Study on the effects of antifouling agents on sinking rate and related cellular physiology of marine planktonic diatoms

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論文題名　：　Study on the effects of antifouling agents on sinking rate and the related cellular physiology of marine diatoms
（防汚剤が海産珪藻類の沈降速度と細胞生理に及ぼす影響に関する研究）

区　　分　：　甲

論　文　内　容　の　要　旨

Antifouling agents play an important role in preventing the settlement and growth of marine organisms on submerged structures, such as oil ships, buoys, fish cages and ship hulls. In the 1960s and 1970s, tributyltin (TBT) containing antifouling paints were commonly used in the world. Although TBT was banned by the International Maritime Organization due to its serious toxic effects on marine life, TBT continues to be detected in coastal area of some countries. Recently, on the other hand, some antifouling agents are used as alternative to TBT. Among them, 3-(3, 4-dichlorophenyl)-1, 1-dimethylurea, phenylurea (diuron) has been used in the world. Diuron is typical photosystem II (PSII) inhibitor which prevents PSII-catalyzed photosynthetic electron transport at the secondary electron acceptor Q_B. Diuron has been detected at higher concentration in the coastal areas of some countries including Japan. Thus adverse effects of diuron on primary production of coastal area are suspected.

Diatom is main primary producer in the sea area. Diatom has a specific weight exceeding that of sea water and as a result, they are supposed to sink in the water column. The depth at which microalgae exist could affect primary production because light intensity and related wave length composition change drastically depending on water depth. Thus the sinking rate of marine diatom is an important factor in primary production. In present study, I investigated the effect of two antifouling agents with different mode of actions, diuron and TBT, on sinking rate and related cellular physiology using two marine diatom species, single-celled *Thalassiosira pseudonana* and chain-forming *Skeletonema marinoi-dohrnii* complex.

At first, I investigated the effects of diuron and TBT on photosynthetic energy flux of two diatoms for comfirming the difference of mode of action between two antifouling agents using OJIP analysis. As a result, diuron and TBT significantly decreased the some parameters such as PiAbs, Fv/Fo and Fv/Fm showing the impairment of electron transport function. On the other hand, Q_A related parameters such as Psi_O, TR0/RC and Mo, which were inhibited by diuron treatment, were not affected by TBT treatment. These results showed that both antifouling agents affect the energy flux of photosystem but suggested that TBT has different mode of action with diuron in marine diatoms.

Second, I investigated the effect of diuron on sinking and the biochemical composition of marine diatoms single-celled *T. pseudonana* and chain-forming *S. marinoi-dohrnii*. As a result, diuron significantly retarded the sinking rate of both diatom species at EC50 level. The biochemical compositions, lipid and protein content per cell, increased and decreased at EC50 level, respectively. The correlation analysis suggested that the alteration of these biochemical compositions affected sinking rate. In addition, the positive significant correlation between sinking rate and the numbers of cells per chain in *S. marinoi-dohrnii*, which was decrease by diuron treatment, indicated that chain length is also an important factor in sinking rate regulation for chain-forming diatoms.

I also investigated the effects of TBT on sinking rate and biochemical composition of *T. pseudonana.* The results showed that TBT also retarded the sinking rate in *T. pseudonana*. Protein content per cell significantly decreased due to EC50 level of TBT treatment at 72 h and there was significant correlation between sinking rate and protein content in *T. pseudonana* exposed TBT.

In summary, present study suggested that two antifouling agents with different mode of action could retard sinking rate of marine diatoms. In addition, suppression of photosynthetic performance and the resultant physiochemical changes could induce the decreased sinking rate that may inhibit the normal survival strategy, such as avoidance from the surface layer where strong light either causes photo-inhibition or interrupts resting cell formation. Therefore, the use of antifouling agents should be considered for the sustainable marine environment.