DIWPA: DIVERSITAS in the Western Pacific and Asia

DIWPA News Letter

Office: Center for Ecological Research, Kyoto University, Otsu, Shiga, Japan

March 2022

No. 46

Message from the Chairperson

Shin-ichi Nakano

I wish all people of the world peace and happiness.

On 10 November 2021, "Global Ecological Literacy Youth Forum" was held online, organized by National Institute of Ecology (NIE), South Korea. NIE wants to promote the project to develop practical programs for high school students to foster ecological literacy in South Korea. Through the opportunity, they make friends from the same generation in programs that can cultivate ecological literacy in their local areas. The program focused on wetland, endangered species, and habitat conservation.

The forum was chaired by Dr. Sung Ryong Kang, General Manager of International Cooperation, NIE). As a part of the program, NIE intended to make time to interview international experts. Therefore, I was invited as DIWPA Chair and one of the experts in ecology and biodiversity, together with other experts as follows:

- Dr. Andre Mader: Director, Institute for Global Environmental Strategies
- Dr. Martin Bauert: Head of Conservation, Zoo Zurich

At the forum, total 11 students from 3 high schools participated:

- 3 students from Seocheon High School
- 4 students from Seocheon Girls' High School
- 4 students from Janghang High School

Those high school students provided preliminary questions in advance, and the experts examined them before the forum. I introduced some of those questions below:

- What kind of animals designated as endangered species in your country conserved?
- Are there any species currently recovering well from endangered species?
- Which private companies work to preserve or protect each country's wildlife habitat?

They were also interested in the experts' motivation for research:

- What is the most rewarding moment while studying ecology?
- What advice would you give to students who want to pursue ecology as a career?

Furthermore, those students wanted to know how South Korea's ecosystem conservation is evaluated by the experts:

- How is the evaluation of Korea's ecosystem status from the international community?

Souvenir photo of "Global Ecological Literacy Youth Forum" held on 10 November 2021

I know that South Korea has been successfully taking appropriate measures for environmental and biodiversity conservation during the last generation. At the forum, I have found that those students are highly interested in and motivated in environmental issues especially for endangered species and habitat conservation. I was so much impressed with their diligence and passion for ecology and biodiversity. I strongly hope future collaboration for environmental and biodiversity conservation by the next generations, believing in their great success.

Message

from the Secretary General

Atsushi Ishida

In Japan, we are experiencing the 6th wave of COVID-19 infections driven by Omicron variant. I wonder how you maintain your activities, such as lectures, meetings and conservation programs in your counties. However, since the internet is not affected by COVID-19, we can exchange information on our activities in our respective country. We hope to enhance the activity of DIWPA as a platform for information exchange. In this volume of the DIWPA Newsletter, we can inform good news. Amami-Oshima Islands, Tokuno Island, Iriomote Island and the north part of Okinawa Island in the Ryukyu Archipelago have been registered by UNESCO as the World Natural Heritage sites in July, 2021. This is the 5th World Natural Heritage site in Japan. These islands have a high biodiversity, including many endemic species. This high level of biodiversity was recognized by UNESCO as a value that should be protected in the world, and these areas were registered as a World Natural Heritage site. In Japan, we have two World Natural Heritage sites on islands; the other is the Ogasawara (Bonin) Islands. We have more than 300 oceanic islands in Japan. These oceanic islands provide rich ecological services to humanity through their unique and beautiful nature. However, such islands are vulnerable to climate change and globalization, such as COVID-19. As a result, environmental issues are more likely to become apparent in the islands. Water resources and excessive waste are common factors worldwide that limit the sustainability of islands. In order to maintain their high biodiversity and beautiful nature, we should make planning for the mitigation and adaptation measures to global warming from a more transdisciplinary standpoint, integrating natural and human sciences. This is a challenge shared not only by islands but also by continents. DIWPA welcomes such transdisciplinary papers as well as those in the natural sciences.

I know that many of us are now heartbroken by the recent world situation. We are acutely aware of our privileged position, and we believe that DIWPA must support all people and researchers as a global platform for the exchange of information related to biodiversity and ecology. DIWPA accepts papers from not only Ukrainian but also Russian researchers. Some DIWPA members may not agree with this opinion, but DIWPA is independent on any governmental policy and should not be influenced by the nationality, ethnicity, political beliefs, race, gender, or religion of the authors. I do not want to create any barriers between us in DIWPA. We may also accept Russian researchers participating DIWPA International Field Biology Course (IFBC) in accordance with the above policy. However, because of the global infection of COVID-19, we have not yet determined whether we will be able to hold DIWPA IFBC in this year. We will announce the information of DIWPA IFBC on our website at a later date.

Mail Us!

We welcome your articles, news or any information related to biodiversity.

Please send them to
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Report

World Natural Heritage as Seen by Iriomote Islander

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Fig. 1. Todomari-beach means a place where gods gather. It is also a beach of singing sand where sea turtles spawn.

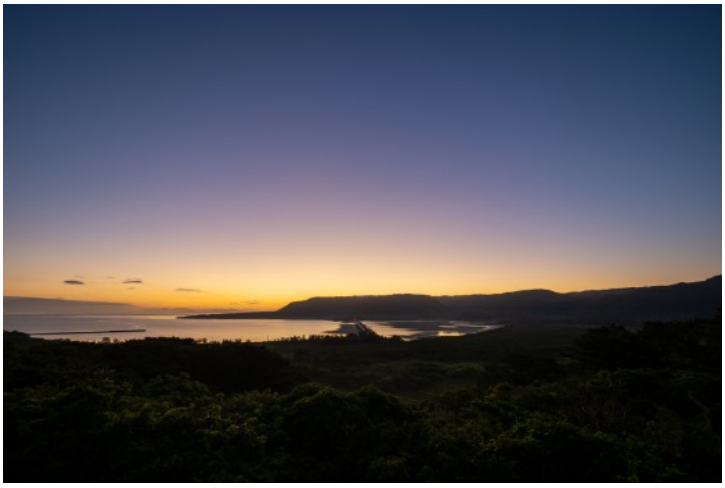

Fig. 2. Funaura Bay, surrounded by mangrove trees, is rich in organic matter, and many creatures inhabit the tidal flats.

Amami/Okinawa area was registered as the Japanese 5th World Natural Heritage Site in 2021

"World Natural Heritage" is defined as a common heritage of humankind that must be passed down to the future. They are recognized by the World Heritage Committee (IUCN: International Union for Conservation of Nature) as important areas with the only value in the world. (UNESCO Institute for Statistics, 2009 UNESCO Framework for Cultural Statistics and UNESCO, Convention Concerning the Protection of the World Cultural and Natural Heritage, 1972.) To be registered as a World Natural Heritage, the property must meet one or more of the four evaluation criteria: natural beauty; topography/geology; ecosystem; and biodiversity. In Japan, Shiretoko, Shirakami Mountains, Yakushima, and Ogasawara Islands have already been registered as World Natural Heritage Sites. Last year, the Amami / Okinawa area was certificated as Japan's World Natural Heritage Site for the first time in 10 years.

Amami / Okinawa world natural heritage site consists of four different islands, Amami-Oshima, Tokunoshima, the Northern part of Okinawa, and Iriomote. This area is separated from the continent, and the geological history causes unique biological evolution in establishing small islands. Also, it is an irreplaceable habitat for some unique terrestrial species, including many endemic and globally threatened species. This property contains essential and significant habitats to conserve this exceptional and rich biodiversity (UNESCO World heritage centre https://whc.unesco.org/en/list/1574/). Although Amami / Okinawa site is less than 0.5% of the Japanese land area, the animal and plant species occupy a considerable proportion of the number of species in Japan, such as 1,819 species of vascular plants, 21 terrestrial mammals, 394 birds, 36 terrestrial reptiles, and 21 amphibians inhabit. Overall, about 57% of the terrestrial vertebrates of "the terrestrial biodiversity hotspot Japan" live in the site, including 44% of Japanese endangered vertebrates and 36% of international endangered species inhabiting Japan. In addition, the number and proportion of endangered species are high on this site, including 95 international endangered species (Recommendation letter to UNESCO submitted in February 2019).

Natural treasure island, Iriomote

Iriomote Island is one of the islands forming Taketomi town of Okinawa prefecture. Only 2400 islanders live on Japan's 16th-largest island (289.62 square kilometers). 72% of the entire island is registered as a World Natural Heritage Site, accounting for 48% of the Amami / Okinawa World Natural Heritage Sites. Dense semi-tropical forests cover most terrestrial areas, and mangrove and coral reefs fringe the island. About 70% of Japanese mangrove forests are distributed on Iriomote Island, and it enhances the biodiversity of fish, crustacea, and shellfish living in brackish water. Many endemic and endangered species live in the various
semi-tropical ecosystem, such as the Iriomote wild cat.

The small population is caused by difficulties of development geographically, which is mountainous and covered by deep forests. Because an airport has not been built on the island, visitors need to fly to the next island Ishigaki and then sail to Iriomote. Moreover, malaria had afflicted residents' livelihood until 1961. After the Reversion of Okinawa to Japan (Japanese administration) in 1972, tourists visiting Iriomote Island increased gradually due to the increment in the transportation capability of planes or ferries. In the 21st century, as the specific and beautiful nature became known widely, annual tourists visiting Iriomote reached more than 300,000 until a new Coronavirus (COVID-19) pandemic occurred. On Iriomote Island, tourism making the best use of the natural environmental property is prosperous. Tour-type sightseeing visiting several popular spots by bus, boat, or cow car, and eco-tour going around nature with a guide using kayak or SUP is held actively.

Fig. 3. On Iriomote Island, Ruddy Kingfisher (*Halcyon coromanda*) flies in the middle of spring and stays until late summer until child-rearing ends.

How to protect and manage?

UNESCO requires compliance for a World Heritage Site; Invasive alien species and roadkill, especially the potentially critical impact of traffic on endangered species, including the Iriomote wild cat, need to be kept at an absolute minimum and strictly monitored and illegal collection of wild rare and threatened species prevented.

Prior to being registered as a World Natural Heritage, administrative organs greatly expanded the national park area of Iriomote Island since the World Natural Heritage registration system has no legal restrictions to protect nature. As a result, almost the entire island was designated as the Iriomote Ishigaki National Park. Moreover, some areas are designated as Special Protection Zones or Class I Special Zones by the Ministry of the Environment and/or Preservation Zones of Forest Ecosystem Reserves by the Forestry Agency. In addition, some buffer zones were established between the residential and protection zones, and activities in the buffer zones also require continued vigilance and are strictly limited and monitored. Last November, Okinawa Prefecture, Taketomi Town, the Ministry of the Environment, the Forestry Agency, local tourism associations, and local community center staff established a general incorporated association named Iriomote Foundation. "To meet the passion and expectations of many people who support us, our basic philosophy is to "protect the rich nature of Iriomote Island and the traditional culture and livelihood of the island and contribute to the sustainable development of the region." We will work towards solving various problems. We hope that people will continue to watch over the "Iriomote Foundation" so that our small steps will be helpful for the future of Iriomote Island, the world's treasure," the director-general, Masanori Kawai, said.

Most Iriomote Islanders might not hope to be registered as a World Natural Heritage Site

According to a townspeople survey/questionnaire conducted by Okinawa Prefectural Government (final response rate was 20%, https://www.facebook.com/okinawa.sekaishizenisan March 1st of 2018), most Iriomote islanders regard nature as fundamentally indispensable for their livelihood and the wild creatures. Then, the degradation of the natural environment, land, and sea is recognized as the most critical issue. Regarding the registration as a World Natural Heritage, while there is some expectation that the local economy

will be enriched mainly in the tourism industry, it is not recognized that the registration will lead to the conservation of the natural environment, and vice versa. In addition, there are many concerns; the deterioration of nature due to the increase in tourism use, lack of infrastructure, impact on people's livelihood, and low support rating for heritage registration of 41% negatively versus 28% positively. 27% of the residents answered neither agree nor disagree.

UNESCO was also concerned about the potential impact of tourism, and establishing a continuous assessment and surveillance system to maintain sustainable tourism levels was a prerequisite for World Natural Heritage registration. Iriomote local preparatory committee struggled to establish tourism rules that would not constrain the islanders' lives. However, the islanders have not fully understood how the World Natural Heritage registration and the accompanying legal restrictions affect their lives. Some islanders are still concerned that new regulations may restrict islanders' activities such as nature walks, edible wild plant picking, and wild boar hunting in the conservation area. So, one issue is to inform all islanders that some activities by islanders' in the buffer zone are allowed as before. In addition, in the conservation area, both ecosystem deterioration due to rapid increment of escaped livestock goats and broad area collapsing in mangrove forests that began to be conspicuous are also urgent issues.

From a long-term perspective, World Natural Heritage registration may have limited the development of non-tourism industries and increased the islanders' reliance on the tourism industry because of its vast conservation area covering almost the whole island. Under the COVID-19 pandemic, as in other regions, the number of tourists dropped sharply, and the tourism industry on Iriomote Island was severely damaged. Therefore, it is crucial to consider the long-term growth strategy of Iriomote Island to achieve the economic stability of the islanders while maintaining a balance with precious nature without being overly dependent on the tourism industry.

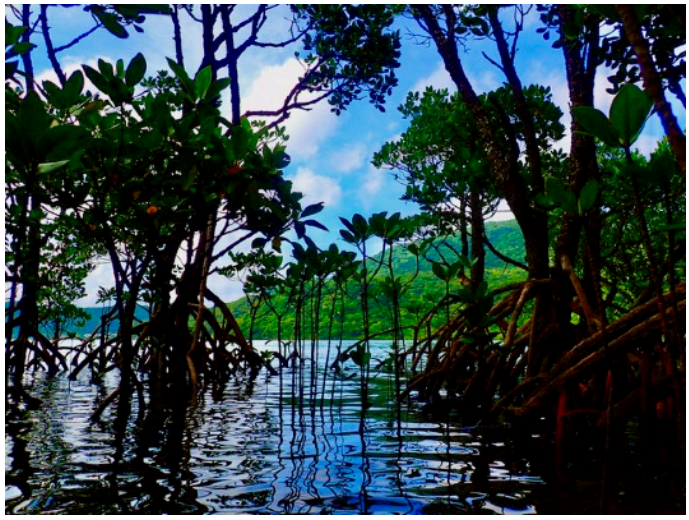

Fig. 4. Seven mangrove species grow on Iriomote Island, where 70% of the domestic mangroves are distributed.

Fig. 5. *Kandelia obovata* produce viviparous seeds in spring.

Fig. 6. In early summer, the flowers of *Barringtonia racemosa* bloom at night. Then in the morning, they fall and float on the river surface.

Fig. 7. In 2020, the NEOWISE comet (C/2020 F3) was observed in Yaeyama area.

Fig. 8. Sekisei Lagoon, which stretches between Iriomote Island and Ishigaki Island, is one of the world's leading coral reef areas.

Report

Evolutionary process of a 6-year periodical mass flowering plant, *Strobilanthes flexicaulis*, in the Ryukyu Islands (Japan) and Taiwan

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National Museum of Nature and Science (Japan)

Amami-Oshima Island, Tokunoshima Island, the northern part of Okinawa Island, and Iriomote Island in the Ryukyu Islands were registered as World Natural Heritage sites in 2021, in recognition of their high biodiversity and a high percent of endemic species. These islands are covered with subtropical rainforest and are inhabited by a variety of endemic plants and animals, making them an ideal region for evolutionary research. I have previously introduced in a DIWPA News Letter the research sites of a 6-year periodical mass flowering plant, *Strobilanthes flexicaulis* (Acanthaceae), which blooms simultaneously every six years on Okinawa Island (Kakishima 2016). In this text, I would like to introduce a study on the evolutionary process of the 6-year periodical mass flowering in Japan and Taiwan (Kakishima *et al.* 2019).

Periodical mass flowering is well known in bamboos (Poaceae) and *Strobilanthes* (Acanthaceae) (Janzen 1976), where most of the individuals in a population flower, fruit and die simultaneously in a given year with a fixed cycle of more than two years (Kakishima *et al*. 2019). Thereafter, seeds germinate en masse and most individuals grow without flowering until the next mass flowering year. The mass flowering cycle varies depending on the species, with the longest cycle in bamboos having ca. 120 years (Kawamura 1927; Janzen 1976). I previously found that *S. flexicaulis* have a 6-year cycle on Okinawa Island (Kakishima *et al.* 2011; Fig. 1A, B). *S. tashiroi* closely related to *S. flexicualis* is a polycarpic perennial plant that blooms every year (Kakishima *et al.* 2011; Fig. 1C). What kind of process did the 6-year periodical mass flowering evolve through? *S. flexicaulis* is distributed not only on Okinawa Island but also on Taiwan Island and the Yaeyama Islands including Ishigaki Island and Iriomote Island (Fig. 2). By surveying the life histories of *S. flexicaulis* on Taiwan Island and the Yaeyama Islands, as well as two closely related species *S. lanyusensis* and *S. rankanensis* in Taiwan (Fig. 1D, E), and estimating their evolutionary relationships by molecular phylogenetic analyses, I investigated the life history evolution in the *S. flexicaulis* group.

We set up two study sites on Ishigaki Island, one on Iriomote Island, and three on Taiwan Island to investigate the annual variation of the flowering individuals of *S. flexicaulis* (Fig. 2). At all these study sites, flowering individuals were observed almost every year, *i.e*., no mass flowering was observed (Kakishima *et al.* 2019; Fig. 3). This indicates that mass flowering of *S. flexicaulis* occurs only on Okinawa Island. We labeled the flowering individuals and observed them again the following year. On Okinawa Island, 98.3% of the labeled individuals died, while in Yaeyama Islands, 95.6% of the labeled individuals also died (Kakishima *et al.* 2019; Fig. 4). On the other hand, only 37.1% of the labeled individuals died on Taiwan Island, and about half of the surviving individuals flowered for two years. This result indicates that *S. flexicaulis* on Okinawa Island and Yaeyama Islands are basically monocarpic perennials, while that on Taiwan Island is a polycarpic perennial. My observation also revealed that *S.*

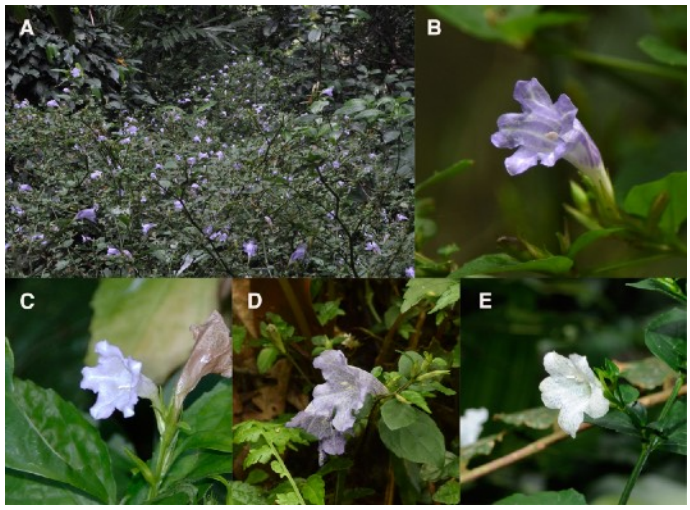

Fig. 1. Mass flowering of *S. flexicaulis* and the morphology of flowers in the *S. flexicaulis* group

(A) Mass flowering of *S. flexicaulis* on Okinawa Island. The flowers of (B) *S. flexicaulis* on Okinawa Island, (C) *S. tashiroi* on Okinawa Island, (D) *S. rankanensis* on Taiwan Island and (E) *S. lanyuensis* on Lanyu Island. Modified from Kakishima *et al.* (2019).

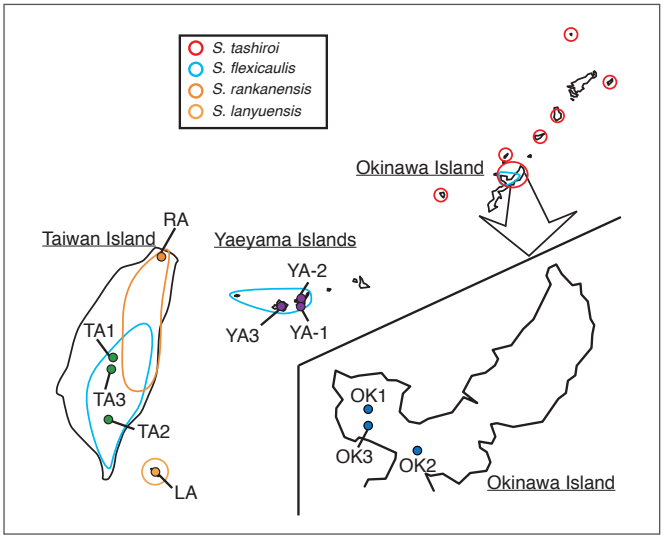

Fig. 2. Distribution and study sites of the *S. flexicaulis* group

Red, light blue, orange, and yellow lines show distribution of *S. tashiroi*, *S. flexicaulis*, *S. rankanensis* and *S. lanyuensis*, respectively. Blue, purple, green, orange and yellow solid circles show the locations of surveyed populations of *S. flexicaulis* on Okinawa Island, *S. flexicaulis* in the Yaeyama Islands, *S. flexicaulis* on Taiwan Island, *S. rankanensis* and *S. lanyuensis*, respectively. Modified from Kakishima *et al.* (2019).

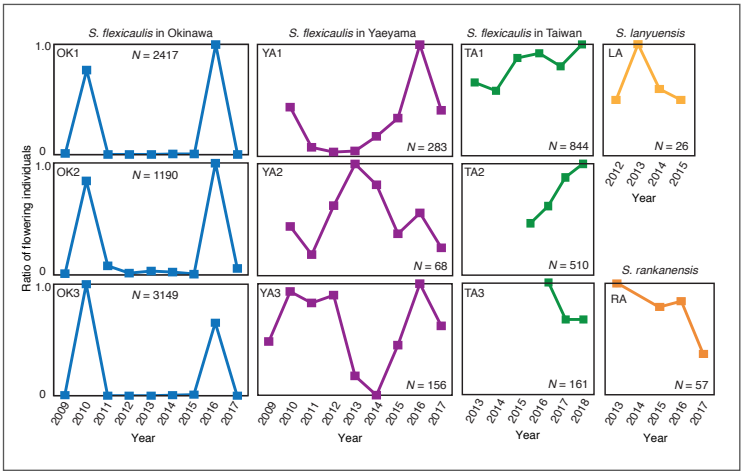

Fig. 3. Temporal dynamics of the flowering individuals ratio in the *S. flexicaulis* group

Temporal dynamics of the ration of flowering individuals calculated from the number of flowering individuals divided by the maximum number of flowering individuals during the surveyed period. OK1, OK2 and OK3 are Okinawa populations of *S. flexicaulis*. YA1, YA2, and YA3 are Yaeyama populations of *S. flexicaulis*. TA1, TA2 and TA3 are Taiwan populations of *S. flexicaulis*. LA is *S. lanyuensis*. RA is *S. rankanensis*. *N*: the total number of examined individuals in each population. Modified from Kakishima *et al.* (2019).

lanyusensis, endemic to Lanyu Island in Taiwan, flowered every year and was a polycarpic perennial (Kakishima *et al.* 2019; Figs. 3, 4). Because *S. rankanensis*, an endemic species on Taiwan Island, is a creeping plant, their individual identification was difficult, making it difficult to elucidate the reproductive mode. At one site, a small number of individuals flowered each year, suggesting that *S. rankanensis* is a not mass flowering plant (Kakishima *et al.* 2019; Fig. 3). These results show that periodical mass flowering is found only in *S. flexicaulis* in this group.

We determined the nucleotide sequences for three regions of chloroplast DNA and one region of nuclear DNA, and inferred the phylogenetic relationship within the *S. flexicaulis* group based on these sequences (Kakishima *et al.* 2019). In this group, *S. tashiroi* was found to have diverged the earliest (Fig. 5). Although the phylogenetic relationship among the remaining three species was not clear, *S. lanyuensis* and *S. rankanensis* had their own unique haplotypes and allele types. The major haplotype and allele type of *S. flexicaulis* was shared among populations on Okinawa Island, Yaeyama Islands, and Taiwan Island, indicating little genetic differentiation among their regional populations. The ancestral life history of this group is suggested as a polycarpic perennial because *S. tashiroi*, which was a sister clade to that of the other species, was a polycarpic perennial (Figs. 4, 5). Because the Yaeyama Islands are located between Taiwan Island and Okinawa Island, we could reasonably infer that *S. flexicaulis* evolved from a polycarpic perennial to a monocarpic perennial and then acquired periodicity (6-year cycle) and synchronicity (mass flowering). This hypothesis is quite different from the life history multiplication hypothesis proposed for the evolution of the elongation of life cycles in bamboos (Veller *et al.* 2015). The life history multiplication hypothesis is the evolution from an ancestral annual to prolonged life time by an integer multiple of the cycle resulted in the simultaneous fruiting of more seeds, increased survival from seed predators, and making evolution of long mass flowering cycles by repeated integer multiples of the cycle. Future research is needed to clarify whether the evolutionary mechanism differs among the plant groups.

This year, 2022, the mass flowering started again on Okinawa Island (Fig. 6). I plan to clarify why periodical mass flowering evolved only on Okinawa Island and what genes are involved in flowering in the sixth year of germination.

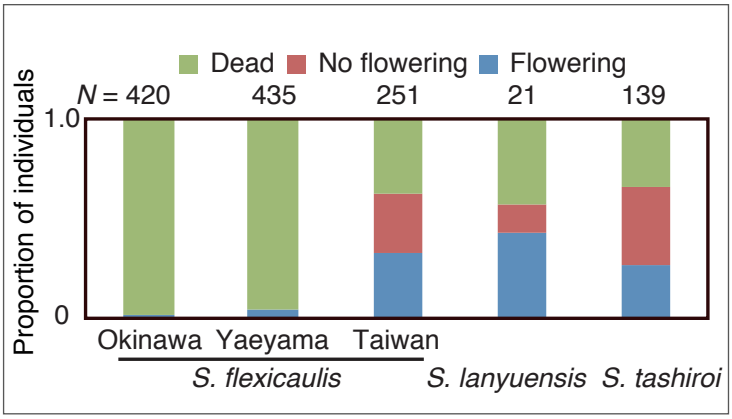

Fig. 4. The number of flowering individuals in the *S. flexicaulis* group

Consequences of the flowered individuals in the following year. Red, green, and blue show dead, survived with no flowers, and survived with flowers, respectively. The numbers above the bar indicate total sample sizes. Modified from Kakishima *et al.* (2019).

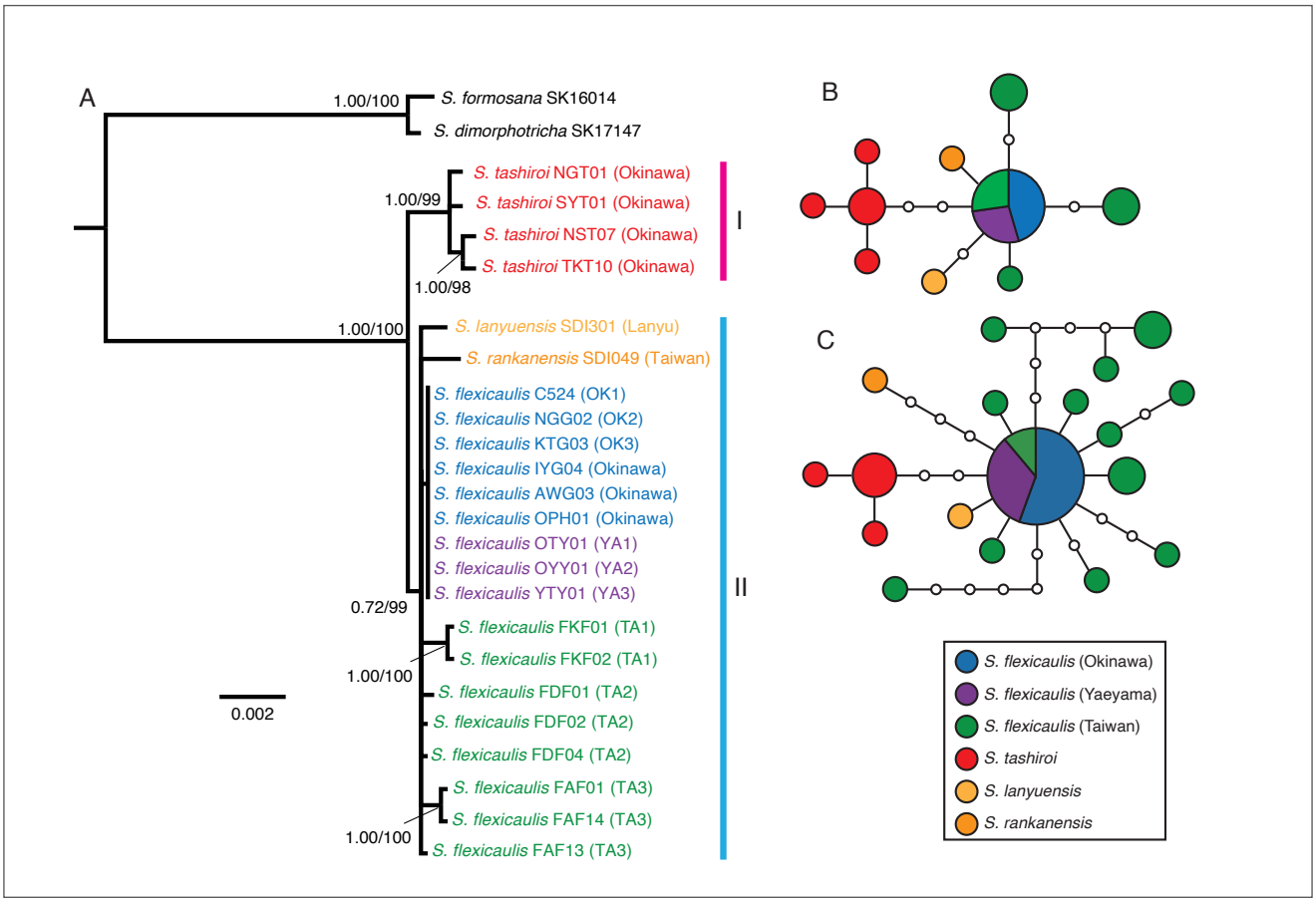

Fig. 5. Bayesian molecular phylogenetic tree and haplotype networks

(A) A Bayesian molecular phylogenetic tree is based on combined sequences (cpDNA and nDNA). Bayesian posterior probabilities and ML bootstrap proportions are shown in each clade. Parsimonious networks are based on (B) cpDNA and (C) nDNA sequences. Modified from Kakishima *et al.* (2019).

Fig. 6. Mass flowering of *S. flexicaulis* on Okinawa Island in 2022

S. flexicaulis was flowering together with planted Cherry trees (*Prunus campanulata*).

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from DIWPA Office

Due to the COVID-19 situation, we are unsure whether we will be able to hold DIWPA International Field Biology Course in 2022. The information will be placed on our website.

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