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二三海藻の初期発生に及ぼす電圧の影響

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Effects of Voltaic Currents on the Early Development of Some Benthic Marine Algae

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Abstract

Spore-germlings of six benthic marine algae viz. *Ulva pertusa*, *Porphyra yezoensis*, *Bangia atropurpurea*, *Palmaria palmata*, *Laminaria japonica* and *Undaria pinnatifida* were observed after treatment with various voltaic currents (5-50 A.C.V) for 1-3 minutes. Ranking these species on a scale from extremely stout to relatively feeble, *Palmaria palmata* ranks highest followed by *Porphyra yezoensis* and *Bangia atropurpurea* : the latter two being Bangiales species. The two species of Laminariales (*Laminaria japonica* and *Undaria pinnatifida*) are considered to be relatively feeble. Generally speaking, after treatment for 3 minutes with 5-10 V, the spore-germlings of each species grew well. After treatment with 20 V for the same time period, about 50% of cells from the germlings died, but the remaining cells continued to grow normally. After treatment with 40-50 V, most of the germlings had died. After treating *Undaria pinnatifida* for 3 minutes with 30-40 V, about 99% of the gametophytes had died, but the remaining 1% grew normally and produced sporophytes. After treatment for 3 minutes with 5-10 V, tetraspore-germlings of *Palmaria palmata* grew normally, however, treatment with 20-30 V delayed both the growth of discs and the occurrence of erect fronds on the discs. When this same species was treated with 40-50 V, it did not produce erect fronds.

藻類に対する電気の作用については今迄主として微小な淡水産の鞭毛藻類を用いて調べられているが (Umrath, 1959; Halldal, 1962), 大型藻類についての報告はない。そこで今回函館近辺に産する海藻数種の初期発生体に電圧が及ぼす影響を調べた。

材料と方法

アナアオサ (*Ulva pertusa*), スサビノリ (*Porphyra yezoensis*), ウシケノリ (*Bangia atropurpurea*), ダルス (*Palmaria palmata*), マコンブ (*Laminaria japonica*), ワカメ (*Undaria pinnatifida*) 以上6種を材料として用いた。アナアオサは遊走子, スサビノリは果胞子又は単胞子, ウシケノリは果胞子, ダルスは四分胞子, マコンブとワカメは遊走子を培養に用いた。培養液としてはアナアオサ, スサビノリ, ウシケノリ, ダルスにはErd-Schreiber (Føyn, 1934) を, マコンブとワカメにはErd-SchreiberにSLPエキス (イカ内蔵蛋白粉末より得た抽出液) を0.01%添加した液 (籔ら, 1984) を使用した。電源としては東芝製スライダックスSK105を, 電圧と電流の測定には

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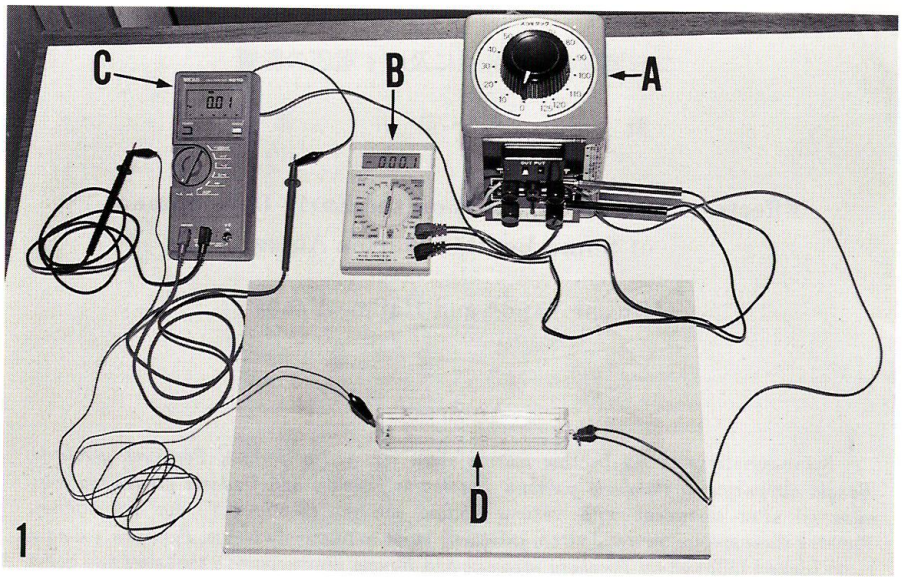


Fig. 1. Experimental apparatus.
A. Toshiba slidac SK 105. B. Toa digital multimeter DMM-9151. C. Soar multimeter 4010. D. Plastic case in which materials were treated with various voltages.

東亜電機製デジタルメーター，ソーア製デジタルマルチメーターの両者を用いた。胞子発生体は長さ 16 cm，幅 2.5 cm，高さ 2.4 cm のプラスチック製容器に入れその中に海水を満たし両端に電源につないだ白線金を取り付けて電流を通した (Fig. 1)。海水中に電流を通すと，通電時間と電圧は両極から生ずる塩素と水素により海水中の pH を変化させ，水温を上昇させるので，海藻の発生体への影響が果して電圧そのものによるのかどうか判断できなくなる。そこで，本実験では電流を通す容器の下にアイスパックを置き海水を約 10°C に保ち，電圧は 5～50 A.C.V とし，通電時間は 3 分以内とした。種々の電流で処理した胞子発生体は直ちに夫々の培養液にもどして観察に供した。

観 察 結 果

本研究に用いた 6 種の海藻について電圧で処理後の生存率 (Figs. 2～29) を見ると，ダルスの四分胞子発生体が他の 5 種の胞子発生体に比べると極めて高く 50 V で 3 分間処理したものでも殆んどの体は生存していた。ダルス以外の 5 種についての生存率はアナアオサ，2 種のウシケノリ目植物 (スサビノリとウシケノリ)，2 種のコンブ目植物 (マコンブとワカメ) の順となっている。何れの種類についても通常 10 V 以下の低電圧で処理するとその後正常に成長を続けるが (Figs. 6, 11, 14, 27)，20 V の電圧では体細胞には死滅するものと残存するものとが約 50% ずつあり (Figs. 5, 9, 10, 13, 23)，残存したものではその後細胞分裂を行って成長した。そして，30 V 以上の高電圧で処理すると殆どの体が死滅した (Figs. 21, 22, 24-26)。ワカメでは 30～40 V で処理すると 99% の配偶体が死滅したが残存した 1% の配偶体はその後発生を続け約 20 日後には正常な幼芽胞体を形成した (Figs. 28, 29)。ダルスでは四分胞子放出後 8 日目の 4～10 個細胞よりなる盤状を呈する発生体 (Fig. 15) の時期に 5, 10, 20, 30, 40, 50 V で 3 分間処理した。その結果，5～10 V で

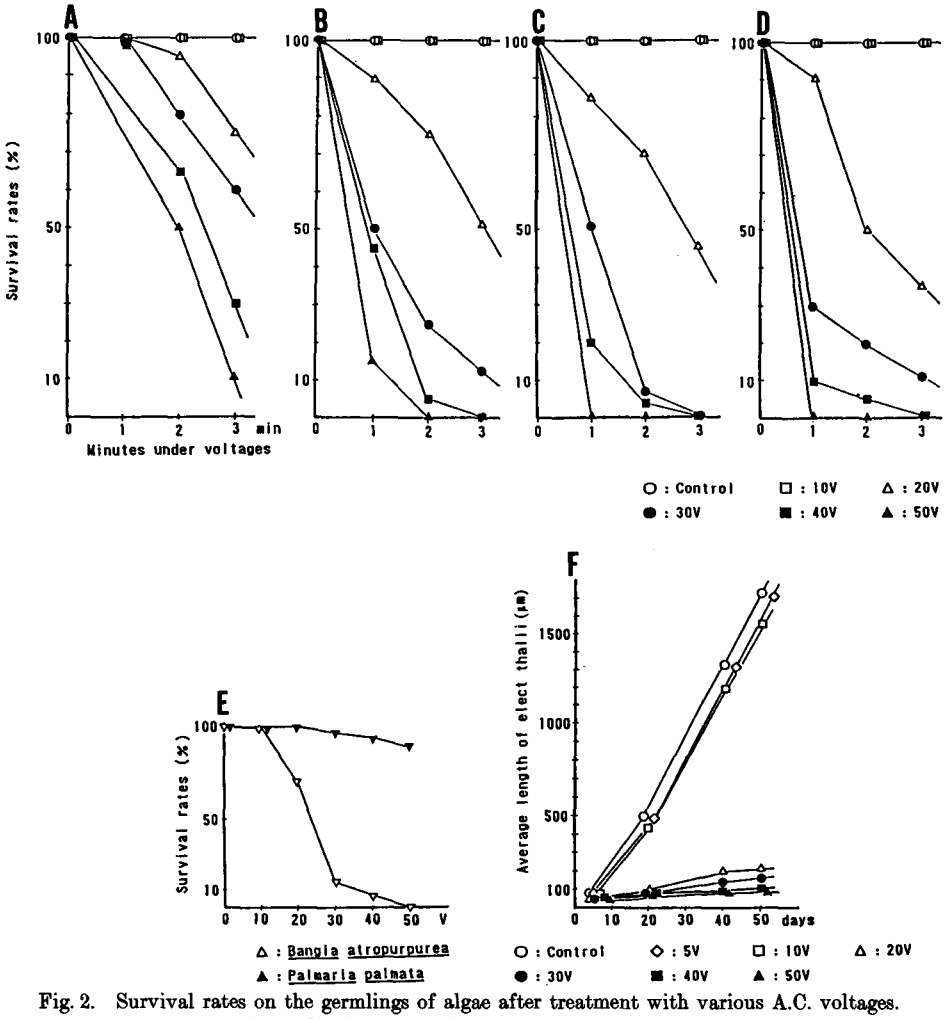
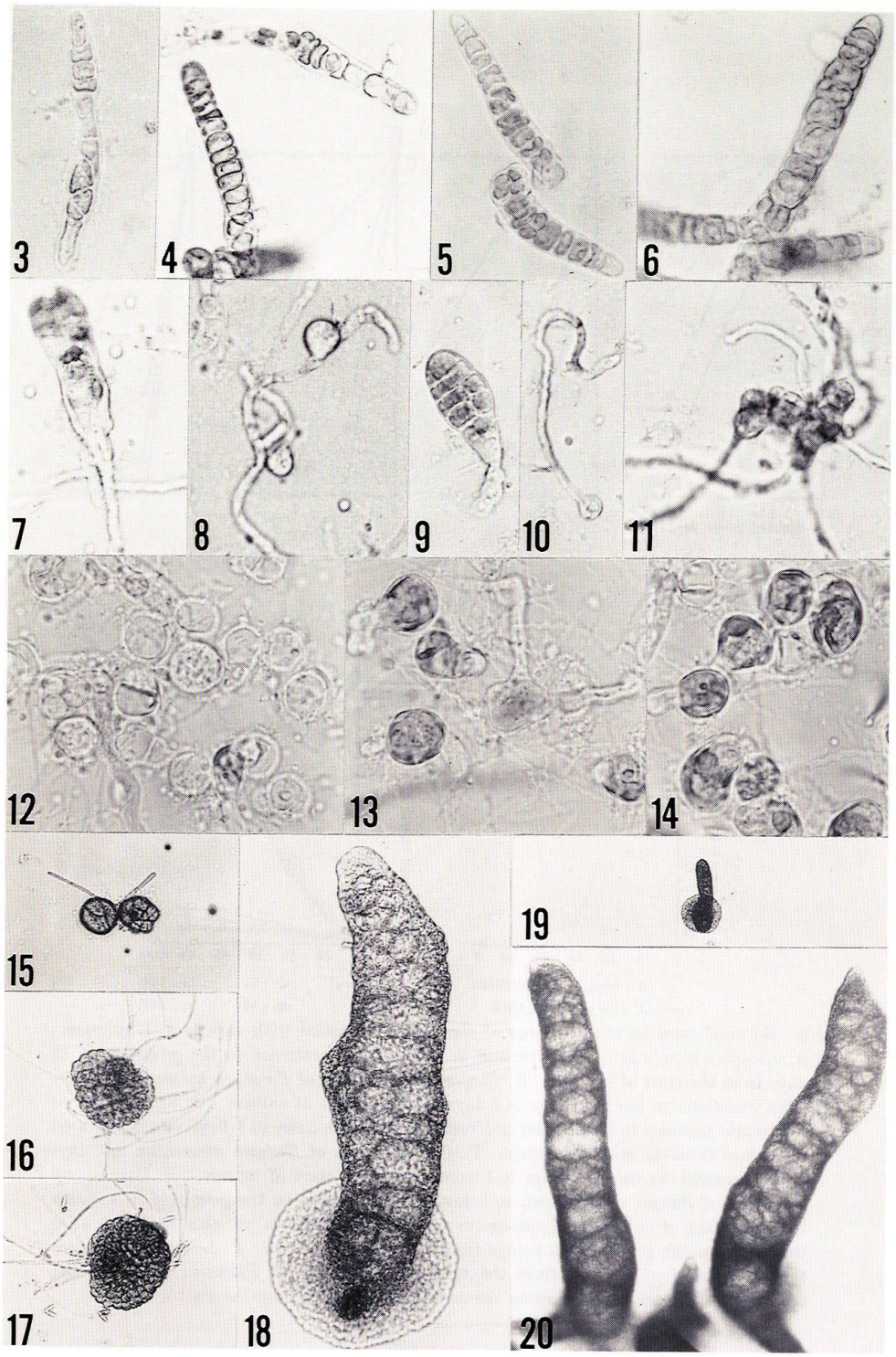


Fig. 2. Survival rates on the germlings of algae after treatment with various A.C. voltages. A. Zoospore-germlings of *Ulva pertusa* in 4 days after treatment on the germlings in 18 days from the start of culture. B. Carpospore-germlings of *Porphyra yezoensis* in 4 days after treatment on the germlings in 8 days from the start of culture. C. Sporophytes of *Laminaria japonica* in 24 hrs after treatment on the sporophytes in 1-6 cell stages produced in 16 days from the start of culture. D. Gametophytes of *Undaria pinnatifida* in 3 days after treatment on the germlings is 1 month from the start of culture. E. Carpospore-germlings of *Bangia atropurpurea* in 3 days after treatment on the germlings in 1 month from the start of culture, and tetraspore-germlings of *Palmaria palmata* in 3 days after treatment on the germlings in 8 days from the start of culture. F. Length of the elect thalli on the discs derived from the tetraspore-germlings of *Palmaria palmata* after treatment with various voltages on the germlings in 8 days from the start of culture.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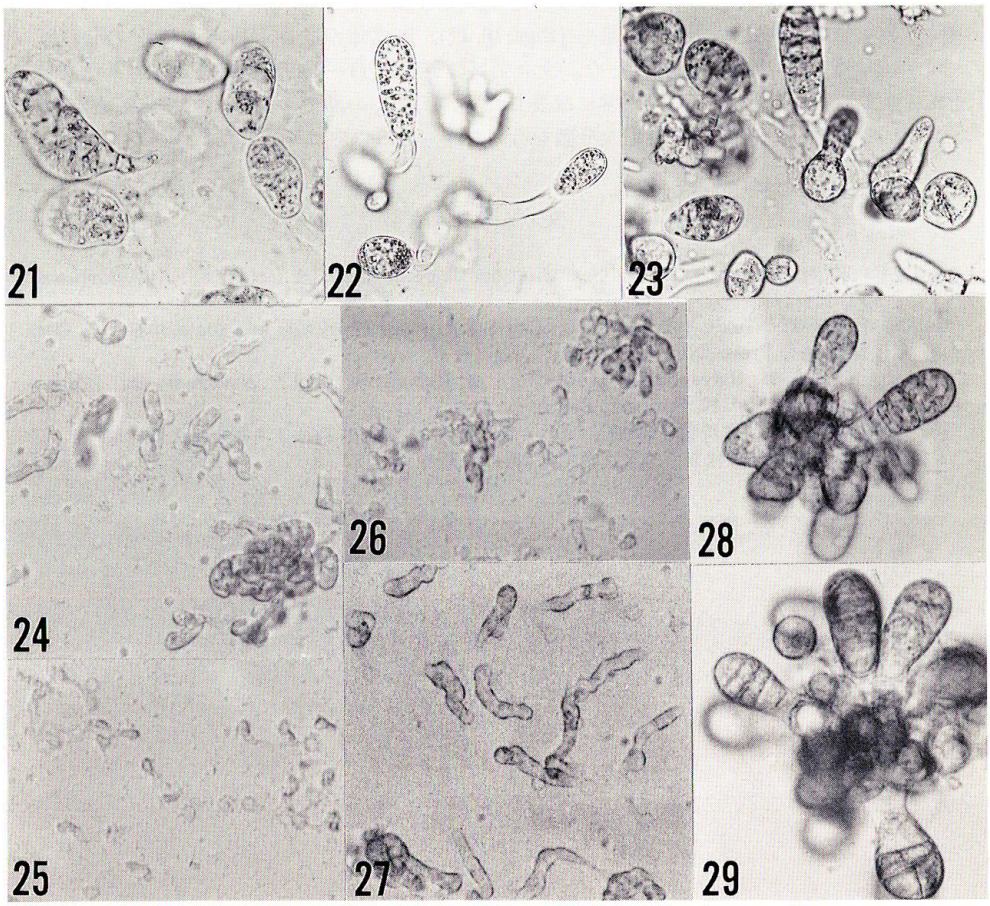

Figs. 3-6. Zoospore-germlings of *Ulva pertusa* in 4 days after treatment with various A.C. voltages on the germlings in 18 hrs from the start of culture. ×350. 3. Treated with 50 V for 3 minutes. 4. Treated with 50 V for 2 minutes. 5. Treated with 20 V for 3 minutes. 6. Treated with 5 V for 1 minute.

Figs. 7-11. Carpospore-germlings of *Porphyra yezoensis* in 4 days after treatment with various A.C. voltages for 1 minute on the germlings in 8 days from the start of culture. ×350. 7 & 8. Treated with 50 V. 9 & 10. Treated with 20 V. 11. Treated with 10 V.

Figs. 12-14. Carpospore-germlings of *Bangia atropurpurea* in 2 days after treatment with various A.C. voltages on the germlings in 10 days from the start of culture. ×400. 12. Treated with 30 V for 3 minutes. 13. Treated with 20 V for 3 minutes. 14. Terated with 10 V for 1 minute.

Figs. 15-20. Tetraspore-germlings of *Palmaria palmata* without or with A.C. voltages. 15-18. ×100; 19 & 20. ×40. 15. In 8 days culture just before treatment with voltages. 16. In 20 days after treatment with 30 V for 3 minutes on the germlings in 8 days from the start of culture. 17. In 20 days after treatment with 20 V for 3 minutes on the germlings at the stage of Fig. 15. 18. In 20 days after treatment with 10 V for 3 minutes on the germlings at the stage of Fig. 15. 19. In 40 days after treatment with 10 V for 3 minutes on the germlings at the stage of Fig. 15. 20. In 40 days after treatment with 5 V for 1 minute on the germlings at the stage of Fig. 15.

はその後盤状体上に直立体が形成されて正常な成長を続けたが (Figs. 18, 20), 20～30 V では盤状体の発育並びに直立体の形成は遅く (Figs. 16, 17), 直立体の成長も極めて悪く (Fig. 19), 40～50 V では直立体は形成されなかった。マコンブの芽胞体 (1～6 細胞期) では, 20 V で 2 分～3 分間処理すると約 75% のものは正常に成長したが, 約 2% の卵で中央部がくびれて瓢箪型となり, これらは通常 1～3 回の不規則な分裂を行った後, 数日以内に死滅した。

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Figs. 21-23. Yonug sporophytes of *Laminaria japonica* in 2 days after treatment with various A.C. voltages. 21. Treated with 40 V for 3 minutes. 22. Treated with 30 V for 3 minutes. 23. Treated with 20 V for 2 minutes.

Figs. 24-29. Gametophytes of *Undaria pinnatifida* after treatment with various A.C. voltages on the gametophytes in 3 months from the start of culture. ×350. 24. In 3 days after treatment with 40 V for 1 minute. 25. In 3 days after treatment with 30 V for 3 minutes. 26. In 3 days after treatment with 30 V for 2 minutes. 27. In 3 days after treatment with 10 V for 3 minutes. 28. In 20 days after treatment with 40 V for 1 minute. 29. In 20 days after treatment with 30 V for 2 minutes.