

Science and Technology Group Annual Report FY2022

Yoko Nomura
Science and Technology Associate

1 Introduction

I continued to engage in two independent research projects during FY2022, namely, engineering of catalytic RNAs (ribozymes, 2A) and investigations on natural fibers (e.g., Bashofu, as PI, 2B).

I explored an RNA ligase having a small catalytic core. Such small catalytic RNAs are intriguing because they could have emerged by chance during the earliest phase of chemical evolution. Moreover, a new RNA aptamer research I was involved in was published in a scientific journal (4 #1).

For the Bashofu (a typical Okinawan traditional textile) projects, in addition to the ongoing research to support the fine craft making tradition at the production area Kijoka, I started developing a more facile process to extract banana fibers for use in more casual clothing. Furthermore, I started a new project to develop a method for identification of genuine Ryukyuan textiles.

2 Activities and Findings

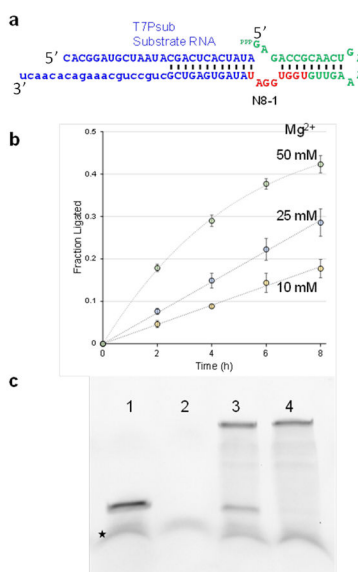
A. Engineering catalytic RNA (project with Yokobayashi Unit)

We explored a simple and small ribozyme motif capable of ligating two RNA fragments in a template-directed fashion (ligase ribozymes, N8-1). One-round selection of small ligase ribozymes from N7/8 library (right figure a, red part) followed by deep sequencing revealed a ligase ribozyme motif comprising a three-nucleotide loop (GGA) opposite to the ligation junction. The observed ligation was magnesium (II) dependent ($k_{\text{obs}} = 0.10 \text{ h}^{-1}$ at 50 mM), and it appears to form a 2'-5' phosphodiester linkage. These results had been submitted to *Scientific Reports* (4 #2), and I started experiments for revision for this paper.

B. Natural fiber projects (KAKENHI projects)

1. Bashofu for ordinary people (Kiban C 19K02308)

Premium Bashofu has been produced as a fine craft of Okinawa by artisan's high skills and their intuitions. However, Bashofu had been also used as ordinary people's clothing without artisan's high skills. Last year, we published the paper about facile extraction of Bashofu fiber from material plant *Itobasho* banana (Kakihara, F. et al., Facile Extraction of Bashofu Fibers, *Journal of Home Economics of Japan*, 2021, 72(12), 818-828). This year, we extracted fibers from *Itobasho* plants that are too old for fine crafts/kimonos and are abandoned. Compared to the twisted fibers extracted from young plants, the morphology of fibers from old plants was non-twisted and closer to



Characterization of N8-1 catalysis.

(a) Predicted secondary structure of N8-1 in the presence of T7Psub by NUPACK. (b) Ligation kinetics of N8-1 with T7Psub in the presence of 10, 25, and 50 mM MgCl₂ at 42°C

(c) Digestion of the N8-1 ligation product by Dz8-17-N8.1 for analysis of the ligation regioselectivity. Lane 1: FAM-T7Psub as a size marker. Lane 2: N8.1 RNA (unlabeled, not visible). Lane 3: FAM-T7Psub-N8.1 ligation product (3'-5' phosphodiester linkage) produced by T4 RNA ligase, digested by Dz8-17-N8.1. Lane 4: FAM-T7Psub-N8.1 ligation product catalyzed by N8.1, digested by Dz8-17-N8.1. Dz8-17-N8.1 selectively cuts 3'-5' phosphodiester linkage. The lower bands marked by a star are from the loading dye used.

Extracted fibers

A fiber from old *Itobasho* plant



A fiber from young *Itobasho* plant, twisted morphology

Science and Technology Group Annual Report FY2022

Yoko Nomura
Science and Technology Associate

the fibers of the craft making extracted by the artisan's way. However, thickness of our fibers (> 90 µm) is too big to use for clothing, and some modification will be required in the future for practical use. Our presentation about these results was accepted at ICCT 2022 (4 #3).

Furthermore, we extracted and characterized fibers from *Shima-banana* (local, edible fruit banana plant). We are going to report the results at the 75th Annual Meeting of the Japan Society of Home Economics (May 2023).

As a different research direction, a historian was interested in our research. We discussed and presented our scientific research of Bashofu connecting to the thoughts of the founder of the folk craft movement Soetsu Yanagi (4 #4).

2. Support for production of traditional craft making (Kiban C 20K02354)

Furthermore, we proceeded with a new extraction method using biotechnology technique for support of the traditional craft making. To file a patent application, we were engaged in on-site experiments at the Bashofu Textile Studio at Kijoka.

3. Development of an accurate and noninvasive identification method for Ryukyuan textiles (new research, Exploratory Research 22K18489)

Sometimes textiles cannot be identified as Okinawa genuine one from the microscopic images of fibers/yarns/textiles. We started a new project of identification of Ryukyuan (old Okinawa) textiles because of artisan's strong demand. In this project I take a charge of accurate identification of textiles. Many Ryukyuan textiles are made from local plants (*Itobasho* or ramie). We expected SSR (simple sequence repeat) characterization of extracted plant DNA from fibers of the textiles would allow to identify Ryukyuan textiles among similar other textiles.

3 Collaborations

Scientific Imaging Section Dr. K. Koizumi, Bashofu Textile Studio (Kijoka), Japan Women's University Prof. R. Mori (historian) and Ms. F. Kakihara

4 Publications and other output

Peer reviewed publications:

1. Fukunaga K., Dhamodharan V., Miyahira N., Nomura Y., Mustafina K., Oosumi Y., Takayama K., Kanai A., Yokobayashi Y. A Small Molecule Aptamer for Regulating RNA Functions in Mammalian Cells and Animals. *Journal of the American Chemical Society*, published.
2. Nomura Y. and Yokobayashi Y. RNA Ligase Ribozymes with a Small Catalytic Core, Submitted to *Scientific Reports*.

Peer reviewed presentation

3. Nomura Y., Kakihara F., and Koizumi K. Utilization of Bashofu Fibers from Neglected Materials in the Traditional Craft Making, KSCT-JRATEU Joint Symposium in 2022 International Conference of Clothing and Textiles Seoul, hybrid. 2022/5/26. **Best poster award.**
4. Mori R., Kakihara F., Nomura Y. For Whom was *Bashofu* Woven? Ryukyuan Banana Fiber Textiles and Social Class, International Conferences on Design History and Studies ICDHS13. Bogota, hybrid. 2022/10/20.

Fundings

KAKENHI Kiban C 19K02308 (PI, 4,420,000 yen, over 4 years, FY 2019-2022)

KAKENHI Kiban C 20K02354 (co-PI, 2,860,000 yen, over 4 years, FY 2020-2023)

KAKENHI Exploratory Research 22K18489 (PI, 4,900,000 yen, FY2022-2023)