Aalto University
School of Science

Biological Names and Taxonomies on the Semantic Web

– Managing the Change in Scientific Conception

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ESWC 2011 – Semantic Web in Use
1.6.2011

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Department of Media Technology

University of Helsinki
Department of Computer Science

UNIVERSITY OF HELSINKI

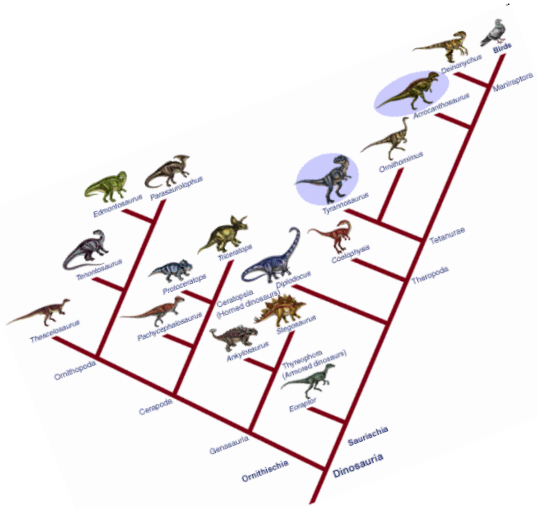
SeCo
semantic computing

Outline of the talk

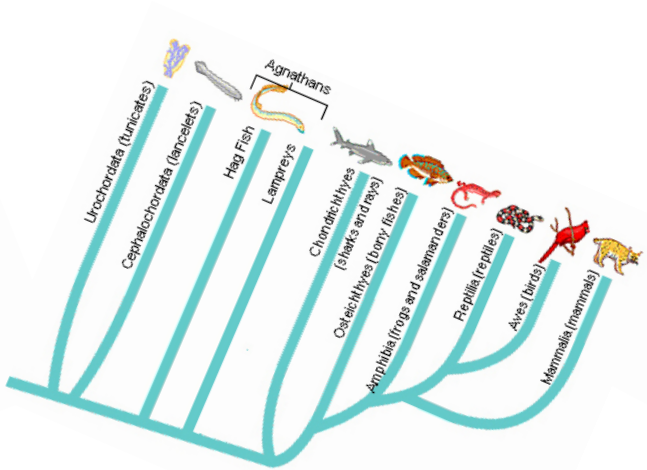
- Biological background and problems
- Semantic web solution
- Use cases

Problem in biology

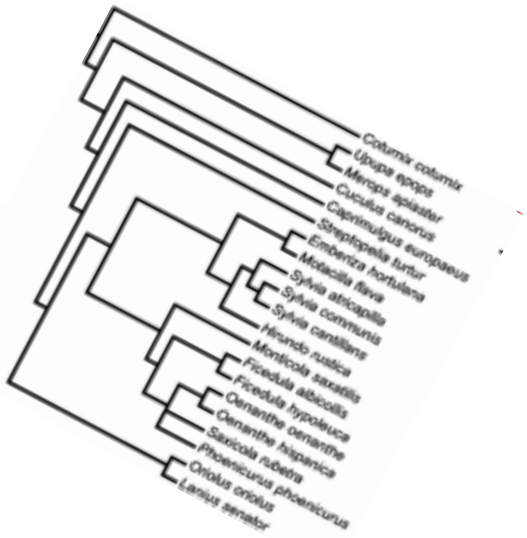
- One evolution – OK, but how did it happen?
- No witnesses, but several theories



http://biology.unm.edu/ccouncil/Biology_203/Summaries/Phylogeny.htm



http://www.hbwbiology.net/quizzes/ch34-vertebrate-evolution.htm



http://beheco.oxfordjournals.org/content/15/4/592.full

Taxonomic hierarchy - Classification

Kingdom

Phylum

Class

Order

Family

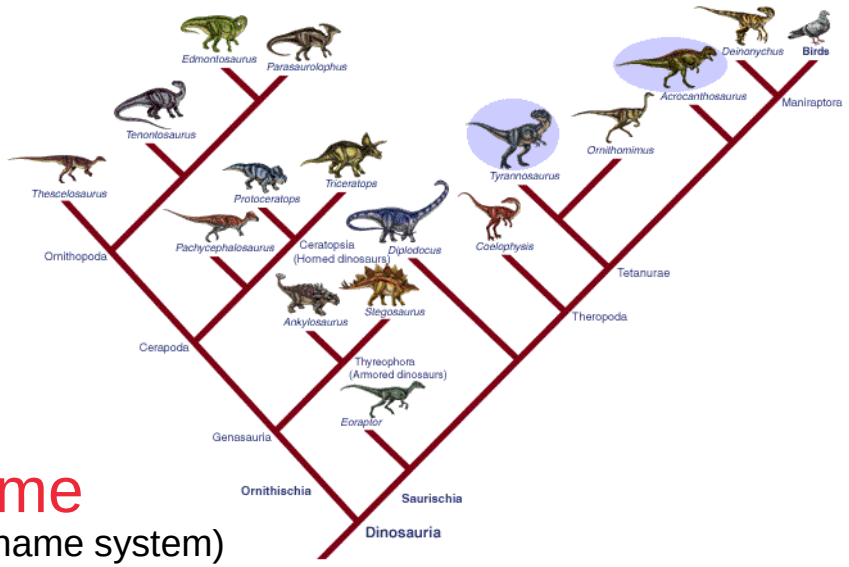
Genus

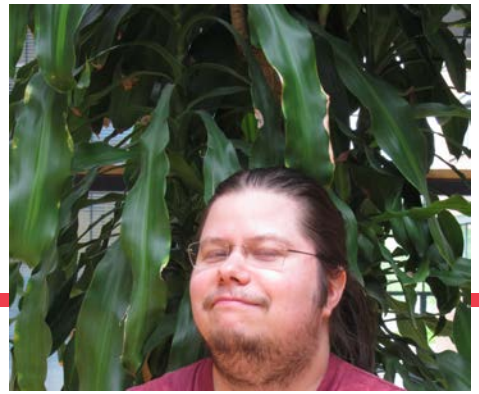
Species

= Scientific name

(Linnean binomial name system)

Homo sapiens





”Lions and carnivores”

- Classical semantic web textbook examples of animals (e.g. ”lions are carnivores”) demonstrate ontologies and inferencing, but are not enough in real life
  - the notion of species is very hard to define precisely: as many as 22 different definitions [Mayden, 1997]
    - organisms sharing particular defining characteristics
    - a single evolving entity in nature
    - …
  - taxonomic knowledge changes and increases due to new research results
    - discovery of new species
    - e.g. molecular methods suggest new positions to organisms in taxonomies

Problem 1/3: One species – many names

Arhopalus rusticus

Criocephalus rusticus

Criocephalus tristis

Arhopalus tristis

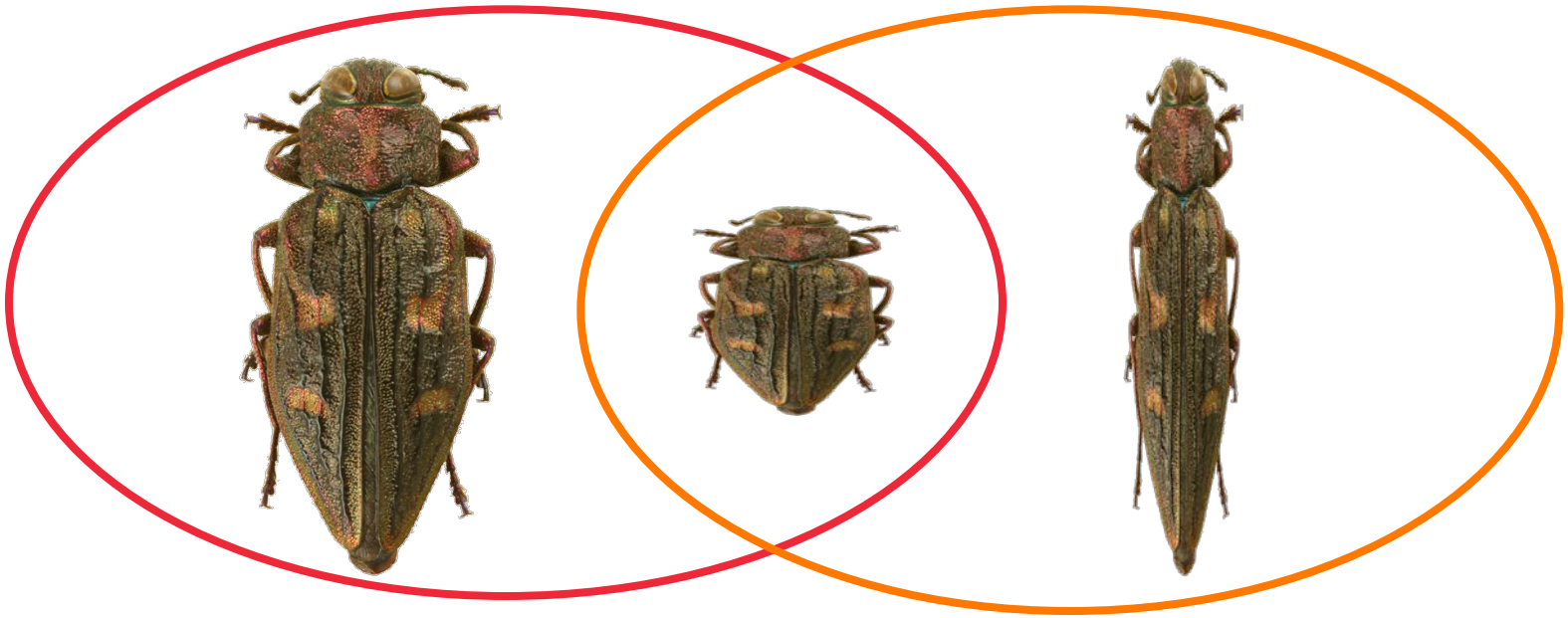
Problem 2/3: One name – many species

Genus *Pieris*

http://www.about-garden.com/fe/en/0001-flame/

http://fi.wikipedia.org/wiki/Tiedosto:Pieris_napi.jpg

Problem 3/3: One name – different definitions



Scientific argumentation

Multiple views in time

Time

Common names

Genus *Pieris*

http://fi.wikipedia.org/wiki/Tiedosto:Pieris_napi.jpg

”**cabbage butterfly**” @en

”**kaaliperhonen**” @fi

”**cabbage white**” @en

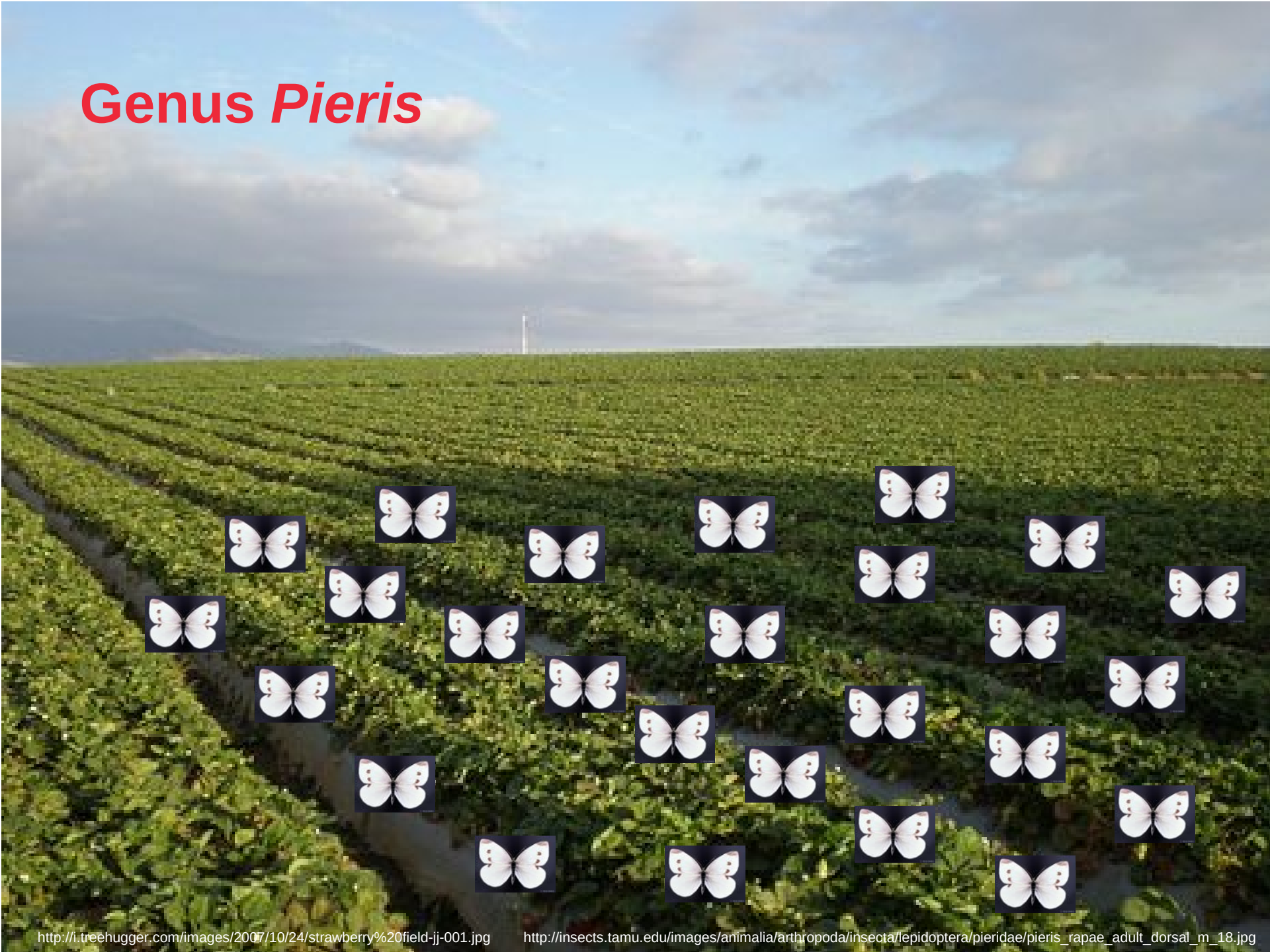
Who cares?

- Species is a basic unit of monitoring biodiversity
- Biological information is scattered in various sources
  - research literature, observational records, natural history collections
- Information integration is challenging without stable identifiers for species

→ the users need to have deep taxonomical knowledge

- Biodiversity research
- Climate change
- Natural history museums

Genus *Pieris*



http://i.treehugger.com/images/2007/10/24/strawberry%20field-jj-001.jpg http://insects.tamu.edu/images/animalia/arthropoda/insecta/lepidoptera/pieridae/pieris_rapae_adult_dorsal_m_18.jpg


http://tiwiislands.files.wordpress.com/2007/09/tiwi-natural-forest.jpg

The IUCN Red List of Threatened Species™ 2010.4

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HELP SAVE SPECIES NOW!

Enter Red List search term(s) GO OTHER SEARCH OPTIONS

Home » Search » Search Results

Explore or refine your search below:

- Keywords
- Taxonomy
- Location
- Systems
- Habitats
- Threats
- Assessment
- History

Displaying species assessments **1** - **50** of **3269** in total

« 1 2 3 4 5 ... 66 »

Acanthaeschna victoria (Thylacine Darner)
Status: Vulnerable B1+2c ver 2.3
(needs updating)
Pop. trend: decreasing

Acanthagrion ablutum
Status: Least Concern ver 3.1
Pop. trend: unknown

Acanthagrion adustum
Status: Least Concern ver 3.1
Pop. trend: unknown

Acanthagrion chacoense
Status: Least Concern ver 3.1
Pop. trend: unknown

Acanthagrion cuyabae
Status: Least Concern ver 3.1
Pop. trend: unknown

Acanthagrion hartei
Status: Data Deficient ver 3.1
Pop. trend: unknown

Current search:
Save / Export Search

Search terms
Show taxa:
Species
Search by taxonomy:
INSECTA

The list is compared to the species inventory of the forest

=

http://www.jatan.org/gal/i03-109.jpg

http://thumbs.dreamstime.com/thumblarge_357/1232684459678Rzt.jpg

Aloeides egerides

NOT EVALUATED (NE) | DATA DEFICIENT (DD) | LEAST CONCERN (LC) | NEAR THREATENED (NT) | < VULNERABLE (VU) > | ENDANGERED (EN) | CRITICALLY ENDANGERED (CR) | EXTINCT IN THE WILD (EW) | EXTINCT (EX)

Summary | Classification Schemes | Images & External Links | Bibliography | Full Account

Taxonomy
Assessment Information
Geographic Range
Habitat and Ecology
Threats

View Printer Friendly

Taxonomy [top]

Kingdom	Phylum	Class	Order	Family
ANIMALIA	ARTHROPODA	INSECTA	LEPIDOPTERA	LYCAENIDAE

Scientific Name:	*Aloeides egerides*
Species Authority:	(Riley, 1938)
Common Name/s: English – Red Hill copper	

Name mismatch!

Assessment Information [top]

Red List Category & Criteria:	Vulnerable B1+2c ver 2.3

What can be done?

- We need a system for publishing and managing scientific and common names, and underlying conceptions of organisms
  - for indexing, finding and aggregating biological information

Solution: TaxMeOn

- Taxon Meta-Ontology for creating biological name ontologies
- Core classes: taxonomic concept, scientific name, taxonomic rank, publication, author, vernacular name, status of name

Taxon Meta-Ontology TaxMeOn

http://schema.onki.fi/taxmeon

Namespace Document 26 May 2011

Authors:

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Nina Laurenne (Aalto University)

Abstract

The *Taxon Meta-Ontology TaxMeOn Specification* defines classes and properties for creating biological name ontologies.

Alternate machine-readable versions of this schema are available in either RDF/XML or N3 formats.

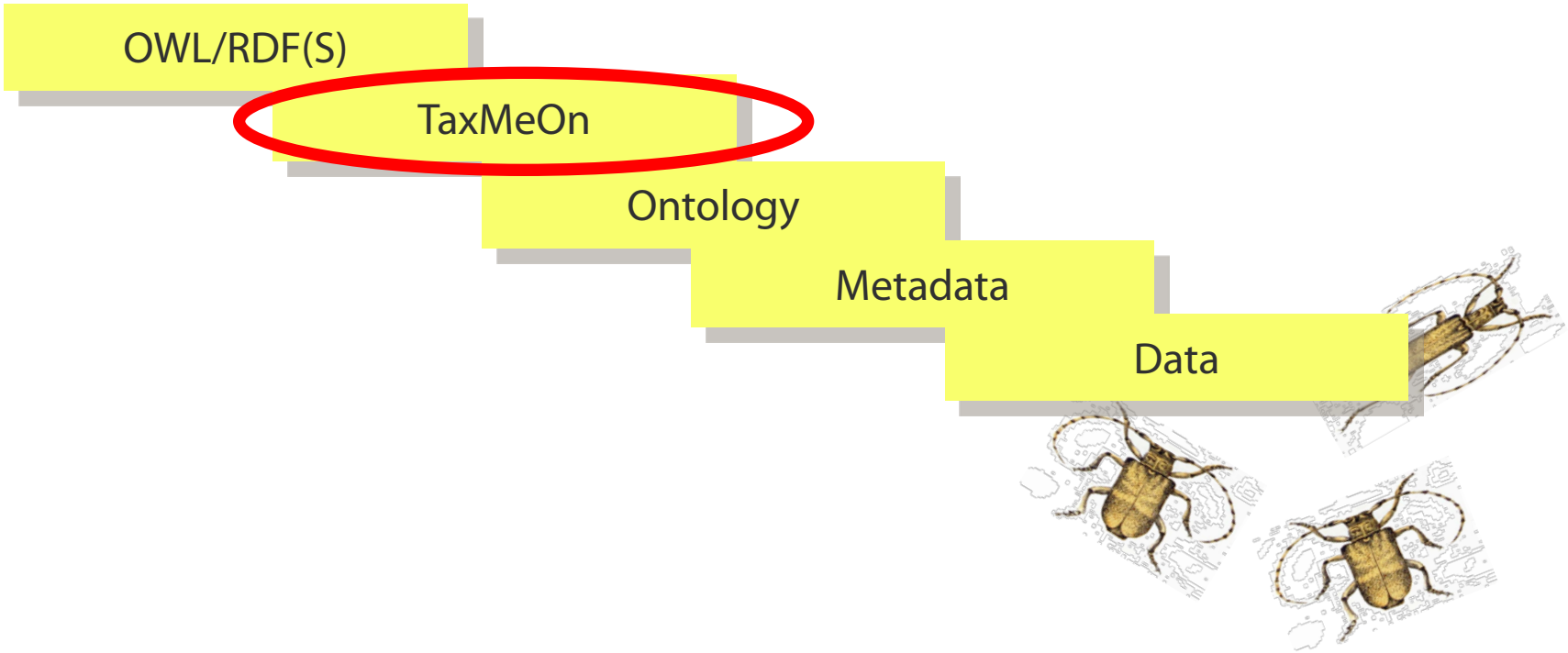
Taxon Meta-Ontology TaxMeOn Classes and Properties

The *Taxon Meta-Ontology TaxMeOn* introduces the following classes and properties.

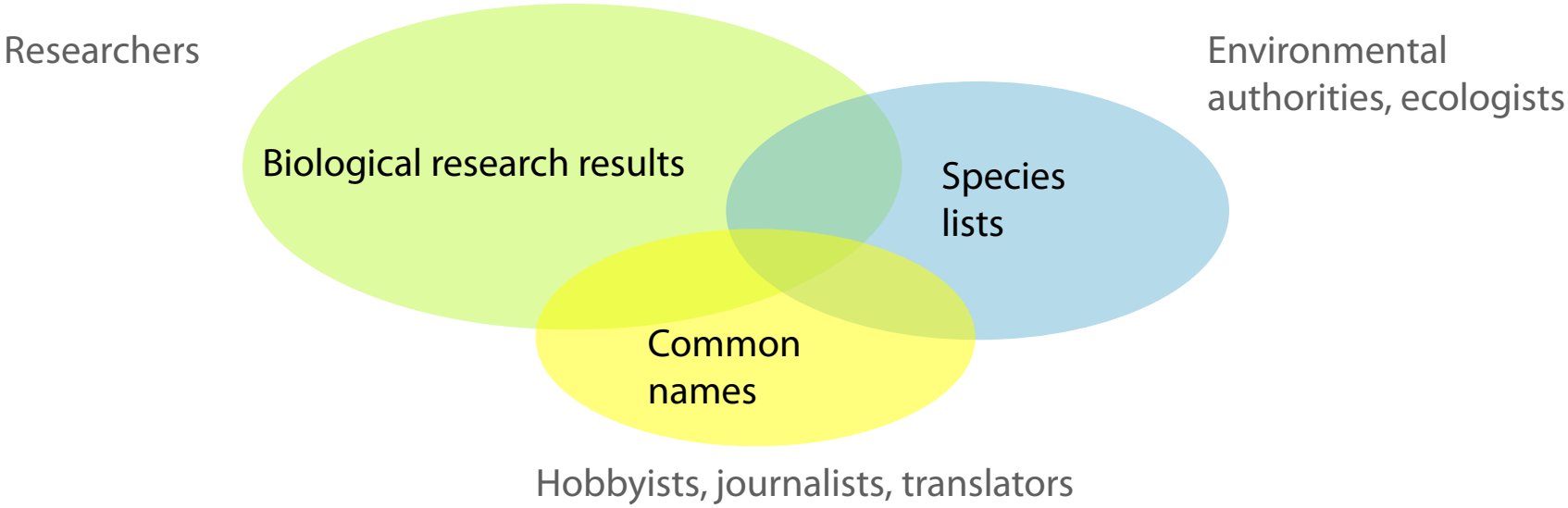
Classes: | Accepted | AcceptedVernacularName | AlternativeVernacularName | Author | Change | ChangeInCircumscription | ChangeInClassification | Checklist | Homonym | Lump | Misapplied | NomenclaturalCode | NomenclaturalStatus | OtherSource | ProposedVernacularName | Publication | Reference | ScientificName | SpellingStatus | Split | Synonym | TaxonGeneral | TaxonInChecklist | TaxonInNameCollection | TaxonInUpperClassification | TaxonomicConcept | TaxonomicRank | TaxonomicStatus | VernacularName | VernacularNameStatus |

Properties: | abbreviation | after | auctorum | auctorumYear | before | bibliographicCitation | completeAuctorumString | congruentWithTaxon | congruentWithTaxonInt | congruentWithTaxonOst |

The big picture



Three parts of the model



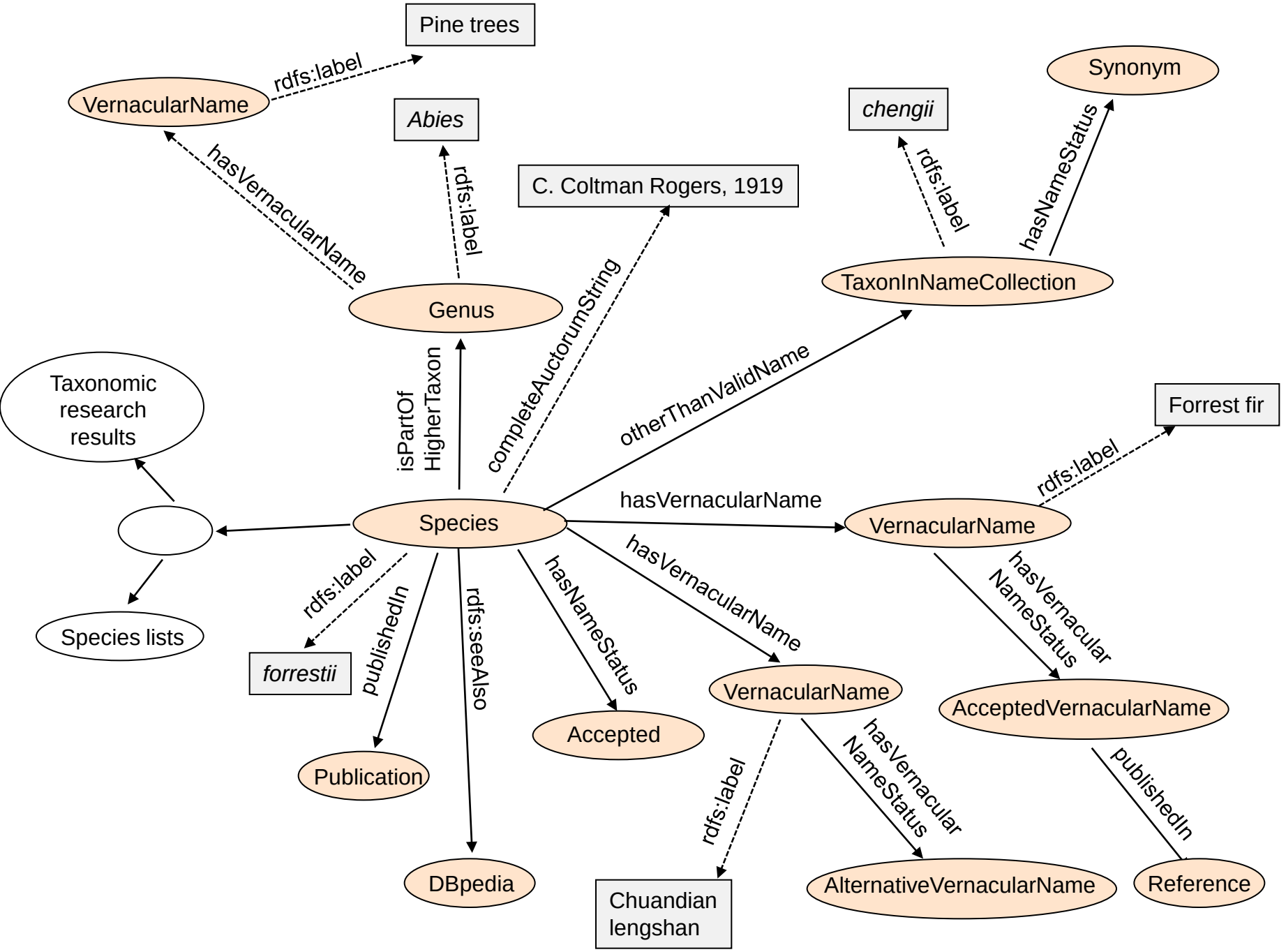
Part 1/3: Species lists

Very old name

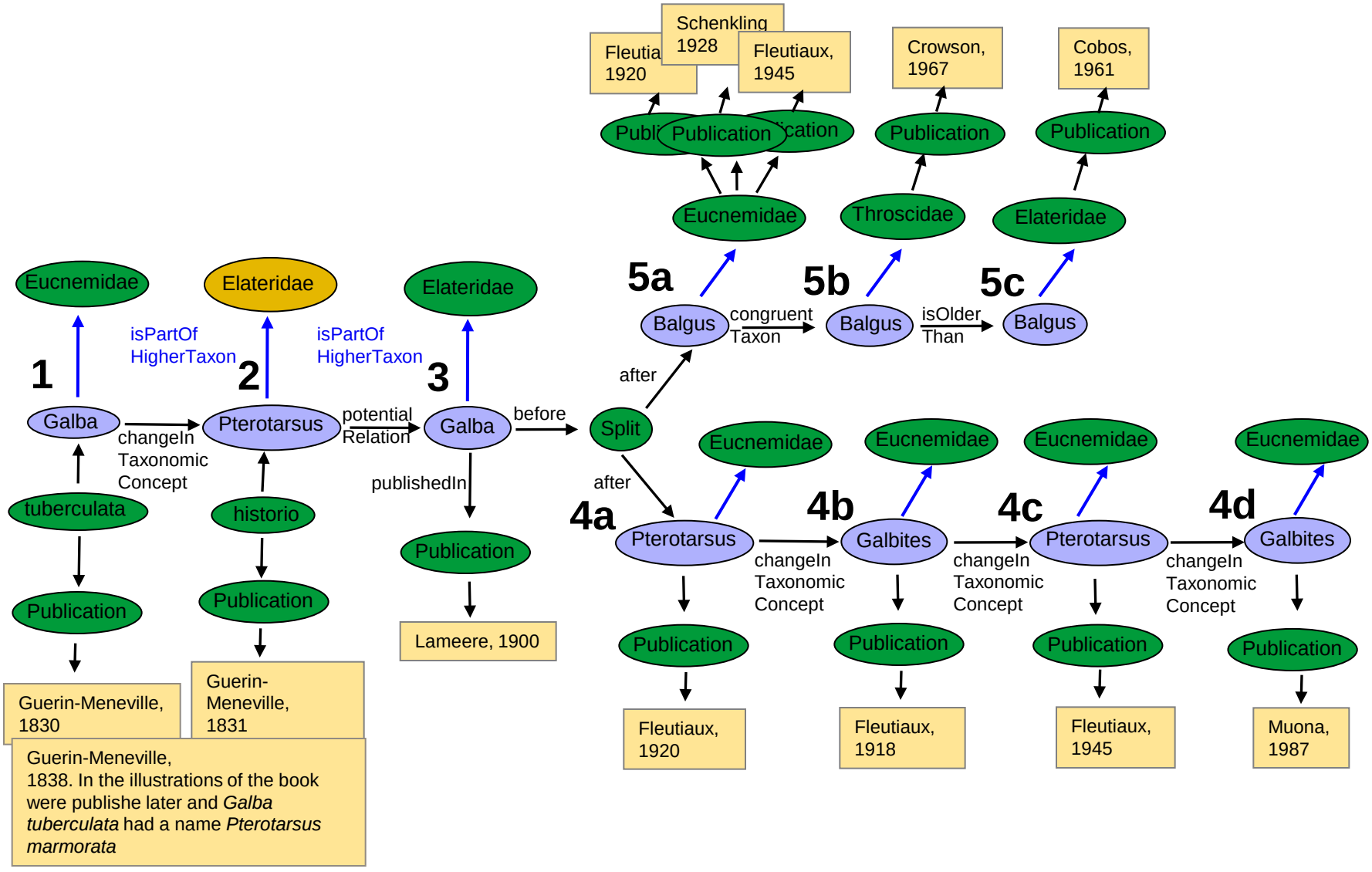
Quite old name

New name

Part 2/3: Common names


Pine trees
rdfs:label
VernacularName
Abies
hasVernacularName
rdfs:label
C. Coltman Rogers, 1919
chengii
Synonym
rdfs:label
hasNameStatus
TaxonInNameCollection
Genus
completeAuctorumString
isPartOf HigherTaxon
otherThanValidName
Taxonomic research results
Forrest fir
rdfs:label
hasVernacularName
Species
VernacularName
Species lists
rdfs:label
publishedIn
rdfs:seeAlso
hasNameStatus
hasVernacularName
hasVernacular NameStatus
forrestii
VernacularName
AcceptedVernacularName
Publication
Accepted
DBpedia
rdfs:label
hasVernacular NameStatus
publishedIn
Chuandian lengshan
AlternativeVernacularName
Reference

Part 3/3: Scientific research results


Eucnemidae
Elateridae
Elateridae
isPartOf HigherTaxon
isPartOf HigherTaxon
1
2
3
Galba
changeIn Taxonomic Concept
Pterotarsus
potential Relation
Galba
before
Split
tuberculata
historio
publishedIn
Publication
Publication
Publication
Guerin-Meneville, 1830
Guerin-Meneville, 1831
Lameere, 1900
Guerin-Meneville, 1838. In the illustrations of the book were publishe later and Galba tuberculata had a name Pterotarsus marmorata
Schenkling 1928
Fleutia 1920
Fleutiaux, 1945
Crowson, 1967
Cobos, 1961
Publi
Publication
ication
Publication
Publication
Eucnemidae
Throscidae
Elateridae
5a
5b
5c
Balgus
congruent Taxon
Balgus
isOlder Than
Balgus
after
after
4a
4b
4c
4d
Eucnemidae
Eucnemidae
Eucnemidae
Eucnemidae
Pterotarsus
changeIn Taxonomic Concept
Galbites
changeIn Taxonomic Concept
Pterotarsus
changeIn Taxonomic Concept
Galbites
Publication
Publication
Publication
Publication
Fleutiaux, 1920
Fleutiaux, 1918
Fleutiaux, 1945
Muona, 1987

Taxon group	Region	Publ. years	# of taxa
Vascular plants	World	constantly updated	25726
Long-horn beetles (Coleoptera: Cerambycidae)	Scandinavia, Baltic countries	1939, 1960, 1979, 1992, 2004, 2010, 2010	205, 181, 247, 269, 300, 297, 1372
Butterflies and moths (Lepidoptera)	Scandianavia, North-West Russia, Estonia	1962, 1977, 1996, 2002, 2008	313, 256, 265, 4573, 12256, 3244, 3251, 3477
Thrips (Thysanoptera)	Finland	2008	219
Lacewings and scorpionflies (Neuroptera and Mecoptera)	Finland	2008	113
True bugs (Hemiptera)	Finland	2008	2690
Flies (Diptera: Brachycera)	Finland	2008	6373
Parasitic wasps (Hymenoptera: Ichneumoidae)	Finland	1995, 1999, 1999, 2000, 2003	282, 398, 919, 786, 733
Bees and wasps (Hymenoptera: Apoidea)	Finland	2010	1048
Mammals	World	2008	6062
Birds	World	2010	12125
False click beetles (Coleoptera: Eucnemidae)	Afrotropics	–	9 genera

Table 2. Datasets TaxMeOn has been applied to. Vascular plants are included in the name collection, the false click beetles are biological research results, and all other datasets are based on species lists.

TaxMeOn use cases

- Mapping five species lists of long-horn beetles and publishing them as services for humans and machines
  - for content annotation, search, aggregation
- Collaborative management of common names of vascular plants
- Managing the changing scientific conception of organisms based on biological research results
  - temporal chains of taxon concepts and names

Ontologies and vocabularies

Finnish Ontology Library Service ONKI

Please begin by selecting an ontology or a vocabulary for browsing. You can also search from all or specific ontologies and vocabularies by using the search at the right.

Follow ONKI on Twitter!

twitter

Search for concept...

Language: en | Clear

Select ontologies and vocabularies

Search for ontology or vocabulary:

2 hits

Subject

- 2 Upper
- 4 Geography
- 2 **Nature**

Structure

- 1 Class ontology
- 2 **Instance ontology**
- 2 Advanced vocabulary

Publishing status

- 2 Public ONKI-ontology

Publisher

- 2 FinnONTO Consortium

- **Butterfly checklists**
- **Long-horn beetle checklists**

Concept type:

All types

Search language:

en

Show relations:

separately in hierarchy

Search for concept:

abdominalis

Grammoptera (Grammoptera) abdominalis Stephens, 1831

Grammoptera abdominalis (Stephens, 1831)

Grammoptera abdominalis (Stephens, 1831)

Grammoptera abdominalis (Stephens, 1831)

Grammoptera abdominalis (Stephens, 1831)

Grammoptera (Grammoptera) abdominalis Stephens, 1831

Superordinate concepts:

Cerambycidae Latreille, 1802
└ Lepturinae Latreille, 1802
└ Lepturini Latreille, 1802
└ Grammoptera Audinet-Serville, 1835
└ Grammoptera Audinet-Serville, 1835
└ **abdominalis**

Auctorum year: 1831

Complete auctorum citation: Stephens, 1831

Has name status: Accepted

Has scientific name authorship: Stephens

Occurs in checklist: Catalogue of Palaearctic Coleoptera. Volume 6. Chrysomeloidea

Ordering weight: 105

Ostensively congruent with taxon:

Grammoptera abdominalis (Stephens, 1831)
Grammoptera abdominalis (Stephens, 1831)
Grammoptera abdominalis (Stephens, 1831)
Grammoptera abdominalis (Stephens, 1831)

Refers to taxon: Coleoptera_abdominalis_Stephens_1831*

Type:

Species
Taxon in a checklist

Coordinate concepts:

Grammoptera (Grammoptera) ruficornis Fabricius, 1781
Grammoptera (Grammoptera) ruficornis Fabricius, 1781
Grammoptera (Grammoptera) ustulata Schaller, 1783

URI: http://www.yso.fi/onto/bio/FMNH_384490

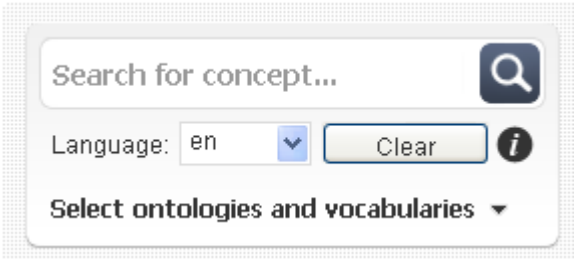
ONKI APIs

The following API versions are available.

Version	Date	Description
v1	15.04.2011	soap
v2	15.04.2011	http

Return to ONKI front page

Selector Widget



API v2

Ontology methods

The status information of the server

- ping

The ontology metadata

- getMetadata
- getAvailableLanguages
- getAvailableTypeUris

Concept search

- search

Concept hierarchy

- getConceptHierarchy
- getHierarchyRoots

Concept information

- getProperties
- getLabels
- getAltLabels
- getDescriptions
- getEquivalentConcepts
- getRelatedConcepts
- getGroups
- getTypes
- getFullPresentation

Author
Change
- Change in a hierarchy
- Change in a taxonomic concept
- Lump of taxa
- Split of a taxon

Nomenclatural status of a taxon
Nomenclature code
Reference to literature
- Checklist
- Other source
- Publication

Scientific name
Spelling status
Taxon general
Taxon in a checklist
Taxon in a name collection (25,868)
Taxon in an upper classification
Taxonomic concept
Taxonomic rank
- Biovariety
- Candidate
- Class
- Convar
- Cultivar
- Cultivar group (248)
- Denomination class
- Division
- Domain
- Empire
- Family (450)

Species or infraspecific taxon (21,590)

[create a new instance]

Page
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 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 |
43 | 44

Filter

(Species or infraspecific taxon, Taxon in a name collection)
'Argentea' auct. (Species or infraspecific taxon, Taxon in a name c...
'Blanda' auct. (Species or infraspecific taxon, Taxon in a name col...
'Francofort' auct. (Species or infraspecific taxon, Taxon in a name...
'Hansa' x nitida (Species or infraspecific taxon, Taxon in a name c...
'Hollandica' auct. (Species or infraspecific taxon, Taxon in a name...
'Repens' auct. (Species or infraspecific taxon, Taxon in a name col...
'Rudolf' auct. (Species or infraspecific taxon, Taxon in a name col...
'Sericea' auct. (Species or infraspecific taxon, Taxon in a name co...
'Summer Snow (Species or infraspecific taxon, Taxon in a name colle...
abbreviata (Species or infraspecific taxon, Taxon in a name collect...
abbreviatum (Species or infraspecific taxon, Taxon in a name collec...
abbreviatus (Species or infraspecific taxon, Taxon in a name collec...
abelicea (Species or infraspecific taxon, Taxon in a name collection)
abessinica (Species or infraspecific taxon, Taxon in a name collect...
abies (Species or infraspecific taxon, Taxon in a name collection)
abies (Species or infraspecific taxon, Taxon in a name collection)
abies 'Columnaris' (Species or infraspecific taxon, Taxon in a name...
abies 'Echiniformis' (Species or infraspecific taxon, Taxon in a na...
abies 'Globosa' (Species or infraspecific taxon, Taxon in a name co...
abies 'Hyrry' (Species or infraspecific taxon, Taxon in a name coll...
abies 'Kartio' (Species or infraspecific taxon, Taxon in a name col...
abies 'Maxwellii' (Species or infraspecific taxon, Taxon in a name ...
abies 'Nana' (Species or infraspecific taxon, Taxon in a name colle...
abies 'Nidiformis' (Species or infraspecific taxon, Taxon in a name...

name
message

Author
Change
- Change in a hierarchy
- Change in a taxonomic concept
- Lump of taxa
- Split of a taxon

Nomenclatural status of a taxon
Nomenclature code
Reference to literature
- Checklist
- Other source
- Publication

Scientific name
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Taxon in an upper classification
Taxonomic concept
Taxonomic rank
- Biovariety
- Candidate
- Class
- Convar
- Cultivar
- Cultivar group (248)
- Denomination class
- Division
- Domain
- Empire
- Family (450)

Vernacular name (19,829)

[create a new instance]

name

message

Page

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 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40

Filter

aleponmänty (Vernacular name)
alepponkierto (Vernacular name)
alepponmänty (Vernacular name)
alepponmänty (Vernacular name)
alepponmorsinko (Vernacular name)
alfalfa (Vernacular name)
alfredinsineraaria (Vernacular name)
algeriankampakaninkeltto (Vernacular name)
algeriankampakaninkeltto (Vernacular name)
algerianpihta (Vernacular name)
algerianpiippuruoho (Vernacular name)
algerianpiippuruoho (Vernacular name)
algeriantamariski (Vernacular name)
algeriantatar (Vernacular name)
algerianvoikeltto (Vernacular name)
algerianvoikeltto (Vernacular name)
algerianvuorisauramo (Vernacular name)
algerianvuorisauramo (Vernacular name)
alkanna (Vernacular name)
alkannat (Vernacular name)
allaslumme (Vernacular name)
alligaattori(n)kurpitsa (Vernacular name)
alligaattorinkurpitsa (Vernacular name)
allonokkoset (Vernacular name)
alokasiat (Vernacular name)
alpiot (Vernacular name)

http://www.yso.fi/onto/bio/Vanamo_Species_5821

name
message

Species or infraspecific taxon, Taxon in a name collection: tomentellus

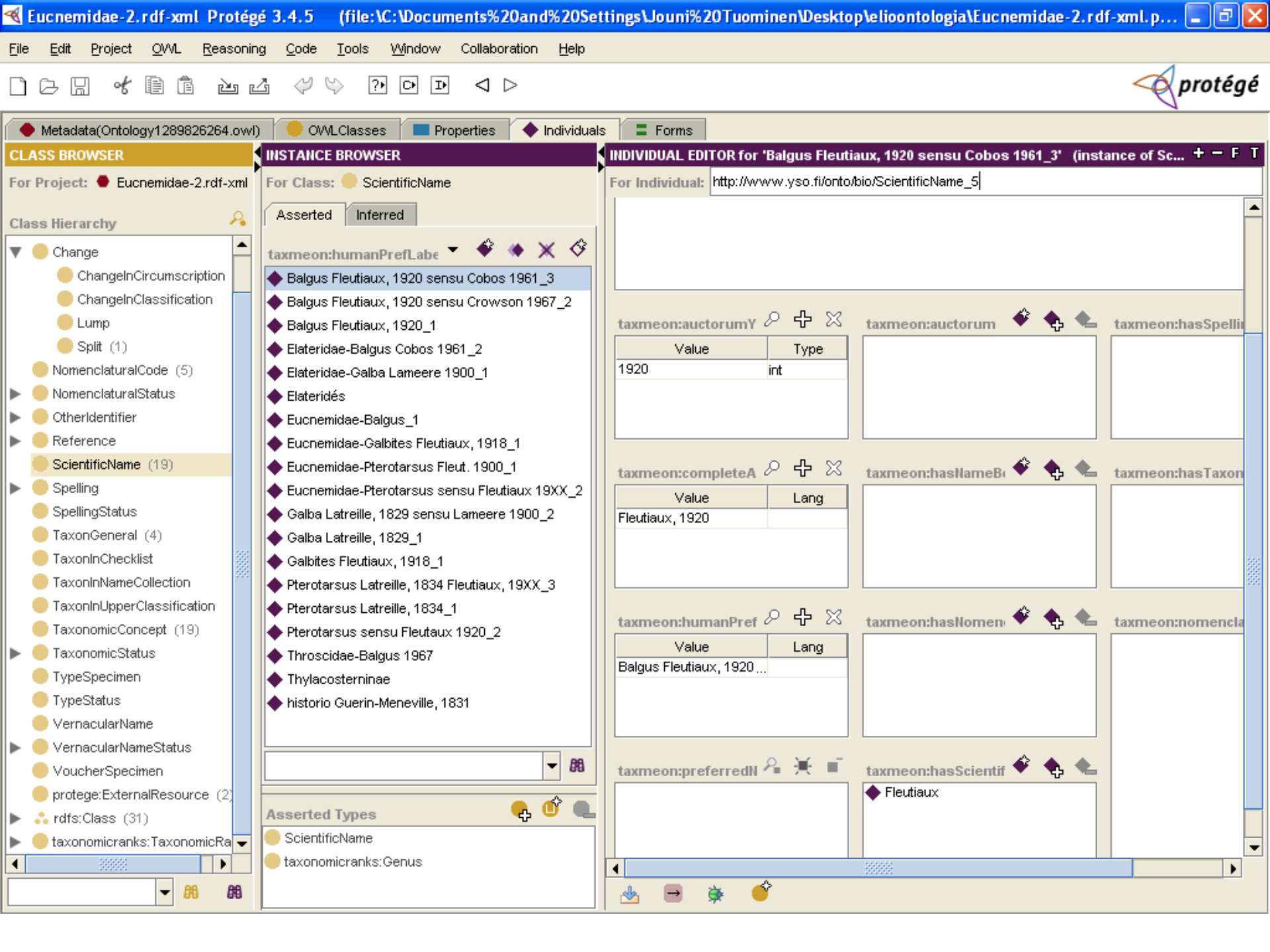
[edit]

comment	Päivämäärä: 2004, Suomalaisen nimen lähde: Vanamon toimikunta
completeTaxonName	Cotoneaster tomentellus
Has vernacular name	arotuhkapensas
Has name status	Accepted
Is part of higher taxon	Cotoneaster
label	tomentellus
type	Species or infraspecific taxon, Taxon in a name collection

References (1)

arotuhkapensas (Vernacular name) ← inverse_of_hasVernacularName

Has vernacular name status	Accepted vernacular name
inverse_of_hasVernacularName	tomentellus
label	arotuhkapensas
type	Vernacular name


Eucnemidae-2.rdf-xml Protégé 3.4.5 (file:\C:\Documents%20and%20Settings\Jouni%20Tuominen\Desktop\elioontologia\Eucnemidae-2.rdf-xml.p...
File Edit Project OWL Reasoning Code Tools Window Collaboration Help
protégé
Metadata(Ontology1289826264.owl) OWLClasses Properties Individuals Forms
CLASS BROWSER
For Project: Eucnemidae-2.rdf-xml
Class Hierarchy
Change
ChangeInCircumscription
ChangeInClassification
Lump
Split (1)
NomenclaturalCode (5)
NomenclaturalStatus
OtherIdentifier
Reference
ScientificName (19)
Spelling
SpellingStatus
TaxonGeneral (4)
TaxonInChecklist
TaxonInNameCollection
TaxonInUpperClassification
TaxonomicConcept (19)
TaxonomicStatus
TypeSpecimen
TypeStatus
VernacularName
VernacularNameStatus
VoucherSpecimen
protege:ExternalResource (2)
rdfs:Class (31)
taxonomicranks:TaxonomicRa
INSTANCE BROWSER
For Class: ScientificName
Asserted Inferred
taxmeon:humanPrefLabe
Balgus Fleutiaux, 1920 sensu Cobos 1961_3
Balgus Fleutiaux, 1920 sensu Crowson 1967_2
Balgus Fleutiaux, 1920_1
Elateridae-Balgus Cobos 1961_2
Elateridae-Galba Lameere 1900_1
Elateridés
Eucnemidae-Balgus_1
Eucnemidae-Galbites Fleutiaux, 1918_1
Eucnemidae-Pterotarsus Fleut. 1900_1
Eucnemidae-Pterotarsus sensu Fleutiaux 19XX_2
Galba Latreille, 1829 sensu Lameere 1900_2
Galba Latreille, 1829_1
Galbites Fleutiaux, 1918_1
Pterotarsus Latreille, 1834 Fleutiaux, 19XX_3
Pterotarsus Latreille, 1834_1
Pterotarsus sensu Fleutaux 1920_2
Throscidae-Balgus 1967
Thylacosterninae
historio Guerin-Meneville, 1831
Asserted Types
ScientificName
taxonomicranks:Genus
INDIVIDUAL EDITOR for 'Balgus Fleutiaux, 1920 sensu Cobos 1961_3' (instance of Sc...
For Individual: http://www.yso.fi/onto/bio/ScientificName_5
taxmeon:auctorumY
Value Type
1920 int
taxmeon:auctorum
taxmeon:hasSpelli
taxmeon:completeA
Value Lang
Fleutiaux, 1920
taxmeon:hasNameB
taxmeon:hasTaxon
taxmeon:humanPref
Value Lang
Balgus Fleutiaux, 1920 ...
taxmeon:hasNomen
taxmeon:nomencla
taxmeon:preferredN
taxmeon:hasScientif
Fleutiaux

Future work

- Using TaxMeOn ontologies
  - to provide better search, recommendation, etc. services to observational data of organisms (e.g. birds)
  - in portal for sharing and controlling biodiversity occurrence data in the EU project Envirofi

Thank you!

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  - nina.laurenne@helsinki.fi (biology)
- More information:
  - research project page: http://www.seco.tkk.fi/ontologies/biology/
  - TaxMeOn schema specification: http://schema.onki.fi/taxmeon
  - species lists in ONKI ontology service: http://onki.fi
  - common name collection management in SAHA editor: http://demo.seco.tkk.fi/saha/VascularPlants