



Μεγάλα δεδομένα, νέα μέσα, νέοι τρόποι διαχείρισης, ανάλυσης και ερμηνείας: Επιτεύγματα και Προκλήσεις

Big Data, New Means new ways of management, analysis and interpretation: Achievements and Challenges



Christos Arvanitidis

Project Coordinator

Ανοικτές Διαλέξεις/Συζητήσεις «Μεγάλα Δεδομένα, Νέα Μέσα, Ζητήματα Τεκμηρίωσης: Μαθαίνοντας από πρωτοπόρα εγχειρήματα»

Open talks/discussions “Big Data, New Means, Documentation Issues: Learning from pioneering attempts”
Athens, NRF, March 20, 2019



European Union



G. S. Research & Technology



Hellenic Centre
for Marine Research



European Strategy Forum
for Research Infrastructures



Competitiveness
& Entrepreneurship



National Strategic
Reference Framework



Foundation for Research
and Technology - Hellas

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Outline

- (a) Introduction
- (b) The MedOBIS Virtual Laboratory (vLab)
- (c) The micro-CT vLab
- (d) The R vLab



The field: biodiversity

Definition(s)

...”the variability among living organisms from all sources including inter-alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part” (CBD)

....”includes diversity within species between species and ecosystems” (Gaston & Spicer, 2004)

Biodiversity is...

Genes and DNA

10^6 to 10^9 nucleotides in a DNA molecule



Species (organisms and their populations)

$>10^7$ species; each species with 10^2 - 10^{12} individuals

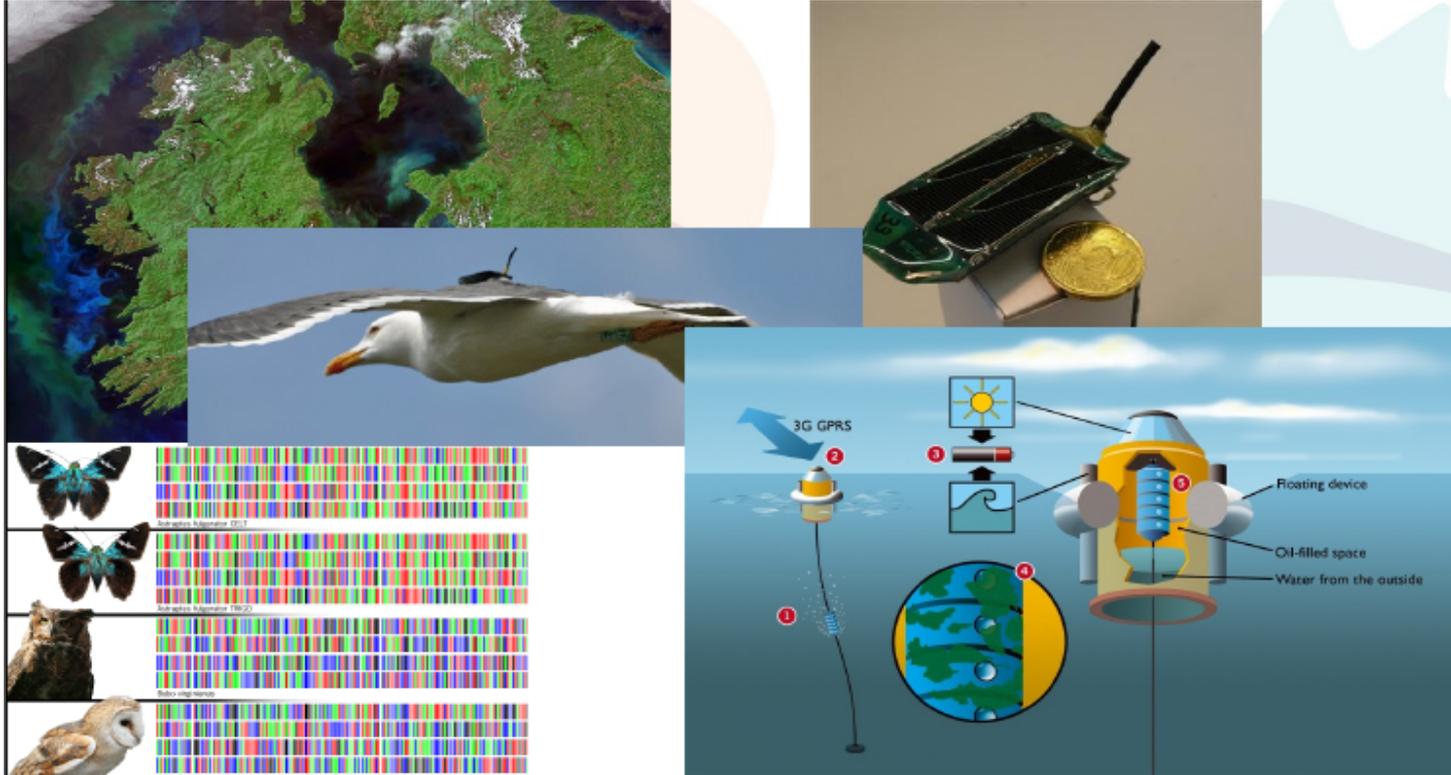


Ecosystems

habitats with 10^4 to 10^6 species,
and manifold interactions



LifeWatch: the “data era”



Scientific approach

— **Patterns**

— **Processes**

— **Consequences from changes**



What do we need for its study?

Data

+ Observatories

+ Capacity

+ Networks

+ People

= Infrastructure



The concept of ESFRIs: LifeWatch



ESFRIs: a new era of mega-science

- Computational capacity free VREs
- Transparency
- Change in the way we work –
change in the way we think
- Transition towards mega-science

LifeWatchGreece Project info

- Nov2012-Dec2015 (extension?)
- Almost 4 MEuros
- 49 Research Institutions and Academic Departments
- 400 participants from all over

What makes LifeWatchGreece?

- Human Network
- Physical Installations
- Equipment (mostly hardware)
- Software

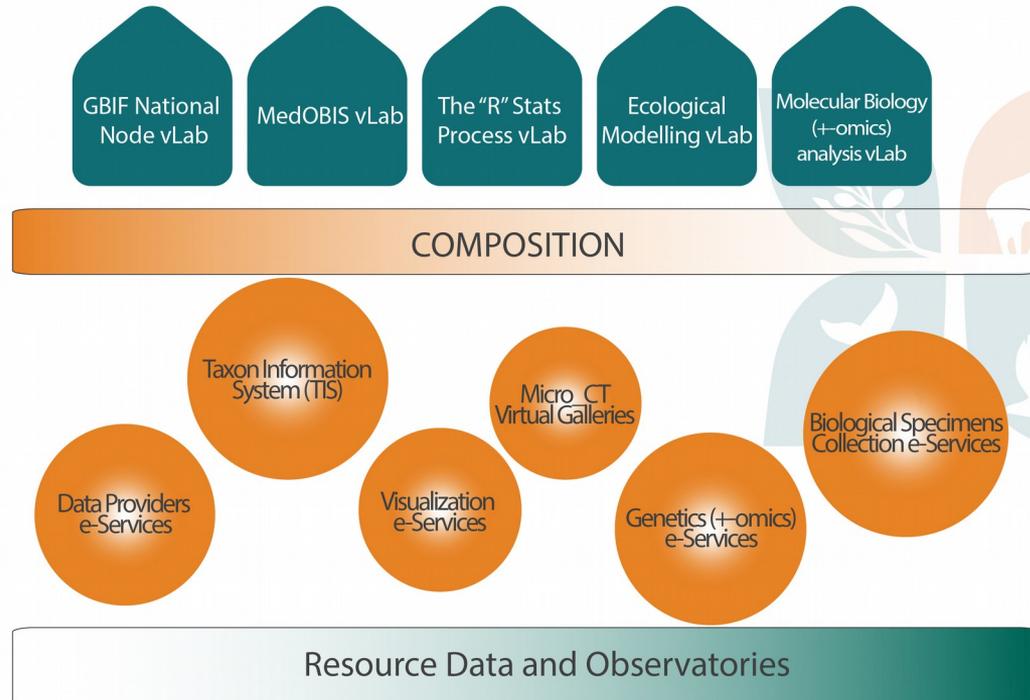


LifeWatchGreece Research (e-)Infrastructure



LifeWatchGreece Concept Architecture

Technical architecture of LifeWatchGreece





View Forums Active topics Unanswered topics New & updated topics

Forums

Forums				
Forum	Topics	Posts	Last post	
 General discussion <small>Subscribe to this forum</small>	5 1 new	26 1 new	test by Matina Nikolopoulou 26/09/2014 - 15:24	

LifeWatch Workgroups

LifeWatch Workgroups				
Forum	Topics	Posts	Last post	
 Lifewatch Ontology Group (LOG) <small>Subscribe to this forum</small>	1	1	LOG Meeting 21/02... by Admin 21/02/2014 - 14:46	
 Data Collection (DC) <small>Subscribe to this forum</small>	5	7	Finding Old Maps by Gavriella Papas... 26/09/2014 - 16:33	

SEARCH LIFEWATCH WEB PAGES (FOR DATA GO TO SEARCH DATA)

 Search

USER MENU

- My account
- Log out

CALENDAR | LIFEWATCH

« July »

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

SEARCH LIFEWATCH WEB PAGES (FOR DATA GO TO SEARCH DATA)

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CALENDAR | LIFEWATCH

« July »

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13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

USER LOGIN

Username *

Password *

Request new password

Log in

Experience / principles

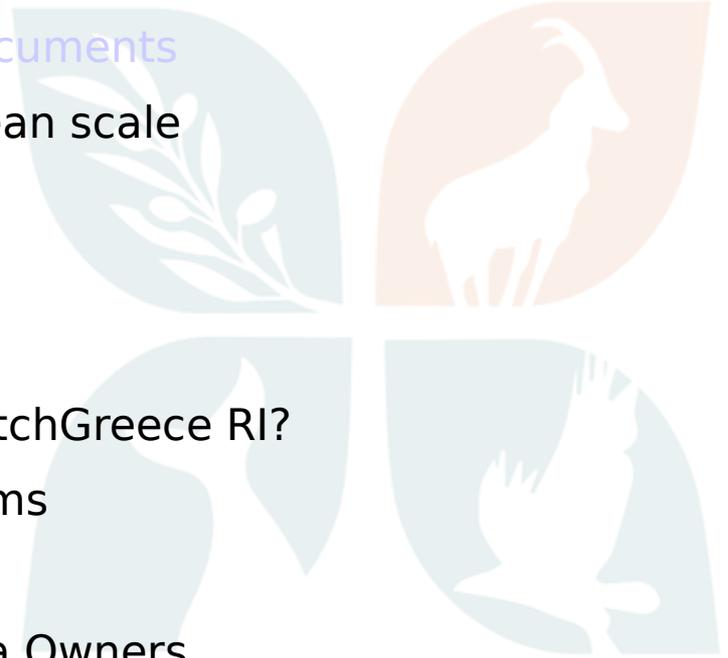
- Not all researchers like the idea of data sharing: this is MY data
- Need to know the fair play side of the game: policy
- Incentives: data publicizing, data papers, data impact factor

- EU and MS are in favour of: data is a capital produced by tax-payers money
- EU and MS are in favour of: data is a capital and can create jobs



Data Policy and Data Sharing Agreement

- <http://www.lifewatchgreece.eu/?q=content/documents>
- The landscape at the international and European scale
- LifeWatch ESFRI and LifeWatchGreece
- Why should I share my data?
- Why to support open access data?
- What kind of data can be submitted to LifeWatchGreece RI?
- Copyright, Creative Commons and related terms
- LifeWatchGreece General Terms of Use
- Rights and duties of the Data Providers & Data Owners
- Fair reuse of data published through LifeWatchGreece RI





Copyright, Creative Commons and related terms

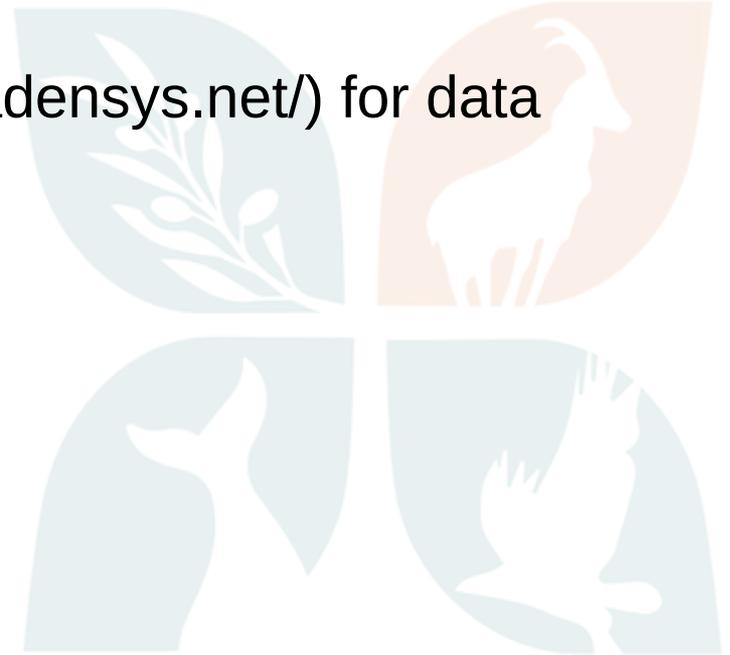
- LifeWatchGreece RI licenses: LifeWatchGreece RI uses Creative Commons as a legal instrument to define the usage rights of the data. Creative commons is legally binding, simple to use, globally accepted and its licenses are both human-readable and machine-readable, the latter being especially important in the digital age.
- LifeWatchGreece RI data release: under two different conditions:
 - 1) CC-Attribution (CC-BY, <https://creativecommons.org/licenses/by/3.0/>): “You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use”;
 - 2) CC-Zero (waiver, <https://creativecommons.org/publicdomain/zero/1.0/>): “The person who associates a work with this deed has dedicated the work to the public domain by waiving all of his/her rights to the work worldwide under copyright law, including all related and neighboring rights, to the extent allowed by law. You can copy, modify, distribute and perform the work, even for commercial purposes, all without asking permission.”
- Embargo: all data submitted to LifeWatchGreece RI can be subjected to an embargo period to be determined by the Data Provider and/or Data Owner.



Fair re-use of data published through LifeWatchGreece RI

The Canadensys norms (<http://www.canadensys.net/>) for data publication and use:

- Give credit where credit is due
- Be responsible
- Share knowledge
- Respect the data license



How can I participate?

- Explore the web site: **<http://www.lifewatchgreece.eu>**
- Inform us about your needs (methods of analysis, software, etc.)
Your messages to: **info@lifewatchgreece.eu**
- Contribute and publish your own data and metadata

Mediterranean node of Ocean Biogeographic Information System(OBIS)

- Virtual laboratory (vLab) in the LifeWatchGreece Research Infrastructure
- Platform offering a suite of applications to facilitate data gathering, storage & analysis devoted to Mediterranean Marine Biodiversity



The screenshot shows the 'LifeWatch Greece Portal' with a search bar and a list of available tools. The tools listed are:

- Statistical R**: The R vLab makes use of "R" which is a statistical processing environment widely used by scientists working in many biodiversity related disciplines. It supports an integrated and optimized (in respect to computational speed-up and data manipulation) online R environment. This vLab tackles common problems faced by R users, such as severe computational power deficit. Many of the routines operating under the R environment, such as the calculation of several biodiversity indices and the running of the multivariate analyses, are often of high computational demand and cannot deliver a result when the respective datasets are in the form of large matrices. **Available after Sign In**
- Micro CT**: Micro-tomography (micro-computed tomography or microCT) is a method of non-destructive 3D x-ray microscopy, which allows the users to create 3D models of objects from a series of x-ray projection images, similar to the conventional clinical computer tomography. The MicroCT Service will offer a collection of virtual galleries of taxa which will be displayed and disseminated through a web-based framework, and will allow the user to manipulate the 3D models through a series of online tools or to download the datasets for local manipulations. **Under development**
- MedOBIS**: The MedOBIS (Mediterranean node of Ocean Biogeographic Information System (OBIS: <http://www.obis.org/>)) vLab provides reliable and quality controlled marine species datasets, meta-data and satellite data from all over the Mediterranean Sea. The concept of MedOBIS, in agreement with OBIS, is to create a comprehensive system for the retrieval of Mediterranean biological data and to deliver them to OBIS and ultimately to GBIF. **Available without Sign In**

MedOBIS - Infrastructure

- **Database** (PostgreSQL database system) (50 datasets- some historical(Emodnet digitization)- 27 new are coming)
- **IPT -GBIF Integrated Publishing Toolkit** (<http://ipt.medobis.eu/>) (Darwin core schema –Follow Obis Schema- sampling events- occurrences-measurements(extendedMeasurementorFacts)- [Expanding the Ocean Biogeographic Information System \(OBIS\) beyond species occurrences](#))
- **Geoserver** -serves to MedOBIS viewer
- **MedOBIS viewer** (<https://portal.lifewatchgreece.eu/>) –medOBIS vLab

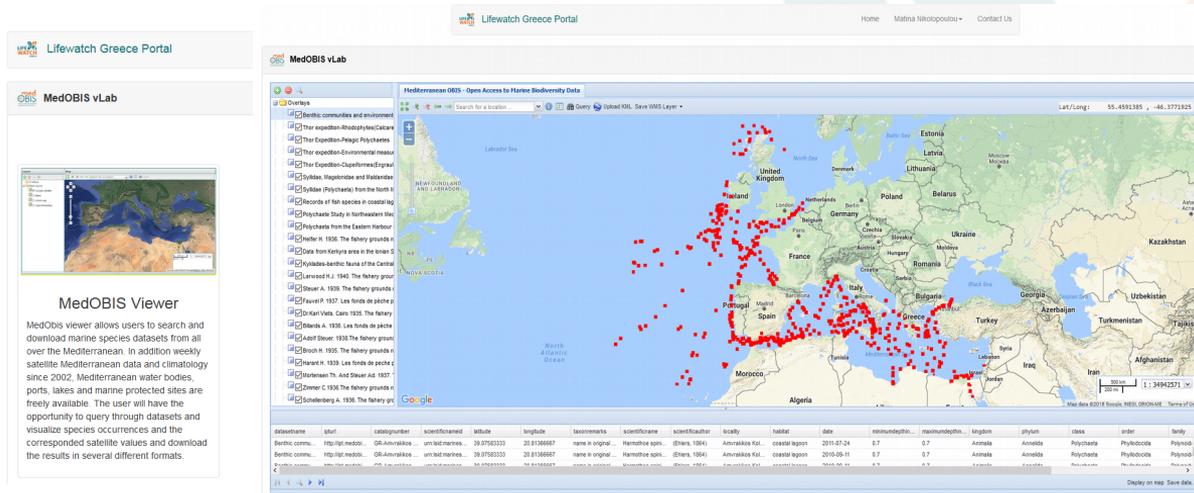
The GBIF Integrated Publishing Toolkit (IPT) is a software platform developed by the Global Biodiversity Information Facility to facilitate efficient biodiversity data sharing

Data Harvesting provide to OBIS, and ultimately to GBIF

Hosted resources available through this IPT

Logo	Name	Organisation	Type	Subtype	Records	Last modified	Last publication	Next publication
	Polychaetes from two subtidal rocky shores of the North coast of Crete, collected for the NaGISA project 2007-2008	Not registered	Occurrence	Observation	11,514	2015-05-22	2014-08-27	--
	Eastern Mediterranean Syllidae from three locations in Crete and Israel.	Not registered	Occurrence	Observation	997	2015-08-24	2015-08-24	--
	Benthic communities in Amvrakikos Wetlands: Mazoma, Tsopeli, Tsoukalio, Rodia and Logarou lagoons (September 2010 - July 2011)	Not registered	Occurrence	Observation	718	2015-08-28	2015-08-28	--
	Records of fish species in coastal lagoons that belong to Municipality of Arta, for the period 1999-2011	Not registered	Occurrence	Observation	411	2015-08-24	2015-08-24	--
	Records of fish species in coastal lagoons and sea shore that belong to Municipality of Preveza, for the period 2002-2011	Not registered	Occurrence	Observation	389	2014-11-26	2014-11-26	--
--	A Vedel Tanning 1918. A 7 Mediterranean Scopelidae (Saurus, Aulopus, Chlorophthalmus and Myctophum). Report on the Danish	Not registered	Metadata-only	--	0	2015-09-25	Not published	--

- GeoExt & OpenLayers



The screenshot shows the MedOBIS Viewer interface. On the left, there is a sidebar with the 'Lifewatch Greece Portal' and 'MedOBIS vLab' logos. Below the logos is a small map preview and a text box titled 'MedOBIS Viewer' which describes the tool's capabilities: 'MedOBIS viewer allows users to search and download marine species datasets from all over the Mediterranean. In addition weekly satellite Mediterranean data and climatology since 2002. Mediterranean water bodies, ports, lakes and marine protected sites are freely available. The user will have the opportunity to query through datasets and visualize species occurrences and the corresponded satellite values and download the results in several different formats.'

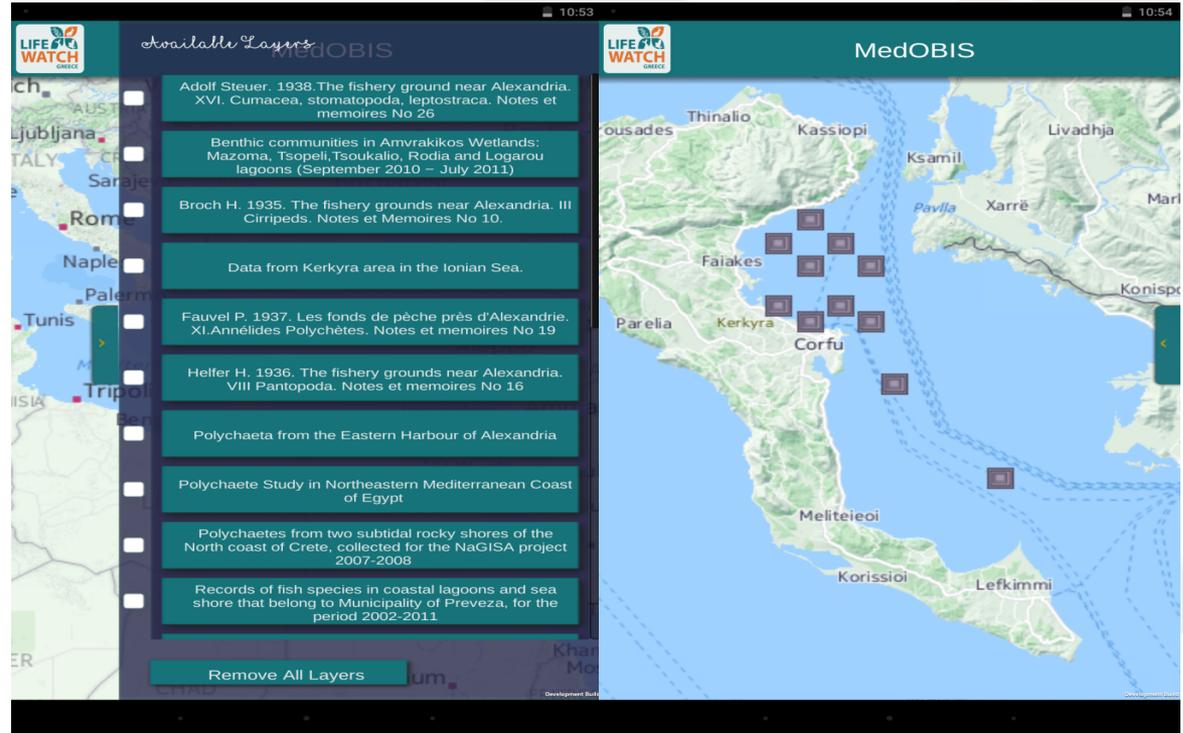
The main area features a map of the Mediterranean region with numerous red data points. A search bar and navigation controls are visible at the top of the map area. Below the map, there is a table of data with the following columns: datasetname, url, catalognumber, sciencenumber, latitude, longitude, taxonremarks, scientificname, scientificauthor, locality, habitat, date, minimumdepth, maximumdepth, kingdom, phylum, class, order, family. The first row of data is:

datasetname	url	catalognumber	sciencenumber	latitude	longitude	taxonremarks	scientificname	scientificauthor	locality	habitat	date	minimumdepth	maximumdepth	kingdom	phylum	class	order	family
Beritic comm.	http://ip.mediterranean.org/mediterranean	GR-Ann-arkiv	ann-1042-marine	39.37923333	23.81268887	none in original	Hamirotes spm.	(Shen, 1994)	Annakliss Kol., coastal lagoon	coastal lagoon	2011-07-24	0.7	0.7	Animalia	Araneida	Polychaeta	Polychaeta	Polychaeta

Users can visualize their own data in KML, publish and download the results in different formats (CSV, Geojson, WMS, WFS, KML).

LifeWatchGreece - More MedOBIS Apps

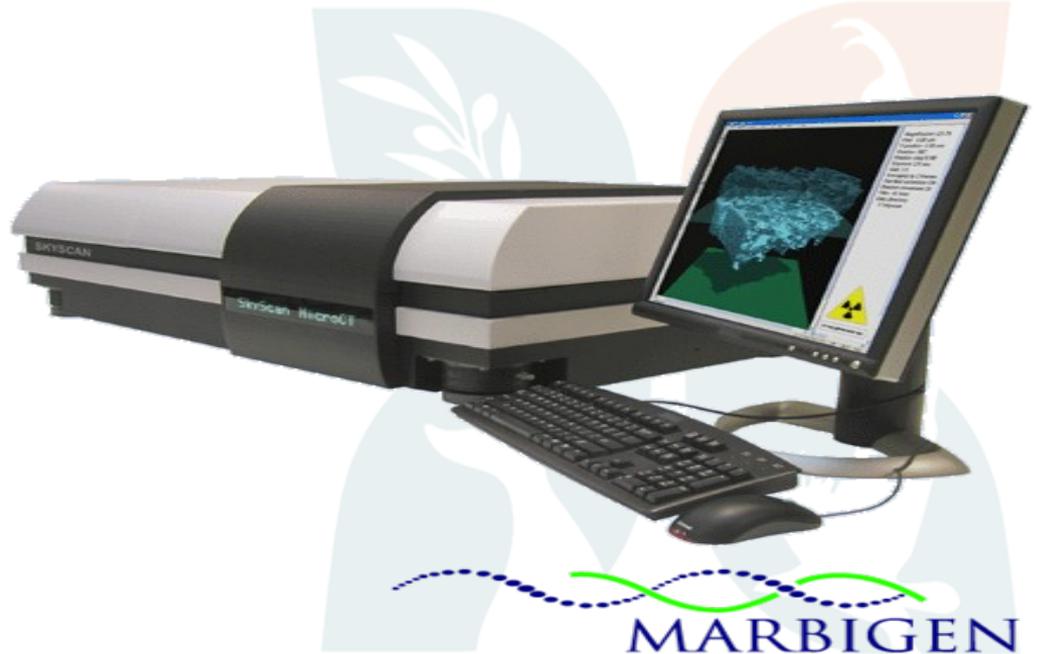
A MedOBIS mobile application is experimentally developed to run on smartphones and tablet computers.



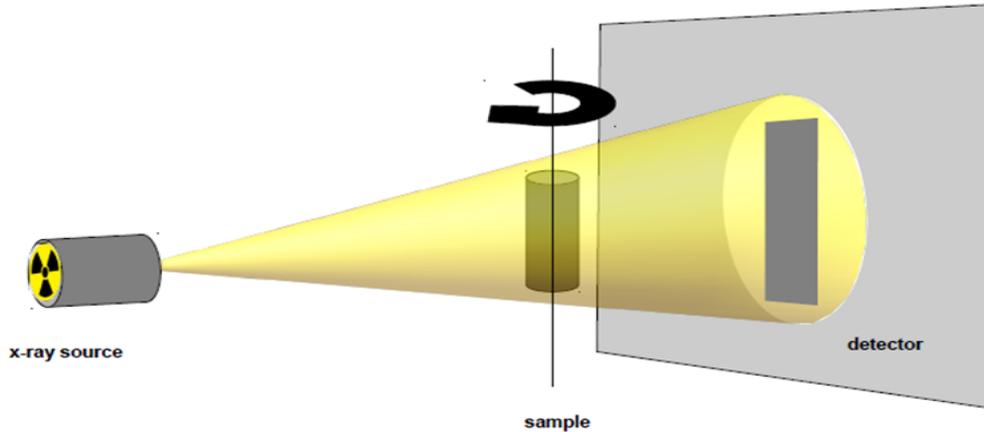
What is micro-CT?

- Non destructive three-dimensional imaging technique similar to computer tomography used in hospitals, just on a much smaller scale

- Samples of a few millimeters up to a size of a mouse, and structures in the range of a few microns ($<0,5\mu\text{m}/\text{pixel}$) can be seen in the images



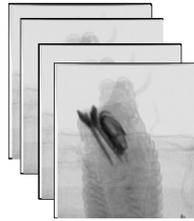
What is micro-CT?



What is micro-CT?

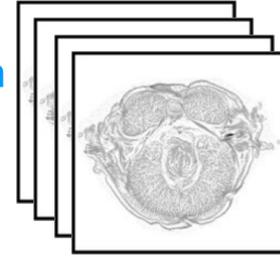


1. scanning



projection images

2. reconstruction



cross-sections



*three-dimensional
volume rendering*

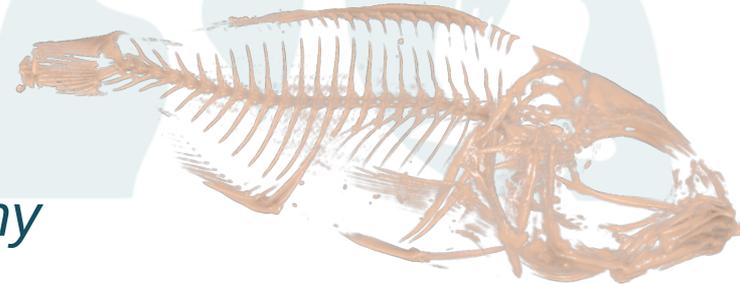


3. visualisation

What is micro-CT?



Exterior parts: morphology

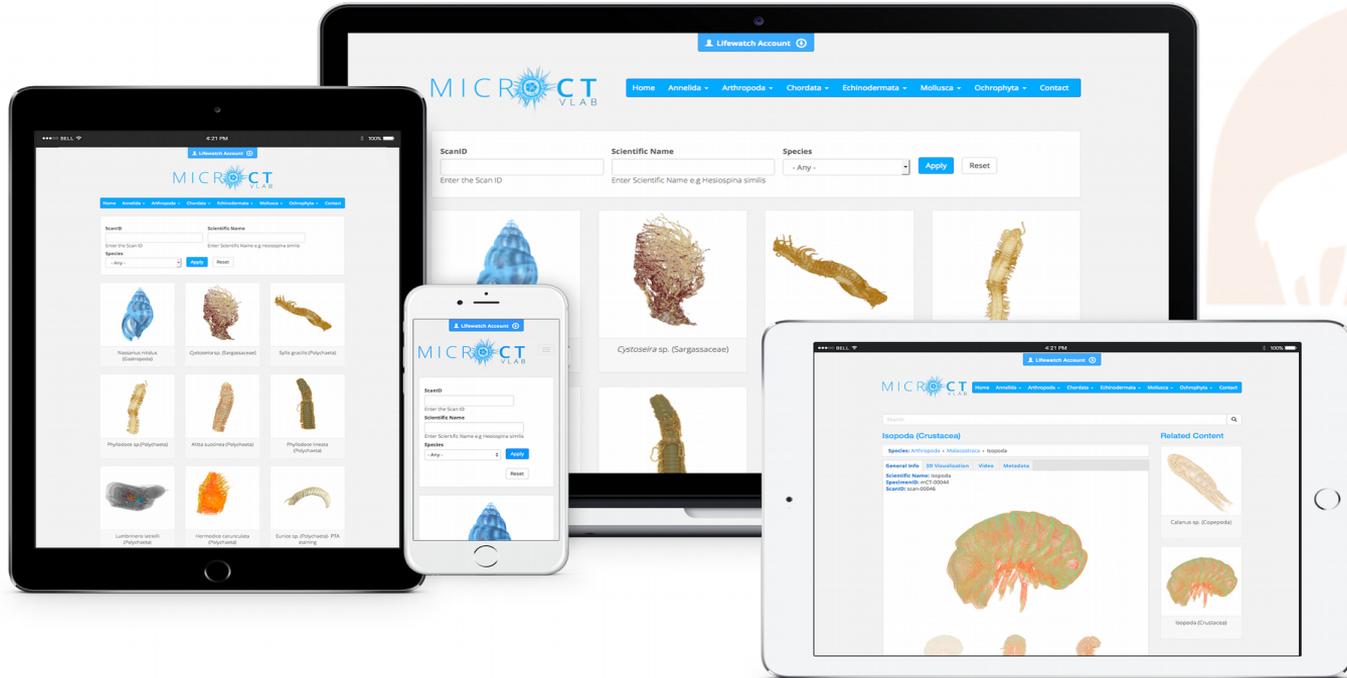


Interior parts: anatomy



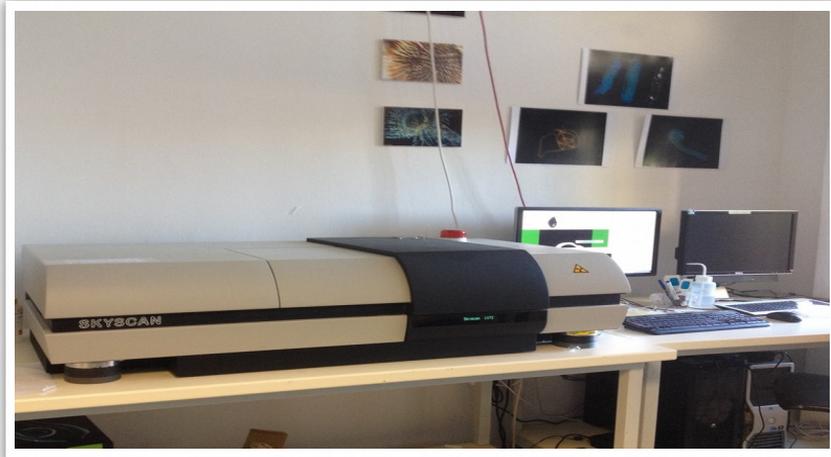
Micro-CT services are now available through
<http://microct.portal.lifewatchgreece.eu/>





Micro-CT virtual galleries

- 650 scans have been created and for the initiation of this web service only 17 of them were uploaded
- The uploaded datasets belong to several marine organisms and they are fully annotated with metadata



- 7 micro-CT datasets can be downloaded from the Dryad Digital Repository which is a repository system for several datatypes
- The remaining datasets can be shared through personal communication as the storage is still under construction

Accessed through LifewatchGreece Portal

portal.lifewatchgreece.eu

Lifewatch Greece Portal

E-mail

[Forgot your password](#)

R vLab
The R vLab makes use of "R" which is a statistical processing environment widely used by scientists in biodiversity related disciplines. It supports an integrated and optimized (in respect to computational power) online R environment. This vLab tackles common problems faced by R users, such as the calculation of indices and the running of the multivariate analyses, are often of high computational demand and can be cumbersome when the respective datasets are in the form of large matrices.

medOBIS vLab
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MicroCT Services
Micro-tomography (micro-computed tomography or microCT) is a method of non-destructive 3D x-ray computed tomography. The MicroCT Service will offer a collection of virtual galleries of taxa which will be disseminated through a web-based framework, and will allow the user to manipulate the 3D models of the objects or to download the datasets for local manipulations.

GBIF Greece

Lifewatch Greece Portal

Home Administration Emmanouella Panteri

Home Page

 R vLab	 MedOBIS vLab	 GBIF GBIF Greece	 Ecological Modeling Ecological Modeling
 Eco-systems Biology	 Metadata Catalogue	 MicroCT Services	 Genetic Services
 Taxon Information System (TIS) Services	 Biological Specimens Collection Services	 Mobile Applications	 SemMedObis

Announcements

Developed by HCMR

LifeWatch Account

MICRO-CT LAB

Home - Annelida - Arthropoda - Chordata - Echinodermata - Mollusca - Ophirophyta - Contact

Search

Musculus costulatus (Bivalvia)

Species: Mollusca > Bivalvia > Mytilozoa > Mytilidae > Musculinae > Musculus > Musculus costulatus

General Info | 3D Visualization | Video | Metadata

Scientific Name: Musculus costulatus
SpecimenID: mCI-00162
ScanID: scan-00184




Sussuria nitida (Gastropoda)



Musculus costulatus (Bivalvia)

Micro-CT was performed to a small bivalve *Musculus costulatus*. This specimen was fixed and preserved in 96% ethanol. Specimen was stained in 0.2% PISA solution in 70% ethanol for 5 days. Scan was performed with a SkyScan 1172 at a voltage of 50kV and 16µA without filter for a full rotation of 360°. This specimen was scanned at the highest camera resolution with an exposure time of 1550ms. This scan was performed for testing contrast enhancing techniques for the application of micro-CT in marine biodiversity studies @http://www.microscopy-analyses.com/view/default/files/2013_March_1_suhw.... Specimen was provided and scanned by Sarah Fiebeler.

Annelida
• Polychaeta

Arthropoda
• Malacostraca
• Insecta

Chordata
• Actinopteri

Echinodermata
• Echinozoa
• Ophiurozoa

Mollusca
• Bivalvia
• Gastropoda

Ophirophyta
• Phlebobranchia

The micro-CT dataset

- *Short description of the dataset*
- *Gallery of 3D images*
- *Related datasets*

Lifewatch Account

MICROCT
VLAB

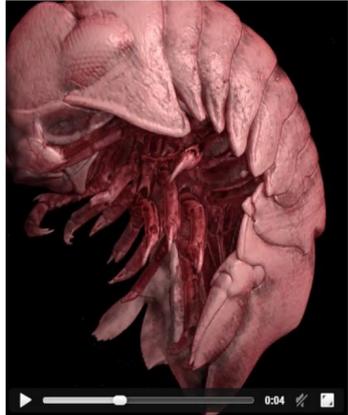
Home Annelida Arthropoda Chordata Echinodermata Mollusca Ochrophyta Contact

Search

Isopoda (Crustacea)

Species: Arthropoda > Malacostraca > Isopoda

General Info 3D Visualization Video Metadata



0:04

Related Content



Calanus sp. (Copepoda)



Isopoda (Crustacea)

Annelida

- Polychaeta

Arthropoda

- Malacostraca
- Maxillopoda

Chordata

- Actinopteri

Echinodermata

- Echinoidea
- Ophiuroidea

Mollusca

- Bivalvia
- Gastropoda

Ochrophyta

- Phaeophyceae



[Lifewatch Account](#)



[Home](#) - [Amelida](#) - [Arthropoda](#) - [Chordata](#) - [Echinodermata](#) - [Mollusca](#) - [Dichrophyta](#) - [Contact](#)

Isopoda (Crustacea)

Species: [Arthropoda](#) - [Malacostraca](#) - [Isopoda](#)

[General Info](#) | [3D Visualization](#) | [Video](#) | [Metadata](#)

MicroCT Scanning Results Found

Result 1 (Related Dataset):

Specimen ID: <http://lifewatch.gr/entity/specimen/mct-00001>

Specimen Name: mCT-00001

Scanning ID: <http://lifewatch.gr/entity/digitizationProcess/scan-00001>

Product ID: <http://lifewatch.gr/entity/dataObject/scan-00001.zip>

Product Name: scan-00001.zip

Device ID: http://lifewatch.gr/entity/device/skyscan_1172

Device Name: SkyScan 1172

Actor ID: http://lifewatch.gr/entity/actor/sarah_faulwetter

Actor Name: Sarah Faulwetter

Date: 2013-02-18

Dataset Name: microCT_ElectronicLog

Dataset ID: http://lifewatch.gr/entity/dataset/microct_electroniclog

Result 2 (Related Dataset):

Specimen ID: http://lifewatch.gr/entity/specimen/paraehlersia_ferrugina-cala-20c-07

Specimen Name: Paraehlersia_ferrugina-CALA-20C_07

Scanning ID: <http://lifewatch.gr/entity/digitizationProcess/scan-00011>

Product ID: <http://lifewatch.gr/entity/dataObject/scan-00011.zip>

Product Name: scan-00011.zip

Device ID: http://lifewatch.gr/entity/device/skyscan_1172

Device Name: SkyScan 1172

Actor ID: http://lifewatch.gr/entity/actor/sarah_faulwetter

Actor Name: Sarah Faulwetter

Date: 2012-04-25

Dataset Name: microCT_ElectronicLog

Dataset ID: http://lifewatch.gr/entity/dataset/microct_electroniclog

Related Content



Calanus sp. (Copepoda)



Isopoda (Crustacea)



- *Huge storage capacity demand*
- *Downloading bandwidth*
- *3D Pattern recognition solutions*



Source: <http://www.naturkundemuseum-berlin.de/typo3temp/pics/d09e9f46e0.jpg>



type material



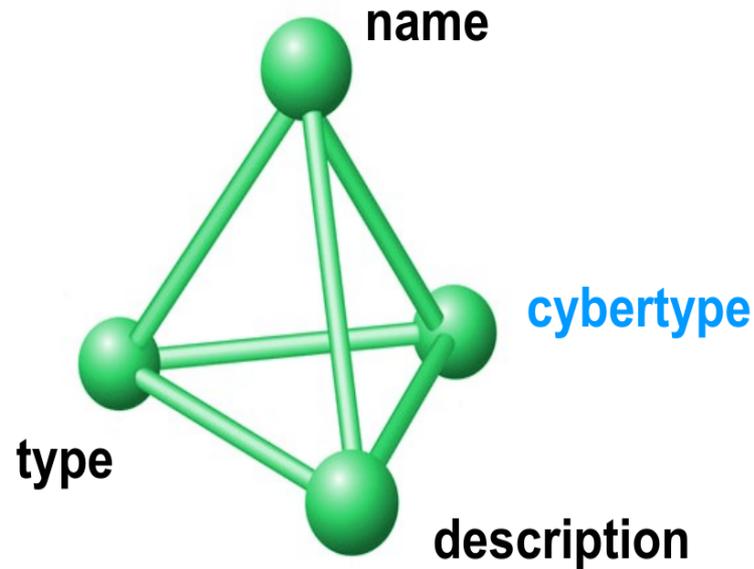
cybertype

Godfray, HCJ (2007)
Linnaeus in the information age.
Nature 446: 259–260



Big changes: from phenetics to phenomics

... to the “taxonomic tetrahedron”?



Adoption from the

ICZN

is needed

The first idea!

Journal of Experimental Marine Biology and Ecology 366 (2008) 184–186



Contents lists available at [ScienceDirect](#)

Journal of Experimental Marine Biology and Ecology

journal homepage: www.elsevier.com/locate/jembe



All animals are equal, but some animals are more equal than others

R.M. Warwick ^{*}, P.J. Somerfield

Plymouth Marine Laboratory, Prospect Place, West Hoe, Plymouth, PL1 3DH, UK

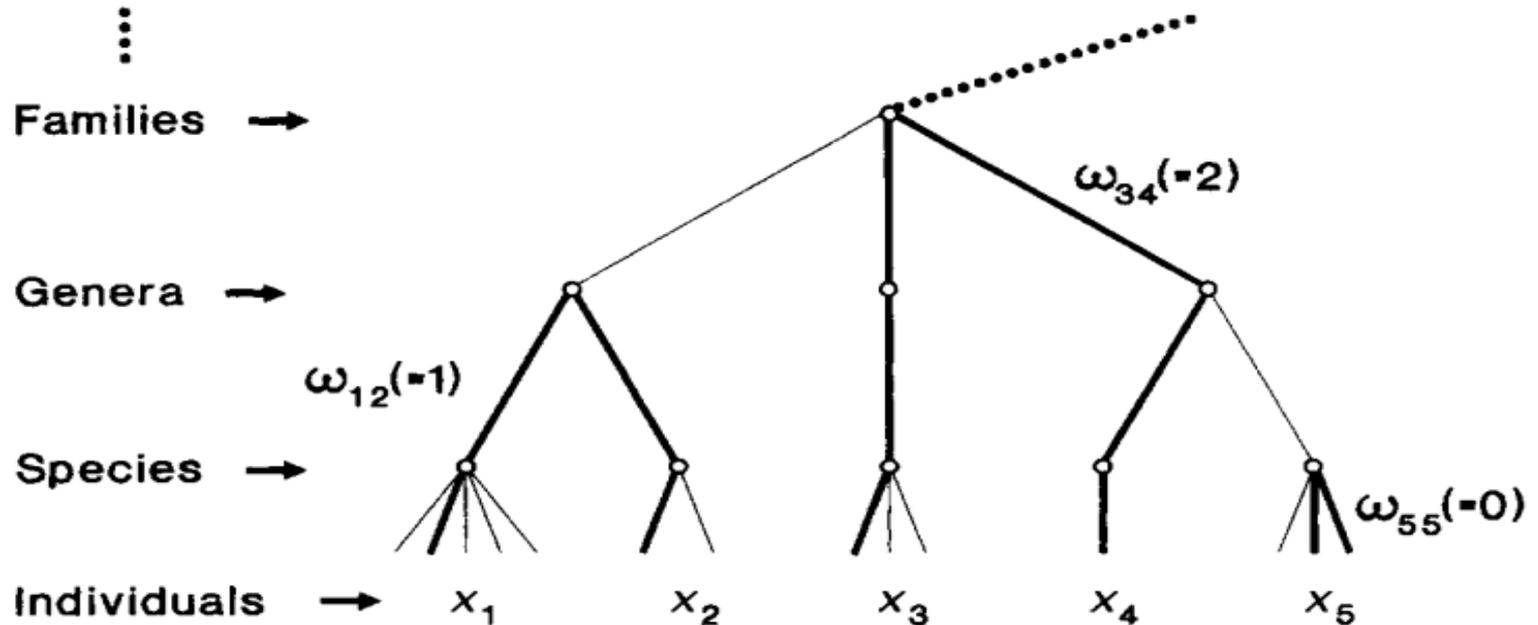
What was the concept?

1. *“If the number of animal species is to be used as a measure of ‘biodiversity’, or if distributions of species among taxa of higher rank are to be used to infer evolutionary or ecological patterns, then we need to know whether animal phyla are consistently subdivided in such a way that each species represents an equal division of life's diversity.*”

2. *It is widely assumed, intuitively, that the traditional Linnean classification of marine animals is inconsistent between different major groups. We demonstrate formally that this is the case.”*

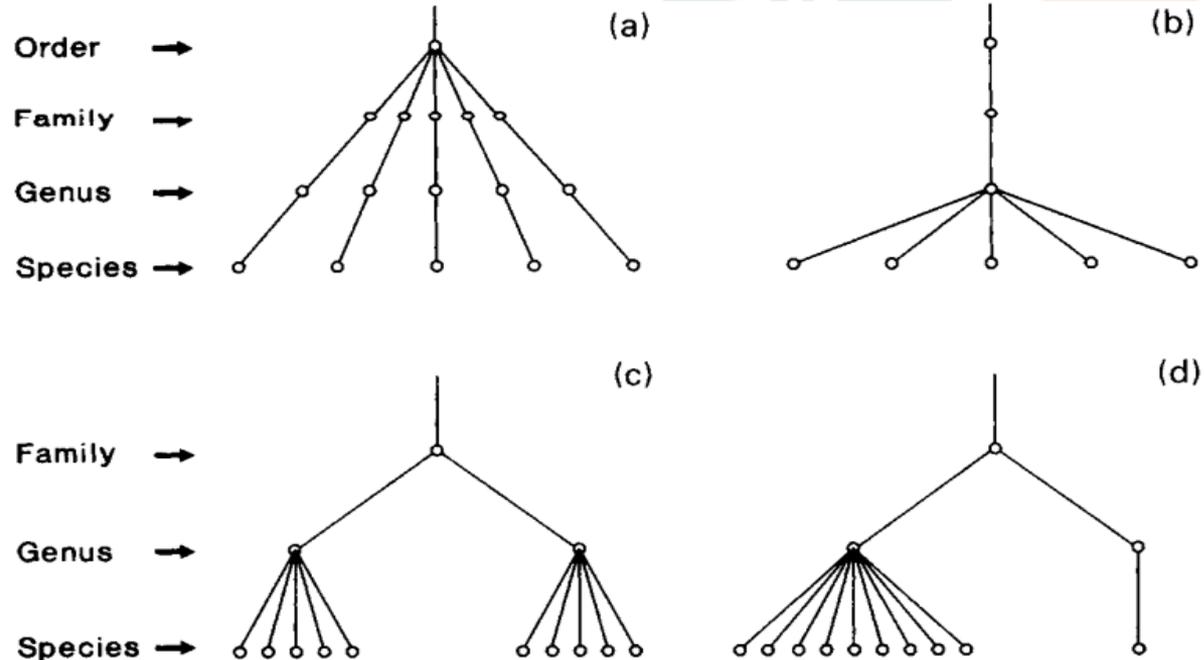
What was the concept?

The taxonomic distinctness indices (Clarke & Warwick, 1998; JAE):



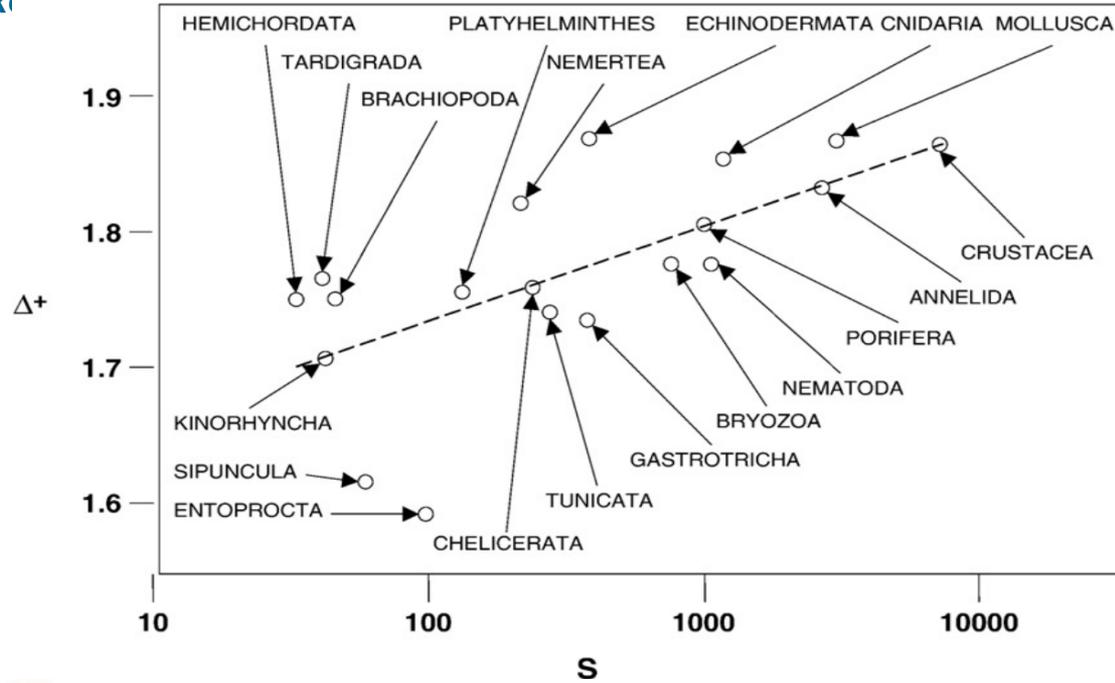
What was the concept?

The taxonomic distinctness indices (Clarke & Warwick, 1998; JAE):



What was the result?

3. “The **value** of average taxonomic distinctness Δ^+ is shown to **vary considerably between phyla**. There is a highly **significant relationship** between the **number of species within a phylum** and the **average distance through the tax**”



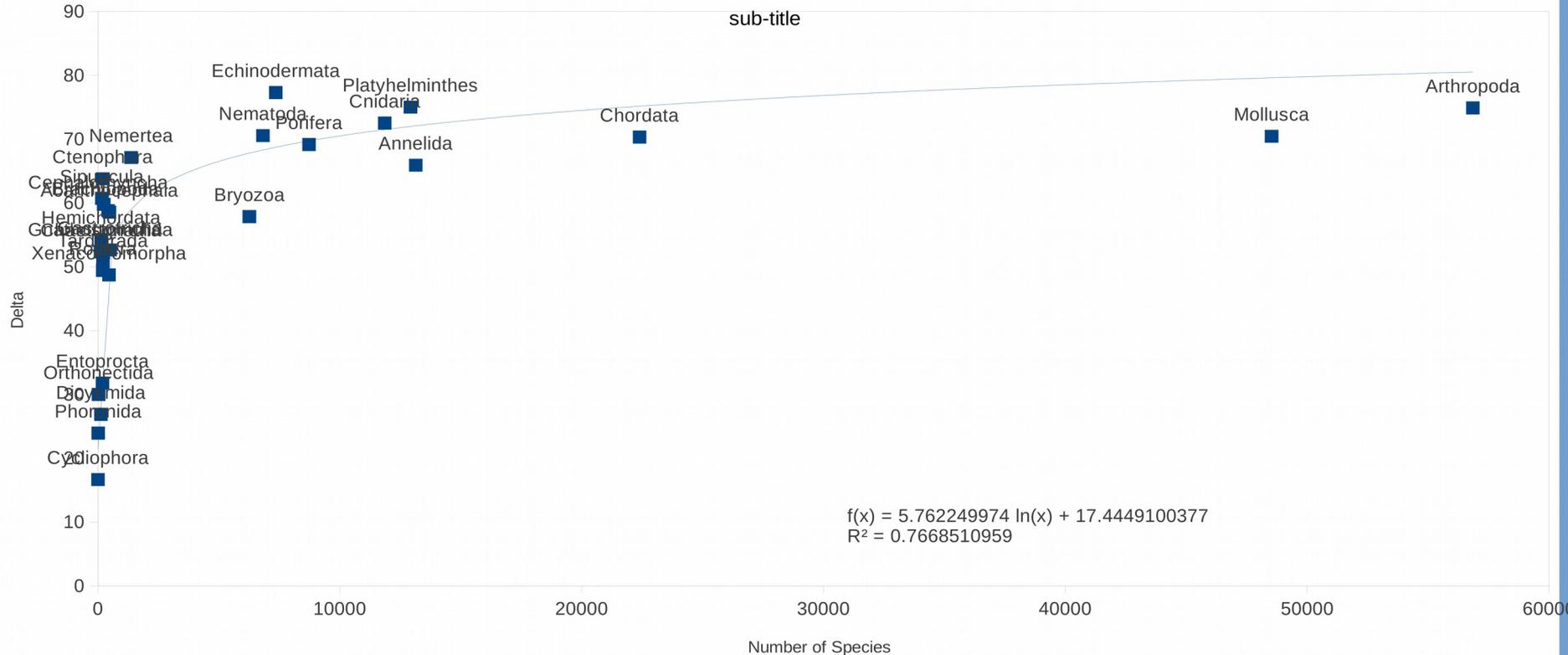
What were the conclusions?

4. *There is a **highly significant relationship** between the number of species within a phylum and the **average distance through the taxonomic hierarchy** between those species.*
5. *This implies that **larger phyla are broken up into relatively small units at higher taxonomic levels**. Interestingly, this occurs **independently** of the perceived **taxonomic difficulty** within phyla.*
6. *Species number is therefore a **poor unit of currency** for **evaluating biodiversity**, and studies which **infer patterns** using **distributions of, or ratios between, higher taxa** through time should take **phyletic differences** into account.”*

What is the current concept?

1. Pretty much the same but now we **scale up**:
2. From the **UK inventory to WoRMS**
3. Include both average and variation in taxonomic distinctness (Δ^+ , Λ^+) to infer from both the average distance **length** but also from the (un)equal distribution of species to higher categories (**width**) of the WoRMS phylogenetic/ taxonomic tree.

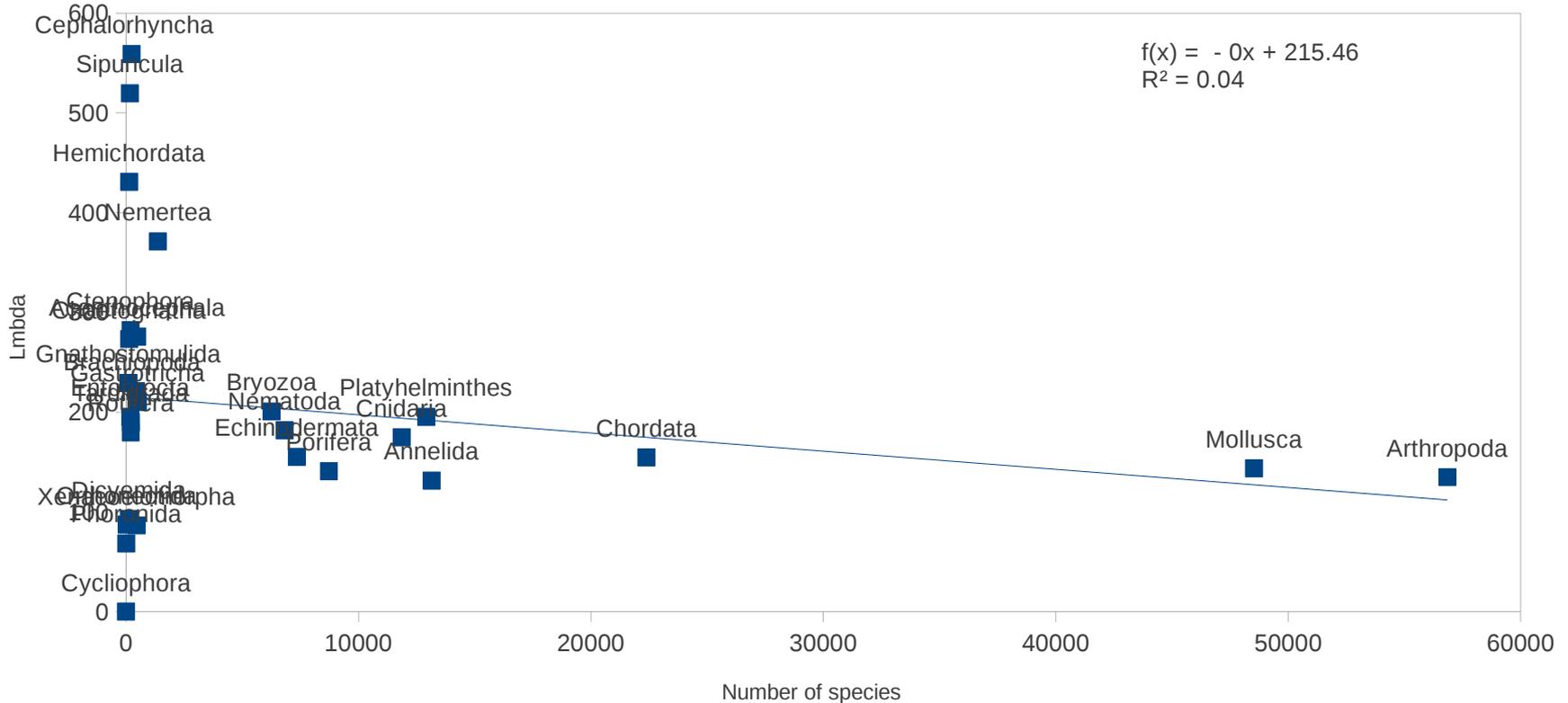
What are the results?





What are the results?

sub-title



What are the results?

1. The **value** of average taxonomic distinctness Δ^+ **still varies considerably between phyla** but **much less** so. Again, there is a highly **significant relationship** between the **number of species within a phylum** and the **average distance through the taxonomic hierarchy** between those species **but** this relationship becomes **logarithmic** now.
2. The **value** of variation in taxonomic distinctness Λ^+ **varies enormously between phyla**, especially between those with **less than 5,000 species**. There is **still** a positive but **weak linear relationship** between the **number of species within a phylum** and the **average spread of the species into higher categories**.

What might these results mean?

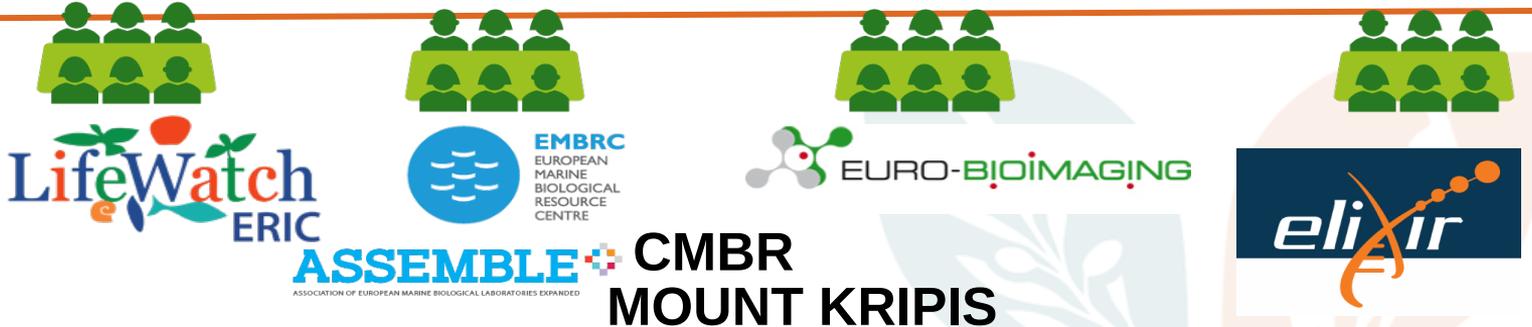
1. Again, *“larger phyla are broken up into relatively small units at higher taxonomic levels. Interestingly, this occurs **independently** of the perceived **taxonomic difficulty** within phyla”*.
2. The two biodiversity indices bring **complementary patterns** when applied to the entire WoRMS tree.
3. **Phyla** also **differ** in the **horizontal** dimension of their **architecture**, which now needs to be investigated in the lower taxonomic categories: e.g. **classes, orders and families, within each phylum**.
4. We currently **need** not only to know whether species number is a **poor unit of currency** for **evaluating biodiversity**, but also if higher categories can serve as such currency.
5. **Do these trends occur in other phylogenetic systems (CBOL, ATOL)? If not what are the differences and why?**

Next steps are....

1. Apply the same methodology to the **lower taxonomic categories**.
2. Test the **phylogenetic trees** produced by **CBOL** and **ATOL** for the same hypothesis and make comparisons with the present findings (this will require an adjustment of the WoRMS tree).



What a collaborative VRE might look like?



Sorting and Integration layer



Vlabs and eServices layer



Thank you for your attention
Special tanks to W. Los for the LifeWatch slides

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