



TAXONOMY AND BIODIVERSITY

- EUROPEAN OVERVIEW -

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May 2009

TABLE OF CONTENTS

Executive Summary	3
1 - Taxonomic Information: Strategy and Methods.....	6
2 - Taxonomy as a Basis for Ecological Research and Sustainable Management of the Biodiversity	17
3 - Taxonomy, Potential Users and Capacity Building of Experts	29

EXECUTIVE SUMMARY

This report is an overview on Taxonomy and Biodiversity based on the National Reviews on this topic received from various BIOSTRAT partners. The National Reviews were prepared as a contribution to the preparation for the Czech EPBRS (European Platform for Biodiversity Research Strategy) Meeting on “World Biodiversity and European Taxonomy – Strategies in Taxonomy: Research in a Changing World” to be held in Pruhonice between 19th and 22nd May 2009.

The organizing committee of the Czech EPBRS invited the BIOSTRAT partners to address a number of questions regarding different aspects of the relationship between Taxonomy and Biodiversity in their country. The questionnaire has three parts:

- Taxonomic information: Strategy and Methods
- Taxonomy as a basis for ecological research and sustainable management of the biodiversity
- Taxonomy, potential users and capacity building of experts

The main objective was to collect information on what the users of taxonomic information see as the main issues that taxonomists should focus on, as well as explore what taxonomists can offer to these users. The users targeted include managers and policy makers dealing with the Nature Directives, Water Framework Directive, and Marine Strategy Directive. Also a much wider group that includes Customs officials dealing with CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), or people responsible for environmental assessments, or coping with biological invasions, or assessing the impact of climate change, or dealing with ecosystem processes and ecosystem services, bio-prospecting, access and benefit sharing, or understanding disease and vectors.

We received fifteen questionnaires by the 7th of May 2009 from the following countries (Table 1): Austria, Belgium, Croatia, Estonia, Finland, Hungary, Ireland, Lithuania, Norway, Portugal, Russia, Slovakia, Spain, The Netherlands, and Ukraine. From United Kingdom, we received the Science and Technology Committee - Fifth Report, which was ordered by the House of Lords (July 2008). France delivered a draft of the questionnaire during the Czech EPBRS meeting, and it was not considered for the summary presented during the Czech EPBRS meeting.

The structure of the reviews followed the questionnaire provided. The partners addressed almost all the aspects requested but with a different degree of detail. Most of the answers were based on the knowledge of the person who was answering regarding taxonomic issues in their country and their field of expertise, and literature reviews and internet information were used. Some partners send the questionnaires to the relevant entities and persons in their countries in order to assess the subject of this reviews directly from those who work with and/ use taxonomy. Some differences and difficulties in interpretation of the questions were also found.

Most of the reviews did not present concrete measures to address the problems that taxonomists and taxonomy end-users are facing. Here we summarised the information found, and present some highlights and reflections for future discussion and research in order to be able to have and use the necessary taxonomic information to stop biodiversity loss and use its components in a sustainable way.

Table 1 – Questionnaires received.

Austria	Norbert Sauberer, VINCA (Vienna Institute for Nature Conservation and Analyses) Stefan Schindler University of Vienna, Department of Conservation Biology, Vegetation Ecology and Landscape Ecology
Belgium	Hendrik Segers, Freshwater Laboratory, Royal Belgian Institute of natural Sciences
Croatia	Toni Nikolić, Department of Botany, Division of Biology, Faculty of Science, University of Zagreb
Estonia	Tiiu Kull, Estonian Agricultural University
Finland	Jari Niemelä, Professor, Dean, Faculty of Biosciences – Department of Biological and Environmental Sciences
France	Preliminary information's delivered by Flora Pelegrin, Foundation for Research on Biodiversity, France
Hungary	Edition: Edit Kovács-Láng and Katalin Török, Institute of Ecology and Botany, Hungarian Academy of Sciences Technical edition: Eszter Székely-Bognár
Ireland	Louise Scally, Botanical, Environmental & Conservation Consultants Ltd
Lithuania	Eduardas Budrys, Institute of Ecology of Vilnius University
Norway	Erik Framstad, Norwegian Institute for Nature Research
Portugal	Marina Pereira Silva and Isabel Sousa Pinto, CIMAR - Centre of Marine & Environmental Research
Russia	Vladimir Vershinin, Russian Academy of Science, Institute of Plant and Animal Ecology
Slovakia	RNDr. Robert Kanka, PhD., Institute of Landscape Ecology - Slovak Academy of Sciences
Spain	Esteban Manrique Reol, Instituto de Recursos Naturales - CSIC
The Netherlands	Dr. A. van Opstal, secretary of the (Dutch) Biodiversity Platform-NI
Ukraine	Viktor Gasso, Dnipropetrovs'k National University
United Kingdom	Science and Technology - Fifth Report, House of Lords, 2008 ¹

The efforts to facilitate access to taxonomic information have grown in most countries, but there is still a lack of trained taxonomists available to assess biological diversity on the ground, to assist the end users of taxonomy. There is also a lack of financial resources.

Measuring progress towards halting the decline in biodiversity is a key international obligation, which cannot be achieved without baseline knowledge of biodiversity. Creating baselines and monitoring change is dependent upon the availability of taxonomic expertise across the range of living organisms¹.

¹ House of Lords (2008). Science and Technology - Fifth Report.
<http://www.publications.parliament.uk/pa/ld200708/ldselect/ldscitech/162/16202.htm>

The recommendations to ensure that the necessary knowledge and expertise in taxonomy are obtained and that access to this knowledge by taxonomists and by the users of taxonomic information and products is further developed can be summarised as following:

- To invest more in training and education of new taxonomists, supporting also training programmes in the early stage of education and for non-specialists.
- To invest more in preparation of checklist and databases, updating the existing ones.
- To increase the digitalisation of the national biological collections.
- To increase and improve the dissemination of the work carried out by the biological collections depositary.
- Increase the use of the taxonomists' knowledge and work in regional planning and conservation of habitats and species.
- Recognition of the importance of taxonomy in the prevention and control of invasions and introduction of indigenous / exotic species.

Following we will present the main contribution received from the BIOSTRAT partners. The full reviews sent by the partners can be found in the website of BIOSTRAT².

² <http://www.biostrat.org/>

1 - TAXONOMIC INFORMATION: STRATEGY AND METHODS

Inventory and Identification: “What is it, and how does it fit among its relatives?”

1.1 Does your country use taxonomy-based tools for biodiversity assessments and policy-making? What are these tools?

In all the country that presented a review, there is some use of taxonomy-based tools for biodiversity assessments and policy-making. The tools are mainly: data from professional taxonomists, naturalist societies, national taxonomic standards, red books/lists, online biodiversity data-based, ecological assessment tools, check lists, monitoring systems in place under Water framework directive (Portugal and Hungary, for example), and taxonomic surveys.

Ireland highlighted that such tools are not available for a wide range of taxonomic groups. While specialists use taxonomic tools to a limited extent in biodiversity assessment they would not be directly used in policy-making and their relevance, here would seem to be limited. The use of taxonomic databases has limited use for non-specialists who argue that most databases are too technical for their use. There is a need for more online databases with simple explanations and a variety of images at both species and sub-species level. In Ireland, this was found to be especially true for custom officials working on the implementation of CITES.

1.2 Does your country have a national species checklist? When it was last revised and updated? Is there any national assessment of which taxonomic groups in particular lack taxonomic information? Did you submit a response to the GTI questionnaire on these issues?

All the contributors stated that there were national check lists and online databases that cover various groups of organisms in each country.

The checklists are maintained and updated by several groups (museums, universities, research centres, governmental institutions, NGO, private enthusiasts) and the level of updating varies from country to country and depends on the activity and resources of each responsible institution.

Belgium, Austria and The Netherlands have a national assessment on which taxonomic groups' needs taxonomic information. On the other hand, Croatia, Estonia, Finland, Ireland and Portugal do not have that national assessment.

Austria, Croatia, Estonia and Belgium have submitted a response to the GTI (Global Taxonomy Initiative) questionnaire, but Hungary, Ireland and Portugal did not.

Ukraine is planning to do the national assessment in a near future as well as the response to the GTI questionnaire, since the Research Taxonomic Centre of Ukraine was established in 2008 in response to the GTI.

Under the Science and Technology Committee report¹, handbooks, identification keys and field guides are noted as highly important in the United Kingdom Taxonomic Needs Assessment. However, several species groups have never been covered by an identification guide and many existing guides are out of date due to nomenclatural changes, and to the influx of invasive species.

The production of identification keys and field guides is critical, especially in an environment of increasing numbers of invasive alien species, but in many groups of organisms - about half of all UK insects, for example - no field guides are available for the UK. There are several established and prestigious series, such as the Synopses of the British Fauna, the Royal Entomological Society handbooks and the Freshwater Biological Association keys, but the production of new guides is slow. The limiting factor is not the funding or marketing of the handbooks but the availability of taxonomic specialists willing to produce handbooks.

Understanding Patterns and Change: “Where is it, what’s happening to it, and where is it going?”

Describe 1-2 flagship projects related to bullet points below and suggest some recommendations useful for meeting as a result from these projects:

1.3 Please outline any national taxonomy-based monitoring or surveys designed to establish the distribution, status and trends of any taxonomic group.

Following, we present examples of projects regarding national taxonomy-based monitoring or surveys designed to establish the distribution, status and trends of any taxonomic group as they were indicated by the respondents.

In Austria the zoological recording is based on a 1’x1’ minutes system, and there is some work going on in relation to:

- Breeding birds: Atlas was published by Dvorak *et al.* (1993)³
- Dragonflies: Atlas was published by Raab *et al.* (2006)⁴
- Orthopterans: work in progress (Zuna-Kratky *et al.*, in prep.)

Since the seventies (but not yet published) vascular plants are mapped applying a grid of 5’x3’ geographical minutes (appr. 35 km²), and Austria has a share of 2 566 grid units.

The respondent from Belgium stated that there are no such national systems for Biodiversity monitoring in his country. However, several projects fit under this category and are implemented either by Federal Research Institutes or by Universities. For a partially updated overview is recommended to see the BioBel database⁵.

³ Dvorak M, Ranner A & Berg HM (1993). Atlas der Brutvögel Österreichs. Österreichische Gesellschaft für Vogelkunde und Umweltbundesamt Wien, 528 pp.

⁴ Raab R, Chovanec A & Pennerstorfer J (2006). Libellen Österreichs. Umweltbundesamt, Wien. Springer, Wien-New York, 345 pp.

⁵ <http://BioBel.biodiversity.be>

The area of distribution and estimation of the number of threatened individuals and narrow endemic species *Degenia velebitica* (Degen) Hayek (Velebit, Croatia) was done in Croatia. Trend to gorse with natural potential vegetation was detected on all regions. Results should serve as a background for tracking population trends and should serve as a background for the development of conservation action plans.

The examples indicated by Estonia are:

- Monitoring of endangered species,
- Atlas of the Estonian Flora,
- Estonian Breeding Bird Atlas,
- Estonian Red Data Book, and
- Distribution maps of Estonian fungi.

The Finnish research programme of deficiently known and threatened forest species PUTTE has responded to the deficiency of information, which became apparent during the assessment of the nation's forest species, and while planning forest protection. Based on that new information, the threatened status of 3 000 - 4 000 species not included in the preceding evaluation process of threatened species, was assessed⁶. The research programme PUTTE aims to improve the knowledge about deficiently known forest species in Finland. It is part of METSO - Forest biodiversity programme for Southern Finland.⁷

Several examples were presented by Hungary regarding national taxonomy-based monitoring:

- The Hungarian Biodiversity Monitoring System
- The Hungarian Light Trap Network for Forestry and Agriculture
- The Biodiversity Inventories of the Hungarian National Parks
- The development and maintenance of the National Plant Reference List & Ecological Flora Database of Hungary (FLORA 1.2)
- The development and maintenance of the CoenoDatRef Database of Hungary
- The Water Framework Directive Monitoring System
- The Development of the Natura 2000 monitoring project
- Szigetköz project: Impact of the Water Damming of the Danube
- Faunagenesis project: The origin and genesis of the fauna of the Carpathian Basin: diversity, biogeographical hotspots and nature conservation significance.

⁶ <http://www.ymparisto.fi/default.asp?contentid=267820&lan=EN>

⁷ <http://www.ymparisto.fi/default.asp?contentid=228996&lan=en&clan=en>

A number of national projects conducted through the Irish National Parks and Wildlife Service were designed to establish the distribution, status and trends of key taxonomic groups. However, to-date most of the information gathered is baseline data so that future conservation status can be monitored. This data is limited to a small number of species. These assessments are species based.

In Lithuania the national biodiversity monitoring program (a part of the national Environment Monitoring Program) includes monitoring of several taxa, mostly those included into the Habitat Directive Annex II, but also some exploited taxa (game animals, fish).

The Norwegian Taxonomy Initiative officially opened in January 2009, aiming to strengthen knowledge of species in Norway. Focus is on species groups where knowledge is poor. In addition, there is the MAREANO program in Norway, which maps depth and topography, sediment composition, contaminants, biotopes and habitats in Norwegian waters. The results of the surveys are available on the program website, visualised through maps.

As part of the Norwegian National Programme for the Surveying and Monitoring of Biodiversity, methods for surveying and monitoring red-listed species groups are under development. Several monitoring programmes for birds and mammals are already established.

In Portugal, some projects are undergoing:

- MACOI project - biodiversity database of Portuguese seaweeds: distribution, occurrence, geographic coordinates, taxonomic groups used (Class, Genus and Species).
- RECITAL II - project in implementation phase under Water European Framework.
- BALA project - Biodiversity of Arthropods from the Laurisilva of the Azores (1998-2005), under the coordination of the Azorean Biodiversity Group.
- PRO-BIO - profiling reliable organisms as bioindicators (An integrated approach for island systems).
- Consequences of land-use change on Azorean fauna and flora - the 2010 Target.

Lichen-diversity based tools are used for biomonitoring in Portugal. The information is collected at the regional level (with a 2 km sampling grid). Main project in this area is the ongoing project at SW Portugal. At north of Tagus river inventories were made at one location within Natural Park of *Serra d'Aires e Candeeiros*. To the south, all regions were evaluated except the Algarve.

The Botanical Institute of the Russian Academy of Sciences (BIN RAS) has developed the information system "Historia Gagearum"⁸ with the purposes of discussion and exchange of information on taxonomy and morphology of *Gageae Rouy* (Liliaceae).

⁸ <http://www.binran.ru/infosys/gagea/index.htm>

In Russia, there is some national taxonomy based surveys on amphibians to establish the distribution, status and historical trends in *Triturus*, *Rana* species, *Pelobates fuscus*, *Bufo viridis complex* (Borkin *et al.*, 2001⁹, 2002¹⁰, 2003¹¹, 2003a¹², 2004¹³; Litvinchuk *et al.*, 1998¹⁴, 2002¹⁵), the data on *Lacerta agilis* (Kalgabina *et al.*, 2001¹⁶; Grechko *et al.*, 2006¹⁷) phylogeography and taxonomy (Kupriyanova *et al.*, 2003¹⁸).

The Slovakian respondent referred the “Flora of Slovakia” since 1999 to present. And also, the European Distributed Institute of Taxonomy (EDIT) as the collective answer of 28 leading European, North American and Russian institutions to a call of the European Commission, issued in 2004, for a network in « Taxonomy for Biodiversity and Ecosystem Research »

In Spain, some singular studies about the relationship between some global change drivers and some plants and animals are being carried out¹⁹.

According with the respondent from the Netherlands, there is no single national monitoring or survey to establish the distribution, status and trends of taxonomic groups. Such tasks are mainly with the Netherlands Centre of Biodiversity and various private observation societies, the latter was organized at the national level within the VOFF (Organisation for Faunal and Floral Research). A flagship project is for instance Wil Tamis’ in depth analysis of “Changes in the flora of the Netherlands in the 20th century” (2005) which for the first time demonstrated climate change as a very significant factor affecting floristic composition in the Netherlands.

⁹ Borkin LJ, Litvinchuk SN, Rosanov JM & Milto KD (2001). Cryptic speciation in *Pelobates fuscus* (Anura, Pelobatidae): Evidence from DNA flow cytometry // *Amphibia-Reptilia*. 22, №4. P.387-396.

¹⁰ Borkin LYa, Pashkova IM & Litvinchuk SN (2002). The differences in thermoresistance of skeletal muscles between diploid and tetraploid species of green toad (*Bufo viridis complex*) of Central Asia // *Cytology*. 44, №3. P.259-262. (in Russian).

¹¹ Borkin LJ, Litvinchuk SN, Rosanov JM, Khalturin MD, Lada GA, Borissovsy AG, Faizulin AI, Kotserzhinskaya IM, Novitsky RV & Ruchin AB (2003). New data on the distribution of two cryptic forms of the common spadefoot toad (*Pelobates fuscus*) in Eastern Europe // *Russ. J. Herpetol.* 2003. 10, №2. -P.111-118.

¹² Borkin LJ, Litvinchuk SN, Rosanov JM, Lada GA, Ruchin AB, Faizulin AI & Zamaletdinov RI (2003a). Hybridogenious complex *Rana esculenta*: is it exists “Volga’s paradox”? // 3rd Conference of Povolzhie herpetologists. Regional conference materials. Tolyatti; Samara. P. 7-12 (in Russian).

¹³ Borkin LJ, Litvinchuk SN & Rosanov JM (2004). On a cryptic species (on an example of Amphibian) // *Zool. zhurnal*. 83, №8. P. 936-960 (in Russian).

¹⁴ Litvinchuk SN, Rosanov JM & Borkin LJ (1998) A case of natural triploidy in a Smooth Newt *Triturus vulgaris* (Linnaeus, 1758), from Russia (Caudata: Salamandridae) // *Herpetozoa*. 11, №1-2. P. 93-95.

¹⁵ Litvinchuk SN & Borkin LJ (2002). Distribution, ecology and conservation status of newt *Triturus dobrogicus* (Amphibia, Salamandridae) on the territory of Ukraine and Moldova // *Vestn. Zool.* 36, №3. P.35-44,99 (in Russian).

¹⁶ Kalgabina SA, Milto KD, Ananjeva NB, Legal L, Joger U & Wink M (2001). Phylogeography and systematics of *Lacerta agilis* based on mitochondrial cytochrome B gene sequences: First results // *Russ. J. Herpetol.* 8, №2. P.149-158.

¹⁷ Grechko VV, Fedorova LV, Ryabinin DM, Ryabinina NL, Chobanu DG, Kosushkin SA & Darevsky IS (2006). Molecular markers of nuclear DNA under investigation of speciation and systematic on example of lizards “*Lacerta agilis complex*” (Sauria: Lacertidae) // *Molec.biol.* 40, №1. P 61-73 (in Russian).

¹⁸ Kupriyanova LA, Zavyalov EV & Tabachishin VG (2003). Viviparous lizard *Zootoca vivipara* (Lacertidae) on the North of Nizhnee Povolzhie: cytogenetic analysis and reproductive ecology // 3rd Conference of Povolzhie herpetologists. Regional conference materials. Tolyatti; Samara. P.36-38

¹⁹ <http://www.mma.es/portal/secciones/biodiversidad/inventarios/inb/index.htm>

National taxonomy-based monitoring in Ukraine can be seen as multipoint studies of different areas and purposes, according to the Ukrainian contribution. Among them there are:

- The Annals of Nature, an annual data collection for assessment of state and trends of natural complexes of the nature reserve. The studies are carried out according to standardized programme and it is obligatory for the reserves.
- The design of a cadastre of animals and plants for particular regions and Ukraine in general.
- Phyletic and typological organisation of biodiversity of certain groups of contemporary and fossil biota at the territory of Ukraine. Taxonomical groups under research were *Collembola*, *Protura*, free-living *Nematoda*, *Gastropoda*, *Oribatida* and *Carabidae*. The leading organisation is the State Museum of Natural History of National Academy of Science of Ukraine, Lviv.

Projects related to distribution, status and trends of a particular taxonomic group are subjects of many dissertations in the field of zoology and botany in Ukraine. For example, for invertebrates this subject of the research averages 70% of all dissertations. Some groups – amphibians, birds, chiropterans and carnivores – are well studied at the regional level and partially at the national one. A study of taxonomic status, distribution and trends of vipers in Ukraine (Kotenko *et al.*, 1999²⁰; Újvári *et al.*, 2002²¹) may be considered as a good example. A great contribution has been made by scientists of the I.I. Schmalhausen Institute of Zoology of National Academy of Sciences of Ukraine²². Recently, an overview of the biodiversity monitoring programmes in Ukraine (Kostiushyn *et al.*, 2008²³) described 95 relevant programmes²⁴, and most of them involve taxonomists.

1.4 Is there any coordinated effort in your country regarding barcoding for identification or the assessment of biodiversity?

Partners from Croatia, Finland, Lithuania and Ukraine claim that there are no such efforts in their counties. In Austria, coordinated efforts are rarely use.

However, some examples were presented showing that there are some coordination efforts regarding barcoding for identification or assessment of biodiversity undergoing in Europe.

Use of molecular tools (beyond DNA barcoding) is becoming a standard technique in taxonomic research in Belgium, although a true coordinated effort is not present. Nevertheless, two federal research institutes (RBINS, RMCA) cooperate in the Joint Experimental Molecular Unit²⁵.

²⁰ Kotenko TI, Morozov-Leonov SY & Mezhzherin SV (1999) Biochemical genetic differentiation of the steppe viper (*Vipera ursinii* group) in Ukraine and Romania. In: 10th Ord. Gen. Meet. Soc. Eur. Herp.: Progr&Book Abstr. (Irakleio, 6–10 Sept. 1999). Irakleio: 88–90.

²¹ Újvári B, Madsen Th, Kotenko T, Olsson M, Shine R & Wittzell H (2002). Low genetic diversity threatens imminent extinction for the Hungarian meadow viper (*Vipera ursinii rakosiensis*). In: Biol. Conserv. 105: 127–130.

²² www.icfcst.kiev.ua/siz/depart/taxonomy/dept-proj-last.htm

²³ Kostiushyn VA, Andrienko TL & Melnichuk VP (2008) Overview of biodiversity monitoring programmes in Ukraine. Kyiv, National Ecological Centre Of Ukraine. 80 pp. (in Ukrainian and English).

²⁴ www.biomon.org/en/

²⁵ <http://www.jemu.be/>

Efforts were made in the frame of the Hungarian Project “Faunagenesis - The origin and genesis of the fauna of the Carpathian Basin: diversity, biogeographical hotspots and nature conservation significance” (NKFP B/023/2004). Theoretical and practical basis for barcoding of specimens in the Lichen Herbarium were studied in Hungary.

Molecular barcoding is used for a variety of taxonomic studies in Ireland, although there is no coordinated national effort in this regard. On the other part in Norway, a Norwegian Barcode of Life (NorBOL) network is established as part of the iBOL project.

For Portugal, two examples were indicated:

- A Marie Curie Post-Doc based on a project for the Azorean Vascular Plants, running at the Imperial College (UK).
- Integrating molecular approaches into marine biodiversity research in Portugal: implementing DNA barcoding and investigating phylogeographic patterns²⁶.

On 15 June 2005, the Russian Academy of Sciences take an important decision on forming the project entitled "Barcode for flora and fauna of Russia". This project is to continue the initiative by the world Consortium for the Barcode of Life (CBOL), established in 2004²⁷.

There is not a national coordinated effort for barcodes in Spain, but there are some individual projects and an informal platform for internal coordination for a possible future coordinated project. This topic in Spain is under discussion and only some scientists support it. Most of them have the opinion that this is a matter for biodiversity conservation managers. There were an attempt in organising the Spanish node for barcoding “HispaBOL” (Spanish Barcoding of Life), included or related to iBOL and ECBOL, but still unclear.

Barcoding in the Netherlands is coordinated in the framework of NBOL²⁸ (Barcoding of Life Netherlands). Increasingly DNA barcoding is being applied in identification and assessment, for example with respect to plant parasitic nematodes²⁹. The NCB, together with the CBS, aim to host the European node (EBOL) within these institutes for which initial funds have been allocated.

Examples of barcoding for identification or assessment of biodiversity can be found in Slovakia at the Institute of Botany³⁰ and the Institute of Zoology³¹ of the Slovak Academy of Sciences, and The Databank of Slovak fauna (DFS)³² a project maintained by the Department of Zoology Comenius University (Bratislava, Slovakia).

In the UK, there is substantial barcoding effort currently involved with diagnostics - that is, with identification. However, it is apparent that UK research on barcoding has slipped behind progress made elsewhere and the Wellcome Trust refers to an "apparent lack of collaboration between different barcoding initiatives which makes for significant confusion".

²⁶ http://www.fct.mctes.pt/projectos/pub/2006/paine1_result/vglobal_projecto.asp?idProjecto=69892&idElemConcurso=860

²⁷ http://www.informnauka.ru/eng/2005/2005-07-08-5_48_e.htm

²⁸ <http://www.dnabarcoding.nl/>

²⁹ <http://www.nem.wur.nl/UK/education/MSc+Thesis+Subjects/Plant+parasitic+nematodes/>

³⁰ <http://ibot.sav.sk>

³¹ <http://www.zoo.sav.sk>

³² <http://www.dfs.sk/>

The evidence received by the Science and Technology Committee¹ focused on plant pathogenic fungi, where barcoding effort comes from at least four teams (the Central Science Laboratory (CSL), the Scottish Crops Research Institute, Forest Research and the University of Reading). The CSL is a lead partner in an EU project to barcode statutory plant health pests and diseases. The development of barcoding technology represents an unprecedented opportunity to tackle the "taxonomic impediment" in mycology but these efforts require close co-ordination.

In UK the Science and Technology Committee¹ is concerned about lack of co-ordination of barcoding effort nationally and about the potential for duplication of effort.

1.5 Are you aware of any major efforts (or projects) in your country to integrate morphological and molecular taxonomy?

Some projects integrating morphological and molecular taxonomy are presented. Minor projects are ongoing especially under taxonomic research in universities, research institutions, museums and biological collections.

In the (former) Botanical Institute of Vienna (now Faculty Centre of Biodiversity), the integration of morphological and molecular taxonomy has a long tradition (Prof. Ehrendorfer, Prof. Stuessy, Prof. Hesse). Studies have been published or underway on e.g. *Ranunculus* (Hörandl, 2006³³), *Veronica*, *Orobancha*, *Achillea* (Ehrendorfer and Guo, 2006³⁴), Lemnaceae and Araceae (Hesse, 2006³⁵).

The research group lead by Elisabeth Haring and Anita Gamauf in the Museum of Natural History Vienna has a research focus on the integration of morphological and molecular taxonomy regarding the buteonine hawks (Kruckenhauser *et al.*, 2004³⁶), honeybuzzards (Gamauf and Haring, 2004³⁷) and other birds of prey especially in the Philippines (Gamauf *et al.*, 2005³⁸).

The respondent from Estonia indicated the following projects as examples of the efforts made in his country to integrate morphological and molecular taxonomy.

- Phylogeny and distribution of selected plant species and intra-specific taxa of the Baltic Sea region (project in University of Tartu).
- Taxonomy, molecular phylogenetic and ecological studies of basidio - and ascomycetes (including lichenized fungi) (project in University of Tartu).

³³ Hörandl E (2006): Evolution, phylogeny and taxonomy of the genus *Ranunculus* - integrative molecular and morphological studies from the population to the generic level. Universität Wien, Wien. Habilitationsschrift.

³⁴ Ehrendorfer F & Guo Y-P (2006): Multidisciplinary studies on *Achillea sensu lato* (Compositae-Anthemideae): new data on systematics and phylogeography. *Willdenowia* 36: 69-87.

³⁵ Hesse M (2006): Pollen wall ultrastructure of Araceae and Lemnaceae in relation to molecular classifications. In: Columbus JT, Friar EA, Porter JM, Prince LM & Simpson MG (eds) *Monocots III*. Rancho Santa Ana Botanic Garden, Claremont, California, 2003. *Monocots: comparative biology and evolution*. *Aliso* 22: 204-208.

³⁶ Kruckenhauser L, Haring E, Pinsker W, Riesing MJ, Winkler H, Wink M & Gamauf A (2004): Genetic versus morphological differentiation of Old World Buzzards (genus *Buteo*, Accipitridae). *Zool. Scripta* 33: 197-211.

³⁷ Gamauf A & Haring L (2004): Molecular phylogeny and biogeography of Honey-buzzards (genera *Pernis* and *Henicopernis*). *J. Zool. Syst. Evol. Research* 42: 145-153.

³⁸ Gamauf A, Gjershaug J-O, Rov N, Kvaloy K & Haring E (2005): Species or Subspecies? - the dilemma with taxonomic ranking of some South-East Asian hawk-eagles (genus *Spizaetus*). *Bird Conserv. Intern.* 15: 99-117.

- Systematic and molecular phylogenetic studies of selected taxa of basidio - and ascomycetes (including lichenized fungi), and autecology of fungal taxa important in agriculture (project in University of Tartu).
- Hybridization of the Greater Spotted Eagle *Aquila clanga* and Lesser Spotted Eagle *A. pomarina*, and its impact: analysis by molecular markers (project in Estonian University of Life Sciences)

In Hungary there are several projects integrating morphological and molecular taxonomy aiming population genetic and biogeography studies, using molecular taxonomy for identifying possibly new subspecies, identifying population genetic differences for phylogeographic pattern and nature conservation. The studies are carried out mainly at Hungarian laboratories, but sometimes international cooperation is also involved.

Some examples were indicated for Hungary:

- The Natura 2000 Monitoring Project;
- The origin and genesis of the fauna of the Carpathian Basin: diversity, biogeographical hotspots and nature conservation significance Project;
- The Reptilia-projects (*Bombina*, *Triturus*, *Rana*, *Podarcis*, *Vipera*, etc.);
- Projects for different species of conservation importance, such as: *Aquila heliaca*, *Otis tarda*, *Sicista subtilis*, *Nannospalax*, *Microtus oeconomus*, etc., Mollusca (*Kovacsia*, *Theodoxus*); Coleoptera (*Carabus*, *Dorcadion*, etc).

Ireland has a number of projects underway that integrate molecular and morphological information. Most of which are run by researchers within the university sector. The majority of work integrating morphological and molecular taxonomy is related to plant species.

The integration of molecular and morphological taxonomy is less advanced for other animal species and invertebrates. However, projects related to molecular phylogenetics and population genetics of marine invertebrates integrating both approaches are conducted at the National University of Ireland, Galway, while studies integrating molecular and morphological taxonomy in a limited number of mammal groups are conducted at University College of Dublin.

The respondent from Lithuania stated that no major efforts were made. Part of the ongoing taxonomic research, fulfilled by national universities and research institutes and subsidised by national budget, includes elements of integration of morphological and molecular taxonomy.

In addition, there are any major efforts in Norway. However, there are many minor projects doing this. A main problem is that research funding in Norway rarely opens for funding of taxonomic research.

The Barcode of Marine Life in Portugal is coordinated by the University of Minho. It is an international initiative to enhance the capacity of the European researchers to identify marine life by utilizing DNA Barcoding. A new technique for that uses a short DNA sequence from a standardized and agreed-upon position in the genome, as a molecular diagnostic for species-level identification.

In the Azores there is a project doing this for the Azorean Tarphius (Coleoptera) and Hipparchia (Lepidoptera) under the coordination of the Azorean Biodiversity Group.

For plants, there are projects at the general level in Portugal. The Herbarium of the University of Coimbra (COI) is involved in a project with the large genus *Vitex* (Lamiaceae) at a world level.

There are some surveys in Russian Federation aiming to integrate morphological and molecular taxonomy. One of the first attempts was made on vole species (Borodin and Rybnikov, 1988³⁹), and on the viviparous lizard - *Zootoca vivipara* (Kupriyanova *et. al.*, 2003⁴⁰).

Examples for Slovakia are:

- Phylogenetic relationships in the polyploid complex *Alyssum montanum* - *A. repen* (Brassicaceae). Duration: 2009-2012.
- Database of Chromosome Numbers of Pteridophytes and Flowering Plants of Slovakia (A Revised Chromosome numbers Survey of ferns and flowering plants of Slovakia will include a bibliography of the published chromosome data, critical revisions and revision of voucher herbarium specimens).
- Species Plantarum - Flora of the World: Cardamine and related genera, represents a complex of co-ordinated activities funded from various sources with an aim to publish Flora of the World in separate volumes dedicated to a single family or a group of genera.

The “Origin and evolution of morphological novelties in plant lineages - An approximation evo-devo” developed at the Royal Botanical Garden of Madrid (RJB-CSIC) is indicated as an effort made in Spain.

In the Netherlands efforts to integrate, morphological and molecular taxonomy were made in the National Herbarium (Plant molecular systematic, phylogeny and biogeography⁴¹) and the Fungal Biodiversity Centre (Evolutionary phytopathology⁴²).

A serious effort was made in the Ukraine to clearing taxonomy of Collembola, Protura and free-living nematodes Dorylaimida. The leading organisation of this project is the State Museum of Natural History of National Academy of Science of Ukraine, Lviv⁴³.

³⁹ Borodin AV & Rybnikov DE (1988). Evaluation of morphologic and molecular distances of voles subfamily (Mammalia, Rodentia) // Problems of macroevolution. Moscow. P.34 (in Russian).

⁴⁰ Kupriyanova LA, Zavyalov EV & Tabachishin VG (2003). Viviparous lizard *Zootoca vivipara* (Lacertidae) on the North of Nizhnee Povolzhie: cytogenetic analysis and reproductive ecology // 3rd Conference of Povolzhie herpetologists. Regional conference materials. Tolyatti; Samara. P.36-38

⁴¹ <http://www.nationaalherbarium.nl/taskforcemolecular/>

⁴² <http://www.cbs.knaw.nl/Research/Phytopathology.aspx>

⁴³ <http://museum.lviv.net/en/index.php>

Regarding the vertebrates in the Ukraine, the studies relating to the European pond turtle (Kotenko *et al.*, 2005⁴⁴), the green lizard (Böhme *et al.*, 2006⁴⁵) and the sand lizard (Kalyabina-Hauf *et al.*, 2004⁴⁶) may be designated. Considerable achievements were made in taxonomy of mice (Mezhzherin, 1998⁴⁷) and amphibians (Mezhzherin *et al.*, 1998⁴⁸).

According with the Science and Technology - Fifth Report¹, despite the power of molecular taxonomy, "it is important that molecular approach develops alongside the classical [morphological] approach". There is considerable concern about the risk of growing "sectoral separation" between professional taxonomists using molecular approaches and the conservation and volunteer communities who require the translation of taxonomic outputs into tailored products such as field guides and keys. The Committee recommends that NERC support research into developing an effective, functioning interface between rapid taxonomic techniques such as metagenomics and traditional morphological taxonomy.

⁴⁴ Kotenko T, Zinenko O, Guicking D, Sauer-Guerth H, Wink M & Fritz U (2005). First data on the geographic variation of *Emys orbicularis* in Ukraine: mtDNA haplotypes, coloration, and size. In: *Herpetologia Petropolitana*. Eds. N. Ananjeva and O. Tsinenko. Saint-Petersburg. 43–46.

⁴⁵ Böhme MU, Fritz U, Kotenko T, Džukić G, Ljubisavljevic K, Tzankov N & Berendonk TU (2006). Phylogeography and cryptic variation within the *Lacerta viridis* complex (Lacertidae, Reptilia). In: *Zoologica Scripta*. 36 (2): 119-131.

⁴⁶ Kalyabina-Hauf SA, Milto KD, Ananjeva NB, Joger U, Kotenko TI & Wink M (2004). Reevaluation of the status of *Lacerta agilis tauridica* Suchov, 1926. In: *Russ. J. Herpetol.* 11 (1): 65–72.

⁴⁷ Mezhzherin SV (1998). Mice – Muridae of North Eurasia: systematics and comparative molecular evolution. *Diss. Dr. Biol. Sc.*: 03.00.08. Kiev. 279 pp. (in Russian).

⁴⁸ Mezhzherin SV, Morozov-Leonov SY, Kotenko TI & Piontkovskaya EA (1998). Biochemical gene differentiation of newts (Amphibia, Salamandridae, Triturus) of fauna of Ukraine. In: *Reports of NANU*. 1: 193–197 (in Russian).

2 - Taxonomy as a Basis for Ecological Research and Sustainable Management of the Biodiversity

Ecological Functions and Services: “What does it do, and what does it interact with?”

How does taxonomic research contribute to better understanding of the functions and attributes of species, and to the management of biodiversity?

2.1 Do you know projects involving taxonomists in the understanding of ecological functioning, or the assessment of ecosystem services?

Examples were indicated, however the participation of taxonomists are still smaller than the participation of experts from other fields of investigations. For example, the respondent from Belgium stated that projects in which taxonomists are full and equitable partner in ecologic or ecosystemic research are rare.

Austria indicated the following examples of projects involving taxonomists:

- Integrated Monitoring of air pollution effects on ecosystems (Umweltbundesamt Vienna⁴⁹): experts for lichens, bryophytes and vascular plants have been involved.
- Wolfgang Wanek & Anton Weissenhofer (University of Vienna, Faculty Centre of Biodiversity): Terrestrial litter-trapping plants: Significance of above-ground nutrient scavenging by tropical understorey plants (Costa Rica), taxonomists and eco-physiologists are working together.
- BIOSERVE (University of Vienna, IFF Klagenfurt, University of Applied Life Sciences Vienna, and University of Sopron): Assessment of actual and potential landscape functions (nature conservation, agriculture, tourism) in the Pannonian lowlands involving experts of botany and zoology.

In Estonia, there are projects ongoing in the University of Tartu, under the “Frontiers in Biodiversity Research – FIBR”: 1 - Macroecology of biological diversity; 2 - Phylogenetic comparative ecology; 3 - Coevolution, ecological interactions and biodiversity

In Hungary, there are taxonomic surveys and biodiversity studies form the basis for the research work on ecosystem structure and functions in the frame of the Long Term Ecological Research Network - LTER Network. There are three functioning LTER sites, SIKFIKUT LTER site, KISKUN LTER site, and BALATON LTER site representing the main biomes of the country.

The examples indicated by Hungary are presented below:

- EASY - Evaluating current European Agri-environment Schemes to quantify and improve nature conservation efforts in agricultural landscapes.
- FAUNAGENESIS - The origin and genesis of the fauna of the Carpathian Basin: diversity, biogeographical hotspots and nature conservation significance.

⁴⁹ <http://www.umweltbundesamt.at/en/umweltschutz/oekosystem/im/>

- BioAssess - The Biodiversity Assessment Tools, under EU 5th Framework. The purpose of the project was the development of biodiversity assessment tools for inland terrestrial ecosystems, comprising sets of indicators of biodiversity, to assess the impact of policies on the changes in biodiversity in Europe.
- MacMan - Maculinea butterflies of the Habitat Directives and European Red List as indicator and tools for habitat conservation and management, under EU 5th Framework.
- Fauna Europe – NAS extension (FaEu-NAS). The main purpose is to accomplish the database of the terrestrial and aquatic invertebrate and vertebrate species, which inhabit Europe.
- BioCase - A Biological Collection Access for Europe. The main purpose is to develop computer software packages and data management (taxonomical, ecological, geographical thesaurus) tools for accessing the Biological Collections with the help of Internet.

In Portugal there are some efforts made. For example, under the Millennium Ecosystem Assessment the Azores (Portugal) have contributed with the publication “Ilhas Oceânicas” (Borges *et al.*, in press). In addition, some Portuguese researchers are participating in the Portuguese Macroalgae biodiversity and taxonomy and RECITAL II.

The lichens group from the Centre for Environmental Biology (Faculty of Science, University of Lisbon) use lichens-diversity as functional indicators in several projects.

The Herbarium of University of Coimbra (COI) is involved in a multidisciplinary project on high altitude grasslands in Portugal in which taxonomists and ecologists works on the understanding of ecological functioning. This project was initiated by taxonomists. However, such collaborations are not common in Portugal in the botanical world and, when they occur there is not a true collaboration between equal partners because ecologists simply require the identification of plants.

Scientists from the Botanical Institute of the Russian Academy of Sciences (BIN RAS) are cooperating in the framework of the "Panarctic flora" project⁵⁰. The site is devoted as result of the international project "The species concept in the High North - A Panarctic Flora Initiative", and further development of this project, and, mainly, researches of the international botanical collective on the manuscript of vascular plants of Circumpolar Arctic Region.

In Russia, there is an Interdisciplinary Expert Group (IEG) to assess the ecosystems of the Russian sector of Baltic Sea⁵¹. In addition, a program specific for the Caspian Sea Biodiversity Project is undergoing, the Caspian Sea Environment Program⁵².

The respondent from Slovakia indicated the LTER-Net (A Long-Term Biodiversity, Ecosystem and Awareness Research Network), the EUMON (EU wide monitoring methods and systems of surveillance for species and habitats of Community interest), and the GLORIA (Global observation research initiative in alpine environments), as examples of projects

⁵⁰ <http://www.binran.ru/projects/paf/index.htm>

⁵¹ <http://www.zin.ru/projects/ieg/index.html>

⁵² <http://www.zin.ru/projects/caspdiv/index.html>

involving taxonomists in the understanding of ecological functioning, or the assessment of ecosystem services.

On the other part, in Ukraine some taxonomical researches are usually used to prepare National reports for the Convention on Biological Diversity, Environmental Impact Assessment, and Nature protection management of biological diversity of a particular territory.

Example of projects involving taxonomists in the understanding of ecological functioning, or the assessment of ecosystem services in Ukraine are:

- Monitoring of natural community of coastline and overflow lands of the Danube Biosphere Reserve under resumption of deep-water ships' traffic "Danube-Black Sea" (from 2008);
- Transformation processes in the basin of the river Dniester (2000–2004). The project integrated taxonomical research aimed as indication of natural and anthropogenic processes including forest management in the Carpathians.
- BBI-MATRA project - Establishment of Ramsar sites in the Danube-Carpathian region of Ukraine. The project included taxonomical analysis of the bird communities.

2.2 What is the contribution of taxonomy in your country to the management of biological invasions?

Various examples were presented, and we can conclude that despite all the difficulties taxonomists are contributing for the identifications of the invasive species, terrestrial and marine, and producing checklists and contributing with important information for biological invasions management.

In Austria, Essl and Rabitsch (2002) published a recent and comprehensive synopsis of invasive species⁵³. While in Belgium taxonomists, provide identification services of potential or suspected invasive species^{54, 55}.

Two important publications were indicated by the respondent from Croatia as contributions from the Croatian taxonomists to the management of biological invasions in their country: "A preliminary check-list of invasive alien plant species in Croatia" (Boršić *et al.*, 2008⁵⁶) and "Alien flora of Croatia: proposals for standards in terminology, criteria and related database" (Mitić *et al.*, 2008⁵⁷).

All data about Estonian alien species are available from the taxonomy Database of Alien Species in Estonia⁵⁸ and The North European and Baltic Network on Invasive Alien Species (NOBANIS), a gateway to information on alien and invasive species in North and Central Europe⁵⁹.

⁵³ Essl F & Rabitsch W (2002). Neobiota in Österreich. Umweltbundesamt, Wien, 432 pp.

⁵⁴ <http://ias.biodiversity.be/>

⁵⁵ <http://www.europe-aliens.org/index.jsp>

⁵⁶ Boršić I, Milović M, Dujmović I, Bogdanović S, Cigić P, Rešetnik I, Nikolić T & Mitić B (2008). Preliminary check-list of invasive alien plant species (IAS) in Croatia. Nat. Croat. Vol. 17, No.2:55-71.

⁵⁷ Mitić B, Boršić I, Dujmović I, Bogdanović S, Milović M, Cigić P, Rešetnik I, Nikolić T (2008). Alien flora of Croatia: proposals for standards in terminology, criteria and related database. Nat. Croat. Vol. 17, No.2:73-90.

⁵⁸ <http://eelis.ic.envir.ee/voorliigid/eng/>

⁵⁹ <http://www.nobanis.org/>

Also, the respondent from Estonia present two publications as examples of the contribution of taxonomy to the management of biological invasions: Holm (2005)⁶⁰ and Eek and Kukk (2008)⁶¹.

In Finland, taxonomic knowledge is essential, but this type of research is more faunistic than taxonomic, as stated by the Finish contributor.

Hungary has several tools for detecting biological invasions. Problems were point out regarding the identification of new invasive species, especially with subtropical-tropical sea-grasses in the thermal waters, and recognized the need of implement regulation for the introduction of new species (e.g. for ornamental plant). This will lead to the need of risk analysis with correct taxonomic identification including their invasive behaviour in other parts of the world.

Some taxonomic workshops are conducted in Ireland, addressing the issue of taxonomic identification of alien invasive species for non-specialists and specialists alike. In June 2009, a training workshop on the identification of alien species within terrestrial, freshwater and marine habitats will be carried out under the Biochange project. In addition, the Invasive Species Ireland project is using museums and herbaria to verify records of invasive aliens.

In Ireland the Environmental Protection Agency funded Biochange project⁶² has developed a database of alien plants in Ireland containing detailed information on 716 alien plant taxa currently occurring in (semi-) natural habitats in Ireland (both the Republic and Northern Ireland).

The contribution from the Norwegian taxonomists is their participation in the development of the Norwegian Black List of invasive species. The former Biodiversity Research Program at the Research Council of Norway has funded some projects, e.g. on the invasion of macro-algae.

Portugal regulates the introduction of non-indigenous species of fauna and flora trough Decree-Law 565/99, of 21st December. The list of invasive species in Portugal, established under this regulation is now being revised. Other contributor that presents a specific regulation for this problem is Slovakia (Regulation nr. 24/2003 Z.z. - Ministry of Environment).

For Portugal examples of the contribution of taxonomy to the management of biological invasions are:

- MACOI website.
- Invasive Terrestrial Flora & Fauna of Macaronesia (Silva *et al.*, 2008⁶³). Azorean Biodiversity Portal.

⁶⁰ Holm B (2005). Biology, distribution and deterrence of invasive *Heracleum* species. Master Thesis. Estonian University of Life Sciences.

⁶¹ Eek L & Kukk T (2008). How to use invasive species <http://www.envir.ee/orb.aw/class=file/action=preview/id=1090211/voorliikide+kasutamise+kasiraamat.pdf>.

⁶² www.biochange.ie/aliernplants/index

⁶³ Silva L, Ojeda EL & Rodriguez-Luengo JL (eds.) (2008). Invasive Terrestrial Flora & Fauna of Macaronesia. TOP 100 in Azores, Madeira and Canaries. ARENA, Ponta Delgada.

- Project “INSPECT24 - Introduced marine alien species in Portuguese estuaries and coastal areas: patterns of distribution and abundance, vectors and invading potential” (2009-2011). The objective of the Project is to study the occurrence patterns of marine alien species in Portuguese estuaries and coastal zones, to evaluate environmental conditions prone to the establishment of potential invasive species and contribute to increase the public awareness on this threat. In the initial phase, all relevant information will be collected, with a consolidation of data and taxonomical validation.

In Russia, they have Project KRONAROS⁶⁴ directed to the evaluation of changes in biodiversity of a blood-sucking insects in selected regions of Russia under effect of geographical and anthropogenous transformations. Global changes in climate and character of land use in different regions determines the significance of the problem. Because of these processes, they have serious transformation of landscapes and vegetation cover. Now, within the framework of the project KRONAROS supported by the Russian Foundation for Basic Research (RFBR) is undergoing the project "Evaluation of blood-sucking insects' biodiversity changes and development of analytic database for their monitoring in Northwest of Russia".

The respondent from Spain indicated two web sites where we could find the contribution of taxonomy to the management of biological invasions:

- DAISIE - Delivering Alien Invasive Species in Europe (Region Factsheet – Spain)⁶⁵
- PHORON - *Grupo de Trabajo SEA en artrópodos exóticos e invasores*⁶⁶

In The Netherlands, taxonomists are part of the FES Project on research Infrastructure for Plant Health, coordinated by the Plant Health Service (Ministry of LNV). In this project, various consortia such as the Dutch Invasive Plant Species Consortium and the Invasive Insects Consortium are active.

The lack of funds in Ukraine makes the relevant studies fragmentary, as part of a large project and the country do not have a special programme of research and prevention of biological invasions.

2.3 What is the contribution of taxonomy in your country to efforts to understand the status and trends of key functional groups such as pollinators?

Further efforts to build and apply the skills of taxonomists to this area are required. Austria, Slovakia, Russia, Spain (few local studies), Belgium, Hungary, Estonia, The Netherlands, Croatia (very small and sporadic contributions) and Portugal mentioned some research to understand the status and trends of key functional groups such as pollinators.

⁶⁴ <http://www.zin.ru/projects/kronaros/index.html>

⁶⁵ <http://www.europe-aliens.org/regionFactsheet.do?regionId=SPA-SP>

⁶⁶ <http://www.sea-entomologia.org/PHORON/generales.htm>

In Austria there is an active group of entomologists in the biology centre in the Upper Austrian State Museums (head: Fritz Gusenleitner) with a special focus on the taxonomy of bees and wasps including their ecological functions as pollinators. At the University of Vienna, some research groups have focus on taxonomy and evolution of pollinators (Hannes F. Paulus, Tod F. Stuessy, and Anton Weber). An example of a recent study is presented by Schlüter *et al.* (2009)⁶⁷.

A related initiative to understand the status and trends of key functional groups is the one carried by the Belgian National Focal Point to the Global Taxonomy Initiative, which currently supports the production of a volume in the monographic series “Abc Taxa”, dealing with the bee genera of Africa. This volume, authored by a South African, a British and a Belgian taxonomist, is expected to be released in 2010. It will contribute to help the taxonomists in Africa to identify their bee fauna and as such better document the trends.

The European Social Fund (ESF) is supporting a project in the Estonian University of Life Sciences regarding “Foraging behaviour of pollinators in farmland: use of bumble bee colonies for increasing the seed yield of entomophilous crops”.

The Institute of Ecology and Botany of HAS (Hungary) as partner in the Field Site Network of the EU FP6 ALARM Project participated in geographically extensive but locally intensive studies of ecological interactions focusing on the effects of land use intensity on the status and trends of key functional groups.

In addition, distribution database and UTM maps on Bumblebee species (*Bombus Latr.*) are being developed in Hungary.

According with Irish partner, contribution of taxonomy to understand the status and trends of key functional groups in Ireland has been limited to-date. The “Biodiversity Knowledge Programme for Ireland” published in 2006 has highlighted the need for further research to improve basic understanding of how genetic, species and ecosystem ecology and processes together with the taxonomic needs to understand these processes influence the development and maintenance of biodiversity across a gradient of managed and natural ecosystems.

One of the main projects currently addressing this need in Ireland is the Trinity College of Dublin Insect Conservation and Pollination Research Group, which is examining insect biology and conservation (primarily focusing on pollinators such as bees) and on the interactions between these insects and the plants which they pollinate.

In the Netherlands, there are many permanent research activities on this matter, programmed and implemented in close cooperation with the organizations of beekeepers. Wageningen University has a special group for this research⁶⁸.

In Ukraine special projects on pollinators are not known. Nevertheless, there are some projects for other key functional groups: leaf-mining moth (*Acrocercops brongniardella*), entomophagous insects, and soil detritophagous.

⁶⁷ Schlüter PM, Ruas PM, Kohl G, Ruas CF, Stuessy TF & Paulus HF (2009). Genetic patterns and pollination in *Ophrys iricolor* and *O. mesarctica* (Orchidaceae): sympatric evolution by pollinator shift. Botanical Journal of the Linnean Society 159: 583-598.

⁶⁸ <http://www.bijen.wur.nl/>

Taxonomy, biodiversity and its conservation: “How to manage it in sustainable way?”

Describe 1-2 flagship projects related to bullet points below and suggest some recommendations useful for meeting as a result from these projects:

2.4 Are there also non-professional organisations recording biodiversity data collections (e.g. ornithologists) involved in the decision process of land-use planning etc.?

The level of involvement of non-professional organisations and NGOs recording biodiversity data collections in the decision process of land-use planning varies from country to country.

They all have various non-professional organizations and NGOs involved with data collection and recording. In most of the case, qualified personnel in voluntary base conduct the work. Ornithologists are the most referred. Hungary also refers bats, reptiles, amphibians, butterflies, molluscs, orchids and fungi.

According with the Norwegian contributor the results from these activities will only have an indirect effect on land use planning, especially where red-listed species have been recorded or where major species concentrations are found.

In Lithuania, the national biodiversity monitoring program used to involve the societies for implementation of monitoring, but after the start of Natura 2000, most of biodiversity monitoring became a duty of professionals (staff ecologists of protected territories). The societies like Lithuanian ornithological and entomological society accumulate and publish biodiversity data, but they are not directly involved in the decision making process of land use planning.

According with the Science and Technology Committee Report¹ UK is extremely fortunate in having a large corps of citizen biologists who are actively engaged in biodiversity issues. Volunteers run biological recording in the UK. The Committee received a range of evidence demonstrating the value of their contribution.

2.5 Are there some indicators (or red-list species) either for monitoring Natura 2000 sites or for delimitation and management of nature reserves used in your country?

Almost all respondents indicated the existence of indicators or red-list species in their countries for monitoring and delimitation and management of nature conservations sites.

The “Umweltbundesamt Vienna”, a programme for monitoring Natura 2000 sites in Austria with indicators is close to finalisation. In Belgium, there are the Brussels Red List, Flandres Red List, and Wallonia Red List.

In Croatia, the main indicators are red-list species and species and habitats listed for national territory in Bern convention and Habitat Directive. Vast efforts in building red list in the last decade results in excellent series of red books covering dragon flays, fungi, freshwater and marine fishes, mammals, plants and birds. The development of red lists is still going on to cover groups of Plecoptera, Lichenes, Carabidae, Anthozoa, etc. All these data and palette of other kind of data were used for spatial valorisation of the country.

The results are presented and concentrated in the National Ecological Network (NEN) and legislation prescribes the rules for land uses and conservation for NEN area. NEN is main background for Natura 2000 development during Croatian EU approaching process. Several monitoring projects started to be implemented as pilot projects.

“Natura 2000 lists” of selected plant and animal species exist in Hungary, which were used by nature conservation authorities and the national park directorates for the delimitation of Natura 2000 sites. Mammals, birds, reptilians and butterflies have to be mentioned among the animal species. Among indicator plants, rear species of the Pannonic Biogeographical Region can be found. The status and trends of these marker populations serve as indicator of the effectiveness of the management.

The National Parks and Wildlife Service conducts surveys and is developing red-lists of fauna and flora in Ireland. NPWS and the Environment Agency Northern Ireland are currently formulating All-Ireland red lists and books, which will include many more Irish species in need of conservation assessment. Red data lists and books are underway for the following groups: Molluscs, Mammals, Moths, Butterflies, Dragonflies Lichens, Bryophytes, and Seaweeds as well as an update of the Red Data Book on Vascular Plants.

On the other part, the Irish National Biodiversity Data Centre is currently facilitating the production of a Non-Marine Mollusc Regional Red List. When this is produced (June 2009), a suite of key Red List species will be identified for priority conservation action, including the identification and monitoring of designation sites. A similar process has been completed in relation to Irish Bees.

Usually, in Lithuania, presence of populations of red list species (which include also nearly all Habitat Directive Annex II and IV species present in Lithuania) are used for monitoring of Natura 2000 sites, including nature reserves (nearly all of them are Natura 2000 sites), delimitation of the reserves and sometimes for management of them.

The Norwegian respondent stated that, as Norway is not party to the Habitat Directive, there are no Natura 2000 sites and hence no monitoring of these. However, the occurrence of red-listed species and concentrations of other species is often important indicators for identification and prioritisation of conservation areas.

In Portugal, the Vertebrates of Portugal Red Book (Eds: Cabral *et al.*, 2006⁶⁹) coordinated by the ICNB and developed in narrow collaboration with the national scientific community was ended in 2006. This list updated the former Mammals, Birds, Reptiles and Amphibious Red book (1990), and Fresh Water and Migratory Fishes Red Book (1991).

Regarding the Marine and Estuarine Fishes the red book existent in Portugal is from 1993, so the information available is not updated.

The Red List of bryophytes of the Iberian Peninsula, Portugal, Spain and Andorra (Sergio *et al.*, 2006⁷⁰) was revised and updated in 2006.

⁶⁹ Cabral MJ, Almeida J, Almeida PR, Dellinger T, Ferrand de Almeida N, Oliveira ME, Palmeirim JM, Queiroz AL, Rogado L & Santos Reis M (eds.) (2006). Livro Vermelho dos Vertebrados de Portugal. Instituto das Conservação da Natureza, 660pp. Accessed through <http://portal.icnb.pt/ICNPportal/vPT2007/Valores+Naturais/Livro+Vermelho+dos+Vertebrados/>, 2009-04-21.

⁷⁰ Sergio C, Brugués M, Cros RM, Casas C & Garcia C (2006). Lista Vermelha dos Briófitos da Península Ibérica.

The first phase of the updating works of the Flora of Portugal Red List will be finished with the conclusion of the reference list of species to be classified, under the partnership established with the Association of Fitossociology - ALFA.

Officially, in Russian Federation the “chemical” approach for control and ecosystems transformation criterion predominates. That means underestimation of biological (and taxonomy) data for ecological monitoring, delimitation and management of nature reserves between decision-making people in Russia.

The Slovakian respondent indicated the publication Šeffler and Lasák (2004)⁷¹ as a response for this question. This publication includes the identification of taxa and habitats under the habitats directive, sources of information for identification of Natura 2000 sites, preparation of data for selection of SCIs, identification of the proposed sites of community importance (pSCIs), specification and adjustment of borders, references, annexes (lists of habitats and taxa with threshold values of coverage, maps of habitats and taxa, scientific proposal of Natura 2000 network).

The Spanish Ministry of Environment has developed a project on “National Inventory of Biodiversity” for the conservation of biodiversity that requires a prior knowledge about the distribution of habitats and wildlife. Moreover, it is also necessary to understand their state of conservation and the evolution of their populations, the most important areas to ensure their survival and provide for updating this. This project aims to achieve and maintain a long-term continuity of an inventory of Spanish biodiversity, structured in a series of Atlas, by taxonomic groups⁷².

In the Netherlands, taxonomists are involved in monitoring of habitat directive and red-list species in and outside nature reserves in the framework of national and European legislation that makes reporting on these species compulsory.

In spite of Natura 2000 is extended to the EU countries it is not implemented in Ukraine yet. Nonetheless, the Programme of integration of Ukraine into European Union presupposes development of the Emerald Network. It is an ecological network made up of “areas of special conservation interest”. Also, the “Biodiversity Indicators for National Use: Agrobiodiversity, Ukraine” project⁷³ resulting from the cooperation between the Ministry for Environmental Protection of Ukraine and UNEP World Conservation Monitoring Centre is undergoing.

2.6 Which taxonomy-related research (standardized taxonomic metadata, delivery of checklist building tools, building expertise network) in developing non-European biodiversity-rich countries is supported by policy-makers from your country based on your national expertise and experience?

We received contributions from Austria, Belgium, Hungary, Lithuania, Norway, Russia, Slovakia, the Netherlands and Ukraine that evidences the support give by their policy-maker, based on their national expertise and experience, to the taxonomy-related research in developing non-European biodiversity-rich countries.

⁷¹ Šeffler J & Lasák R (Eds.) (2004). Natura 2000 in Slovakia - Methodology for Site's Identification. Bratislava, 107p.

⁷² <http://www.mma.es/portal/secciones/biodiversidad/inventarios/inb/index.htm>

⁷³ www.ulrnc.org.ua/services/binu/index.html

In Austria, there are some examples of projects and individual contribution. These contributions are indicated below:

- Building expertise network: Hans Malicky founded research groups studying caddisflies (Trichoptera) in Thailand and Indonesia.
- Christian Schulze (Faculty Centre of Biodiversity, University of Vienna) conducts an annual three week field course in Indonesia. Indonesian and Austrian students are investigating biodiversity pattern (mainly birds and butterflies) along gradients of altitude and land use. Several Master and PhD thesis have emerged in both countries.
- Martin Wiemers (Faculty Centre of Biodiversity, University of Vienna) initiated a digitization project for biodiversity data in Papua New Guinea. GTI has funded this project.
- Walter Hödl (Department of Evolutionary Biology, University of Vienna) is cofounder and board member of the Tropical Biology Association (TBA) and directs plenty of taxonomy related research in mixed field courses, mainly about neotropical and African amphibians.
- The GLORIA project (Global Observation Research Initiative in Alpine Environments) led by Georg Grabherr (Faculty Centre of Biodiversity, University of Vienna) is related to mountain vegetation diversity and climate-change-related shifts in plant communities. The network contains 63 active study sites in five continents, and the project includes capacity building regarding methodological and taxonomical aspects⁷⁴.

The Belgium respondent indicated project Metafro⁷⁵ as an example of this type of support to the taxonomy-related research in developing non-European biodiversity-rich countries.

There are several cooperative projects coordinated and supported by the Hungarian Academy of Sciences research with countries like Taiwan, Korea, Vietnam, etc. Many taxa based studies were funded by Hungarian granting organizations for studying different groups of plants, animals all over the world or in the Palearctic region (Acarina, Nematoda, Coccoidea, Diptera, Heteroptera, some Hymenoptera, Lepidoptera, Rubiaceae, cryptogams). Zoological and botanical expeditions to South America, Tanzania, Cuba resulted in publications on local floras, world monographs on Acari, tropical bryophytes and other groups, Palearctic Catalogues, etc.

A wide spectrum of animal groups has been studied within the cooperation between Hungary and the three mentioned countries of South-East Asia different soil mites, myriapods, amphibians and reptiles, small mammals.

Some Lithuanian taxonomists are involved in taxonomic research in Mongolia and Peru, funded by international funds, but the Lithuanian policymakers do not support this research.

The contributor from Norway stated that there is very little support. Some is funded by funding set up for capacity building by Norwegian universities in developing countries (NUFU), e.g. in African countries. Norwegian development aid authorities have in general very limited interest in biodiversity-related topics.

⁷⁴ http://www.gloria.ac.at/res/gloria_home/

⁷⁵ <http://www.metafro.be/>

Based on Russian experience and national expertise the Russian Federation has developed some methods (standardized taxonomic metadata, delivery of checklist building tools) in countries of former Soviet Union. Now these countries are developing their own systems of national biodiversity monitoring and if cooperation is needed in the field of biodiversity control and conservation policy-makers from Russian Federation will support it.

In Slovakia there are projects related mostly to research of particular species or problems and for developing taxonomical tools. For example, the effect of light on development of the thoracic muscle and flight behaviour of tsetse fly (*Glossina pallidipes*), or the supply of tsetse pupae for tsetse eradication in Ethiopia.

There are various taxonomic projects in non-European biodiversity-rich countries supported from the Netherlands. These involve tropical terrestrial regions on all continents as well as marine environments. A few examples are:

- Flora Malesiana⁷⁶
- PROTA: Plant resources of tropical Africa⁷⁷
- Contribution to UNESCO support programme by ETI biodiversity centre⁷⁸

In Ukraine, the support was mostly devoted to the delivery of checklist building tools:

- South and Central America, South-East Asia – research of ants (Formicidae). Researcher Dr Radchenko A. G.
- Guatemala: taxonomy and distribution of dipteran (Insecta: Diptera: Tephritidae, Ulidiidae). Researchers Drs. Korneev V.O. and Kameneva O.P. (I.I. Schmalhausen Institute of Zoology of National Academy of Sciences of Ukraine).
- Experts in botanical taxonomy participated in international projects resulted in the editions “Flora of North America”, “Flora of China”, etc. (N.G. Kholodny Institute of Botany NANU).

2.7 Is there a National Needs Assessment of GTI in your country? If yes, what are your specific needs, e.g. for conservation, protected areas, CITES/customs, dealing with invasive species etc?

According with their response to the questionnaire Norway, Ireland, Ukraine, Portugal, Lithuania, Belgium and Croatia do not have a National Needs Assessment of GTI. Austria is developing the assessment and The Netherlands authorities are studying the need and possibilities for a national need assessment. It was impossible to say if Slovakia, Spain, Hungary, Russia and Estonia have an assessment since they did not answer the question. The partner from Finland does not know if there is an assessment in his country.

⁷⁶ <http://www.nationaalherbarium.nl/rhb/malesia.htm>

⁷⁷ <http://www.prota.org/uk/About+Prota/>

⁷⁸ <http://www.eti.uva.nl/products/catalogue.php>

The compilation of National Taxonomic Needs and Priorities (GTI, 2006⁷⁹) indicates the needs presented by each country in the national reports submitted under CBD. Based on this report we can know which country did present a GTI National Need Assessment:

- Some national taxonomic needs assessments made: Austria, Belgium, Norway, Spain, The Netherlands, UK
- No national taxonomic needs assessment made: Croatia
- Not submitted: Estonia, Finland, Ireland, Lithuania, Portugal, Russia, Ukraine
- No report on GTI, but national taxonomic needs assessment is under way: Hungary
- No national taxonomic needs assessment made, but assessment is under way: Slovakia

⁷⁹ <http://www.cbd.int/doc/programmes/cro-cut/gti/gti-needs-summary-en.pdf>

3 - Taxonomy, Potential Users and Capacity Building of Experts

Open Access to Information: “How to find out about it?”

How does taxonomic information get from where it resides to where it is needed elsewhere in the world?

3.1 To what extent is taxonomic research in your country contributing to international biodiversity initiatives and projects (e.g. GTI, GBIF, PESI, EOL)

All partners respond to the question showing that taxonomic research in each country is contributing to international biodiversity initiatives and projects. The level of contributions varies from country to country. In general, most of the country is contributing to:

GBIF - Ukraine, the Netherlands, Slovakia, Portugal, Norway, Finland, Austria, Hungary, Spain, Belgium, Ireland, UK

GTI - Ukraine, Slovakia, Belgium

PESI - Ukraine, the Netherlands, Slovakia, Belgium, Lithuania

EOL - Ukraine, the Netherlands, Belgium

There is no particular cooperation with international biodiversity initiatives and projects in Croatia and limit cooperation in Estonia.

The Hungarian Natural History Museum also participates, as partner in the consortium of the following initiatives: EDIT, CETAF and Synthesys.

According with Finland, although there is a lot of work to be done; only limited effort is provided now. The contributor from Finland also stressed the fact that GBIF and other similar projects are not extremely friendly for the users, which decreases the attractiveness of them.

GBIF-Austria currently provides about 3 million records describing the distribution of 40 000 native species of fauna and flora (incl. lichens) and fungi. The information is obtained by 16 Austrian databases. The available amount of records increases with a rate of about 100 000 data sets per year.

Regarding the Global Strategy on Plant Conservation (GSPC) two workshops have been organised by Michael Kiehn in the year 2008 (University of Vienna, Faculty Centre of Biodiversity). In total, 16 objectives were formulated regarding documentation, conservation and sustainable use of plant diversity.

Digitization of Botanical Collections in Austria (managing institution: University of Vienna) is under going with an emphasis on selected plant groups, that are highly relevant for ongoing international projects (Flora Hellenica, Fl. Iranica, Fl. of China, Fl. Neotropica).

The contribution of taxonomic research to international biodiversity initiatives and projects is well developed in Belgium. Belgian partners are active in PESI, 4D4Life (species 2000), ERMS (and WoRMS), EoL. The Belgian GTI national focal point is amongst the most active ones and the Belgian Biodiversity Platform is a very active GBIF node, with a digitization project call, and involvement in several projects (e.g., SCAR-MarBIN⁸⁰, FADA⁸¹). Other institutes are equally active in this field, e.g., the regional Flanders Marine Institute⁸² (VLIZ) is active as European OBIS node, and the Tervuren Museum for Central Africa has developed a portal for African biodiversity information⁸³.

Ireland became a full member of GBIF in 2008, and the National Biodiversity Data Centre has been established as the national GBIF node. The Centre is currently working on the portal to enable data to feed into GBIF.

The Melon foundation project at the University of Dublin, Trinity College supplies type specimens of vascular plants to the African Types Project. Algaebase at the National University of Ireland, Galway, provides information on algae at a Global level⁸⁴.

In Portugal, the MACOI database will be linked to the GBIF Portuguese node. The Portuguese Spiders database⁸⁵ is already associated with GBIF, and it is a data provider for GBIF in charge of the project “Iberian Spider Catalogue”.

Five Portuguese biological collections can be found in the GBIF data portal⁸⁶:

- Bryophyte collection and Lichen collection, Botanic Garden, National Museum of Natural History, University of Lisbon.
- Coimbra Collection of Algae (ACOI), University of Coimbra.
- Micoteca of Minho University Collection.
- Herbarium collection - Instituto de Investigação Científica Tropical.

According with the Norwegian respondent Norway substantially contributes to GBIF. About 3 million objects from 41 databases from 11 Norwegian institutions are available⁸⁷.

Taxonomic research in Russia is contributing to several international biodiversity initiatives and projects:

- World Wide Fund program for marine conservation in the Russian Far East⁸⁸;
- The Arctic initiative⁸⁹.
- A concept for the sustainable growth of traditional land use zones in Sikhote-Alin⁹⁰;

⁸⁰ <http://www.scarmarbin.be/>

⁸¹ <http://fada.biodiversity.be/>

⁸² <http://www.vliz.be/EN/INTRO>

⁸³ <http://www.metafro.be/>

⁸⁴ <http://www.algaebase.org/>

⁸⁵ <http://www.ennor.org/catalogue.php>

⁸⁶ <http://data.gbif.org/>

⁸⁷ <http://norbif.uio.no:8080/gbifmeta.php>

⁸⁸ <http://www.biodiversity.ru/publications/arctic/archive/n12/marine.html>

⁸⁹ <http://www.biodiversity.ru/publications/arctic/archive/n12/protokol.html>

⁹⁰ <http://www.biodiversity.ru/publications/arctic/archive/n12/sikhote.html>

- UNDP/GEF Project "Kamchatka Biodiversity Conservation"⁹¹.
- The Global Tiger Initiative⁹².

In addition, specialists from the ZIN RAS (Russia) are involved in:

- ArcOD - an international research program assessing and explaining the diversity, distribution and abundance of marine organisms throughout the Arctic Ocean⁹³.
- CAML - an international research program assessing and explaining the diversity, distribution and abundance of marine organisms throughout the Southern Ocean⁹⁴.
- CNAF (Computer Network for Arctic Marine Fauna) - a NATO Science Program where eight scientists from ZIN working⁹⁵.
- European project SaLLE - data-base of saline lakes and lagoons of Europe⁹⁶.

Slovakia has a GTI National focal point and it is member of the GTI co-ordination mechanism since 2001. Slovakia is carrying out the Implementation of the GTI Programme of Work, particularly at the European level within the frame of project EDIT.

The Slovak Republic became a full member of GBIF in June 2007. In this framework there are several activities contributing to international biodiversity initiatives.

1. Checklist of non-vascular and vascular plants of Slovakia. This checklist includes accepted names, synonyms, basionyms, substituted names, misidentifications, Slovak vernacular names and other additional information about taxa, such as status (native, introduced, cultivated, etc.), endangerment (IUCN criteria), endemism, and invasiveness. It consists of five indifferent parts (Cyanophytes, Algae, Fungi, Lichens, Mosses, and Ferns and Flowering Plants).
2. František Nábělek's Collection 1909-1910. Specimens from the area of Bahrain, Iran, Iraq, Israel, Jordan, Turkey). Unit data available via BioCASE Portal, BGBM, Germany.
3. Biodiversity collections. Metadata available via BioCASE Portal, BGBM, Germany.
4. Database of Chromosome Numbers of Pteridophytes and Flowering Plants of Slovakia. A Revised Chromosome numbers Survey of ferns and flowering plants of Slovakia will include a bibliography of the published chromosome data, critical revisions and revision of voucher herbarium specimens.
5. NaTaF - National Taxonomic Facility. The joint research and educational centre of Comenius University, the Slovak Academy of Sciences, J.P. Safarik University and Slovak National Museum.

⁹¹ <http://www.unkam.ru/english/>

⁹² <http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/ECAEXT/RUSSIANFEDERATIONEXTN/0,,contentMDK:21919207~menuPK:305605~pagePK:2865066~piPK:2865079~theSitePK:305600,00.html>

⁹³ <http://www.zin.ru/projects/arccoml/eng/index.html>

⁹⁴ <http://www.zin.ru/projects/ecoant/index.html>

⁹⁵ <http://www.zin.ru/projects/cnamf/index.html>

⁹⁶ <http://www.zin.ru/projects/saltlakes/default.asp>

In addition, Slovakia contributes to PESI through the participation of the Institute of Botany of Slovak Academy of Sciences.

In the Netherlands, taxonomic research is contributing to several international biodiversity initiatives and projects:

- Netherlands GBIF node⁹⁷
- PESI: Coordinated by the University of Amsterdam
- EOL: EOL-Netherlands, the first national EOL branch
- Flora Malesiana: Coordinated by the National Herbarium of the Netherlands
- Fauna Malesiana: Coordinated by the national natural history museum Naturalis
- Flora of the Guianas⁹⁸
- Flore du Gabon: Coordinated by the National Herbarium of the Netherlands
- Fauna Europaea: Coordinated by the University of Amsterdam
- LifeWatch: Coordinated by the University of Amsterdam
- NCB-partners in the taxonomic network of excellence EDIT
- NCB-partners and CBS participating in the EU-SYNTHESYS initiative.

The Ukrainian experts contribute to some international biodiversity initiative, for example GTI (CBD), “Fauna Europea”⁹⁹, and Checklist of the Collembola¹⁰⁰. There is no constant cooperation with GBIF, PESI or EOL. In general, the extent of Ukrainian contribution can be characterized as inadequate, according with the Ukrainian contributor. Potential abilities of the experts are much more considerable than used.

3.2 What is the state of the art in biodiversity informatics in your country? e.g. etaxonomy and e-science tools)

Almost all partners refer that there are progress, a lot of work has been done, and still there is a lot to do. Countries like Croatia, Estonia, Portugal and Ukraine says that funding is needed to organise all the system and digitalize the enormous amount of information that exists in their biological collections, museums, and research centres.

The respondent from Austria stated that recently there has been some progress. At least three homepages are now in function: ZOBODAT¹⁰¹ (mostly insects), Mycological database¹⁰², and GBIF Austria¹⁰³.

⁹⁷ <http://www.nlbif.nl/>

⁹⁸ http://www.bio.uu.nl/~herba/Guyana/Flora_of_the_Guianas/

⁹⁹ www.faunaeur.org/

¹⁰⁰ www.collembola.org

¹⁰¹ <http://www.zobodat.at/D/runD/D/cacheD/>

¹⁰² Austrian Mycological Society (2008). Database of fungi in Austria. Edited by Dämon W, Hausknecht A & Krisai-Greilhuber I. <http://www.austria.mykodata.net>

¹⁰³ <http://www.gbif.at/>

In Belgium the contribution of taxonomic research to international biodiversity initiatives and projects is highly developed. For example, initiatives like VLIZ, SCAR-MarBIN, and NeMYS¹⁰⁴. Several other, more isolated, projects are also installed and running.

Generally, there is a lack of organised contribution in Croatia. Beside the well done projects (see answer to question 3.6), there are on-line checklist for some groups, broad overview of museum collections, and small amount of information managed by some NGOs.

The National Biodiversity Information System (NBIS) is under development, Fauna Croatica Database as part and GIS support for biodiversity services. Main problems with this initiative are lack of funds and problems with data authorisation and copyrights.

There are some efforts made by the Natural History Museum of University of Tartu (Estonia). The Global Taxonomy Initiative is partly covered in Estonia. A national programme “Collections of humanities and natural sciences 2004–2008” was adopted in 2004, ensuring the allocation of funds from state budget. The more than 200-year-old Natural History Museum at the University of Tartu¹⁰⁵ can be seen as an umbrella institution for taxonomic activities in Estonia.

The activities relevant for GTI include the creation of the Estonian Species Index¹⁰⁶ and the related database. The Species Index is unique, as it contains all eukaryotic species of Estonia (over 22 000 species). A new version of the ESI, which is based on published research references, is being developed in cooperation with several institutions. The version of the web-based database (PlutoF 1.0) developed by the Natural History Museum of the University of Tartu within the framework of the national programme is available.

According to the respondent from Finland, the state of the art in biodiversity informatics in his country is rather good; probably one of the best in the world, but still there is enormous amount of work to be done in this field.

There are several taxonomy based tools, mainly databases, in Hungary belonging to the circle of biodiversity informatics. The Hungarian Nature Conservation Information System (NCIS) has the purpose of supporting the work of the Hungarian Nature Conservation Authorities at the Ministry of Environment and Water, the national park directorates and the green authorities.

In Ireland, significant developments in this regard have taken place in the last year. The National Biodiversity Data Centre has developed a state of the art online national mapping and data management system to display biodiversity data. This system will be launched in May 2009 and will be fully accessible to users.

A recently published interactive key to the flora of the Burren has been designed so that it can be expanded to cover the entire flora of Ireland in the future. The Irish Species Register¹⁰⁷ has also made significant contributions to e-taxonomy in Ireland.

¹⁰⁴ <http://nemys.ugent.be/>

¹⁰⁵ <http://natmuseum.ut.ee/390683>

¹⁰⁶ <http://unite.ut.ee/est/index.php>

¹⁰⁷ <http://species.ie/>

Some scientists maintain taxonomic databases used for their research in Lithuania. Having in mind that Lithuania is one of the few European countries that have no endemic species (except few “pseudoendemes” – the species described from Lithuania and not yet identified in other countries due to the lack of actively working taxonomists there at the moment), this country does not face special taxonomic problems and prefers to use results of taxonomic research done in other countries.

In Norway there is considerable amount of information on species through web-based tools such as Artsobservasjoner¹⁰⁸ (the public contributes observations of species occurrences), Artskart¹⁰⁹ (distribution maps), and GBIF¹¹⁰. Searchable databases on red-listed and alien species are also available at the Norwegian Species Biodiversity Information website¹¹¹. For molecular genetics and similar activities needing bioinformatics tools, the most commonly internationally used tools are available.

Biodiversity informatics is under development in Portugal, but it needs funding. Several laboratories in research institutions and universities use bioinformatics tools for research, namely concerning genetic data. Most of the research facilities have computers and internet access.

In 2006 FCT (Portuguese Foundation for Science and Technology) financed five projects (641.000€) for the network qualification and organization of biological collections¹¹².

According with the results of the Biocase inquiry carried out during the summer of 2006, based on the 94 collections recorded there are approximately 2,4 millions specimens, most of them (67%) of the flora domain, only 10% of the records are digitalized in databases¹¹³.

The action plan for the establishment of the GIBIF Portuguese node (Portuguese Infrastructures of Biological Diversity Information – GBIF.PT) was presented for appreciation to the Portuguese Ministry of Science, Technology and High Education (MCTES) in 2007.

In the Biodiversity collections index¹¹⁴ we can find information about 22 biological collections from Portugal, mainly herbariums and entomology (insects and spiders).

The Russian Zoological Institute of RAS (ZIN) – one of the leading institutions on zoological taxonomy in the world - has signed a state contract (in 31 January 2002) to perform research and skilled-design works on "Information system on a biodiversity" (ISBD). The main task of the project is the implementation of a program and data bases for animal and plant taxonomy, that will serve as base of information-search system (ISS) on Russia biodiversity that supporting non-uniform collections of information resources on systematic, collections and ecology.

According with the Slovakian contributor biodiversity informatics in Slovakia is at relatively high level. Almost all the important taxonomical information is available via internet and developed Access database tools.

¹⁰⁸ <http://www.artsobservasjoner.no/>

¹⁰⁹ <http://artskart.artsdatabanken.no/Default.aspx>

¹¹⁰ <http://www.gbif.no/>

¹¹¹ www.biodiversity.no

¹¹² http://www.fct.mctes.pt/projectos/pub/2006/Painel_Result/default2.asp?idElemConcurso=928

¹¹³ http://biomonitor.ist.utl.pt/gbif/media/outros/PlanoAccaoGBIF_PT.pdf

¹¹⁴ <http://www.biodiversitycollectionsindex.org/>

The respondent from Spain indicated the GBIF Spain web site¹¹⁵ to answer this question. There we can find the available tools for biodiversity informatics in Spain.

Organizations in the Netherlands have initiated and established various biodiversity informatics activities, i.e.: ETI biodiversity centre, European Network for Biodiversity Information, LifeWatch. All taxonomic institutes have staff in biodiversity informatics and hold substantial amounts of digitized specimen data, the majority available through GBIF.

The state of the art in biodiversity informatics in Ukraine is unsatisfactory, says the Ukrainian respondent. Though the relevant work is carried out, the progress is insignificant. As an example, there are e-version of the Red Data Book of Ukraine and the Cadastre of animals and plants of Ukraine. Unfortunately, due to lack of funds the last one is not accessible.

In what concerns the UK, the Science and Technology Committee¹ report find the rate of progress by the UK taxonomic institutions in digitising and making collections information available to be disappointingly low. Unless a more strategic view is taken of how they can contribute to the development of the field of biodiversity informatics, there is a significant risk of damage to the international reputation of major institutions such as the Natural History Museum.

<p>3.3 Has there been a national assessment of best practices for taxonomic data quality and validation?</p>
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There is no national assessment of best practices for taxonomic data quality and validation in Croatia, Ukraine, Portugal, Lithuania, Estonia, Belgium, Austria, Norway and The Netherlands. However, Dutch partners in EDIT and SYNTHESYS are actively involved in developing international best practices. The contributor from Finland does not know if there is such assessment in his country.

In the case of the Hungarian Nature Conservation Information System (NCIS) there is a Biotic Working Team formed by experts in taxonomy, biogeography, ecology and nature conservation that is responsible for regular updating and revising of Core Taxonomic and National Habitat Checklists. There are several checking schemes to control data quality at field surveys, habitat mapping and data input processing. The Hungarian National Advisory Board of experts supervises the Hungarian National Biodiversity Monitoring System.

For the respondent of Hungary a good international tool for taxonomic quality control is developed into EDIT WP6 (European Distributed Institute of Taxonomy – WP6: Unifying Revisionary Taxonomy on the Web). Taxonomic revisions are a fundamental part of science, and it is still the most time-consuming, difficult aspect to overcome. Thanks to new technologies, knowledge can be shared and work distributed to speed up taxonomic revisions, make them more reliable and more powerful. EDIT provides websites and communication channels to speed up and strengthen collaborative revisions.

In Ireland, the National Biodiversity Data Centre is developing standards for data collection and presentation, and guidelines documents have been produced setting Irish best practice. This programme of work will continue over the coming years.

There are three worldwide known national institutions on biological taxonomy in Russian Federation that contributes for the Russian national assessment of best practices for

¹¹⁵ <http://www.gbif.es/>

taxonomic data quality and validation: the Zoological Institute of RAS (ZIN) in St.-Petersburg, the Institute of Animal Systematics and the Ecology of the Siberian Branch RAS in Novosibirsk, and the Botanical Institute RAS (BIN) in Moscow.

In Slovakia the assessment is made according to particular taxonomical groups, stated the Slovakian respondent.

According with the Spanish contributor, assessment can be found mostly in Spanish in the GBIF Spain web site¹¹⁶.

3.4 Do you have any national guidelines on how to approach the proof of absence?

Twelve partners say that there are no national guidelines on how to approach the proof of absence: The Netherlands, Belgium, Austria, Norway, Ukraine, Portugal, Lithuania, Ireland, Spain, Croatia and Finland.

In this regard, Slovakia follows the IUCN criteria and Estonia uses the Estonian Red Data Book.

In addition, Hungary follows their red data book, the Hungarian Red Data Book¹¹⁷ that contains the extinct and endangered plant and animal species of Hungary. For species of plant recently extinct, the HBMS protocols require the revisiting of known occurrences of the endangered populations in a standard way each year (or at a defined frequency), and this also has to be recorded. Therefore, the absence of data in this case means that the population was not found despite the repeated field visits. This implies to certain animal species as well: e.g. souslik populations.

In Russia national guideline on how to approach the proof of absence results from the cooperation of scientific institutions with Federal and local legislation systems in the field of improvement of Red Data Books (Federal and regional) system and Federal service of supervision of nature usage for the best executive results.

3.5 What are the taxonomic standards used in the databases (TDWG, Darwin core, COL, PESI, etc.)?

Initiatives / Projects in almost all countries uses the taxonomic standards TDWG (Belgium, Croatia, Hungary, Russia, The Netherlands, and Slovakia); Darwin core is used in Hungary, Ireland (National Biodiversity Data Centre), and Portugal; Darwin 2 is used by MACOI database in Portugal as well as GBIF-Norway and Russia; The Netherlands (including PESI) and Hungary also uses GBIF Database.

There are no common standards between countries but also between initiatives within the countries:

Hungary - Digital Database of the Insects of Mongolia (DIDIM, 2004-2006).

Ireland - Other databases of taxonomic information have applied a variety of criteria, most of which are related to standard texts of the Irish flora and fauna rather than established international systems.

¹¹⁶ <http://www.gbif.es/formaciondetalles.php?IDForm=46>

¹¹⁷ The Hungarian Red Data Book (1989) contains the extinct and endangered plant and animal species of Hungary. Rakonczay, Z. (ed.) 1989. Akadémiai Kiadó, Budapest, Pp.566.

Lithuania - Fauna Europaea online database.

Slovakia - Brummitt & Powell, Authors of Plant Names¹¹⁸; Botanico-Periodicum-Huntianum¹¹⁹.

Norway - A national register with scientific and common names for Norwegian species will be available from June 2009.

Portugal - The Herbarium of the University of Coimbra (COI) uses SPECIFY, developed by the University of Kansas and it complies with all the taxonomic standards required by GBIF (TDWG, Darwin core, etc).

Spain – Indicated the software available in the GBIF Spain website¹²⁰.

The Russian national taxonomic standards used in digital description of animals collections of the Zoological Institute RAS and their metadata are presently Darwin Core, RDF, and Dublin Core Metadata Elements. The collection includes more than 100 000 samples of 26 000 species of sea invertebrates. For this purpose, the Institute (ZIN) developed IPS Ocean, Zoocode and Ecoant in format dBase. In the taxonomic database ZOOCOD were added field SYN, with synonymic taxa¹²¹.

In Russia, the experience of databases in ZIN RAN is developed as standard TDWG.3, taxonomic standards Darwin Core 2. The most widely deployed formats for biodiversity occurrence data are Darwin Core (wiki) and ABCD (wiki). New deployments of these and other XML based formats should use the TAPIR exchange protocol. The TDWG community's priority is the deployment of Life Science Identifiers (LSID), the preferred Globally Unique Identifier technology and transitioning to RDF encoded metadata as defined by a set of simple vocabularies. All new projects should address the need for tagging their data with LSIDs and consider the use or development of appropriate vocabularies.

According to the Ukrainian respondent, there are not any standards. Some databases have been designed according to the point of view of a particular expert. For example, databases “Collembolan of Ukraine”, “Proturan of Ukraine” and “Gastropods of West Ukraine” (State Museum of Natural History NASU, Lviv¹²²), databases of systematic collections including holotypes, paratypes and other types of vertebrates of the Zoological Museum of NSNM NANU¹²³ (Kyiv), and databases of systematic collection of Zoological Museum of the Dnipropetrovs’k National University and other Universities of Ukraine.

3.6 Could you identify the major digitization efforts for biodiversity data (e.g. collections, observations, species checklists)?

In spite of the problems with lack of resources (both human and financial) efforts for digitization of biodiversity data is evident in all countries.

¹¹⁸ www.ipni.org

¹¹⁹ www.ipni.org

¹²⁰ http://www.gbif.es/Recursos3_in.php

¹²¹ http://rcdl2008.jinr.ru/presentation/conf_hall/08_10_2008/Smirnov.ppt

¹²² <http://museum.lviv.net/en/index.php>

¹²³ www.museumkiev.org/index_main.html

In Slovakia the major efforts aims to complete digitization of botanical, zoological and microbiological collections. The checklists are available in both printed form and digital tools (Access and web databases).

According with Finish partner the “digitization at the museums is huge work”.

Large scale digitization efforts are continuously for The Netherlands. Major funding came from the national research council in 2005-2006.

The efforts implemented by Spain can be found in the web sites of GBIF¹²⁴ and GBIF Spain¹²⁵.

According with Götzl *et al.* (2003)¹²⁶ in Austria there are 46 531 024 surveyed collection objects, 8 712 965 of which are digitally recorded data (18,73 %). This collection are classified in: Agricultural living collections, Botanical living collections, Botanical specimen collections, Live animal collections in zoos, Zoological specimen collections, Microbiological living collections.

In Belgium the main taxonomic institutes develop activities in this field (see Metafro, DarWin¹²⁷, and others) supported by federal funding. The BBPF issues an annual digitization project call. The National Botanic Garden of Belgium also digitizes its herbarium and related collections¹²⁸. Regional activities exist; especially promising is the cooperation between the Flemish Institute for Nature and Forest Research (INBO¹²⁹) and the Flanders Marine Institute.

Flora Croatica Database, is the most advanced product in Croatia, covering national vascular flora from different aspects: check list, classification, nomenclature, vernacular names, synonyms, authorisation, followed by herbarium management, field observation, bibliography, mapping facilities and integrated GIS, ecological indices, on-line spatial analysis, red data, allochthonous taxa status, economic botany elements, etc. This database is fully Internet accessible.

Several other tools are available in Croatia:

- Habitats maps of Croatia in scale 1:100.000, fully Internet accessible.
- National Ecological Network in scale 1:100.000, fully Internet accessible.
- Land cover maps in scale 1:100.000, fully Internet accessible.
- Different capacity infrastructure geographically limited on several protected area as a management tools (LAN)
- Bio speleological database (LAN)

¹²⁴ <http://data.gbif.org/datasets/provider/57>

¹²⁵ http://www.gbif.es/Financiacion_in.php

¹²⁶ Götzl M, Abdel-Qader O, Ehrendorfer F, Geisler A, Kainz W, Kaufmann A, Kiehn M, Kraus G, Lödl M, Malicky M, Paumkirchner P, Rainer H, Schumacher F & Vitek E (2003). Die österreichischen Sammlungen und Datenbanken zur Artenvielfalt. Eine interdisziplinäre Studie im Rahmen der Global Biodiversity Information Facility. Bundesministerium für Bildung, Wissenschaft und Kultur, Wien 185 pp.

¹²⁷ <http://www.naturalsciences.be/darwin/>

¹²⁸ <http://www.biodiversity.be/bbpf/data/projects.html>

¹²⁹ <http://www.inbo.be>

- Database on big carnivores (lynx, wolf and bear) (LAN)

The Estonian digitization efforts for biodiversity data is illustrated by:

- Most of Estonian herbaria are just in the process of digitization, lichenological collection is digitalized already (eSamba)¹³⁰
- Lists of mosses and vascular plants and algae from Tartu University (TU)¹³¹
- Digitalization of collections of Estonian University of Life Sciences (TAA) is on half-way¹³²
- Database of fungal cultures¹³³

The Estonian Nature Observations Database¹³⁴ was created to enlarge people knowledge about the nature. This database was established for everyone to insert his or her own observations. Inserted data are used for composing species distribution atlas and others analyses. It means this database collects useful information about Estonian biodiversity. Information about observations of protected species is sent after inspection to the Estonian Environment Register. The Nature Observations Database has a map application, where one can find observations, borders of the Estonian protected areas and location of protected nature monuments. The Estonian Species Registry¹³⁵ is a database of Estonian and Latin names of taxa found in Estonia.

Estonia also has the Estonian Biodiversity Data Base. The goal of this database is to ensure and assess the quality of the biodiversity data. The main activities are the development of the unified Estonian species list using academic expertise on systematic of different groups of animals, plants and fungi (to ensure that the species are recognized and named correctly) and integrating biodiversity data from monitoring and field observations to the data base.

In Hungary, the existing and functioning monitoring systems are supported by digitized databases. The main biological data collection system is the Hungarian Biodiversity Monitoring System, which is in close connection with the National Conservation Information System (NCIS). The NCIS systematizes the primary databases of nature conservation, including biodiversity data of flora, fauna and communities of distinct spatial areas. Beside it supports to reveal trends and can create distribution maps. For ordering collected data and establishing systematized biological datasets, species checklists were developed.

Further main digitized datasets are the Flora Database, CoenoDat Database, Database of the Lichen Herbarium, the Bird Monitoring database, the catalogues of the Hungarian Molluscs, the Database of Protected Butterflies; the Aggtelek National Park Fauna etc. According with the Hungarian respondent this work requires informatics capacity and financial support, what is missing in most cases.

Species checklists have been developed in Ireland, notably for plants. GIS systems exist for many plant records, in particular for Invasive Alien Species.

¹³⁰ <http://natmuseum.ut.ee/401730>

¹³¹ <http://natmuseum.ut.ee/388856>

¹³² <http://kogud.emu.ee/?do=coll&id=11>

¹³³ <http://erast.ut.ee/temp/cfungi/>

¹³⁴ <http://eelis.ic.envir.ee/kaart2/index.php?topic=1&meny=ENG&subtopic=2>

¹³⁵ <http://unite.ut.ee/est/index.php>

The following checklists have been digitised: Craneflies of Ireland, Irish pseudoscorpions, Irish harvestmen, Irish chalcids (Hymenoptera), Microlepidoptera, Irish Topographical Botany (Praeger), and Irish Vegetation Data. Additional digitised databases of the following taxa have also been compiled by various organisations: Bats, Birds, and Vascular plants.

The Irish National Parks and Wildlife Service have created an online mapping system for species records from key datasets and reports held by NPWS. Species records are accurate to 1 km² level, after that there may be errors due to different map scales being used to calculate the grid references. Many were calculated before the widespread use of GPS. All records within the database are specific to the date of recording and do not necessarily imply the continuance of the species at that site.

On the other hand, in Lithuania the collection data are digitised during the research process by scientists, and they keep these collections in their research institutions (e.g.: herbaria in universities and Institute of Botany, vertebrate collections in the Tadas Ivanauskas zoology museum, and invertebrate collections in universities and Institute of Ecology).

A lot of effort, made by Norway, has resulted in full or partially digitalization of some major collections. Funds come from the Norwegian Biodiversity Information Centre, GBIF, Revita and other sources. More funding is needed to digitize all existing collections.

In cooperation with GBIF, the Norwegian Biodiversity Information Centre has introduced a map service on internet¹³⁶. The service Artskart (Species Maps) allows you to search databases located in 20 different scientific institutions, simultaneously. The databases so far contain data on 6 million species locations. 17 500 species are so far represented. More data will be added to the service in the years to come.

In Portugal there are some examples, but there is a need of human and financial resources to digitalize all the available data that exist in the Portuguese institutions (collections, museums, and laboratories).

- Digitization of historical herbarium COI - Phycological Collection. Recently a project was submitted to FCT (Portuguese Foundation for Science and Technology) for financing. COI has c. 800 000 specimens and has digitized 45 884 specimens until now.
- Collections and observations of marine crustaceans.
- Work done at the Botanical Garden of the University of Lisbon.
- The ATLANTIS project, which generated the list of species of all Macaronesian archipelagos (Canary, Cape Verde, Madeira-Selvagens and the Azores).

¹³⁶ www.biodiversity.no

The major digitization efforts for biodiversity data on collections and observations are only now under construction in Russia, because of huge volumes of collections, lack of financial support and specialists on digital technologies. The data on rare and disappeared species of Russia (species checklists) are accessible for any user on the Institute of Problems of Ecology and Evolution¹³⁷ (IPEE) RAS website in Moscow. This institute developed information system with database from two parts: 1 - Red Data Book of Russian Federation (animals) with 434 species; 2 - Red Data Book of Russian Federation (plants) with 533 species.

The corresponding efforts for biodiversity data in Ukraine may be pointed out by digitization of zoological museum's collections and herbaria. Scientific Collections of the I.I. Schmalhausen Institute of Zoology NASU illustrates some advancement in that field: Systematic, Holotypes, Paratypes and other types collections: Protozoa, Plathelminthes, Acanthocephala, Nematelminthes, Annelida, Mollusca, and Arthropoda: Crustacea, Collembola and Insecta, Arachnoidea. Unfortunately, through the Internet you have access only to stored numbers of specimens of the groups, but not to the particular species or its descriptions.

There are several different scientific collections in Ukraine, but the digitization is at the beginning of implementation. Following we present some examples indicated by the Ukrainian respondent:

- Information Taxonomy System (soil and fossil fauna) in the State Museum of Natural History NASU, Lviv¹³⁸
- E-checklist of species (Oribatida, Gastropoda, Carabidae, Buprescidae, Collembola, Protura, Ephemeroptera, Trichoptera) of Ukraine or several regions.
- Crimean Malacological Site¹³⁹

In the United Kingdom the Science and Technology Committee¹ report welcomes the progress of the Linnean Collection digitisation project with its 17 000 images of plants and 27 000 images of insects already available on the web, and the success of RBG Kew in obtaining substantial funding from charitable trusts, such as the Andrew W. Mellon Foundation, to support digitisation projects for African and Latin American plants. However, the lack of core funding and the consequent reliance on external charitable sources have resulted in the major UK taxonomic institutions being slow in making collections data available over the Internet.

3.7 Is there any effort in your country to make taxonomic information especially identification services easily accessible and useful to practitioners?

Efforts to make taxonomic information and especially identification services easily accessible and useful to public vary from country to country and more work in this field is needed.

In Austria, there is no particular effort that goes beyond conventional field guides. The most convenient field guides in German language are usually published in Germany.

¹³⁷ www.sevin.ru

¹³⁸ <http://museum.lviv.net/en/index.php>

¹³⁹ <http://malacology.crimea.edu/?Lang=ENG>

Also in Lithuania, there is no special effort, as taxonomy is considered part of research in the field of biomedical and environmental sciences. Some products of this research are monographs (e.g. series “Fauna of Lithuania”) and other publications with identification keys, field guides, etc.

On the other hand, there are some ongoing projects now in Finland. In Belgium is being produced an online identification tool under SCAR-MarBIN project and several other, more isolated, projects are also implemented and running¹⁴⁰. The Biodiversity Data Centre from Ireland has established a programme of taxonomic identification workshops in 2009, and the plan is to develop and enable identification tools available online.

For Slovakia, “there are good links between scientific taxonomical information and readable and understandable outputs for practitioners”.

The Science and Technology Committee¹ report recommends that the UK taxonomic institutions with major biological collections should develop strategic plans for making biodiversity informatics more readily accessible to users through the Internet, and that the Department for International Development should fund, selected digitisation projects that focus on the biodiversity conservation and sustainability needs of developing countries.

In Croatia, there are guidelines for inventory and mapping, separately for flora, habitats, sea habitats, and bats, with instruction for recognizing the target species. These guidelines are available as hard copies free of charge and internet available for downloads. In addition, an image gallery as an identification tool inside Flora Croatica Data base is available for download in the internet. The publication of “Botanical Library” series have started, and up to now two titles have been published, covering flora of continental forests and coastal and islands flora on popular manner.

Estonia is participating in KeyToNature project¹⁴¹, which enables producing identification keys also in the Estonian language. This project is described as a new e-way to discover biodiversity. The project mobilizes 14 partners from 11 EU countries, including leading centres in biology, pedagogy, education, and information technology.

The Database of correct Latin and Estonian names of vascular plants is available via internet - the Index of Estonian Plant Names¹⁴². The Commission of Botanical Terminology of Estonian Naturalists Society improves it, and it was updated in March 2009.

Estonia also have classical printed key-books of Estonian vascular plants, mosses, lichens, fungi, fishes, butterflies, birds, insects etc.

In Hungary there is an email-based identification service run by the Zoological and Botanical Departments of the Hungarian Natural History Museum, covering the following groups: vertebrates, invertebrates, cryptogams, conifers and flowering plants. On several points of the capital and the major cities of Hungary regular identification service for mushrooms is operating in the summer periods with the aim of preventing poisoning.

According to the Norwegian contributor, a validating service for species observations will be available for Norway, in the next version of Artsobservasjoner (the Species gateway for field observations).

¹⁴⁰ www.abctaxa.be

¹⁴¹ http://www.keytonature.eu/wiki/Main_Page

¹⁴² <http://www.ut.ee/taimenimed/>

For Portugal, one of the examples is the new tools for the identification of Azorean Spiders available in the Azorean Biodiversity Portal¹⁴³ and in the publication Mendonça and Borges (2009)¹⁴⁴.

In Russia, there are information resources on collections, ecology and taxonomy of some systematic groups and species, identification services accessible on ZIN RAS website¹⁴⁵ and can be easily used by practitioners. Some of these resources are:

- Information System ZooInt (ZOOlogical INTegrated retrieval system), for gathering author's projects on animal systematics¹⁴⁶.
- ZINSECTA - an interactive database of World Insects fauna taxonomy¹⁴⁷. Information System ZInsecta, for gathering author's projects on insect systematic and structure of entomological collections.
- PICKEY - an interactive multi-entry polychotomous key for identification of organisms by intensive use of images¹⁴⁸.
- WebKey-X - an interactive identification program for Internet users¹⁴⁹.
- Botanical Institute RAS (BIN) developed Guide to main collections of the LE herbarium¹⁵⁰.
- The Botanical Institute (BIN) RAS developed the “Checklist of the Panarctic Flora (PAF) Vascular”¹⁵¹ including English version, Palynological Laboratory Database¹⁵², Checklist of fungi and lichenicolous fungi of the Russian Arctic¹⁵³, database of the lichens of the Russian Arctic¹⁵⁴, flora of Chukotka mosses¹⁵⁵, herbarium of lichens – type collection¹⁵⁶.

Easy access of identification expertise, in the Netherlands, is promoted by the ETI biodiversity centre¹⁵⁷ and developed by specialists of the NCB (e.g. Plant Families of Malesia, www.InsideWood interactive wood identification online, etc.). Moreover, the websites and organizations mentioned above as VOFF, PGO’s.

¹⁴³ www.azoresbiportal.angra.uac.pt/

¹⁴⁴ Mendonça E & Borges PAV (2009). Images of Azorean Spiders with details for male and female identification v. 3.0. Univ. Azores, Angra do Heroísmo. http://www.azoresbiportal.angra.uac.pt/files/noticias_Preview%20of%20Images%20of%20Spider%20Identification%20v3.0.pdf

¹⁴⁵ www.zin.ru

¹⁴⁶ <http://www.zin.ru/projects/zooint/zoointw/zoointw.asp>

¹⁴⁷ <http://www.zin.ru/projects/zinsecta/index.html>

¹⁴⁸ <http://www.zin.ru/projects/pickey/index.html>

¹⁴⁹ <http://www.zin.ru/projects/webkey-x/indexe.html>

¹⁵⁰ <http://www.mobot.org/MOBOT/Research/LEguide/>

¹⁵¹ <http://www.binran.ru/infsys/paflist/index.htm>

¹⁵² http://www.polba.binran.ru/new_site1_5_eng/

¹⁵³ http://www.binran.ru/infsys/ra_fun/index.htm

¹⁵⁴ http://www.binran.ru/infsys/ra_lich/index.htm

¹⁵⁵ <http://www.binran.ru/infsys/chubrio/index.htm>

¹⁵⁶ http://www.binran.ru/infsys/li_type/

¹⁵⁷ <http://www.eti.uva.nl/>

On the other hand, there are no special efforts in Ukraine to make identification services easily accessible and useful to practitioners. For the practical needs the special service exist in the Ministry of Agrarian Policy of Ukraine, Ministry of Health of Ukraine and State Forestry Committee of Ukraine. In general, practitioners may apply to any state Institute or University for a consultation, but the built system does not exist.

Capacity Building in Biodiversity-rich Countries and Worldwide

What is the state of training and education in systematic and are there any gaps in capacity?

3.8 Are there any policy initiatives in your country to orient capacity building in taxonomy?

Capacity building is a key question in almost all countries, in general taxonomy training programmes are being carried out at university level, and taxonomy training at early stage of education (secondary school) is scarce as well as training programmes for non-specialists.

There are no policy initiatives to orient capacity building in the following countries: Estonia, Slovakia, Hungary, Belgium, Ukraine, Lithuanian and Portugal.

According with the Belgian partner EDIT has recently made a detailed evaluation of the European training offer¹⁵⁸.

In Finland, the PUTTE research program of poorly known taxa is ongoing.

The situation in Norway is about to change, hopefully, with implementation of the Norwegian Taxonomy Initiative, e.g. by establishing a research school in biosystematics.

The Netherlands Centre of Biodiversity (NCB) aims to provide taxonomic training at BSc, MSc and PhD level for the universities of Amsterdam, Leiden and Wageningen.

In Croatia, as stated by the Croatian contributor, policy initiatives to orient capacity building in taxonomy exists as a proclamation but formally no. Inside the National Strategy and Action Plans for Biodiversity and Landscape Conservation there are several broadly defined action plans covering the taxonomy issues, but without performance tools or allocated funds. None of these plans was performed.

The main problems in Croatia are:

- Related to the activities in taxonomy that are not “pure” science (i.e. building up determination keys, e-floras, maintaining data bases, standard floras, mapping activities, etc.). The Ministry of Science does not fund these activities because it is not “pure science”. In the same time for other potential funder all, these activities are “too scientific”. Main producer (universities, institutes) are not capable to cover costs for these activities from national resources.
- Related to staff in taxonomy. 80% of taxonomists work on universities and institutes where there are forced to publish papers with as high as possible SCI, IF, CC, leaving no time to work on fundamental issues (floras, faunas, atlases, etc. ...)

¹⁵⁸ <http://www.e-taxonomy.eu/node/150>

As a result, from the problems indicated above there are no floras, keys, atlas, popular literature, etc.

In common with many countries worldwide, there are enormous gaps in taxonomic capacity in Ireland. The situation has been highlighted in a number of reports including the “Biodiversity Knowledge Programme for Ireland” published by the Irish National Platform for Biodiversity Research. While there are a number of specialists for particular taxa, the taxonomic capacity across a wide range of taxa is very low.

Taxonomic training within the third level sector in Ireland is extremely low and while a number of initiatives to train non-specialists in the identification of key taxa have commenced it is unlikely that the level of training currently envisaged will assist in filling the enormous gaps that exist without specific policy objectives and funding to address the problem.

All initiatives to build capacity in taxonomy have been driven by the research sector rather than through policy initiative. The “Biodiversity Knowledge Programme for Ireland” a report compiled by the Irish National Platform for Biodiversity Research has highlighted the need for policy to implement a programme for capacity building in taxonomy in Ireland. Unfortunately, this has not been acted on by policy.

In Portugal, mainly the University of Madeira has carried out training programmes on marine taxonomy for graduated, MSc and PhD students. MSc and PhD projects have been developed at University of Madeira, often in collaboration with local institutions, focused on MPAs, threatened and/or endangered marine species (including birds, cetaceans, monk seal and turtles), and other marine resources (phytoplankton, fish stocks). Some genetic monitoring is carried out in some *Pterodroma* species populations, marine turtles and cetaceans. Involved institutions: Regional Fisheries Directorship, Funchal Marine Biology Station, Whale Museum, Funchal Municipality Museum, University of Madeira¹⁵⁹.

The Russian contributor stated that it is possible to say that Russian Federation it is passing by a period of recent developments characterized as utilitarian approach to environmental management. Russia's response to the recent World Summit on Sustainable Development (WSSD) is assessed in the broader context of the country's problems in producing major environmental policy changes.

According with the Science and Technology Committee¹ report there are several UK Masters courses in systematic biology and taxonomy, some involving partnerships between universities and research institutes, such as the University of Edinburgh and RBG Edinburgh, and Imperial College and The NHM. Masters courses are typically broadly based and produce a pool of new postgraduates each year trained in the basics of systematic biology. There is a substantial number of PhD projects based in the UK that "tick the box" for having at least some component of taxonomy, but only in a minority of these is the primary focus on descriptive or revisionary taxonomy. At this higher level of the PhD or post-doctoral fellowship, it appears from the evidence of Dr Alastair Culham of the Centre for Plant Diversity and Systematics at the University of Reading that it is common for qualified taxonomists to leave the UK because career paths are much stronger abroad.

¹⁵⁹ <http://www.cbd.int/doc/world/pt/pt-nr-vmc-en.pdf>

In order to promote awareness of environmental sustainability as an over-arching issue, the Science and Technology Committee¹ report consider that, as a matter of high priority, a greater component of biodiversity-related topics, including taxonomy, should be included in the school curricula. Field study trips and other practical exercises, which have served to introduce generations of children to the diversity of living organisms, should be encouraged as a means of engaging and stimulating young people (as future volunteers) to become involved in biological recording.

3.9 Are there any sources of finance or policy actions in your country dedicated to applied taxonomy (e.g. identification tools, training for parataxonomists, i.e. field-trained biodiversity collection and inventory specialists recruited from local areas)?

Another key question for taxonomy is availability of funds. All countries are facing funding problems, e.g.: in The Netherlands, Estonia, Norway, Estonia there are any sources of finance or policy actions dedicated to taxonomy; in Croatia there are no particular sources of finances. Some related initiatives are driven by State Institute for Nature Protection regarding education of amateurs to monitor particular species. These initiatives contribute with interesting experience and useful data; in Lithuania, the applied taxonomy is financed as part of the scientific research in universities and research institutes.

In Belgium, the Belgian National Focal point to the GTI has set up a Capacity Building programme for taxonomy¹⁶⁰, whereas the African Biodiversity Information Centre of the Royal Museum of Central Africa, Tervuren issues scholarship grants¹⁶¹. The Belgian Development Cooperation funds both opportunities.

Training has been provided by the National Botanic Gardens in Ireland to staff of the Environmental Protections Agency in relation to collecting and identifying aquatic plants. The National museum also assists with the identification of specimens being investigated by customs officers and the police force. However, there is no dedicated source of finance or specific policy actions in this regard.

Some investments are being made in Portugal regarding plant and animal germplasm banks. For example in Madeira, the construction of infrastructures to house herbarium collections as well as laboratories for taxonomic and systematic studies is planned. However, there is a lack of funds and continuity in these investments, and most natural history museums and botanical gardens struggle with lack of funding and human resources¹⁶².

In addition, there are some projects but not at national level or with national coordination. There is collaboration between research centres, Universities and NGO that helps in coordination of courses of taxonomy.

As examples we detach in Azores the Project INTERREG IIIB (2000-2006) Atlantic “*Listagem de espécies de fauna e flora terrestres dos Açores*” and Project INTERREG III Aquamac “*Técnicas e Métodos para a Gestão Sustentável da Água na Macaronésia*”. Some technical and academic training programmes in marine species taxonomy have been recently carried out, utilizing the oceanic research vessel NORUEGA, in collaboration between IPIMAR and Portuguese universities, with graduated, master and PhD students¹⁶².

¹⁶⁰ http://www.biodiv.be/cooperation/gti_coop

¹⁶¹ <http://www.africamuseum.be/news/research/zoology/ABIC>

¹⁶² Portuguese CBD Third National Report (2007) (accessed through <http://www.cbd.int/doc/world/pt/pt-nr-03-en.pdf>, 2009-04-21).

The Centre of Marine and Environmental Research (CIMAR) contributes for the Taxonomic Clearing System from MarBEF (Marine Biodiversity and Ecosystem Functioning - EU Network) which uses available taxonomic expertise across the MarBEF community to provide fast responses to taxonomic questions and help to enhance taxonomic expertise in Europe¹⁶³. MarBEF is also responsible for the database of European Marine Species and for the European part of OBIS (Ocean Biogeography Information System¹⁶⁴) that has records from 63 000 species.

CIMAR is also involved with “PROPE taxon - Web Accessible Taxonomic Expertise in MarBEF” providing an e-Platform for the European Taxonomists¹⁶⁵.

Some work is being done in the context of ICES working groups, namely International Bottom Trawl Survey Working Group. ICES use the Interagency Taxonomic Information System¹⁶⁶ for exchange of species information¹⁶⁰.

In Russia, during 2003, after re-organizing Ministry of Industry, Science and Technology into Ministry of Education and Science of Russian Federation the financial support of BioDiv project have stopped¹⁶⁷. Attempts to get some grants to support the project in 2004 were failed. Now (since 2006) the Russian Foundation for Basic Research (RFBR) has supported the “Animal Biodiversity” (ZooDiv)¹⁶⁸ project.

There are no other special resources for financial support or policy actions in Russian Federation directly dedicated to any needs of applied taxonomy, but there are possibilities for training of parataxonomists, i.e. field-trained biodiversity collection and inventory specialists as amateur volunteers from different local areas. At the Zoological Institute RAS, there is the “Small ZIN” program¹⁶⁹. Within the framework of this programme, amateurs can get information on this oldest research establishment of Russia and take part in researches of the institute. Actually, there are some amateurs who work in the field of biodiversity collection and inventory specialists after training in the leading Institutes mentioned above (ZIN, BIN etc.) on their own initiative. This activity is not supported by any funds.

Applied taxonomy is under development in some Research Institutions and Universities in Ukraine, as traditional lines of research from the times of the USSR. Government (public) supports considerable achievements in this field financing in frames of applied research projects. However, there is no special programme of the applied taxonomy advance. Mostly that develops as a part of the ecology and biodiversity research projects.

Regarding the United Kingdom, the approach of NERC to funding taxonomy appears confused. The Science and Technology Committee¹ report is very concerned that the mixed signals perceived within the taxonomic community are detrimental to the transparency, which should characterise scientific discourse. The Committee invite NERC to make a clear statement setting out its approach to the funding of taxonomy.

¹⁶³ <http://www.marbef.org/>

¹⁶⁴ <http://www.iobis.org/>

¹⁶⁵ <http://www.medobis.org/prope/index.php>

¹⁶⁶ <http://www.itis.usda.gov>

¹⁶⁷ <http://www.zin.ru/ZOODIV/index.html>

¹⁶⁸ <http://www.zin.ru/ZooDiv/Project.htm>

¹⁶⁹ <http://www.zin.ru/projects/tinyzin/index.html>

The Science and Technology Committee¹ recommend the establishment of a new process for commissioning the production of identification keys and field guides, involving joint actions between users setting priorities, funders supporting fixed-term appointments, host institutions providing access to collections and literature resources, and established series publishers producing the volumes. The Committee also recommend that UK BRAG should explore the options for commissioning the production of new and updated identification guides for the UK fauna and flora.