

Extensive Cryptic Diversity in Indo-Australian Rainbowfishes Revealed by DNA Barcoding

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- # Lembaga Ilmu Pengetahuan Indonesia (LIPI)
- ‡ Badan penelitian dan Pengembangan Kelautan dan Perikanan



Interest for Rainbowfish



Pearl for aquarium trade

- Rainbowfish = suborder Melanotaenioidei (129 species)
- Distribution : Madagascar, Sulawesi, Indo-australian
- Great diversity morphology (form & Coloration)
- Robust & Easy to reproduce



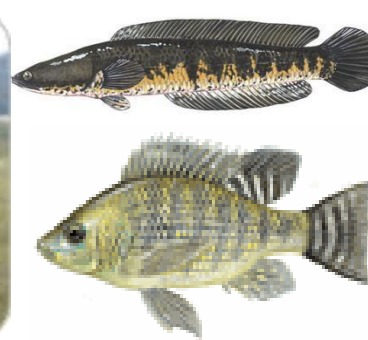
Diversity & Systematic confusion

- Melanotaeniidae: 7 genera, 76 species-subspecies
- West Papuan Rainbowfish diversity underestimated
- Incomplete diagnose
- Need revision systematic (biometric & molecular)



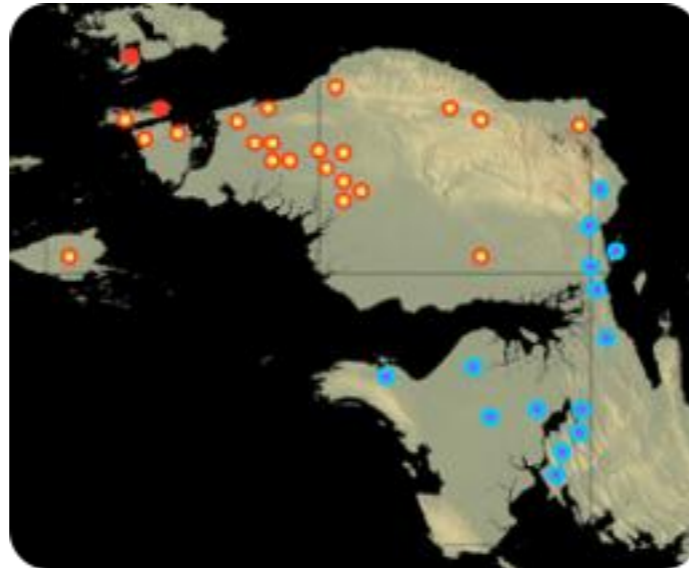
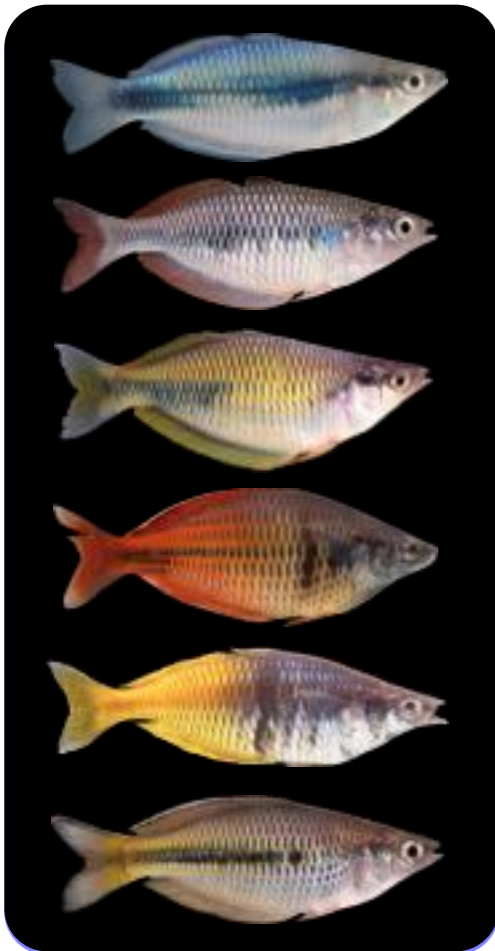
Threats on Papuan Melanotaeniids

- Over-catch
- Degradation of habitat
- Introduction Invasive species (5 species)
- Threatened species: Papua (9), Vogelkop (7)



Objectives

- DNA-barcoding to unravel species diversity in New Guinea (centre of biodiversity);
- Incorporating COI data with multiple locus in an ongoing works on systematic and biogeography for conservation purposes.



Study area and sampling localities



105 Localities
4 Genera
53 Nominal Species

35 IRG specimens



Vogelkop

New Guinea

Port Moresby

Cape York



Iriatherina



Glossolepis



Chilatherina



Melanotaenia

Image © 2011 TerraMetrics
© 2011 Cnes/Spot Image
Image © 2011 DigitalGlobe
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Methods and Analysis

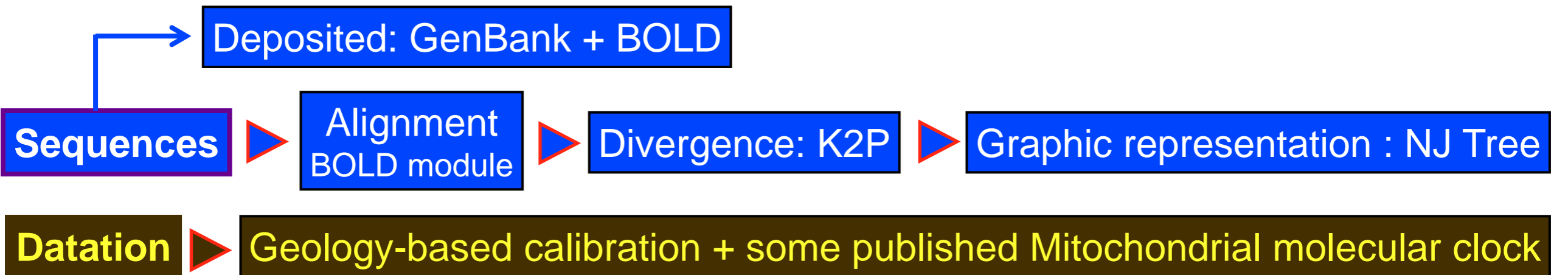
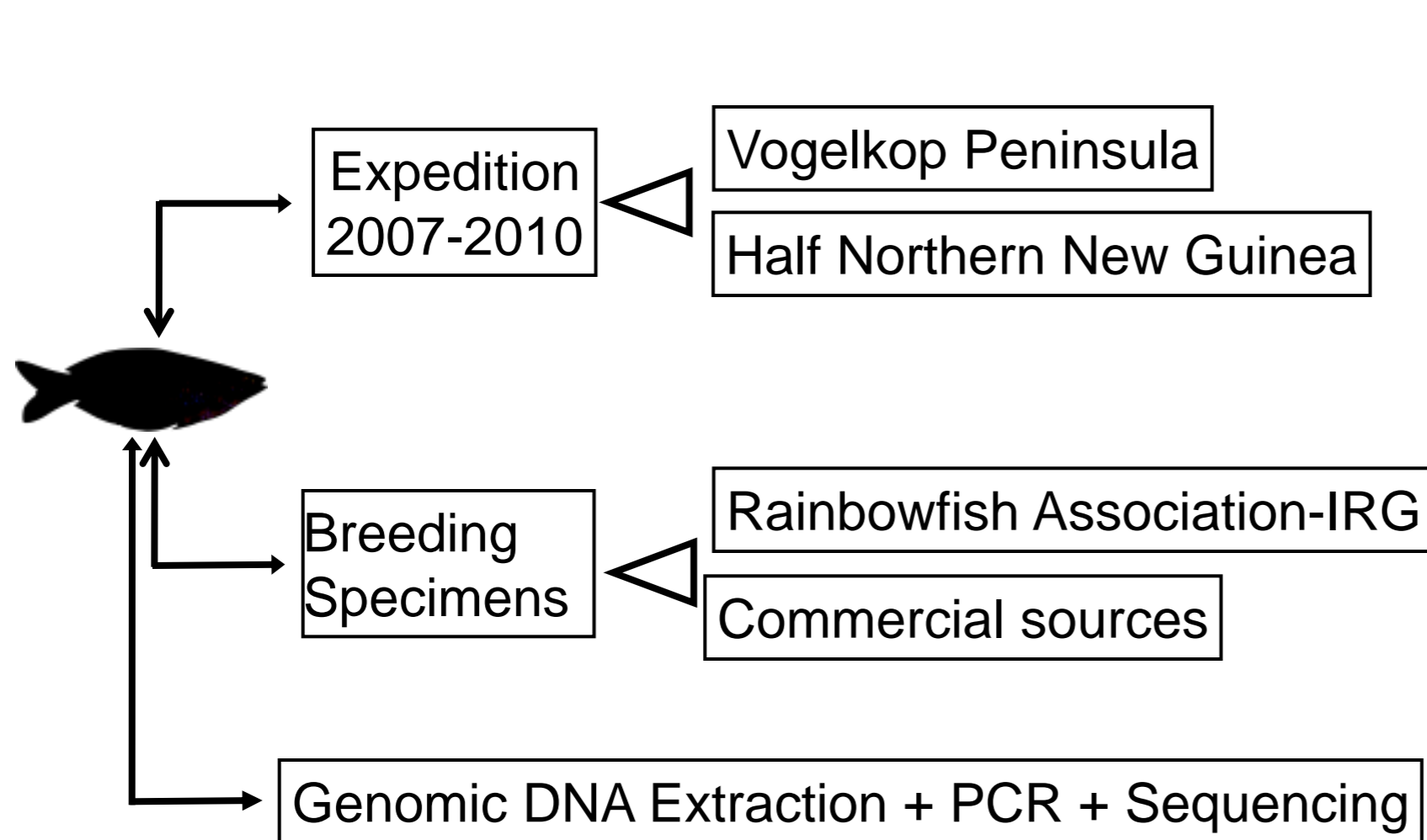
1. validate

Phylogenetic Species



2. define

Diagnostic morphological characters



Results and discussion

- 350 Barcodes (Melanotaeniidae)
- 53 species
- 4 genera
- 15 new lineages (new localities)

Highlight four major clades :

I: Vogelkop Peninsula

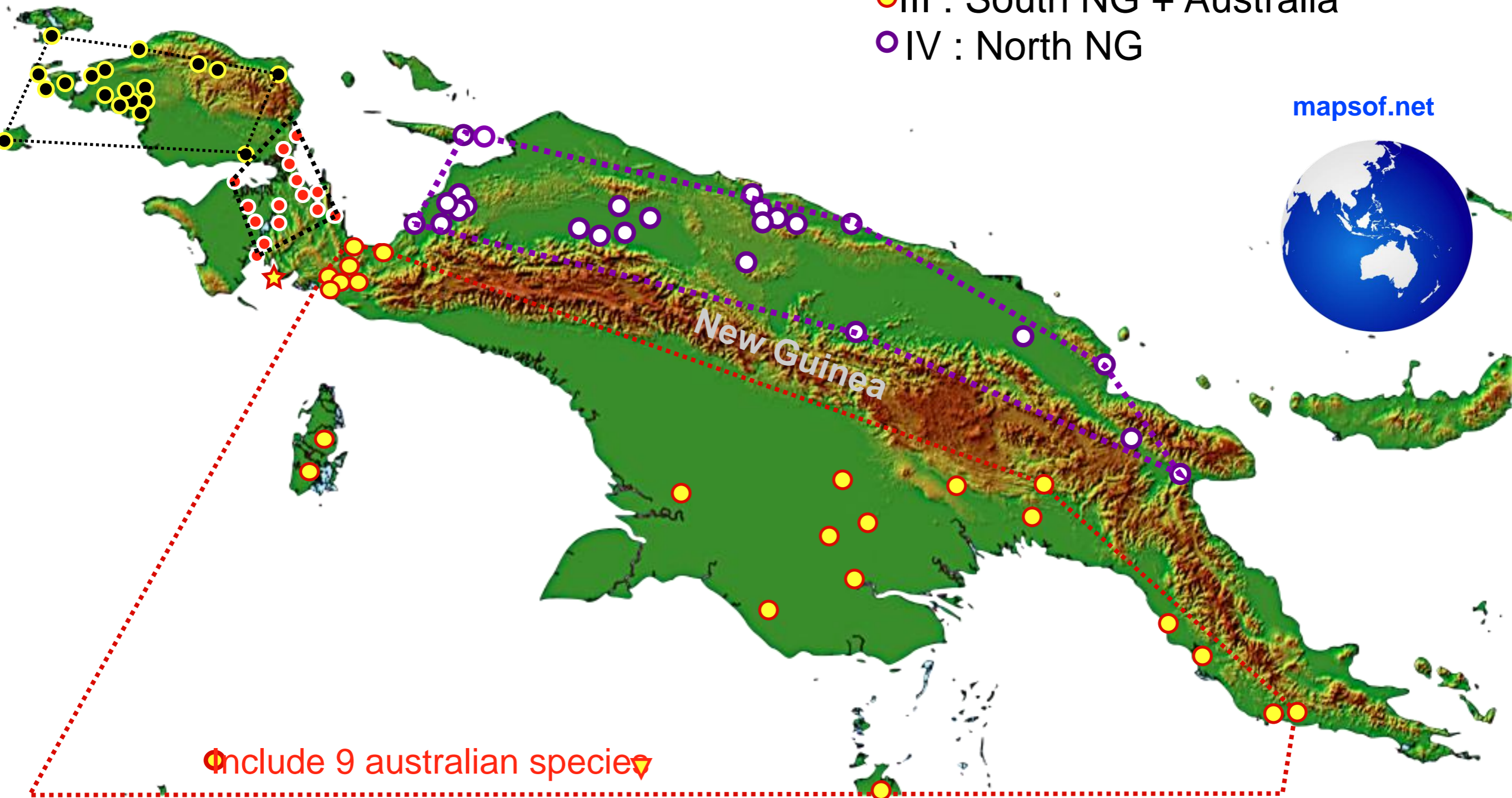
● IA: Main Vogelkop

● IB: Bomberai

★ II : Kuwéri Lengguru

● III : South NG + Australia

● IV : North NG



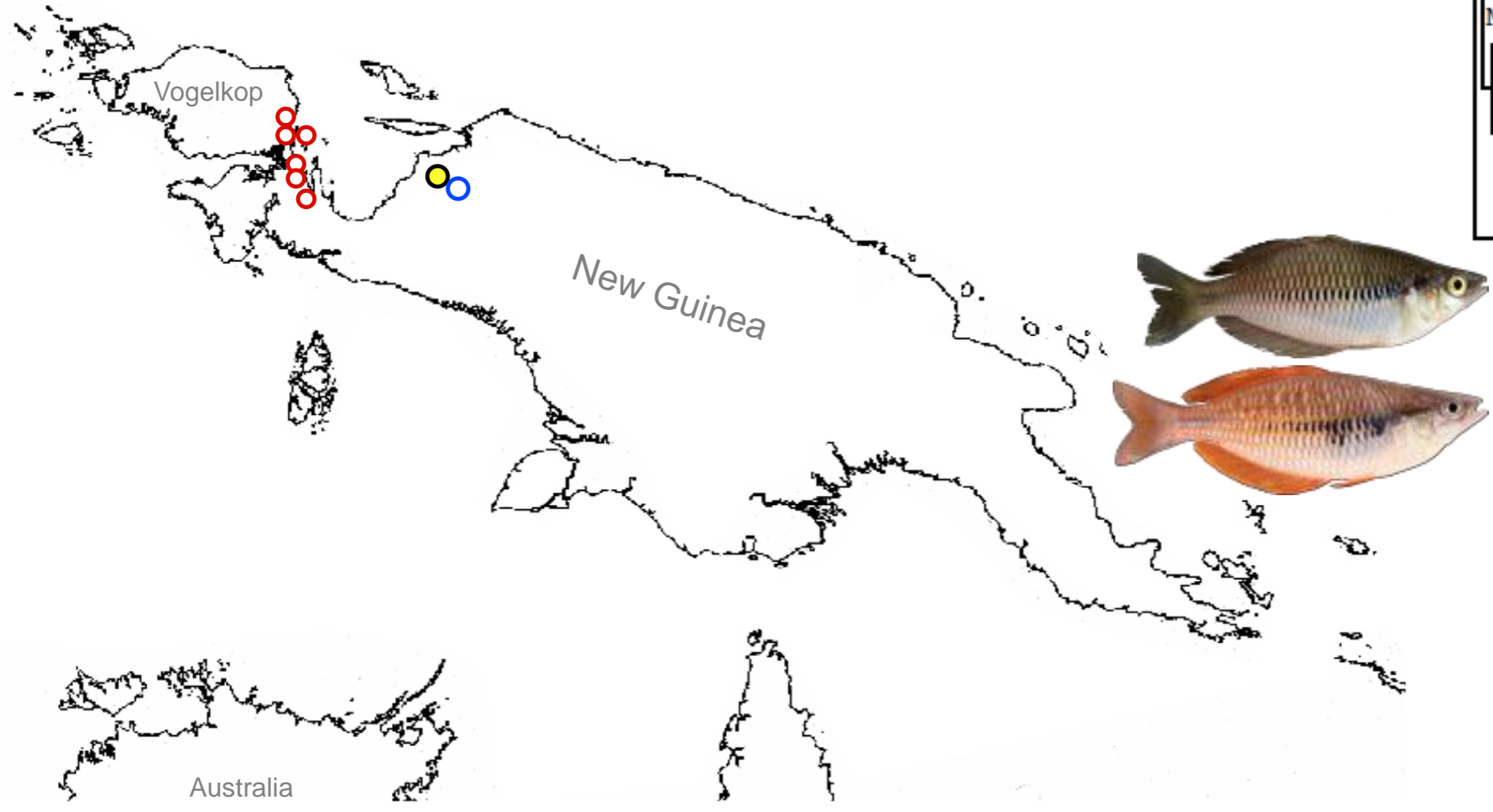
Mixed COI cluster

- 8 species *Melanotaenia* (e.g *M.parva* & *M.angfa*)
- 3 species *Glossolepis* (*G.leggetti* & *M. rubripinnis*)
- 40 species have non-overlapping cluster

```
Glossolepis leggetti|Leggetti wapoga 1278
Glossolepis leggetti|Leggetti wapoga 1274
Glossolepis leggetti|Leggetti wapoga 1276
Glossolepis leggetti|Leggetti wapoga 1279
Glossolepis leggetti|Leggetti wapoga 1273
Glossolepis leggetti|Leggetti wapoga 1275
Melanotaenia rubripinnis|Rubripinnis wapoga 1285
Melanotaenia rubripinnis|Rubripinnis wapoga 1284
Melanotaenia rubripinnis|Rubripinnis wapoga 1283
```

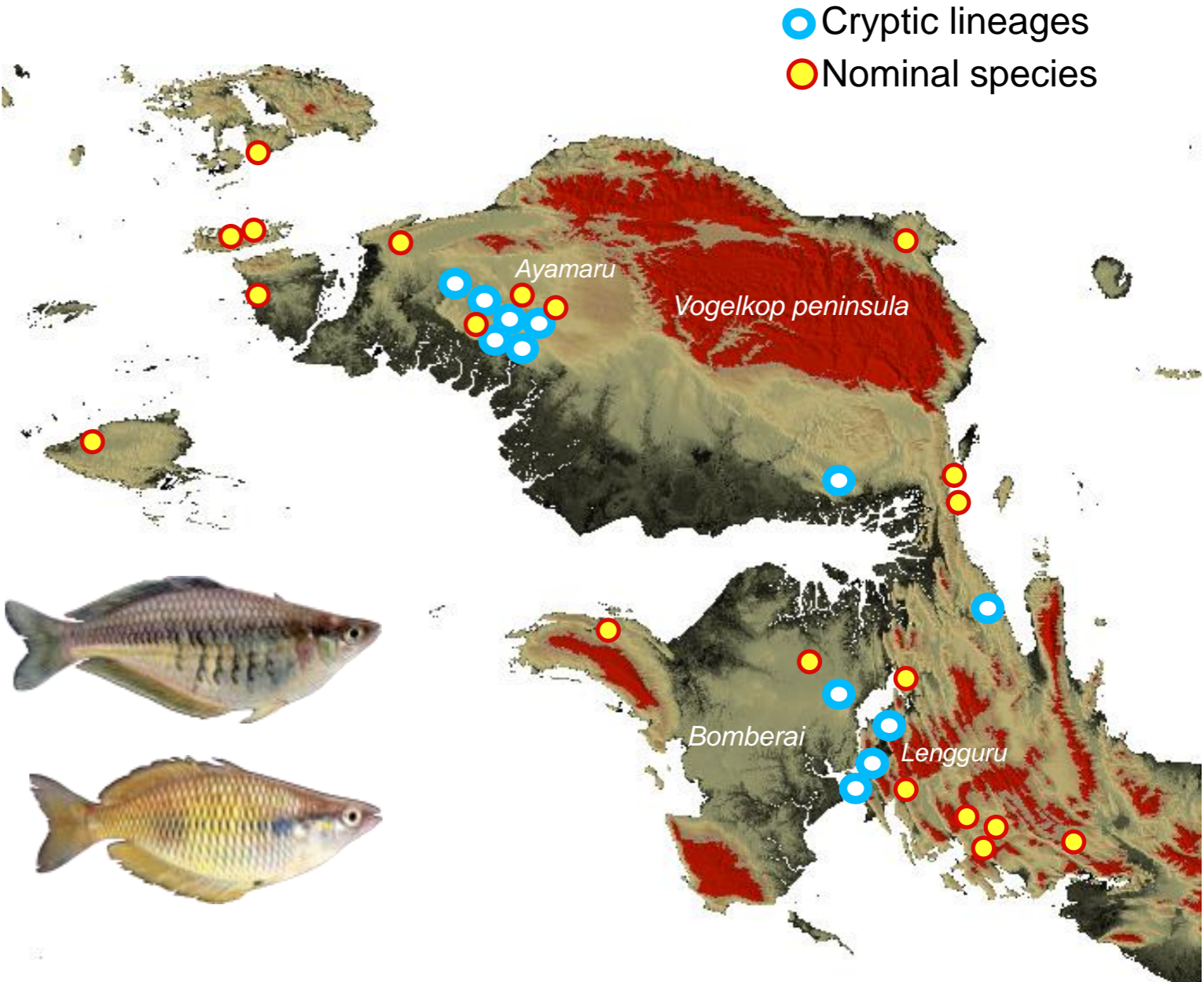
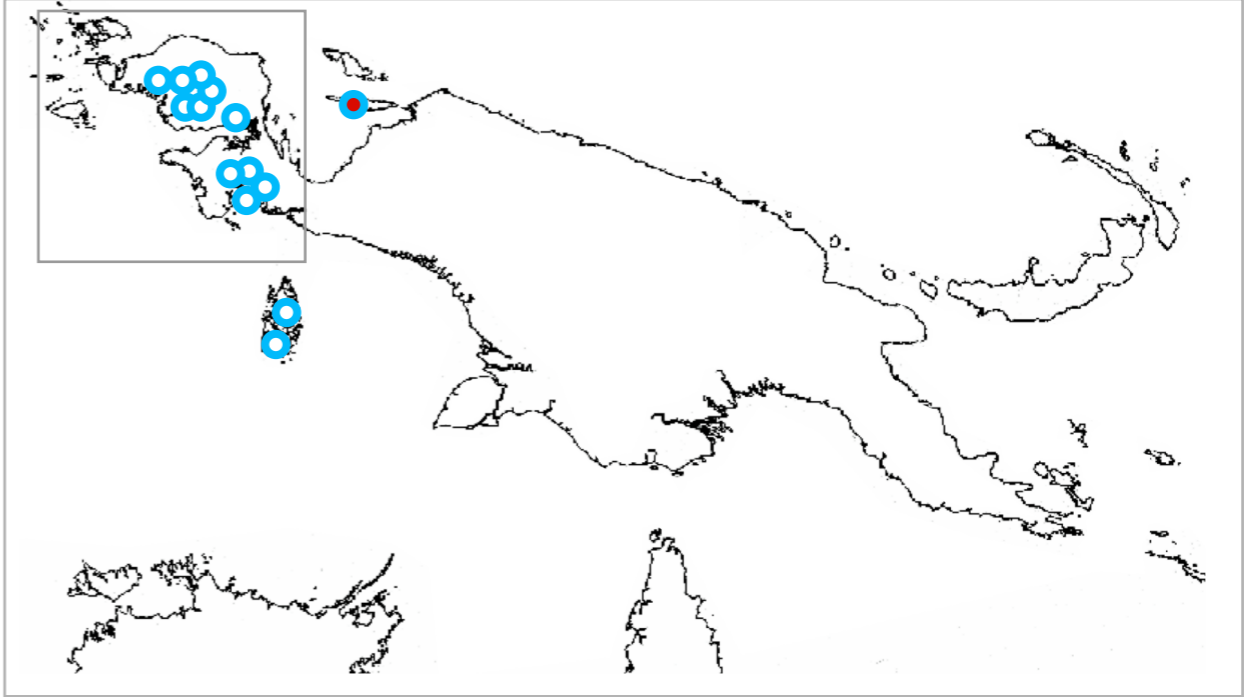


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Melanotaenia angfa|Naramasa 1107
Melanotaenia angfa|Naramasa 1106
Melanotaenia angfa|Naramasa 1102
Melanotaenia angfa|Naramasa 1101
Melanotaenia angfa|Rumberpon 701
Melanotaenia angfa|Rumberpon 705
Melanotaenia angfa|Siku 541
Melanotaenia angfa|Siku 542
Melanotaenia angfa|Siku 543
Melanotaenia angfa|Siku 544
Melanotaenia angfa|Siku 545
Melanotaenia angfa|Siku 618
Melanotaenia angfa|Mammeh 723
Melanotaenia angfa|Mammeh 724
Melanotaenia angfa|Mammeh 726
Melanotaenia angfa|Mammeh 728
Melanotaenia angfa|Rumberpon 707
Melanotaenia angfa|Rumberpon 706
Melanotaenia angfa|Rumberpon 704
Melanotaenia angfa|Rumberpon 700
Melanotaenia parva|Kurumoi 628
Melanotaenia parva|Kurumoi 627
Melanotaenia angfa|Yakati 729
Melanotaenia parva|Kurumoi 629
Melanotaenia angfa|Yakati 738
Melanotaenia angfa|Yakati 734
Melanotaenia angfa|Yakati 741
Melanotaenia angfa|Yakati 740
Melanotaenia parva|Kurumoi 626
Melanotaenia parva|Kurumoi 624
Melanotaenia parva|Kurumoi 623
```



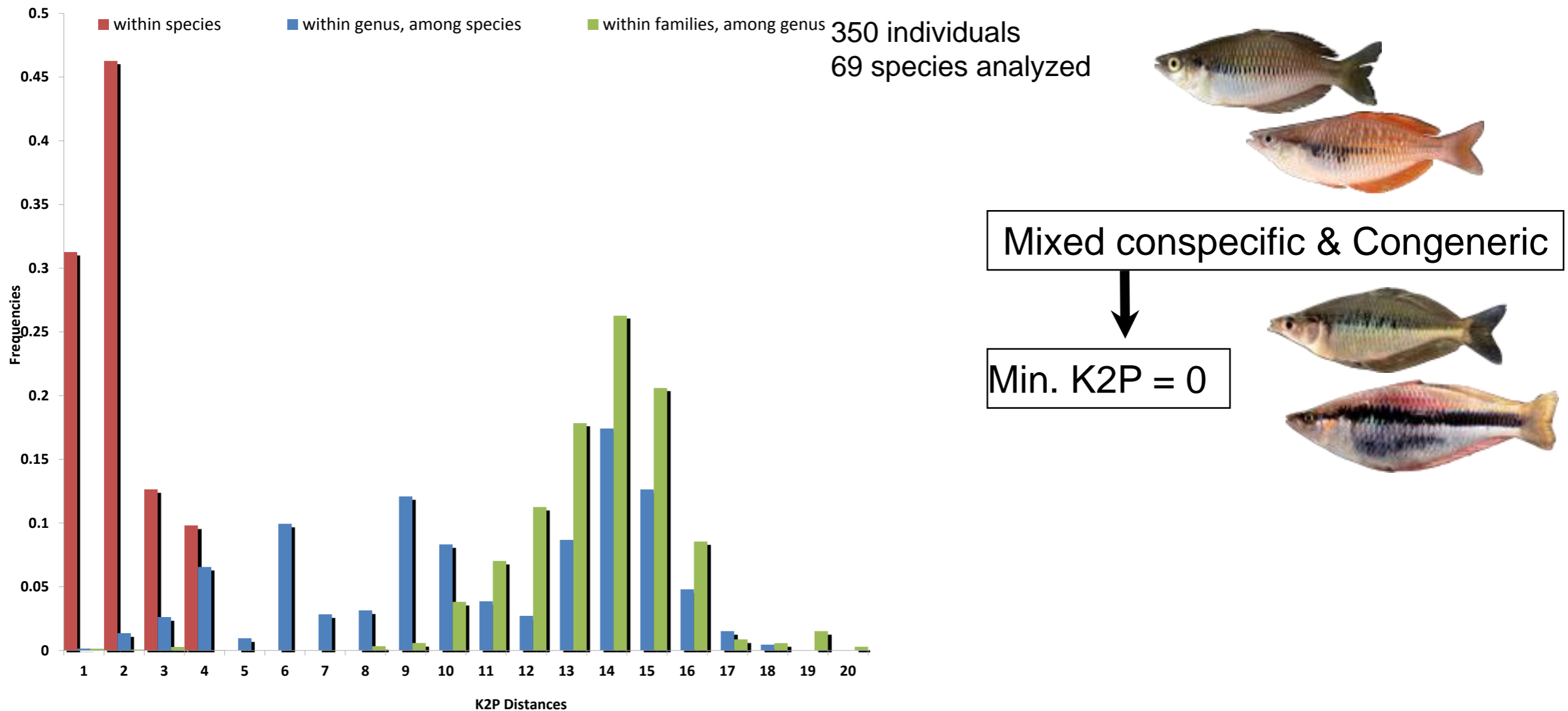
Cryptic lineages detected

- ✓ 14 Melanotaenia
- ✓ 1 Chilatherina
- ✓ Cryptic lineages all endemic



Genetic divergence and taxonomic levels

Fig. 1. Distribution of the K2P distances

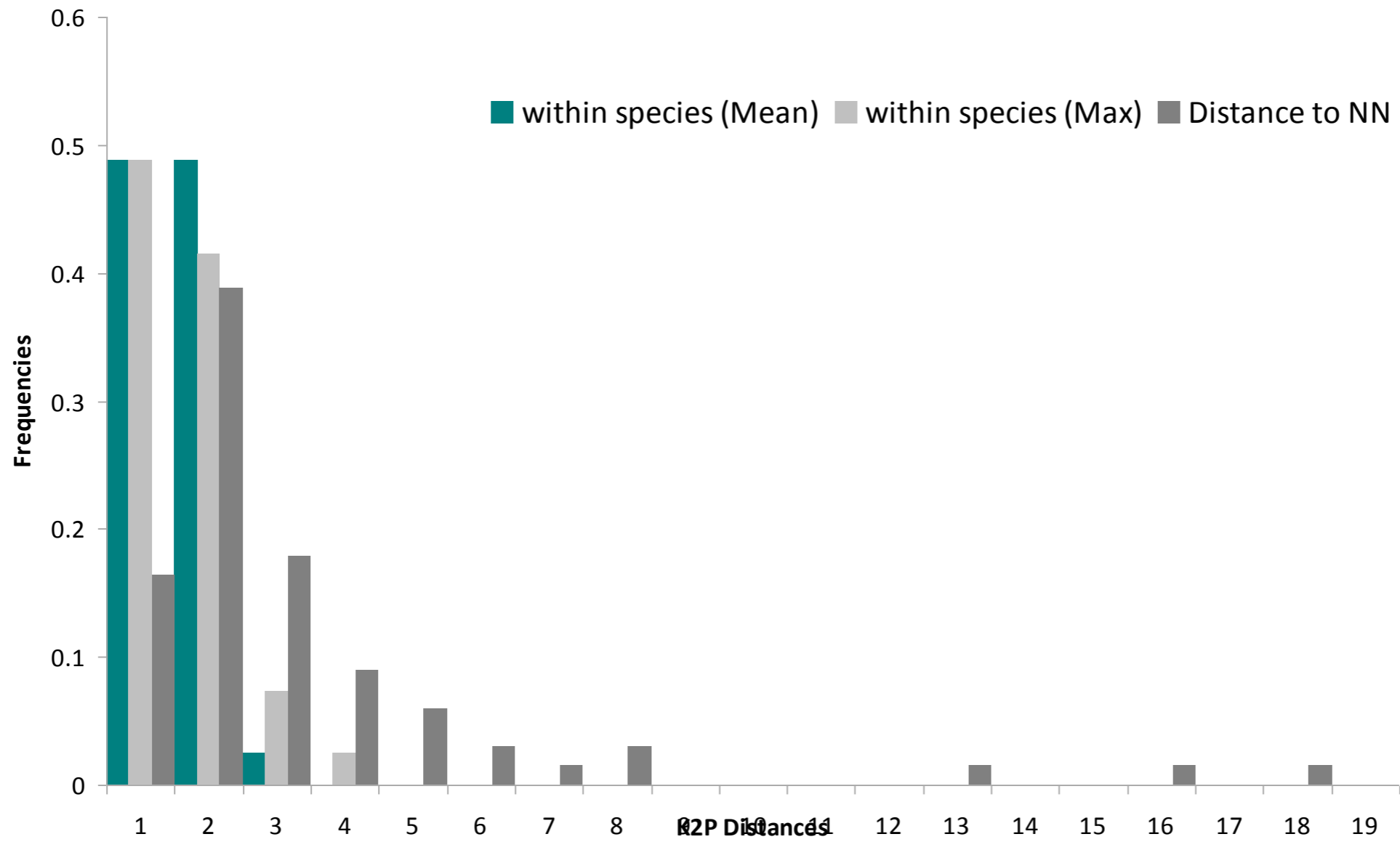


Genetic Divergence : Congeneric 14x higher than Conspecific

Overlap between within and among species K2P distances (closely related species)

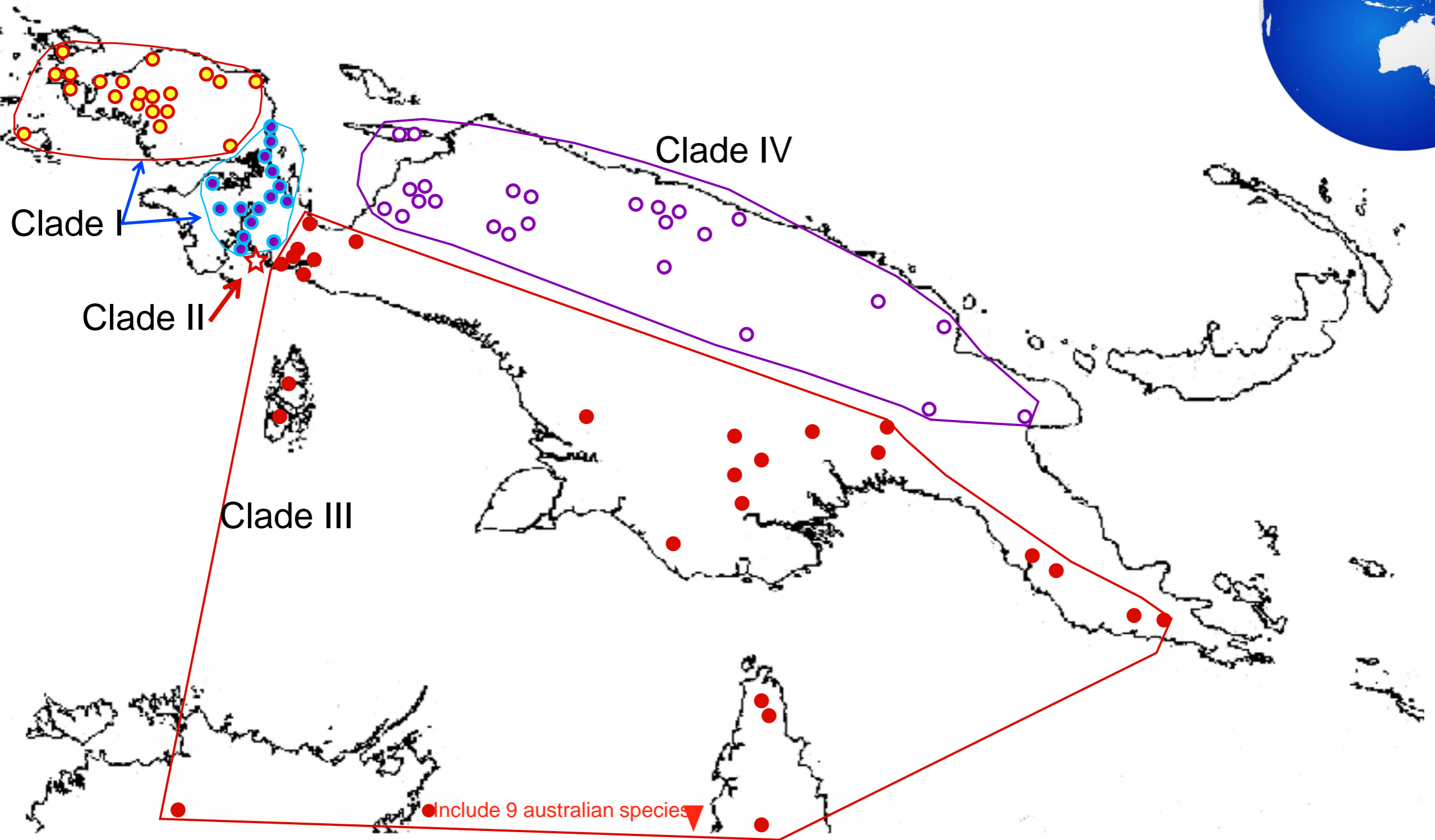
Intraspecific divergence

Fig. 2. Distribution of the K2P distances to NN



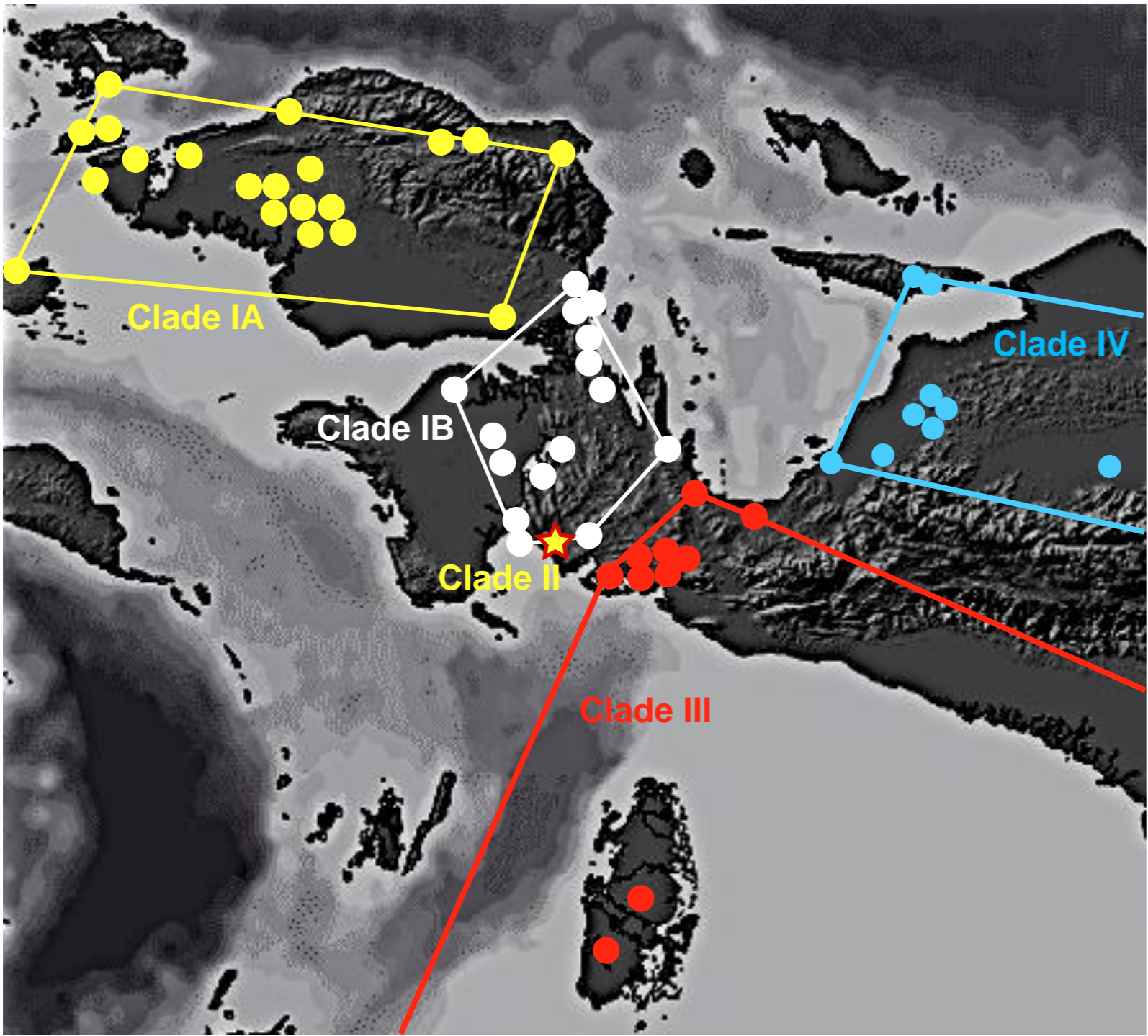
Overlap between within species genetic distances and distances to NN (closely related species)

Large scale pattern of genetic divergence



- ☀ Divergence among clades very similar
- ☀ Min. III vs IV = $10.5\% \pm 1\%$
- ☀ Max. I vs II = $13.7\% \pm 1\%$
- ☀ II vs III = same

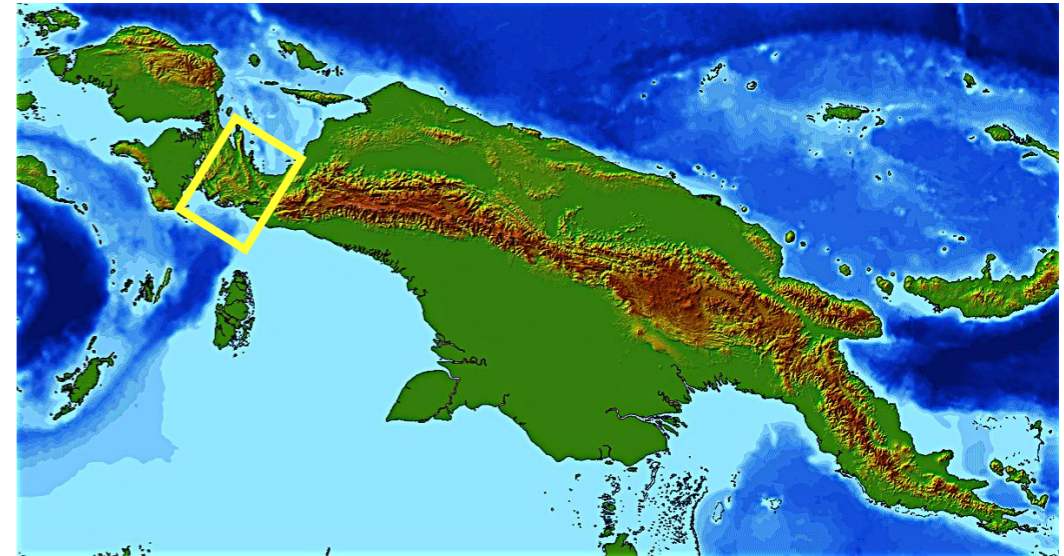
Relationship among clades



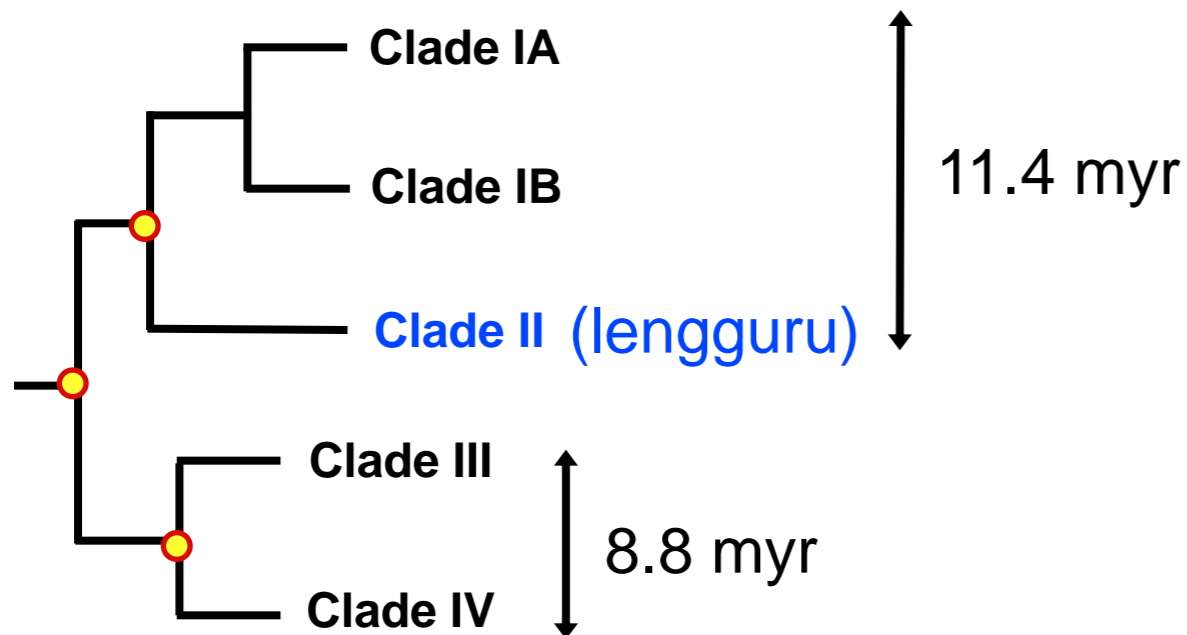
- Clades IA, IB and II are most diverse
- Considered as center of Melanotaeniids diversity

Datation

- 📍 Canonical fish : 0.012/Myr (Panamian isthmus) + references.
- 📍 Geological age uplift Lengguru Arch : 9-12 Myr (divergence among all clades).



Synthetic cladogram among clades



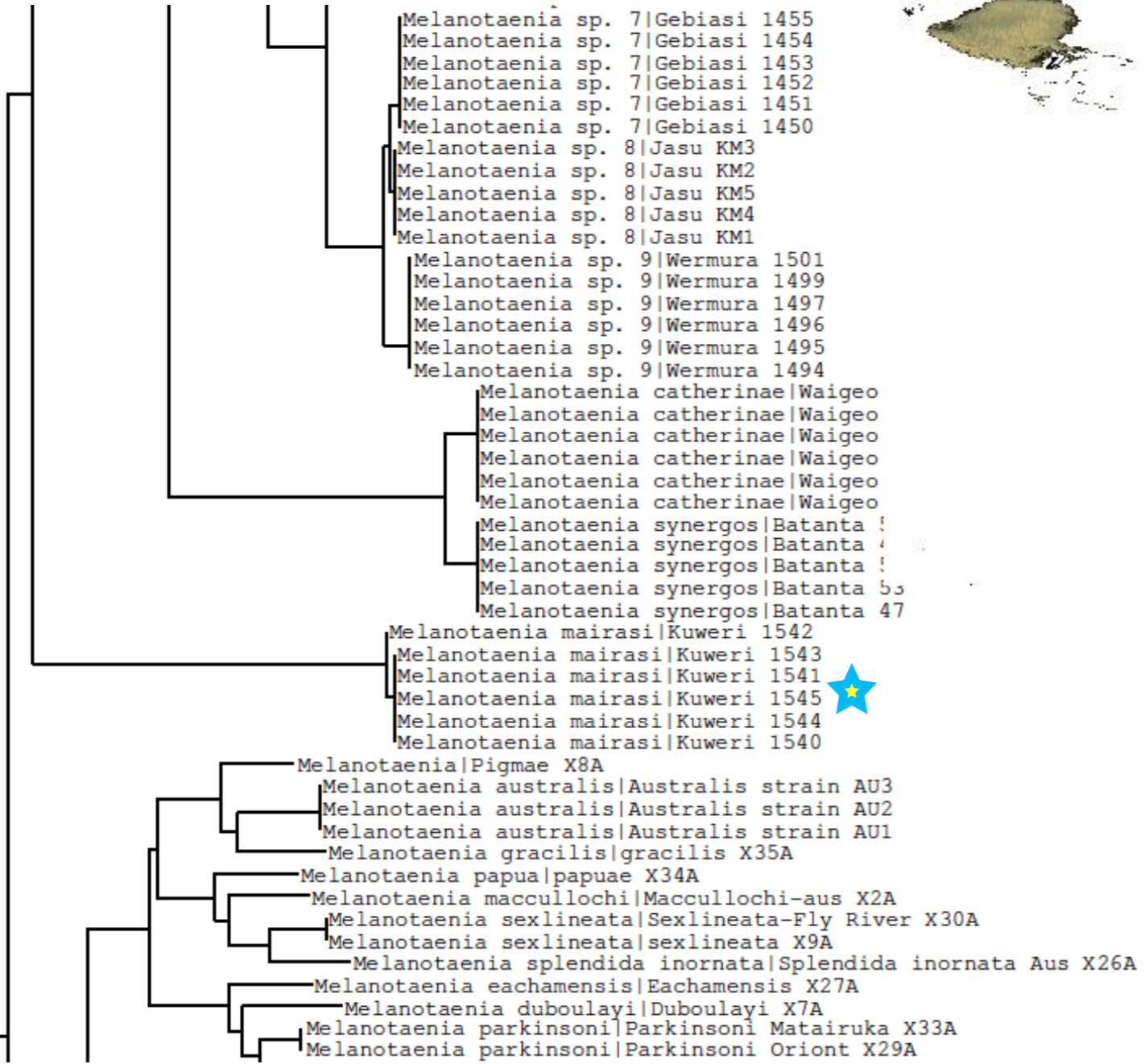
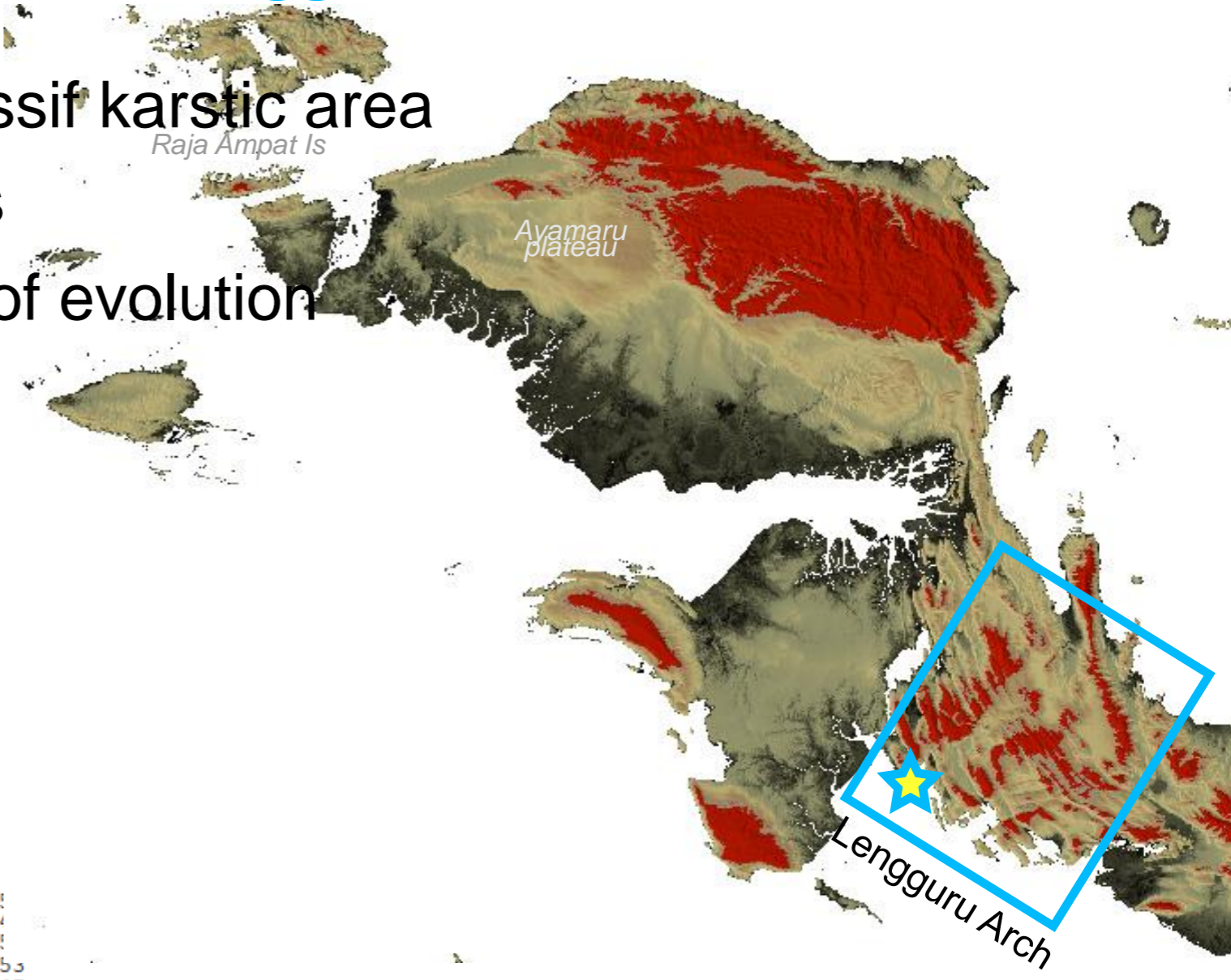
Min.subs R: 27.4 and 21 Myr
Canonical 'fish' :
- Estimated : 11.4 and 8.8 Myr
- Fixed: 0.012 subst./Myr
Can. Verteb. Subs R: 11.4 and 5.3 Myr

Uplift Lengguru Arch :
- Fixed : 12 and 9 Myr
- Estimated: (0.009 and 0.015 subst./Myr)

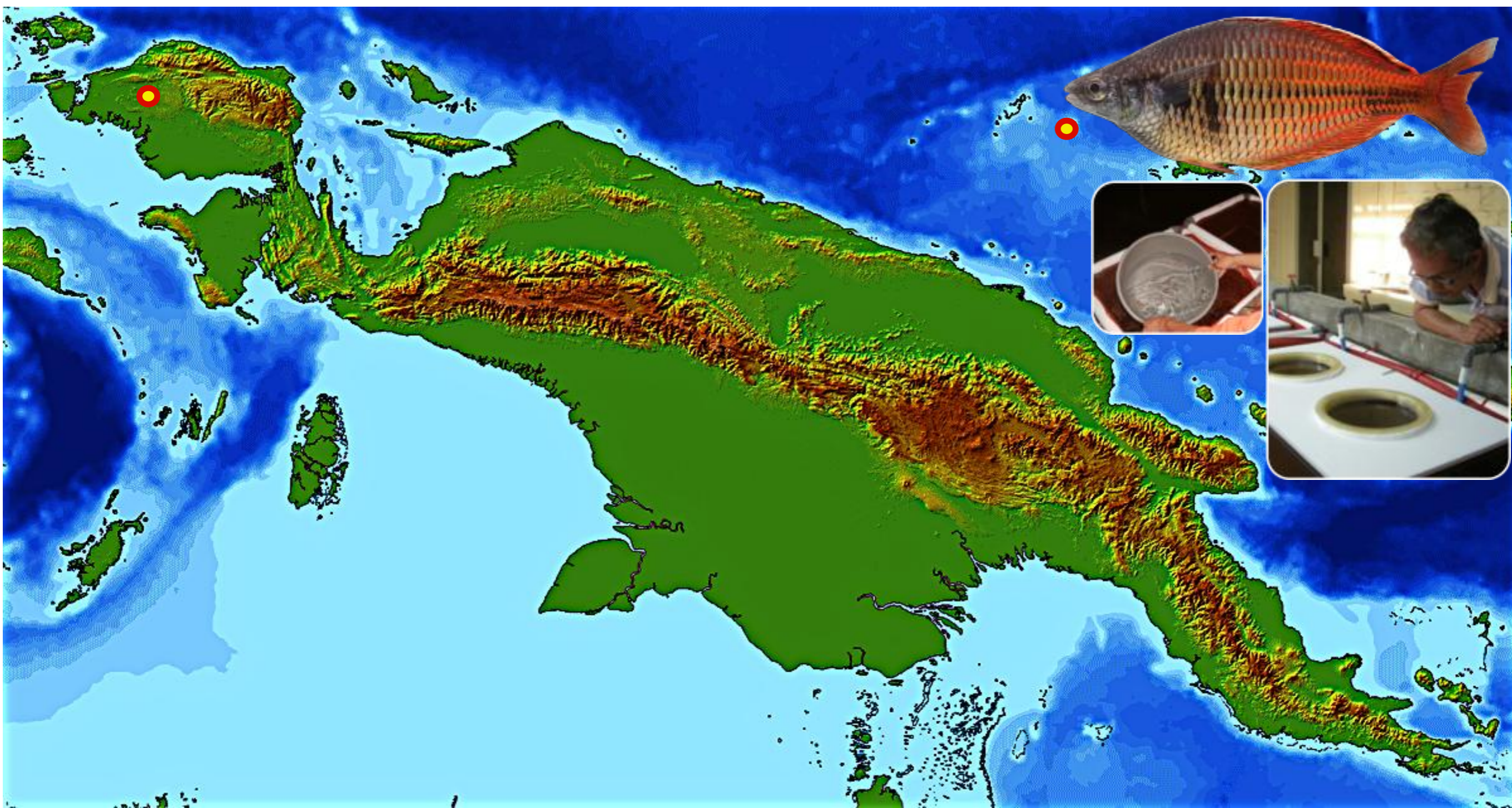


Vogelkop and the role important of Lengguru Arch

- * Most rugged area covered massif karstic area
- * Origin first cladogenetic events
- * Kuwéri rainbowfish: a witness of evolution



Conclusion



- (1) Utility of DNA-barcoding (species recognition & cryptic species)
- (2) **Vogelkop diversity overlooked: 30 lineages among 15 nominal species**
- (3) Papua remains less explored ichthyologically, endemism is underestimated
- (4) **Threatened species: PNG (13), Papua (9) Vogelkop (7), Australia (4)**
- (5) Promoting domestication trial (IRD & KKP)



Melanotaenia fasinensis
Kadarusman et al. 2010



Melanotaenia ajamaruensis
Allen & Cross, 1980



Melanotaenia parva
Allen, 1990

Thanks