

# Pharmaceutical and Biotechnological Applications of the Coral Microbiome



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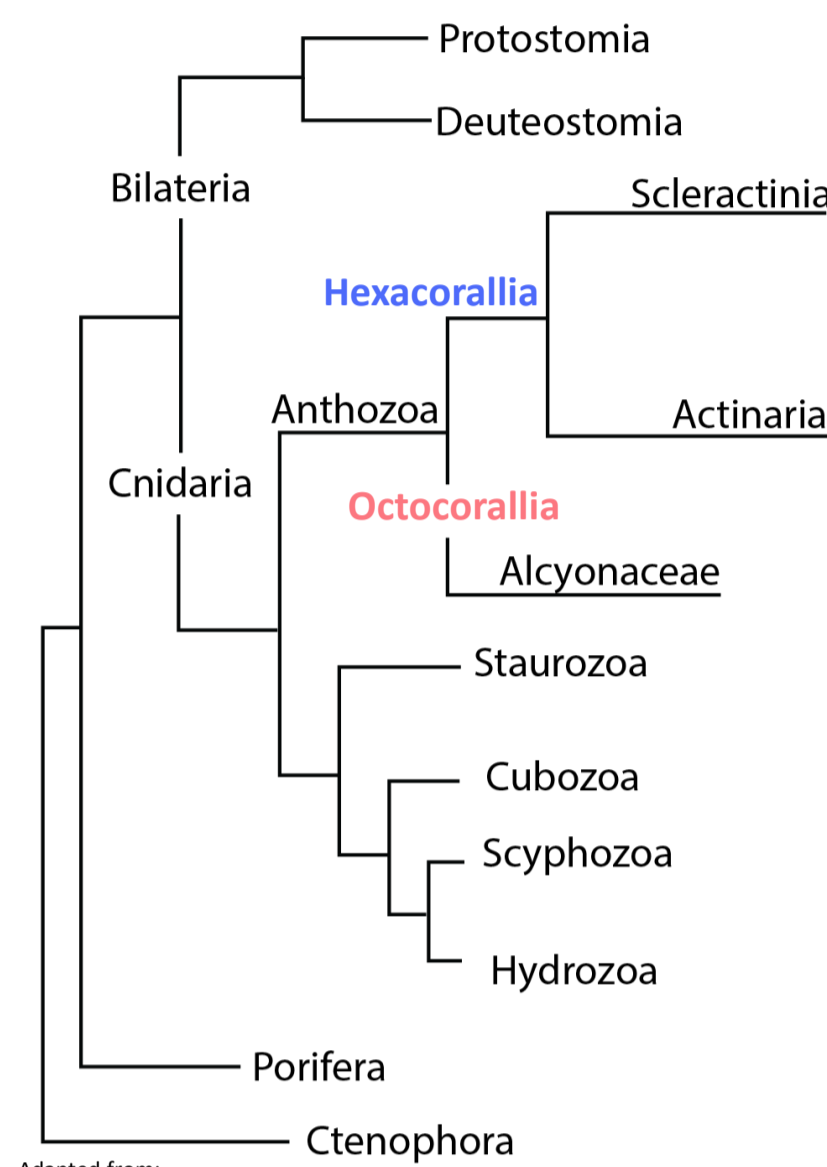
## Background & Motivation

### Corals (Cnidaria, Anthozoa)

- Marine, sessile, invertebrate animals.
- Distributed all around the globe: from shallow tropical waters to colder and deeper seas.
- Reef builders – create habitats for many marine species.



Photo by Fabrizio Fabroni.



Adapted from: Palmer, C.V., Traylor-Knowles, N.G. (2018). Cnidaria: Anthozoans in the Hot Seat. In: Cooper, L. (eds) Advances in Comparative Immunology. Springer, Cham.

**Corals and their associated microbiota** rely on chemical defence and signalling for protection against other organisms (predators and pathogens) for competition and for physiological processes.

### Examples of the coral holobiont's chemistry:

- octocoral *Maasella edwardsii* extracts as feeding deterrents against common grazers like shrimp *Palaemon elegans*; → **Protection against predators**
- soft coral extracts effects on the hydrophobicity of biofilms formed by *Vibrio harveyi* (opportunistic coral pathogen); → **Protection against pathogens**
- hard coral extracts lethal to several species of coral planulae larvae; → **Competition**
- Sperm attraction to coral colonies mediated by diterpenes. → **Physiological Processes**

**Distinctive and unique lifestyle & unprecedented species diversity**

**Corals and their associated microbiota have evolved into one of the most prolific sources of natural products**

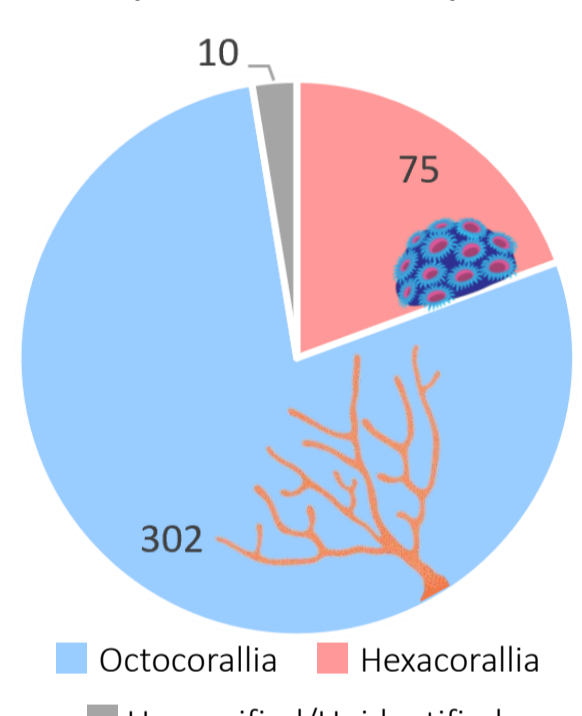
### Objective of this review:

Analyse the novel compounds reported from coral-associated microorganisms in the 5-year period of 2018-2022.

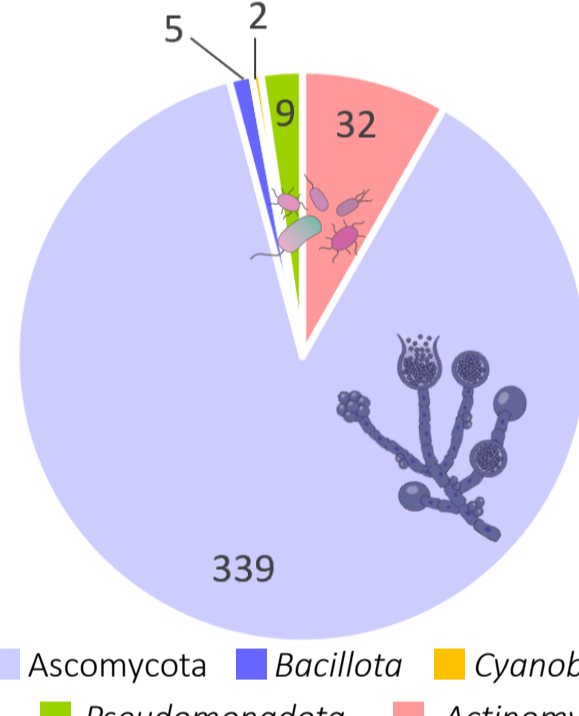
## New natural products from the coral microbiome discovered between 2018 and 2022

### Diversity and provenance of new natural products from the coral microbiome

Coral host order of the novel reported compounds



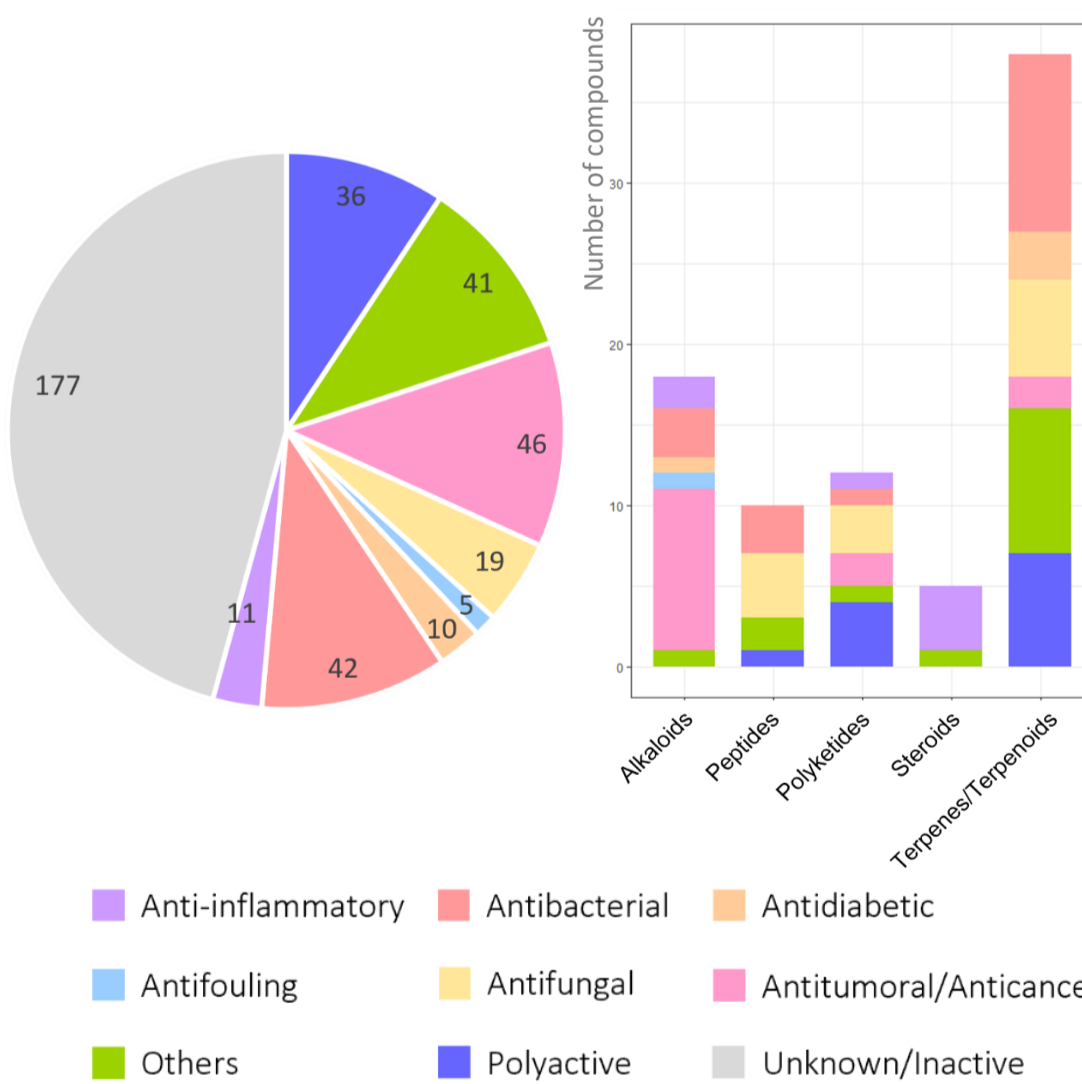
Phylum of the microbial producer of the novel reported compounds



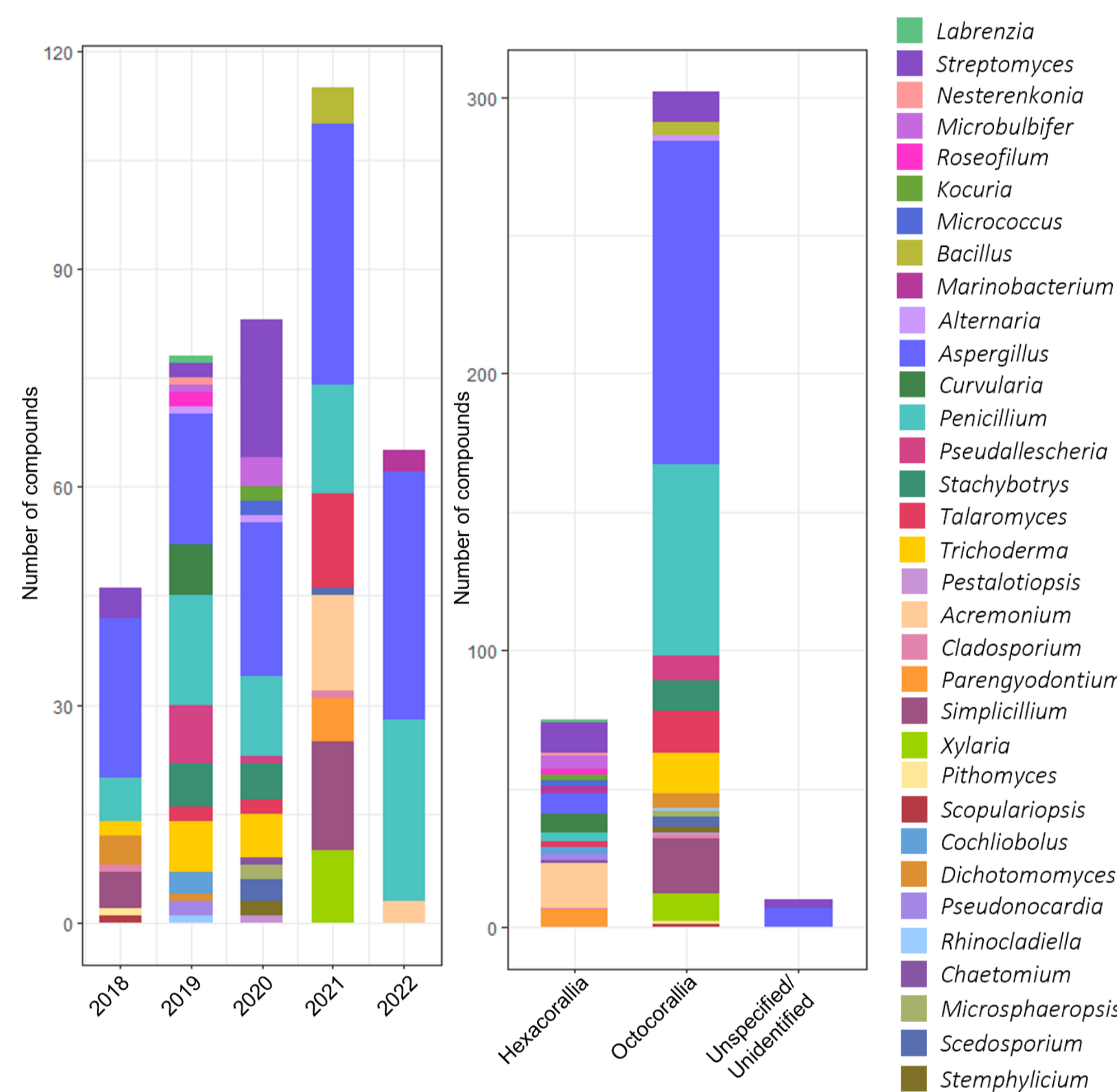
- A larger number of compounds (around 75% of the total) originated from octocoral-associated microbes;
- The most represented phylum is Ascomycota (fungi)

### Compound classes and compound activities

- Alkaloids associated with antitumoral or anticancer activities;
- Terpenes, terpenoids, peptides and polyketides showed a broad spectrum of bioactivities
- Significant portion of the compounds which do not have their bioactivities described and characterized.

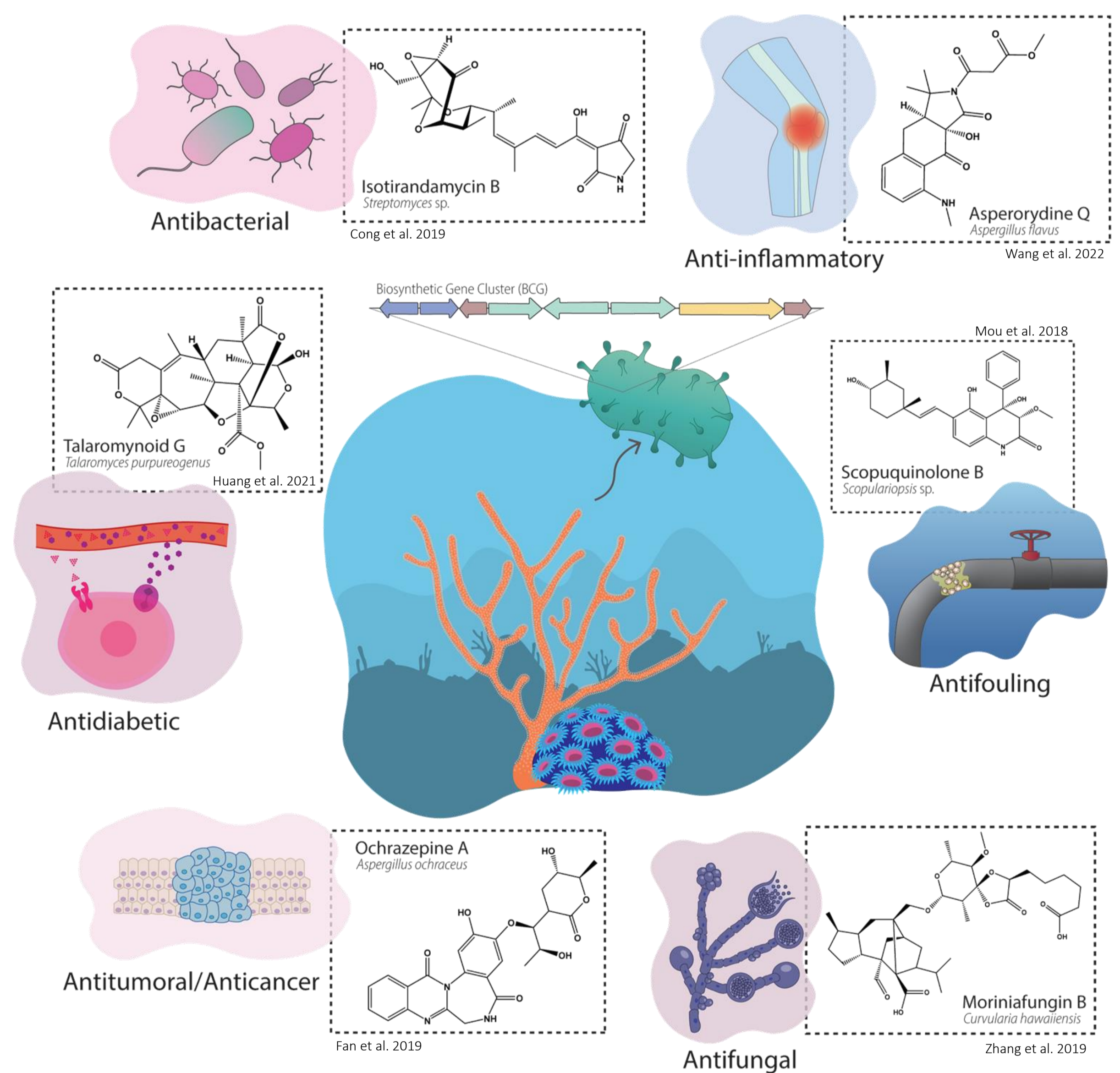


### Coral-associated microbes that produce bioactive compounds



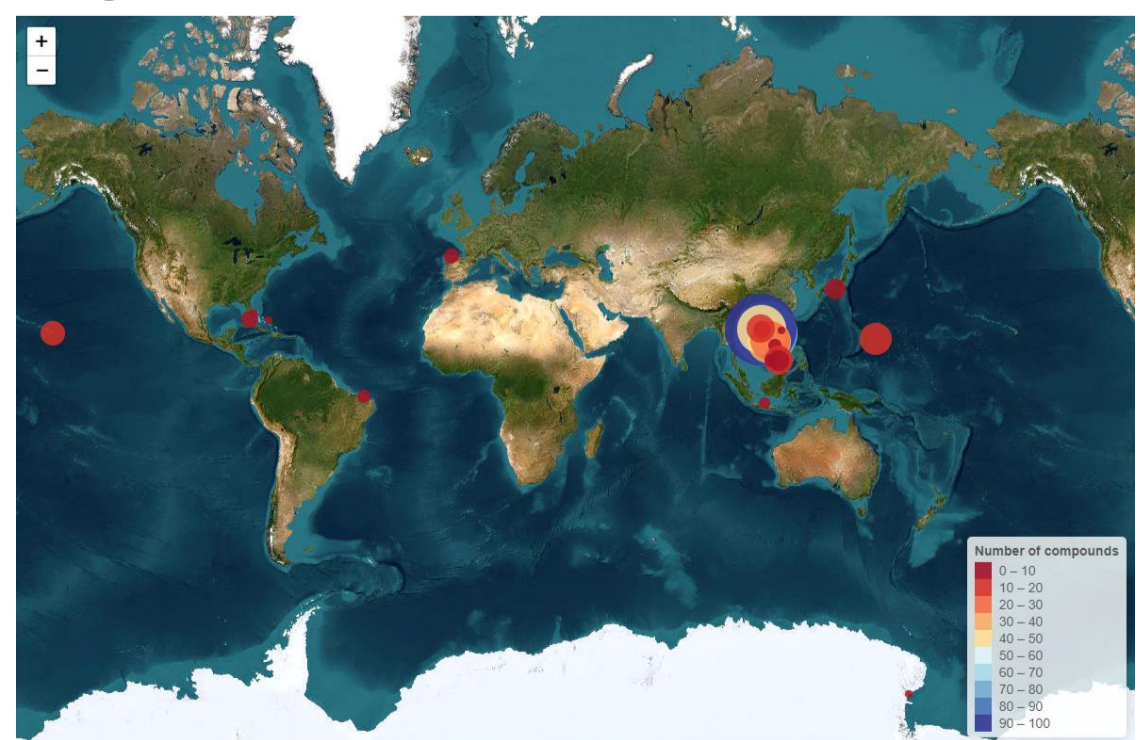
- Nine different bacterial genera & 24 different fungal genera;
- Evident dominance of *Streptomyces*, *Penicillium* and *Aspergillus*;
- Presence of *Labrenzia*, *Microbulbifer*, *Micrococcus* and *Kocuria*, taxa frequently described in association with corals;
- *Penicillium* and *Aspergillus* in larger number in octocorals.

### Examples of new molecules from the coral microbiome and their main bioactivities



## Conclusion and Future Prospects

### Tendencies in novel Natural Product Provenance: cultivation and regional bias



World map representing the number of novel compounds reported from coral-associated microbes according to sampling location.

The profile of the compounds reported is strongly influenced by sampling bias or cultivation bias:

- Location (strong investment in the South China Sea region);
- Type of corals sampled (e.g., soft corals are easier to process);
- Well-studied microbes (e.g., *Streptomyces* spp., *Aspergillus* spp., *Penicillium* spp.) have growth conditions optimized;
- Laboratories tend to screen bioactivities based on availability of in-house expertise and protocols.

### Future directions:

- Exploration of less studied coral hosts (e.g., cold water corals);
- Increasing representativity of microbial communities by varying growth conditions (e.g., longer incubation times, lower temperatures, oligotrophic media);
- Expansion of the breadth of bioactivities tested;
- Integration of 'multiomics' approaches and genome mining for secondary metabolite biosynthetic gene clusters;
- Introduction of alterations in growth conditions for activation of silenced BGCs (OSMAC principle);
- Implementation of cultivation-independent methods for prospecting of possible new molecules & heterologous expression protocols.

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