

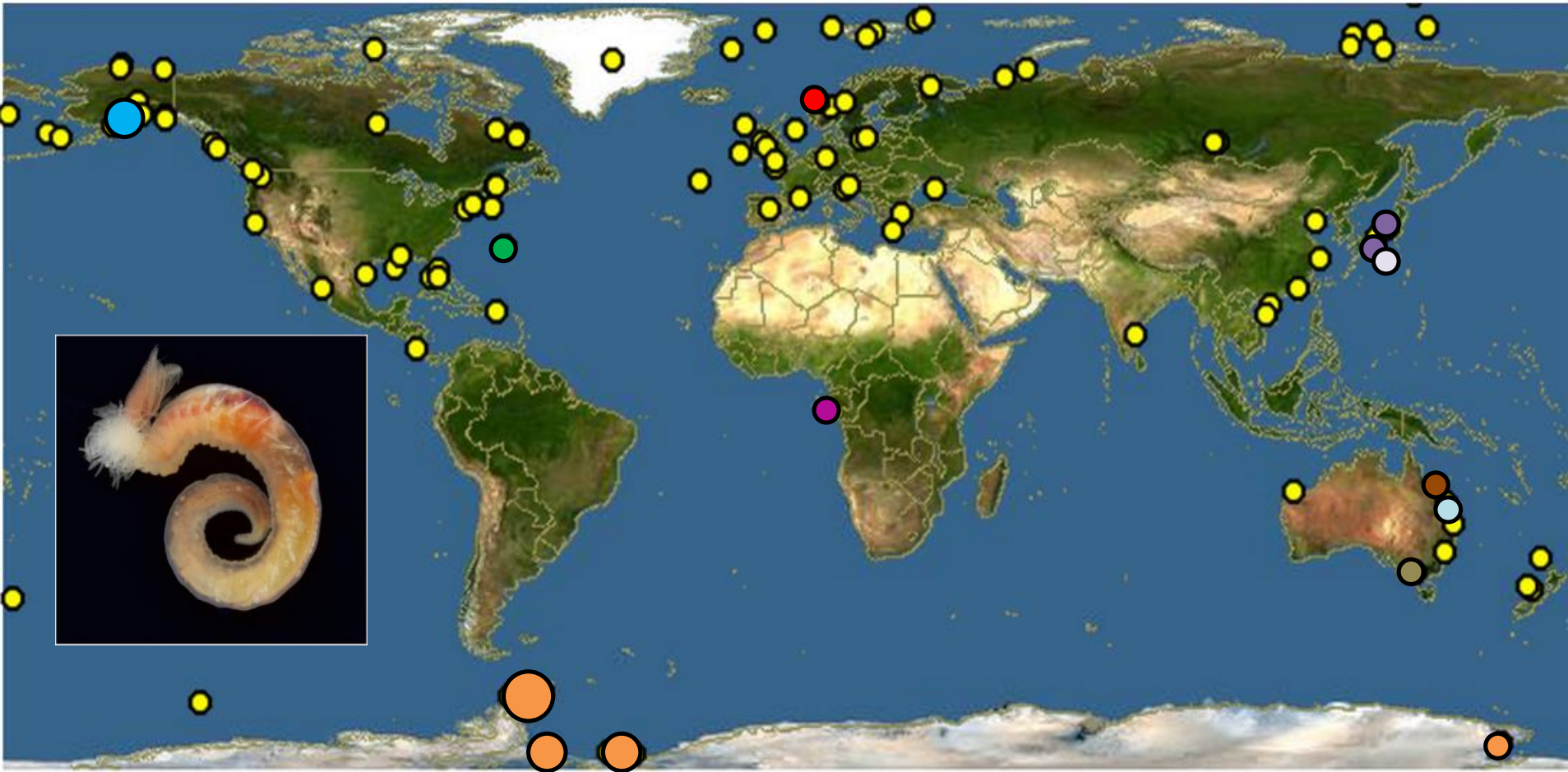
The background image shows a wooden pier structure extending over a body of water. The pier has several vertical support posts. In the foreground, a jellyfish is visible in the water, partially obscured by the dark, shadowed area under the pier. The water is a light blue-grey color, and the sky is not clearly visible.

# **Understanding invasive polychaetes: integrative taxonomy to the rescue**

Elena Kupriyanova, Yanan Sun,  
Eunice Wong, Pat Hutchings

# Invasive or naturally widely distributed species?

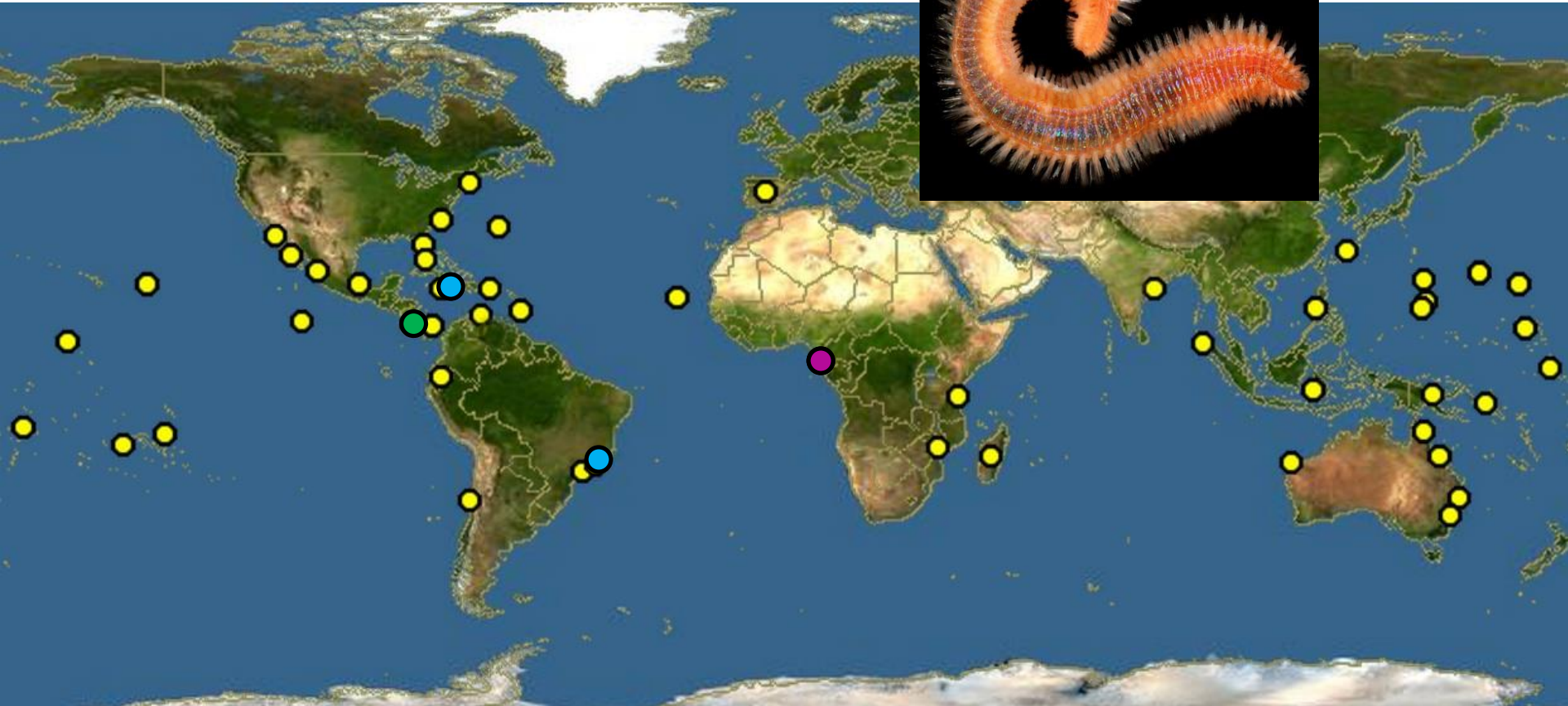
- Insufficient traditional (morphological) taxonomic studies



*Terebellides stroemi* Sars, 1835 → ~ 10 morphologically distinct species (Hutchings & Peart, 2000)

# Invasive or naturally widely distributed species?

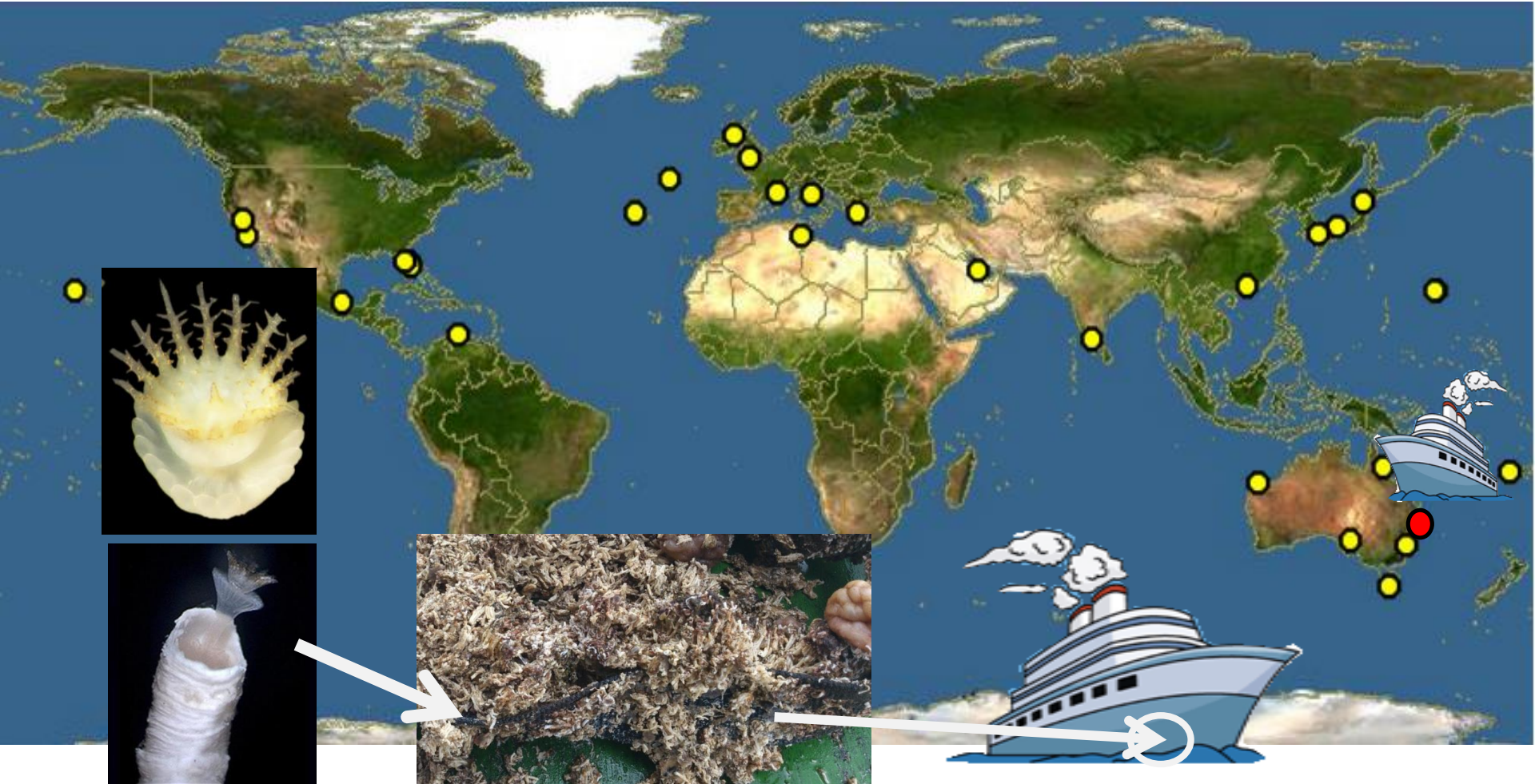
- Presence of cryptic species



*Eurythoe complanata* (Pallas, 1766) → at least 3 cryptic species (Barroso *et al.*, 2010)

# Invasive or naturally widely distributed species?

- Anthropogenic translocations (invasive tube worms)



*Hydroides elegans* (Haswell, 1883)

# Easily translocated species, species complexes, cryptic species, or all the above?

- **Polychaeta:** 292 species were transported around the world with human-mediated assistance (Çinar, 2013)
- The family Serpulidae includes the highest number (46) of translocated species.

## *Hydroides* spp.



*Hydroides elegans*

*Hydroides ezoensis*

*Hydroides sanctaecrusis*

*Hydroides diramphus*

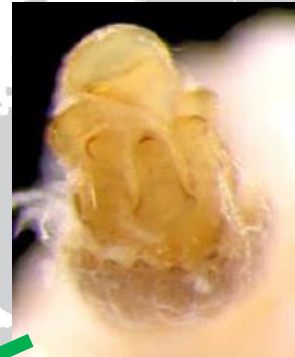
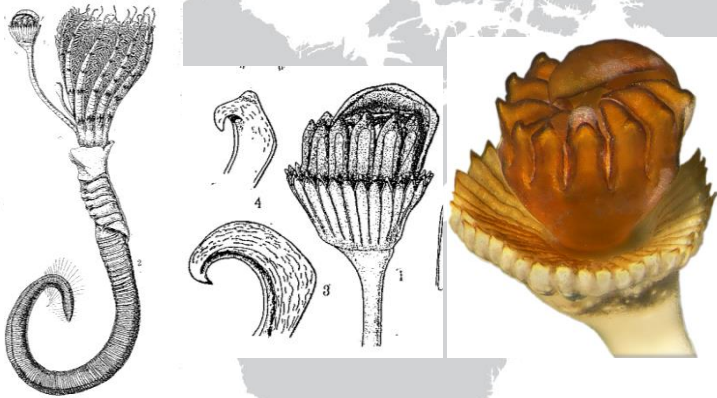
*Hydroides brachyacanthus*

*Hydroides dianthus*

*Hydroides operculata*

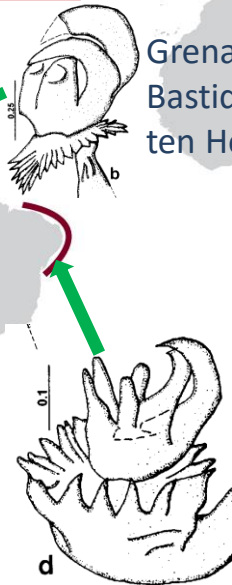
# *Hydroides brachyacantha* Rioja, 1941

Type locality (Rioja, 1941)

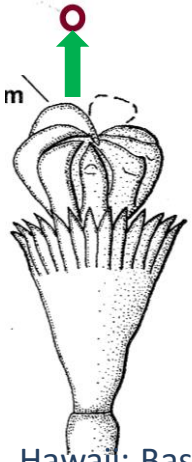
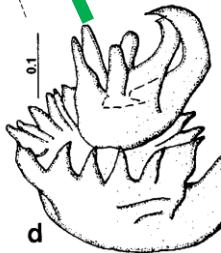


Turkey: Çınar, 2006

Grenada:  
Bastida-Zavala &  
ten Hove 2002



Brazil: Bastida-  
Zavala & ten  
Hove 2002



Hawaii: Bastida-  
Zavala & ten  
Hove 2003



# *Hydroides amri*, a new species in *H. brachyacantha* complex

(Rioja, 1941)

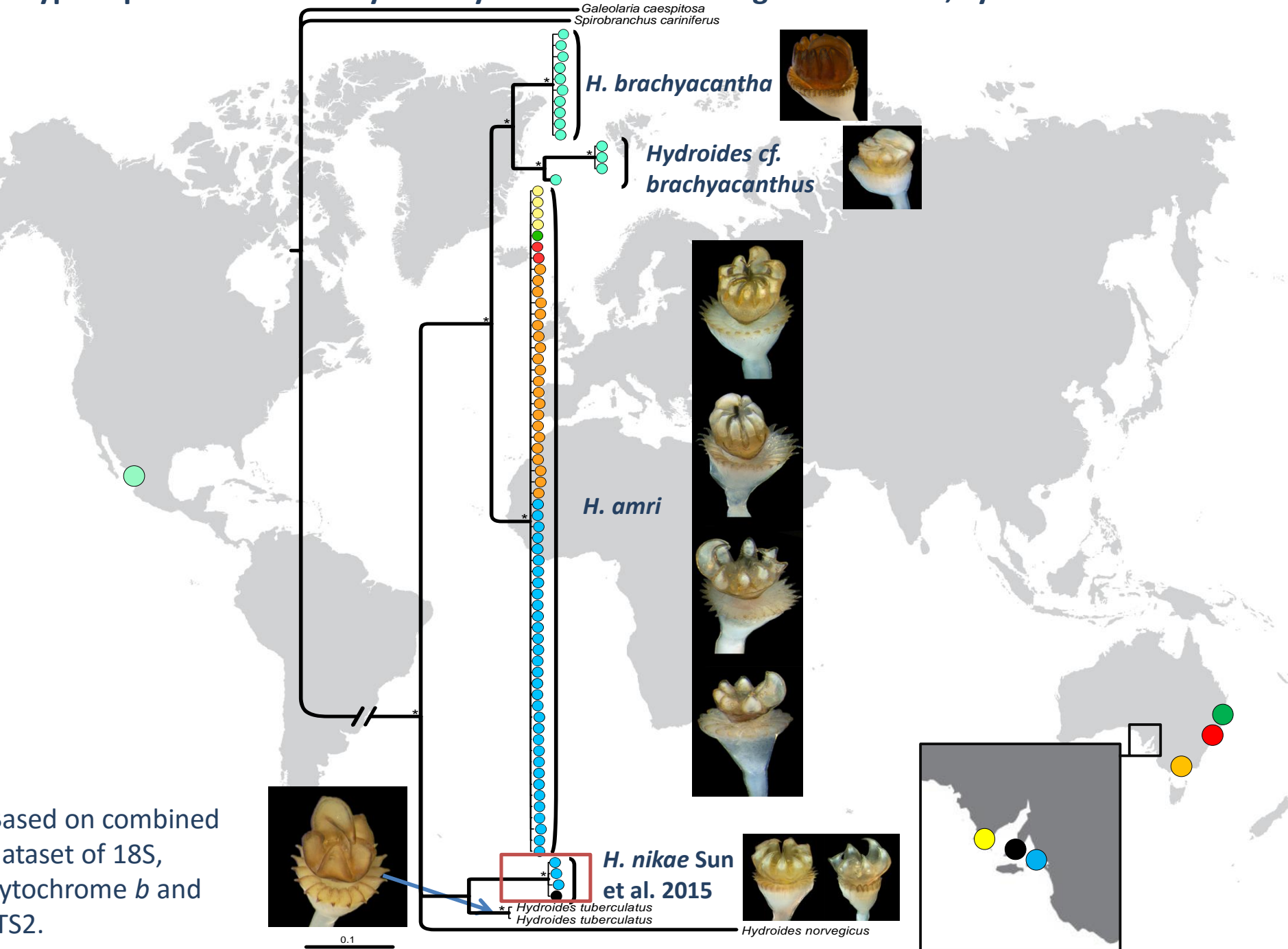
Type locality



*Hydroides amri* Sun et al., 2015

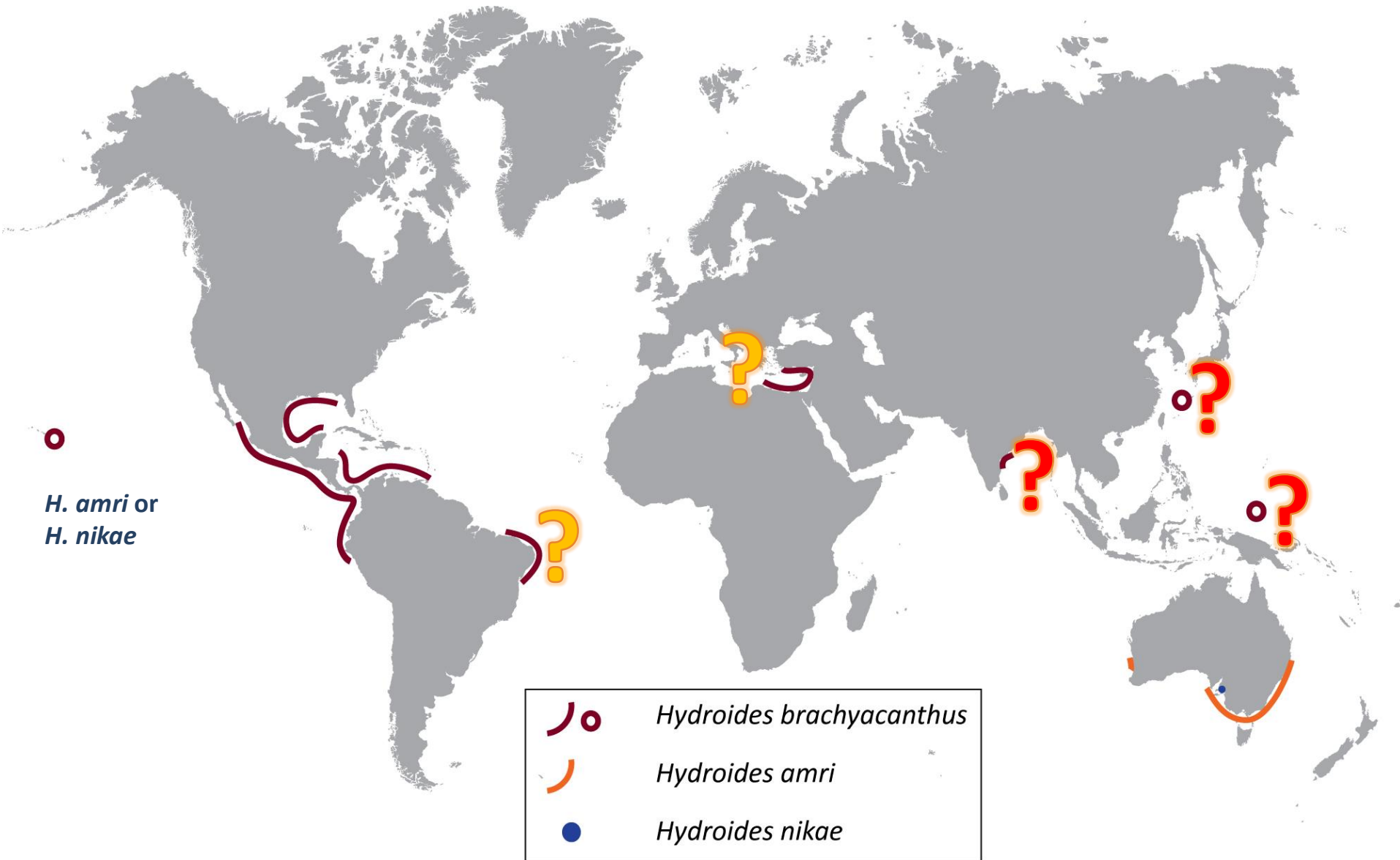


# Cryptic species indicated by a analysis of combined fragments of 18S, cytochrome *b* and ITS2

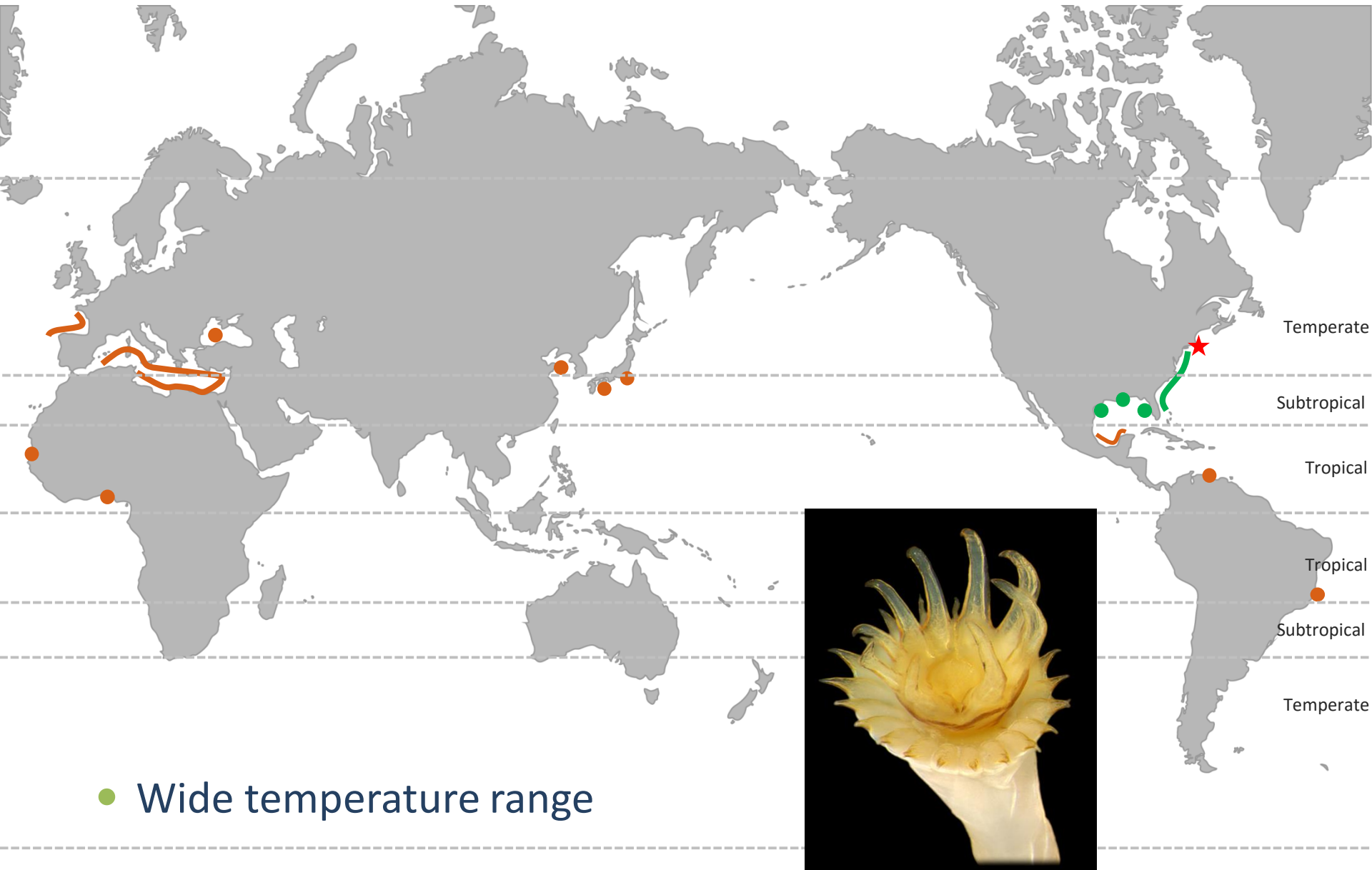




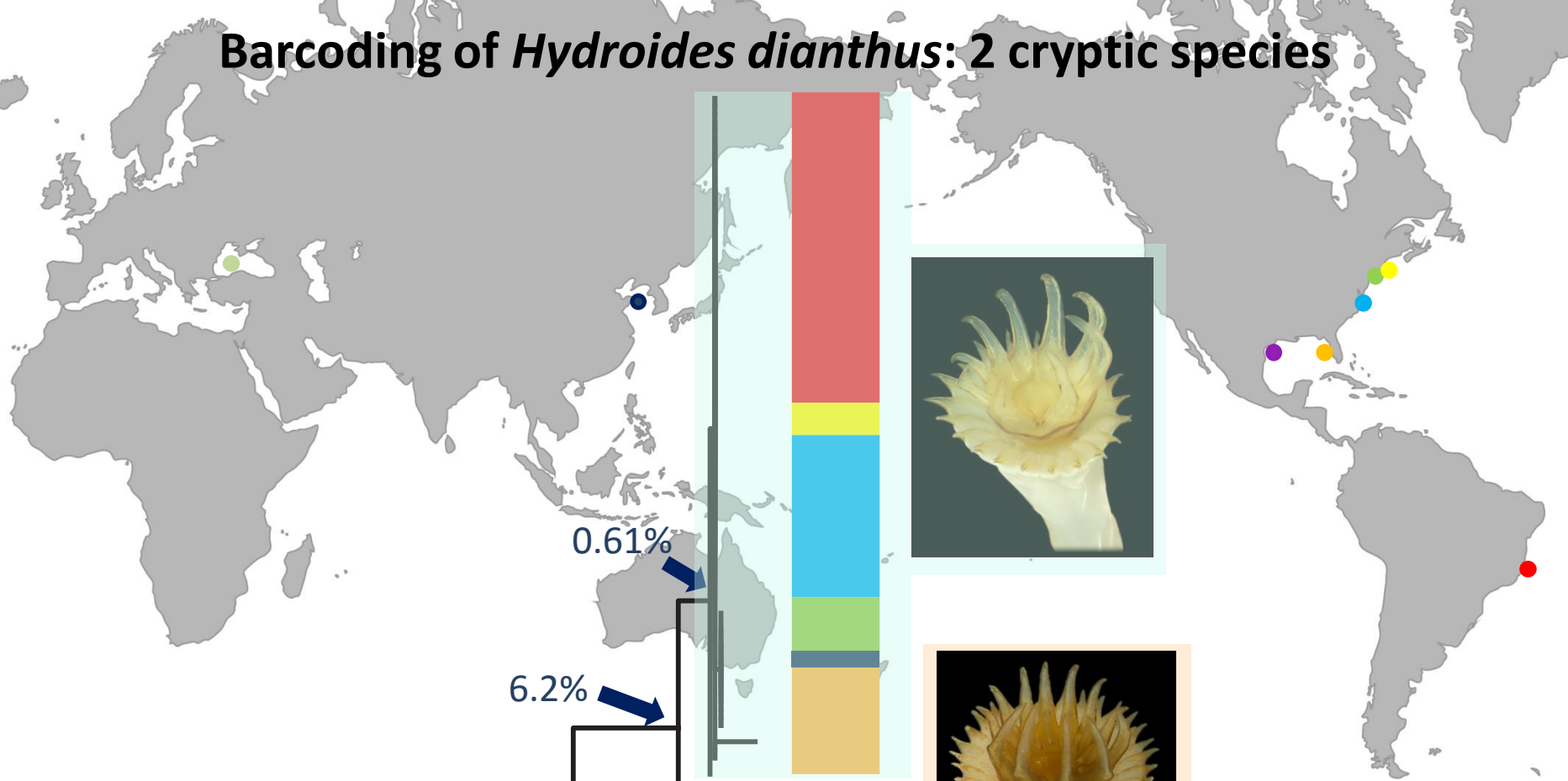
# New status map of *Hydroides brachyacantha* complex



# *Hydroides dianthus* (Verrill, 1873)



# Barcoding of *Hydroides dianthus*: 2 cryptic species

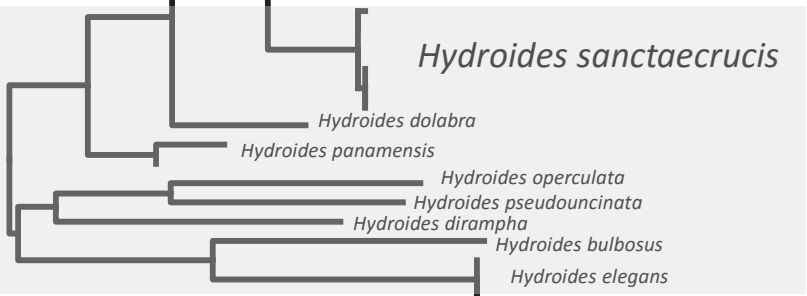


0.61%

6.2%

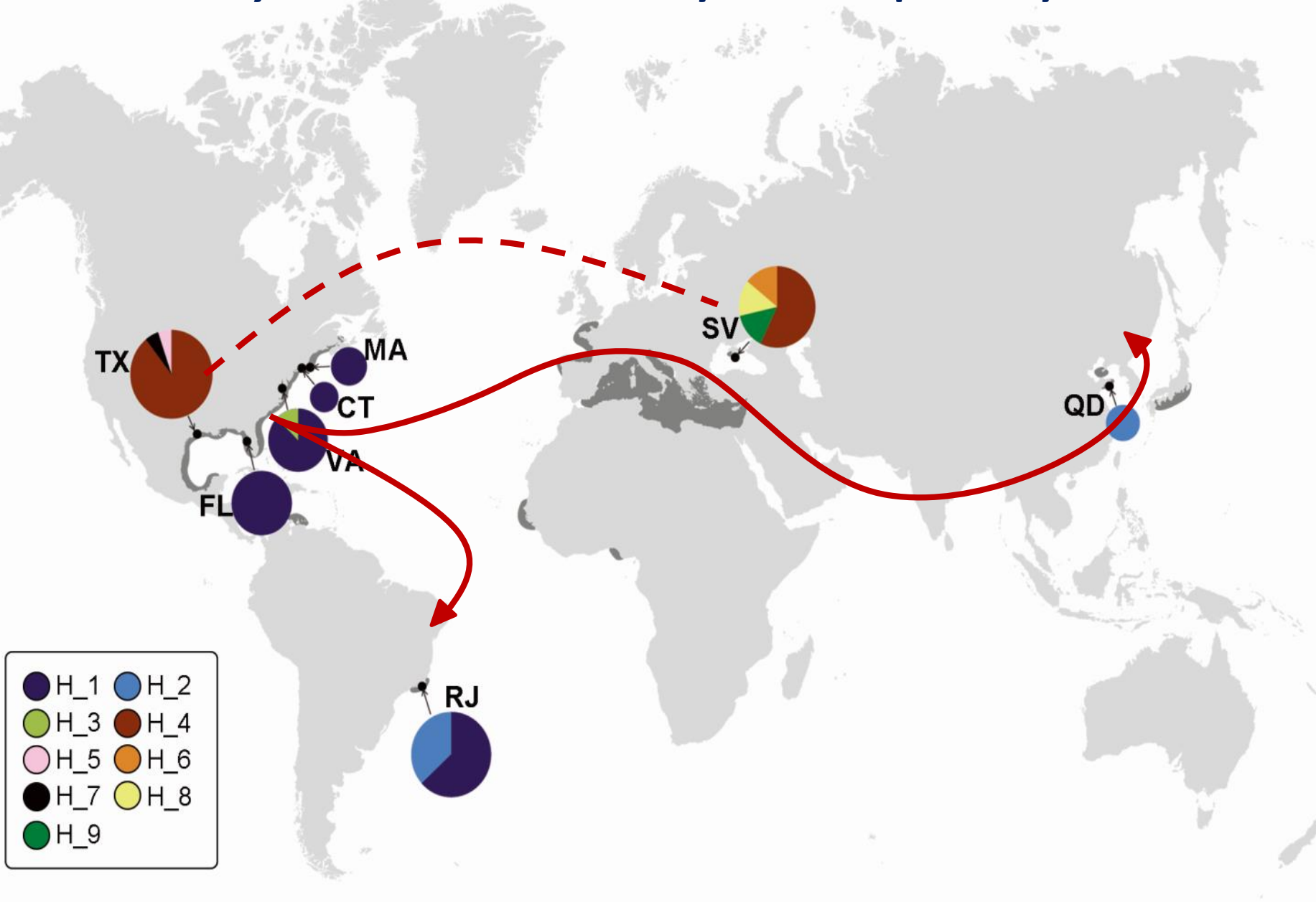
0.23%

21%-30%

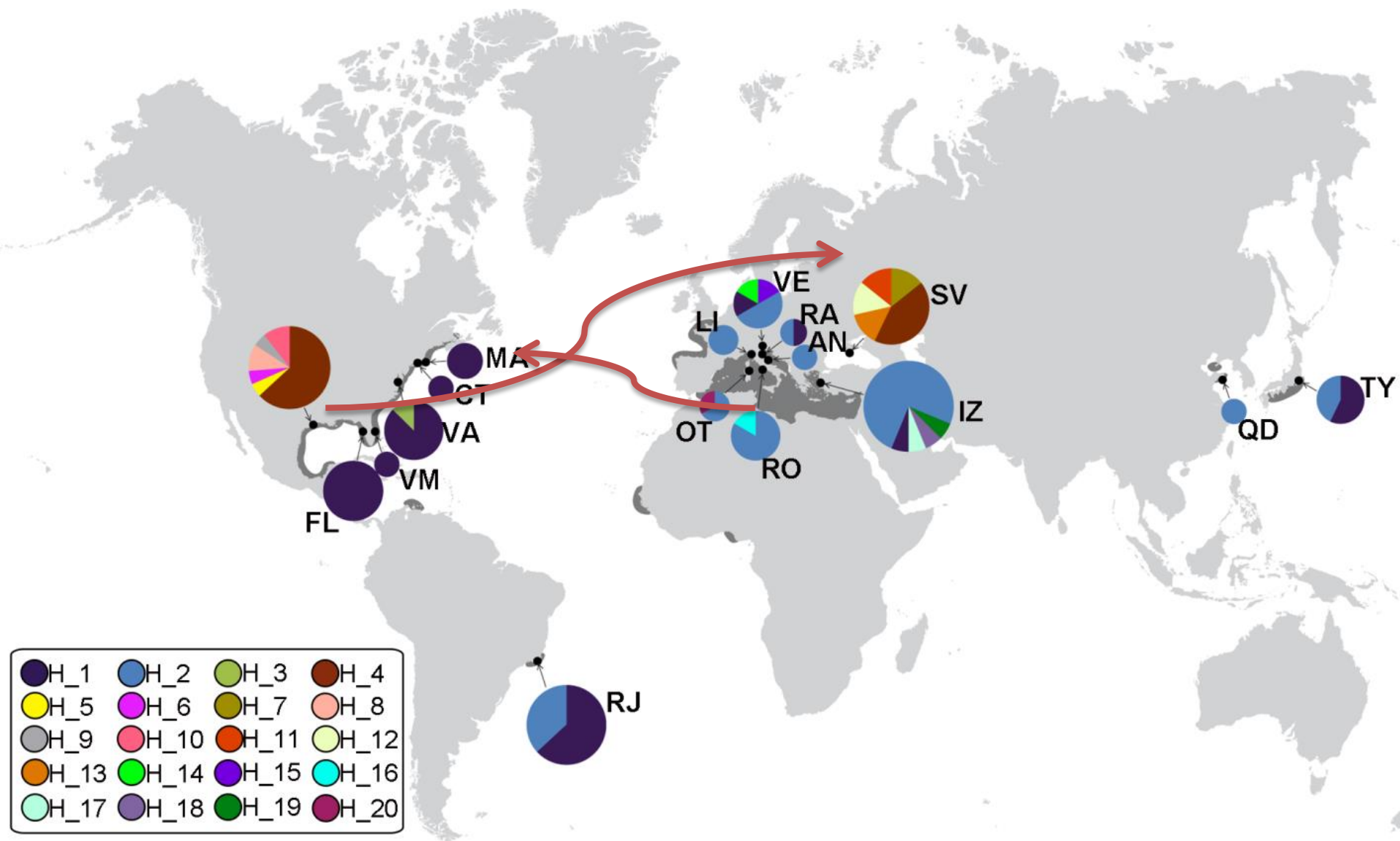


Outgroup

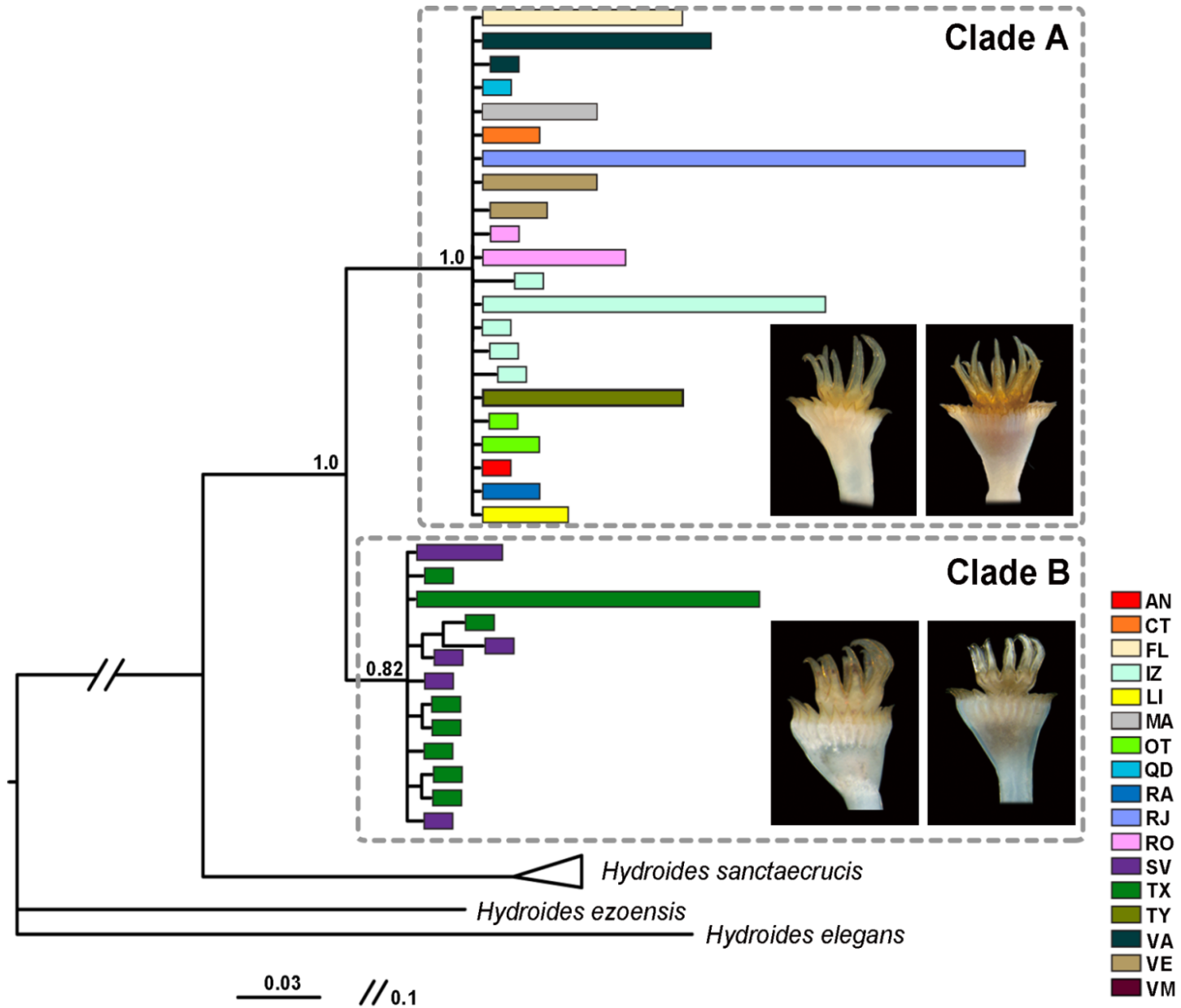
# *Hydroides dianthus*: likely invasion pathways



# *Hydroides dianthus*: likely invasion pathways



# Barcoding of *Hydroides dianthus*: 2 cryptic species



# *Hyroides operculata*

## *Hyroides operculata* Treadwell, 1929

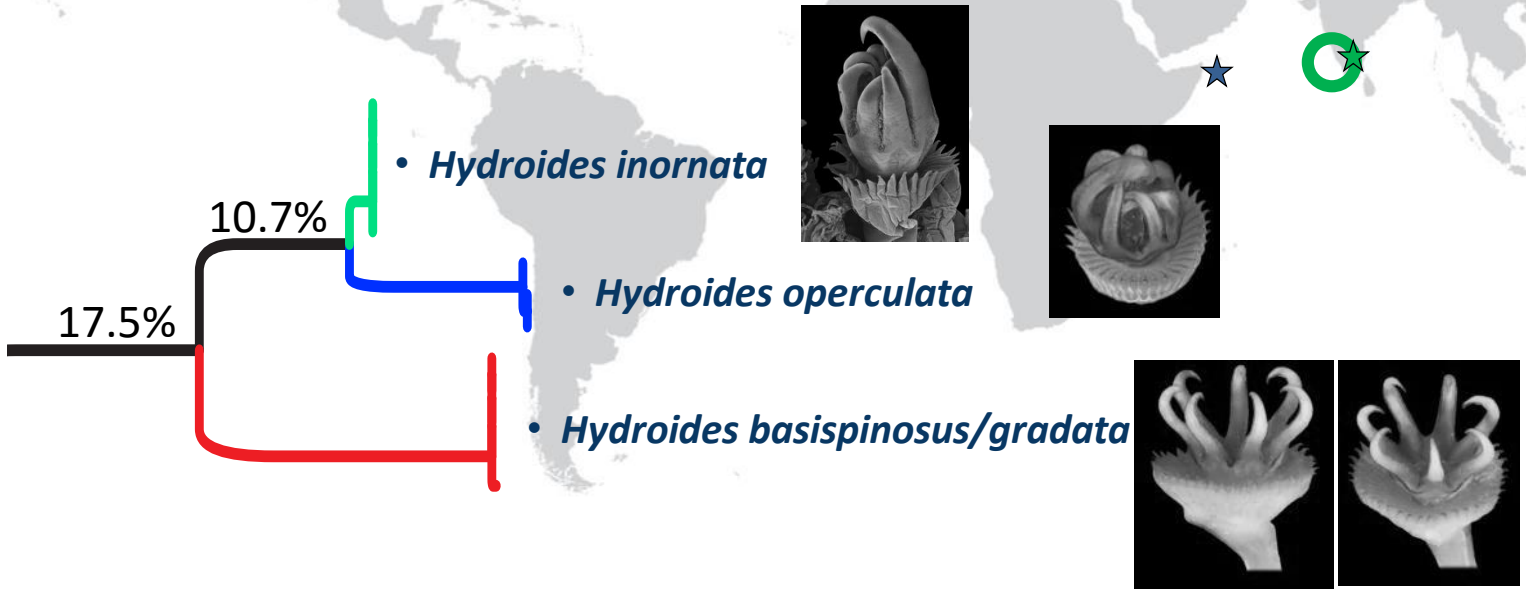
★ Type localities

Synonymised names :

*Hyroides inornatus* (Pillai, 1960)

*Hyroides basispinosus* Straughan, 1967

*Hyroides gradata* Straughan, 1967



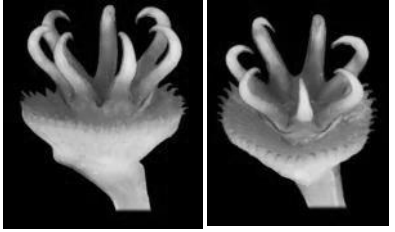
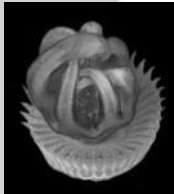
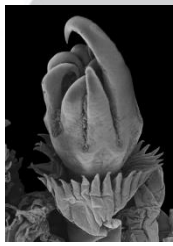
10.7%

• *Hyroides inornata*

17.5%

• *Hyroides operculata*

• *Hyroides basispinosus/gradata*



# “Australian tubeworm” *F. enigmaticus* (Fauvel, 1923)

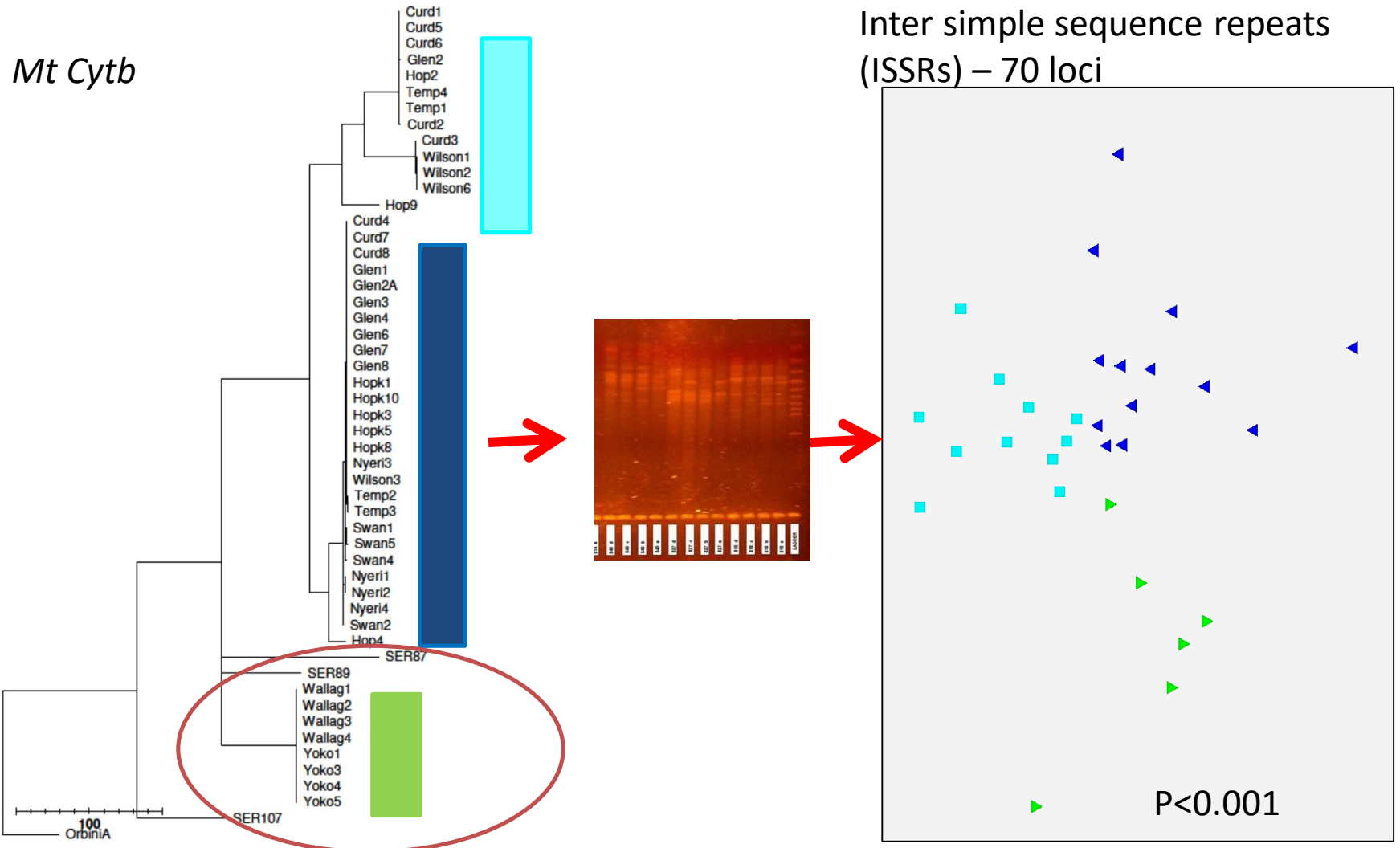


- Estuarine reef building serpulid
- Locally, increases in abundance, fouling issues
- **Worldwide invader of Australian origin?**





# *Ficopomatus enigmaticus*: 3 cryptic species in Australia



## Results: three *Ficopomatus* species with overlapping distributions



- Within each “blue” species – some evidence that WA different to VIC/NSW (mtDNA, ISSRs) → native?
- No obvious morphological differences between “blue” worms in sympatry

# Third species from SE NSW is morphologically distinct

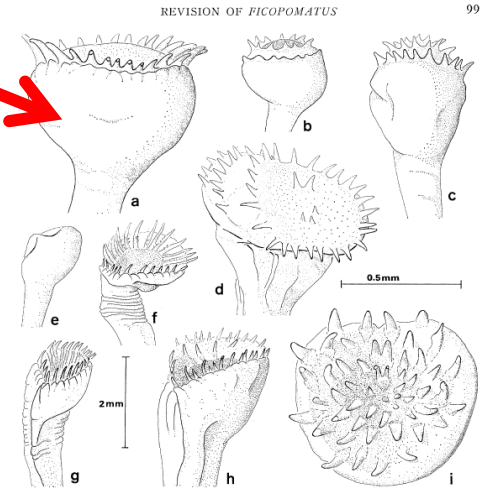


FIGURE 2. Opercula, different orientations. The specimens represented in a-d are *Ficopomatus uschakovi*: a-c, from Guadalcanal; d, paratype of var. *lingayenensis* from Luzon. The specimens in e-i are *F. enigmaticus*: e-h, from the Netherlands; i, from Uruguay. Scale in f, g, h is 2 mm; in remaining figures, the scale is 0.5 mm.

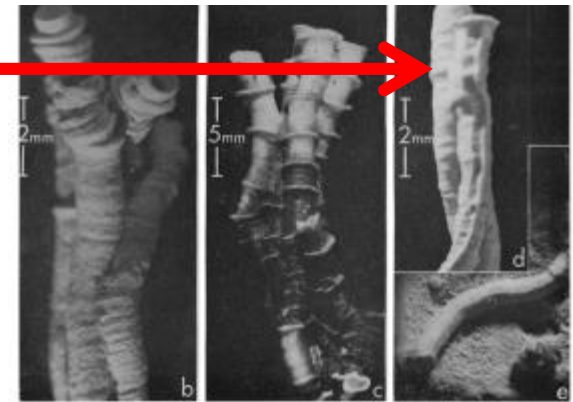


FIGURE 5. Tubes of *Ficopomatus*: a, b, *F. miamiensis* from Barbados, showing differences between two populations from Holstebro river pool and from one-half mile north of Bellairs Institute; c, *F. enigmaticus* from the Netherlands; d, *F. uschakovi* from India, showing three longitudinal keels; and e, *F. macredes* from Talch-Sag, showing one longitudinal keel.

# Nothing is simple with common invasive tubeworms

- ***Hydroides brachyacantha***: a large complex that includes an unknown number of morphologically distinct and cryptic species
- ***Hydroides dianthus***: includes 2 cryptic invasive species
- ***Hydroides operculata***: a complex of at least 3 cryptic genetically distinct species
- ***Ficopomatus enigmaticus***: a complex of 2 cryptic species across southern Australia and a morphologically distinct one from NSW/Victoria.
- Integrative taxonomic studies should be included in bioinvasion studies