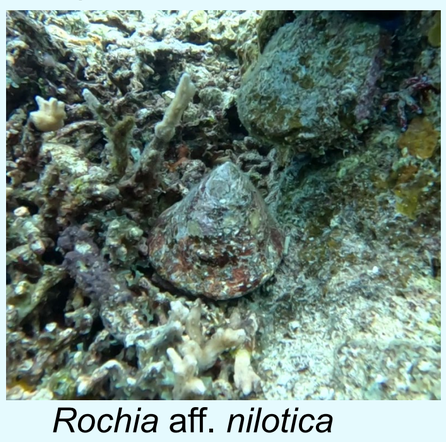
TURNING ECOLOGICAL THREAT INTO AQUACULTURAL VALUE: *Sargassum horneri* AS A SUSTAINABLE FEED INGREDIENT FOR THE JUVENILE TOP SHELL, *Rochia nilotica*

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Rochia nilotica

- *Rochia nilotica* (=previously *Trochus niloticus*) (Linnaeus 1767), commonly known as the button-top shell, is a large marine gastropod in the family Tegulidae, typically inhabiting shallow coral reefs.
- *R. nilotica* is valued not only as an edible species but also primarily harvested for its thick nacreous shells, which are widely used in the production of buttons, ornaments, and other decorative items.
- However, intensive harvesting has caused sharp population declines, with Pacific Island production falling from ~2,300 t in 1996 to ~1,400 t in the late 2010s (↓39%), consistent with global reductions of >50% due to overexploitation.



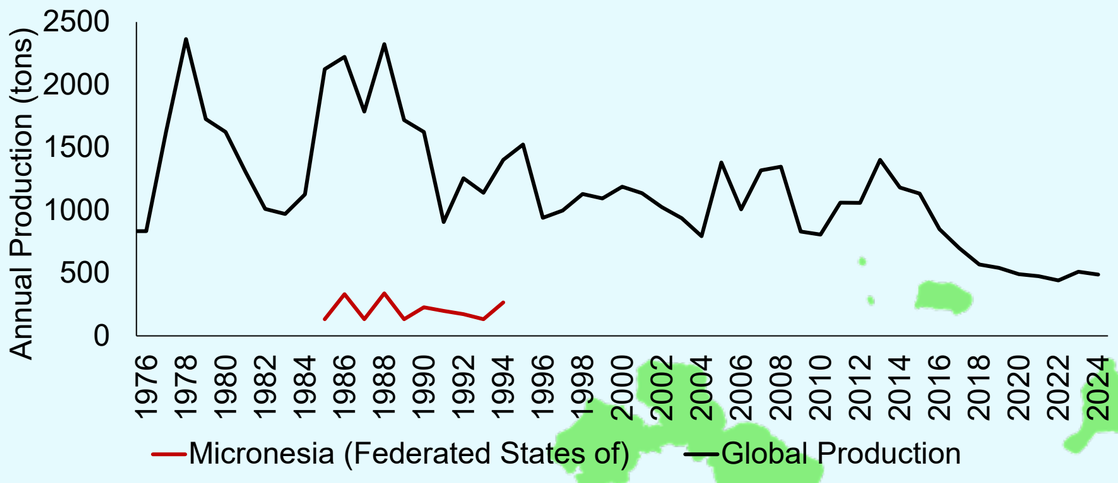
Rochia aff. *nilotica*



Mother-of-pearl buttons

R. nilotica Production

- Global landing have drastically declined due to overexploitation (e.g., 2,324 tons ➔ 510 tons).
- Production in the FSM reached 200–300 tons in the 1990s, but no production data has been available since then.
- To restore populations, countries like Indonesia and Japan have strictly prohibited wild collection and export.



- *R. nilotica* aquaculture is currently practiced across various Pacific Island nations, but faces significant challenges.
- Limitations of Traditional Aquaculture
  - Prolonged Cultivation: Requires >3 years to reach marketable size
  - High maintenance due to constant feed requirements.
  - High Feed Cost: Heavy reliance on expensive fishmeal.

Golden Tides

- Continuous massive influxes of the brown macroalga *Sargassum horneri* cause severe environmental issues along the Korean coasts (golden tide).
- In 2021 alone, approximately 15,987 tons of this seaweed were collected, requiring enormous disposal costs.
- By utilizing this marine waste to produce formulated feed for aquaculture, we can significantly reduce feed costs and promote a sustainable circular bioeconomy.



S. horneri golden tide in Jeju Korea



S. horneri meal

Study Objectives

- Evaluate *S. horneri* as a functional, sustainable feed ingredient for juvenile *R. nilotica* to replace traditional feeding methods.

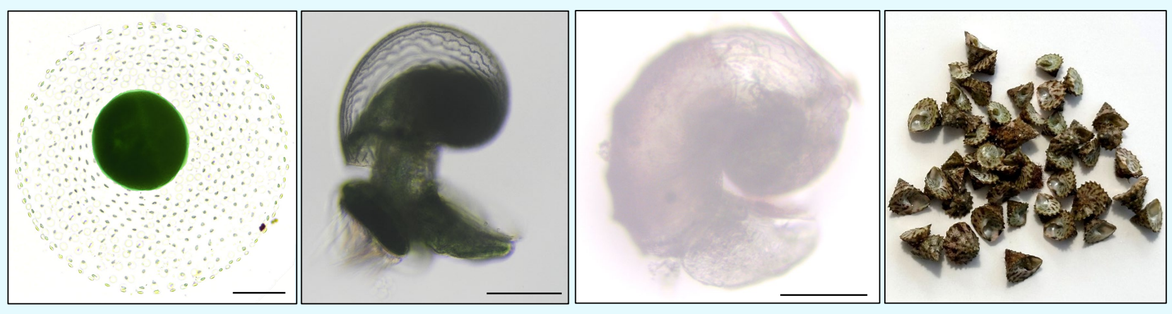
Experimental Diets

- The experimental diet was formulated to contain 40% *S. horneri* powder and included 11% fish meal, 20% corn gluten meal, and 2.3% defatted soybean meal as the main protein sources.

Ingredients	Contents (%)
Fish Meal	11.00
S. horneri	40.00
Corn Gluten Meal	20.00
Defatted Soybean Meal	2.30
Wheat Flour	20.00
Dextrin	1.60
Vitamin Mix	0.90
Mineral Mix	2.00
Choline	0.50
Fish Oil	1.70
Proximate Analysis (% Dry Matter)	
Crude Protein	33.4
Crude Lipid	3.98
Ash	18.63

Larva Preparation and Feeding Trials

- Broodstock of *R. nilotica* were collected by SCUBA diving from shallow coral reefs of Weno Island, Chuuk State, FSM.
- Live rocks were placed in the tank to promote the growth of filamentous and film-forming algae on the rock surfaces and tank walls.
- After approximately four months of rearing, the juveniles reached a shell diameter of about 1.6 cm, and were used to initiate the feeding trial.
- All the collection and experimental procedures involving *R. nilotica* were conducted under the permission of the Chuuk State Government

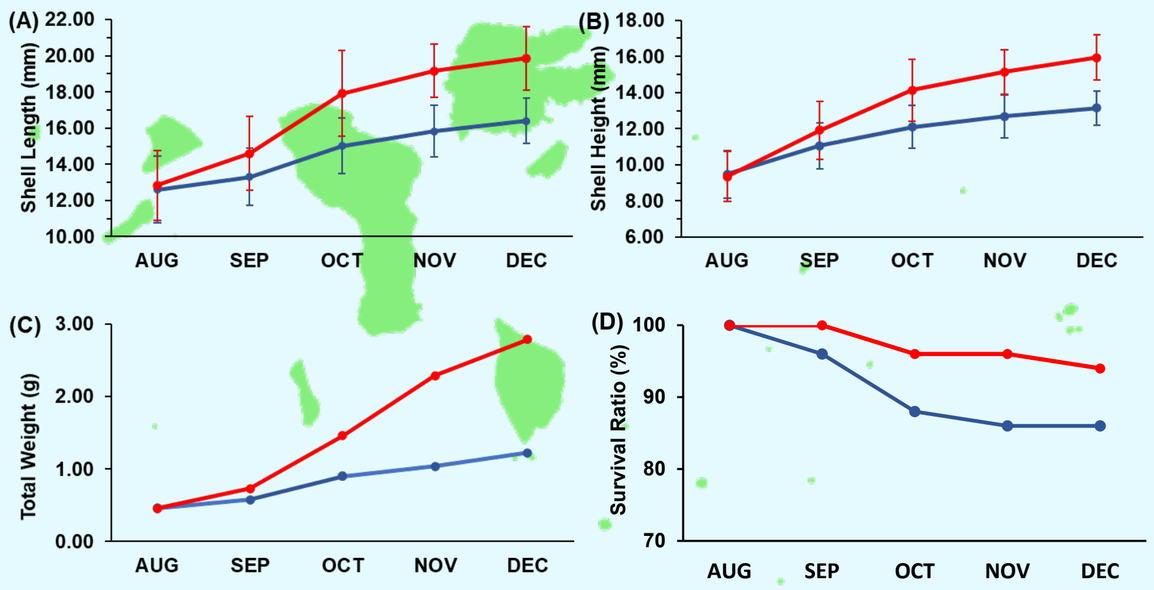


- Mean initial size: 12.8 mm SL, 0.46 g Tissue Wet Weight
- Feeding Groups (3 replicates per group (n=50/tank).
  - Formulated Diet Group: Fed diet containing 40% *S. horneri* powder.
  - Control Group: Kept on live-rock with natural algae biofilm
  - Condition: Flow-through 200-L tanks, 29°C, 120-day duration.

Shell Length Growth Rate (%) = [(FSL-ISL)/ISL] × 100
Daily Increment in Shell Length (μm/day) =[(FSL-ISL)/DOC] × 1000
Shell Height Growth Rate (%) = [(FSH-ISH)/DOC] × 100
DISH (μm/day) = [(FSH-ISH)/ISH] × 1000
Weight Growth Rate (%) = [(FW-IW)/IW] × 100
Specific Growth Rate in Weight (%/day) = [(FW-IW)/DOC] × 100
Survival Rate (%) = [(final number of *R. nilotica*)/(initial number of *R. nilotica*)]×100

Growth Performance (After 120 days)

- Shell Length: 19.86 ± 1.76 mm in *S. horneri* group vs. 16.40 ± 1.26 mm in Control.
- Shell Height: 15.92 ± 1.25 mm in *S. horneri* group vs. 13.14 ± 0.96 mm in Control.
- Total Weight: Showed remarkable increase; 2.79 g in *S. horneri* group vs. 1.22 g in Control (Weight Growth Rate: 506.5% vs. 165.2%).
- Survival Rate: Reached 94% in the *S. horneri* group, higher than the 86% in the Control.



Monthly growth performance of *R. nilotica* juveniles under two feeding regimes from August to December 2024 (120 days). (A) Shell Length (mm), (B) Shell Height (mm), (C) Total Weight (g), and survival rate (D). Values are monthly means ± S.D. (n varied between 43 and 50 due to mortality).

Dietary effect on the growth performance of *R. nilotica* juveniles after four months of feeding trials with *S. horneri*-based diet and live-rock control..

	Control	*S. horneri*
Initial Shell Length (mm)	12.61 ± 1.82	12.83 ± 1.94
Final Shell Length (mm)	16.40 ± 1.26	19.86 ± 1.76
Shell Length Growth Rate (%)	30.06	54.79
Daily Increment in Shell Length (μm/day)	31.58	58.58
Initial Shell Height (mm)	9.48 ± 1.32	9.35 ± 1.38
Final Shell Height (mm)	13.14 ± 0.96	15.92 ± 1.25
Shell Height Growth Rate (%)	38.61	70.27
Daily Increment in Shell Height (μm/day)	30.50	54.75
Initial Weight (g)	0.46	0.46
Final Weight (g)	1.22	2.79
Weight Gain Rate (%)	165.22	506.52
Specific Growth Rate in Weight (%/day)	1.38	4.22
survival rate (%)	86	94

Discussion

- **High Dietary Tolerance**: Unlike abalone, which show reduced growth at >20% inclusion , *R. nilotica* exhibited excellent growth and no adverse effects at a 40% *S. horneri* inclusion level. This indicates a remarkably high species-specific tolerance and efficient digestive physiology.
- **Nutritional & Microbial Benefits**: The abundant bioactive substances in *S. horneri* (e.g., fucoidan, laminarin) likely promoted digestion and immune responses. Additionally, this growth improvement may be highly attributed to microbiome-mediated enhancements in energy metabolism.
- **Sustainable Circular Bioeconomy**: Recycling low-value "Golden Tide" waste into functional aquaculture feed effectively mitigates coastal environmental damage. This approach reduces reliance on expensive imported fishmeal and supports the sustainable development of marine resources in Pacific island nations.