Molecular tools to support impact assessment surveys and monitoring in Western Australia

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Biologic

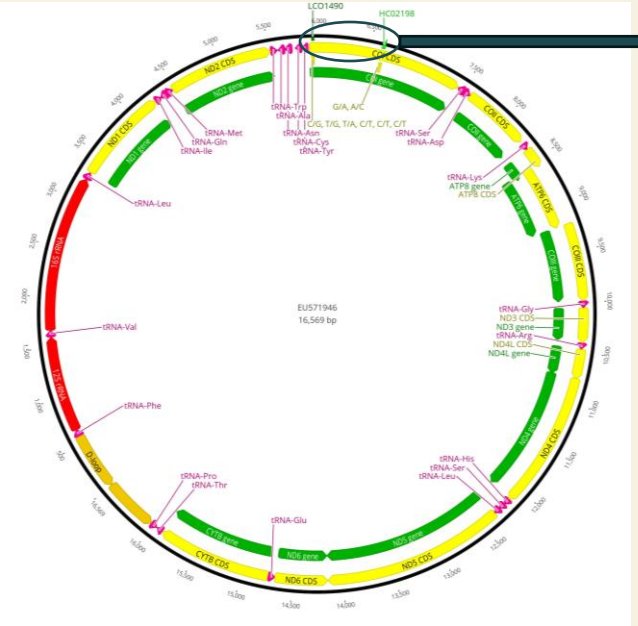
Questions

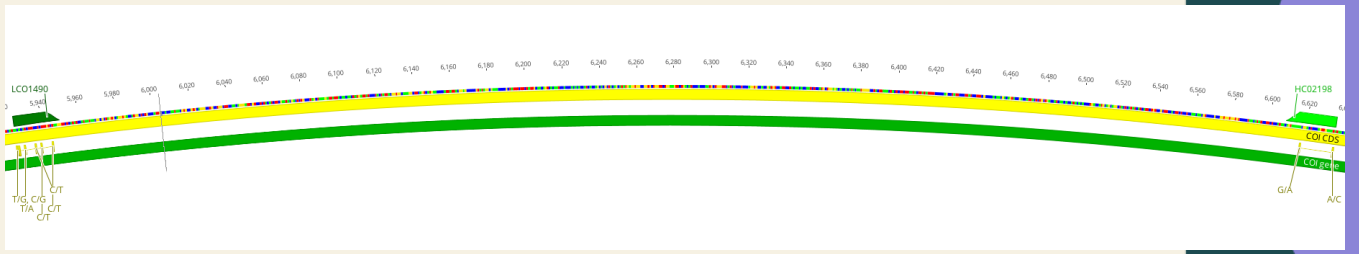
- When will DNA barcoding replace morphology?
- Why you should give me your sequence data!
- Why can’t we just do Environmental DNA?

Biologic

DNA Barcoding

- Identification of species using a short fragment of DNA





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DNA Barcoding

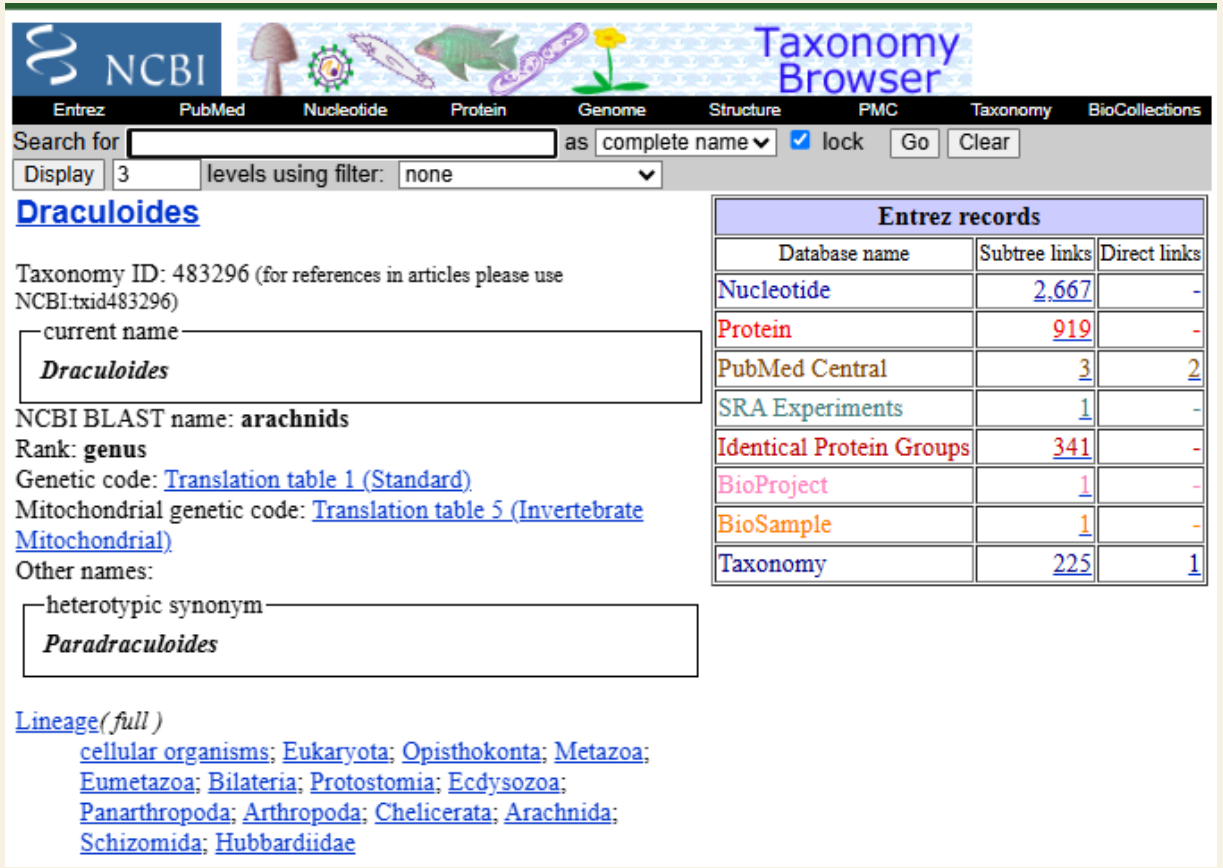
- *Draculoides* (Schizomida: Hubbardiidae)
  - Hyper-diverse subterranean radiation in the Pilbara
  - Most species are Short Range Endemics
  - Juveniles and females are morphologically cryptic

The West Australian, 29 March 2007

Draculoides julianneae (Cape Range) – video courtesy of WA Museum (Clay Bryce, Kym Abrams and Mark Harvey)

Biologic

DNA Barcoding



NCBI Taxonomy Browser

Entrez | PubMed | Nucleotide | Protein | Genome | Structure | PMC | Taxonomy | BioCollections

Search for [ ] as [complete name] lock [Go] [Clear]

Display [3] levels using filter: [none]

Draculoides

Taxonomy ID: 483296 (for references in articles please use NCBI:txid483296)

current name
Draculoides

NCBI BLAST name: **arachnids**
Rank: **genus**
Genetic code: Translation table 1 (Standard)
Mitochondrial genetic code: Translation table 5 (Invertebrate Mitochondrial)
Other names:

heterotypic synonym
Paradraculoides

Lineage *(full)*
cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Chelicerata; Arachnida; Schizomida; Hubbardiidae

Entrez records

Database name	Subtree links	Direct links
Nucleotide	2,667	-
Protein	919	-
PubMed Central	3	2
SRA Experiments	1	-
Identical Protein Groups	341	-
BioProject	1	-
BioSample	1	-
Taxonomy	225	1

Speciation patterns in complex subterranean environments: a case study using short-tailed whipscorpions (Schizomida: Hubbardiidae)

DANILO HARMS[1*], MICHAEL K. CURRAN[2], ROBERT KLESSER[1], TERRIE L. FINSTON[3] and STUART A. HALSE[2]

[1]*Zoological Museum, Center of Natural History, University of Hamburg, Martin-Luther-King-Platz 3, D-20146 Hamburg, Germany*
[2]*Bennelongia Environmental Consultants, 5 Bishop Street, Jolimont, W.A. 6014, Australia*
[3]*School of Animal Biology (M092), University of Western Australia, Crawley, W.A. 6009, Australia*

Too hot to handle: Cenozoic aridification drives multiple independent incursions of Schizomida (Hubbardiidae) into hypogean environments

Kym M. Abrams[a,b,*], Joel A. Huey[b,a,c], Mia J. Hillyer[b], William F. Humphreys[b,a], Raphael K. Didham[a,d], Mark S. Harvey[b,a]

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[b] *Department of Terrestrial Zoology, Western Australian Museum, Locked Bag 49, Welshpool DC, Western Australia 6986, Australia*
[c] *School of Natural Sciences, Edith Cowan University, Joondalup, Western Australia 6027, Australia*
[d] *CSIRO Health & Biosecurity, Centre for Environment and Life Sciences, Floreat, Western Australia 6014, Australia*

A systematic revision of *Draculoides* (Schizomida: Hubbardiidae) of the Pilbara, Western Australia, Part I: the Western Pilbara

KYM M. ABRAMS[1,2*], JOEL A. HUEY[2,1,3], MIA J. HILLYER[2,5], RAPHAEL K. DIDHAM[1,4] & MARK S. HARVEY[2,1,6]

Molecular and morphological characterization of new species of hypogean *Paradraculoides* (Schizomida: Hubbardiidae) from the arid Pilbara bioregion of Western Australia

Volker W. Framenau[1,2,3], Zoë R. Hamilton[2,4], Terrie Finston[2], Garth Humphreys[1,2,4], Kym M. Abrams[1,2], Joel A. Huey[1,2,5] and Mark S. Harvey[1,2]: [1]Department of Terrestrial Zoology, Western Australian Museum, Locked Bag 49, Welshpool

Molecular and morphological systematics of hypogean schizomids (Schizomida : Hubbardiidae) in semiarid Australia

Mark S. Harvey[A,D], Oliver Berry[B], Karen L. Edward[A] and Garth Humphreys[C]

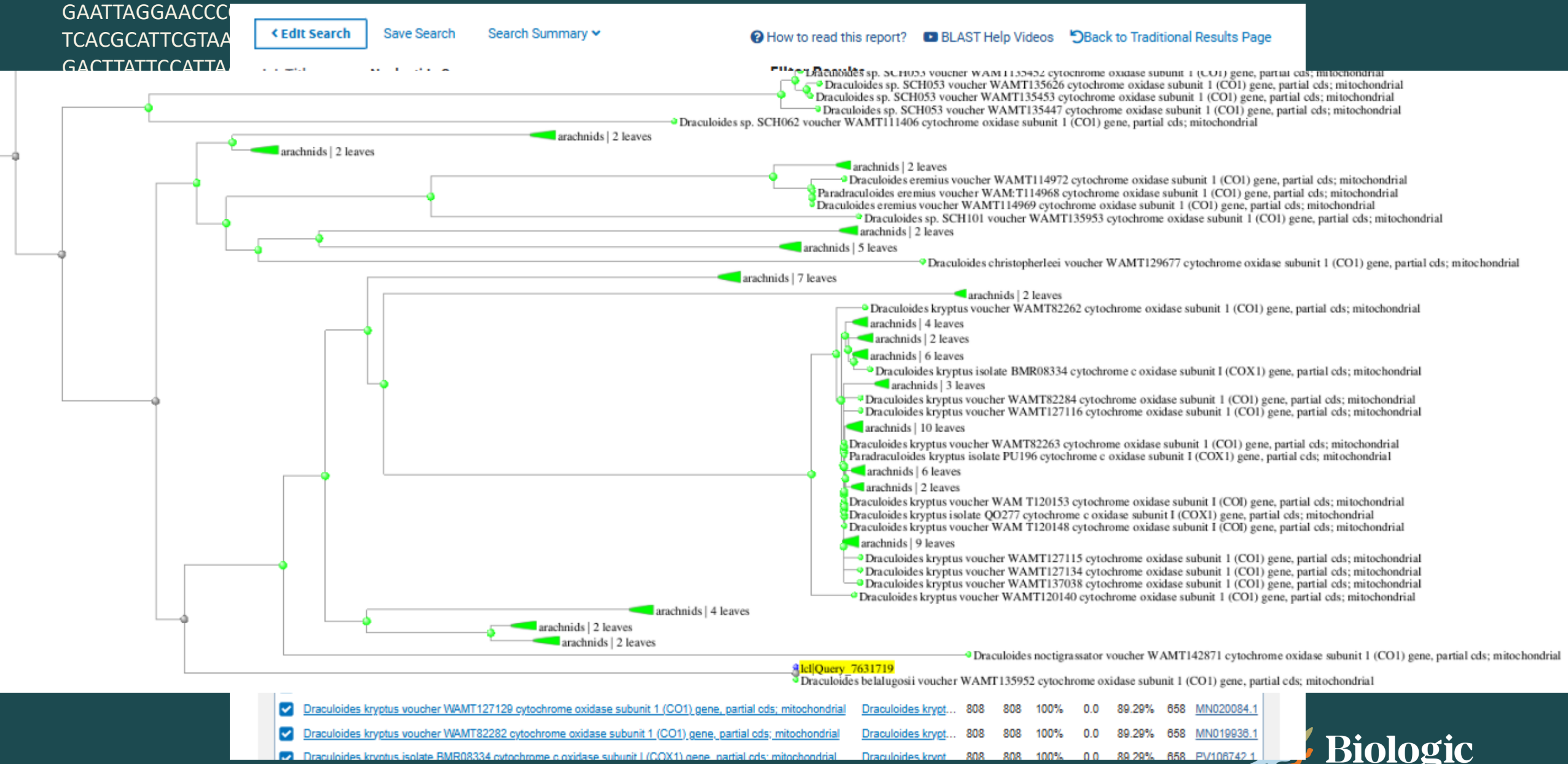
Biologic

Lineage (full): cellular organisms; Eukaryota; Opisthokonta; Metazoa; Eumetazoa; Bilateria; Protostomia; Ecdysozoa; Panarthropoda; Arthropoda; Chelicerata; Arachnida; Schizomida; Hubbardiidae

- **Draculoides** LinkOut *Click on organism name to get more information.*
  - Draculoides affinis
  - Draculoides akashae
  - Draculoides anachoretus LinkOut
  - Draculoides belalugosii
  - Draculoides bramstokeri LinkOut
  - Draculoides brooksi
  - Draculoides bythius LinkOut
  - Draculoides carmillae
  - Draculoides catho
  - Draculoides celatus
  - Draculoides christopherleei
  - Draculoides claudiae
  - Draculoides cochranus
  - Draculoides confusus
  - Draculoides eremius LinkOut
  - Draculoides gnophicola LinkOut
  - Draculoides immortalis
  - Draculoides julianneae LinkOut
  - Draculoides kryptus LinkOut
  - Draculoides mckechnieorum
  - Draculoides mesozeirus LinkOut
  - Draculoides minae
  - Draculoides noctigrassator
  - Draculoides nosferatu
  - Draculoides obrutus
  - Draculoides piscivultus
  - Draculoides trinity
  - Draculoides vinei LinkOut
  - Draculoides warramboo
  - unclassified Draculoides
    - Draculoides sp. 'Paradraculoides' OFB-2007
    - Draculoides sp. B2 group BSC001
    - Draculoides sp. B2 group BSC003
    - Draculoides sp. B2 group BSC021
    - Draculoides sp. B2 group BSC022
    - Draculoides sp. B2 group BSC033
    - Draculoides sp. B2 group SCH023
    - Draculoides sp. B555353
    - Draculoides sp. B558132
    - Draculoides sp. B576659
    - Draculoides sp. B578143
    - Draculoides sp. B621842
    - Draculoides sp. Biologic-SCHI010
    - Draculoides sp. Biologic-SCHI011
    - Draculoides sp. Biologic-SCHI012
    - Draculoides sp. Biologic-SCHI013
    - Draculoides sp. Biologic-SCHI014
    - Draculoides sp. Biologic-SCHI015
    - Draculoides sp. Biologic-SCHI016
    - Draculoides sp. Biologic-SCHI017
    - Draculoides sp. Biologic-SCHI018
    - Draculoides sp. Biologic-SCHI019
    - Draculoides sp. Biologic-SCHI023
    - Draculoides sp. BSC039
    - Draculoides sp. BSC042-DNA
    - Draculoides sp. SCH002
    - Draculoides sp. SCH003
    - Draculoides sp. SCH004
    - Draculoides sp. SCH009
    - Draculoides sp. SCH012
    - Draculoides sp. SCH012 group BSC030
    - Draculoides sp. SCH016
    - Draculoides sp. SCH019
    - Draculoides sp. SCH020
    - Draculoides sp. SCH021
    - Draculoides sp. SCH023
    - Draculoides sp. SCH027
    - Draculoides sp. SCH030 complex BSC036
    - Draculoides sp. SCH031
    - Draculoides sp. SCH032
    - Draculoides sp. SCH037

gic

CCTAATCTTTGGAATATGAGCAGGAATTTTAGGAAGAGCCCTCAGAATCTTAATTCGAATT
GAATTAGGAACCC
TCACGCATTCGTAA
GACTTATTCCATTA



Biologic

Select stygofauna specimens

A) Bogidiellidae sp. `Biologic-AMPH121`
B) Eriopsidae sp. `Biologic-AMPH122`
C) *Nedsia sp.*
D) *Halosbaena sp.*
E) Candonidae sp.
F) Hydrobiidae sp.
G) *Kagalana sp.* `Biologic-ISO214`
H) *Pilbaraphreatoicus sp.* `Biologic-ISO074`
I) *Atopobathynella sp.*
J) *Pilbarana sp.*
K) *Elaphoidella sp.*
L) *Stygoridgewayia sp.*
M) Chydoridae sp.
N) *Halicyclops sp.*

Plate compiled by JingYi Lin

Molecular para-taxonomy

- DNA Barcoding to support “species” discovery
- Operational taxonomic units (OTUs)
- Since 2020
  - 9,336 COI Barcodes from invertebrate specimens
  - 2,726 OTUs/species
  - ~80% of OTUs are “new”
  - 1,423 OTUs are singletons (52%)

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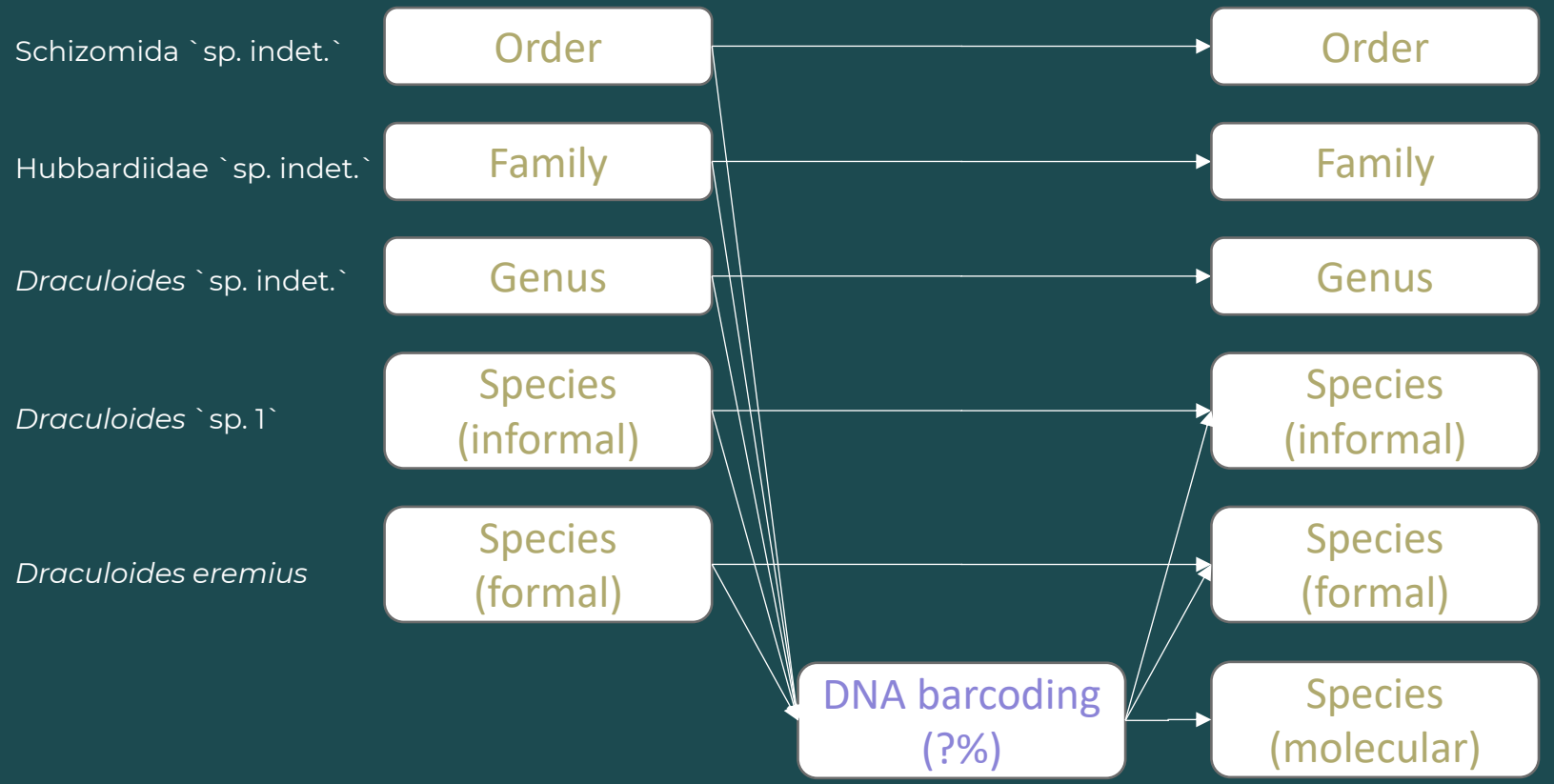
Questions

- When will DNA barcoding replace morphology?
- Why you should give me your sequence data!
- Why can't we just do Environmental DNA?

- Never…
- Morph identifications
  - Provide ecological information
  - Ground truth molecular results
  - Assist prioritisation of sequencing
  - Cheaper per specimen
- Molecular identifications
  - Are sharable – sequence data are easier to examine than specimen collections
  - Can be independently verified (more easily)
  - Can be done on immature/damaged specimens
  - Support other sampling methods (eDNA)
- How do we integrate them?

Biologic

Integrating identifications



- Test morphological IDs
- Interesting 'sp. indets.'
- Known SRE groups

Schizomida `sp. indet.`

Hubbardiidae `sp. indet.`

Draculoides `sp. indet.`

Draculoides `sp. 1`

Draculoides eremius

Draculoides `sp. Biologic-SCHI023`

Possible Synonyms

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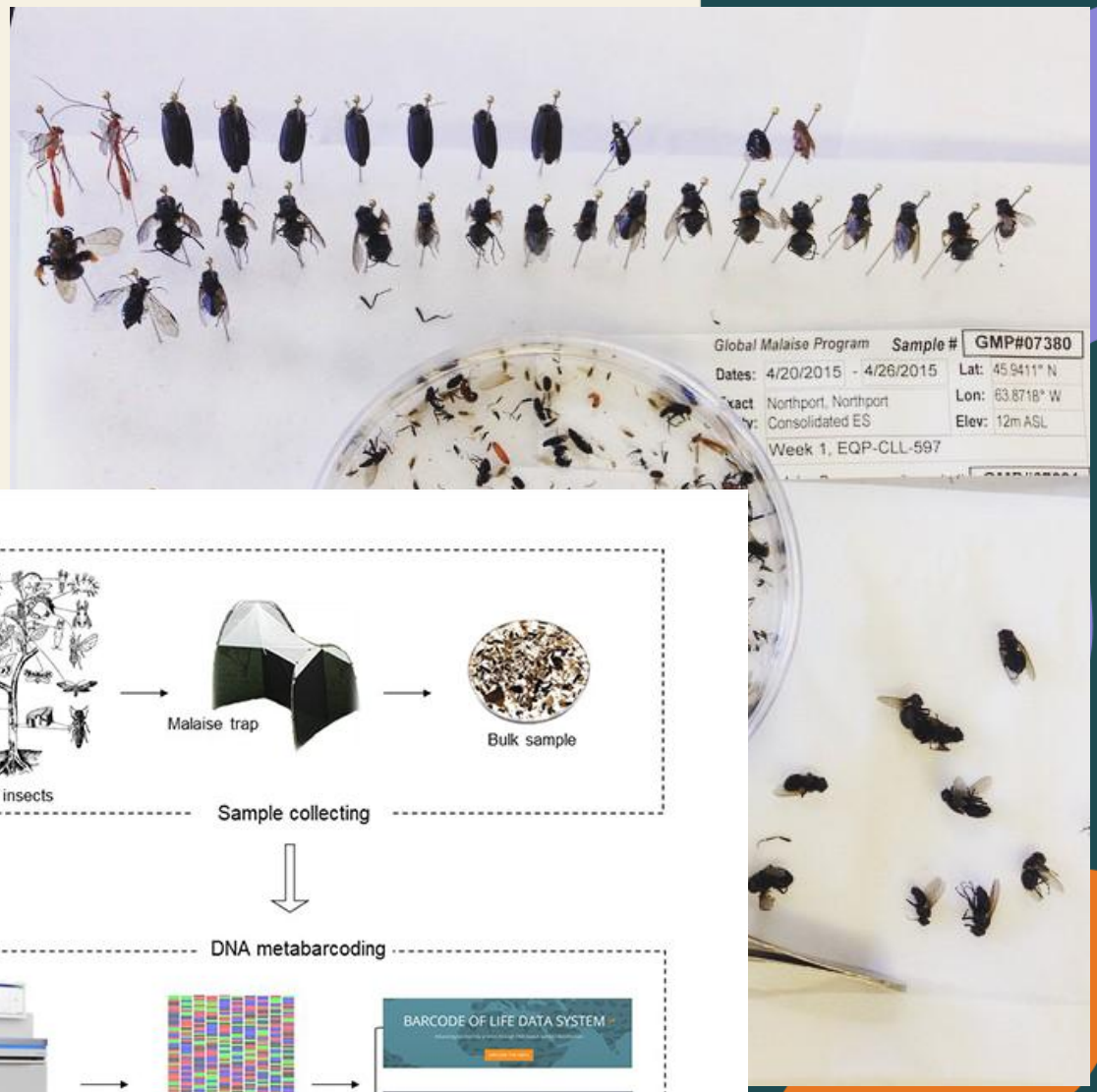
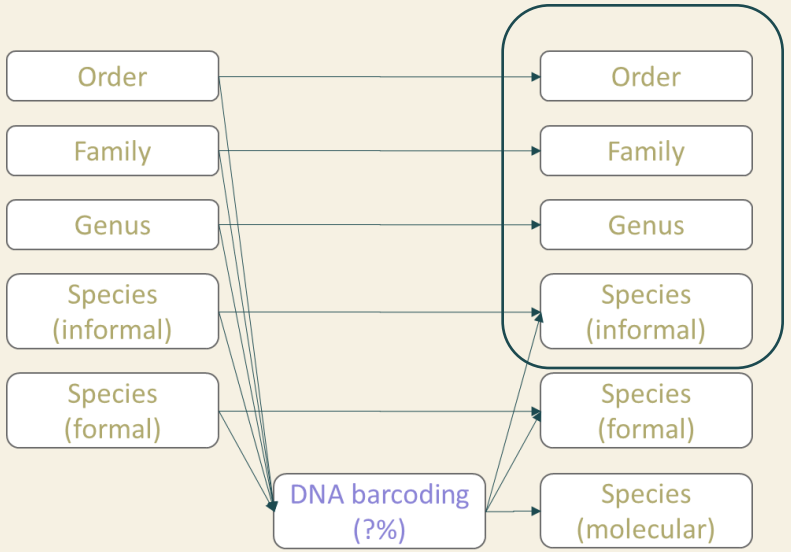
More sequencing?

- Primary cost is specimen handling
- Bulk sample metabarcoding
  - Take bulk samples, extract DNA (destructive)
  - Blast sequence output against sequence library of specimens that have been individually sampled





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https://www.ars.usda.gov/office-of-international-research-engagement-and-cooperation/overseas-biological-control-obcl-highlights/using-dna-metabarcoding-for-assessing-biodiversity-of-insect-pests-and-their-natural-enemies/

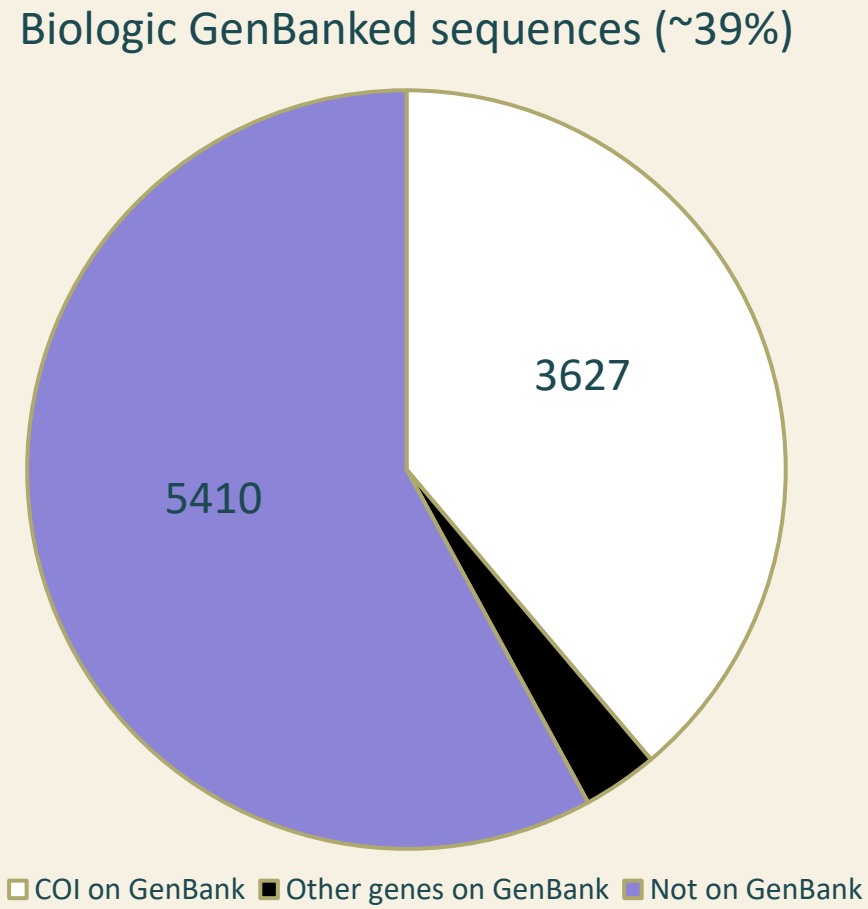
Questions

- When will DNA barcoding replace morphology?
- Why you should give me your sequence data!
- Why can’t we just do Environmental DNA?

Biologic

Data sharing

- Value of DNA barcoding data
  - ability to rapidly compare across datasets/project areas/collections
  - easily detect and communicate synonyms
  - repeatable/defensible/allows for expert interpretation
  - makes ongoing detection of taxa easier
- All dependent on availability of sequence data
  - Timing of GenBank submission dependent on Client
  - Data are siloed in consultant databases



Biologic

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Biologic


Net haul sampling in Pilbara (Image credit: Biologic)

Environmental DNA

- Organisms shed DNA into the environment
- Directly amplify the DNA from environmental samples
  - Soil, water, air, insects, sampling mediums (ethanol), spider webs
- Positive detections interpreted as organism existing near that sampling location
  - Environmental sample type?
  - DNA degradation rate?
  - DNA dispersal?
  - Alive vs dead organism?
  - Sensitivity of assay?
  - False positives and negative rates?

Biologic

Blind Cave Eel

Blind cave eel (Image credit: WA Museum)

Moore et al (2018)

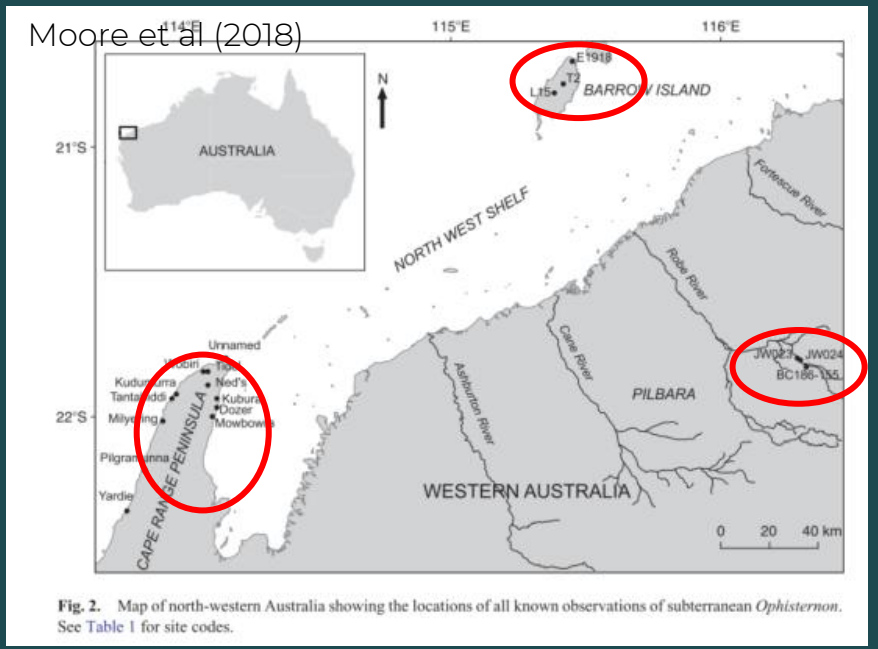


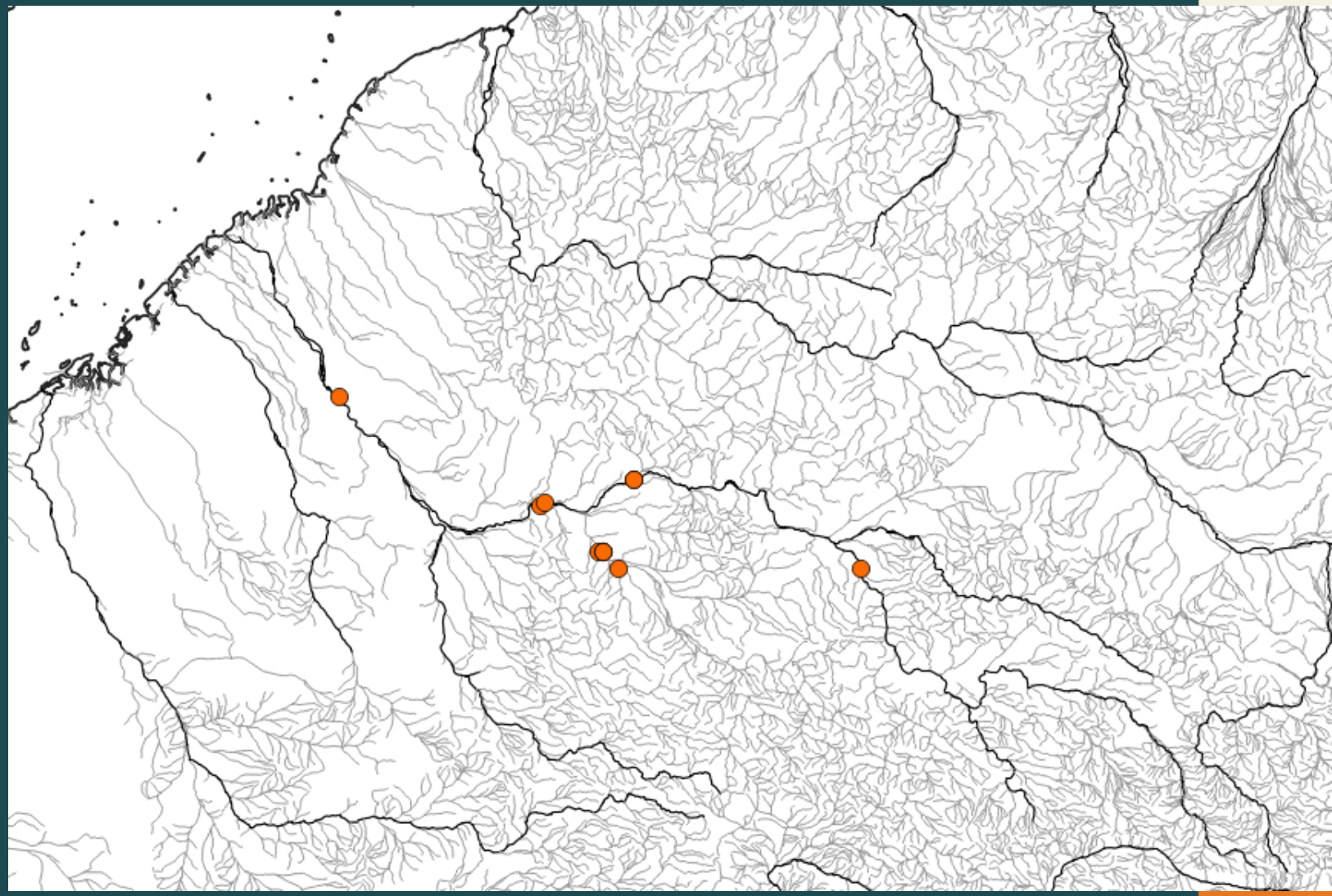
Fig. 2. Map of north-western Australia showing the locations of all known observations of subterranean *Ophisternon*. See Table 1 for site codes.

Live Robe Valley blind cave eel (Image credit: Biologic)

RioTinto Biologic

Specimens

- 12 specimens collected since 2009
- 8 sites
- Estimated over 1,500 net haul sampling events

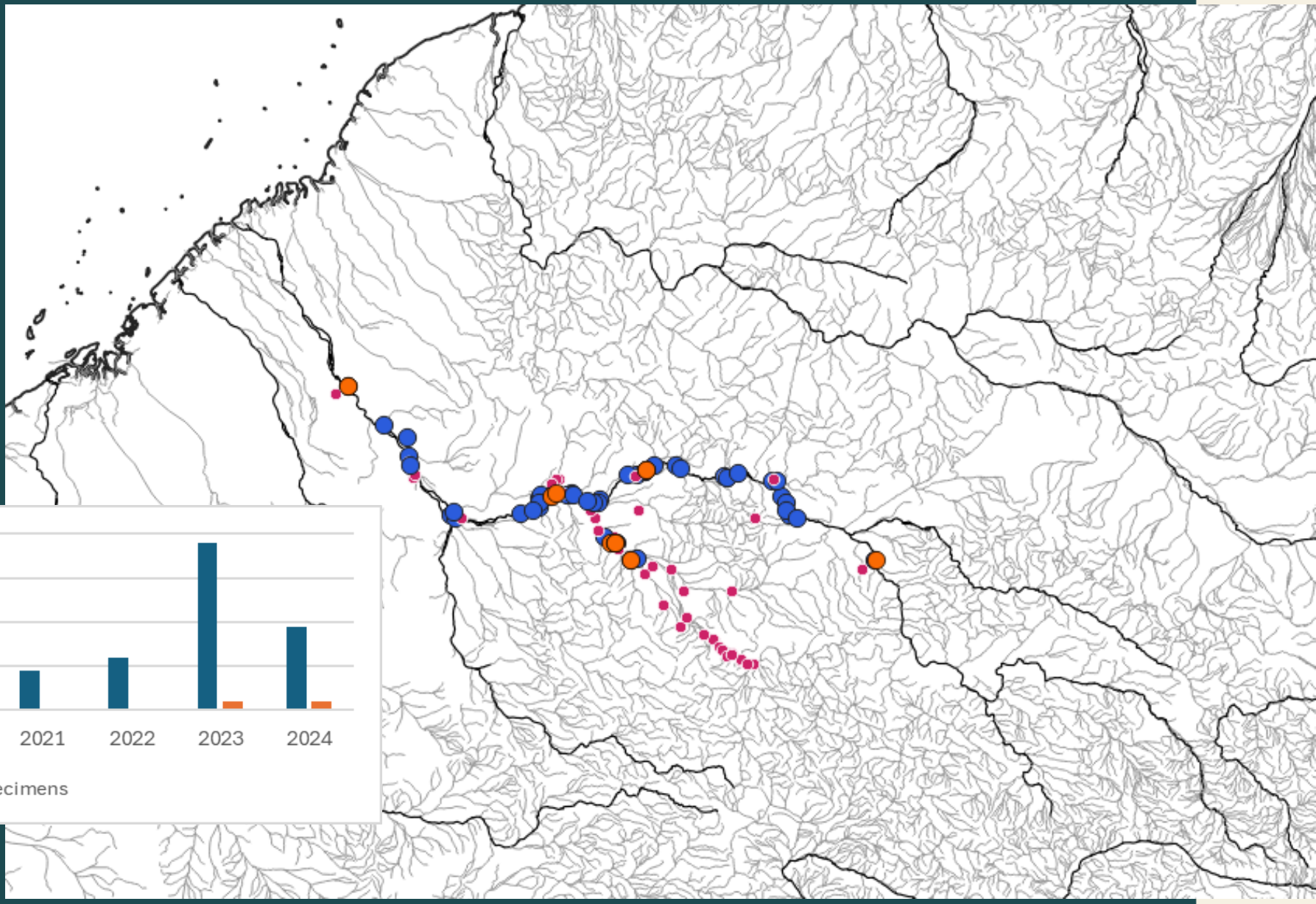


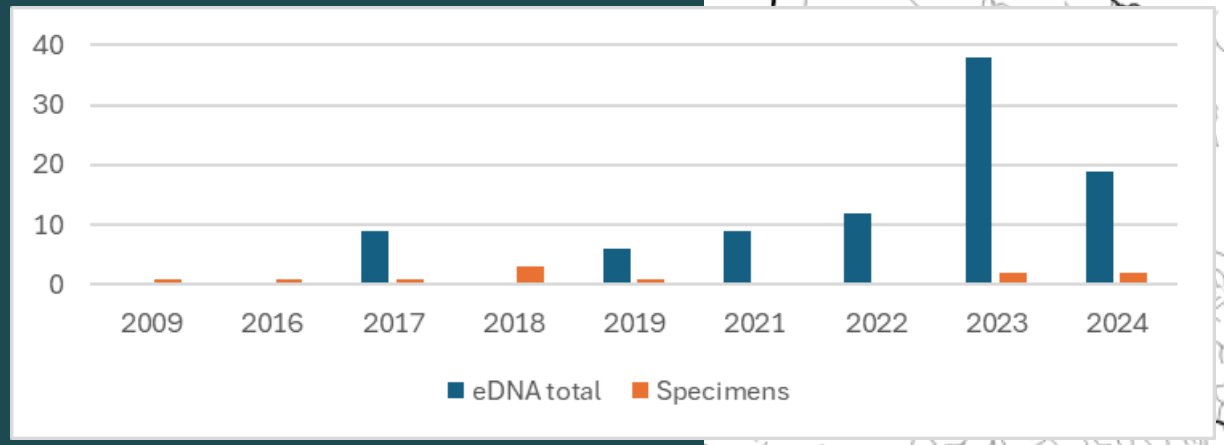
Biologic

RioTinto

eDNA

- 93 positive hits (unique sampling event)
- 30 positive sites (of 98 sampled)
- Bores and Karaman samples





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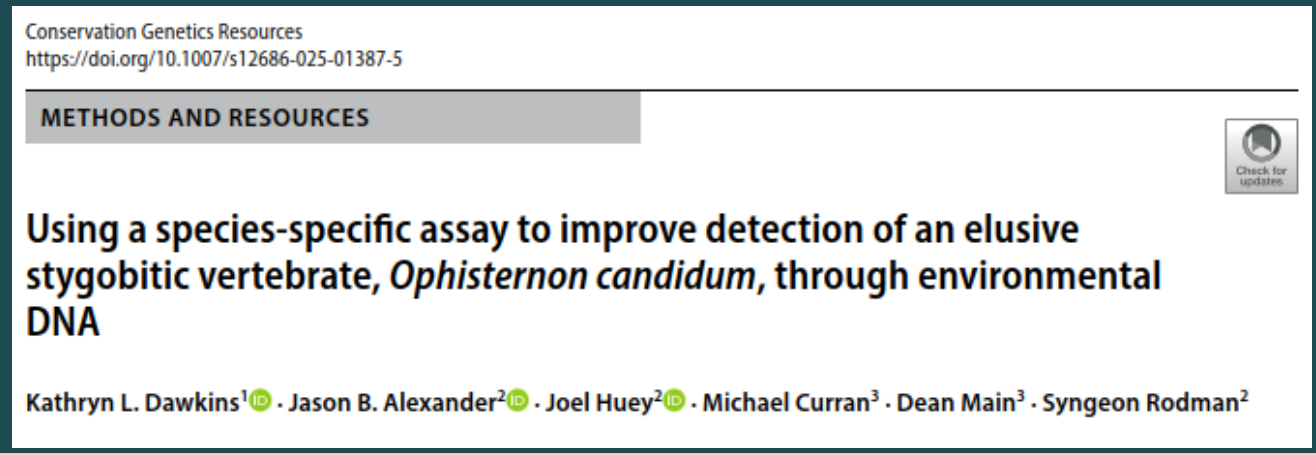
RioTinto

Challenges

- Data availability
- Interpretation
- Laboratory standards
- Availability of assays
- eDNA only biodiversity assessments
    - Complementary methods



Conservation Genetics Resources
https://doi.org/10.1007/s12686-025-01387-5

METHODS AND RESOURCES

Check for updates

Using a species-specific assay to improve detection of an elusive stygobitic vertebrate, *Ophisternon candidum*, through environmental DNA

Kathryn L. Dawkins[1] · Jason B. Alexander[2] · Joel Huey[2] · Michael Curran[3] · Dean Main[3] · Syngeon Rodman[2]

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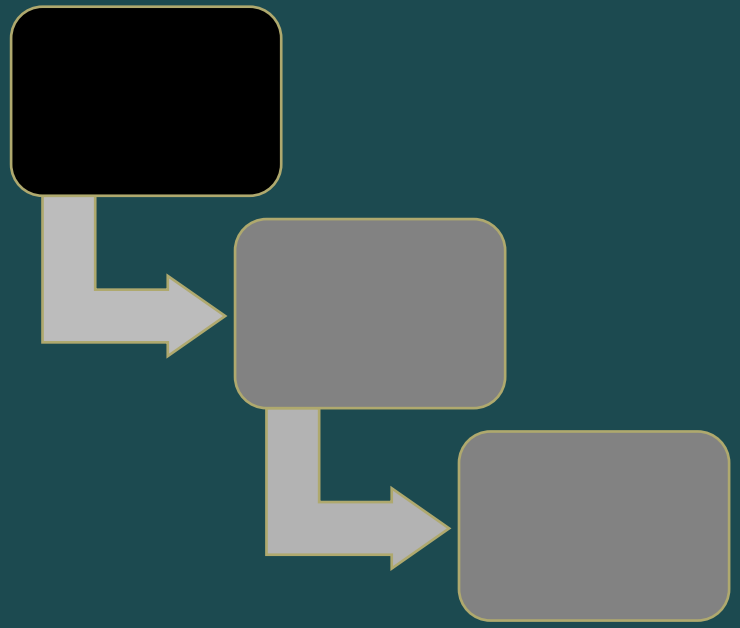
How will different eDNA evidence be considered by regulators?

- Specimens vs eDNA
  - Method, spatial design, replication, read numbers, etc
- Ongoing detection vs range extensions
- Extending ranges beyond impacts



The Western Australian Biodiversity Science Institute

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Thanks!

Dr. Joel Huey

(Manager Molecular Systematics | Principal Geneticist)

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