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The Use of Ultrasound to Control Algae

The use of ultrasound for controlling algae has been known for some time. However, the practical use of such technology is relatively recent and involves the resonance effects of ultrasonic waves on the algae cell. The ultrasonic waves are derived from the creation of certain sound vibrations with periodic interruptions. A submerged transducer that is specifically designed and purposely built to be small and water-resistant generates the ultrasonic vibrations. These sound shock waves are directed at the vacuole of the algae. Initial observations show that the shock waves probably weaken the cell membranes, causing the algae to collapse in on themselves and sink out of suspension.

Ultrasonic waves appear to disrupt connections between the plasmalemma and algal cell walls, causing loss of membrane integrity, probable leakage of cytoplasm and cell collapse.

This new approach is environmentally friendly, cost-effective and uses no chemicals. These ultrasonic vibrations, which are inaudible to people, are no threat to human beings, animals or fish.

These ultrasonic devices are used in horticulture, aquaculture, potable and wastewater applications. The transducers used are capable of emitting ultrasonic vibrations up to a range of 500 feet, covering a radius of 180°.

Formal investigations of the mode of action of ultrasound on algae have revealed some interesting data. The featured light micrograph pictures of *Selenastrum* were taken from algal samples exposed to ultrasound for eight weeks. The pictures of *Spirogyra* were taken over a three-week period from a tank experiment performed in controlled conditions.

The mode of action appears to be by disruption of the connections between the plasmalemma and the algal cell walls. This causes loss of membrane integrity, probable leakage of cytoplasm and a collapse of the cell into a dense brown mass. The cells remain buoyant for at least 4-5 weeks after exposure, although they are no longer viable.

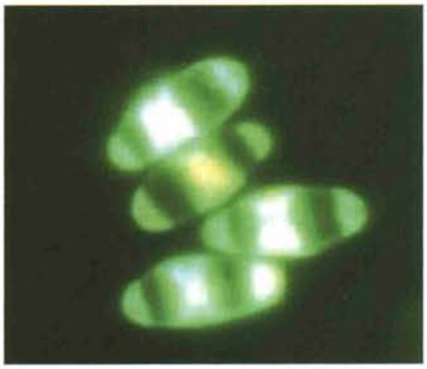

Figure 1.

Figure 1 shows *Selenastrum capricornutum* with the cytoplasm bunched towards the center of the cell. This is a result of separation of the plasmalemma from the cell wall; clear gaps can be seen where the dark stripes appear. The cytoplasm has split into three sections in this species, an indication of complex binding patterns between cell walls and plasmalemma in different species of algae.

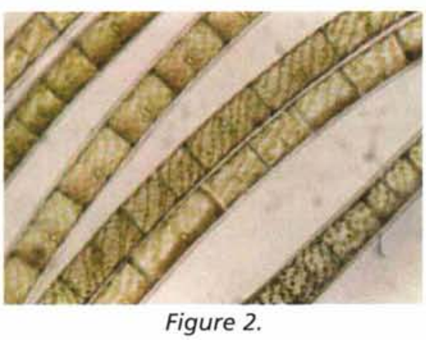

Figure 2.

Figure 2 shows healthy *Spirogyra*, with cells full of cytoplasm, and the characteristic spiraling chloro-

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plasts. The alga was sourced from a controlled growing tank and had been healthy for at least five years.

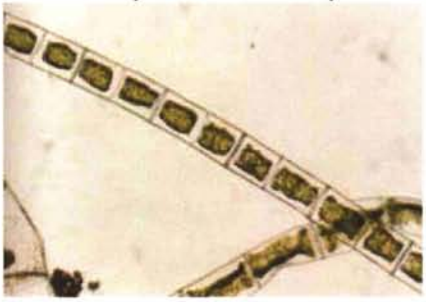

Figure 3.

Figure 3 was taken after only seven days' exposure to ultrasound. Already the plasmalemma is coming away from the cell wall, and the cells have shrunk. There is increased granulation of the cytoplasm, indicating loss of chloroplast structure, and loss of connectivity with other cells and the external environment.

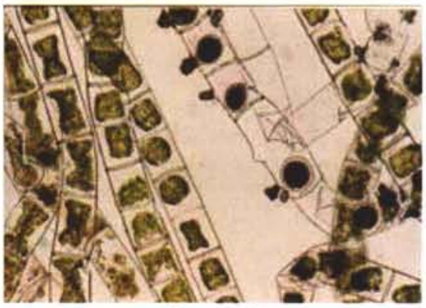

Figure 4.

Figure 4 was taken after 14 days' exposure. The cells have continued to shrink, with some forming denser, circular, brown agglomerations in the center of the cell. There is some evidence of cytoplasm leakage from the cells, indicating further damage to the cell walls.

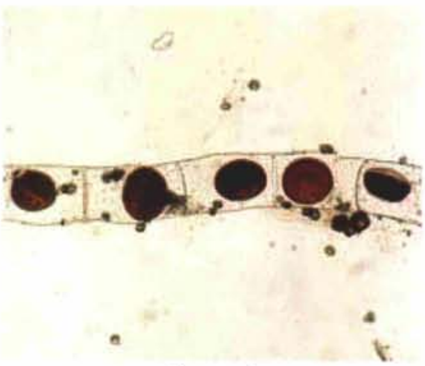

Figure 5.

Figure 5 was taken after 21 days, and shows complete breakdown of cell structure.

The damage to the cell structure is correlated with a decrease in the chlorophyll *a* concentration in the treated tanks. In contrast, in the control tank, chlorophyll *a* continues to increase. This can be seen clearly in Figure 6 below

In a 28-day regrowth experiment, the chlorophyll concentration continued to increase from day 1. However, the increase in the ultrasonic-treated *Spirogyra* was significantly less than in the control treatment. See Figure 7. This indicates significant structural damage is associated with cell death in *Spirogyra*.

In summary, exposure of *Spirogyra* and *Selenastrum* to ultrasound waves causes irreversible structural damage to the cells, loss of chlorophyll and loss of viability.

Reference:

SonicSolutions Product Bulletin.

Figure 6

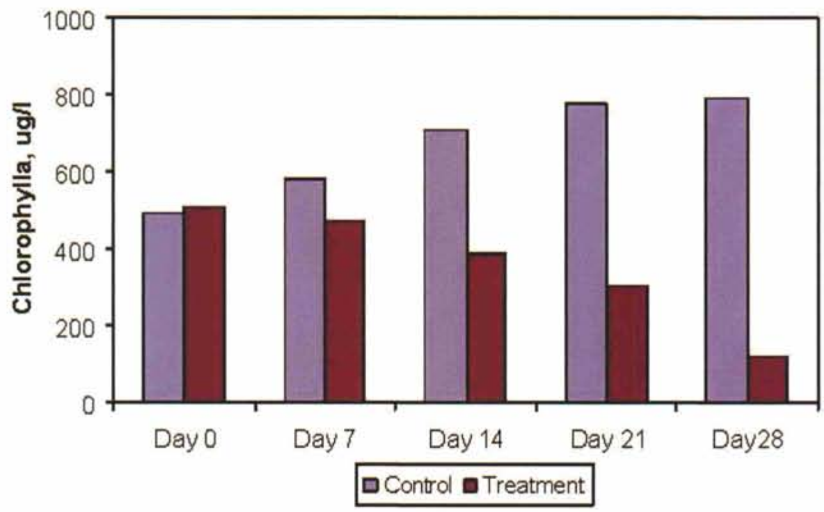

Figure 7