The DEEP-SEA BENTHOS – opens a gateway to study of biodiversity, phylogeography and phylogeny of deep-sea barnacles

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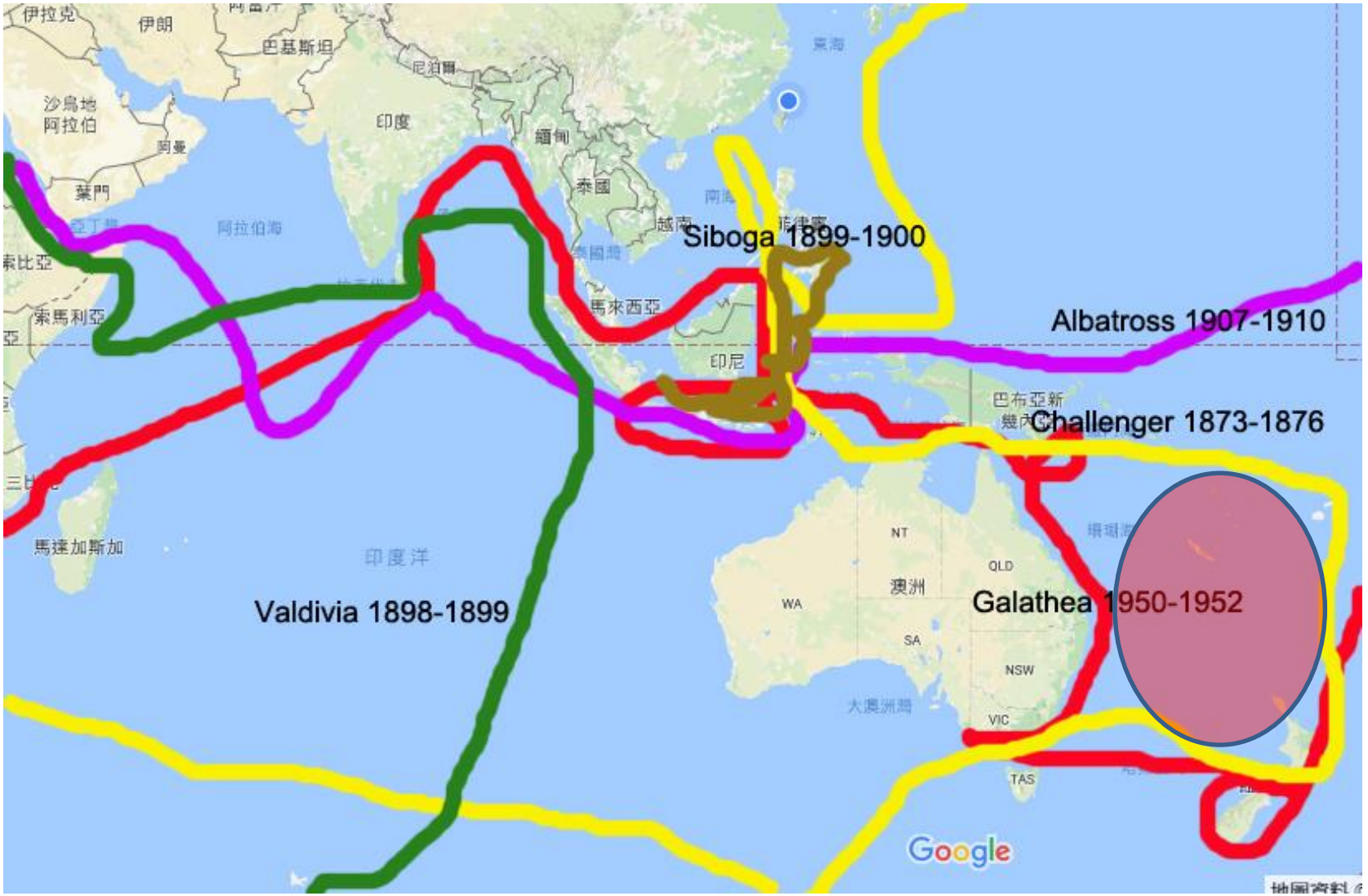
Historical deep-sea expeditions in the Indo-Pacific



Previous barnacle studies from the French Pacific Expeditions

- Buckeridge JS 1994. Verrucomorph of New Caledonia, Indonesia, Wallis and Futuna Islands. Resultat des Campagnes. Musortom Vol 12
- Buckeridge JS, 1996 – *Waikalasma boucheti*
- Buckeridge JS 1998 – *Chionelasmus* in New Caledonia
- Jones 2000 – Revision in Chionelasmatoidea and Pachylasmatoidea of New Caledoina, Vanuatu and Wallis and Futuna Islands

Recent achievements from the French Expeditions

- New species discovery in the deep-sea Scalpellimorphs, Waikalasmatidae
  - Chan, Corbari, Martin-Levefre, Jones, Chen
  - Zootaxa (2014), J. Nat. History (2015)

- Phylogeny of the deep-sea lower balanomorph barnacle Pachylasmatoidea and Chionelasmatoidea
  - Chan, Tsang, Corbari, Martin-Levefre
  - in press in Zool. J. Linn Soc.

- Phylogeography of the deep-sea barnacle *Scalpellum stearnsii* in the Pacific waters
  - Chan, Lin, Corbari, Martin-Levefre

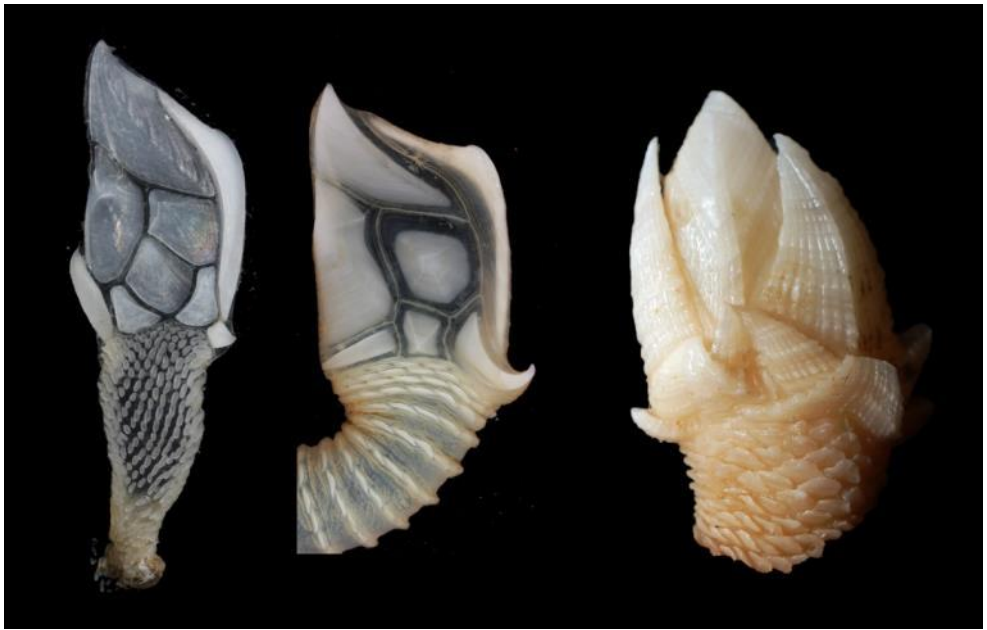
Deep-sea Scalpellimorphs from the South Pacific

Scalepellimorphs – deep-sea inhabitants

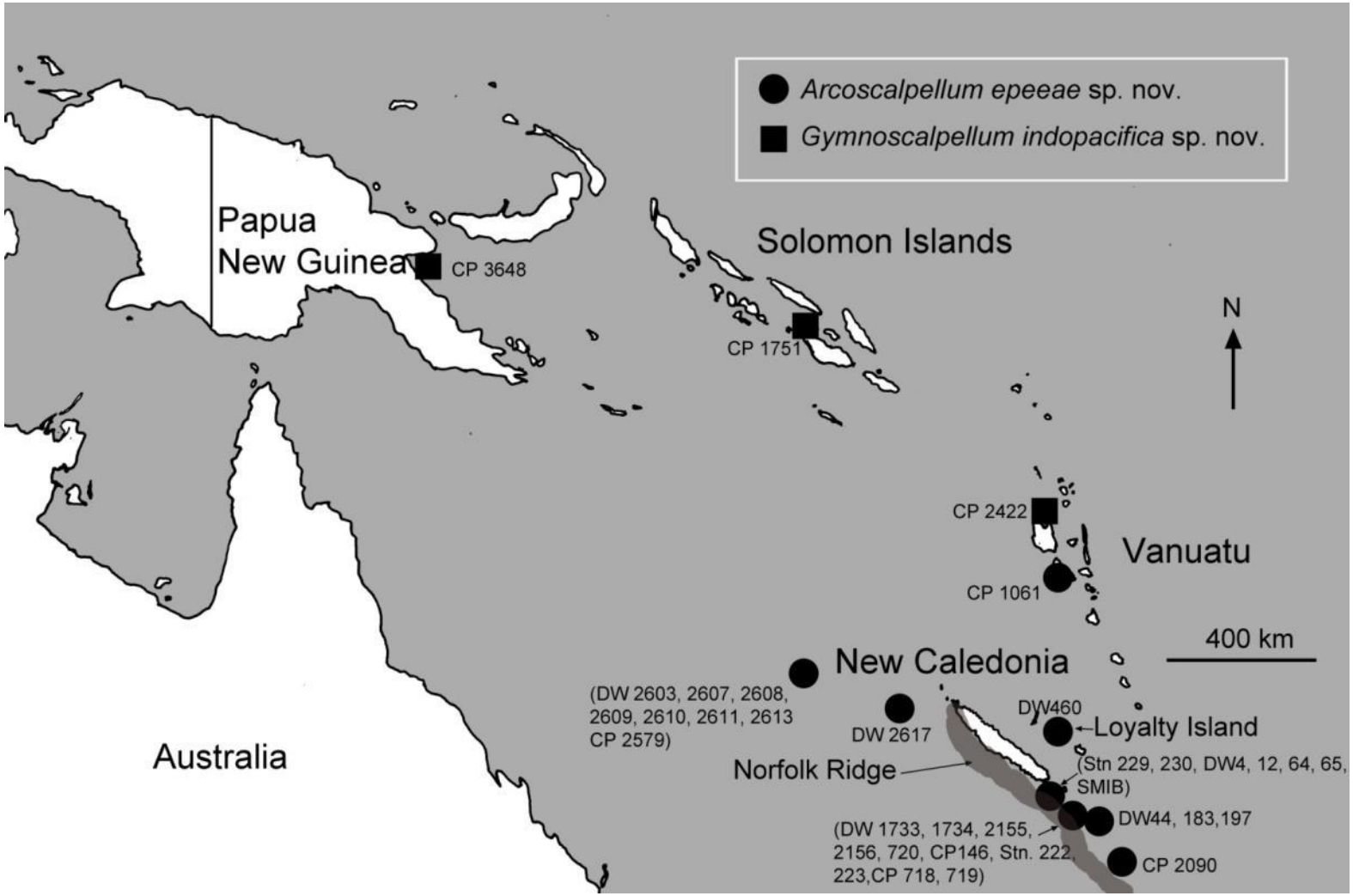
Family assigned according to the number of plates in the capitulum

Number of plates > 13 – Scalpellidae

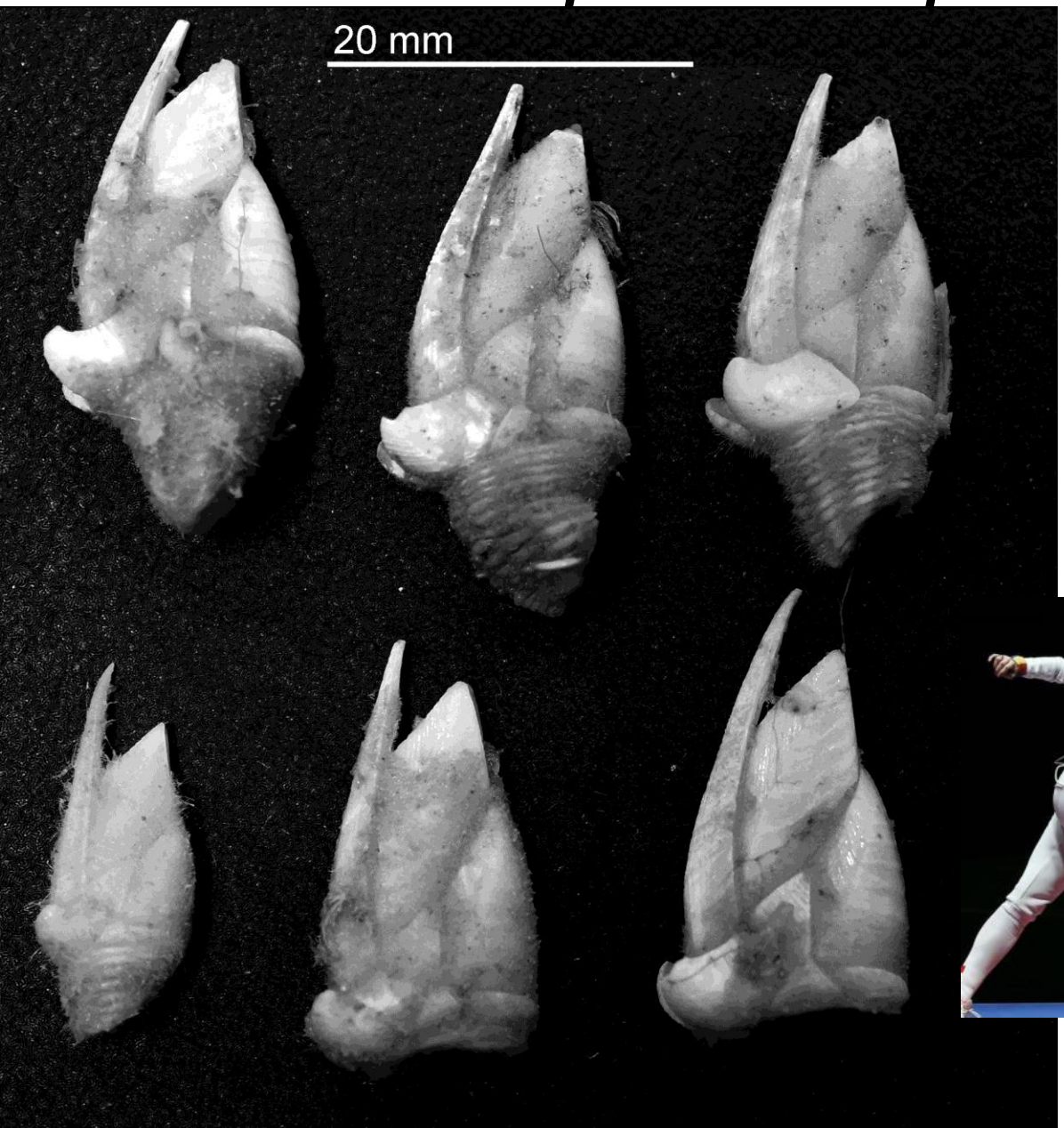
Number of plates in 2 rows - Calanticidae



Description of new species (Scalpellidae) – endemic in South Pacific

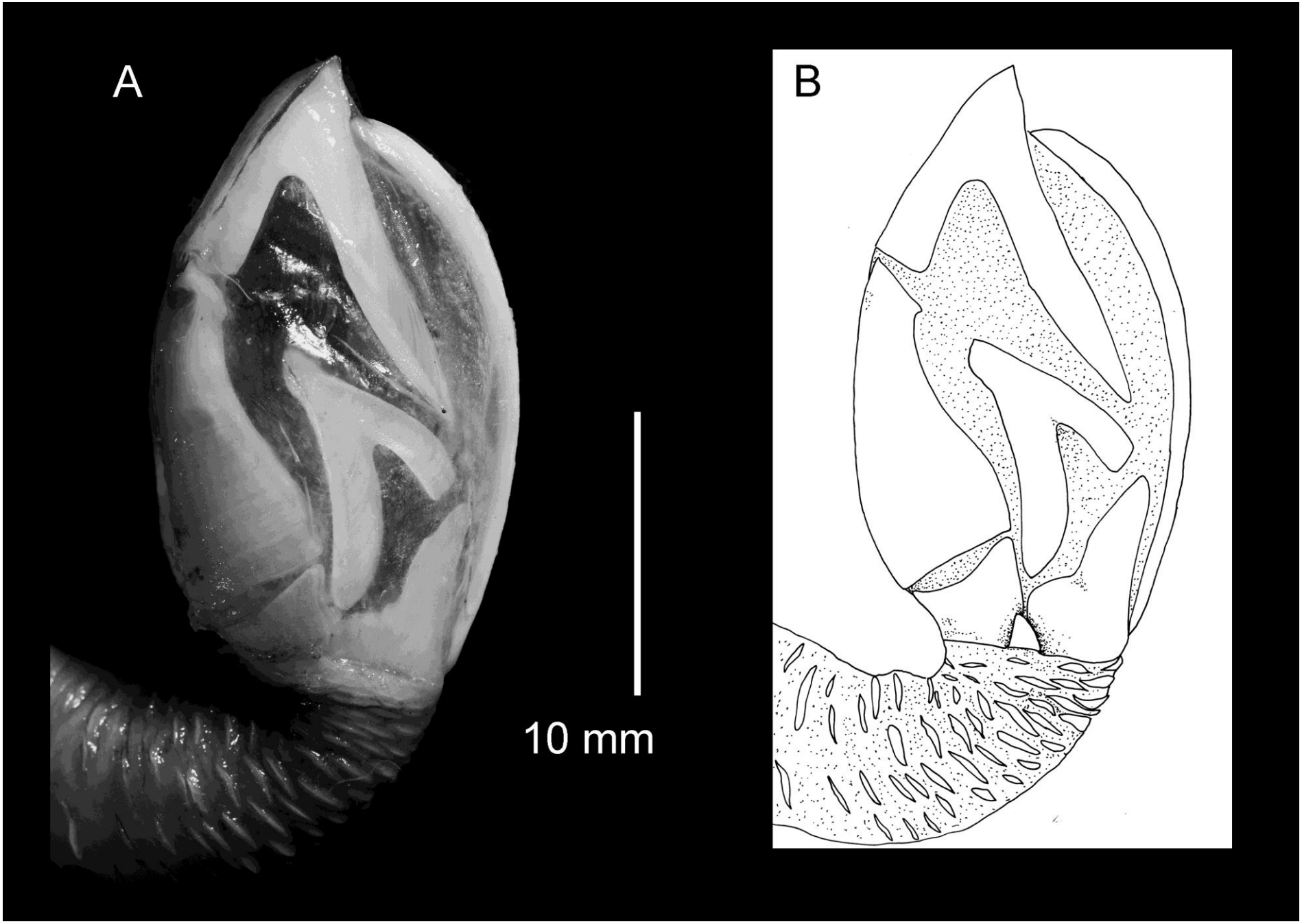


Arcoscalpellum epeeae sp nov.



An French epee

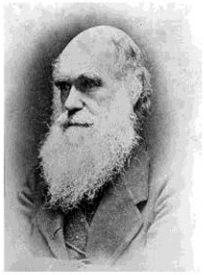
http://www.bbc.co.uk/sport/live/olympics/36774442


A
10 mm
B

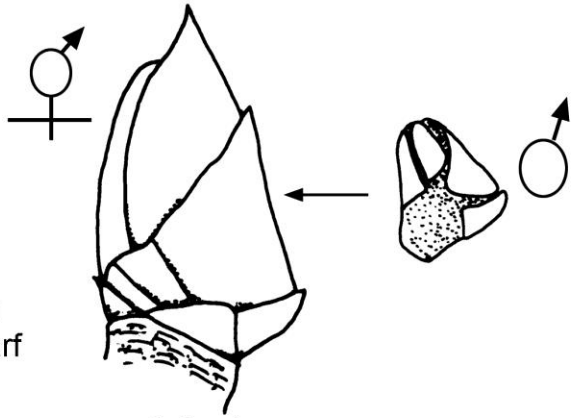
Specialized reproductive system

Low population density

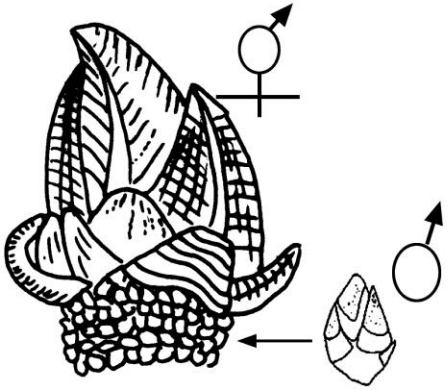
- Especially in the deep-sea
- Dwarf males evolved
- Dwarf males: difference in morphology and on the location of the large female/hermaphrodites



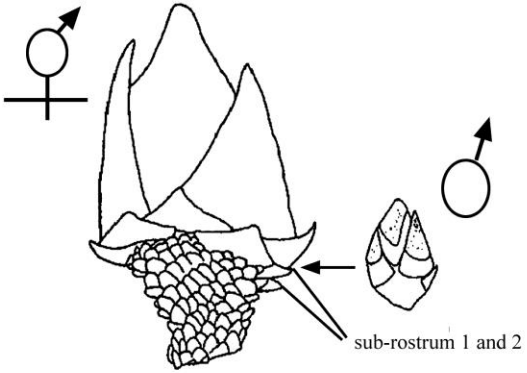
"Regarding the final cause of separation of the sexes and of the existence of dwarf males, I can throw no light"
- Darwin 1852, page 291



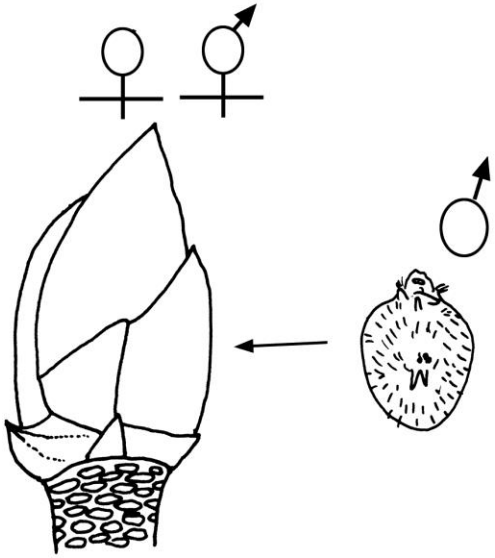
Calantica



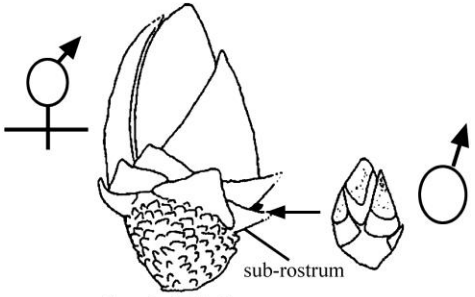
Scillaelepas



Gruveliaepas



Scalpellidae

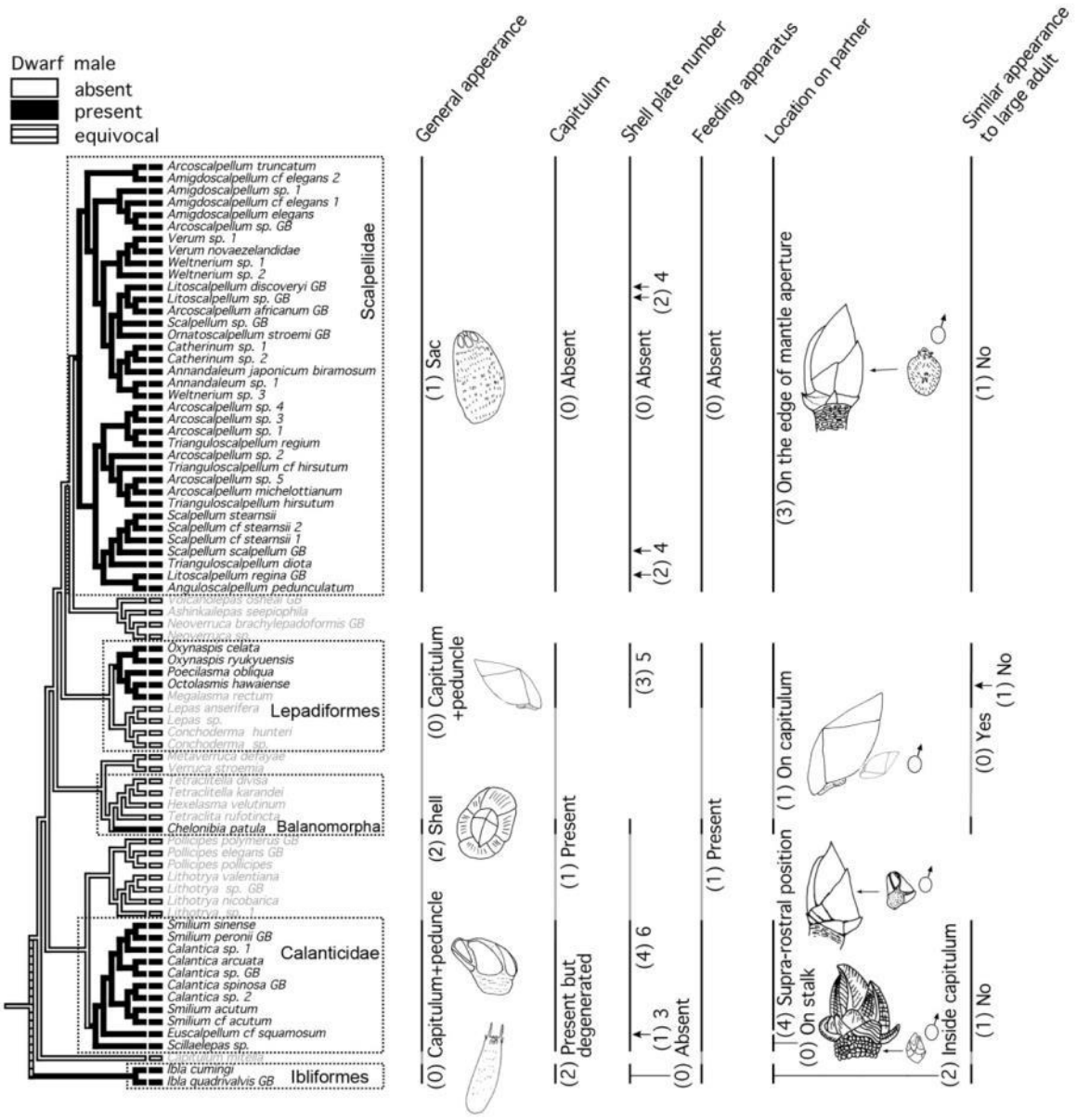


Aurivillialepas

Calanticidae

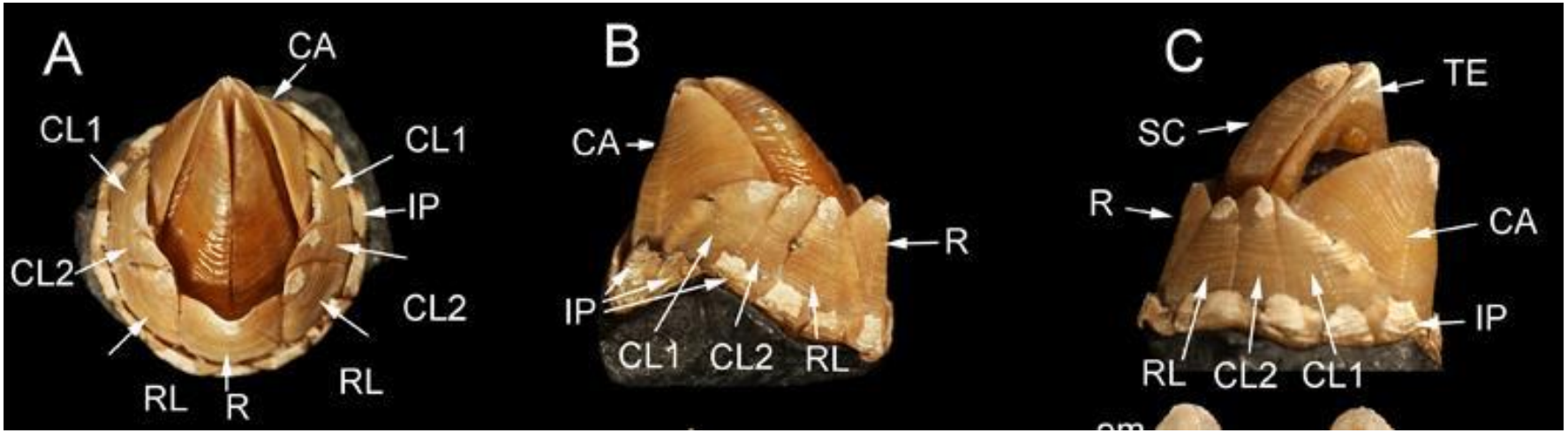
Phylogenetic analysis of dwarf male morphology and position

- Males evolved convergently at least four times from hermaphrodites
- Independent evolution : males morphology and position on their mating partner



Waikalasma diversity

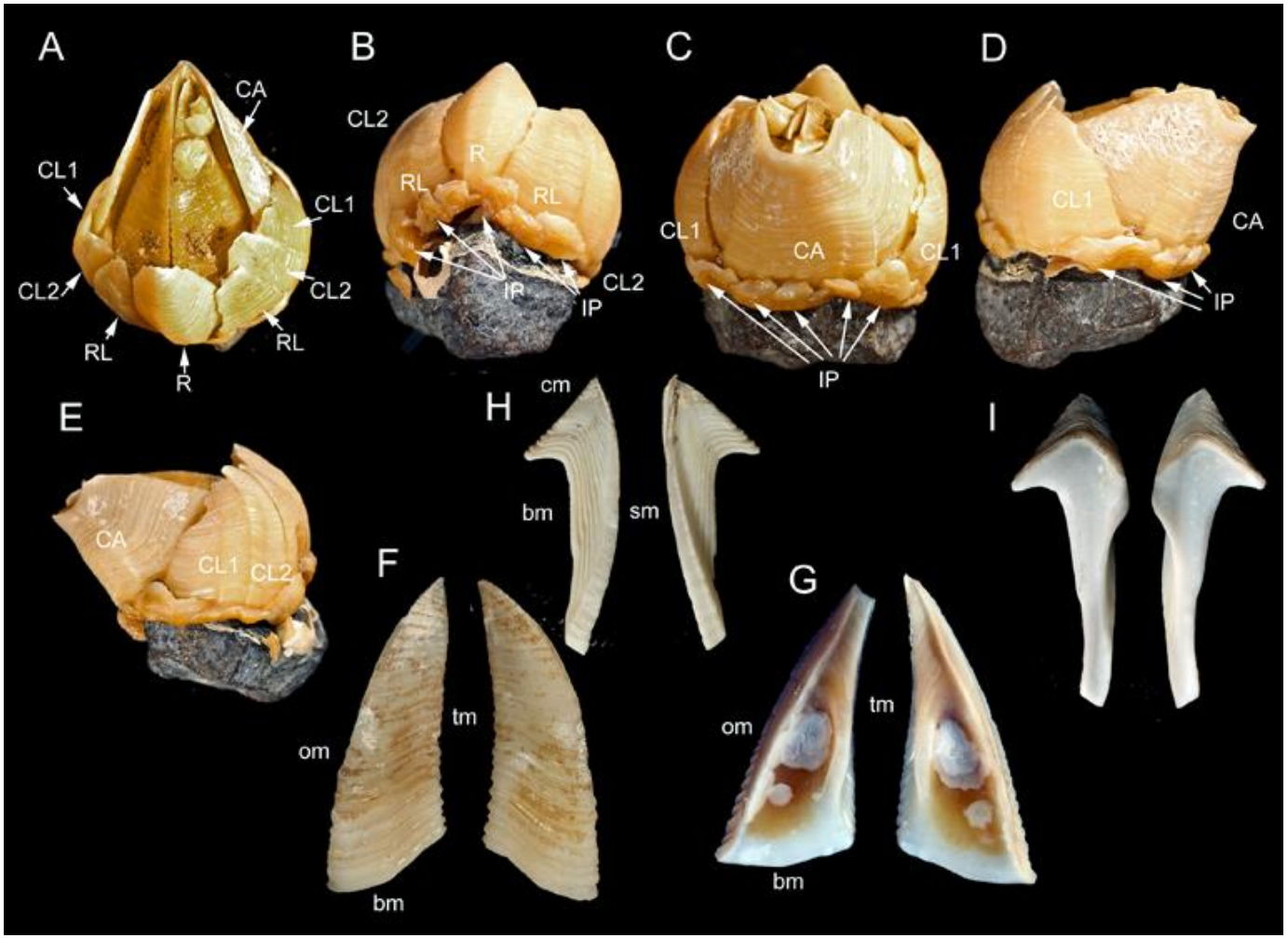
- Waikalasma boucheti was described by Buckeridge (1996)
- In honor to Philip Bouchet
- Considered as rare living fossil

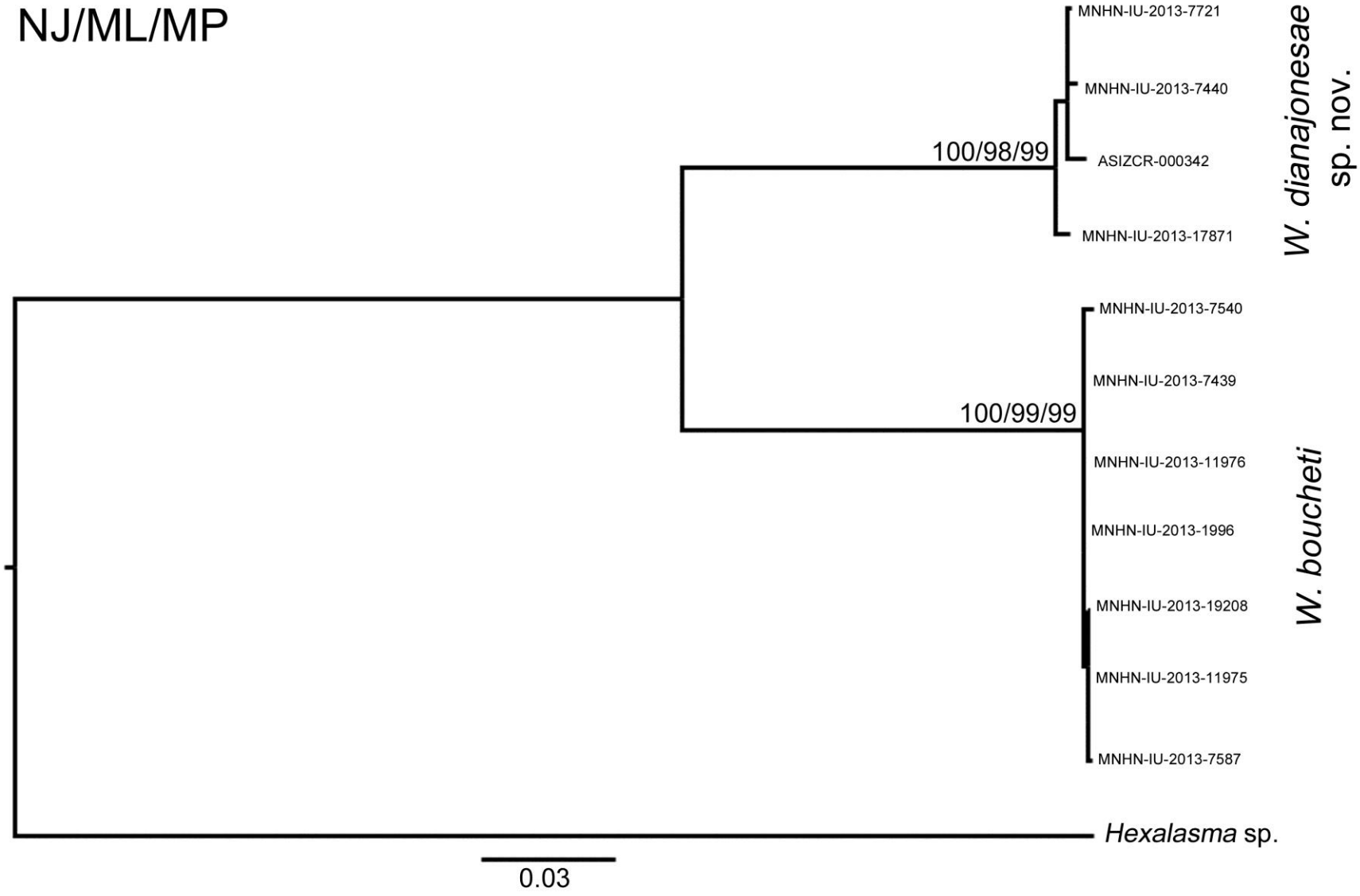


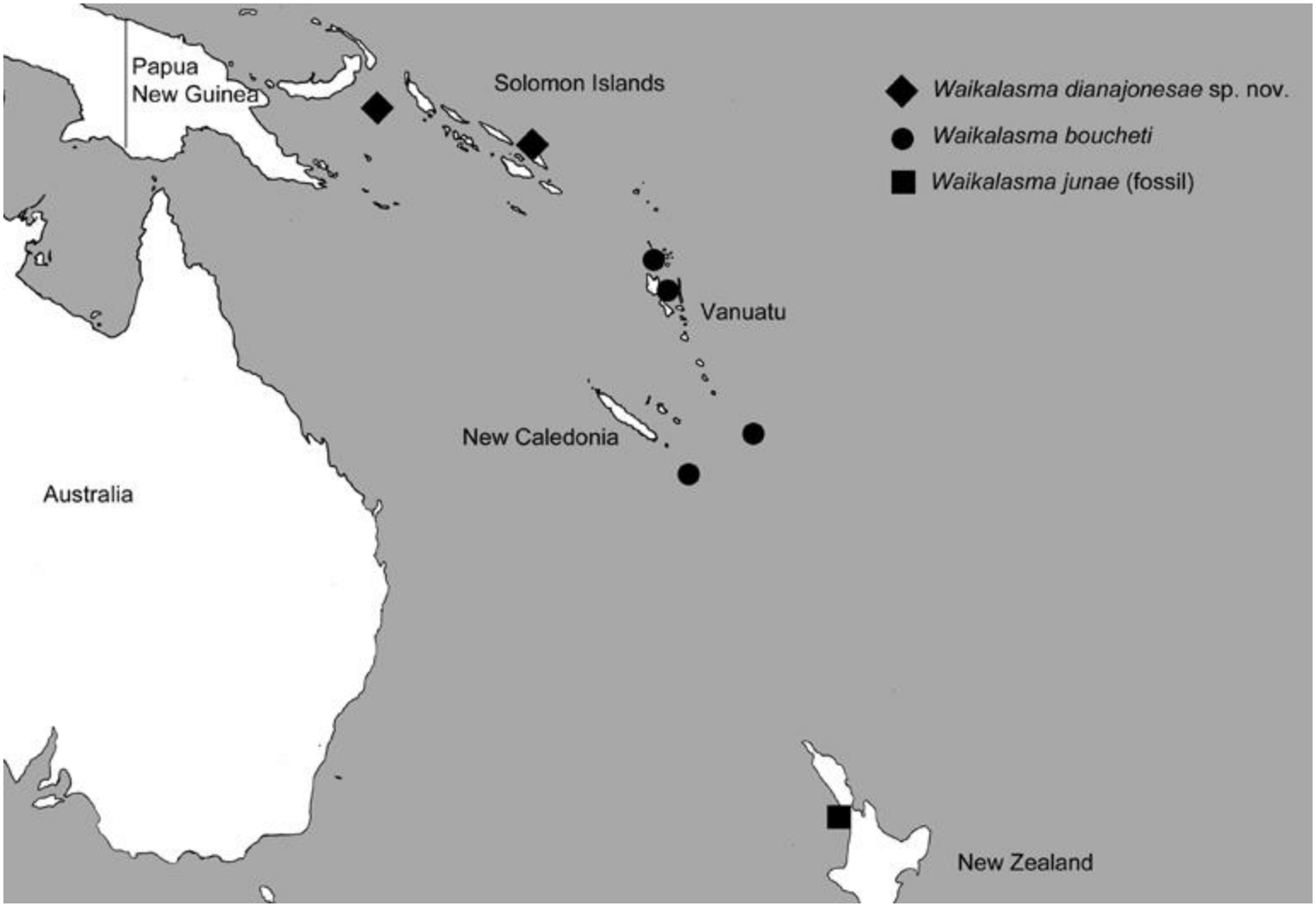

L'ACTUALITÉ DE LA RECHERCHE AU MUSÉUM
OCTOBRE 2016
DEPUIS PLUS DE 20
D'ANNÉES,
DES BALANES À AR
AU FOND DES OCÉA
ARTICLE ORIGINAL
IRD

With the additional collections

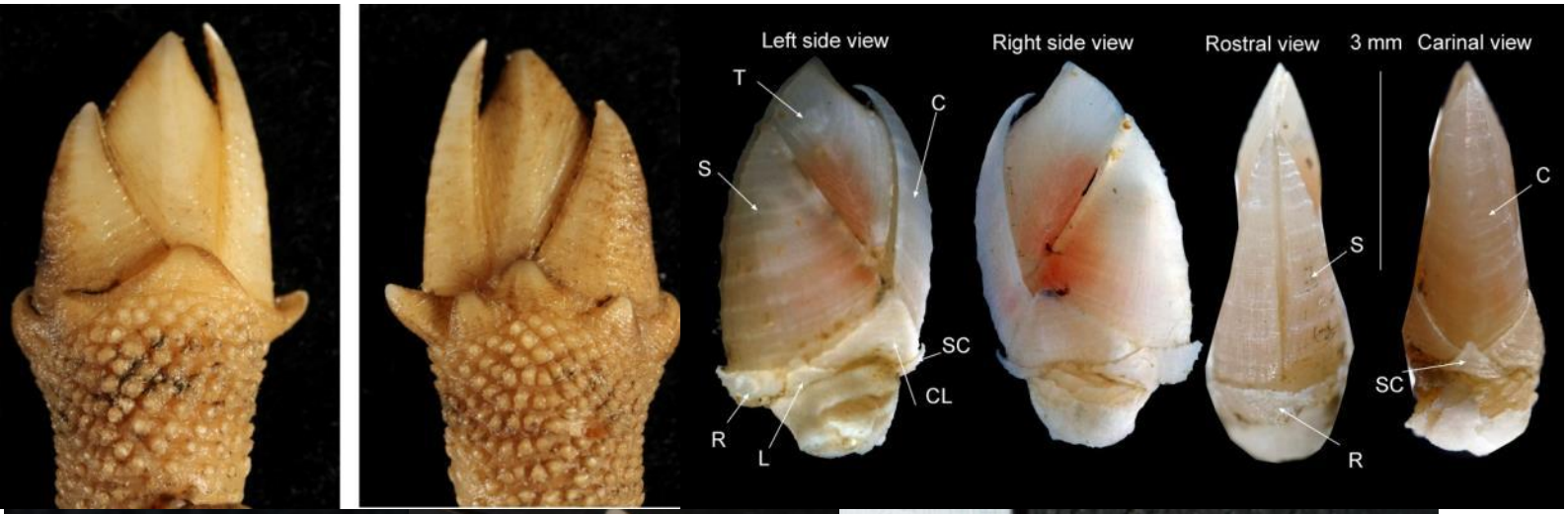
- One new species – *Waikalasma dianajonesae* sp. nov. identified
- In honor to Diana Jones (director of Western Australian Museum)




NJ/ML/MP
MNHN-IU-2013-7721
MNHN-IU-2013-7440
ASIZCR-000342
MNHN-IU-2013-17871
100/98/99
W. dianajonesae sp. nov.
MNHN-IU-2013-7540
MNHN-IU-2013-7439
100/99/99
MNHN-IU-2013-11976
MNHN-IU-2013-1996
MNHN-IU-2013-19208
MNHN-IU-2013-11975
MNHN-IU-2013-7587
W. boucheti
Hexalasma sp.
0.03


Papua
New Guinea
Solomon Islands
Vanuatu
New Caledonia
Australia
New Zealand
Waikalasma dianajonesae sp. nov.
Waikalasma boucheti
Waikalasma junae (fossil)

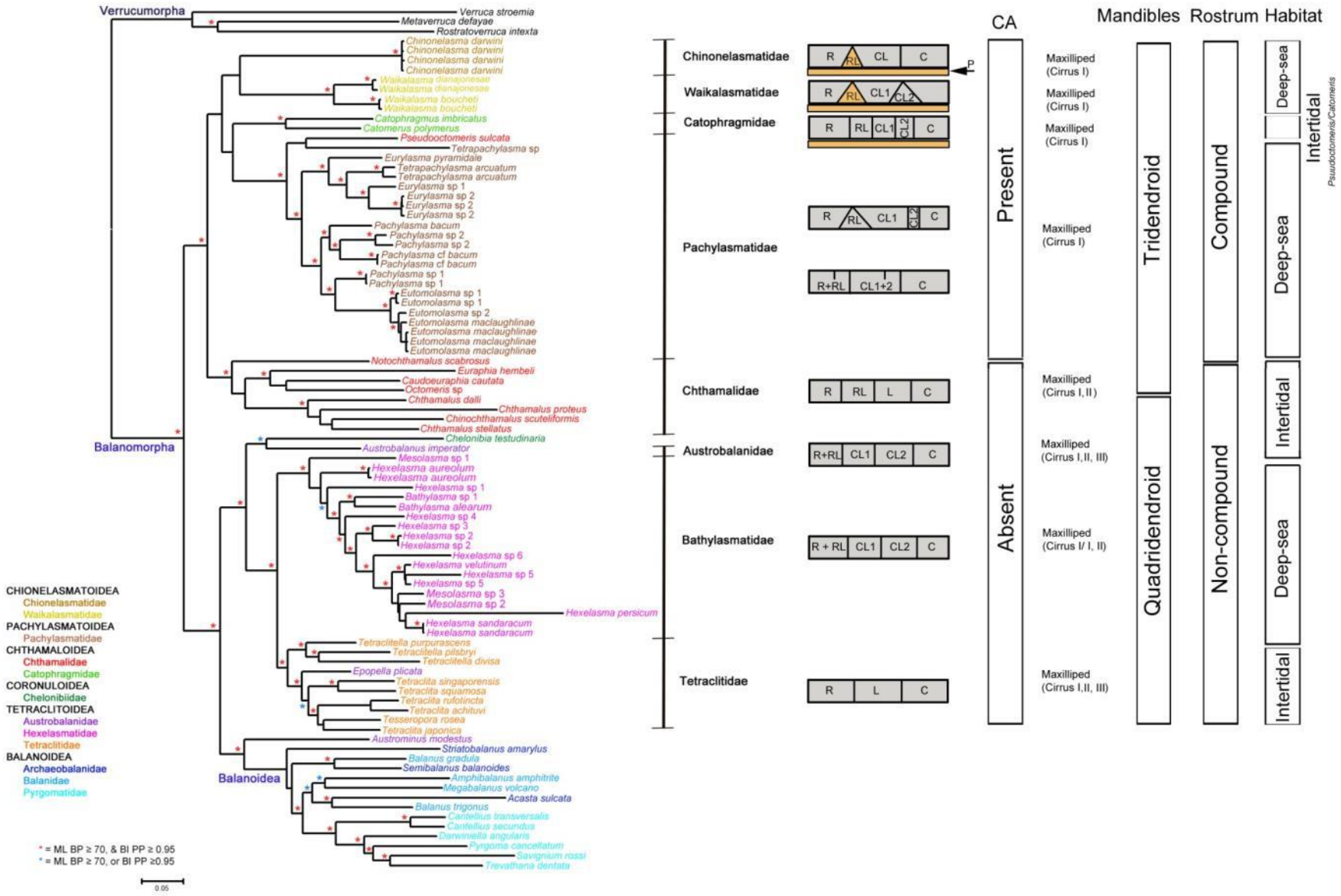
A lot more new species to be described…



Lower Balanomorph phylogeny

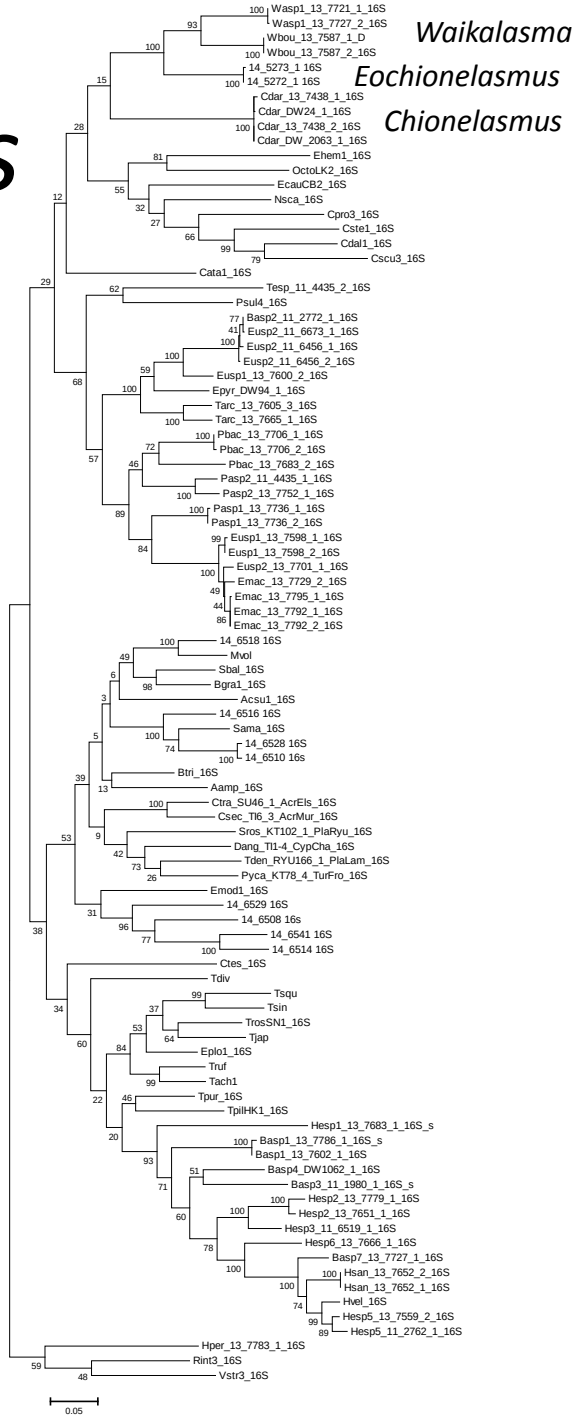
- Pachylasmatoidea – non-stalked barnacles exclusive deep-sea inhabitants
- Family Chionelasmatoidea – consists of 6 or 8 shell plates individuals, but the periphery are supported by Imbricating plates
- Such morphology is believed to be a primitive character

- We obtained 49 samples from 30 species of the Chionelasmatidae, Pachylasmatidae, Waikalasmatidae, and Bathylasmatidae families from the Muséum National d'Histoire Naturelle (NMHN), which represent the collection of recent French deep-sea expeditions in the Indo-West Pacific region
- Molecular phylogeny – 7 markers


Verrucumorpha
Balanomorpha
Balanoidea
Verruca stroemia
Metaverruca defayae
Rostratoverruca intexta
Chinonelasma darwini
Chinonelasma darwini
Chinonelasma darwini
Chinonelasma darwini
Waikalasma dianajonesae
Waikalasma dianajonesae
Waikalasma boucheti
Waikalasma boucheti
Catophragmus imbricatus
Catomerus polymerus
Pseudooctomeris sulcata
Tetrapachylasma sp
Eurylasma pyramidale
Tetrapachylasma arcuatum
Tetrapachylasma arcuatum
Eurylasma sp 1
Eurylasma sp 2
Eurylasma sp 2
Eurylasma sp 2
Pachylasma bacum
Pachylasma sp 2
Pachylasma sp 2
Pachylasma cf bacum
Pachylasma cf bacum
Pachylasma sp 1
Pachylasma sp 1
Eutomolasma sp 1
Eutomolasma sp 1
Eutomolasma sp 2
Eutomolasma maclaughlinae
Eutomolasma maclaughlinae
Eutomolasma maclaughlinae
Eutomolasma maclaughlinae
Notochthamalus scabrosus
Euraphia hembeli
Caudoeuraphia cautata
Octomeris sp
Chthamalus dalli
Chthamalus proteus
Chinochthamalus scuteliformis
Chthamalus stellatus
Chelonibia testudinaria
Austrobalanus imperator
Mesolasma sp 1
Hexelasma aureolum
Hexelasma aureolum
Hexelasma sp 1
Bathylasma sp 1
Bathylasma alearum
Hexelasma sp 4
Hexelasma sp 3
Hexelasma sp 2
Hexelasma sp 2
Hexelasma sp 6
Hexelasma velutinum
Hexelasma sp 5
Hexelasma sp 5
Mesolasma sp 3
Mesolasma sp 2
Hexelasma persicum
Hexelasma sandaracum
Hexelasma sandaracum
Tetraclitella purpurascens
Tetraclitella pilsbryi
Tetraclitella divisa
Epopella plicata
Tetraclita singaporensis
Tetraclita squamosa
Tetraclita rufotincta
Tetraclita achituvi
Tesseropora rosea
Tetraclita japonica
Austrominus modestus
Striatobalanus amarylus
Balanus gradula
Semibalanus balanoides
Amphibalanus amphitrite
Megabalanus volcano
Acasta sulcata
Balanus trigonus
Cantellius transversalis
Cantellius secundus
Darwiniella angularis
Pyrgoma cancellatum
Savignium rossi
Trevathana dentata
CHIONELASMATOIDEA
Chionelasmatidae
Waikalasmatidae
PACHYLASMATOIDEA
Pachylasmatidae
CHTHAMALOIDEA
Chthamalidae
Catophragmidae
CORONULOIDEA
Chelonibiidae
TETRACLITOIDEA
Austrobalanidae
Hexelasmatidae
Tetraclitidae
BALANOIDEA
Archaeobalanidae
Balanidae
Pyrgomatidae
* = ML BP ≥ 70, & BI PP ≥ 0.95
* = ML BP ≥ 70, or BI PP ≥0.95
0.05
Chinonelasmatidae
Waikalasmatidae
Catophragmidae
Pachylasmatidae
Chthamalidae
Austrobalanidae
Bathylasmatidae
Tetraclitidae
R
RL
CL
C
P
CL1
CL2
L
R+RL
CL1+2
R + RL
CA
Present
Absent
Mandibles
Rostrum
Habitat
Maxilliped (Cirrus I)
Maxilliped (Cirrus I)
Maxilliped (Cirrus I)
Maxilliped (Cirrus I)
Maxilliped (Cirrus I, II)
Maxilliped (Cirrus I, II, III)
Maxilliped (Cirrus I/ I, II)
Maxilliped (Cirrus I, II, III)
Tridendroid
Quadridendroid
Compound
Non-compound
Deep-sea
Intertidal
Deep-sea
Intertidal
Deep-sea
Intertidal
Pseudooctomeris/Catomeris

Eochionelasmus

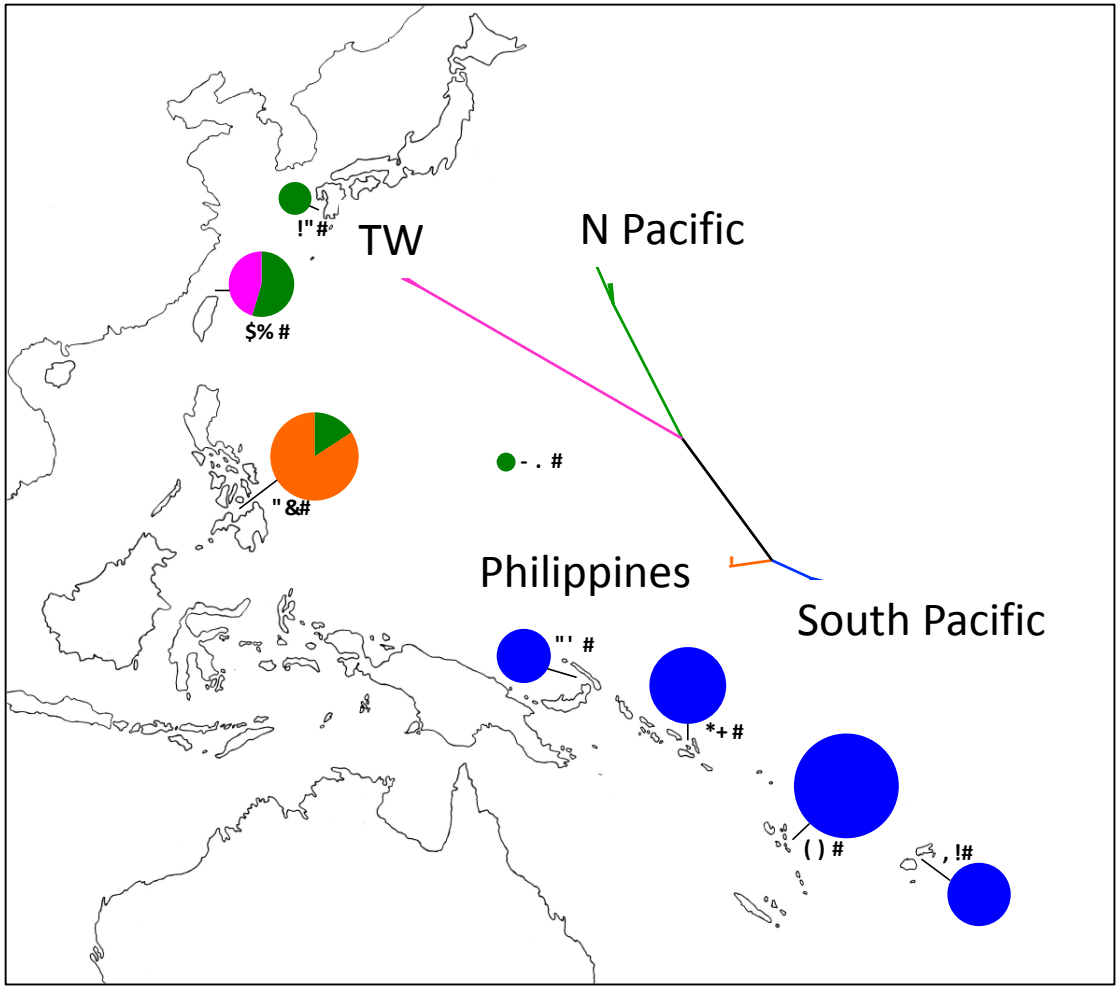
- 6 plates – multiple rows of imbricating plates
- Does multiple rows of imbricating plates is a primitive character?



Phylogeography of Scalpellidae

- The deep-sea barnacle *Scalpellum stearnsii*
- Commonly reported in the whole Indo-Pacific deep-sea 200-1000 metres depth

Genetric differentiation COI



South Pacific deep-sea barnacles

- Endemism
- Distinct genetic differentiations
- Contains many lower balanomorph species

- On-going directions:
- Evolution on dwarf male positions in Scalpellimorph barnacles
- Verrucumorpha – assymetrical barnacles

Acknowledgement

- This study has been supported by the ANR project France-Taiwan DeepEvo and MOST Binary grant (Co PI S. Samadi, W-J Chen)
- Tropical Deep-Sea Benthos programme (MNHN, IRD) and by previous French expeditions to the Norfolk Ridge (SMIB 2, SMIB 4), the Loyalty Islands (BIOCAL, MUSORSTOM 6), New Caledonia (MUSORSTOM 4, MUSORSTOM 5, BATHUS 2), banc Aztèque (SMIB 8) and Vanuatu (MUSORSTOM 8).
- PIs of the Tropical Deep-Sea Benthos programme cruises; B. Richer de Forges, P. Bouchet and S. Samadi.
- Special thanks are also given to the crew of RV *ALIS*.