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Case Studies in Marine Bioprospecting from Discovery to Commercialization

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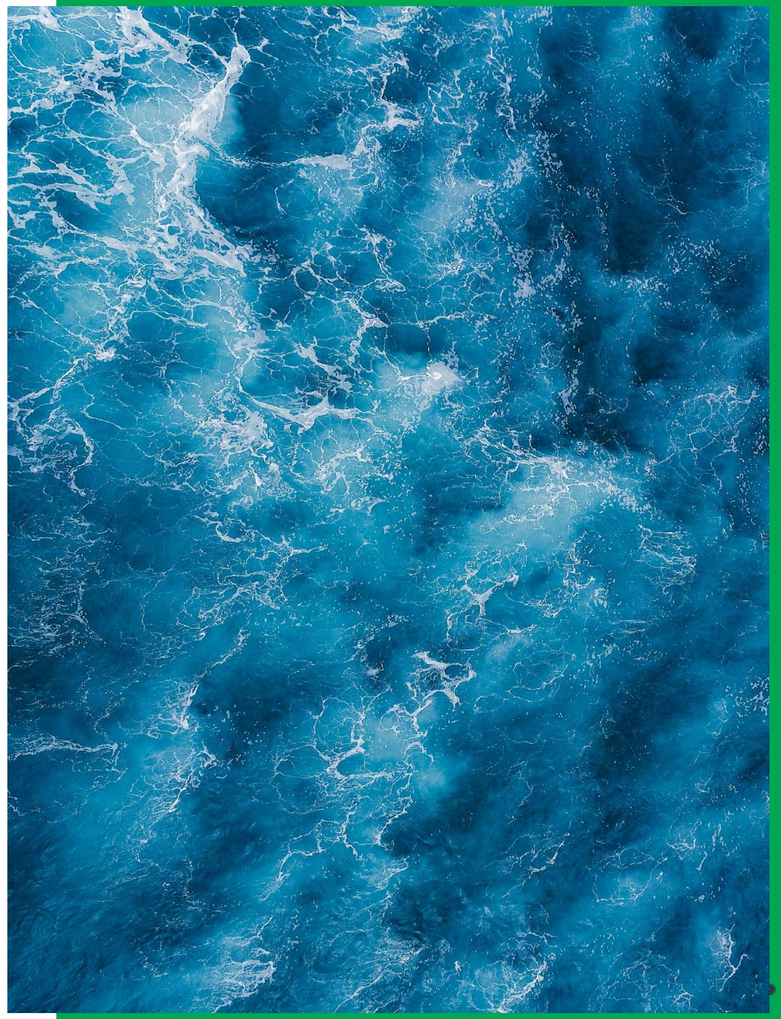
Content



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Introduction

What is Bioprospecting?

Systematic search for valuable products from marine organisms (drugs, enzymes, biomaterials).

Why Marine Bioprospecting?

- ❑ Unique adaptations → novel chemistry.
- ❑ High success rate: 7 of 13 FDA-approved marine-derived drugs came from invertebrates.

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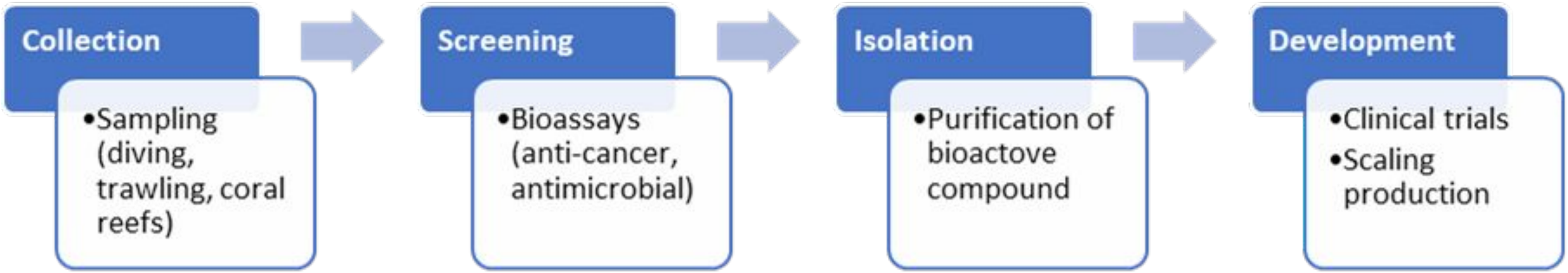
The Bioprospecting Pipeline

❑ Steps



❑ Challenges

- Supply
- Sustainability
- Intellectual Property

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Discovery

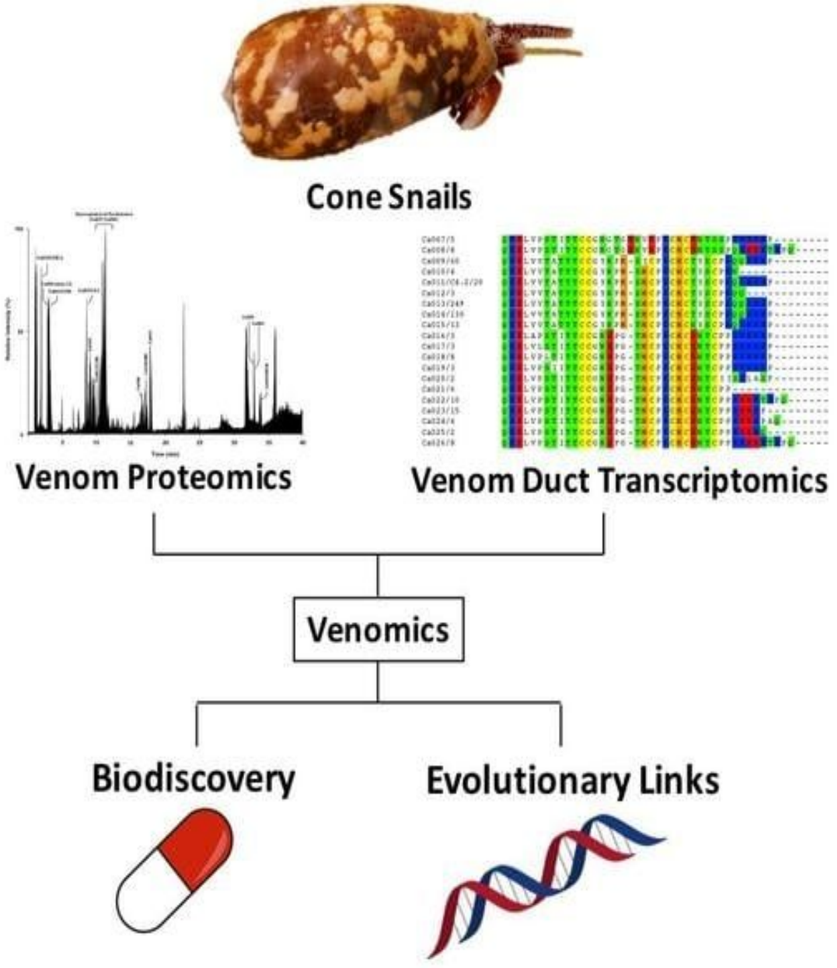
Case Study 1:

Ziconotide (Prialt®) – Cone Snail Venom

- **Source:** *Conus magus* (Pacific cone snail).
- **Observation:** Paralysis in prey → potent neurotoxins.
- **Key Compound:** ω-Conotoxin MVIIA (blocks calcium channels).

Development & Impact

- **Application:** Chronic pain relief (1,000x stronger than morphine).
- **Challenge:** Synthetic production (too complex to harvest from snails).
- **Lesson:** Venom peptides are a goldmine for neuroscience.



(Himaya & Lewis, 2018)

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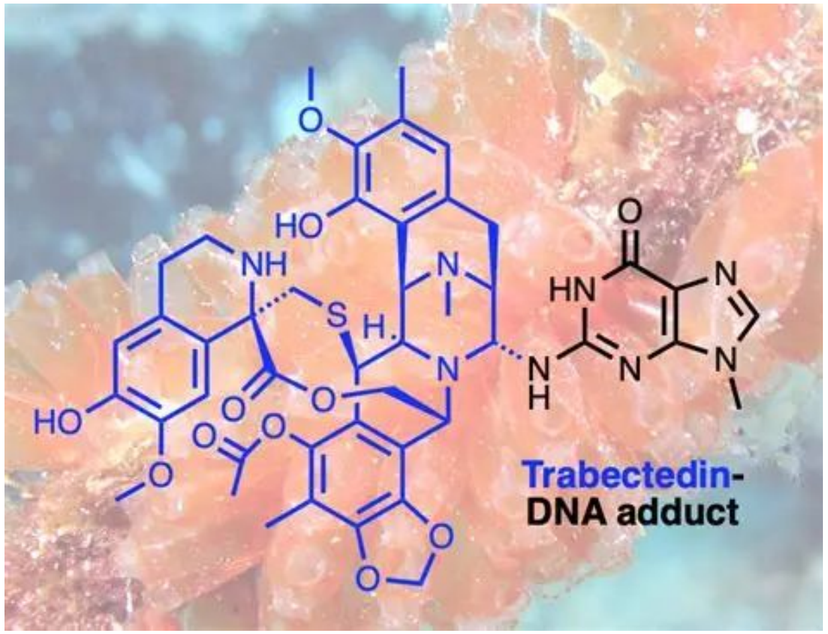
Discovery

Case Study 2:

Trabectedin (Yondelis®) – Sea Squirt

- **Source:** *Ecteinascidia turbinata* (Caribbean tunicate).
- **Observation:** Anti-cancer activity in lab screens.
- **Key Compound:** Trabectedin (alkylates DNA, kills tumor cells).



(van Kesteren *et al.*, 2003)

Commercialization

- **Approval:** FDA-approved for soft tissue sarcoma (2007).
- **Supply Solution:** Aquaculture + semi-synthesis (avoid overharvesting).
- **Lesson:** Symbiotic bacteria may produce the compound (source debate).

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Discovery

Case Study 3:

Halichondrin B → Eribulin (Halaven®) – Sponge

(Menis, *et al.*, 2011)

- **Source:** *Halichondria okadai* (Japanese sponge).
- **Observation:** Potent microtubule inhibitor.
- **Challenge:** Needed 1 ton of sponge for 1 gram of compound!

Synthetic Breakthrough

- **Solution:** Total synthesis → simplified analog (eribulin).
- **Impact:** Breast cancer drug (2010), Nobel-recognized chemistry.

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Discovery

Case Study 4:

Pseudopterosins – Coral Anti-Inflammatories

- **Source:** *Pseudopterogorgia elisabethae* (Caribbean coral).
- **Use:** Natural anti-inflammatory (blocks prostaglandins).
- **Application:** Estée Lauder cosmetics (reduces skin irritation).

Sustainability

- **Problem:** Coral harvesting unsustainable.
- **Solution:** Fermentation using symbiotic bacteria.

(Ringel et al., 2020)

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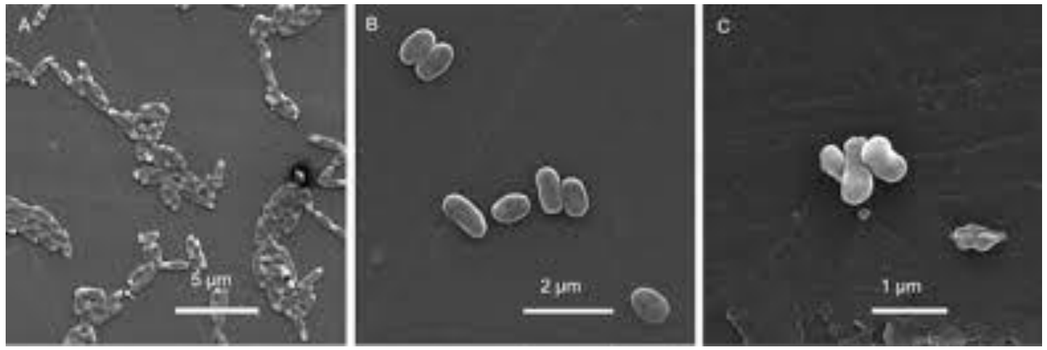
Emerging Frontiers

- **Deep-Sea Hydrothermal Vents:**

Exiguobacterium bacteria heat-stable enzymes.

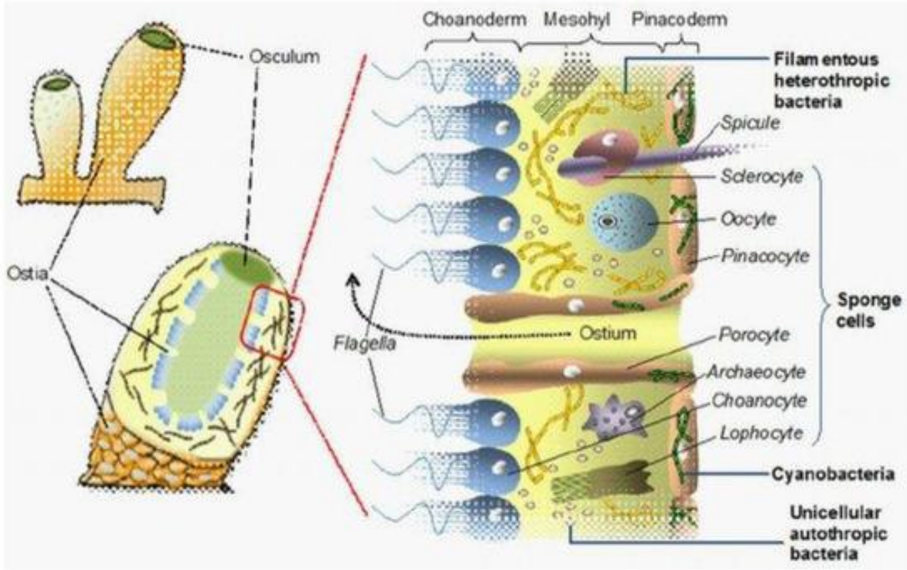


(Cavanaugh et al., 2021)

- **Microbiome Mining:**

Sponge symbionts produce >50% of "host"

compounds.



Symbiotic bacterial in sponge tissue

(Nnaji et al., 2022)

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Challenges & Ethics

- **Access & Benefit-Sharing:**

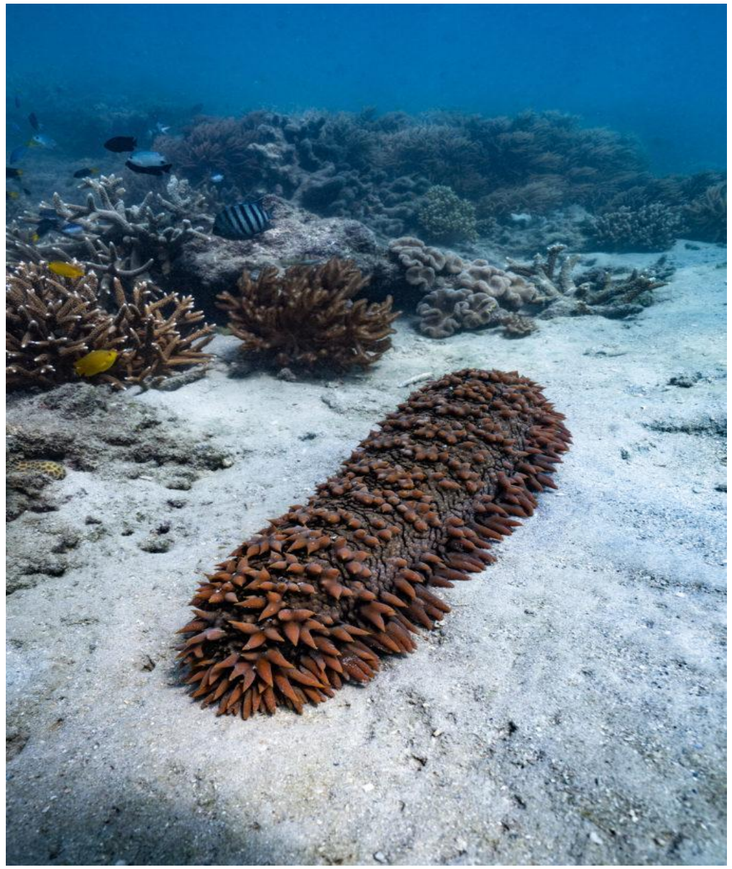
  Nagoya Protocol (legal frameworks).

- **Ecological Impact:**

  Overharvesting (e.g., sea cucumbers).

- **Biopiracy:**

  Who "owns" marine genetic resources?



[Source:https://oceanrafting.com.au/06-06-23-sea-cucumber/]

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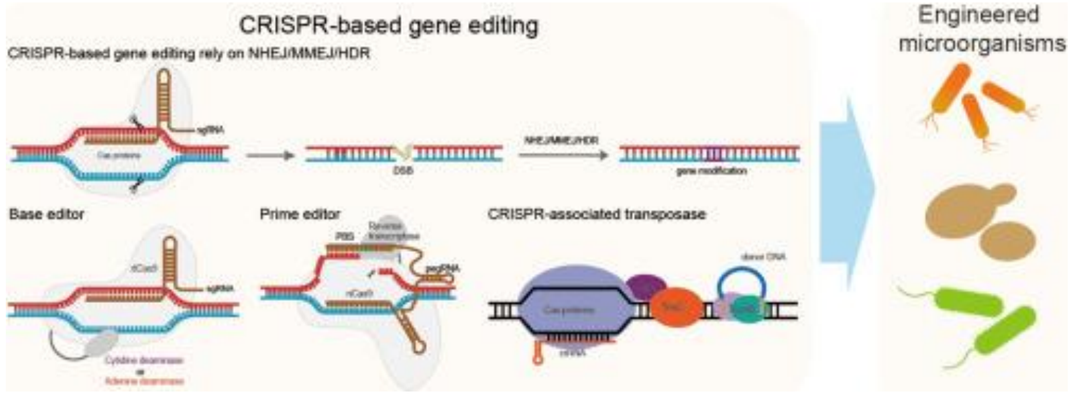
Future Directions

- **CRISPR & Synthetic Biology:**

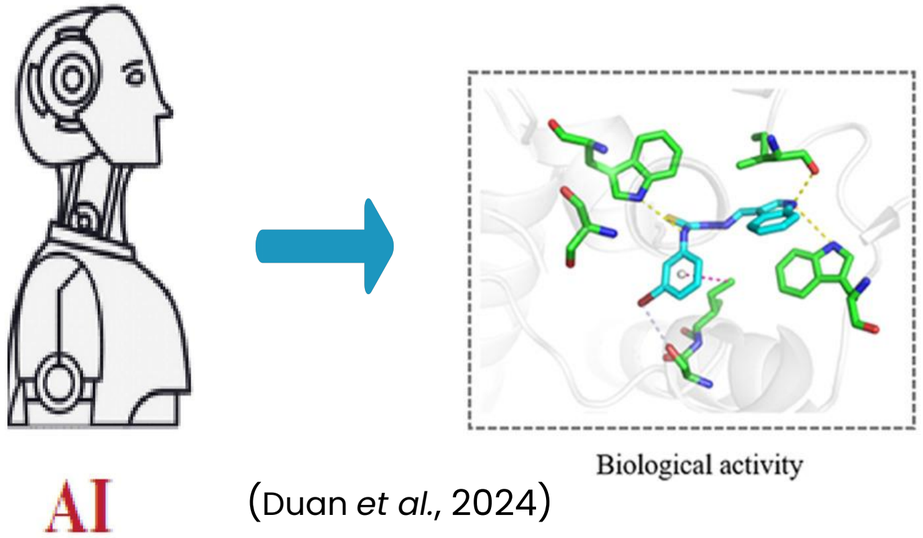
  Engineer microbes to produce MNPs.



(Wei & Li, 2023)

- **AI-Driven Discovery:**

  Machine learning to predict bioactivity.



(Duan *et al.*, 2024)

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