A BARCODING FACILITY FOR ORGANISMS & TISSUES OF POLICY CONCERN

NATHALIE SMITZ, KENNY MEGANCK, ANN VANDERHEYDEN, ANICEE LOMBAL,
THIERRY BACKELJAU & MARC DE MEYER

BopCo

EMPOWERING BIODIVERSITY CONFERENCE

24-25 MAY 2022

bopco@naturalsciences.be

http://bopco.myspecies.info/

museum

LifeWatch

belspo

AFRICA museum

A BARCODING FACILITY FOR ORGANISMS & TISSUES OF POLICY CONCERN

NATHALIE SMITZ, KENNY MEGANCK, ANN VANDERHEYDEN, ANICEE LOMBAL,
THIERRY BACKELJAU & MARC DE MEYER

BopCo

BOPCO JOINTLY RUN
BY RBINS AND RMCA

FEDERAL CONTRIBUTION
TO THE ERIC LIFEWATCH

museum

LifeWatch

belspo

AFRICA museum

A BARCODING FACILITY FOR ORGANISMS & TISSUES OF POLICY CONCERN

BopCo

- Aim: Supplying identifications of policy concern organisms and derived products

A BARCODING FACILITY FOR ORGANISMS & TISSUES OF POLICY CONCERN

BopCo

- Aim: Supplying identifications of policy concern organisms and derived products
- Objective: Provide access to knowledge (taxonomic expertise) and infrastructure (laboratory) necessary to identify biological samples of policy concern

A BARCODING FACILITY FOR ORGANISMS & TISSUES OF POLICY CONCERN

BopCo

- Aim: Supplying identifications of policy concern organisms and derived products
- Objective: Provide access to knowledge (taxonomic expertise) and infrastructure (laboratory) necessary to identify biological samples of policy concern
- For whom: All stakeholders who deal with biological materials of policy concern and who need an accurate identification

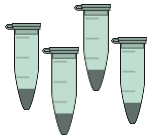
A BARCODING FACILITY FOR ORGANISMS & TISSUES OF POLICY CONCERN

- Aim: Supplying identifications of policy concern organisms and derived products
- Objective: Provide access to knowledge (taxonomic expertise) and infrastructure (laboratory) necessary to identify biological samples of policy concern
- For whom: All stakeholders who deal with biological materials of policy concern and who need an accurate identification
- Conditions: Compliance with BopCo scope & Costs may be charged

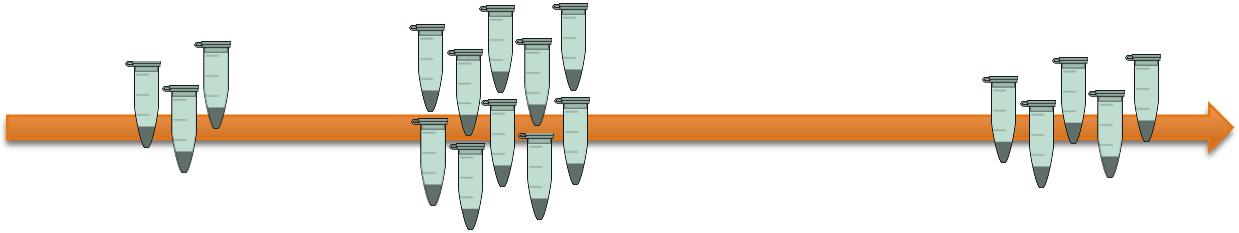
- Policy concern organisms including endangered species, invasive alien species, human and veterinary disease organisms or their vectors, species of forensic relevance, agricultural pest species, organisms of the human food chain, etc.

IDENTIFICATION REQUESTS AND PROJECTS

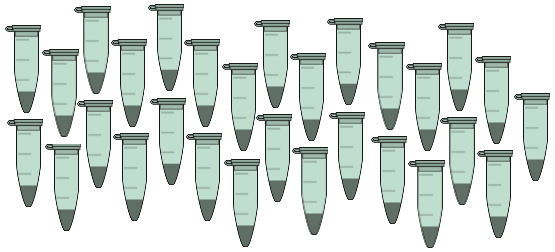
- Punctual identification requests



- Recurrent identification requests



- Identification projects & filling the gaps



Morphological characteristics

Monographs, identification keys, scientific periodic

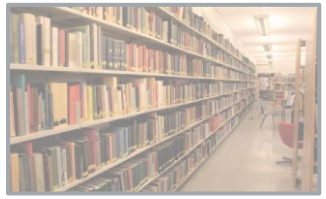
Microscopy

Network of in-house and external taxonomic experts

Specimen collections

Morphological characteristics

Monographs, identification keys, scientific periodic



Microscopy

Network of in-house and external taxonomic experts

Specimen collections

Meretrix meretrix

Excluding CITES-listed species by partial ID

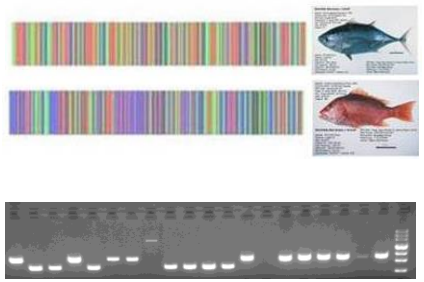
Hippopus hippopus

All species of the genus *Tridacnidae* (giant clams) are CITES-listed

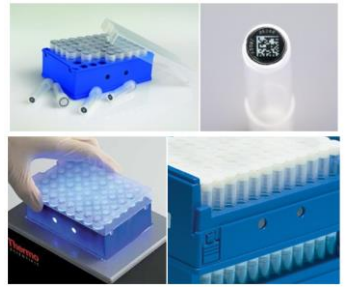
Strombus gigas

Confirmation of non CITES-listed species ID

DNA-based techniques



Access to laboratory facilities and sequence databases

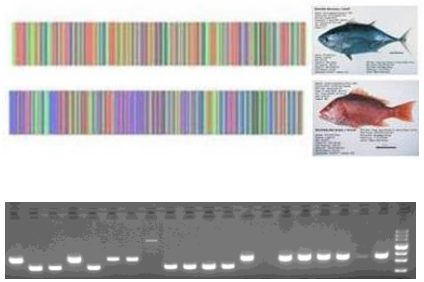


MORPHOLOGY??

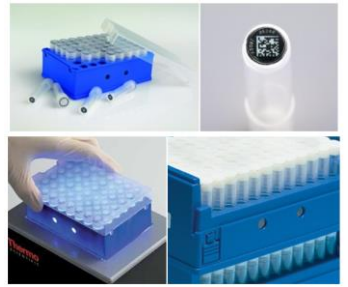
Early life stage, damaged specimen, processed sample, trace material,….

DNA Barcoding

DNA-based techniques



Access to laboratory facilities and sequence databases



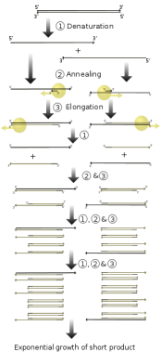
MORPHOLOGY??

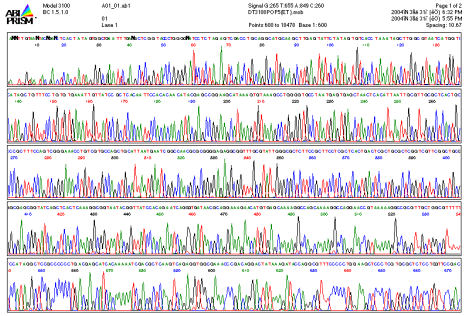
Early life stage, damaged specimen, processed sample, trace material,….

DNA Barcoding

DNA Extraction

Amplification

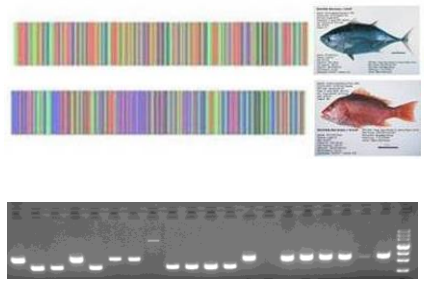




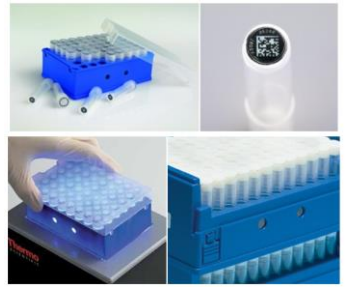
Sequencing

…TTGCCTTATGATCAGGAACC….

DNA-based techniques



Access to laboratory facilities and sequence databases



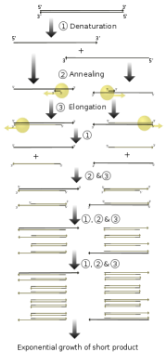
MORPHOLOGY??

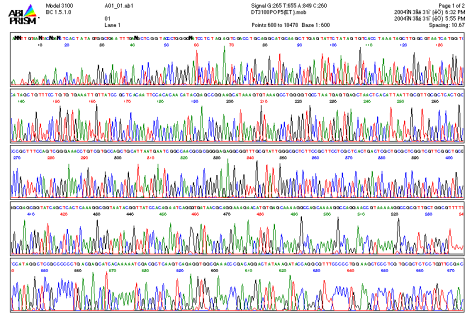
Early life stage, damaged specimen, processed sample, trace material,….

DNA Barcoding

DNA Extraction

Amplification

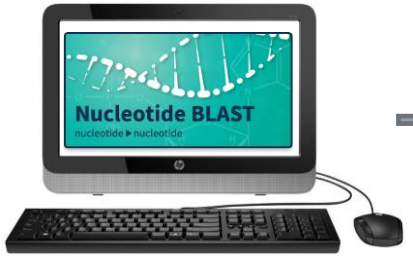


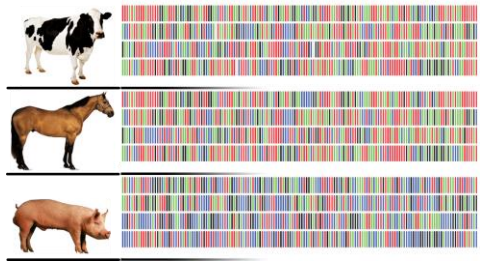


Sequencing

…TTGCCTTATGATCAGGAACC….

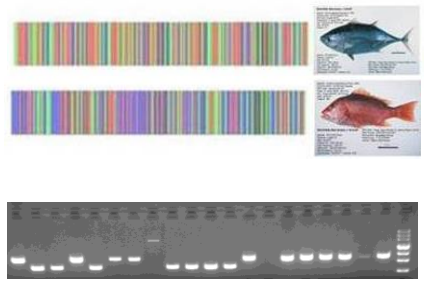
Comparison



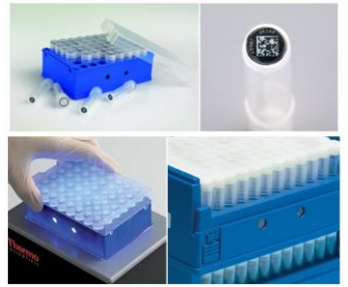


Online repositories

DNA-based techniques



Access to laboratory facilities and sequence databases



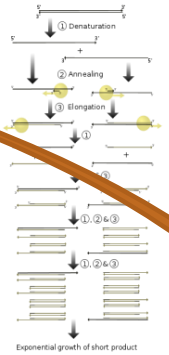
MORPHOLOGY??

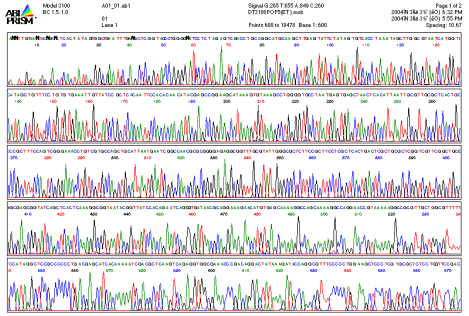
Early life stage, damaged specimen, processed sample, trace material,….

DNA Barcoding

DNA Extraction

Amplification

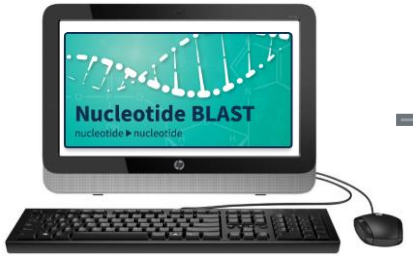


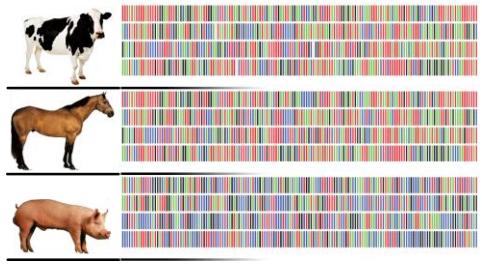


Sequencing

TTGCCTTATGATCAGGAACC….

Comparison

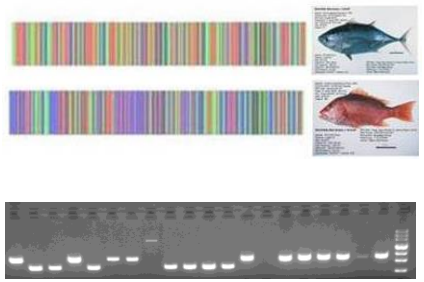




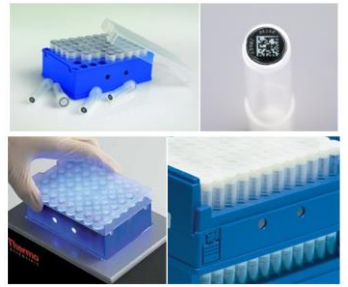
Online repositories

Species identification

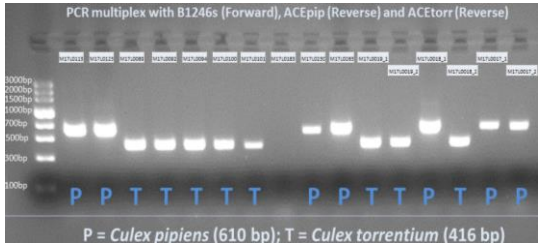
DNA-based techniques

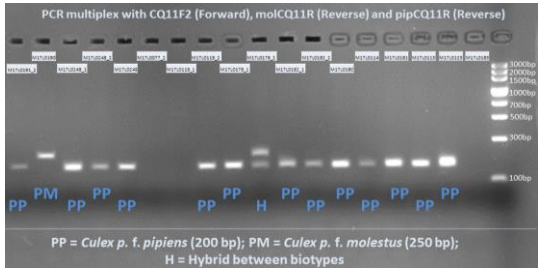


Access to laboratory facilities and sequence databases

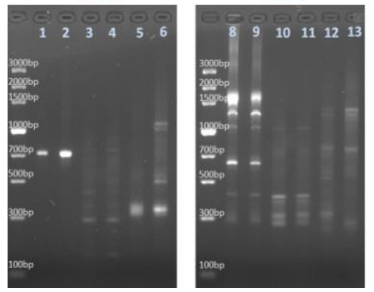


Size fragment analyses
Mosquito species & biotype identifications

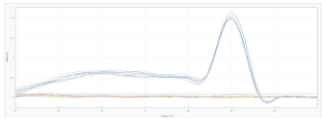




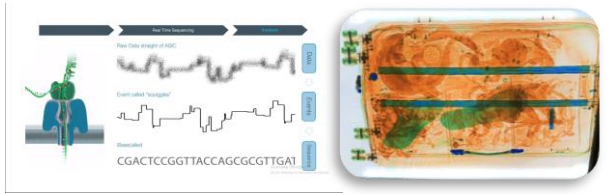
Random Amplified Polymorphic DNA
CITES species identification



eDNA - qPCR
Detection of the invasive *Xenopus laevis* using environmental DNA (eDNA) from aquatic samples

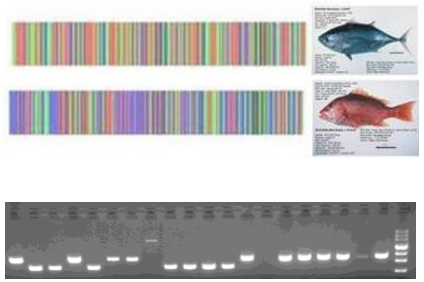


MinION
Understanding illegal wild meat markets and associated health risks in target EU countries

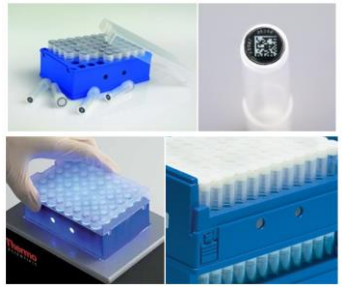


WWF

DNA-based techniques

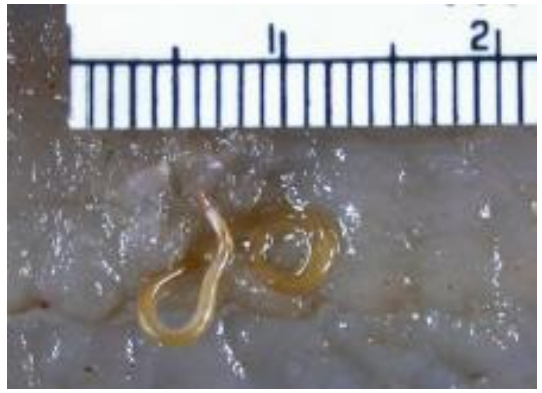


Access to laboratory facilities and sequence databases



Agricultural pest:
ID of morphologically undistinguishable fruit fly pests from orchards in South Africa

Disease organisms and their vectors:
ID of parasitic worm found in a cod fillet → *Pseudoterranova decipiens* = sealworm



Exotic species:
ID of a new alien invasive terrestrial flatworm for Belgium → *Caenoplana bicolor* which is native to Australia

Pest species:
ID and tracing origin of insect larva and pupa found in drum of chemical product → *Plodia interpunctella* = a world-wide pest of stored products

Referring to network

INSTITUTE OF TROPICAL MEDICINE ANTWERP

CETAF
CONSORTIUM OF EUROPEAN TAXONOMIC FACILITIES

BeBoL
Belgian Network for DNA Barcoding of Life

Network of scientific institutes and collaborators

NICC INCC

JEMU

Referring to network

INSTITUTE OF TROPICAL MEDICINE ANTWERP

CETAF CONSORTIUM OF EUROPEAN TAXONOMIC FACILITIES

BeBoL Belgian Network for DNA Barcoding of Life

Network of scientific institutes and collaborators

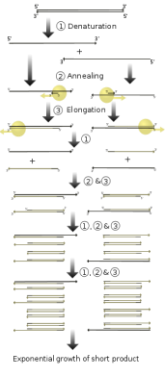
NICC INCC

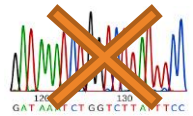
JEMU

ID of fungi for notary office from Brussels

no in-house taxonomic expertise or technical facilities

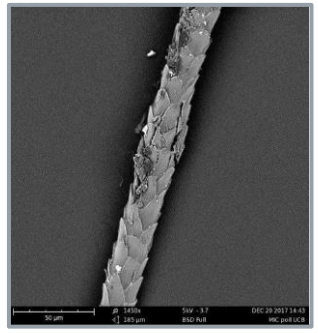
Quantity?
Quality?





ID of a non-human hair

shrew
or harvest mouse
or dormouse



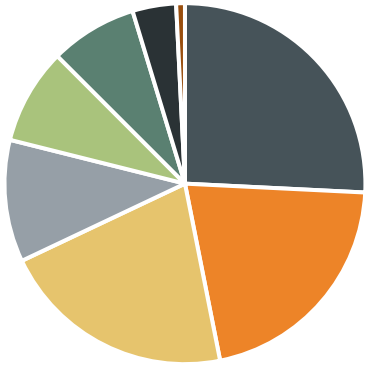
Botanic Garden Meise

NICC INCC

PUNCTUAL IDENTIFICATION REQUESTS

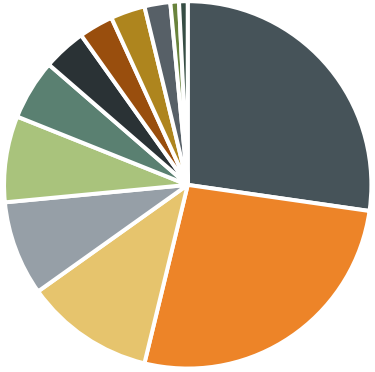
OVERVIEW IDENTIFICATION REQUESTS UNTIL OCTOBER 2021 (N=128)

Policy Concern



- Pest species
- Agricultural pest
- Protected species
- Biodiversity
- Public health
- Exotic species
- Food safety
- Museum validation

Taxon diversity

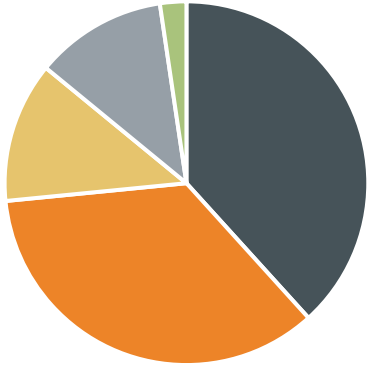


- Diptera
- Other Insecta
- Arachnida
- Mollusca
- Mammalia
- Other invertebrates
- Aves
- Plantae
- Pisces
- Reptilia
- Fungi
- Virus

Stakeholders

- Government
- Research Institute
- Private person
- University
- Company
- Museum
- Small business
- NGO

Outcome



- Morphology-based ID
- DNA-based ID
- Literature-based information
- Morphology-based + DNA-based ID
- Referral to an external expert

RECURRENT IDENTIFICATION REQUESTS EXAMPLES

Bird strikes: ID bird remains for Belgian Air Force and Brussels Airport

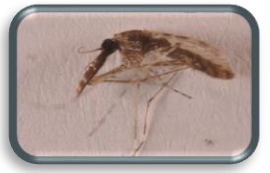
Disease organisms and their vectors: ID of mosquitoes from Belgium and countries of deployment for the Belgian Army

Disease organisms and their vectors: Identifying all life stages of (exotic) mosquitoes within the framework of the Monitoring of Exotic MOsquitoes in Belgium (MEMO) project

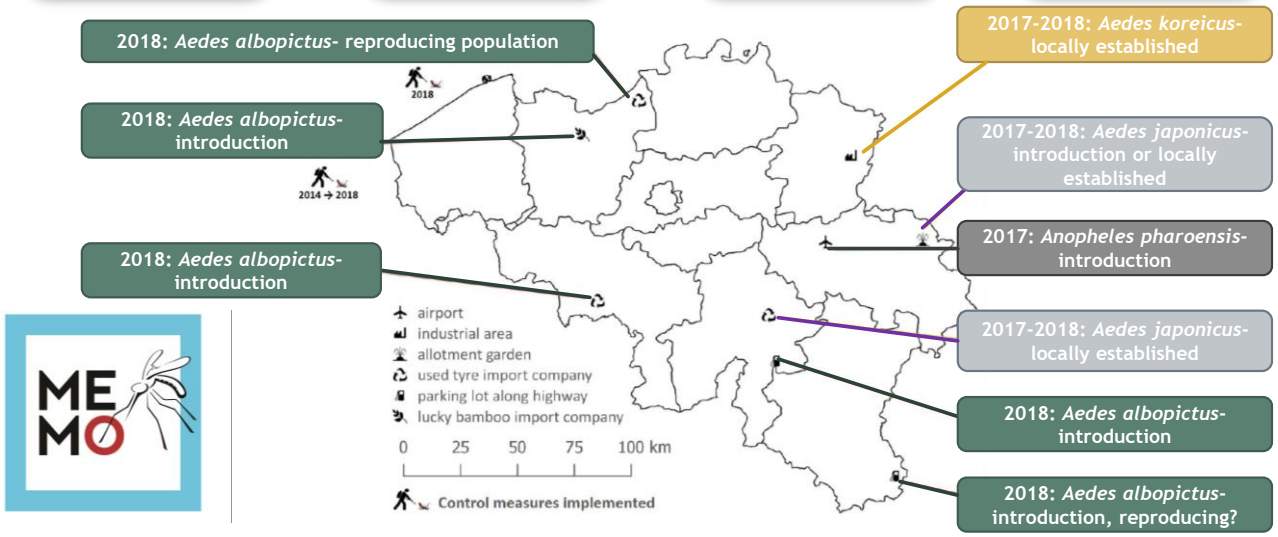
Aedes albopictus

Aedes koreicus

Anopheles pharoensis



Aedes japonicus



Map of Belgium indicating the PoEs where EMS were detected in 2017 and 2018 (data ITM)

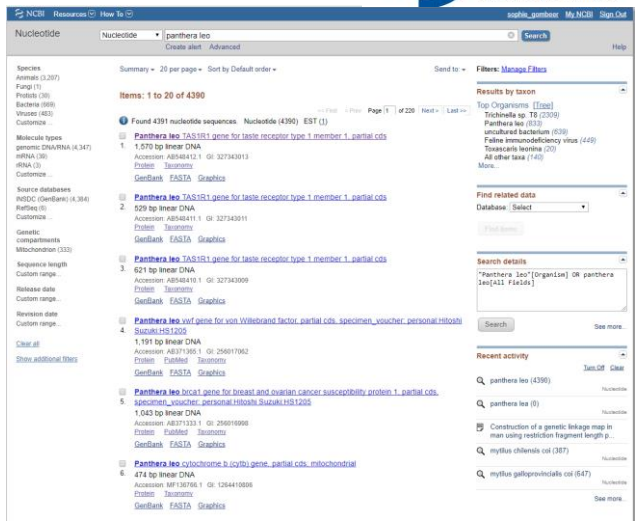
Limitations of DNA-based technologies

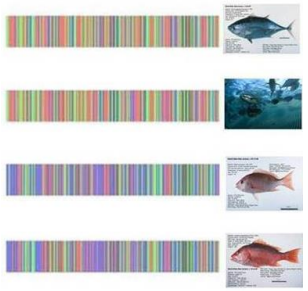
- Reference database: success species identification depends on available sequence data
  - comprehensive, otherwise identification only to higher taxonomic level
  - reliable, if mistakes in the databases no confident identification can be made

- Different markers
- Data publically available
- No requirements for sequences
- No curation of data

GenBank

NCBI National Center for Biotechnology Information





Reference library

Online repositories

- Barcodes, e.g. COI (animals)
- Not all publically available
- Strict requirements: - vouchers
  - metadata
  - quality & length

BOLD SYSTEMS

BOLD

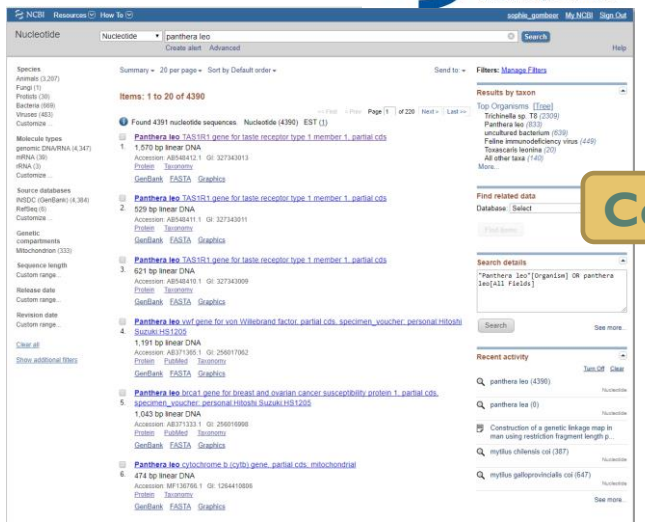
Limitations of DNA-based technologies

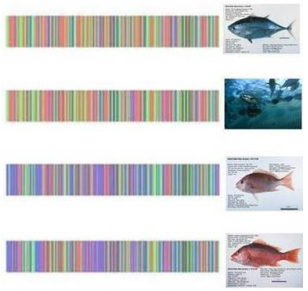
- Reference database: success species identification depends on available sequence data
  - comprehensive, otherwise identification only to higher taxonomic level
  - reliable, if mistakes in the databases no confident identification can be made

- Different markers
- Data publically available
- No requirements for sequences
- No curation of data

GenBank

NCBI
National Center for
Biotechnology Information



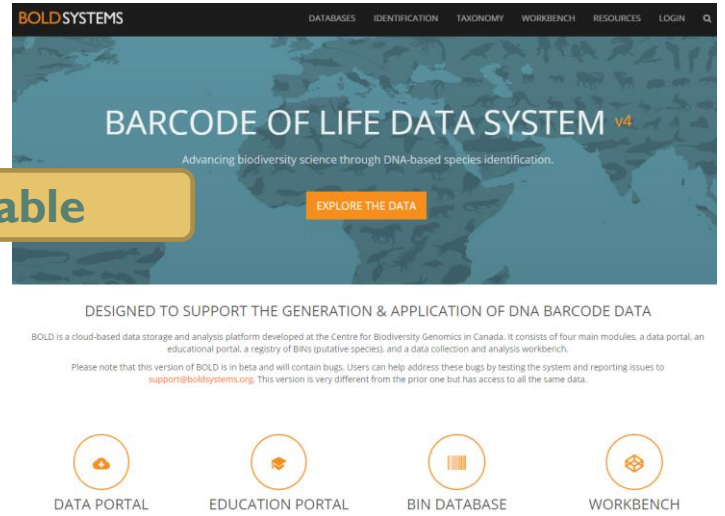


Reference library
Online repositories

- Barcodes, e.g. COI (animals)
- Not all publically available
- Strict requirements: - vouchers
  - metadata
  - quality & length

BOLD SYSTEMS

BOLD



Comprehensive

Reliable

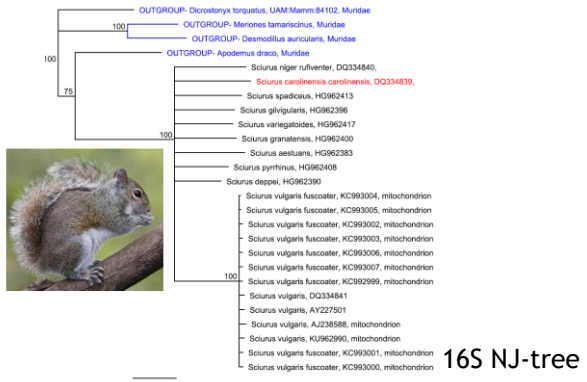
Use both databases in combination to compare and interpret the results, taking in to account the strengths and weaknesses of each

IDENTIFICATION PROJECTS & FILLING THE GAPS EXAMPLES

Invasive Alien Species:
in silico testing of available sequence data
Evaluate ID reliability of 49 IAS on EU list based on publicly available DNA sequences to identify gaps in the online databases

49 species on Regulation 1143/2014 issued by the European Commission

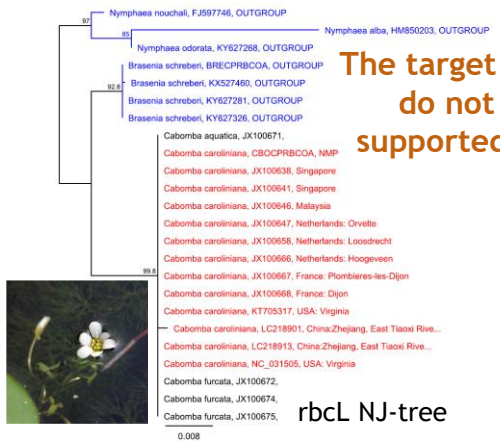
Insufficient publicly available DNA sequences of the target species to capture the intra-species divergence



16S NJ-tree

Eastern Gray squirrel (Sciurus carolinensis)

Insufficient publicly available DNA sequences of the congeners to capture the inter-species divergence



The target sequences do not form a supported cluster

rbcL NJ-tree

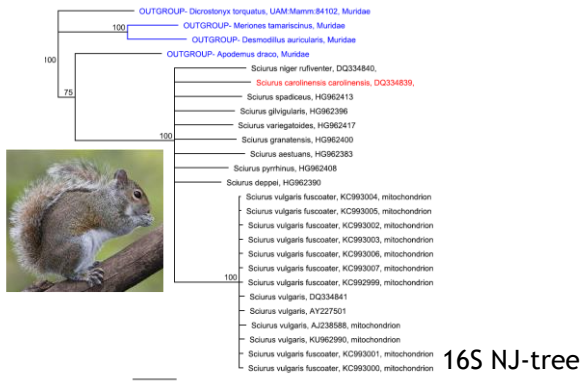
Carolina fanwort (Cabomba caroliniana)

IDENTIFICATION PROJECTS & FILLING THE GAPS EXAMPLES

Invasive Alien Species:
in silico testing of available sequence data
Evaluate ID reliability of 49 IAS on EU list based on publicly available DNA sequences to identify gaps in the online databases

49 species on Regulation 1143/2014 issued by the European Commission

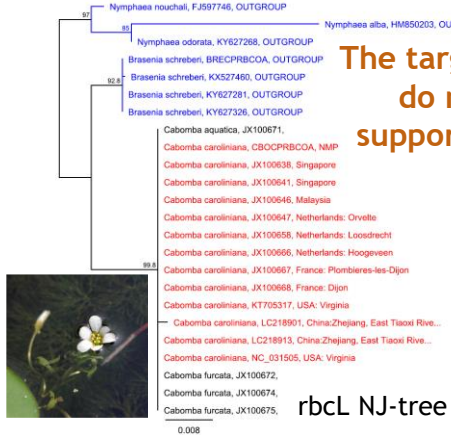
Insufficient publicly available DNA sequences of the target species to capture the intra-species divergence



16S NJ-tree

Eastern Gray squirrel (Sciurus carolinensis)

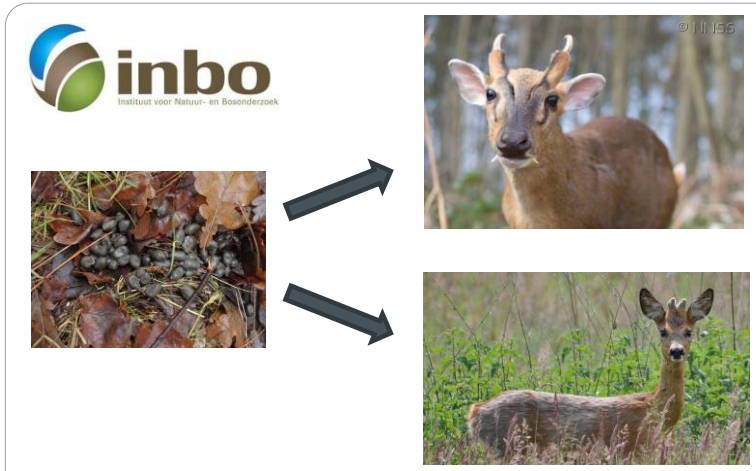
Insufficient publicly available DNA sequences of the congeners to capture the inter-species divergence



The target sequences do not form a supported cluster

rbcL NJ-tree

Carolina fanwort (Cabomba caroliniana)



IDENTIFICATION PROJECTS & FILLING THE GAPS EXAMPLES

Forensic species:
Building a barcode reference library for the Belgian rove beetle species (Staphylinidae) of forensic importance in collaboration with the NICC

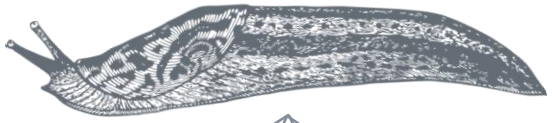
National Institute of Criminalistics and Criminology

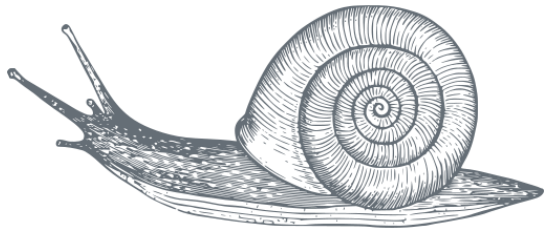
48 species of rove beetles of forensic interest

Estimate post mortem interval

IDENTIFICATION PROJECTS & FILLING THE GAPS EXAMPLES

Disease vectors:
ID of terrestrial snails and slugs acting as intermediate hosts of nematode parasites, e.g. metastrongyloid lungworms that infect canids, felids and humans





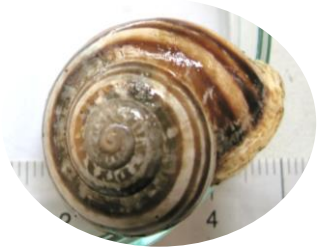
Ambigolimax valentianus
(N = 1)

Deroceras sp.
(N = 1)

Limax cf. *conemenosi*
(N = 1)

Tandonia cf. *sowerbyi*
(N = 1)

Cornu aspersum
(N = 3)



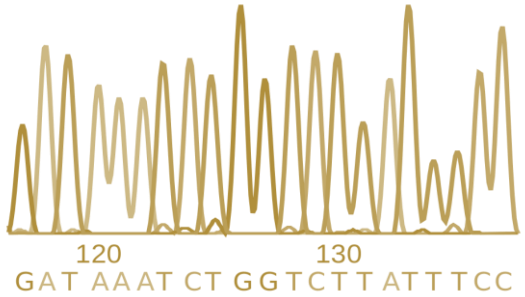
Eobania vermiculata
(N = 6)

Helix lucorum
(N = 1)

BOPCO SEQUENCE DATABASE

- Sanger sequencing of ≠ marker regions:

COI, 16S rRNA, NADH4, 28S, EF1-alpha, wg, LW Rh, ITS, cytb, rbcL, matK, trnH-psbA, COII, …



- Generated sequences:
  - Deposition in GenBank (including BioProjects)
  - Voucher specimen barcodes → BOLD

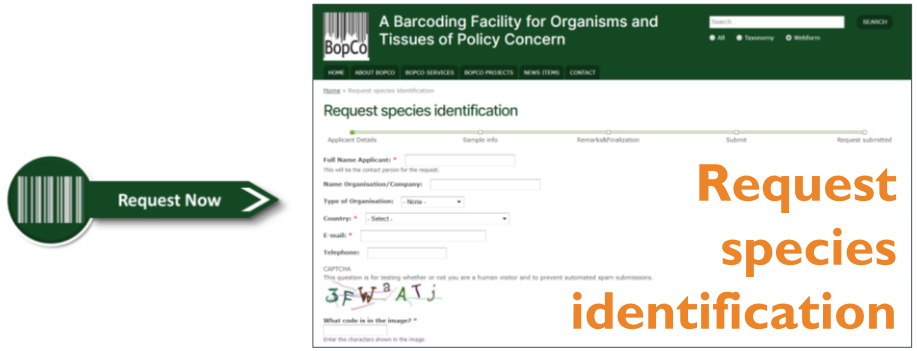
NCBI
National Center for Biotechnology Information

BOLD SYSTEMS

A BARCODING FACILITY FOR ORGANISMS & TISSUES OF POLICY CONCERN

bopco@naturalsciences.be

HTTP://BOPCO.MYSPECIES.INFO/



Request species identification

Information folder