Spotlight on Research

2024-25 Hokkaido University

SMART SENSOR PATCH
detects health symptoms through edge computing

Long-distance relationship revealed in the seemingly random behavior of
BOWHEAD WHALES

A holy grail found for
CATALYTIC ALKANE ACTIVATION

Scientists discover a
SINGLE-ELECTRON BOND
in a carbon-based compound

Syrian hamsters reveal genetic secret to
HIBERNATION

Probing the effects of interplanetary space on
ASTEROID RYUGU

HOKKAIDO UNIVERSITY

CONTENTS

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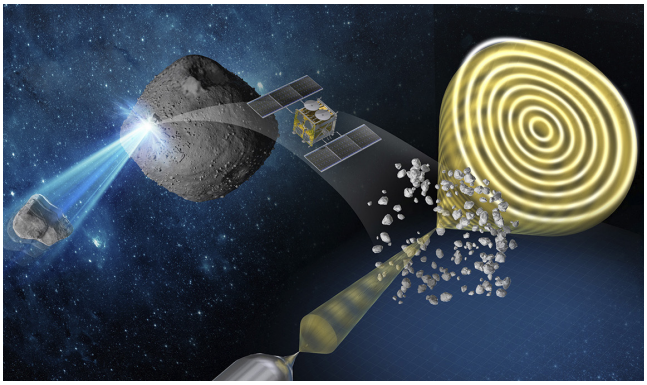
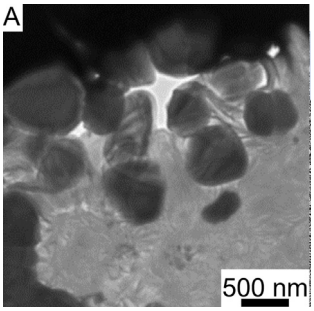
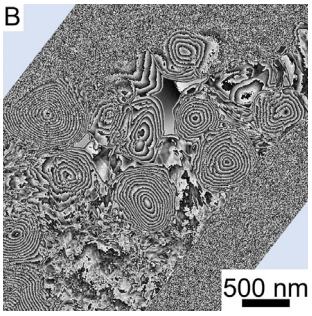
Probing the effects of interplanetary space on asteroid Ryugu

Samples reveal evidence of changes experienced by the surface of asteroid Ryugu, some probably due to micrometeoroid bombardment.



ABOVE
Artistic depiction of the collection and analysis of samples from asteroid Ryugu. Illustration: Yuki Kimura





RIGHT
Magnetite (round particles) particles cut from a Ryugu sample. (A) Bright field transmission electron microscopy image. (B) Magnetic flux distribution image obtained by electron holography. The concentric circular stripes seen inside the particles correspond to magnetic lines of force. They are called vortex magnetic domain structures and are more stable than ordinary hard disks, which can record magnetic fields for more than 4.6 billion years. (Yuki Kimura, et al. *Nature Communications*. April 29, 2024)

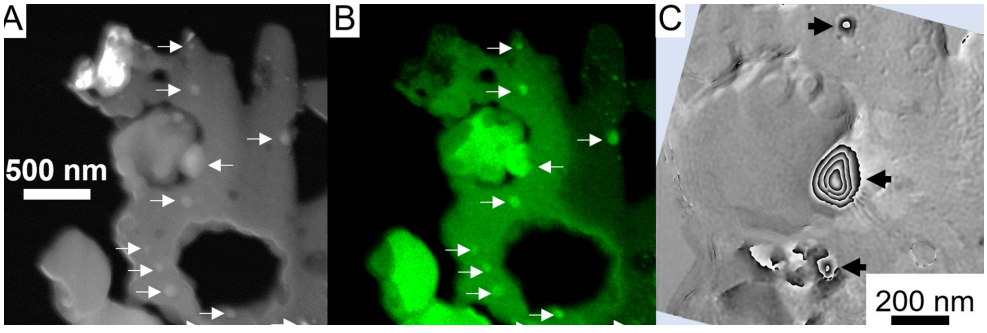
Analyzing samples retrieved from the asteroid Ryugu by the Japanese Space Agency's *Hayabusa2* spacecraft has revealed new insights into the magnetic and physical bombardment environment of interplanetary space. The results of the study, carried out by Professor Yuki Kimura at Hokkaido University and co-workers at 13 other institutions in Japan, were published in the journal *Nature Communications*.

The investigations used electron waves penetrating the samples to reveal details of their structure and magnetic and electric properties, a technique called electron holography.

One advantage of collecting samples directly from an asteroid is that it allows researchers to examine long-term effects of its exposure to the environment of space. The 'solar wind' of high energy particles from the sun and bombardment by micrometeoroids cause changes known as space-weathering. It is impossible to study these changes precisely using most of the meteorite samples that land naturally on Earth, partly due to their origin from the internal parts of an asteroid, and also due to the effects of their fiery descent through the atmosphere.

One particularly interesting finding was that small mineral grains called framboids, composed of magnetite, a form of iron oxide, had completely lost their normal magnetic properties. The researchers suggest this was due to collision with high velocity micrometeoroids between 2 and 20 micrometers in diameter. The framboids were surrounded by thousands of metallic iron nanoparticles. Future studies of these nanoparticles will hopefully reveal insights into the magnetic field that the asteroid has experienced over long periods of time.

"Although our study is primarily for fundamental scientific interest and understanding, it could also help estimate the degree of degradation likely to be caused by space dust impacting robotic or manned spacecraft at high velocity," Kimura concludes. ●



Iron nanoparticles distributed around pseudo-magnetite. (A) Dark-field image taken with a scanning transmission electron microscope. (B) Corresponding iron distribution image. White arrows indicate iron nanoparticles. (C) Magnetic flux distribution image of the central region of A and B. No magnetic field lines can be seen in the pseudo-magnetite, whereas concentric vortex-like magnetic domain structures can be seen inside the iron particles as shown by black arrows. (Yuki Kimura, et al. *Nature Communications*. April 29, 2024)

ORIGINAL ARTICLE
Yuki Kimura, et al. Nonmagnetic framboid and associated iron nanoparticles with a space-weathered feature from asteroid Ryugu. *Nature Communications*. April 29, 2024.

FUNDING
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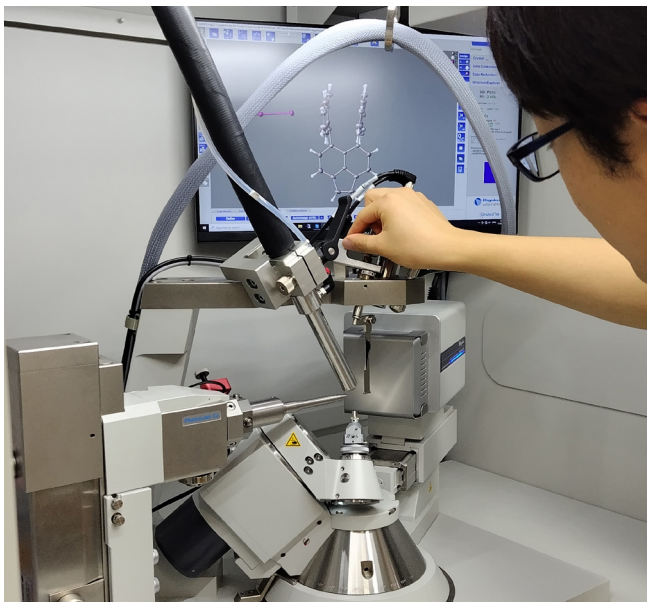
Scientists discover a single-electron bond in a carbon-based compound

The discovery of a stable single-electron covalent bond between two carbon atoms validates a century-old theory.



Using an X-ray diffractor to study the sigma bond. Photo: Yusuke Ishigaki

Covalent bonds, in which two atoms are bound together by sharing a pair of electrons, form the scaffolding that underpins the majority of organic compounds. Single-electron bonds were hypothesized to be much weaker than a standard covalent bond involving a pair of electrons. Such bonds have been observed, but never in carbon or hydrogen.

Now, a team of researchers from Hokkaido University has isolated a compound in which a single electron is shared between two carbon atoms in a remarkably stable covalent bond, known as a sigma bond. Their findings are published in the journal *Nature*.

"Elucidating the nature of single-electron sigma-bonds between two carbon atoms is essential to gain a deeper understanding of chemical-bonding theories and would provide further insights into chemical reactions," explains Professor Yusuke Ishigaki, of the Department of Chemistry at Hokkaido University, who co-authored the study.

The single-electron bond was formed by subjecting a derivative of hexaphenylethane, which contains an extremely stretched out paired-electron covalent bond between two carbon atoms, to an oxidation reaction in the presence of iodine. The reaction produced dark violet-colored crystals of an iodine salt.

The team used X-ray diffraction analysis to study the crystals and found that the carbon atoms in them were extremely close together, suggesting the presence of single-electron covalent bonds between carbon atoms. They were then able to confirm this using a form of chemical analysis called Raman spectroscopy.

"These results thus constitute the first piece of experimental evidence for a carbon-carbon single-electron covalent bond, which can be expected to pave the way for further developments of the chemistry of this scarcely-explored type of bonding," says Takuya Shimajiri, the lead author of the paper and now at the University of Tokyo. ●

> "Elucidating the nature of single-electron sigma-bonds ... would provide further insights into chemical reactions."

ORIGINAL ARTICLE
Takuya Shimajiri, et al. Direct evidence for a carbon–carbon one-electron σ-bond. *Nature*. September 25, 2024.

FUNDING
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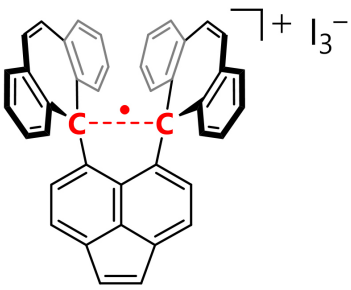
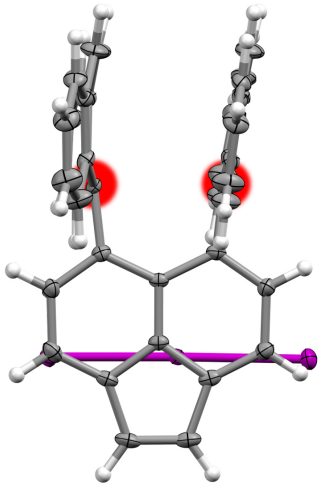
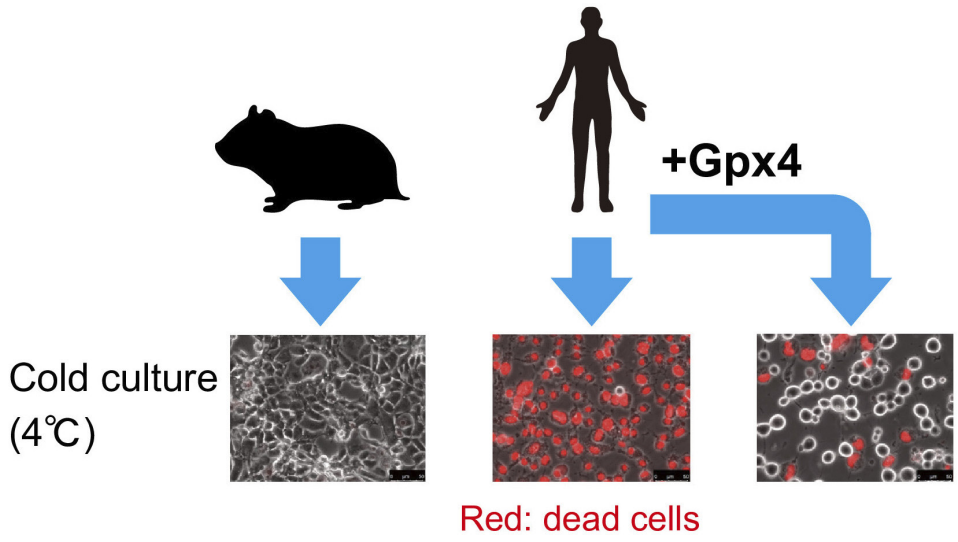
(from left) Yusuke Ishigaki, Soki Kawaguchi, Takuya Shimajiri, and Takanori Suzuki of the research team. Photo provided by Yusuke Ishigaki



single-electron bond between carbon atoms



Structure of the compound highlighting the C–C sigma bond (red). (Takuya Shimajiri, et al. *Nature*. September 25, 2024)



LEFT Syrian hamster cell cultures survive in cold conditions at 4°C (left). Human cell cultures typically exhibit cell death in cold conditions (middle), but when Gpx4 is overexpressed by cells in the culture, cell death rate drops drastically (right). Photo provided by Masamitsu Sone

Syrian hamsters reveal genetic secret to hibernation

A gene that limits cellular damage could be the key to surviving prolonged cold exposure.

Researchers have identified a gene that enables mammalian cells to survive for long periods at extremely low temperature, which animals experience during hibernation.

Body temperatures below 10 degrees Celsius (°C) swiftly prove fatal for humans and many other mammals, because prolonged cold stress causes cells to accumulate damaging free radicals—in particular lipid peroxide radicals—resulting in cell death and organ failure. But a few mammalian species can survive cold stress by hibernating.

Now, a study led by Assistant Professor Masamitsu Sone and Professor Yoshifumi Yamaguchi of the Hokkaido University, Japan, has identified a key gene that helps hibernating Syrian hamsters (golden hamsters, *Mesocricetus auratus*) to avoid cold-induced cell death. The findings were published in the journal *Cell Death and Disease*.

The researchers first engineered cold-sensitive human cancer cells to carry genes from cold-resistant hamster cells, and then they exposed the human cells to the repetition of prolonged cold conditions and rewarming from the cold. By analyzing the genomes of the human cells that survived this cold exposure and rewarming stresses, the team could identify the hamster genes that had been incorporated into the human cells' genome and enabled them to survive the cold.

This analysis revealed a likely candidate: the gene coding for glutathione peroxidase 4 (Gpx4), one of a family of proteins already known to reduce the impact of reactive oxygen species in mammalian cells. When the activity of this gene was suppressed in hamster cells, the cells could only survive shorter periods of exposure to extreme cold—two days, instead of five—before they died due to the build-up of lipid peroxide.

Gpx4 is expressed in human and hamster cells, but only hamsters can hibernate, so the research team examined whether human Gpx4 and hamster Gpx4 behave differently. Interestingly, they found that even the human Gpx4 can provide cold protection when overexpressed in human cells.

"It's still an open question why non-hibernator cells are much more vulnerable to cold stress than hibernator cells even though the expression levels of Gpx4 protein are comparable," says Sone.

These findings are a first step towards finally understanding the mystery of how some mammals are able to safely hibernate through extreme cold. The discovery could have potential applications for human health, such as improving the long-term preservation of organs for transplantation using low temperatures, or in the use of hypothermia as a therapeutic tool. ●

LEFT A hibernating Syrian hamster Photo: Hibernation metabolism, physiology, and development group, Hokkaido University

ORIGINAL ARTICLE
Masamitsu Sone, et al. Identification of genes supporting cold resistance of mammalian cells: lessons from a hibernator. *Cell Death and Disease*. September 19, 2024.

FUNDING
MEXT/JSPS KAKENHI (20H05766, 23H28012, 23H04939, 23H04940, 22K19320, 24K10062); AMED (23gm6310019); Hokkaido University (19K002); Toray Science Foundation; Takeda Science Foundation; Inamori Research Institute for Science; Cell Science Foundation; Sekisui Chemical Innovations Inspired by Nature Research Support Program; Sumitomo Foundation for Basic Research Projects; Naito Foundation; Uehara Memorial Foundation; Mochida Memorial Foundation for Medical and Pharmaceutical Research; Terumo Life Science Foundation; Joint Research of ExCELLS (21-205 22EXC202); Akiyama Life Science Foundation.

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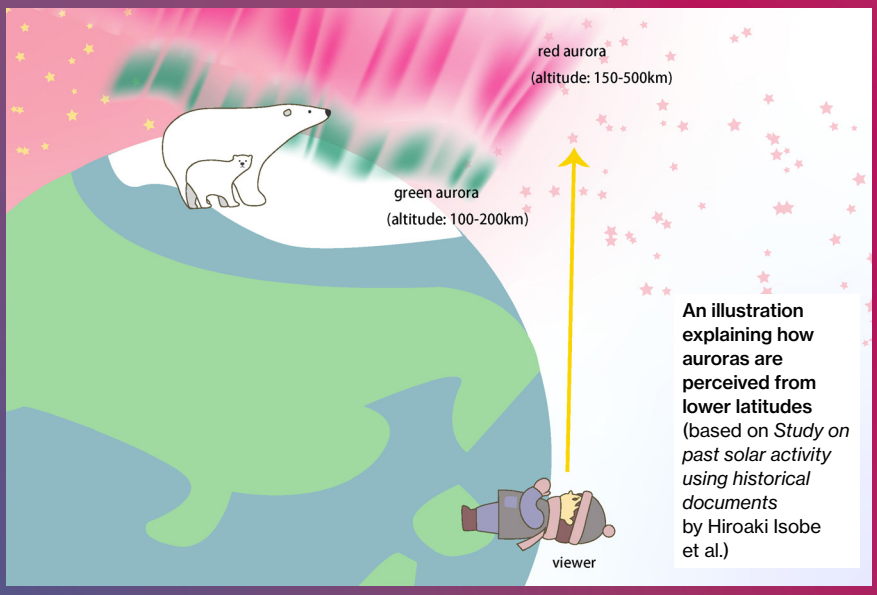
Masamitsu Sone (left) and Yoshifumi Yamaguchi (right), corresponding authors of the paper. Photo provided by Yoshifumi Yamaguchi

LOW-LATITUDE AURORA
captured by Hokkaido University Astronomy Club

A photo of a low-latitude aurora borealis
Photo by Tomohiro Nakayama, B4 School of Agriculture

Auroras float like a curtain in the sky at high-latitude places such as the North Pole and the South Pole. In December 2023, an aurora borealis was observed in Hokkaido, a lower-latitude region. Students of the Hokkaido University Astronomy Club managed to capture this "low-latitude aurora" in Shikaoi Town (central Hokkaido). The low-latitude aurora was characterized by a red glow in the sky, and it was the first time in about 20 years that it could be clearly observed with the naked eye. Auroras appear when the sun is active, and until the sun's activity reaches a peak around the year 2025, there will still be more chances to observe them in Hokkaido. Shigeto Watanabe, Professor Emeritus at Hokkaido University, also explained how low-latitude auroras are visible.

At around 6 PM on December 1, 2023, six members of the Hokkaido University Astronomy Club drove to Shikaoi Town, 180 kilometers east of Sapporo. They arrived at the observation site, where the temperature was 7 degrees below zero, at around 10 PM. The sky was of a dull reddish-purple color that looked like a sunset with a slightly different hue. Through the camera's viewfinder, they witnessed several vertical lines that looked like pillars. This was evidence of the red aurora borealis, dancing without a sound.



An illustration explaining how auroras are perceived from lower latitudes
(based on *Study on past solar activity using historical documents* by Hiroaki Isobe et al.)

Tomohiro Nakayama (B4, School of Agriculture) looked back on the day of the event and said, "Everyone was excited and enthusiastically captured the aurora with their cameras."

When he was a high school student in Okinawa Prefecture, he learned that the Northern Lights could be seen in Hokkaido, so he decided to enter Hokkaido University to witness the aurora in Japan. He joined the Astronomy Club and has previously attempted to observe the aurora borealis eight times, with no positive results. For his ninth aurora observation attempt, Nakayama conducted his own investigation to predict the location where an aurora borealis could be observed.

According to Nakayama, the best place to observe the aurora is in the northern area where there is an unobstructed view of the northern sky, and no city lights to the north. He had his sights set on Shakotan Peninsula and Nayoro City, both of which are dark on the north side, but after preliminary inspections, he decided on Shikaoi Town because it met all of the conditions.

In addition, since the appearance of the aurora borealis is related to increased solar activity, Nakayama regularly checked National Oceanic and Atmospheric Administration (NOAA)'s website and other publicly available information for the solar activity logs. Nakayama recalled, "Until the very last minute I was still worried about whether to follow my prediction; even if I did go, I wasn't sure if I would actually be able to witness the aurora. It felt like a gamble."

The low-latitude aurora observed in Shikaoi shone so brightly that the members of the club were able to capture it with their smartphones. Nakayama commented, "I think it was truly a miracle that we were able to see it this time thanks to the combination of good weather and various other favorable conditions. I was just so impressed. I would like to try photographing the northern lights again."

Professor Emeritus Shigeto Watanabe, an expert in space science, confirmed that the photographs taken by the Astronomy Club show many vertical lines and pillars, which are evidence of an aurora shining along the Earth's magnetic field lines. Watanabe explained how auroras are visible. "Auroras are a phenomenon in which nitrogen and oxygen in the Earth's air collide with high-energy particles called solar wind (plasma) from the sun." Auroras can be seen at altitudes higher than 100 km above the North and South Poles. When oxygen atoms collide with high-energy plasma, green glow occurs, and when they collide with low-energy plasma, red glow occurs. Red auroras are seen at higher altitudes than green auroras. The more active the sun is, the larger the aurora extends vertically. In other words, auroras visible from low latitudes such as Hokkaido are the upper red portion of a large aurora that occurs near the North Pole.

Auroras are generated by the solar wind, but because the Earth's circumference is protected by magnetic field lines, the amount of plasma that falls directly from the sun to the Earth is understood to be very little. On the other hand, a "plasma sheet" is formed on the far side of the Earth from the sun, from which high-energy plasma flows along the magnetic field lines to the north and south poles and shines as brightly as the aurora does, but exactly how this occurs is still a mystery.

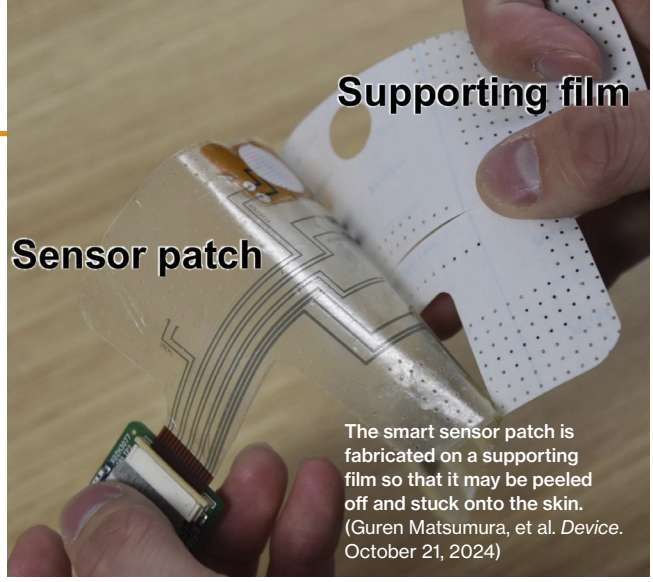
When an aurora is visible, it means that there is also a big shift in the magnetic field lines around the Earth, which can result in a major change in the temperature and density of the atmosphere, affecting the orbits of satellites. Watanabe explains, "Behind the beautiful aurora, there may be a major impact on communications with space, such as weather satellites and GPS, which is actually related to our daily lives. Aurora researchers are now studying space weather, including solar wind observations."

Members of the Astronomy Club observing the low-latitude aurora. Photo by Tomohiro Nakayama

Tomohiro Nakayama (middle) and his fellow members of the Astronomy Club. Photo by Yuka Saito

Smart sensor patch detects health symptoms through edge computing

Edge computing on a smartphone has been used to analyze data collected by a multimodal flexible wearable sensor patch and detect arrhythmia, coughs and falls.



The smart sensor patch is fabricated on a supporting film so that it may be peeled off and stuck onto the skin. (Guren Matsumura, et al. *Device*. October 21, 2024)

Wearable sensors are devices that can be worn on the body and measure the state of the body. They are part of the Internet of Things (IoT) and show great promise for monitoring health. These sensors generate large amounts of data, and that data must be processed to be understood. The field of computing dealing with processing these data on the sensor or a device that the sensor is connected to—rather than at a remote server on the cloud—is called edge computing. Edge computing is a key element in wearable sensor technology.

A research team from Japan, led by Professor Kuniharu Takei at Hokkaido University and Associate Professor Kohei Nakajima at The University of Tokyo, have fabricated a flexible multimodal wearable sensor patch and developed edge computing software that is capable of detecting arrhythmia, coughs and falls in volunteers. The sensor, which uses a smartphone as the edge computing device, was described in a paper published in the journal *Device*.

"Our goal in this study was to design a multimodal sensor patch that could process and interpret data using edge computing, and detect early stages of disease during daily life," explains Takei.

The team fabricated sensors that monitor cardiac activity via electrocardiogram (ECG), respiration, skin temperature, and humidity caused by perspiration. After confirming their suitability for long-term use, the sensors were integrated onto a flexible film (sensor patch) that adheres to human skin. The sensor patch also included a Bluetooth module to connect to a smartphone.

The team first tested the capability of the sensor patch to detect physiological changes in 3 volunteers, who wore it on their chests. The sensor patch was used to monitor vital signs in the volunteers under wet-bulb globe temperatures (used to determine likelihood of heat stress) of 22°C and over 29°C. "Although our test group was small, we could observe their vital signs change during time-series monitoring at high temperature. This observation may eventually lead to the identifying symptoms of early-stage heat stress," Takei explains.

The team developed a machine learning program to process the recorded data to detect other symptoms such as heart arrhythmia, coughing and falls. "In addition to performing the analysis on a computer," Nakajima elaborates, "we also designed an edge computing application for smartphones that could perform the same analysis. We achieved prediction accuracy of over 80%."

"The significant advance of this study is the integration of multimodal flexible sensors, real-time machine learning data analyses, and remote vital monitoring using a smartphone," Takei concludes. "One drawback of our system is that training could not be carried out on the smartphone, and had to be done on the computer; however, this can be solved by simplifying the data processing." This study advances the concept of a patched-based, edge-computing system for telemedicine or telediagnosis. ●

ORIGINAL ARTICLE
Guren Matsumura, et al. Real-time personal healthcare data analysis using edge computing for multimodal wearable sensors. *Device*. October 21, 2024.

FUNDING
JSPS KAKENHI (JP22H00594, JP24H00887); JST (JPMJCR21U1); Murata Science Foundation; Takeda Science Foundation; Hitachi Global Foundation.

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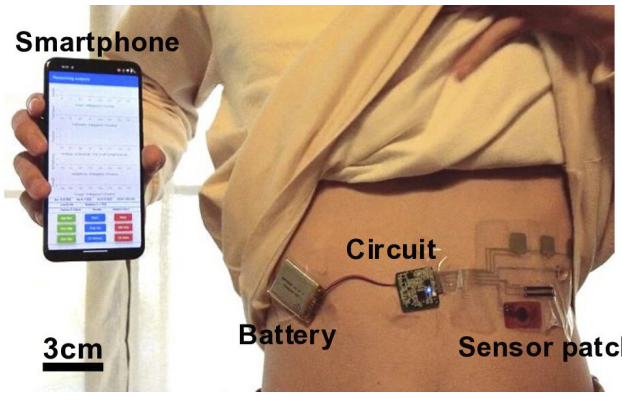


The sensor patch is connected to a processor (circuit) that includes a Bluetooth module and is powered by a battery. The Bluetooth module allows the sensor patch to be linked to a phone to record data. (Guren Matsumura, et al. *Device*. October 21, 2024)

ABOVE A demonstration of how the newly developed smart sensor patch is paired to a phone to detect changes in various parameters, as well as conditions such as arrhythmia, coughs and falls. (Guren Matsumura, et al. *Device*. October 21, 2024)

Long-distance relationship revealed in the seemingly random behavior of bowhead whales

Applying chaos theory to the movement of iconic arctic whales uncovered a 24-hour diving cycle and a long-range (~100 km) synchronization.

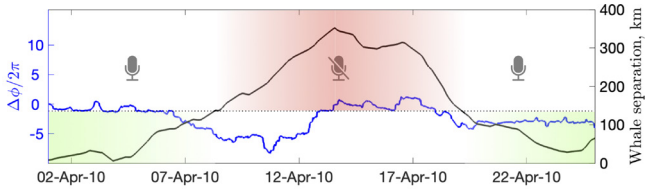
Bowhead whales are tagged in Disko Bay, West Greenland, to track their movements and diving behavior. Photo: Mads Peter Heide-Jørgensen

Bowhead whales are among the largest and longest-lived mammals in the world. They play a vital role in the marine ecosystems of the Arctic Ocean, yet relatively little is known about their foraging and diving behaviors. Now, in a paper published in the journal *Physical Review Research*, a team of scientists from Japan, Greenland, and Denmark have detected patterns in the whales' behavior that could offer clues into how they forage and socialize.

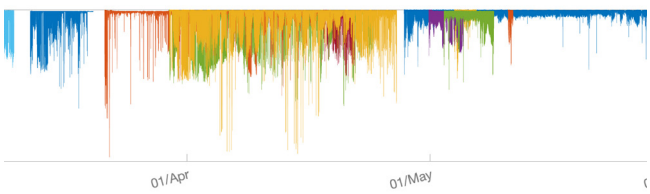
Associate Professor Evgeny A. Podolskiy at the Arctic Research Center, Hokkaido University, Professor Jonas Teilmann at the Department of Ecoscience, Aarhus University, and Professor Mads Peter Heide-Jørgensen at the Department of Birds and Mammals, Greenland Institute of Natural Resources, studied 144 days of diving records of 12 bowhead whales tagged in Disko Bay, West Greenland. The researchers used a dynamical systems chaos approach to uncover patterns within the apparently disorderly collective whale diving behavior.

Their analysis detected a 24-hour cycle of diving during the spring, with the whales swimming deepest in the afternoon to track the daily movement of their prey towards the surface, a phenomenon known as the diel vertical migration.

"We find that foraging whales dive deeper during the daytime in spring, with this diving behavior being in apparent synchrony with their vertically migrating prey," said Heide-Jørgensen. "Until now, this hasn't been shown for spring, and remained contradictory for autumn."



The main episodes of synchronization (quantified by phase difference) occur when the whales remain within the maximum acoustic communication range of ~130 km (black line; green/red shading indicates where the acoustic contact is likely/unlikely). (Evgeny A. Podolskiy, et al. *Physical Review Research*. August 15, 2024)



Depth records from the twelve tagged bowhead whales in Disko Bay, West Greenland (data are relative to the start of a year, irrespectively of year). (Evgeny A. Podolskiy, et al. *Physical Review Research*. August 15, 2024)

The research team also made the surprising discovery of two bowhead whales diving in synchrony over the course of a week at a time, even when they were around one hundred kilometers apart. The pair — one female and one of unknown sex — were sometimes as close as five kilometers and sometimes hundreds of kilometers apart, yet they would closely time their diving bouts for durations of up to a week, although to different depths. The synchronization was observed when they were within acoustic range of each other, which can exceed 100 kilometers, although the researchers didn't record the whales' sounds to determine whether they were interacting, as it remains a technically challenging task.

"Without direct observations, such as recordings of the two whales, it isn't possible to determine that the individuals were exchanging calls," said Teilmann, nevertheless, "the observed subsurface behavior might be the first evidence supporting the acoustic herd theory of long-range signaling in baleen whales proposed by Payne and Webb back in 1971."

"The possibility of acoustically connected whales, which seem to be diving alone but are actually together, is mind bending. Our study identifies a framework for studying the sociality and behavior of such chaotically moving, unrestrained marine animals, and we encourage the research community to collect more simultaneous tag data to confirm if our interpretation is appropriate," Podolskiy concluded. ●

ORIGINAL ARTICLE
Evgeny A. Podolskiy, Jonas Teilmann, Mads Peter Heide-Jørgensen. Synchronization of bowhead whales. *Physical Review Research*. August 15, 2024.

FUNDING
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(From left) Evgeny A. Podolskiy, Jonas Teilmann, Mads Peter Heide-Jørgensen. Photos: Evgeny A. Podolskiy, Jonas Teilmann, Mads Peter Heide-Jørgensen


Yuki Kimura


Harunori Nagata

MEXT


Miki Haseyama


Atsushi Fukuoka


Yu Harabuchi

Eight researchers from Hokkaido University were awarded the 2024 Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology (MEXT). These awards are awarded annually to honor individuals who have achieved outstanding results in research and development and the promotion of understanding in science and technology in Japan. The awardees are **Professor Yuki Kimura**, Institute of Low Temperature Science, for *in situ* experiments on crystal nucleation; **Professor Harunori Nagata**, Faculty of Engineering, for practical applications of hybrid rocket technology; **Professor Miki Haseyama**, Faculty of Information Science and Technology, for heterogeneous media fusion theory and its applications; **Specially Appointed Professor Atsushi Fukuoka**, Institute for Catalysis, for depolymerization of cellulosic biomass by heterogeneous solid catalysts; **Specially Appointed Associate Professor Yu Harabuchi**, Institute for Chemical Reaction Design and Discovery (WPI-ICReDD), for construction of quantum chemical calculation techniques to understand the optical functions of molecules; **Associate Professor Masatoshi Maeki**, Faculty of Engineering, for development of functionalized microdevices and their application in drug discovery; **Professor Keisuke Takahashi**, Faculty of Science, for creation of the field of catalytic informatics and the development of catalysts for methane oxidation; and, **Technical Specialist Norifumi Abo**, Central Institute of Isotope Science, for comprehensive contributions to promoting the use of Radio Isotopes (RI) and fostering safety awareness.

AWARDS & RECOGNITIONS
received by Researchers at Hokkaido University


Keisuke Takahashi


Masatoshi Maeki


Norifumi Abo


Jian Ping Gong

Royal Society of Chemistry


Michael Rubinstein

The NSF Center for Molecularly Optimized Networks team, of which **Professor Jian Ping Gong** of the Faculty of Advanced Life Science and the Institute for Chemical Reaction Design and Discovery (WPI-ICReDD) at Hokkaido University is a member, won a Horizon Prize from the Royal Society of Chemistry (RSC). The RSC's Prizes portfolio recognizes achievements by individuals, teams and organizations in advancing the chemical sciences. They reward those undertaking excellent work in the chemical sciences from across the world. The NSF Center for Molecularly Optimized Networks (MONET) team, including Professor Gong and **Professor Michael Rubinstein** of Hokkaido University's ICReDD, was awarded for demonstrating the potential and impact of embedded mechanochemical reactivity on the mechanical limits of cross-linked polymer networks. **Professor Stephen L. Craig**, director of MONET, is also affiliated with the Soft Matter Collaborative Research Unit (SMCR), Frontier Research Center for Advanced Material and Life Science, Hokkaido University.


Stephen L. Craig


Toshio Tsubota

Hokkaido Shimbun Press

Hokkaido Shimbun Press, the publisher of the *Hokkaido Shimbun* newspaper, presents the Hokkaido Shimbun Press Cultural Award to individuals and organizations that have made significant contributions to the development of Hokkaido. The awards are given annually in three fields: society, academia, and economy. In the 78th annual Hokkaido Shimbun Press Cultural Award, **Professor Toshio Tsubota**, Director of the Hokkaido University Museum and Professor at the Graduate School of Veterinary Medicine, was named as the recipient of the annual Hokkaido Shimbun Press Cultural Award in the Academic Field. The award recognizes his work on "brown bear reproduction, physiology and ecology," which are closely linked to the issue of human-bear coexistence – an especially pressing concern in Hokkaido.


Peter Jordan

Antiquity

A research paper titled *Disaster, survival and recovery: the resettlement of Tanegashima Island following the Kikai-Akahoya 'super-eruption', 7.3ka cal BP*' co-authored by Hokkaido University Global Station for Indigenous Studies and Cultural Diversity's Professor Peter Jordan has been awarded the prestigious Ben Cullen Prize 2024 for making an "outstanding contribution" to World Archaeology. The prize-winning paper was published in *Antiquity* and examines the social and environmental impacts and legacies of the largest volcanic eruption ever to impact global humanity in the last 30,000 years – the Kikai-Akahoya "super-eruption" which destroyed much of East Asia around 7,300 years ago.

Adobe stock ©Green Wind

Students rounded up start-ups in the Hokkaido Innovation Week

The final pitch competition night of The Northern Challenge held in Deep Tech Core, Sapporo, on January 30, 2024.

Endowed with rich local resources, Hokkaido has great potential to foster a healthy business ecosystem. With Hokkaido Innovation Week (HIW), Hokkaido University's students and staff members sought to unveil this regional potential through activities held from the last week of January to early February, 2024, bringing together budding and established entrepreneurs.

Hokkaido University's Institute for the Promotion of Business-Regional Collaboration was one of the organizing entities. Hokkaido University students also managed some student-led events.

HIW's Student Event Lead, Taiga Haguro (School of Engineering, B2), said that HIW desires to encourage Hokkaido's budding start-up culture, and their target is not limited to students. "In 2023, some representatives from Hokkaido University went to a start-up community gathering called Tech BBQ in Denmark. We thought that it would be great to have that kind of platform that is locally initiated, for the most part, but is open to anyone from anywhere."

One of HIW's core events is The Northern Challenge, planned and managed by a student organization – the majority of which are Hokkaido University students – called Hokkaido Unique Base (HUB). Supported by start-up and tech companies, HUB organized hackathons allowing the participants to refine their ideas and build prototypes.

Unlike most constituent events of HIW, the Hult Prize on Campus Competition at Hokkaido University (HP@HU) is a long-running, student start-up competition held every year. This year's competition, the ninth annual competition was special for being an integral component of the HIW.

Some other main and side-events of HIW managed by Hokkaido University members also garnered attention from interested parties. Hakodate Startup Days was held by Hokkaido University's Institute for the Promotion of Business-Regional Collaboration in Hakodate City. A Hokkaido University student business start-up team, Beeber Global, hosted two intercultural activities for networking on Sapporo campus: an art workshop and a gala dinner celebrating Indian Republic Day.

The OnCampus Finals of HP@HU 2024 held in EZOHUB, Sapporo, on January 27, 2024.

A Congolese researcher in full personal protective equipment (PPE) holding a "QuickNavi™-Ebola" kit. Photo provided by Ayato Takada

DRC approves "QuickNavi™-Ebola" kit for the detection of Ebola virus antigens

On June 21, 2024, the Ministry of Health of the Democratic Republic of the Congo (DR Congo) approved the use of the "QuickNavi™-Ebola" kit for the diagnostic detection of Ebola virus antigens in humans. The kit was jointly developed by Denka Company Limited (Denka) and the International Institute for Zoonosis Control (IIZC), Hokkaido University. This follows the approval for the kit granted by the Pharmaceuticals and Medical Devices Agency of Japan, on March 18, 2021.

Ebola virus disease (EVD) is a viral hemorrhagic fever with a mortality rate between 25% to 90%. There have been several outbreaks of EVD in sub-Saharan Africa; diagnosis is generally confirmed by detecting the virus genome in blood by PCR.

The kit can demonstrate diagnostic results in approximately 10 minutes, can be stored at room temperature, and requires no special equipment or devices. It is expected to be used in remote areas that are far from major cities and without adequate medical facilities. Formal approval for the use of this kit in the Democratic Republic of the Congo is expected to lead to the prevention of the spread of infection by enabling early diagnosis of future cases of EVD. Denka collaborated with Professor Ayato Takada at the IIZC to develop this rapid test for EVD.

The Central Lawn of Hokkaido University's Sapporo Campus

An aerial photo of Uryu Experimental Forest
Provided by Forest Research Station, FSC, Hokkaido University

Hokkaido University sites registered in an international biodiversity conservation database

Two Hokkaido University sites: the Uryu Experimental Forest and Sapporo Campus, are two of the "Nationally Certified Sustainability Managed Natural Sites" (a designation for an area where biodiversity is being conserved through efforts by the private and other sectors) designated by the Ministry of Environment of Japan.

As of August 2024, 48,000 hectares of the "Nationally Certified Sustainability Managed Natural Sites" – including the aforementioned two Hokkaido University sites – have been registered in an international biodiversity conservation database "Other Effective area-based Conservation Measures," or WD-OECM. This is part of international efforts to conserve 30% of the ocean and land areas as healthy ecosystems by 2030, called "30 by 30."

Located in Horokanai Town in northern Hokkaido, the Uryu Experimental Forest is the oldest experimental forest owned by Hokkaido University. Covering the registered area of 24,953 hectares, the forest's vegetation is characterized by a mixture of coniferous and broadleaf forests.

The primary academic and administrative site of the University, the Sapporo Campus covers the registered area of 126 hectares, situated in the heart of Sapporo City. The campus ground is also a place of recreation and relaxation for many people, including citizens, due to its rich natural environment of green spaces, forests, creeks, and farms.

Wine Tasting at the Center of Education and Research for Hokkaido Wines

The Center of Education and Research for Hokkaido Wines was established in April 2022 to conduct education and research for the sustainable development of Hokkaido's wine industry. In September 2023, the Former School of Entomology, a historical building on the Sapporo Campus, was restored and renovated to house the Center.

From September 6, 2024, the Center opened its gallery area to the public where visitors can try tasting a dozen brands of Hokkaido wines. The tastings are intended to convey the appeal of Hokkaido wines to the general public and also serve as part of research into the relationship between the chemical composition of wines and their palatability.

The selection includes a rarely available wine produced from grapes grown at Hokkaido University's Yoichi Orchard; the selection changes regularly. The details for the wine tastings can be found at the link in the QR code (above).

LEFT: The Center of Education and Research for Hokkaido Wines Building. RIGHT: The wine tasting stand in the gallery area. Wine is served by coin-operated dispensers (black cabinets).

The Fisheries Science Library and Museum Complex inaugurated

Photo by Miho Nagao

Ceremony attendees looking at the ship model with interest

The newly built "Fisheries Science Library and Museum Complex" on the Hakodate campus, opened on October 1, 2024, is a new educational facility that serves as an advanced archives in addition to its functions as a museum and a library. The inauguration ceremony was held on September 29, 2024.

The Fisheries Science Library and Museum Complex is a three-story building. The first thing that catches visitors' eyes is the display of the life-sized skeleton of a Bryde's whale in the outdoor space next to the entrance.

The first floor of the Complex has a multipurpose hall that accommodates various events, as well as a wet lab equipped with a microfocus X-ray machine to inspect minuscule objects.

The second floor houses the library, with reading rooms and stacks. The library can accommodate up to 140,000 books.

The third floor is the Fisheries Science Center, a branch of The Hokkaido University Museum. At this museum, the storage room is an open area for visitors with a "storage exhibition" format.

THE PRESIDENT'S ADVENTURES IN KNOWLEDGE-LAND

The President's Adventures in Knowledge-Land is an ongoing series in which Hokkaido University president Kiyohiro Houkin, who is a neurosurgeon, visits fascinating researchers at Hokkaido University.

VOL. 1
"FIVE VALUES OF DINOSAUR RESEARCH"

President Houkin talked with Professor Yoshitsugu Kobayashi aka "Dinosaur Kobayashi." Affiliated with the Hokkaido University Museum, Professor Kobayashi spearheaded the excavation and research of a new dinosaur species, *Kamuysaurus japonicus*, discovered in Mukawa Town, Hokkaido, Japan. They discussed Hokkaido University's research environment, where field research is one of the strengths, as well as future prospects for Hokkaido University Museum.

VOL. 2
"ENDLESS RESEARCH ON THE ENDLESS SPACE"

President Houkin visited Professor Hisayoshi Yurimoto of the Graduate School of Science. Professor Yurimoto led an international team of more than a hundred researchers in analyzing samples from the asteroids Itokawa and Ryugu, brought back by the asteroid-exploring spacecraft *Hayabusa* and *Hayabusa2*, respectively. They discussed the fascination of research into the origin of the solar system and the research environment at Hokkaido University.

VOL. 3
"FROM TOXICOLOGY TO ONE HEALTH APPROACH"

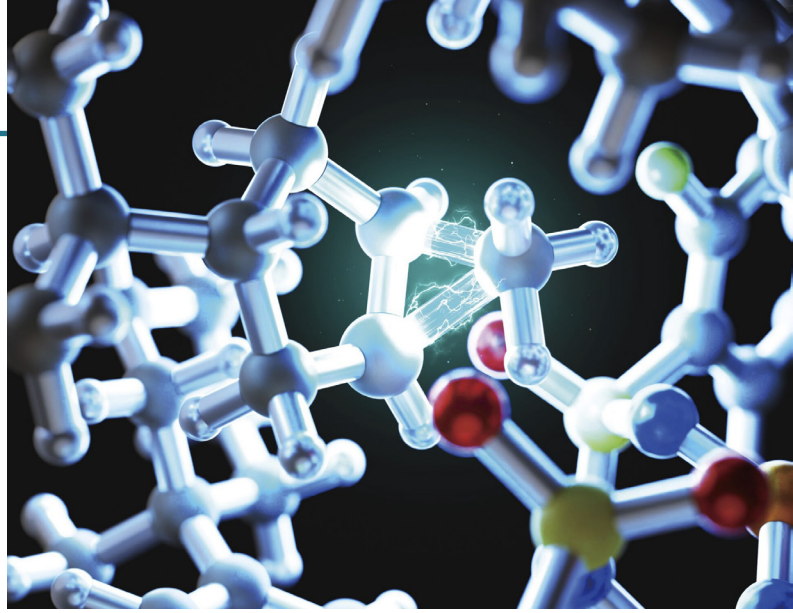
President Houkin had a discussion with Professor Mayumi Ishizuka of the Graduate School of Veterinary Medicine. Professor Ishizuka's toxicology research on environmental pollution in Zambia led to the launching of the interdisciplinary "One Health" initiative at the University. They discussed her research history, the research environment at the University, as well as future prospects.

VOL. 4
"ACOUSTICS REVEALS SECRETS OF GLACIERS AND MAMMALS IN GREENLAND"

President Houkin spoke to Associate Professor Evgeny Podolskiy of the Arctic Research Center. Associate Professor Podolskiy is conducting diverse lines of Arctic research in Greenland. They talked about his contributions to cryosphere research, discussing how acoustics helps unveil the secrets of glaciers and the behavior of narwhals.

A holy grail found for catalytic alkane activation

An organic catalyst offers chemists precise control over a vital step in activating hydrocarbons.



An artist's rendition of the new catalytic method for asymmetric fragmentation of cyclopropanes. Credit: YAP Co., Ltd.

Researchers at Hokkaido University in Japan have made a significant breakthrough in organic chemistry by developing a novel method to activate alkanes, which are compounds that play a crucial role in the chemical industry. The new technique, published in *Science*, makes it easier to convert these building blocks into valuable compounds, offering advances in the production of medicines and cutting-edge materials.

Many of the existing techniques for breaking down long-chain alkanes, known as cracking, tend to generate a mixture of molecules, making it challenging to isolate the desired products. This challenge arises from the cationic intermediate, a carbonium ion, which has a carbon atom bonded to five groups instead of the three typically described for a carbocation in chemistry textbooks. This makes it extremely reactive and difficult to control its selectivity.

The research team discovered that a particular class of confined chiral Brønsted acids, called imidodiphosphorimidate (IDPi), could address this problem. IDPi's are very strong acids that can donate protons to activate cyclopropanes and facilitate their selective fragmentation within their microenvironments. The ability to donate protons within such a confined active site allows for greater control over the reaction mechanism, improving efficiency and selectivity in producing valuable products.

"By utilizing a specific class of these acids, we established a controlled environment that allows cyclopropanes to break apart into alkenes while ensuring precise arrangements of atoms in the resulting molecules," says Professor Benjamin List, who led the study together with Associate Professor Nobuya Tsuji of the Institute for Chemical Reaction Design and Discovery at Hokkaido University, and is affiliated with both the Max-Planck-Institut für Kohlenforschung and Hokkaido University. "This precision, known as stereoselectivity, is crucial for example in scents and pharmaceuticals, where the specific form of a molecule can significantly influence its function."

The success of this method stems from the catalyst's ability to stabilize unique transient structures formed during the reaction, guiding the process toward the desired products while minimizing unwanted byproducts. To optimize their approach, the researchers systematically refined the structure of their catalyst, which improved the results.

"The modifications we made to certain parts of the catalyst enabled us to produce higher amounts of the desired products and specific forms of the molecule," explains Associate Professor Nobuya Tsuji, the other corresponding author of this study. "By using advanced computational simulations, we were able to visualize how the acid interacts with the cyclopropane, effectively steering the reaction toward the desired outcome.

The researchers also tested their method on a variety of compounds, demonstrating its effectiveness in converting not only a specific type of cyclopropanes but also more complex molecules into valuable products.

This innovative approach enhances the efficiency of chemical reactions as well as opens new avenues for creating valuable chemicals from common hydrocarbon sources. The ability to precisely control the arrangement of atoms in the final products could lead to the development of targeted chemicals for diverse applications, ranging from pharmaceuticals to advanced materials. ●

ORIGINAL ARTICLE
Ravindra Krushnaji Raut, et al. Catalytic asymmetric fragmentation of cyclopropanes. *Science*. October 10, 2024.

FUNDING
MEXT; Hokkaido University; JSPS KAKENHI (21H01925, 22K14672); JST SPRING (JPMJSP2119); MPG; DFG (EXC 2033-390677874-RESOLV); ERC (694228; 101055472; FCI.

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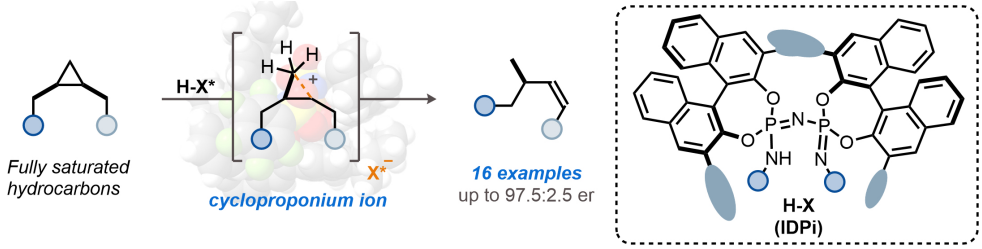

Confined chiral Brønsted acids, IDPi, are used to efficiently convert cyclopropanes into valuable compounds by donating protons during the reaction. (Ravindra Krushnaji Raut, et al. *Science*. October 10, 2024)

Climate change may lead to shifts in vital Pacific Arctic fisheries

Commercially important marine fish and invertebrate species will likely shift northwards under a warmer climate.

ORIGINAL ARTICLE
Irene D. Alabia, et al. Future redistribution of fishery resources suggests biological and economic trade-offs according to the severity of the emission scenario. *PLOS ONE*. June 6, 2024.

FUNDING
MEXT ArCS II (JPMXD1420318865)

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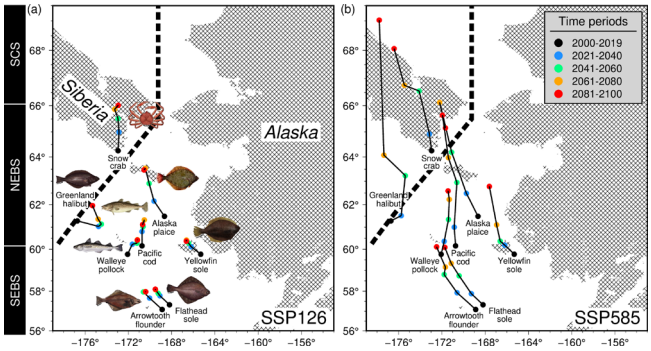
Marine fisheries are an essential source of protein for a large part of the world's population, as well as supporting around 390 million livelihoods and an industry worth approximately US$ 141 billion, according to the UN FAO. Yet, climate change presents a major threat to the world's fisheries, particularly in the Pacific Arctic. The eastern Bering Sea and Chukchi Sea—which contain eight of the most productive fisheries in the world—are already experiencing significant climatic shifts that have contributed to the surprise collapse of two important species, snow crab and Pacific cod.

To better understand the potential impact of climate change on fisheries in the region, a research team from Hokkaido University, The University of Tokyo, and the National Institute of Polar Research used bioeconomic modeling to study how the abundance and distribution of eight commercially important marine fish and invertebrate species might change under a range of climate scenarios from 2021-2100. The study was published in the journal *PLOS ONE*.

The researchers' model includes biological parameters, such as population growth rate and fishing mortality rate, and economic parameters, such as the costs and income associated with each species' fishery. The team modeled four climate-based socioeconomic pathway scenarios: sustainable development, middle of the road, regional rivalry and fossil-fuelled development.



Trajectories of the abundance-weighted center of gravity (COG) for eight commercial species from modeled abundance from the present (2000-2019) to future periods (2021-2100) under the (a) SSP126 and (b) SSP585 climate scenarios. Overlain on the maps are the land masses (hachures) for reference and the US-Russia exclusive economic zone (EEZ) boundary (dashed line). Species photo credits https://www.fisheries.noaa.gov/species/. (Irene D. Alabia, et al. *PLOS ONE*. June 06, 2024)

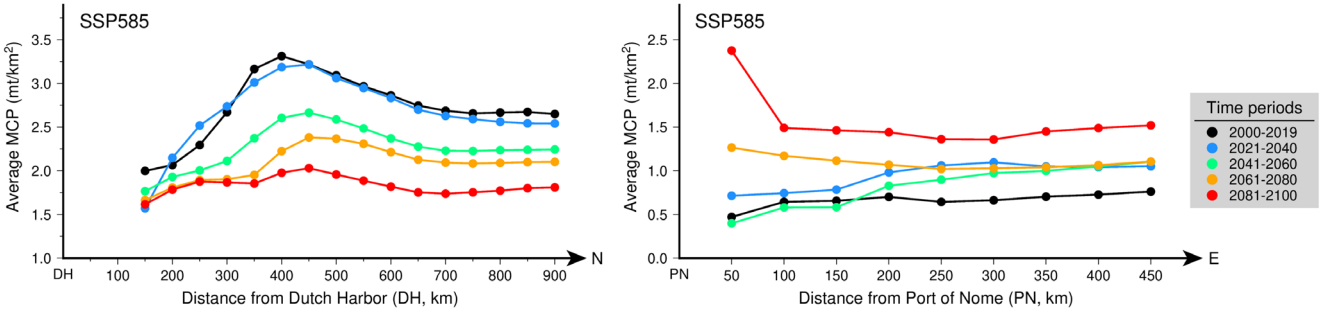
The analysis suggested that under low to moderate levels of climate change, well-managed marine ecosystems may experience only limited economic impacts between now and 2040. However, more extreme warming, including the loss of sea ice, would have more severe impacts.

All the climate scenarios pointed to a shift northward for all of the species studied due to the loss of sea ice habitat and warmer water temperatures in the eastern Bering Sea. The most significant shift in abundance was predicted for Greenland halibut, with the fishery's center of gravity forecast to move by more than 80 kilometers per decade under the highest impact climate scenario. In contrast, the walleye pollock fishery was projected to shift around 30 kilometers per decade.

Even in the most extreme climate scenario, the news wasn't all bad. The abundance of Pacific cod was forecast to increase, but the high-value snow crab was forecast to decrease.

"The magnitude of abundance changes varied across species, identifying potential winners and losers under climate change and hinting at the potential restructuring of future marine communities in the Pacific Arctic region," Alabia said.

The researchers stressed the importance of climate-smart solutions to protect and preserve marine fisheries in order to support food security and ensure a sustainable fishery sector under climate change. ●



The averaged maximum catch potential (MCP) within the US Exclusive Economic Zone (EEZ) computed at each 100-km buffer zone from the Dutch Harbor (left) and Port of Nome (right) for the present (2000-2019) and future periods (2021-2100) under SSP585. (Irene D. Alabia, et al. *PLOS ONE*. June 06, 2024).

Regulatory gene influences shape recognition in medaka fish

Medaka fish that lacked functional Hmgn2 genes were unable to distinguish between simple shapes, revealing a new function for the regulatory gene.

A medaka fish from the study. Photo: Saori Yokoi

The medaka, also known as the Japanese rice fish (*Oryzias latipes*), is a model organism for the study of biology, as well as a popular aquarium fish. As a model organism, much research has been carried out to understand all aspects of the medaka, but much still remains to be done, especially in the area of genetics.

A research team led by Assistant Professor Saori Yokoi of the Faculty of Pharmaceutical Sciences, Hokkaido University, has discovered an evolutionarily distinct variant of the gene Hmgn2 in medaka, which influences shape preference in the species. Their findings were published in the journal *Communications Biology*.

"We identified this Hmgn2 variant, oHmgn2, as part of our research on identifying genes expressed in the medaka brain with unknown functions," Yokoi explains. "HMGN proteins play crucial roles in chromatin remodeling and gene expression regulation in other vertebrates."

oHgmn2 was selected as it was an unknown gene that was characteristically expressed in medaka brains. After confirming that the gene coded for an HMGN protein, sequencing oHmgn2 RNA showed that it was 99 base pairs shorter than Hmgn2 from other vertebrates. Evolutionary analysis confirmed that oHmgn2 was a unique variant.

"The most striking difference was the presence of oHmgn2 in the nucleolus, the region in the nucleus where transcription from DNA to RNA occurs," Yokoi elaborates. "oHmgn2 is predicted to have a weaker interaction with DNA-binding proteins called histones, compared to the typical interaction, explaining its distribution."

oHmgn2 expression is localized in the neurogenic regions of the brain, and the team found indications that it was involved in neural progenitor cell function. Knockout studies showed that the lack of functional oHmgn2 affected the development of the telencephalon—the region of the brain that corresponds to the cerebrum/frontal lobes in humans.

Most interestingly, wild type medaka exhibits a preference for triangles over circles, spending more time in that arm of the maze, while oHmgn2 knockout medaka spend an almost equal time in both arms of the maze—indicating deficits in their ability to recognize shapes.

"Our study has revealed that the oHmgn2 gene is a key player in the molecular evolution of brain development and cognitive behavior within the medaka," Yokoi concludes. "Future work will focus on understanding the mechanisms by which oHmgn2 affects shape recognition in medaka."

Shape preferences of wild type medaka (WT) vs. oHmgn knockout mutants (ohmgn2 mutant) in a Y maze with triangles in one arm (blue) and circles in the other (pink). Provided by Saori Yokoi

ORIGINAL ARTICLE
Shuntaro Inoue, Yume Masaki, Shinichi Nakagawa, Saori Yokoi. An evolutionarily distinct Hmgn2 variant influences shape recognition in Medaka Fish. *Communications Biology*. August 23, 2024.

FUNDING
NIBB (23NIBB336); JSPS KAKENHI (21H05708, 23K05841, 23H03839); Astellas Foundation for Research on Metabolic Disorders; Takeda Science Foundation; Naito Foundation.

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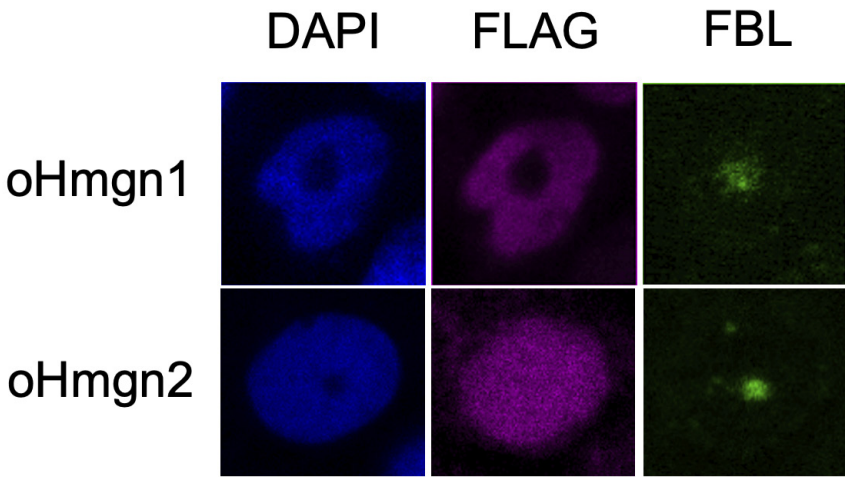


oHmgn2 shows different nuclear localization compared to related Hmgn proteins (FLAG, purple). oHmgn1 is associated with the nucleoplasm (DAPI, blue) of the nucleus, and is not associated with the nucleolus (FBL, green). However, oHmgn2 is dispersed throughout the nucleus. (Shuntaro Inoue, et al. *Communications Biology*. August 23, 2024)

Revolutionizing heat management with high-performance cerium oxide thermal switches

Groundbreaking cerium oxide-based thermal switches achieve remarkable performance.

Thermal switches, which electrically control heat transfer, are essential for the advancement of sophisticated thermal management systems. Historically, electrochemical thermal switches have been constrained by suboptimal performance, which impedes their extensive utilization in the electronics, energy, and waste heat recovery sectors.

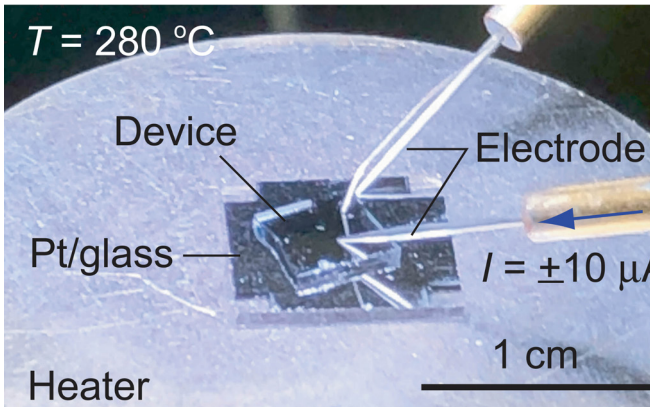
A research team led by Professor Hiromichi Ohta of the Research Institute for Electronic Science, Hokkaido University employed a novel approach of using cerium oxide (CeO_2) thin films as the active material in thermal switches, providing a highly efficient and sustainable alternative. Their findings have been published in *Science Advances*.

CeO_2-based thermal switch performance can exceed prior benchmarks. "The novel device features an on/off thermal conductivity ratio of 5.8 and a thermal conductivity (κ)-switching width of 10.3 W/m·K, establishing a new benchmark for electrochemical thermal switches," Ohta explains. "The thermal conductivity in its minimal state (off-state) is 2.2 W/m·K, but in the oxidized state (on-state), it significantly rises to 12.5 W/m·K. These performance metrics remain consistent after 100 cycles of reduction and oxidation, demonstrating remarkable durability and reliability for extended usage in practical applications."

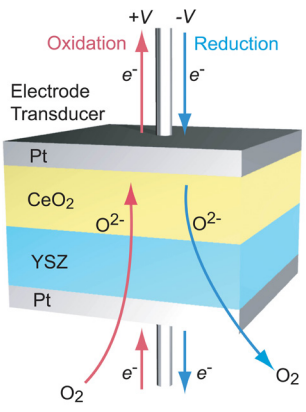
A notable benefit of this technology is the utilization of cerium oxide, a substance abundant in the earth, recognized for its economic viability and ecological sustainability. CeO_2 is sustainable and readily available, reducing expenses and the ecological footprint of thermal management solutions. This enhances the technology's efficiency, scalability, and applicability across diverse industrial sectors.

The development of CeO_2-based thermal switches represents a significant breakthrough in thermal management technology, offering broad applications across industries such as electronics cooling and renewable energy systems. These switches, utilized in thermal shutters and advanced displays, efficiently regulate infrared heat transfer, enhance waste heat recovery, and contribute to energy-efficient systems. ●

An artistic representation of a thermal switch. Illustration provided by Hiromichi Ohta



Photograph of a CeO_2-based thermal switch operating at 280 °C in air. (Ahrong Jeong, Mitsuki Yoshimura, et al. *Science Advances*. January 1, 2025)



Schematic device structure of a CeO_2-based solid-state electrochemical thermal switch. (Ahrong Jeong, Mitsuki Yoshimura, et al. *Science Advances*. January 1, 2025)

ORIGINAL ARTICLE
Ahrong Jeong, Mitsuki Yoshimura, et al. High-performance solid-state electrochemical thermal switches with earth-abundant cerium oxide. *Science Advances*. January 1, 2025. DOI: 10.1126/sciadv.ads6137

FUNDING
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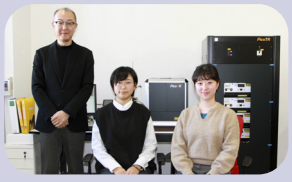


(From left) Hiromichi Ohta, Mitsuki Yoshimura and Ahrong Jeong of the research team. Photo: Hiromichi Ohta

Reconnecting Sapporo and Massachusetts Agricultural Colleges – UMass Amherst's Visit to HU

The history of Sapporo and Massachusetts Agricultural Colleges was intertwined. Dr. William Smith Clark, the first vice president of Sapporo Agricultural College (now Hokkaido University, HU) served as the third president of Massachusetts Agricultural College (now University of Massachusetts Amherst, UMA). Hired by the Japanese Government in the Meiji Period, Dr. Clark stayed in Sapporo for nine months to build the foundation of HU and left a significant impact there not only academically and scientifically but also philosophically.

Photo: Office for International Collaborations

On October 1-2, 2024, UMA dispatched a delegation to HU to deepen the strategic research partnership with UMA. The two universities have cherished their almost 150-year-old international bond. That includes academic staff mobility in recent years: joint appointments of faculties since 2015; exchange of early career researchers; and other initiatives.

The delegates followed the tracks of Sapporo Agricultural College: Sapporo Agricultural College Farm #2 Model Barn, Hokkaido University Museum, Hokkaido University Archives, where they could see the materials related to Dr. Clark and Dr. William Penn Brooks, who was a successor of Dr. Clark and dedicated twelve years to Hokkaido. At the end of visit, President Kiyohiro Houkin expressed his gratitude for the lasting partnership and suggested the UMA delegates' return to HU upon the 150th anniversary of HU in 2026.

Ambassador Extraordinary and Plenipotentiary of Ukraine to Japan delivered lecture at Hokkaido University

On October 22, 2024, the Ambassador of Ukraine to Japan, H.E. Dr. Sergiy Korsunsky, gave a lecture entitled "Cooperation for Future Eurasia: Dialogue between Ukraine and Japan" at the Slavic-Eurasian Research Center of Hokkaido University. About 60 faculty, staff, and students attended the lecture.

After an introduction of the Ambassador by Professor Akihiro Iwashita of the Slavic-Eurasian Research Center, the lecture was held in a dialogue format at the Ambassador's request, in which they spoke about the current situation in Ukraine, gratitude for the support from Japan, and relations with other countries and regions in the world, including the EU, the 'Global South', and East Asian countries. During the Q&A session, the Ambassador answered questions from participants on the possibility of a peace agreement similar to the Dayton Agreement and relations with Latin American countries.

The Ambassador also had a meeting with President Kiyohiro Houkin, and Executive Vice President Aya Takahashi, where they exchanged opinions on future cooperation between the two countries.

Photo: Office for International Collaborations

Nobel Laureate in Chemistry Dr. Benjamin List donates an official replica of Nobel Prize medal

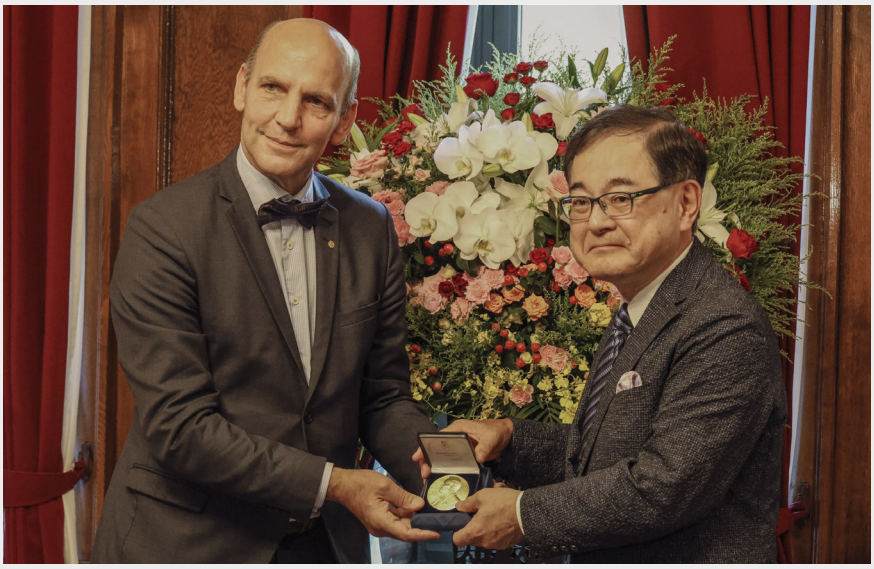
Specially Appointed Professor of WPI-ICReDD and Hokkaido University Professor Benjamin List (Director of the Max-Planck-Institut für Kohlenforschung) won the Nobel Prize in Chemistry in 2021. On August 28, 2024, Dr. List donated an official replica of the Nobel Prize medal to the Hokkaido University Museum. A donation ceremony was held where Dr. List handed the replica medal to President Kiyohiro Houkin.

Nobel laureates are allowed to receive up to three official replicas with permission from the Nobel Foundation, the first of which was donated to Hokkaido University. The design and size are identical to the original but the gold content is different. “As a scientist, I weighed the medals and compared them. The replica is 20 grams lighter than the real one,” said Dr. List in the ceremony which made everyone laugh.

Dr. List has been conducting research at Hokkaido University as a Principal Investigator since 2018, when WPI-ICReDD was established. “Hokkaido University, which approached me before I won the Nobel Prize, is my ‘second home’ in research. This donation is a token of my gratitude,” he said when asked about the reason behind this donation.

President Kiyohiro Houkin said, “I am honored to have received this extremely rare official replica of the medal. Dr. List’s achievements not only highlight the excitement of chemistry but also benefit the society. I hope that the children who see the exhibition will think, ‘I want to do this kind of work.’ I also hope that researchers at Hokkaido University will be motivated to become candidates for the next Nobel Prize.”

An official replica medal of Hokkaido University Professor and Professor Emeritus Akira Suzuki (2010 Nobel Prize laureate in chemistry) is on display at the Hokkaido University Museum. Dr. List’s medal will be placed next to it in the future.



Specially Appointed Professor Benjamin List (left) hands an official replica of the Nobel Prize medal to President Kiyohiro Houkin. Photo: Miho Nagao

A close-up of the Nobel Prize medal replica donated by Dr. List. Photo: Miho Nagao

LEFT Dr. List in the Nobel Prize exhibition corner in Hokkaido University Museum Photo: Miho Nagao

Toothed whale echolocation organs evolved from jaw muscles

Genetic analysis finds evidence suggesting that acoustic fat bodies in the heads of toothed whales were once the muscles and bone marrow of the jaw.

Pacific white-sided dolphin (*Lagenorhynchus obliquidens*) Photo by Kamata Kazumasa @ Adobe Stock

New research suggests that the collections of fatty tissue that enable toothed whales to echolocate may have evolved from their skull muscles and bone marrow.

Scientists at Hokkaido University determined DNA sequences of genes which were expressed in acoustic fat bodies—collections of fat around the head that toothed whales use for echolocation. They measured gene expression in the harbor porpoise (*Phocoena phocoena*) and Pacific white-sided dolphin (*Lagenorhynchus obliquidens*). Their findings were published in the journal *Gene*.

The evolution of acoustic fat bodies in the head—the melon in the whale forehead, extramandibular fat bodies (EMFB) alongside the jawbone, and intramandibular fat bodies (IMFB) within the jawbone—was essential for sound use such as echolocation. However, little is known about the genetic origins of those fatty tissues.

"Toothed whales have undergone significant degenerations and adaptations to their aquatic lifestyle," said Hayate Takeuchi, a PhD student at Hokkaido University's Hayakawa Lab and first author of the study. One adaptation was the partial loss of their sense of smell and taste, along with the gain of echolocation to enable them to navigate in the underwater environment.

The researchers found that genes which are normally associated with muscle function and development were active in the melon and EMFBs. There was also evidence of an evolutionary connection between the extramandibular fat and the masseter muscle, which in humans connects the lower jawbone to the cheekbones and is a key muscle involved in chewing.

"The evolutionary tradeoff of masticatory muscles for the EMFB—between auditory and feeding ecology—was crucial in the aquatic adaptation of toothed whales," said Assistant Professor Takashi Hayakawa of the Faculty of Environmental Earth Science, who led the study. "It was part of the evolutionary shift away from chewing to simply swallowing food, which meant the chewing muscles were no longer needed."

Analysis of gene expression in the intramandibular fat detected activity of genes related to immune functions, such as the activation of some elements of the immune response and regulation of T cell formation.

"Long-term communication with local people and communities in Hokkaido has enabled researchers to conduct various studies of whale biology, including our surprising findings," said Professor Takashi Fritz Matsuishi, the director of Stranding Network Hokkaido, which collected the samples. ●

ORIGINAL ARTICLE
Hayate Takeuchi, Takashi Fritz Matsuishi, Takashi Hayakawa. A tradeoff evolution between acoustic fat bodies and skull muscles in toothed whales. *Gene*. January 20, 2024.

FUNDING
JSPS KAKENHI (19K16241, 20H04987, 21H04919, 21KK0106, JPJSBP 120219902, JPJSCCA 20170005); Hokkaido University.

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hayatak@ees.hokudai.ac.jp**

(From left) Hayate Takeuchi, Takashi Fritz Matsuishi, and Takashi Hayakawa, authors of the study. Photo: Hayate Takeuchi, Takashi Fritz Matsuishi, and Takashi Hayakawa

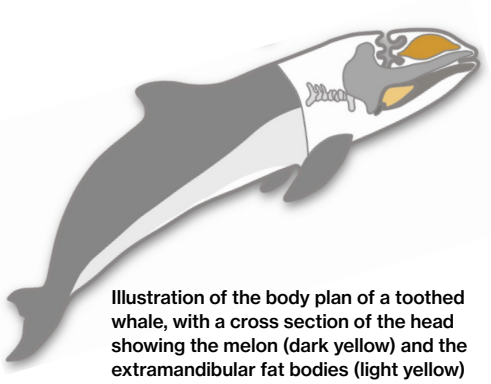
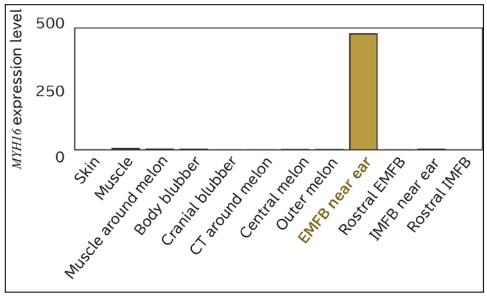


Illustration of the body plan of a toothed whale, with a cross section of the head showing the melon (dark yellow) and the extramandibular fat bodies (light yellow) which are key organs for using sound such as echolocation. (Hayate Takeuchi, Takashi Fritz Matsuishi, Takashi Hayakawa. *Gene*. January 20, 2024)



The extramandibular fat bodies (EMFB) near the ear have a very high expression of the protein MYH16, a specialized protein typically found in the masseter muscle – indicating an evolutionary relationship between them. (Hayate Takeuchi, Takashi Fritz Matsuishi, Takashi Hayakawa. *Gene*. January 20, 2024)

Climate- and land use change threaten traditional food sources in Russia's Far East

The distribution of traditional wild food sources in the Republic of Sakha could change significantly, affecting the diets and incomes of Indigenous rural communities who depend on them.

Climate- and land use change could significantly alter the make-up and availability of wild traditional foods in the vast Russian Far East, a region that is home to many Indigenous Peoples who depend on those native foods.

Native plants, animals and fungi obtained from nature in these regions are vital to the health and livelihood of people in remote and rural areas, but traditional food systems are under increasing threat from climate- and land use change. However, little is known about the actual contribution of wild traditional foods towards supporting rural households or how future changes in the environment may compromise these dependencies.

Now, an international team led by Associate Professor Jorge García Molinos of the Arctic Research Center at Hokkaido University has surveyed rural Indigenous settlements in the Republic of Sakha about their use of wild traditional foods and evaluated the potential impact of future climate and land use change on those food systems. Their findings have been published in *PNAS Nexus*.

The survey covered 400 households in 18 rural settlements across Sakha. It collected data on demographics, dietary habits, and income-generating activities, such as hunting, fishing and gathering of traditional wild food species.

Analyzing the data revealed that dependence on wild food sources varied over the region, with significantly lower intake in settlements in the more developed and accessible central and western areas but a comparatively much higher intake in communities of the remote and isolated northern Arctic region. In the Arctic settlements, the dietary focus was on wild fish and mammals, but rural households in the southern and western areas consumed preferentially wild plant-based foods, such as berries and nuts.

There was a similar pattern in terms of economic dependence on wild food sources. Wild foods—mostly mammals—made up around 11 percent of total household income in one northern settlement, but only around 3 percent—mostly from berries—in a central settlement.

The researchers then used species distribution models to project future changes in the availability of 51 wild food species under different climate- and land use change scenarios. This involved mapping projected changes at regional and local scales; the latter considered within a 100-kilometer radius of the study settlements, representing the areas in which those wild foods would likely be harvested.

The modeling predicted a general decrease in the number of species by 2050 in southern areas of the Republic of Sakha and mild increases in the northern areas as species contract and expand their ranges in response to environmental changes. Locally, these broad regional changes mean that the number and type of food species available to individual settlements will likely change in the future.

"Although our models project these local losses may be compensated by the establishment of other new species experiencing improvements in habitat conditions, anticipating how such trade-offs in availability of local wild food species will impact these rural communities in the future is an important open question that requires further research," García Molinos says. ●

ORIGINAL ARTICLE
Jorge García Molinos, et al. Future climate and land use changes challenge current dependencies on wild food harvesting by rural Indigenous communities. *PNAS Nexus*. November 19, 2024.

FUNDING
e-ASIA JRP, JST SICORP (JPMJSC20E5); RFBR (21-55-70104).

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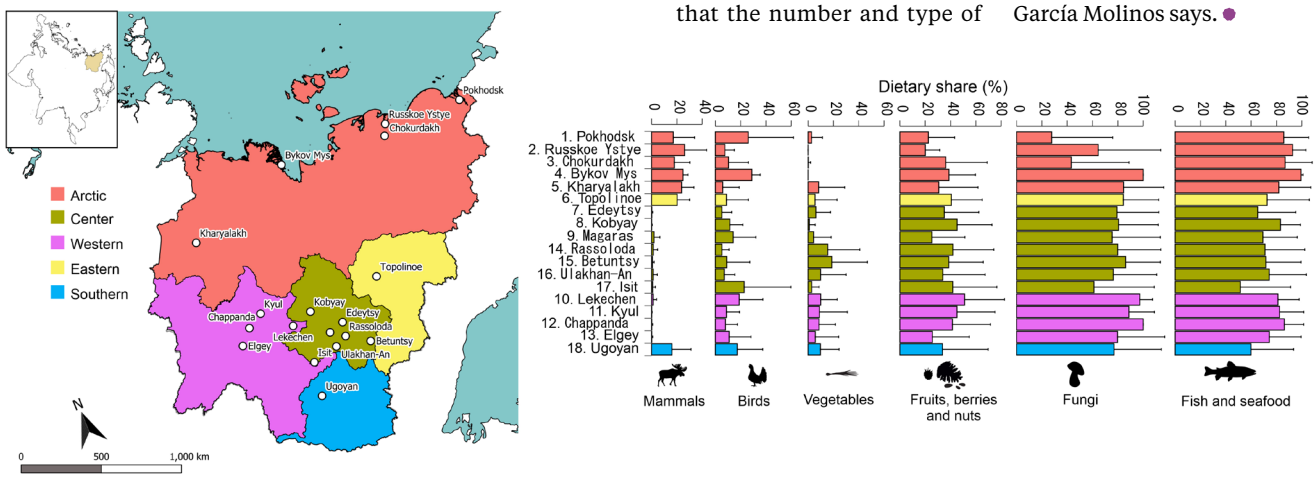


Proportions of wild foods consumed by households in different settlements across regions of the Republic of Sakha. (Jorge García Molinos, et al. *PNAS Nexus*. November 19, 2024)

Hokkaido University *at a glance*

A Long History

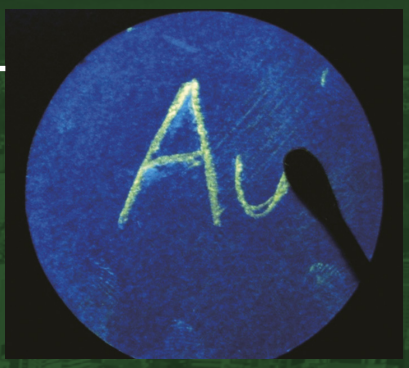
Founded in 1876 as Sapporo Agricultural College, Hokkaido University is one of the oldest, largest, and most prestigious universities in Japan. Boasting one of the largest campuses in Japan, the University houses cutting-edge research facilities, a university hospital, and several field research centers including one of the world's largest research forests. Towards the 150th anniversary of its founding, Hokkaido University aims to be an unparalleled university that contributes to resolving global issues and realizing the SDGs.

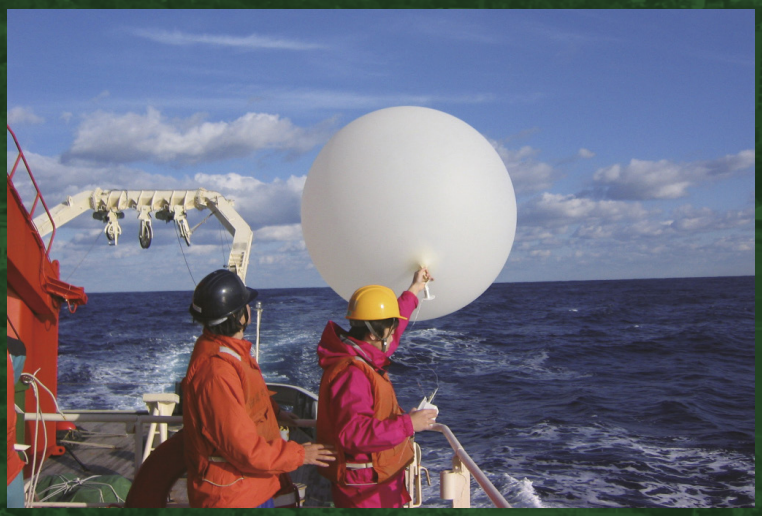
Shining a light
from **Hokkaido**
upon the **world**

Visions for Hokkaido University

The Fourth Period of Mid-Term Goals and Mid-Term Plan, which commenced in 2022, is crucial to the future of the University, and coincides with the 150th anniversary of our founding. The University has developed six visions for this Period, in order to become an autonomous, comprehensive, community-based university. The visions encompass six categories – research, education, collaboration, management, data, and finances – where ambitious measures are being pursued. We are also enacting HU VISION 2030, our medium-term vision leading up to the year 2030. By linking these measures and categories, Hokkaido University will achieve a breakthrough in becoming an unparalleled university.

HU VISION 2030





Research

Since its establishment as an agricultural college, Hokkaido University has expanded its research strengths to encompass a variety of fields in areas such as low temperature science, life sciences, chemistry, veterinary sciences, and fisheries sciences.

The Global Institution for Collaborative Research and Education (GI-CoRE), established in 2014 to conduct top-level research in strategic areas, has proven exceptionally successful. It now encompasses a total of seven hubs, in fields ranging from Arctic Research to Zoonoses. The Institute for Chemical Reaction Design and Discovery (ICReDD), launched in 2018 as part of the World Premier Research Initiative (WPI) by the Japanese Government, has grown by leaps and bounds, and is now recognized as a pioneer in chemical reaction design.

In 2022, Hokkaido University Professor Benjamin List won the Nobel Prize in Chemistry. He is the second Nobel Laureate affiliated with Hokkaido University, following Hokkaido University Professor Akira Suzuki, a 2010 laureate of the Nobel Prize in Chemistry.

International programs

In addition to the 12 undergraduate and 21 graduate schools, Hokkaido University runs a number of degree programs taught in English for international students. The Modern Japanese Studies Program (MJSP) and the Integrated Science Program (ISP) are for undergraduate students; at the graduate level, there are eight specialized programs, and many graduate schools also offer courses in English.

During the summer, the Hokkaido Summer Institute (HSI) offers hundreds of short programs in English covering a wide range of disciplines. The courses are run by top-level researchers from the University and around the world. A plurality of the HSI courses is now offered in a hybrid format, allowing a much more diverse group of students to enroll.

International Student Guide

Hokkaido Summer Institute

TODAY Data as of May 2024

1876
established

18,056*
students
*Including 2,090 international students from 99 countries/regions

3,937**
faculty & staff
**including 849 International staff

660km²
total area of campuses and facilities

12
undergraduate schools

21
graduate schools

247,058
alumni

763***
partner institutions
***located in 73 countries worldwide

RANKING

1st in Japan
72–74th in the world
Times Higher Education World University Impact Rankings 2024

8th
in Japan
Times Higher Education Japan University Rankings 2024

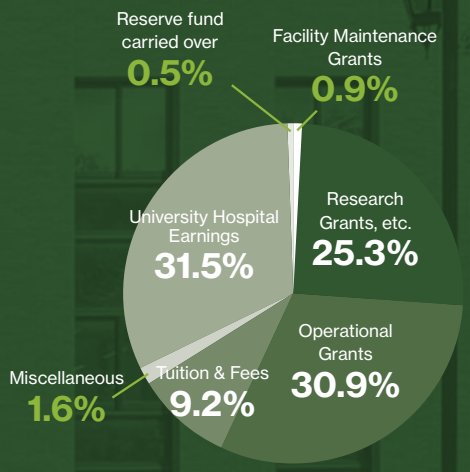
35th
in Asia
QS World University Rankings: Asia 2025

5-9th
in Japan
2024 Academic Ranking of World Universities

8th in Japan
163rd in the world
Nature Index: Institutional Tables (Sept. 1, 2023 – Aug. 31, 2024)

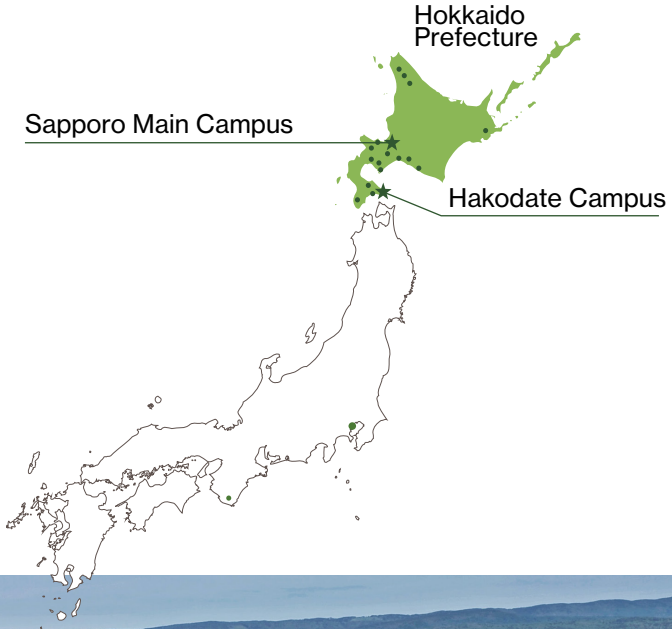
REVENUE

¥114,667m
revenue in 2024



HOKKAIDO UNIVERSITY

Founded in 1876 as Sapporo Agricultural College, Hokkaido University is one of the oldest, largest, and most prestigious universities in Japan. The university attracts prospective students from all around the globe with the diverse degree programs offered and the year-round scenic beauty. The campuses are located in the cities of Sapporo and Hakodate of Hokkaido, and 21 facilities are spread throughout Hokkaido and mainland Japan.



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