to estimate the timing of branching events.

The life forms in Oligochaeta is the very popular theme of many researches. T.Timm wrote a review of literature data. Four main life forms among the Oligochaeta: aquatic sediment-dwellers, inhabitants of the macrovegetation, soil-dwellers, and carnivores. Representatives of all four live also in sea. Vegetation-dwellers of tubificid origin (*Naididae*, *Pristinidae* and *Opistocystidae*) have shifted towards asexual reproduction; some of them swim and have eyes. A convergent group is the «polychaete» family *Aeolosomatidae*.

Some *Lumbriculidae* can also swim. Three clades live mostly in soil: the smaller Enchytraeidae, and the larger (earthworms) Crassiclitellata and Moniligastridae. Enchytraeidae and Crassiclitellata include also secondarily aquatic genera. Some aquatic Tubificidae can facultatively live in dry soil. Carnivory (parasitism or predation) was invented in separate genera of many families and led either to increase of chaetal number, or a stronger pharynx. A large lumbriculid clade including Hirudinea, Acanthobdellidae and Branchiobdellidae, has highly modified due to carnivory (suckers, jaws, loss of chaetae, etc.). Two evolutionary trends are evident in different groups: reduction of the chaetal number from indefinite to two per bundle, and reduction of the upper tooth in the originally bifid sigmoid chaetae. External gills have arosen at least four times. There are many transitions and convergencies in the way of life and morphology of *Oligochaeta*.

So I wrote the the comparison article about gizzard muscles excitation of life forms in *Aporrectodea* caliginosa, induced by acetylcholine. As far as we know, earthworm muscles get excited by acetylcholine. We considered that main morpho-ecological lumbricid groups have different reactions to this biologically active substance. For our research, the amplitude and frequency of contractions of the visceral (gizzard) smooth muscles of life forms in Aporrectodea caliginosa were selected. The different concentrations of acetylcholine were tested and the contractive activity of the muscles was studied according to the method of isolated preparations. Action of acetylcholine on smooth muscles stimulated the tonic contractions. I constructed dose-response curves of reactions of muscles on the discrete concentrations of acetylcholine

The greatest sensitiveness and responsiveness to acetylcholine was recorded for the surface-living *Aporrectodea caliginosa* trapezoides. The muscles of *Ap. caliginosa* caliginosa inhabiting mineral soil layers have been less sensitive to acetylcholine and less responsible. So we supposed that distinctions between parameters of induceous contractive activity of smooth muscles of life forms in *Ap. caliginosa* are related to the metabolic features and particular nervous regulation [3].

As a whole the growing amount of information available about taxonomy and molecular variability enables the establishing of phylogenetic systematics of *Oligochaeta*, and the performing of conceptually and methodologically enriched studies on diverse aspects of taxonomy, biodiversity and phylogeography. In spite of numerous studies the relationships rooted in the evolutionary distant past are poorly understood among Oligochaeta.

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В.С.Әбукенова

5-ші Халықаралық олигохетологиялық конференцияның материалдары бойынша жауын құрттарының таксономиясы және биоәртүрлілігі мәселелері

Мақалада 5-ші халықаралық олиготехнологиялық ғылыми конференция материалы қарастырылған. Әр түрлі жауын құрттарын жинау мен есептеудің таксономиялық және генетикалық сараптауларының қазіргі кездегі жаңа әдістері келтірілген. Топ систематикасының мәселелері, филогенетикалық құрылулардың жаңа әдістері сипатталған. Экологиялық зерттеулердің негізгі бағыттары ретінде әлемнің әр түрлі аудандарының люмбрикофаунасының биоәртүрлілігі талданған. Қазіргі заманғы экология-физиологиялық зерттеулердің тіршілік формаларына әдеби шолу жасалған.

В.С.Абукенова

Вопросы биоразнообразия и таксономии дождевых червей по материалам 5 -ой международной конференции по олигохетам

В статье представлена тематика научных работ 5-й международной конференции по олигохетам. Приведены современные методы сбора и учета, таксономического и генетического анализа разных видов дождевых червей. Описаны проблемы систематики группы. Характеризуются новые методы филогенетических построений. В качестве основного направления экологических исследований анализируется биоразнообразие люмбрикофауны различных регионов мира. Дается обзор жизненных форм в свете современных эколого-физиологических исследований.

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Мекен ету ортасына байланысты кейбір омыртқалы жануарлардың тыныс алу жүйесіндегі ерекшеліктер

Мақалада кейбір омыртқалы жануарлардың тыныс алу жүйесінің құрылыс ерекшеліктері қарастырылды. Омыртқалы жануарлардың тыныс алу тәсілі мен типінің өзгерісі қан айналым мүшесінің қайта құрылуына әкеледі. Жүргізілген зерттеулер нәтижесі бойынша өкпе ауа жолдарындағы безді-секреторлы аппараттың функционалды дифференциациялану ерекшеліктері сол жануарлардың жалпы мүшелерінің жүйесімен коррелятивті тығыз байланысты. Ол әр түрлі топ жануарларының өкілдерінің экологиялық систематикалық жағдайынан көрінеді.

Кілтті сөздер: жануарлар, тіршілік, мүшелер, жүйе, ұлпа, сыртқы орта, абиотикалық факторлар, қосмекенділер, бауыр, эволюция, даму, дифференциация, эпителий.

Жануарлар тіршілігінде мүшелер жүйесі мен олардың атқаратын қызметі және осы мүшелердің ұлпалық құрылымдарының маңызы өте зор. Ендеше, сыртқы ортаның әр түрлі абиотикалық т.б. әсерлері ең бірінші жануарлардың тері жамылғысына әсер етіп қана қоймай, сонымен бірге басқа мүшелер жүйелеріне де өз ықпалын тигізеді. Өкпе организм мен сыртқы орта арасында газ алмасуды ғана қамтамасыз етіп қана қоймай, зат алмасу мүшесі бола отырып, жануарлардың түрлік және тұқымдық ерекшеліктерін, сонымен қатар олардың конституциясы және өнімділік сипатын құруда нәтижелі орын алады. Сол мүшелер жүйесінің ішінде теріден кейінгі сыртқы ортаның әсерін ауа арқылы қабылдаушы тыныс алу жүйесі болып табылады. Осы жағынан алғанда, тыныс алу жүйесін жануарлардың әр түрлі биотоптарда тіршілік етуін ескере отырып, зерттеу маңызды болып саналады.

Омыртқалы жануарлардың өкпесінің салыстырмалы морфологиясы, экология-биологиялық функциясы толық зерттелмеген. Әдебиеттерде негізінен омыртқалы жануарлардың өкпесінің ішкі архитектоникасының эмбриогенездегі дамуы мен қалыптасуы қарастырылған. Омыртқалылардың