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研究課題名(和文) Genetic evidence for the role of cold-induced factors and Flowering Locus C in perennial growth of *Arabidopsis halleri gemmifera*研究課題名(英文) Genetic evidence for the role of cold-induced factors and Flowering Locus C in perennial growth of *Arabidopsis halleri gemmifera*

研究代表者

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研究成果の概要(和文)：開花遺伝子C (FLC) は、アブラナ科開花を抑制する中心的因子である。FLCは冬の一年草ではよく解析されているが、多年草アブラナ科植物ではその機能は不明である。本研究では日本産多年生アブラナ科植物であるシロイヌナズナのFLCのオルソログ変異体を作成した。組織培養における形質転換を最適化した後、AhFLCに対するsiRNAを発現させた一次形質転換体を得た。変異体の表現型を精査した結果、AhgFLC制御のいくつかの多年生形質が判明し、ほぼ予想通りの結果となった。これらの表現型は後続の世代で検証する必要がある。本研究は、一年草と多年草の生育習慣の遺伝的決定要因に関する普遍的理解に貢献する。

研究成果の学術的意義や社会的意義

Vernalization contributed to adaptation to diverse climates and diversification of life histories and was utilised in breeding. Together with work from *Arabidopsis thaliana*, this work contributes to general understanding of the genetic determinants of annual vs perennial growth habits.

研究成果の概要(英文)：Flowering Locus C is a central repressor of flowering in the crucifer family. While exceptionally well characterised in winter annual growth habits, its function had not been studied genetically in crucifers with perennial growth habit, which are less amenable genetic systems but they represent the ancestral forms. In this work, we created mutants in the Flowering Locus C orthologue in *Arabidopsis halleri gemmifera*, a perennial crucifer from Japan with a unique growth habit. After optimizing several steps of the tissue culture *Agrobacterium*-mediated transformation in Ahg, we were able to obtain a limited number of primary transgenics expressing siRNA against AhgFLC. Close investigation of the mutant phenotype pointed to several perennial traits that AhgFLC controls, largely in line with expectations. These phenotypes remain to be substantiated in sequent generations. This work contributes to general understanding of the genetic determinants of annual vs perennial growth habits.

研究分野：plant development and environmental response

キーワード：vernalization life history flowering locus C

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様式 C - 19、F - 19 - 1、Z - 19 (共通)

## 1 研究開始当初の背景

The chilling of winter induces flowering in some plants but they must flower only in spring. This process, vernalization, best studied in *Arabidopsis thaliana*, is based on the potent floral inhibitor FLC, abundant during vegetative phase, and a suite of cold-induced factors that modify FLC chromatin to gradually repress FLC and to maintain repression even after chilling. In contrast to annuals like *Arabidopsis thaliana*, perennials resume vegetative growth after vernalization, based on **reversible**, rather than **stable**, FLC maintenance. The perennial traits controlled by the FLC orthologue in *Arabis alpina* have been defined but other perennial forms are different. For example, *Arabidopsis halleri gemmifera* (*A. halleri*) returns to vegetative growth is based on direct reversion of flowers into vegetative aerial rosettes. Studying perennial crucifers is important as they represent the ancestral types that other growth habits derived from.

## 2 . 研究の目的

To understand how does the FLC chromatin control the degree of stability of FLC maintenance after winter to determine annual and different perennial growth habits, here we aim to characterize genetically FLC and its derived noncoding transcripts in *A. halleri* perennials, which has become a model system for studies in natural environment.

## 3 . 研究の方法

We used transgenic approaches in both *A. halleri* and *A. thaliana*. Multiple stages of the protocol of *A. halleri* *Agrobacterium* mediated transformation via tissue culture were optimized.

## 4 . 研究成果

In this work, we created mutants in the *Flowering Locus C* orthologue in *A. halleri* (*AhFLC*). We obtained a limited number of primary transgenics expressing siRNA against *AhFLC*. Close investigation of the mutant phenotype pointed to several perennial traits controlled by *AhFLC*, largely in line with expectations. These findings await confirmation in subsequent generations. In addition, we derived functional information on the *AhCOOLAIR* antisense noncoding RNA originating from FLC locus in the context of the three distinct chromatin domains of *AhFLC* in a natural population (Nishio et al 2020, Buzas et al 2021) as well as confirmed one proposed function of the sense noncodingRNA *COLDAIR* in a heterologous system (Buzas in prep). This work contributes to general understanding of the genetic determinants and epigenetic regulation of annual vs perennial growth habits.

5. 主な発表論文等

〔雑誌論文〕 計2件（うち査読付論文 2件 / うち国際共著 0件 / うちオープンアクセス 0件）

1. 著者名 Diana Mihaela Buzas, Haruki Nishio and Hiroshi Kudoh	4. 巻 12: 640442
2. 論文標題 Many plant species overwinter before they flower. Transition to flowering is aligned to the seasonal transition as a response to the prolonged cold in winter by a process called vernalization.	5. 発行年 2021年
3. 雑誌名 The Flowering Season-Meter at FLOWERING LOCUS C Across Life Histories in Crucifers	6. 最初と最後の頁 1-17
掲載論文のDOI（デジタルオブジェクト識別子） 10.3389/fpls.2021.640442	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 -

1. 著者名 Haruki Nishio, Diana M Buzas, Atsushi J Nagano, Koji Iwayama, Masayuki Ushio, Hiroshi Kudoh	4. 巻 11:2065
2. 論文標題 Natural environments require organisms to possess robust mechanisms allowing responses to seasonal trends.	5. 発行年 2020年
3. 雑誌名 Repressive chromatin modification underpins the long-term expression trend of a perennial flowering gene in nature	6. 最初と最後の頁 1-12
掲載論文のDOI（デジタルオブジェクト識別子） 10.1038/s41467-020-15896-4	査読の有無 有
オープンアクセス オープンアクセスではない、又はオープンアクセスが困難	国際共著 -

〔学会発表〕 計1件（うち招待講演 1件 / うち国際学会 0件）

1. 発表者名 Diana Buzas
2. 発表標題 Determinism to chaos: two decades of science ongoing
3. 学会等名 Science Ongoing（招待講演）
4. 発表年 2021年

〔図書〕 計0件

〔産業財産権〕

〔その他〕

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6. 研究組織

氏名 （ローマ字氏名） （研究者番号）	所属研究機関・部局・職 （機関番号）	備考
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7. 科研費を使用して開催した国際研究集会

〔国際研究集会〕 計0件

8 . 本研究に関連して実施した国際共同研究の実施状況

共同研究相手国	相手方研究機関
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