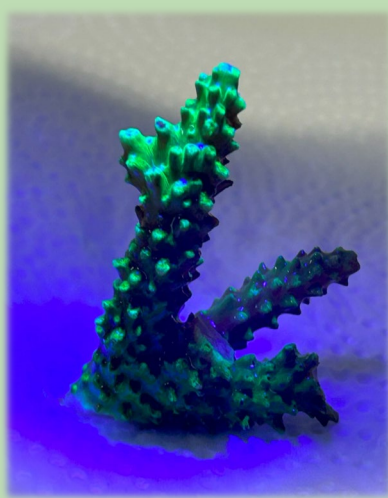


Coral reef research: Identification of chemical stressors with negative influence on tropic costal ecosystems



Guido Gonsior, Maren Dill, Sara P. Cuellar-Bermudez, Gundula Gonsior
GG BioTech Design GmbH, Homberg (Ohm), Germany



Coral reefs act as natural barriers that protect coasts from erosion and storm damage and provide an important source of food through fisheries and other marine resources. Beside these corals also contribute to carbon sequestration by absorbing CO₂ from the atmosphere and storing it in the form of limestone. Also, tourism based on coral reefs is an important source of income for many countries. Overall, coral reefs are essential to the health of the oceans and the well-being of the people who depend on them. The protection and conservation of these ecosystems is therefore of paramount importance.

The deterioration of water quality in coastal waters is jeopardising marine fauna. The highly sensitive corals in particular are under increasing pressure from industrial wastewater, fertilisers and pesticides from agriculture, as well as from cosmetics. However, up to now, less focus was given on pharmaceuticals which were identified to have a huge effect on ecosystems. Therefore, first studies were initiated to clarify potential issues. We present data toxicity tests from the selected pharmaceuticals valsartan and diclofenac with the focus on their effects on coral ecosystems.

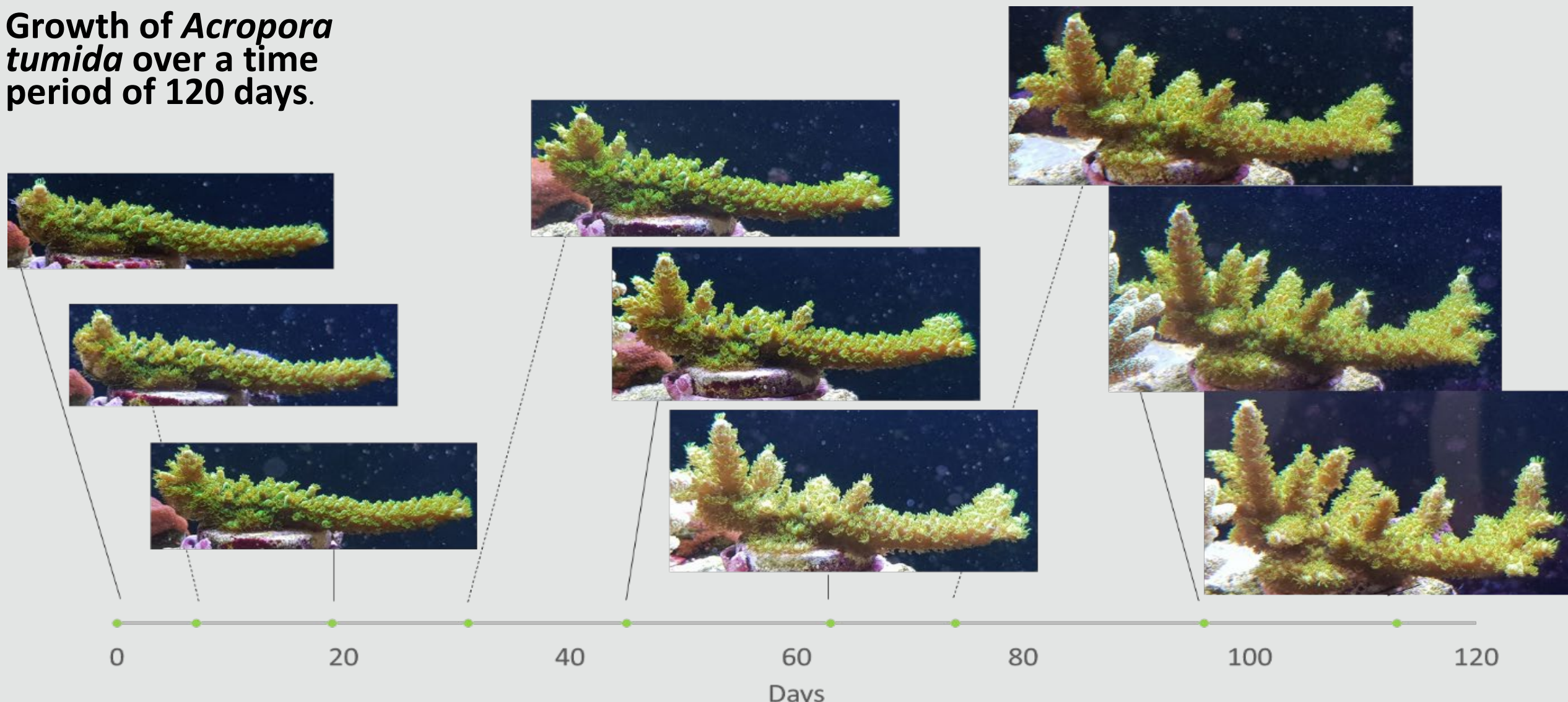
Test conditions

Temperature: 25°C±1°C
pH-value: 8.2±0.2
Calcium: 410 mg/L
Magnesium: 1020 mg/L
Salinity: 35.4 g/L

Carbonate Hardness: 7.0 (°dkH)
Oxygen content: 8.40 mg/L

Acute Toxicity Testing up to 96 hours (prolonged to 7 days)
Screening of Valsartan and Diclofenac (concentration 1.00 (TS 1), 10.00 (TS2) and 100.00 (TS3) mg/L)
Species selected: *Acropora tumida*; showed good growth rates under lab conditions and low mortality after fragmentation
Replicates: 10 per treatment and control

Growth of *Acropora tumida* over a time period of 120 days.



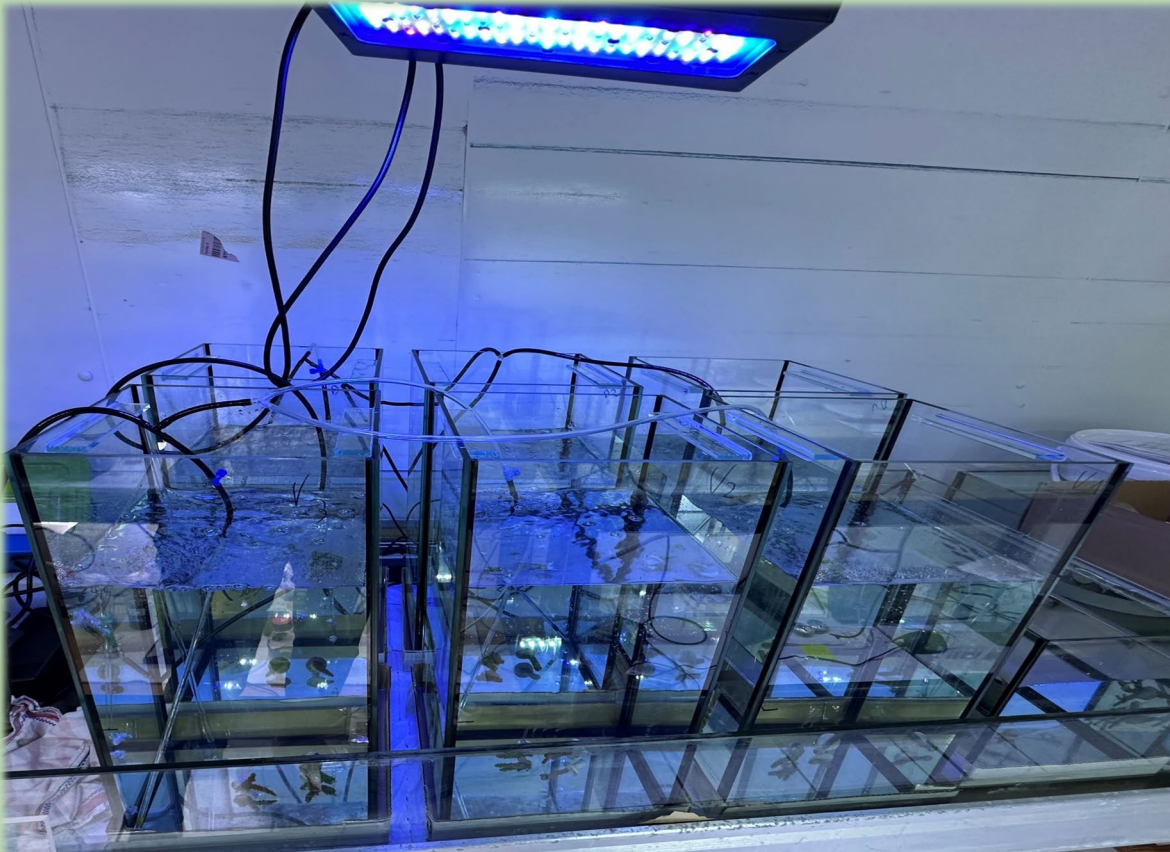
Selection of test substances

Valsartan and diclofenac are detected in large quantities in wastewater. Like many other pharmaceuticals, they are persistent and mobile, which means that they remain in the environment for a long time and can spread quickly. In wastewater treatment plants, if present, pharmaceuticals are only partially removed so that residues can enter the water and accumulate in the environment.

Results

Observation on Health of Corals

| Test item | | Valsartan | Diclofenac | Valsartan | Diclofenac | Valsartan | Diclofenac |
|-----------|--------------|------------------------------|--------------------------------|-------------------|-------------------|-------------------|---------------------------|
| Treatment | Conc. [mg/L] | 24 hours-96 hours (0-5 days) | 24 hours-96 hours (0-5 days) | day 6 (prolonged) | day 6 (prolonged) | day 7 (prolonged) | day 7 (prolonged) |
| control | 0.00 | no effects | no effects | no effects | no effects | no effects | no effects |
| TS1 | 1.00 | no effects | no effects | no effects | no effects | no effects | no effects |
| TS2 | 10.00 | no effects | no effects | no effects | no effects | no effects | coral bleaching |
| TS3 | 100.00 | no effects | slight necrosis after 96 hours | no effects | mucus formation | no effects | coral bleaching, necrosis |



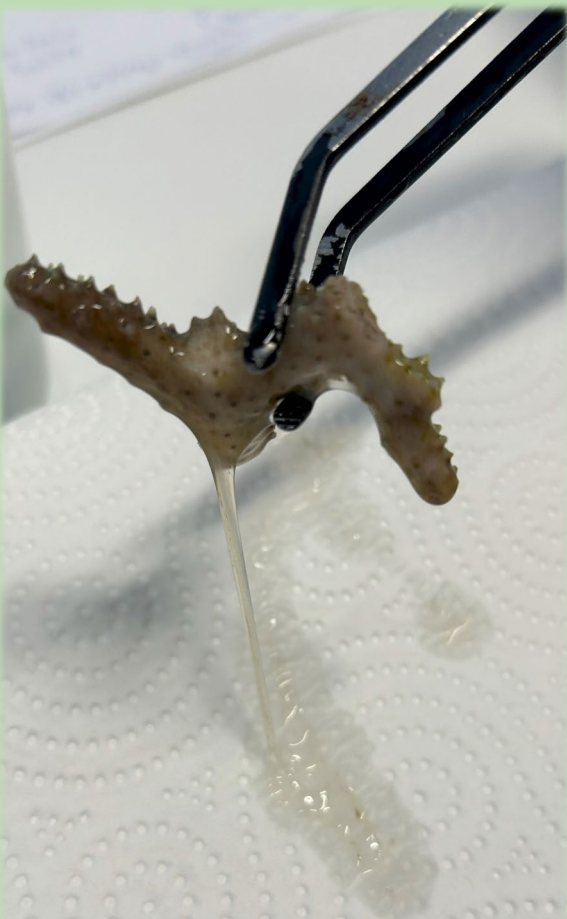
40-litre test aquarium with high water mixing



Healthy coral tissue

No effects could be observed over the test period of 96 hours for valsartan. Diclofenac shows only slight necrosis on single coral fragments. Based on these findings it could be assumed that no or only slight acute toxic effects occurred on coral reefs. As slight effects were observed, the test was extended to 7 days. At day 7 corals bleaching was observed at the concentration of 10 and 100 mg/L. It should be noted that these concentrations are far above the concentrations expected in the environment. To avoid effects caused by water quality a 40-litre test aquarium with high water mixing was selected. For longer tests, however, it is important to change the water at least once a week and to choose an even larger volume. A daily water change or a flow-through system would be ideal. Otherwise, there is a risk that the deterioration in water quality caused by the test substance will lead to effects that do not occur under natural conditions, as we have a very high water exchange rate in coral reefs. On the basis of this initial screening, a chronic effect cannot be ruled out and requires further clarification.

Effects on Corals



Mucus formation



Bleaching and necrosis of coral tissue



Discussion

Marine ecosystems have a high dilution factor compared to freshwater ecosystems. Therefore, most risk assessments for chemical stressors are based on freshwater ecosystems. However, most freshwater systems are connected to marine ecosystems. Especially in coastal regions with high touristic or industrial activity, a higher exposure to chemicals can be assumed and long-term effects from persistent compounds cannot be ruled out. This should be investigated further, particularly in the case of pharmaceuticals with high persistence and mobility. Accumulation in corals is possible, which could lead to chronic effects over a longer period of time. Initial studies indicate that the risk of acute toxicity is low, but possible long-term effects from direct exposure and effluents should be considered. Corals are indicator species, especially corals that live in symbiosis with algae. Global coral bleaching is one of the most serious observations. Whether pharmaceuticals play a significant role remains to be clarified. The selected test substances valsartan and diclofenac were tested because they were found in high concentrations in wastewater and also in drinking and surface water compared to others. It can be assumed that other human and veterinary pharmaceuticals have an impact on the coral ecosystem. A general screening should be carried out to identify possible risks to one of the most endangered ecosystems.