

ミューラー先生 (Dieter G. Müller 教授) を悼んで

ドイツの藻類学者で、永らく日本藻類学会の会員でもあった、D.G. ミューラー先生 (Prof. Dr. Dieter G. Müller) が、2025 年 8 月 7 日にコンスタンツで逝去された。享年 90 才であった。

ミューラー先生は、主に褐藻を対象に、その生活史と性誘因メカニズムを含む有性生殖過程、褐藻に寄生する新奇ウィルスの発見とその感染過程やゲノム構造の解析のほか、多様な研究テーマで数多くの独創的な研究業績を残された。これらは末尾に示す 220 編を超える原著論文として出版され、その主要な成果の一部は Nature や Science などの評価の高い一般誌で発表された。ミューラー先生は、少なくとも 4 回来日され、講演や採集、多くの研究者との交流を行われるなど、日本との関わりも深い。筆者の一人、川井は 1989 年から 1990 年にかけてフンボルト奨学生として、同氏の研究室に滞在させていただき、その後も 35 年にわたり、さまざまな交流をさせて頂いた。またもう一人の筆者ペータース (Akira F. Peters) は学部学生時代から同氏に師事し、以来 40 年以上にわたり数多くの共同研究を行ってきた。ミューラー先生のご逝去に際し、長年にわたりお世話になった両名が簡単にではあるがそのご業績を紹介することで心からの哀悼の意を表したい。

ミューラー先生は南ドイツのシュトゥットガルトで生まれ、チュービンゲン大学で Erwin Bünning 教授のもと、培養による褐藻アミジグサ *Dictyota dichotoma* の月齢リズムの研究で博士号を取得された。その後、米国・ペンシルバニア大学での博士研究員、ケルンのマックスプランク研究所の研究員を経て、1971 年にコンスタンツ大学で植物発生学講座の教授に就任され、2000 年の定年退職まで、同大学を拠点に終始活発な研究活動を行われた。その間、コンスタンツは最も近い海岸まで数百 km 離れた内陸に立地するが、欧州でもっとも重要な海藻研究の拠点の 1 つであった。

ミューラー先生は、学位取得後、同じく褐藻のシオミドロ *Ectocarpus siliculosus* を主な研究対象に選び、単藻培養と核相解析を用いた精緻な生活史研究を行われた。その結果、この種がいずれも単列糸状だが、形態が少し異なる孢子体と配偶体の間で世代交代を行うこと、その生活環は孢子体の無性的な繁殖や配偶子の単為生殖もみられるため非常に複雑だが、配偶体は雌雄異株で、その雌雄性は遺伝的に固定されていることを示された。これは、それまで提唱されていた褐藻における「相対的な性」という説を明確に否定した点で大きく注目される研究成果であった。さらにシオミドロの雌雄の配偶子は同形だが、受精時には雌性配偶子が先に基質に着生して鞭毛を取り込んだ後に、揮発性の性誘因物質を放出し、走化性による雄性配偶子の誘引を経て細胞融合がおこることを

見いだされた。この現象は、その後、筆者の 1 人である A.F. Peters との一連の共同研究を通して、褐藻の有性生殖における一般的な現象であることが示された。ミューラー先生は、さらに化学分野の研究者との共同研究によって、配偶子の走化性を担う性誘因物質の構造決定と人工合成を行い、これによって可能になった濃度既知の性誘因物質を用いた精度の高いバイオアッセイによって、10 種類を超える褐藻の性誘因物質を同定し、性誘因物質の種類と科や目レベルでの系統には相関があることを明らかにされた。これらの研究成果の多くが発表された 1980 年代は遺伝子情報による系統関係の解明が困難であったことから、褐藻の高次分類に興味があった筆者の 1 人、川井にはきわめて興味深い研究内容であり、1989 年～90 年にフンボルト奨学生として同氏の研究室に滞在し、その後も共同研究を行わせていただくきっかけとなった。

一方、川井の滞在の少し前に、同じくフンボルト奨学生として同研究室に滞在しておられた E.C. ヘンリー博士 (Dr. Eric C. Henry) が、褐藻フェルドマニア属 *Feldmannia* に寄生する藻類ウィルスの研究を行われたのを契機に、ミューラー先生ご自身もシオミドロに寄生する藻類ウィルスを対象に、その



1990 年頃のミューラー先生 (コンスタンツ大学の研究室で)

感染経路やゲノム構造に関する研究を実施された。すなわち、シオミドロに感染する新奇 DNA ウィルスである EsV-1 の藻体へ感染は、細胞壁を持たない遊泳細胞だけでおこり、ウィルス遺伝子は寄主のゲノムに組み込まれるが、藻体の栄養組織では発現せず、遊走子嚢や配偶子嚢などの生殖器官の形成時にのみ増殖し、多数のウィルス顆粒を放出することを明らかにされた。また、このウィルスはシオミドロ属の種だけで無く、近縁の属の種にも感染可能であることなどを明らかにされた。川井の滞在はちょうどこの時期にあたり、EsV-1 の TEM と蛍光染色によるウィルス DNA の増幅とウィルス粒子の形成過程の解析を担当することができた。また、その後はウィルスの研究から派生して、褐藻に寄生する真菌類についても、その分類や感染経路に関する研究を行い、多くの新知見を報告された。

ミュラー先生はさまざまな褐藻の性誘因物質の探索をきっかけに、世界各地で採集を行い、シオミドロのみならず多様な褐藻の単藻培養株、無菌培養株を確立し、長期にわたり継代培養により保存してこられた。その多くは現在も生存しており、最も古いものは、1959 年にナポリで採集されたシオミドロの培養株まで遡るが、寄託先の神戸大学海藻類系統保存室 (KU-MACC) とスコットランドの The Culture Collection of Algae and Protozoa (CCAP) で保存、提供されている。

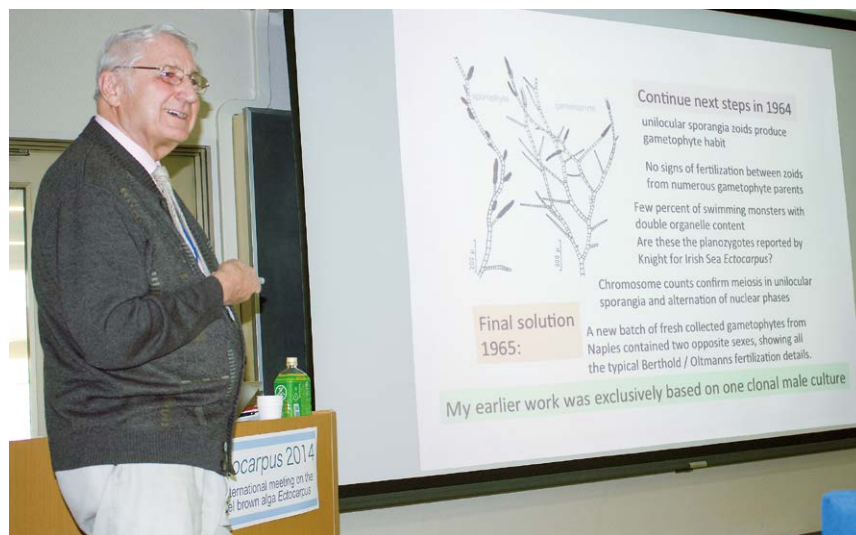
シオミドロは、ミュラー先生ご自身と多くの共同研究者の研究によって、前述の有性生殖過程を含む生活史やウィルスに関係する研究のほか、鞭毛運動、細胞及び鞭毛微細構造、走光性、脂質、生殖的隔離、生物地理、船体汚損防止などさまざまな研究に用いられ、褐藻のなかでも最も多様な生物学的な知見が蓄積される種となった。このため、フランスの研究グループを中心に褐藻を対象とした全ゲノム解析プロジェクトが企画された際にも、最終的にシオミドロが解析対象種

として選ばれ、多細胞海藻での初めての全ゲノム解読例として 2010 年に報告された。さらに、ミュラー先生が収集された培養株は、筆者らも参加して 2024 年に報告された褐藻のほとんどの目を網羅した全ゲノム解析プロジェクトでも非常に重要な役割を果たした。

ミュラー先生はこれらの基礎科学における業績のみならず、1985 年以降はチリの研究者との継続的な研究交流により、現地でのマクロシスティスの養殖技術の確立にも大きな貢献をされた。また 2000 年の定年退職後も自宅に培養庫を備えた実験室を作られ、培養株の維持だけではなく、さまざまな新たな現象を見いだされ、共同研究による研究活動を継続された。この様にミュラー先生の研究上の貢献と活発な研究交流がなければ、現在の我々の褐藻に関する生物学的な知見のみならず、入手できるゲノム情報もはるかに乏しいものになっていたと確信する。改めて、ミュラー先生の膨大な研究業績に敬意を表すると共に、ご冥福をお祈りする。

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