National Biodiversity Centre

Status Report 2022

INSIDE

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2022

National Biodiversity Centre (NBC)
Ministry of Agriculture and Forests
Royal Government of Bhutan
Serbithang, Thimphu

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Published by:

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October, 2022

Layout & Design: Choki Gyeltshen & Tshering Pem, NBC

Cover Photos: Photos from the Royal Bhutan Flower Exhibition at Gyelposhing, Mongar.

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Printed @ Yoebar Prints (yoebarprinters@gmail.com)

Message from the Program Director

Bhutan became party to and ratified the UN Convention on Biological Diversity (CBD) in 1995 by the 73rd National Assembly of Bhutan in recognition of the country's biodiversity conservation and sustainable utilization efforts. In order to implement the convention's obligation and to achieve country's own goal of biodiversity conservation including National Biodiversity Strategies and Action Plans (NBSAPs), in 1998 the National Biodiversity Centre (NBC) was established. Bhutan also signed the Nagoya Protocol on Access and Benefit Sharing (ABS) in 2011 to enable meaningful ABS collaborations that will benefit country and the people at large through regulated access to biological resources.

This fiscal year observed several achievements and advancement in the field of biodiversity in Bhutan. Thus, through the Centre's Status Report for the fiscal year, July 2021 to June 2022, we present various biodiversity conservation efforts and achievements including the progress towards fulfilling the national and international targets and goals. This report comprises rational for biodiversity conservation, achievements, success stories, research abstracts, Annual Performance Agreement, project information, and other relevant information on biodiversity of Bhutan.

As the threats of biodiversity increases each year due to multiple factors such as climate change, human interventions, pollution, invasive species, overexploitation, habitat loss and global pandemic, it is high time to strengthen our conservation strategies and collaborations to reduce the biodiversity threats and to use biodiversity sustainably. Thus, for effective biodiversity conservation, the Biodiversity Act of Bhutan 2022 was passed in the 7th session of the Third Parliament and received Royal Assent from the Druk Gyalpo on the 17th Day of the 5th Month of the Water Male Tiger Year 2022. The Act ensures that the people get maximum benefits, with regulated access to biological resources and associated Traditional Knowledge.

As a part of CBD obligations, the centre is actively contributing to the development of Post-2020 Global Biodiversity Framework, assessment of biodiversity targets, and to develop a new NBSAP for Bhutan. To improve the access to biodiversity information internationally, biodiversity datasets are made available on Global Biodiversity Information Facility (GBIF) and the Bhutan Biodiversity Portal. This year the centre became a member of the World Flora Online, which aims to provide online information on flora and its herbarium specimens. With this membership, access and availability of floral data and information will be greatly improved.

The Centre successfully established several Access and Benefit Sharing initiatives with the local communities, conducted national moth and butterfly weeks, discovery of several species new to science, enhancement of agrobiodiversity ex-situ conservation, implementation of 2nd Global Plan of Action on Plant Genetic Resources for Food and Agriculture (GPA-PGRFA), development of nature-based products, among others.

We thank our conservation partners and donors for assisting us to effectively conserve country's biodiversity. We hope you will enjoy reading the report, and we welcome your valuable comments.

Dr. Karma Dema Dorji
Program Director/Specialist Head

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Meconopsis bhutanica

1. Background

1.1. Biodiversity of Bhutan

Biological diversity is vitally important for every sphere of human existence and provides us with a vast range of products and services ranging from food, water, timber, fiber, genetic resources, and medicines to recreational, aesthetic, and spiritual benefits as well as regulation of climate, water and soil quality, and pollination among others. Biodiversity is the very basis for sustainable development. In the context of Bhutan, not only has the conservation of biological diversity always played a pivotal role in Bhutan's development history but concern for the natural environment and biological diversity is deeply embedded in Bhutanese traditional beliefs, socio-cultural outlook and the overarching development philosophy of Gross National Happiness (GNH). As a result, Bhutan has emerged virtually unscathed in the twenty-first century in terms of its biological wealth.

The country has 70.77 percent of the total area under forest cover and 51.44 percent secured as protected areas and biological corridors and is home to 11,248 species of flora and fauna including 4978 species of vascular plants, 3511 insects, 129 mammals, 736 birds, 125 fishes and 158 amphibians and reptiles. To date, over 300 species of medicinal plants have been found at altitudes ranging from 200 to 7800 meters above sea level. In terms of domestic biodiversity, there are more than 55 species of agriculture crops and 6 species of livestock (NBC, 2019). Some of these have adapted to the country's rugged mountains and harsh climatic conditions and, therefore, bear distinctive features which need to be conserved, especially to build resilience in the face of climate change for food security and improved livelihoods. About 79% of the Bhutanese population depends on natural resources for their livelihoods (BAP 2002) and the figure could be significantly higher if we take into account non-rural people dependent on other natural resources such as timber which justify the paramount importance of conservation and sustainable utilization of biodiversity to Bhutan and its people.

The nation's strong commitment to the environment is also apparent from the fact that the Constitution of the Kingdom of Bhutan mandates the country to maintain at least 60% percent forest cover for all time to come. Internationally as well, Bhutan has spearheaded environmental commitments such as staying carbon-neutral and fostering regional climate change cooperation and is party to many international instruments committed to protecting the biodiversity and environment such as the United Nations Convention on Biological Diversity (CBD), United Nations Framework Convention on Climate Change (UNFCCC) and United Nations Convention to Combat Desertification (UNCCD), International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), among others. The Bhutan Trust Fund for Environmental Conservation (BTFEC) which was established through the command and guidance of His Majesty the Fourth King is now a robust fund that has supported and continues to support various national initiatives to protect the environment. Bhutan for Life (BFL) was established to be the strategic and long-term solution to ensure that Bhutan remains economically and environmentally sustainable forever.

Nevertheless, we cannot rest on our past laurels and remain passive in the face of emerging challenges such as fast economic growth, increasing rural-urban migration, expanding urbanization, increased need for forest resources, human wildlife conflict, climate change, land degradation, etc. which

impacts biodiversity and environmental conservation in one way or the other. The increasing pressure on the nation's coffers from the growing needs of the population also has implications on the growing cost of conservation for the sake of conservation alone. We also have to be conscious of the fact that in the face of increasing erosion of biodiversity in the neighboring countries due to the constant struggle between conservation and fast socio-economic development as well as an expanding population and the threat of changing climate, the value of Bhutan's natural resources will increase in terms of relative importance presenting numerous opportunities for deriving benefits. As the loss of biodiversity is irreplaceable, the level of concerns of biodiversity in recent times is rising more than ever before and many world leaders are rethinking their priorities with respect to the allocation of resources towards biodiversity conservation.

Given these considerations, we need to invest strongly in strengthening national capacities particularly in developing a sound scientific knowledge base of our rich biological diversity and tapping the opportunities from biodiversity for effective utilization of our biological resources in a sustainable manner. Therefore, it has become of utmost importance that the country establishes and strengthens measures that will enable the country to benefit from its rich biological resources and encourage people-centric conservation to take place.

Dagala botanical trek

Conservation has always played a pivotal role in Bhutan's development history and concern for the natural environment and biological diversity is deeply embedded in Bhutanese traditional beliefs, socio-cultural outlook and the overarching development philosophy of Gross National Happiness.

Bhutan has one of the most rugged terrains with diverse altitudinal range and climatic conditions. Crop diversity and genetic diversity within species is important to adapt to this diverse and heterogeneous agro-ecological zones of Bhutan. The importance of crop diversity and genetic diversity is gaining more importance than ever before as part of climate change adaptation and mitigation measures. Given these considerations, it is imperative that the government invests strongly in strengthening national capacities particularly in developing a sound scientific knowledge base of the country's rich biological diversity and tapping the opportunities from biodiversity for effective conservation and utilization of our biological resources in a sustainable manner. Therefore, it has become of utmost importance that the country establishes and strengthens measures that will enable the country to benefit from its rich biological resources and promote leadership of people at grass root level in conservation.

1.2. History of NBC

In recognition of the importance of biodiversity to humankind and to its own goal of environmentally sustainable development and due to the committed leadership in environmental conservation, Bhutan became party to and ratified the Convention on Biological Diversity (CBD) in 1995 by the 73rd session of the National Assembly. The CBD is one of the most comprehensive international agreements, signed by 196 countries committed to the conservation and sustainable utilization of biological resources and the fair and equitable sharing of benefits arising from the access to biological resources. Bhutan also ratified the Nagoya Protocol on Access and Benefit Sharing (ABS) in 2012 by the 9th session of the 1st Parliament of Bhutan to enable meaningful ABS collaborations that will benefit the country and the people at large through the regulated access to biological resources in the country.

With the ratification of the Convention, Bhutan developed its first Biodiversity Action Plan in 1997, as a guiding policy document for conservation and sustainable utilization of biological resources of the country. To date, Bhutan has developed and implemented four Biodiversity Action Plans- the first in 1997, second in 2002, third in 2009, and fourth in 2014 – a guiding policy document for conservation and sustainable utilization of biological resources of the country. The Biodiversity Action Plans are "living documents" that guide conservation and sustainable utilization of biodiversity in the country and are formulated every few years to evolve with the changing needs of the population and the country vis-à-vis the environment.

During the course of developing the first Biodiversity Action Plan, it was recognized that responsibilities for biodiversity were divided among several units within the Ministry of Agriculture & Forests, based partly on the history of biodiversity management and partly on the distinction made between domestic and wild biodiversity, often leading to problems in coordinating, goal setting, planning and cooperation in comprehensive biodiversity management. As a result, the Action Plan recommended the institutionalization and establishment of an integrated biodiversity conservation program. This led to the

establishment of the National Biodiversity Program (NBP) in 1998 headed by a Program Manager, and with two technical programs, namely the National Herbarium and the Agro-biodiversity Program.

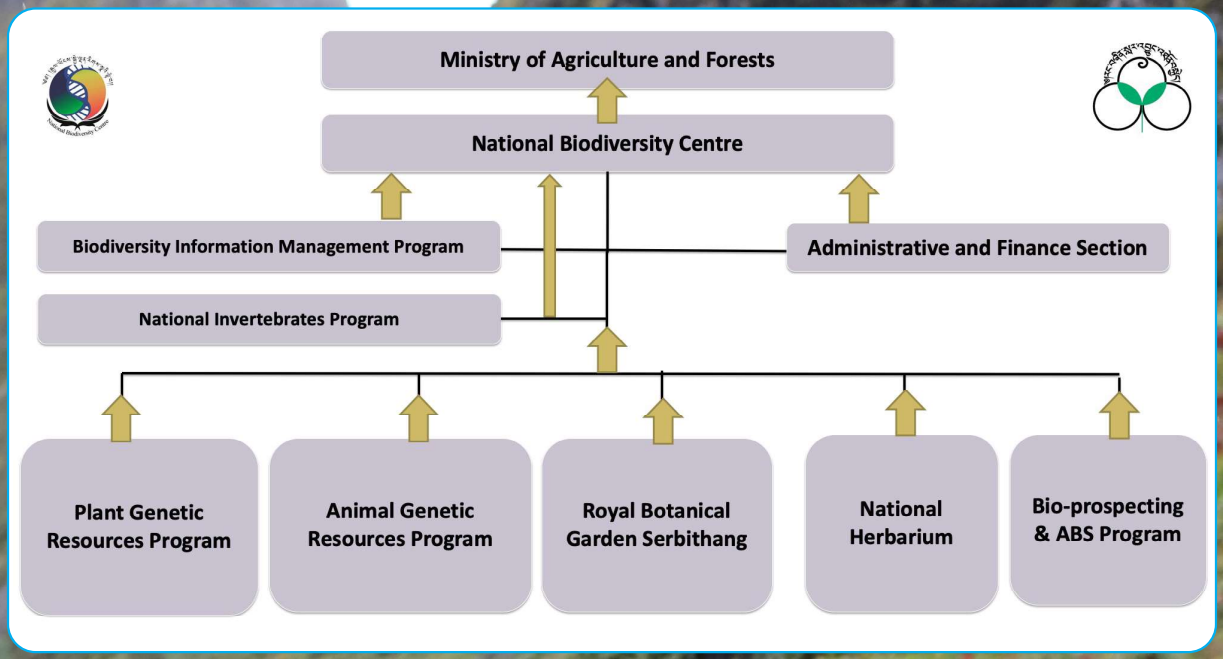
In 1999, the Royal Botanical Garden was established under the NBP as an ex-situ plant conservation area and to commemorate the Silver Jubilee Celebration of the coronation of the 4th King, His Majesty Jigme Singye Wangchuck. Subsequently in 2001, the National Biodiversity Program was upgraded to the National Biodiversity Centre (NBC) as a non-departmental agency headed by a Program Director in order to strengthen conservation initiatives and coordinate biodiversity conservation and sustainable utilization programs in the country.

The Centre has developed a Vision 2030 as a living document to guide implementation of biodiversity conservation and sustainable utilization program in the country.

Sorbus rufopilosa

Cirsium eriophoides at Black Mountains

1.3. Organizational Chart



Vision

Effective conservation, sustainable utilization and equitable sharing of benefits arising from access and use of biological resources.

Goal

To become a premier institute on biodiversity in the country resulting in the effective management of biodiversity and maximizing the benefits from it as well as contributing to international efforts toward conserving biodiversity.

Mission

Biological resources effectively conserved, sustainably used and benefits equitably shared for enhancement of livelihood, food security and environmental well-being of the country.

Mandates

1. To coordinate biodiversity conservation and sustainable use programs in the country and implement where relevant/necessary.

2. To serve as a national biorepository for genetic resources, botanical collections, and collection of other biological resources.

3. To serve as the national focal agency to regulate access to and utilization of biological resources of the country, ensuring equitable sharing of the benefits arising from their access and utilization.

4. To serve as the national focal agency for bioprospecting and documentation of traditional knowledge associated with biological resources.

5. To coordinate formulation and implementation of policies and legal frameworks for conservation and sustainable use of biological resources.

6. To serve as the national clearing house and repository of biodiversity information of the country.

7. To provide specialized technical services related to conservation and sustainable utilization of biodiversity.

8. To provide taxonomic and systematics service on flora of Bhutan.

9. To promote education, awareness and participation in biodiversity conservation and sustainable use to enhance peoples' participation and leadership in conservation.

10. To coordinate and implement obligations under regional and international conventions, treaties and protocols related to biodiversity.

11. To promote national, regional and international institutional linkages and collaboration for technology transfer, technical capacity enhancement and collaborative research in the field of biodiversity.

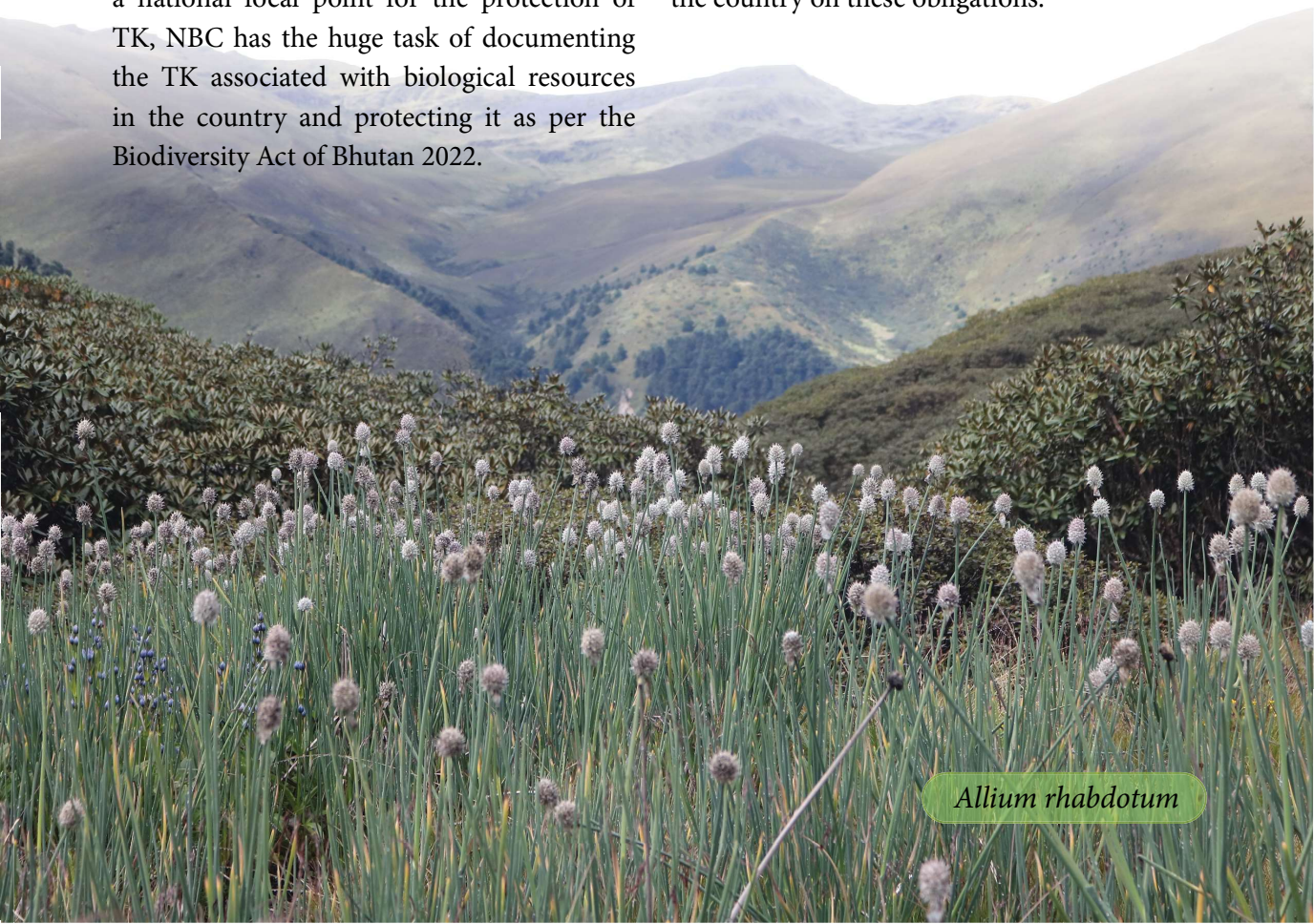
1.4. National & International Obligations

National:

NBC serves as the national focal point for ABS and TK associated with biological resources. It also houses the national portal on biodiversity. NBC is the focal agency leading the development of Biodiversity Action Plans/NBSAPs in the country. It is also the custodian of the Biodiversity Act of Bhutan 2003 and ABS Policy of Bhutan 2015. These responsibilities require the NBC to facilitate government and non-government ventures on biodiversity with the overall principles of ensuring fair and equitable sharing of benefits to the people and the country from the access to biological resources and also to ensure that such access does not contravene with the ethical and spiritual fabric of the country. As a national focal point for the protection of TK, NBC has the huge task of documenting the TK associated with biological resources in the country and protecting it as per the Biodiversity Act of Bhutan 2022.

International:

NBC is the national focal point for the ITPGRFA, CGRFA, Nagoya Protocol on ABS, and the national nodal agency for the Global Biodiversity Information Facility (GBIF). Although NBC is not the National Focal Agency for CBD, it is the key national agency responsible for the implementation of the programs of work under this agreement. Such global obligations and requirements in addition to the country's own needs, require the NBC to strengthen national capacities and mechanisms and align our priorities along with the Global Plan of Actions on Plant and Animal Genetic Resources for Food and Agriculture (PAGR) as well as establish mechanisms on ABS; develop national strategies and action plans and educate the country on these obligations.



Allium rhabdotum

Monitored nucleus native pig breeding farm at Rukha

Native Piglet (Sapha)

Site inspection of native pig fattening farm at Harachu

2. Animal Genetic Resources

The Animal Genetic Resources (AnGR) Program was initiated in 2005 with a mandate to oversee *ex situ* and *in situ* conservation and sustainable utilization of AnGR in the country. The program has steadily grown in capabilities in animal gene banking, coordination and technical backstopping of *in situ* conservation and sustainable utilization activities of prioritized AnGR over the course of a decade. After the implementation of the Type Three project supported by the SDS fund in 2005, it was followed by the Integrated Livestock and Crop Conservation Project (ILCCP) funded by UNDP-GEF in the 10th FYP, which also upgraded the National Animal Genebank to a fully functional facility as well as supporting on farm conservation initiatives. Recent projects included the High Altitude Northern Areas of Bhutan (HANAS) project through World Bank-BTFEC support and the Asian Food and Agriculture Cooperation Initiative (AFACI) project which focused on on-farm conservation of *Jakar* sheep and value addition and improvement of AnGR in Bhutan respectively. Further, the protocol for cryopreservation of semen at the National Animal Genebank was validated through technical support from UNDP and FAO in 2011. Reports on the State of Animal Genetic Resources for food and agriculture were submitted to FAO towards formulating the Global Plan of Action for animal genetic resources in 2009 and 2010. The program is responsible for the management and collection of AnGR data (DAD-IS) and reporting on the state of AnGR in Bhutan to FAO. The Program also has a fully equipped DNA laboratory to undertake basic molecular research and refers samples for advanced genetic studies to the Animal Genetic Resources Research Center, National Institute of Animal Science and the Macrogen Inc. in Korea and the Laboratory of Racing Chemistry and the Kyoto University in Japan.

2.1. In-situ conservation of Animal Genetic Resources

An in-situ conservation activity for animal genetic resources was initiated through the funding support from GEF-UNDP Integrated Livestock and Crop Conservation Project (ILCCP) in 2008. The project focused on capacity building and promotion of local diversity through value addition as well as the establishment of the Nublang Conservation Fund in collaboration with the Department of Livestock. Continued efforts are in place to mobilize resources to implement intervention strategies to strengthen in-situ conservation of animal genetic resources and address emerging threats to the sustenance and existence of traditional livestock genetic resources. Besides, the program in collaboration with various stakeholders is under process of establishing conservation communities for the other indigenous livestock species. Funding supports are being sourced to formulate conservation strategies and implementation plans to strengthen in-situ conservation of animal genetic resources.

Achievements

As a part of our in-situ conservation program, following activities were carried out:

a) Sourced and re-stocked sheep breeding stock for pureline breeding at sheep nucleus breeding farm (NSRRDC) at Bumthang. Sourced 22 numbers of Sakteng type sheep (5 rams and 17 ewes) and also sourced 18 Sipsoo type sheep (5 rams and 13 ewes).

b) Financial support for the inputs in construction of nucleus native pig breeding farm at Rukha under Wangdue.

c) Monitored existing nucleus native pig breeding farm and inspected the site selection for the nucleus native pig fattening farm to promote local product diversification.

d) Financial support granted for the replacement of shed net for the Native Poultry and Heifer Breeding Centre at Lhuentse.

2.2. Ex-situ conservation of Animal Genetic Resources at the National Animal Gene Bank

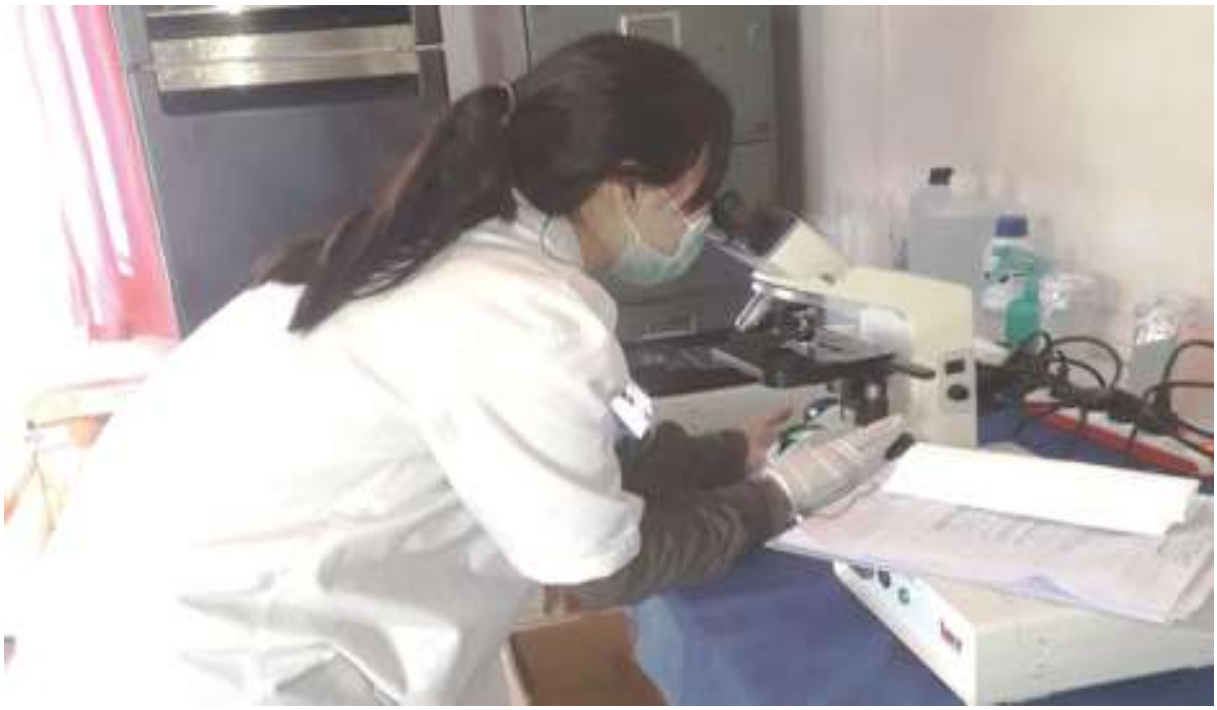
The traditional animal genetic resources of Bhutan are unique and will remain central to rural livelihoods and are of socio-cultural and economic importance. The Animal Gene Bank was established in 2005 in collaboration with the Centre for Genetic Resources of the Netherlands with its objective to conserve the genetic pool of traditional animal breeds unique to Bhutan. The Animal Gene Bank currently holds over 24,000 doses of semen and DNA samples from different indigenous livestock breeds for research, long term conservation and breed reconstruction in case of extinction. Besides semen cryopreservation and DNA banking, the program in collaboration with National Dairy Research and Development Center and National Nublang Breeding Center, Tashiyangphu under Department of Livestock started embryo cryopreservation programs of important livestock species in the country since from 2018. Currently, the joint activities collected and cryopreserved around 20 viable Nublang embryos. Characterization studies of the production parameters and other useful economic triats are being studied through selective breeding and DNA mapping. The conserved germplasm will serve as a genetic pool for enhancing national food security from the emerging challenges of climate change and other risk associated threats.

Achievements

a) Collected 4,852 doses of semen from Sheep, Goat and Chicken. Out of this, 1520 doses of semen from goat achieved through on-station collection, 1430 semen doses from sheep achieved through on-station as well as on-farm collections at National Small Ruminants Research and Development Center and 1902 semen doses from chicken achieved through on-station as well as on-farm collection at Native Poultry and Heifer Breeding Center.

b) Collected and extracted 650 DNA samples from different livestock species. Out of this, 59 samples from native chicken, 567 from Nublang and 24 from Mastiff Dogs.

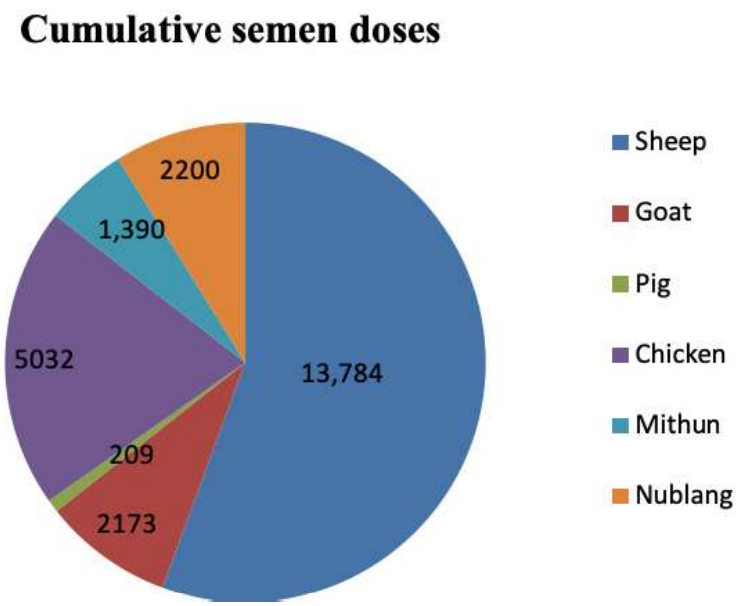
Semen Collection from Sheep



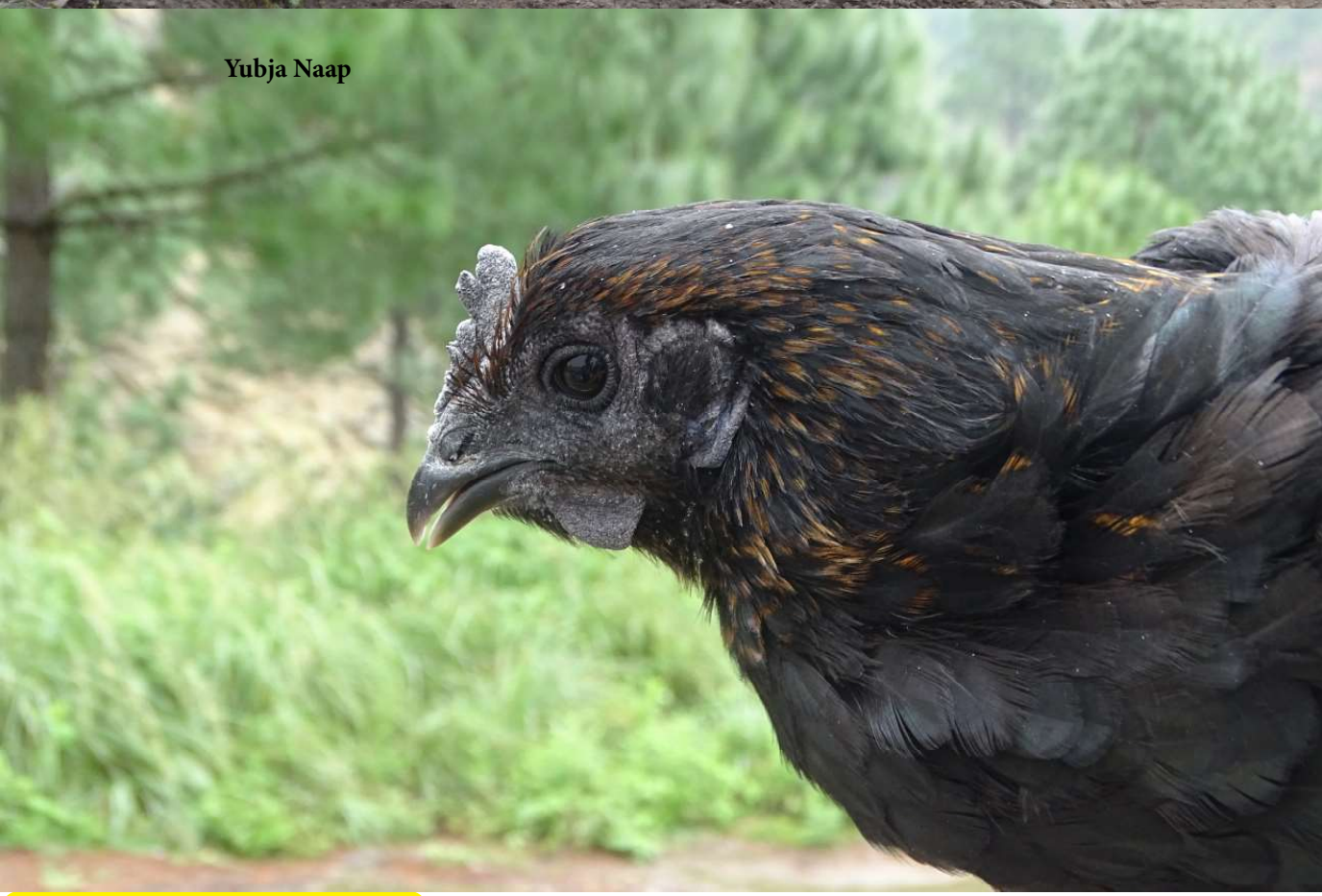
Semen Processing of Sheep

Current Status

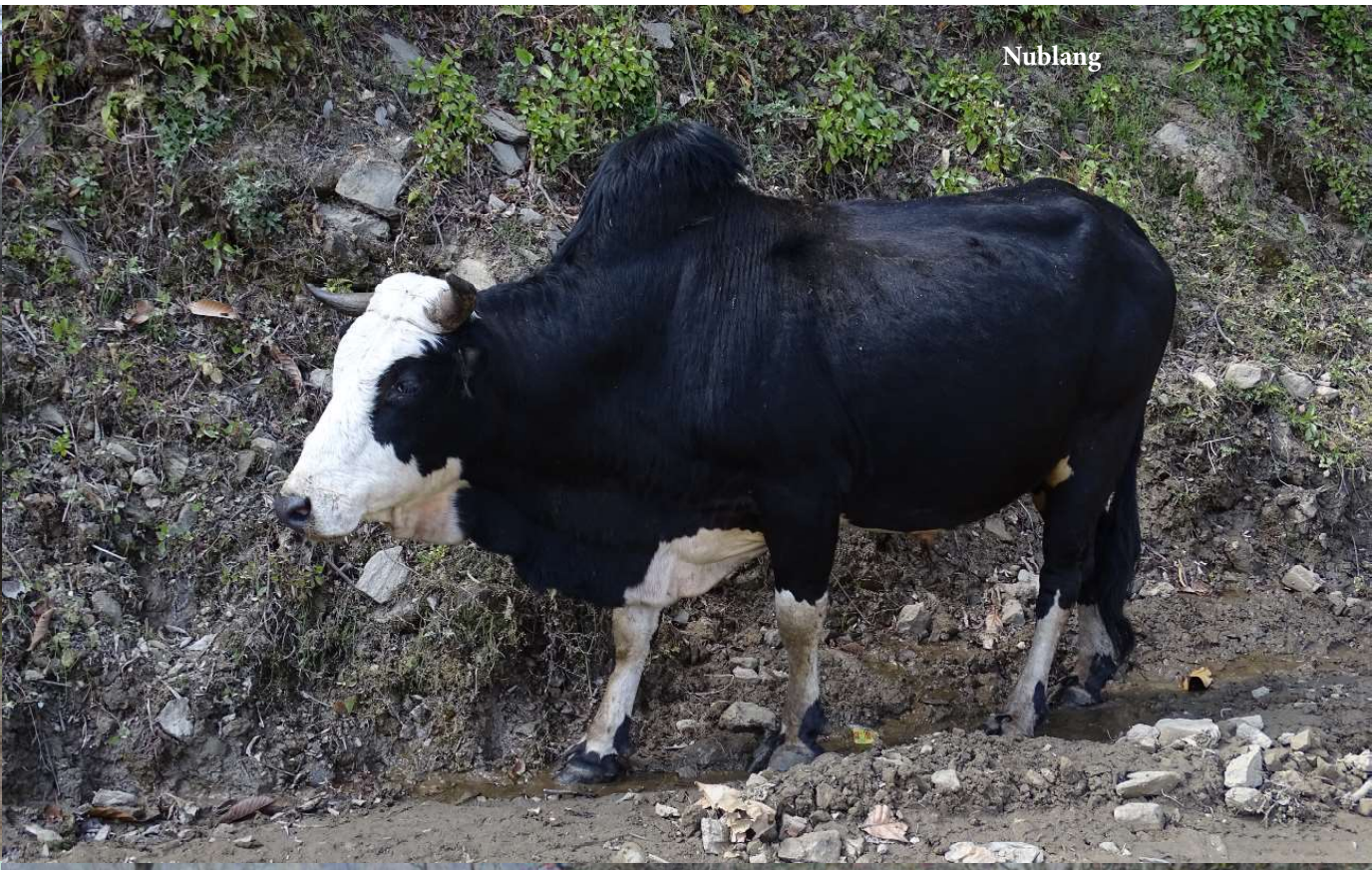
The National Animal Gene Bank also known as National Animal Repository houses to more than 24,000 doses of semen from different traditional animal breeds. A brief pictorial overview of overall gene bank collections is presented below.



Flock of Sakteng Sheep



Yubja Naap


Nublang


Zoe

3. Plant Genetic Resources

Bhutan is a part of the world's biodiversity hotspot and ranks the 12th position in terms of per unit land area [Tamang A.M]. Plant Genetic Resources for Food and Agriculture is a sub-set of Agrobiodiversity and Agrobiodiversity is a subset of biodiversity. PGRFA consists of four sub-components viz. domesticated crops (DC), semi-domesticated crops (SDC), crop wild relatives (CWR) and wild edible plants (WEP). PGRFA on each of the above four components exist at different levels of diversity viz. agroecosystem diversity, species diversity, varietal diversity, ecotype diversity, genotypic and allelic diversity existing over a wide range of altitudes of Bhutan spread across different Agroecological zones viz. Humid Sub-tropics, Wet Sub-tropics, Dry Sub-tropics, Warm Temperate, Cool Temperate and Alpine zones of Bhutan.

Recognizing the importance of PGRFA diversity for food and nutrition security of the country both for present and future generations, both 1) On-farm conservation and 2) Ex-situ conservation strategies are being implemented in a complementary manner since 2001 and 2005 respectively.

The achievements accomplished during the period from July 2021 to June 2022 are narrated below.

3.1. On-Farm Conservation of Crop Genetic Resources

Achievements

Crop Diversity inventory in the On-farm in Gongdue and Sherimuhung

The National Biodiversity Centre in collaboration with Gewog Agriculture Sector of Gongdue and Sherimuhung Gewogs, Mongar Dzongkhag conducted Crop Diversity Inventory on the 12th January 2022 at Gongdue Gewog, and 17th January 2022 at Sherimuhung Gewog Mongar Dzongkhag.

The Crop Diversity Inventory was conducted with the following objectives:

- To create education and awareness among the farming communities on the importance of crop diversity.
- To assess the extent of crop diversity existing in the farmers' field.
- To identify crops and varieties and the donor farmer for germplasm collection.

Awareness raising on the importance of agrobiodiversity

The farmer participants were first introduced to the concept of biodiversity, agro-biodiversity and then narrowed down to crop biodiversity. Then the farmer participants were presented with various rationales for the importance of crop diversity. Farmers were also informed of the trend and various developments in the global arena when it comes to crop diversity. Participants were also informed of the various efforts being put in place by the government in securing diversity in the gene bank and also maintaining on-farm diversity.

Education and awareness were followed by inventorying of crop and varietal diversity being cultivated by the farmers of Gongdue and Sherimuhung Gewog.

On-farm crop diversity at Gongdue Gewog

The meeting was attended by 20 farmers consisting of 4 male and 16 female farmers representing different Chiwogs including Agriculture Extension Officer, Gongdue Gewog.

The on-farm crop diversity inventory revealed the existence of a total of 60 crops consisting of about 120 crop varieties viz cardamom, maize, rice, foxtail millet, finger millet, bitter buckwheat, sweet buckwheat, barley, little millet, mustard, perilla, amaranth, quinoa, sorghum, groundnut, beans, lablab beans, cowpea, azuki bean, soybean, peas, black, gram, potato, sweet potato, tapioca, yam, colocasia, orange, peach, plum, pineapple, avocado, litchi, mango, pear, banana, guava, areca nut, papaya, pomegranate, passion fruit, sugarcane, chayote, pumpkin, cucumber, chili, brinjal, tree tomato, carrot, reddish, spinach, mustard green, cauliflower, cabbage, broccoli, coriander, garlic, onion, ginger, turmeric, stuffing cucumber or slipper gourd, etc.

The inventory also revealed that approximately 10% of crop diversity existing in Gongdue Gewog are improved or imported varieties whereas 90% consisted of local/traditional crops and crop varieties.

Participants from Gongdue Gewog

Gondue Gewog exhibited very high levels of crops and varietal diversity. We also conducted a 4-cell analysis to assess the threat level on the traditional crop diversity. A total of 47 varieties showed an increase in the cultivation trend and 43 varieties showed a stable cultivation trend. Unfortunately, a very high number of 30 crop varieties showed a decrease in cultivation trend, and 8 crop varieties were reported to have been lost. There are numerous reasons for the decline in cultivation trends or loss of certain crops which have been documented.

Cell analysis

On-farm crop diversity at Sherimuhung Gewog

The meeting was attended by 10 participants comprising 3 male and 6 female farmers representing five different Chiwogs and the Agriculture Extension Officer of Shermunung Gewog. Given the spike in the covid cases in the country, the number of participants was minimized and optimized to have a representation of all 5 Chiwogs like Soenakhar Yarab, Jabang Thueling, Malang Serzhong, Muhoong Shiling and Gangmoong. All the participants were made to follow covid protocols of using the mask and maintaining the physical distance.

The on-farm crop diversity inventory revealed the existence of a total of 74 crops consisting of about 147 crop varieties viz. maize, rice, barley, wheat, bitter buckwheat, sweet buckwheat, finger millet, foxtail millet, little millet, sorghum, amaranth, sesame, quinoa, mustard, groundnut, beans, peas, soybean, rice bean, azuki bean, cowpea, perilla, orange, banana, pear, crab apple, plum, pineapple, etc. covering 31 families.

Analysis of previously collected information on on-farm crop diversity inventory for seven Gewogs

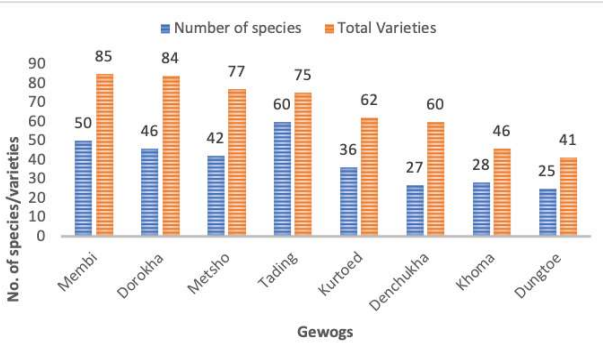
Crop diversity inventory information in the on-farm was documented and analyzed for 8 Gewgos viz. Kurthoe, Khoma, Membi and Metsho Gewogs under Lhuntse Dzongkhag, Dungtoe, Denchukha, Dorokha and Tading under Samtse Gewog to asses levels of species and varietal diversity in these Gewogs.

Crop diversity at Gewog level

We observed crop diversity at Gewog at two levels:

1) Species diversity,
2) Varietal diversity level.

Gewogs like Tading, Membi, Dorokha and Metsho Gewogs all exhibited the highest level of species as well as varietal richness with a species count of 60, 50, 46 and 42 species and varietal count of 75, 85, 84 and 77 varieties respectively.



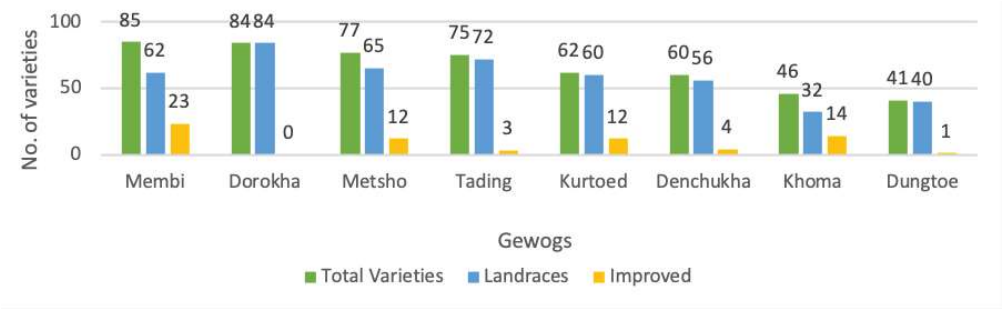
Species & varietal richness in eight gewogs.

Participants from Sherimuhung Gewog

Improved versus Landraces

In terms of landraces versus improved varieties, it revealed that Gewogs under Lhuentse.

Dzongkhag reported cultivation of a higher percentage of improved varieties with Membi (23), Khoma (14) and Metsho/Kurtoed (12) respectively whereas Gewogs under Samtse Dzongkhag reported very small portion of improved varieties with Denchukha (4) and Tading (3).



Total varieties, landraces and improved varieties in eight gewogs.

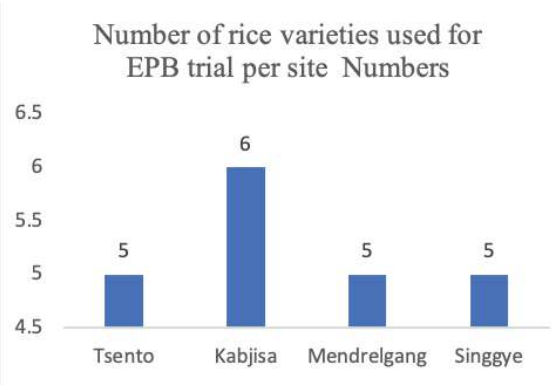
Coordination and implementation of evolutionary plant breeding project activities on rice and beans

Coordinated and implemented evolutionary plant breeding project activities on rice and beans in collaboration with ARDCs, Dzongkhag Agriculture Sectors and farming communities of six the project sites. Th evolutionary plant breeding project "Use of genetic diversity and Evolutionary Plant Breeding for enhanced farmer resilience to climate change, sustainable crop productivity, and nutrition under rainfed conditions" is a global on-farm conservation project implemented in 6 countries including Bhutan. It is funded by the International Fund Agricultural Development (IFAD) through Bioversity International as the International Project Coordinating Unit.

The overall goal of the project is to sustainably increase crop productivity and enhance the resilience to climate change of farming communities under low-input, rainfed and less favoured production conditions and organic production systems. The specific objective is: The resilience of target low-input poor farmers in the project area is enhanced through developing Evolutionary Populations with higher and stable yields under the local farm agronomic and stress conditions, including drought, salinity, pest and diseases.

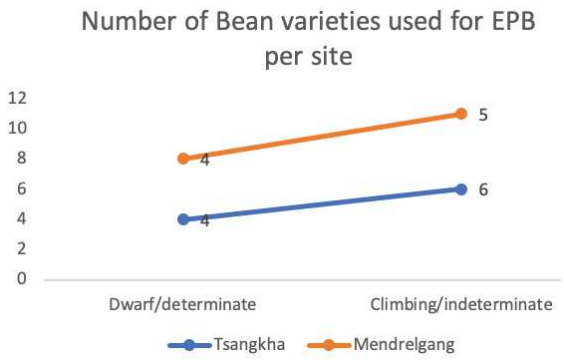
EPB farmers cleaning seeds at Tsento

The Evolutionary plant breeding trails on rice were conducted in 4 sites namely, Tsento (Paro), Kabjisa (Punakha), Mendrelgang (Tsirang) and Singgye (Sarpang). It was carried out with the technical support from the National Centre for Organic Agriculture, Agriculture Research and Devlopment Centres of Bajo, Tsirang and Samtenling in collaboration with the Dzongkhag Agriculture sectors and farming communities of the respective project sites. A total of 25 pure stand rice varieties were used to evaluate the yield, adaptation and nutritional values. The number of rice varieties used per site is presented in the figure below:



Total number of rice EPB varieties.

Similarly, beans evolutionary plant breeding trails were conducted in two sites, namely, Tsangkha (Dagana) and Mendrelgang (Tsirang). The trial was carried out for both dwarf/determinate and climbing/indeterminate types of beans. A total of 19 bean varieties were used for the Evolutionary Plant Breeding trials. The agronomic data for rice such as, days to flowering, number of tillers, plant height, days to maturity, blast score, 1000 grain weight (gm), panicle length, field moisture content, harvest area, yield/plot, yield/acre were collected and shared with the international expert for analysis.



Total number of bean EPB varieties under each gewog.

The participatory assessment and selection of the varieties were done with the project farmers in all the sites coordinated by the Agriculture research and Development Centres. During this day, farmers were briefed on the objectives of the trial and crop improvement through EPB approach and maintenance of crop diversity on-farm for food and nutritional security as well as for resilience to the changing environment.

As part of the project EPB project activity, nutritional profiling tests were carried out for all the pure stand varieties including evolutionary population mixtures of all the sites for both the crops. As there are no laboratories in Bhutan to carry out such tests, it was done at Avon Food Lab. Private Ltd. New Delhi, India. For the rice, as guided by the project proposal the tests were done for the following parameters: Carbohydrates, protein, fat, saturated fatty-acid, monounsaturated fatty-acid, polyunsaturated fatty acid, ash, crude fibre, iron, zinc, folic acid (folate) and riboflavin (vitamin B2). The Trans Fatty-acid and Vitamin K were found to be below qualified limit for all the varieties including Evolutionary population mixture. The qualified limit of the Trans Fatty-acid 0.01 g/100g (LOQ-0.01) and Vitamin K is 0.1 mg/kg (LOQ-0.1).

Similarly for the beans, the nutritional tests were done for the following parameters: Carbohydrate, protein, ash, crude fibre, Iron, Zinc, Folic Acid (Folate), Riboflavin a (Vitamin B2) and Vitamin K. The vitamin K was found to be below qualified limit for all the bean EPB bean varieties including the mixture. The qualified limit of the vitamin K is 0.1 mg/kg (LOQ-0.1).

The details of the nutritional values under each variety of rice and bean are presented in the Annexure 3 and 4.

Review of policies related to PGR conservation and sustainable utilization

Review and analysis of the national and international policy initiatives on conservation and sustainable use of evolutionary breeding products was one the key components of the EPB project. The review was to find out the national policies, legal frameworks and strategies that influence conservation and sustainable use of PGRFA for agricultural development including EPB activities.

A total 13 national policies; 9 legislations; and 3 International Conventions and Treaties; were reviewed. It was found that all the above documents had enabling features that supports the conservation and sustainable use of PGRFA. The review report was submitted to the Bioversity International as part of the periodical technical report. Such review reports would support and facilitate in mobilizing funds for the conservation and sustain able use of PGRFA from the international donors.

Coordination and implementation of on-farm conservation of neglected and underutilized crops species

The On-farm conservation project on "Participatory on-Farm Conservation, Sustainable Use and Management of Neglected and Underutilized Crop Species (NUS) for Livelihood and adaptation to Climate Change" is supported by the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) under its Fourth Cycle of the Benefit Sharing Fund (BSF). The project is nationally coordinated by the National Biodiversity Centre and is implemented in collaboration with the National Centre for Organic Agriculture (NCOA), Yusipang; Agriculture Research and Development Centrs (ARDC) of Samtenling and Wengkhar; Dzongkhag Agriculture Sectors of Chukha, Samtse, Samdrup Jongkhar and Tashi Yangtse; and farming communities of Bongo, Tading, Dorokha, Orong, Wangphu, Yalang and Boomdeling involving over 400 direct farmer beneficiaries.

The project focuses on conservation and sustainable use of neglected and underutilized crops species that includes three millet species namely, Finger millet (*Eleusine coracana*), Foxtail millet (*Seteria italic*) and little millet (*Panicum miliaceum*). Our farmers grow these crops in small pockets as an insurance against crop failures, for nutritional supplements, traditional and religious values and for saving seeds. However, these crops are being marginalized and displaced due to various reasons, such as, limited attention from the research and development programs, lack of seed production and supply, poor awareness on the nutritional contents, crude manual milling and processing techniques, and displacement by other crops. Considering these issues and challenges, the project is focusing to improve management and maintenance of these crops through value addition from seed diversification, seed quality improvement to postharvest processing techniques. The implementation of this project is aimed at contributing to achieve the following objectives.

i. Enhance conservation and sustainable use of Neglected and Underutilized crop Species (NUS).
ii. Strengthen informal seed systems.
iii. Improve the utilization of NUS through value addition, product development and diversification.
iv. Promote education and awareness on importance of NUS in the face of climate change.
v. Build capacities on conservation and sustainable use of NUS and climate change impacts and risks.
vi. Promote Millet as an organic crop for household income generation.

Key activities and Results

Foxtail Millet

On-station evaluation and characterization of neglected and underutilized species

As a collaborative on-farm conservation effort, ARDSC Khangma under ARDC, Wengkhar has evaluated the millet varieties from gene bank. During the FY 2021-2022, ARDSC Khangma was selected to carry out the activity on foxtail millet based on its location and suitability of the trials as accessions were mostly from Samdrupjongkhar and Pemagatshel Dzongkhags. 26 accessions were evaluated and from the total accessions, 4 had very low seed viability and 2 had very low survival rate after transplanting. Hence, evaluation and characterization data were collected for 20 Accessions for 10 different characters from 10 plants from each Accession. Biodiversity International Descriptor list was used as a standard data collection format. The expected output for the Research Center was selection of productive varieties for further dissemination and utilization by the interested farmers. It also contributed in gathering important information on phenotypic characters of the millet accessions.

The foxtail millet accessions BTNC1786, BTNC2608 and BTNC2467 were selected based on the yield considering its yield and adaptation in the region. The selected accessions were shared with the NCOA Yusipang and ARDC Samtenling for further evaluation and seed multiplications for the participatory variety selection and promotion in the NUS sites in their respective region.

Enhance conservation and sustainable use of Finger Millets in Boomdelling, Trashi Yangtse

NUS site at Cheng Bomdeling has an excess production of approximately 15 MT of organic finger millets in the chiwog. It is processed into flour and commonly consumed. It is also brewed as well as used as animal feed. In addition, small quantities of millet flour are sold for income generation in the locality, however the quality of the flour is poor mainly due to crude manual milling techniques. To this, NUS project has supported high end flour mill and millet de-husking machine under the coordination of the ARDC Wengkhar. On establishment and testing the machines, it was handed over to the farmers group of Cheng village following the cost sharing scheme 30%. It is benefiting over 280 households.

Rehabilitation and promotion of NUS through Participatory variety Selection

During the baseline information collection, it was observed that the cultivation status of the neglected and underutilized crops species (Finger millet, Foxtail millet, Little Millet) in all the sites have drastically declined comparing to the past years. Currently, it is grown in very small pockets by only very few farmers. Guided by the Center's vision and the project project's goal of conservation and sustainable use, the project has helped to revive and promote the varieties through participatory variety selection. The participatory variety selection trial and evaluation is still ongoing in the project sites. The varieties used and revived under each site is presented in the table.

Amaranthus

The varieties used and revived under various project sites through PVS.

NUS Crops Revived and Promoted			
Site	**Finger Millet**	**Foxtail Millet**	**Little Millet**
Bongo	Setho	Jabcham	
	Memja	Kacham	
		Napcham	
		Lingphub	
Tading Dorokha	Lung Lung		
	Jatsho		
	Serey		
	Eglung		
	Sarrja		
	Gashey		
	Sari		
	Chagdho		
	Lungjha		
Orong & Wangphu	Samtenling Memjha 1	Drujaymo	Chera Tsalu
		Apchi Yangra	Chera Baling Mo
		Khang Yangra	
		Munchar Yangra	
		Rongshong	
		Yangra	
		Shorpo Yangra	
Yalang & Boomdeling	Khoshomo		
	Khrey		

3.2. Ex-situ Conservation of Crop Genetic Resources

Explore and collect germplasm of traditional crop varieties

Crop diversity is the foundation of agriculture, enabling it to evolve and adapt to meet the never-ending challenge of sustainably producing sufficient and nutritious food for an increasing population. Crop diversity is a key to seed, food and nutrition (SFN) security and is a prerequisite for sustainable agriculture. Crop diversity translates to nutritional diversity and therefore the dietary diversity that contributes to the good health of the population. Crop diversity is the reservoir of diverse genes for current and future crop breeding and varietal development to meet the changing needs of the nation. Crop diversity is one of the mechanisms for climate change adaptation. Crop diversity is intricately linked to Bhutanese traditions and culture. There are many crops and their varieties that are packed with numerous vitamins and minerals some of which are not even discovered by scientific research.

Apparently, despite tremendous benefits to humanity rendered by the natural biological wealth, the prevalence of genetic erosion of many crops and varieties are on the rise in Bhutan.

Therefore, germplasm exploration and collection were conducted in 2 Gewogs viz. Gongdue and Sherimuhung Gewogs under Mongar Dzongkhag.

Gongdue collection:

A total of 51 samples of crop germplasm of different crops have been collected from Gongdue Gewog.

Sherimuhung collection:

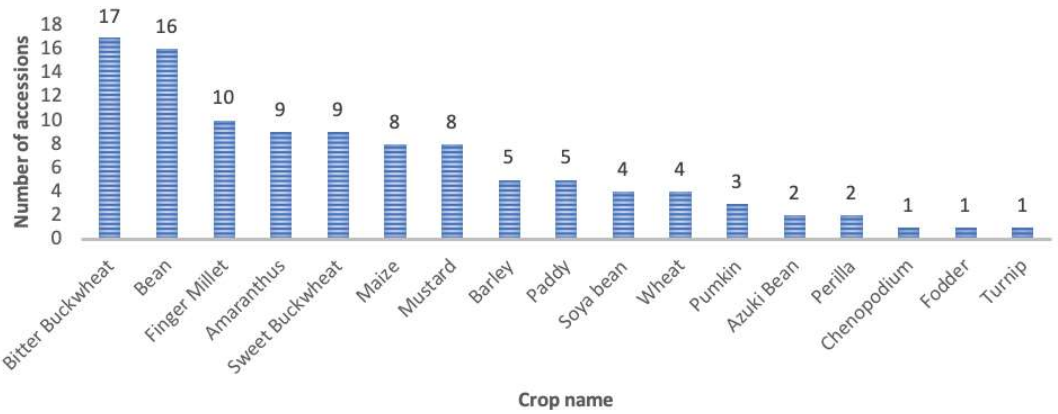
A total of 45 germplasm samples of different crops covering 24 species have been collected from Sherimuhung Gewog that were available at the time of seed collection.

Sl. No.	Crop Name	No. of New Accessions
1.	Bitter Buckwheat	17
2.	Bean	16
3.	Finger Millet	10
4.	Amaranthus	9
5.	Sweet Buckwheat	9
6.	Maize	8
7.	Mustard	8
8.	Barley	5
9.	Paddy	5
10.	Soya Bean	4
11.	Wheat	4
12.	Pumkin	3
13.	Azuki Bean	2
14.	Perilla	2
15.	Chenopodium	1
16.	Fodder	1
17.	Turnip	1
	Total	**105**

Variation of flowers of beans being multiplied.

Processing, assessment, documentation and transference of germplasm in the National Plant Genebank

Total of 105 crop germpasm accessions from 19 crops have been assessed, documented and accredited into the National Genebank for Long-term, Medium-term conservation and for Safety Duplicate maintenance.



Crop wise accessions accredited in the genebank.

Refilling of germplasm in the Community Seed Bank

The National Biodiversity Center, Serbithang, in collaboration with Dzongkhag Agriculture Sector established Bumthang Buckwheat House and Community Seed Bank (CSB) at Chamkhar under Chokhor Gewog in 2011. The Buckwheat House and the Community Seed Bank was formally inaugurated by the Minister of Agriculture and Forests on 17th December 2011 to commemorate Royal Wedding and the 104th National Day. The rationale behind the establishment of the BBH and BCSB was in recognition of the importance of agricultural biodiversity for national food security, agricultural resilience and sustainable development in the face of emerging challenges of global warming and climate change. The CBSB is a treasure house that houses the seeds of traditional varieties collected from farmers' fields.

The Buckwheat house and Community Seed Bank is being managed by Buckwheat group Farmers (Sonam Rangzhin Chigthuen Tshokpa) with support from the Dzongkhag Agriculture Sector and NBC.

It was high time to re-fill the seeds in the Bumthang CSB. Therefore, seed stock in was refilled in collaboration with the Dzongkhag and Gewog Agriculture Sector.

Sonam Rangzhin Chigthuen Tshokpa, who are managing the CSB & Buckwheat house.

Seed stock refilling

Assessment of aberrations, validation and strengthening of information in the GBIS

Old accessions that were collected from 2005 to 2012 are deficient in information on geographic coordinates. The information on geographic coordinates of where the accessions were collected from is crucial to carry out mapping of the accessions, conducting an assessment on coverage, gap and other climatic characterization of the accessions to promote their utilization.
Therefore, geocoding was conducted for accessions from 3 Gewogs viz Ruepisa, Tashiding and Semjong in consultation with Gup, Ex-Gup and Key Informant Farmer of these Gewogs with the use of google earth and QGIS. A total of 51 accessions have been geocoded and geocoded information fed in the GBIS.

This method can be deployed for geocoding for the rest of the data deficient accessions in terms of geographic coordinates to improve the passport information of the accessions being conserved in the genebank. Once geocoding for all the accessions are completed, the information will be useful to conduct eco-geographic characterization of the accessions. The staff venturing into the field for germplasm collection henceforth should make precise geographic coordinates reading and information should be entered in the format of decimal degree and not in the format of degree, minutes and seconds.

Geo-coding with KIF

Recalcitrant Crops conservation in the form of living plants

Recalcitrant crops are those crops the seeds of which do not survive drying and freezing during ex-situ conservation. By and large, these seeds cannot resist the effects of drying or temperatures less than 10 °C (50 °F) and thus, they cannot be stored like orthodox seeds through ultra-desiccation and freezing. Therefore, this group of crops is conserved through in-vitro preservation and conservation in the form of living collection.

Since we do not have technical expertise in in-vitro preservation, the protocol for in-vitro preservation. Since Bhutan is a new entrant into ex-situ conservation, we started working on orthodox seeded crops. Very recently we also started our efforts on recalcitrant crops. The recalcitrant group of crops we have at the National Plant Genebank are mostly potato, garlic and onion species. Maintaining recalcitrant crops in the field is a part of the annual activity. Currently, a total of 11 potato, 7 garlic and 3 onion germplasm samples are being annually regenerated on-station and maintained in the form of the living collections.

Phenotype of Kangpara chili

Small Sample Seed multiplication/Seed Viability Test/Phynotypic data

During the germplasm collection, we often land up with a very small quantity of seed samples which does not meet the criteria in terms of quantity of seeds to accredit into the Genebank. However, if such germplasm is not collected as and when we come across it, we may lose it forever. Therefore, when we come across such small samples, the seed lot is divided into 2 halves of which 1half is left for the farmer and the other half is brought to the genebank. Such small samples on arrival at the Genebank are required to be multiplied with extra care to meet the criteria on the quantity of seeds to accredit into the Genebank.

Therefore, germplasm samples of a total of five (5) bean varieties and two (2) chili varieties were multiplied, processed, documented and conserved in the National Plant Genebank.

Viability of Chili accessions in the field condition and Phynotypic data collection

Besides checking the viability of accessions that are being conserved in the Genebank in the laboratory condition using seed incubators, five (5) accessions of beans that were initially collected from Tsirang and two (2) accessions of chili that were collected from Kangpara were randomly selected from the conserved materials to check germination viability in the field condition and also simultaneously to collect phenotypic information using the same seed stock in order to avode depletion of seed quantity, using International Descriptor list.

Donor farmer displaying different varieties of cereals.

Viability percentages in the field condition were also very good with germination percentages ranging from 90 to 100 percent for beans and chili.

The phenotypic data has been collected and documented in the GBIS for each of the 5 accessions of beans and 2 varieties of chili to expand the information about each accession and thus add value to the conserved germplasm.

Safety back-up

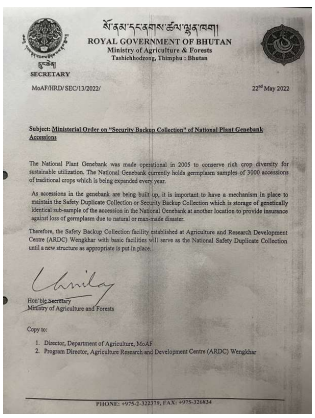
The National Plant Genebank was made operational in 2005 to conserve rich crop diversity for sustainable utilization. Ever since the operationalization of the National Plant Genebank, the NBC has been making concerted efforts to explore, collect, rescue and conserve germplasm of crop diversity in the National Plant Genebank. The National Genebank currently holds germplasm samples of 3000 accessions of traditional crops which is being expanded every year.

As we continue building up the accessions in the genebank, it is important to have a mechanism to maintain the Safety Duplicate Collection or Security Backup Collection which is the storage of genetically identical sub-sample of the accession in the National Genebank at another location to provide insurance against loss of germplasm due to natural or man-made disaster. Different countries have a different mechanisms in place to maintain their Safety Duplicate Collection. Some countries around the world whose genebanks have been in operation for a long time have also opted to maintain their Safety Duplicate Collection in the Svalbard Global Seed Vault in Norway which provides insurance against loss of crop diversity held in traditional genebanks due to natural or man-made disaster. The Svalbard Global Seed Vault is owned and administered by the Ministry of Agriculture and Food on behalf of the Kingdom of Norway.

Since our National Plant Genebank is still at its infancy stage when compared to other countries, we preferred to maintain Safety Duplicate Collection within the country before opting to send it to an outside country. Accordingly, Agriculture and Research Development Centre (ARDC) Wengkhar showed keen interest in maintaining Safety Duplicate Collection at Wengkhar. Since we did not have the budget for a new structure, NBC had supported the renovation of an old structure which has been installed with very basic minimum equipment for storage of Safety Duplicate Collection in 2015. The backup generator also has been installed. The Safety Duplicate Collection is being transferred from NBC to ARDC Wengkhar in batch-wise every year.

The Safety Duplicate Collection at Wengkhar will serve as the National Safety Duplicate Collection until a new structure as appropriate is put in place. A total of 2 monitoring visit was made to the Safety Backup Collection in December 2021 and June 2022. Further, Ministry also issued a Ministerial Order formally on 22nd May coinciding with International Biodiversity Day declaring that ARDC Wengkhar will serve as the National Backup Collection of the germplasm collection maintained at the National Plant Genebank, NBC. The Ministerial order recognizes the significance of maintaining the Safety Duplicate Collection which is important to ensure long-term conservation of the rich aerobiological wealth of the country.

Working at the Safety back-up gene bank



ROYAL GOVERNMENT OF BHUTAN
Ministry of Agriculture & Forests
Tashichhodzong, Thimphu : Bhutan

SECRETARY

MoAF/HRD/SEC/13/2022/ 22nd May 2022

Subject: Ministerial Order on "Security Backup Collection" of National Plant Genebank Accession

The National Plant Genebank was made operational in 2005 to conserve rich crop diversity for sustainable utilization. The National Genebank currently holds germplasm samples of 3000 accessions of traditional crops which is being expanded every year.

As accessions in the genebank are being built up, it is important to have a mechanism in place to maintain the Safety Duplicate Collection or Security Backup Collection which is storage of genetically identical sub-sample of the accession in the National Genebank at another location to provide insurance against loss of germplasm due to natural or man-made disaster.

Therefore, the Safety Backup Collection facility established at Agriculture and Research Development Centre (ARDC) Wengkhar with basic facilities will serve as the National Safety Duplicate Collection until a new structure as appropriate is put in place.

Hon'ble Secretary
Ministry of Agriculture and Forests

Copy to:
1. Director, Department of Agriculture, MoAF
2. Program Director, Agriculture Research and Development Centre (ARDC) Wengkhar

PHONE: +975-2-322371, FAX: +975-324824

Ministerial order recognizing ARDC Wengkhar to serve as National Back-up Collections

Other Activities

Monitoring the implementation of 2nd Global Plan of Action on Plant Genetic Resources for Food and Agriculture (GPA-PGRFA)

The National Biodiversity Center is the Focal Point for the Commission on the Genetic Resources for Food and Agriculture (CGRFA) of the Food and Agriculture Organization (FAO) of the United Nations. Thus, the Centre is obliged to monitor and report the implementation of the Second Global Plan of Action (GPA) on Plant Genetic Resources for Food and Agriculture. To this, the National Focal Point was required to consult with the relevant agencies under the Ministry of Agriculture and Forests for the related information. Therefore, a series of stakeholder consultations were conducted covering 8 stakeholders viz. ARDC Bajo, ARDC Wengkhar, NCOA, ARDSC Tsirang, ARDSC Lingmithang, ARDSC Khangma, NSC and BAS during which, the following activities were implemented:

- The NBC team provided background information on Bhutan's membership to FAO, FAO's subsidiary bodies like the Commission on Genetic Resources for Food and Agriculture, International Treaty on Plant Genetic Resources for Food and Agriculture, second Global Plan of Action on Plant Genetic Resources for Food and Agriculture (GPA-PGRFA), 18 priority areas of 2nd GPA on Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture and the need for reporting on second GPA.
- The NBC team then demonstrated the use of the online reporting tool WIEWS which the stakeholders are required to use to upload information. However, due to the complexities of the reporting tool, the NBC team took up the responsibility of registering each of the stakeholders in the online reporting tool
- Then the information was prepared in response to questions in 18 priority areas on behalf of each stakeholder
- Entered the information on the relevant questions of the 18 priority areas into the WIEWS reporting tool.

The meeting was attended by 37 participants from various relevant stakeholders viz. ARDSC Tsirang (11), ARDC Wengkhar (4), ARDSC Lingmithang (3), ARDSC Khangma (4), ARDC Bajo (5), NCOA Yusipang (3), and NSC Paro (6), Bhutan Alpine Seeds (1).

Stakeholders' consultation on 2nd GPA & WIEWS online reporting tool at ARBSC Tsirang

Stakeholders' consultation on 2nd GPA & WIEWS online reporting tool at NSC, Paro.

Stakeholders' consultation on 2nd GPA & WIEWS online reporting tool at ARDC, Wengkhar.

Series of virtual meetings attended

1. The open-ended working group on Post-2020 Global Biodiversity Framework.
2. The Global Dialogue and High-level Segment on the Role of Food and Agriculture in the Global Biodiversity Framework.
3. The Assessment of Plant Variety Protection Laws: The Case of Vietnam.
4. Expert Workshop on Crop Wild Relatives Documentation: findings from the project.
5. 20th session of CGRFA from 27th September to 1st October, 2021.
6. Participated as a discussant in the meeting on "Regulating Farmers Seed saving practices and intellectual property rights.
7. 5th Adhoc Conservation and Sustainable Utilization (ACSU) meeting organized by FAO.
8. Webinar with MSK Pvt. Ltd on transfer of technical know how and scientific knowledge on analysis of oil samples.
9. 2nd International Agrobiodiversity Congress: Agrobiodiversity for Food System Transformation.
10. The first special session of the governing body of the international treaty on plant genetic resources of Food and Agriculture.

4. Bioprospecting and Access & Benefit Sharing (ABS) Program

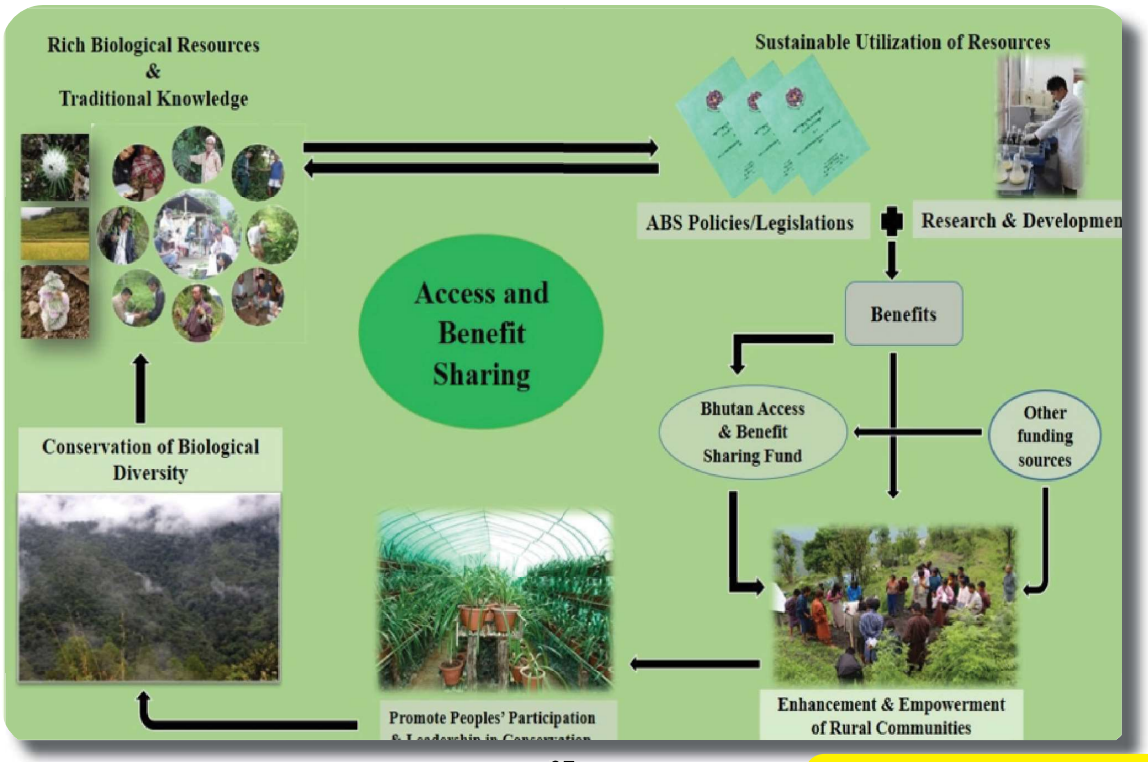
Bhutan become a party to and ratified the UN Convention on Biological Diversity in 1995. The Convention on Biological Diversity has three pillars viz: conservation of biological diversity; sustainable use of its components; and fair and equitable sharing of benefits arising from their utilization. To further the third pillar of the convention, the Nagoya Protocol was adopted in 2010 at Nagoya Japan which Bhutan ratified in 2012 by the 9th session of the first parliament of Bhutan. The Nagoya Protocol will enable meaningful ABS collaborations and enhance research & development that will benefit the country and the people at large through regulated access to biological resources in the country.

The Bioprospecting and ABS Program was instituted in 2009 during the 10th FYP under the directive of the Ministry of Agriculture and Forests with the rationale to build national capacities to understand the value of Bhutan's biological resources and/or associated traditional knowledge, and to explore measures to generate economic benefits from these resources.

The program serves as the national focal point for Nagoya Protocol on ABS and focuses mainly on the biodiscovery research on potential Bhutanese biological resources and associated traditional knowledge under the framework of ABS in order to derive economic benefits for the enhancement of rural livelihood and promotion of peoples' participation and leadership in conservation.

A basic-equipped bioprospecting laboratory and oil distillation facility for biodiscovery research has been established within the program with the capacity to conduct basic phytochemical analysis and has built a collection of more than 1200 traditional knowledge based plant extracts to date.

The program also manages the Bhutan ABS Fund established as a plough-back funding mechanism to receive monetary benefits accrued from access to genetic resources or its associated traditional knowledge and support biodiversity conservation initiatives.



Current Status

A total of 13 ABS agreements have been successfully executed with national as well as international users of genetic resources and its associated Traditional Knowledge which has resulted in the development of 12 nature-based products. A close to 10 Community Based Natural Resources Management (CBNRM) groups have been engaged to promote community participation and leadership in conservation.

To date, more than 300 MTAs have been facilitated for academic and commercial research. The documentation of TK associated with biological resources has been completed in all the 205 Gewogs. Currently, the Bhutan ABS Fund has a total of Nu. 12 million generated from ABS initiatives.

Achievements

The SUBLIMAGE L'EXTRAIT launched:
The SUBLIMAGE L'EXTRAIT, a nature-based cosmetic product has been launched by Chanel Parfums Beaute, France in October 2022 using an active ingredient from the Swertia cirayita domestically grown by the Pedmai Tshothang Ngomen Khalui Bedrur Dey, a community-based group at Lauri Gewog, Samdrupjongkhar under the ABS framework in collaboration. As a supply chain for the product, a 58 members group has been formalized as a cooperative with a bylaw governing the work process and management of the group.

Benefit Sharing by the *Pedmai Tshothang Ngomen Khalui Bedrur Dey:*
The *Pedmai Tshothang Ngomen Khalui Bedrur Dey,* a community-based group involved in the *Swertia chirayita* project made a symbolic contribution of Nu. 185500.00 to the Bhutan Access and Benefit Sharing fund from the monetary benefits derived from the ABS collaboration with the Chanel Parfums Beaute, France.

Biodiversity Act of Bhutan 2022 Enacted:
After being introduced in the fifth session of the National Assembly of Bhutan in June 2021, the much-awaited Biodiversity Bill of Bhutan 2021 has been passed by the sixth session of the National Assembly of Bhutan in December 2021. Both houses of the Parliament of Bhutan passed the Bill in their seventh session in June 2022 and received for the Royal Assent and entered into force after the Royal Assent on 15th July 2022.

Rhododendron shrub land

A scoping agreement executed between NBC and the Blue Zones Group:
A scoping agreement has been executed between the Bluezones Group, Switzerland and the NBC with the College of Natural Resources as their local partner for the research. Under the purview of the agreement, the Blue Zones Group will conduct research on the native wheat and barley to explore their potential use in the pharmaceutical and cosmetic industries.

31 Material Transfer Agreements:
31 Material Transfer Agreements were executed to facilitate transfer of biological resources for academic and commercial research.

Potential medicinal plants:
Eight potential medicinal plants: *Tinospora cordifolia, Cissampelopsis volubilis, Achyranthes aspera, Primula sikkimensis, Oroxylum indicum, Rosa brunonni, Prinsepia utlis* and *Curcuma caesia* has been sent to Chanel PB lab for research and development to explore their potential in pharmaceutical, cosmetical and nutraceutical industries. Currently, they are being researched at Chanel PB's lab in France.

Alternative site for *Primula sikkimensis*:
Alternative site for research and development of *Primula sikkimensis* established at the Yaksha, Tsento, Paro under the Chanel PB project.

Participation in the Convention on Biological Diversity Meetings:
Participated in the negotiation and discussion in the meeting related to the Convention on Biological Diversity and the Nagoya Protocol and in particular Post 2020-Global Biodiversity Framework.

August 23 – September 3, 2021: 3rd meeting of the Open-ended Working Group on the Post-2020 Global Biodiversity Framework (Virtual).

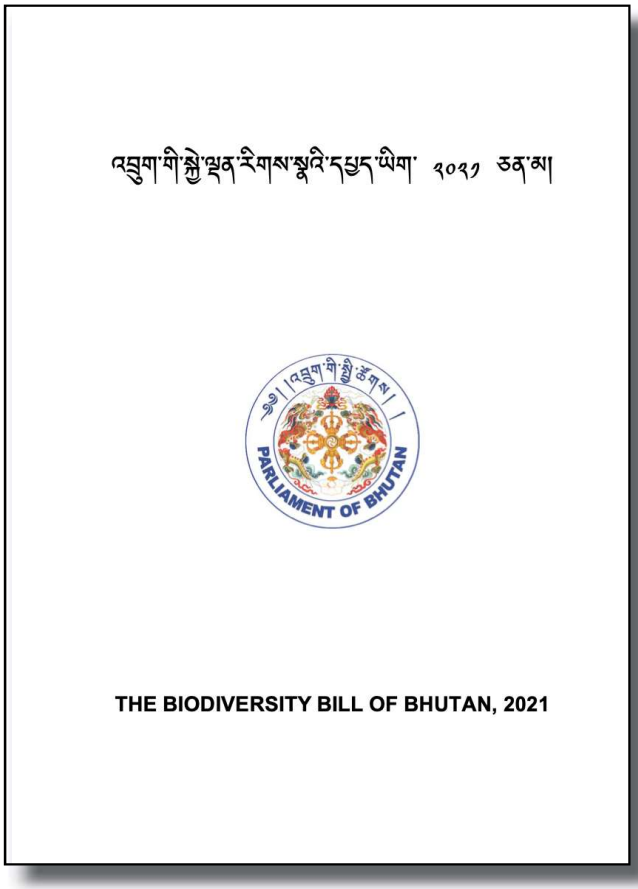
October 11-15, 2021: First part of the 15th meeting of the Conference of the Parties to Convention on Biological Diversity, 10th meeting of the Conference of the Parties to the Cartagena protocol on Biosafety and 4th meeting of the Conference of the Parties to the Nagoya protocol on ABS (Virtual).

March 13-29, 2022: Resumed sessions of Conference of Parties (CoP) of the Convention on Biological Diversity (CBD): SBSTTA 24, SBI 3, and WG2022, Geneva Switzerland (Virtual).

Participation in other meetings:
Represented NBC in numerous fora and presented about Bhutan and its experience in implementing biodiversity conservation programs and access and benefit sharing regime in Bhutan:

- **November 25, 2021:** Access and Benefit Sharing Workshop Bhutan organized by the National Institute of Genetics, Japan (Virtual)
- **November 16, 2021:** 6th North Eastern Green Summit-A Holistic Approach on Value Chain Development for Agriculture, Horticulture and Medicinal Plants, Assam, India (Virtual).
- **December 24 - 25, 2021:** International Conference on 'Minor Forest Produce for Health Security', Madya Pradesh, India (Virtual).
- **June 22, 2021:** 24th DrukRig Colloquium (Virtual).
- **July 20, 2021:** National Policy Dialogue on the Community-based landscape management for resilient ecosystems Thimphu Bhutan.
- **August 19, 2021:** National Consultation on Post 2020 - Global Biodiversity Framework, Paro Bhutan.
- **November 26, 2021:** National Consultation on Non-wood Forest Products in Bhutan, Thimphu Bhutan.
- **September 8-9, 2021:** 6th Annual Research Symposium, Bhutan Ecological Society, Thimphu Bhutan.
- **April 18, 2022:** Stockholm+50 National Consultation in Bhutan
- **23rd June 2022:** National Conference on Securing the future through localizing and implementing SGGs.
- **October 2, 2022:** Research Conference on Development and Resilient in Bhutan-Regulating Farmer Seed-Saving Practices and Plant Intellectual Property in Bhutan (Virtual).

His Excellency, Sanam Lyonpo introducing the Biodiversity Bill to the 7th Session of the National Council of Bhutan (Photo: NCB).



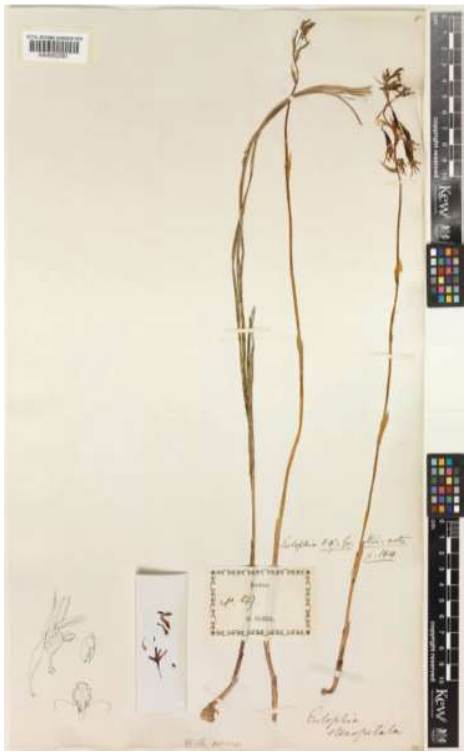
Pleione hookeriana

5. National Herbarium

"A herbarium is a collection of plant specimens, which have been pressed, dried, mounted on herbarium sheets, identified and classified according to some approved system of classification."

The nationally significant Flora of Bhutan project was initiated in 1975, when the major botanical expeditions were undertaken with the initiation of the publication of the three volumes of the Flora of Bhutan. The past collections were mainly deposited at the renowned international herbaria of the Royal Botanic Garden Edinburgh (E), the Royal Botanic Garden Kew (K), the Natural History Museum (BM), Tokyo University (TI) and Indian Botanic Garden (CAL) to name a few, although some of the duplicates were retained in Bhutan. Past collectors were primarily English Botanists, amongst them, the first one was William Griffith, who visited Bhutan in 1838. Several others made botanical expeditions later in early 1900s. Recognizing the importance of the plant taxonomy work in the country, a need for proper infrastructure to house the specimens and to initiate taxonomic research in the country was acknowledged. In 1998, the National Herbarium was established at the National Biodiversity Centre, Serbithang and in 2003 it became operational with the basic facilities and the Flora of Bhutan publications were completed with financial support from DANIDA. The support further assisted in building human capacity in the fields of botany, taxonomy, and herbarium techniques and national and international collaboration linkages. The National Herbarium (THIM) is the first and the only internationally accredited herbarium in the country.

Inside the National Herbarium, Thimphu



Specimen of an orchid - *Eulophia stenopetala,* collected by William Griffith from Punakha in 1800s. This orchid was declared as extinct from wild since several expeditions in search of this species had never found it again. This specimen is housed in the herbarium of Royal Botanic Gardens Kew, London, UK.

Another historical specimen housed in the hebarium of Royal Botanic Gardens Kew, London, UK. *Kydia glabescens* was collected by William Griffith in 1800s.

Fern housed in herbarium of Royal Botanic gardens Kew, London, UK.

This is the specimen of *Potentilla spodiochlora* collected by R.E. Cooper in 1914 (over 105 years old) from Lingshi, Thimphu. His collections are the oldest ones housed in the National Herbarium (THIM).

Significance

In the era of global change, the urgent need to understand the knowledge of plant resources is increasingly recognized worldwide to protect and conserve potentially valuable species. The very key to conservation of biological resources depends on a comprehensive inventory. **"Unless we know what species, we have we would not know what to conserve."** The herbarium provides a basic understanding about the components of biodiversity which is crucial for effective decision-making about conservation and sustainable utilization.

Taxonomic knowledge is essential to conduct surveys of commercially valuable species and to be able to assess the potential of each species for cultivation and sustainable management. The initiatives such as discovery of species new to science, species prioritization for conservation, knowing conservation status of species, conservation planning of threatened and rare species, identification and combating harmful invasive species, floristic research etc. will be hampered due to limited taxonomic knowledge.

The taxonomic information along with habitat, location and associated plants recorded during specimen collections at particular time is essential to determine plant diversity and their distribution patterns.

Herbarium specimens that document a botanical research and serve as a permanent record giving the study substance, repeatability and longevity are known as voucher specimens. Without voucher specimens, a study loses its significance. Most importantly, herbarium specimens are used as tools to evaluate and monitor the impact of climate change on phenological responses such as leafing out, flowering, fruiting and retaining leaves for longer periods.

Botanical expedition in higher elevations in Bhutan (2019)

These are some of the basic equipment/materials used in herbarium techniques.

Current Status of Collections (Bhutan Biodiversity Specimen Portal)

Taxa	Species	Specimens
Tracheophytes (angiosperms & gymnosperms)	2867	14927
Pteridophytes (Ferns & allies)	406	2232
Bryophytes (mosses)	213	934
TOTAL	**3486**	**18093**

Functions

1. National Herbarium serves as a repository of "type" and vouchers specimens of plants and associated data - the foundation for all other kinds of botanical research.
2. Lead taxonomic/systematic work by revising and updating nomenclature and classification based on new and emerging evidences and science (Taxonomy/systematic is not a static science and is not delimited by national boundaries).
3. Lead National Floristic work - revision of the Flora of Bhutan, which goes beyond state forest and protected areas system.
4. National Herbarium utilizes molecular laboratory for Taxonomic and Systematics studies.
5. National Herbarium uses Bioprospecting laboratory for Chemo-taxonomy for analysis of biochemicals in plants for species determinations.
6. National Herbarium uses Thematic Garden of Royal Botanical Garden such as Orchid House for Taxonomic Studies and revision.
7. Promote regional and international linkages for technology transfer and effective conservation and management of botanical diversity.

Achievements

Around 101 additional species of plants collected and documented for the National Herbarium, including nine new records for Bhutan. This was against the APA target of 100 new species added to the collections annually in an attempt to document underrepresented plant species from their natural habits.

Begonia silletensis, Begoniaceae – a new record for the Flora of Bhutan, documented (January 2022) from Panbang, Zhemgang.


BHUTAN
LIFE

6. Royal Botanical Garden Serbithang

The initial establishment of the Royal Botanic Garden in 1999 was facilitated through the funding support of BTFEC, where basic infrastructure of the garden was developed. Further, in order to implement activities to achieve its objective, BTFEC provided a 2nd phase grant amounting to Nu. 5.515 million from July 2001 to January 2004. Post-2004, the garden was mainly funded through the Royal Government of Bhutan (RGoB), with the exception of the Darwin Initiative project implemented from 2004-2006 to develop capacity of the staff and garden through a technical exchange program with Royal Botanic Gardens, Edinburgh.

The garden also carries out activities on the rescue and restoration of rare and threatened plant species. Recently, the garden has initiated tree-seed collections with support from the Royal Botanic Garden, Kew, UK for long term conservation of the woody plant diversity through plant conservation assessments, seed banking, seed longevity research and capacity building.

To serve as an educational resource and to create awareness on biodiversity conservation, the first of its kind Biodiversity Interpretation Centre has been established at the Garden with the support from the European Union (EU-SSP and EU-RDCCRP), UNDP and Botanic Gardens Conservation International (BGCI). The garden has been making significant contributions to the Royal Bhutan Flower Exhibitions and other national events.

Achievements

1. Seventh Royal Bhutan Flower Exhibition at Mongar

The 7th Royal Bhutan Flower Exhibition was held at Gyelposhing and Mongar from 2nd May, 2022 to 6th May, 2022. The event was dedicated to His Majesty the Third Druk Gyalpo Jigme Dorji Wangchuck in commemoration of His Majesty's birth anniversary. Representatives appointed by the MoAF and Mongar Dzongkhag coordinated the overall program and inaugurated on 2nd May, 2022 by the Royal Patron, Her Majesty Gyalyum Ashi Tshering Yangdoen Wangchuck, HRH The Gyaltshab Jigme Dorji Wangchuk and Ashi Yeatso Lhamo Wangchuck. Their Majesties also graced the concluding ceremony of the 7th RBFE on 6th May 2022. His Excellency Lyonpo Yeshey Penjor, Minister for Agriculture and Forest and Dasho Thinley Namgyel, Secretary of the Ministry of Agriculture and Forest also attended the 7th RBFE programs. The exhibition was also successfully held virtually in view of the COVID-19 pandemic and to bring the show to the people across the country. The Royal Botanical Garden, being one of the main stakeholders for the event successfully produced 44,693 potted plants for the exhibition and took part in the beautification and garden development activities.

The exhibition transformed the entire town of Gyelpozhing and Mongar. Desuup skilling Program in floriculture was also held together with the flower show and was successfully completed by training thirteen Desuups in floriculture and landscaping. No flowers or cut flowers were imported during the flower show as enough plants were produced for the show along with cut flowers which is a significant achievement so far in the history of the RBFE.

Flower exhibitions at Gyelpozhing, Mongar

2. 114th National day celebrated at Thimphu, Tashi Chhoe Dzong

The Royal Botanical Garden, Serbithang was one of the main stakeholders for the beautification at the Tashi Chhoe Dzong for the celebration of the 114th National Day on 17th December, 2021. The Garden contributed about five thousand annual flowers and decorative pots for the beautification works. The flowers had to beat the harsh winter frost on the morning of 17th December, and many of the plants were killed by the frost. The event beautification was done in collaboration with the Royal Project Coordination Office and no plants or cut flowers were imported for the day which is a significant achievement.

There were however, several lessons learned from the event which needs to be addressed. Even though, it was possible for the garden to produce fresh blooming flowers in the peak of winter months, thanks to our polycarbonate house with temperature control the real challenge is when the plants are taken out and displayed in the courtyards of the Tashichhoe Dzong at temperatures below freezing point. The flowers were displayed and covered with green nets and hessian clothes to protect from the morning frost which however, were still not enough and by the morning of the National Day, our precious flowers were perishing in the sun due to the frost of the morning.

Therefore, having the national day celebration somewhere in a warmer place would be much favorable and desirable for the plants at least.

National Day Celebration at the TrashiChhoe Dzong, Thimphu, 2021

3. Micropropagation laboratory established at Royal Botanical Garden

As the garden advances towards the conservation of the threatened species through the techniques of micropropagation, a micropropagation laboratory was constructed at the Royal Botanical Garden. Species of conservation concerns will be propagated through tissue culture techniques to conserve the species and reintroduce them to the wild in the near future. Propagation trails were set up for prioritized species of orchids like *Paphiopedilum fairriaenum, Paphiopedilum venustum* and *Chiloschista gelephuense* among others which have been successfully cultured and are being acclimatized at the orchidarium at the Royal Botanical Garden Serbithang. The funding for the construction and lab equipment procurement was supported by the EU-RDCCRP project.

The laboratory once successfully established will be the first in the country to actually invest and implement in the world of science to bank on the technologies to save our species from going extinct. The National Biodiversity Centre, particularly the Royal Botanical Garden Program would like to thank the European Union Rural Development Climate Change Response Program for the funding support to come up with several facilities like the Orchid Micropropagation Laboratory, New Water tank, Accessible footpath among others.

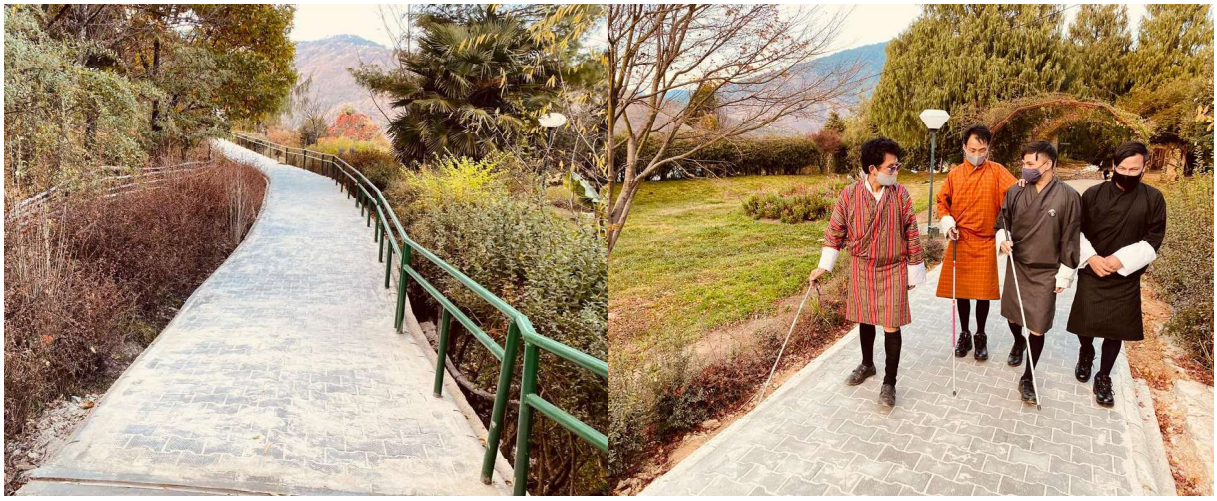
New micropropagation laboratory at the garden

4. Improved accessibility at the Garden

With the funding support from the EU-RDCCRP and the GEF, SGP, UNDP a 187m stretch of footpath from the entrance to the office has been redeveloped to make it accessible to people with disabilities. The footpath contains features like ramp, railings and wheelchair accessible, tactile etc. along with a well-maintained slope for easy navigation of people with disability. The project titled "Nature for All" was implemented in partnership with Zhenphen group which is a group with disability and Disabled People's Organization in addition to our fund supporters. With the redevelopment of the footpaths and some other major facelifting of the garden, the garden is proud to present that the number of visitors at the garden have increased significantly. The entry fee for the visitors have also been revised from July 2022 as follows. Children: Nu. 20 Adults: Nu. 40 which will help in generating revenue for the country. The garden is proud to be socially inclusive of people with disability and is continuously trying to improve the accessibilities at the garden.

An impact fund of AUD 10,000/- only was also applied and granted from the Australian Volunteer's Program Impact Fund to support the soft components of the Nature for All project. This support has been successful in improving the general information sharing within the garden where improved signage and directional information were developed for the visitors. The fund also supported the Zhenphen group with music lessons which will help them produce nature-based songs to create awareness on biodiversity and to support them with their livelihood.

The garden team would like to thank the EU, GEF-SGP, AVP, DPO and Zhenphen group for their support in making our dream of social inclusion a reality. In line with addressing the accessibility issue at the Garden, a two-unit accessible toilet is also in the pipeline to be constructed with the funding support from UNDP which will be completed by the end of 2022. With these facilities in place the garden hopes to be not just a recreational space for the abled but a scientific conservation and awareness Centre for all including people with disabilities.



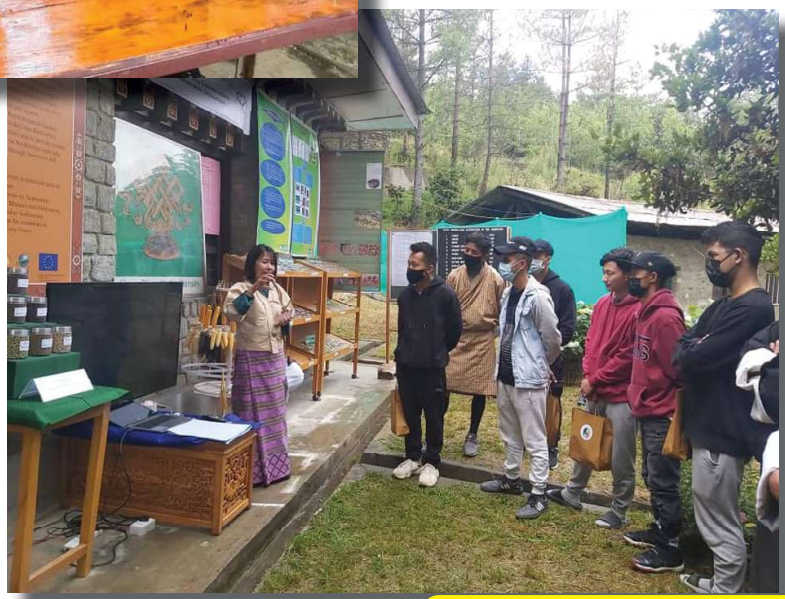
Accessibility for people with disability improved at the garden

5. International Day for Biological Diversity celebrated on 22nd May 2022

International Biodiversity Day (IBD) is a United Nations sanctioned international day to increase understanding and awareness of biodiversity issues. This year we celebrated the day on the theme "Building a shared future for all". The day was observed by the National Biodiversity Centre (NBC), Ministry of Agriculture and Forests at the Royal Botanical Garden by organizing a free biodiversity information day. The day was marked by waiving off the entry fee for all the visitors at the garden on the day and a biodiverse gift hamper comprising of buckwheat cookies, pencils, water, biodiversity pamphlet and a user manual for the biodiversity portal. All the visitors were given a free guided tour of the different thematic gardens and the biodiversity interpretation centre of the Royal botanical Garden. The event raised awareness on the importance of biodiversity conservation and sustainable utilization.

The event was also a remarkable one as it was also joined by our partners of Zhenphen group members who were all persons with disability. It was a successful event with a great social inclusion on the important day of the International Biodiversity Day and it was made remarkable by the handing over of Nu. 100,000/- support to the Zhenphen group to pursue music lessons for two years supported by the AVPIF project Nature for All. The cheque was handed over to the group by Dasho Benji Dorji who graced the event with his presence. The lunch for the day was also supported by the AVPIF project.

Dasho Benji awarding the funding support to the Zhenphen Group in the presence of Dr. Karma Dema Dorji, Program Director of NBC.



Dr. Asta Maya Tamang introducing the agrobiodiversity to the visitors.

6. Increased visitors and awareness

As the third goal of the Royal Botanical Garden in the Vision 2030 document of the National Biodiversity Centre to increase the visitors from the schools in Thimphu, several initiatives were taken to achieve the goal. An official Facebook page was open and constant awareness posts were shared for the followers and others in order to increase awareness on the Botanical Garden and the facilities available.

The Facebook page currently have over three thousand one hundred followers and our posts are being shared quite well. We have received immense number of visitors from different schools in Thimphu at all levels from lower grades to high schools. This is an indication of successful awareness programs being held at the garden especially in terms of environmental education. The increase in number of student visitors is also driven by the fact that the entry fee for the students is waived off to encourage visitors and they are also provided with guided tours around the garden and the Biodiversity Interpretation Centre which is a hit amongst the students.

With the improved accessibility, we now have increased number of visitors with disability which is an indication of successful social inclusion.

Students examining the orchid seeds

Children from the Ability Bhutan Society

Visit of students from various schools in Thimphu

Current Status

The garden currently holds a living collection of more than 800 native plant species which will be increased to 1000 species by the end of the 12th Five Year plan. In the 2021-2022 fiscal year a total of 25 species of live plants and 10 species of seeds were collected as a part of the annual performance agreement. Even though half of the year was invested in organizing the Royal Bhutan Flower Exhibition at Mongar, the Garden was able to achieve the APA target (Annexure 2).

Garden Entry Fee revision:

Visitor Type	From	To
National Adults	Nu. 20	Nu. 40
National Children	Nu. 10	Nu. 20
SAARC Countries	Nu. 50	Nu. 50
International Visitors	Nu. 100	Nu. 100

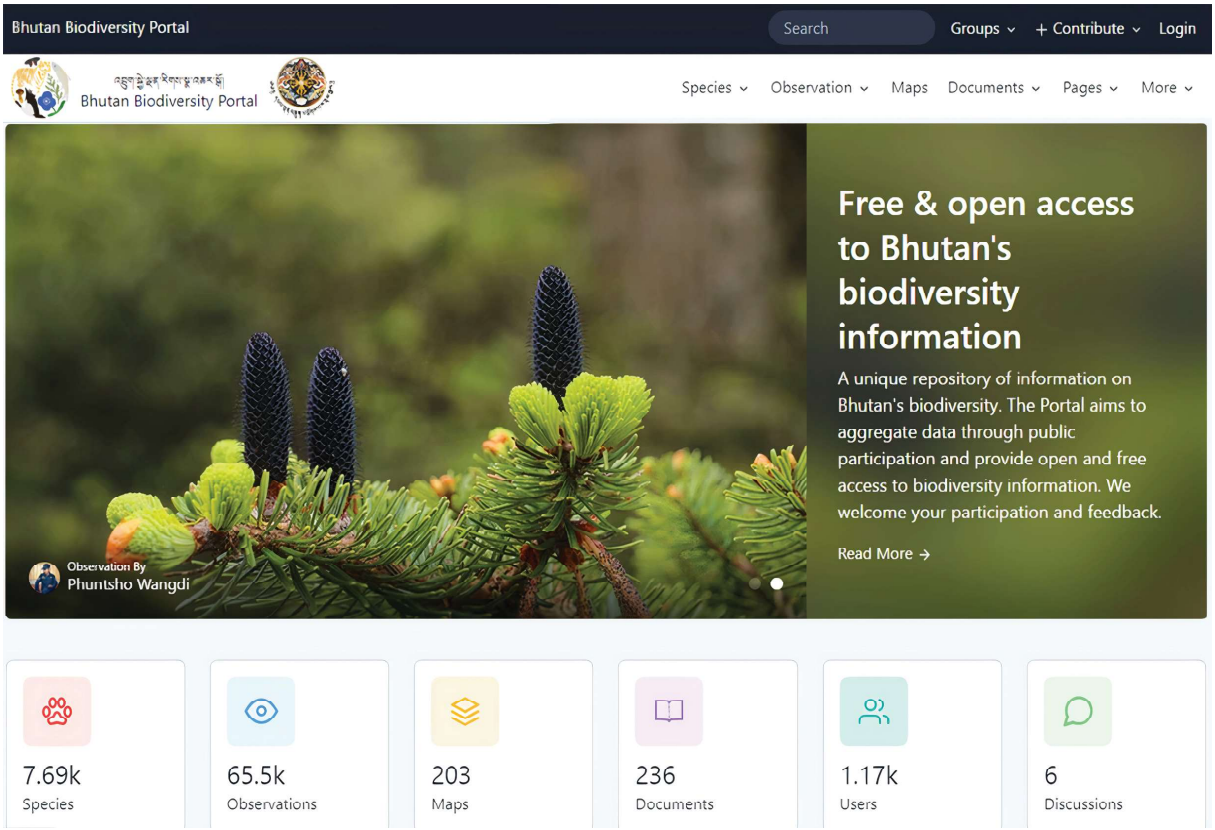
7. Biodiversity Information Management Program

The Biodiversity Information Management Program was initiated in 2003 to coordinate documentation and dissemination of biodiversity information of the country. In 2008 under the framework of South-South Cooperation between Bhutan, Benin and Costa Rica, funded through the government of the Netherlands, NBC developed the biodiversity portal, which currently holds information on the wild and domestic biodiversity of Bhutan. In 2010, the portal was upgraded into the national portal on biodiversity: the Bhutan Biodiversity Portal (www.biodiversity.bt). The portal was officially launched on 17th December 2013. Since then the portal received funding support from WWF Bhutan, National Geographic Society, Global Biodiversity Information Faciltiy (GBIF), and GEF-LDCF/NAPA III project. The portal is technically assisted by the Strand Life Sciences in India.

Currently, efforts are underway to source funds to strengthen the portal as well as the coordination mechanism among the various biodiversity stakeholders to share biodiversity information. In 2019, Biodiversity Statistics of Bhutan was published, reporting more than 11,000 species in the country for the first time. Since then, plans are underway to publish subsequent statistics on biodiversity. The program is the National Focal Point for the Biodiversity for Food and Agriculture under the Commission on Genetic Resources for Food and Agriculture (CGRFA). The program also coordinates the development and implementation of National Biodiversity Strategies and Action Plan (NBSAPs) including the contributions towards the Post-2020 Global Biodiversity Framework. The program also acts as Biodiversity Data Publisher on GBIF.

Current Status

Currently, there are more than 1,970 registered users on the Bhutan Biodiversity Portal and they have contributed a total of 82,400 observations, more than 268 documents and more than 20 datasets related to the country's biodiversity.



Bhutan Biodiversity Portal user interface (www.biodiversity.bt)

Achievements

1. Publication of biodiversity data onto the Global Biodiversity Information Facility

Since the National Biodiversity Centre became Data Publisher on the Global Biodiversity Information Facility (GBIF) in 2020, seven biodiversity datasets were published on GBIF. The seven datasets include: vascular plant species, non-vascular plant species, invertebrate species, vertebrate species, chromista and eubacteria species, fungi species, and the Bhutan Biodiversity Portal data.

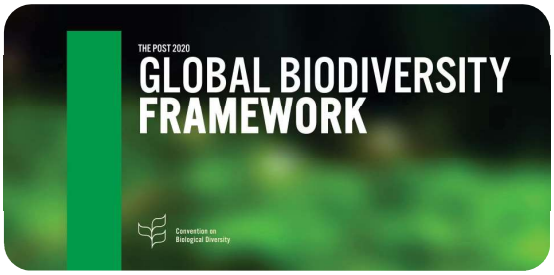
The publication of data on GBIF was supported by BIFA grant from GBIF, and the Australian Volunteers Program including an Australian Volunteer. In addition to the publication on GBIF, a saperate biodiversity data checklist was published on Biodiversity Data Journal (BDJ).

Biodiversity Data Journal

GBIF Global Biodiversity Information Facility

2. Contribution to the Post-2020 Global Biodiversity Framework and NBSAP

As a coordinating program for the National Biodiversity Strategies and Action Plan (NBSAP), the program contributed in stock-taking and assessments of the NBSAP 2014, and also towards the development and negotiation of the Post-2020 Global Biodiversity Framework under the Convention of Biological Diversity (CBD) in collaboration with various relevant stakeholders.



3. NBC joins the World Flora Online (WFO)

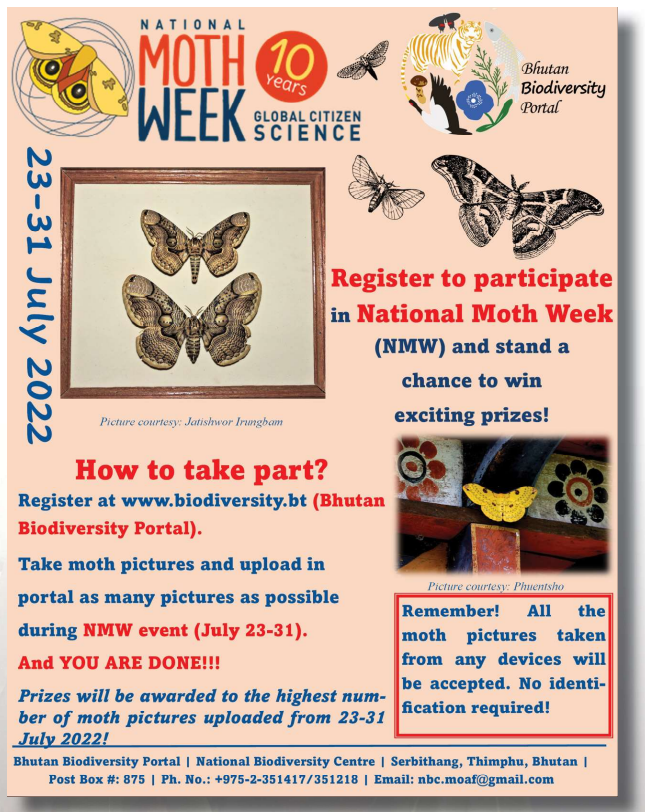
The National Biodiversity Centre joined the World Flora Online (WFO) as the 50th consortium member on 18th July 2022 upon signing the Memorandum of Understanding and attending the 19th Council Meeting. WFO is the international initiative to achieve Target 1 of the Global Strategy for Plant Conservation (GPSC) and provides a global overview of the diversity of plant species. It is the essential tool for conservation planners, policymakers and practitioners at all levels.

4. The first ever National Moth Week observed

The National Moth Week was observed from 23rd to 31st July 2022 in collaboration with the global National Moth Week coordinators. Bhutan participated the country's first ever worldwide citizen science project *"National Moth Week"* in 2022 along with 69 other countries around the globe to sensitize the public on importance of the moths which are often misidentified as their sister order, Butterfly.

The National Moth Week is commemorated on last full week of every July to appreciate the beauty and the life cycle of moths. It is a worldwide citizen science project where people are encouraged to observe, learn and document moths within their vicinity. Online platforms such as the Bhutan Biodiversity Portal and iNaturalist were used for documenting the moth observations.

A total of 71 participants registered their event at National Moth Week. An estimated total of 4,722 observations were made in Bhutan Biodiversity Portal from all around the country, 1,191 observations being the highest moth observation contributed by a single individual.

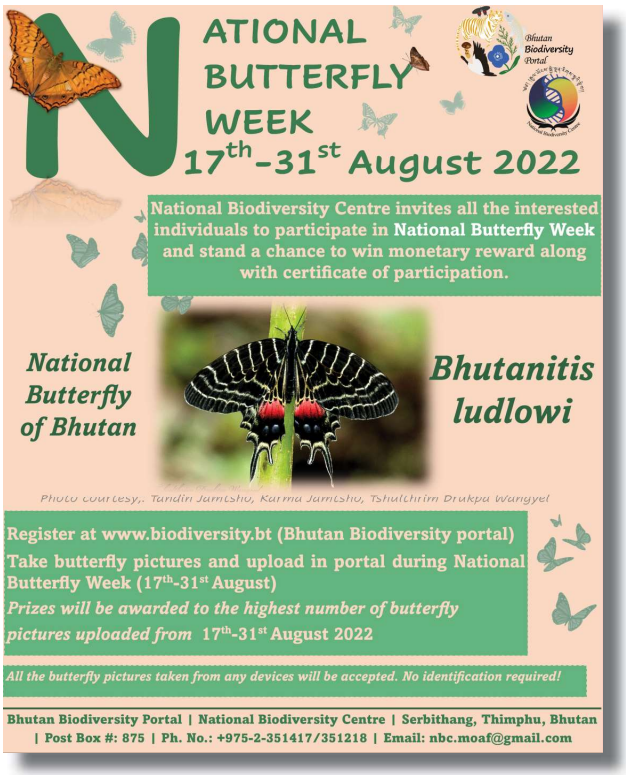


One of the National Moth Week posters used during the week

5. National Butterfly Week observed

National Biodiversity Centre in collaboration with nature guides hosted Bhutan's first ever own National Butterfly Week from 17th to 31st August 2022.

Forty-three participants contributed an estimated total of 9,476 observations of butterfly. The highest number of observations contributed by an individual was 4,949. Majority of the butterfly observations were contributed by Department of Forest and Park Services (83.4%) followed by individuals working under various Government sectors (5.7%) and students (3%). It was also observed that students from various college contributed butterfly observations as a team. While the highest number of participants worked under Department of Forest and Park Services (DoFPS), the Bhutan Biodiversity Portal observed participants from film industry, monastic body and even from Royal Bhutan Police. Looking into the past record of participants, this comes as huge achievement to the Portal.



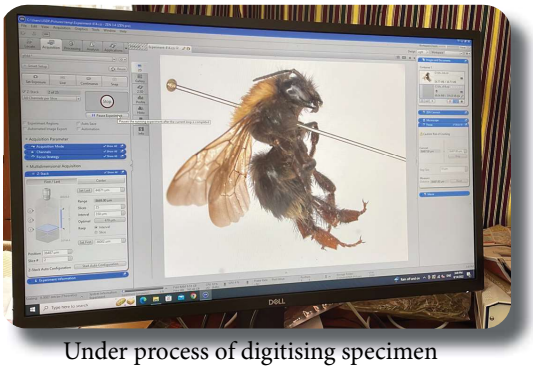
One of the National Butterfly Week posters used during the week.

6. Stacking Microscope installed through the GEF-LDCF /NAPA-3 Project

Stacking Microscope

Training participants

Through the GEF-LDCF/NAPA-3 project managed by the Gross National Happiness Commission (GNHC) supported by UNDP-Bhutan, a country's first ever Zeiss Stacking Stereo Microscope Discovery V20 and other digitising equipment were procured and installed at NBC. The equipment is aimed at digitising biological specimens, which is to be made available at the pages of Biological Corridors and Protected Areas on Bhutan Biodiversity Portal. Installation (harware and software) and utilisation training was also conducted at NBC, Serbithang for the interested officials from NBC, College of Natural Resources and National Mushroom Centre.

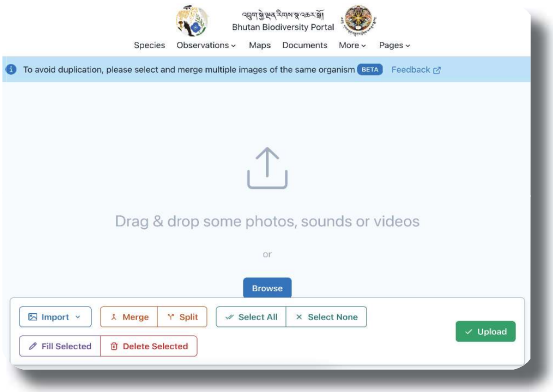


Under process of digitising specimen

7. New multiple upload feature for the Bhutan Biodiversity Portal

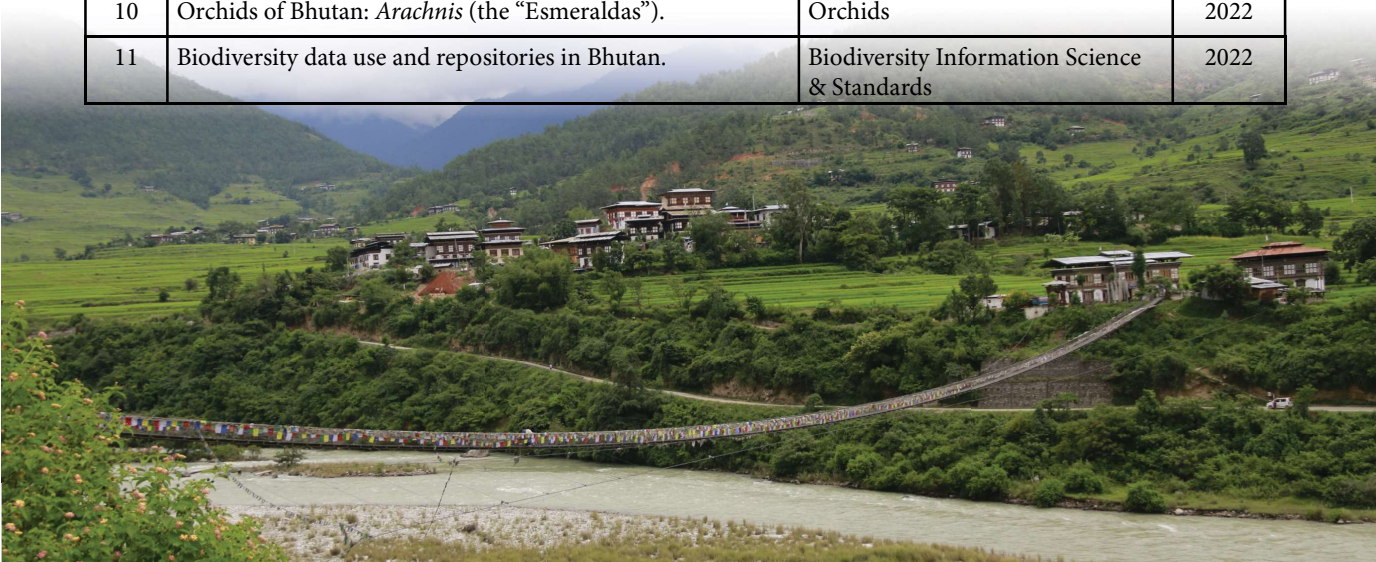
The contribution feature of the Bhutan Biodiversity Portal has been enhanced with the capacity to upload multiple observations at once. The new multiple upload feature automatically creates observation templates from every image upload. This is designed to facilitate quick upload.

Multiple images belonging to the same observation are expected to be merged before upload, to avoid data duplication. All observations duplicated will be flagged by curators or other participants.



8. Publication of journal articles during this fiscal year

S.No.	Title	Journal	Year
1	Biodiversity checklists for Bhutan.	Biodiversity Data Journal	2022
2	Orchids of Bhutan: The genus *Cypripedium.*	Orchids	2022
3	The first record of the rare fern *Pteris griffithii* (Polypodiales: Pteridaceae: Pteridoideae) in the Bhutan Himalayas.	Korean Journal of Plant Taxonomy	2022
4	The genus *Erhaia* (Gastropoda, Truncatelloidea, Amnicolidae), with a new species from Bhutan.	ZooKeys	2022
5	*Galba schirazensis* in Bhutan (Gastropoda: Pulmonata: Lymnaeidae), a thought-provoking record.	Basteria	2021
6	Habitat preference of freshwater fishes along the Gamri River, Trashigang, Bhutan.	Biodiversität und Naturausstattung im Himalaya VII	2021
7	Perception of farmers towards Invasive Alien Plant Species: A case study from Punakha and Samtse Dzongkhags, Bhutan.	Biodiversität und Naturausstattung im Himalaya VII	2021
8	An annotated checklist of the Vespidae (Hymenoptera: Vespoidea) of Bhutan with new records.	ZooTaxa	2022
9	Ecological Conditions of Luetshokha Lake and its Recharge Potential using Rooftop Rainwater Harvesting, Samtengang, Wangdue Bhutan.	Bhutan Journal of Natural Resources and Development	2022
10	Orchids of Bhutan: *Arachnis* (the "Esmeraldas").	Orchids	2022
11	Biodiversity data use and repositories in Bhutan.	Biodiversity Information Science & Standards	2022



9. BioBlitz at Royal Thimphu College (RTC)

The National Geographic Explorer Hub in Bhutan in collaboration with the eConscious Society of the Royal Thimphu College (RTC) invovling various researchers from government, NGOs and independent researchers conducted a day long workshop on 14th August, 2021 at RTC. The workshop focussed on the citizen science and environmental research.

The students from the two cohorts of B.Sc. Environmental Management Program were introduced to the followings:

1. Bhutan Biodiversity Portal including BioBlitz
2. iNaturalist including BioBlitz
3. NASA Development Program
4. EpiCollect 5
5. Camera Traps

Around 25 students attended the program and the BioBlitz. The program was funded by the National Geographic Society (NGS).

Participants during the BioBlitz program at the Royal Thimphu College.

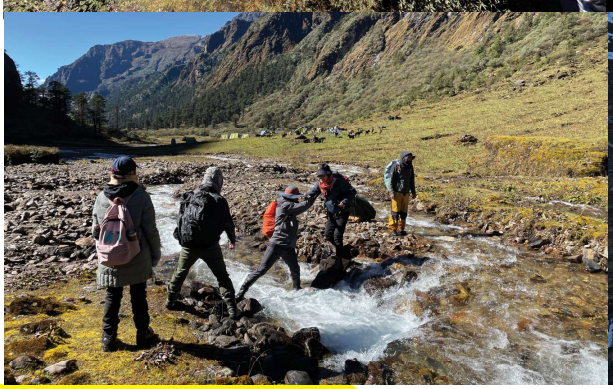
10. Interns complete their month long internship program at the Centre

Around 11 interns from the College of Natural Resources and Royal Thimphu College completed a month long internship program in July 2022. Interns shared the lessons learned and were awarded certificates. Interns were attached with all the programs during thier program, and were provided hands-on-training on biodiversity conservation.

11. GLORIA re-survey at Tampela, Sephu

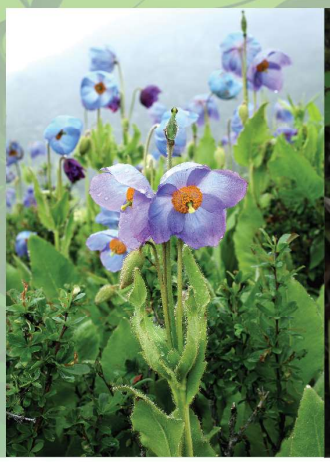
Global Observation Research Initiative in Alpine Environments (GLORIA) re-survey at Tampela (two days hike from Sephu in Wangdue Phodrang) was condcted in collaboration with the Missouri Botanical Garden, USA and Tribhuvan University, Nepal. The previous survey at Tampela was conducted in 2011.

The GLORIA programme operates a world-wide long-term observation network with permanent plot sites in alpine environments. Vegetation and temperature data collected at the GLORIA sites will be used to discern trends in species diversity, composition, abundance, and temperature, and to assess and predict losses in biodiversity in these fragile alpine ecosystems which are under accelerating climate change pressures. The GLORIA programme aims at building globally applicable indicators for comparing magnitudes and velocities of changes of different biodiversity components across the major terrestrial biomes and climate zones on Earth.



Field works at Tampela

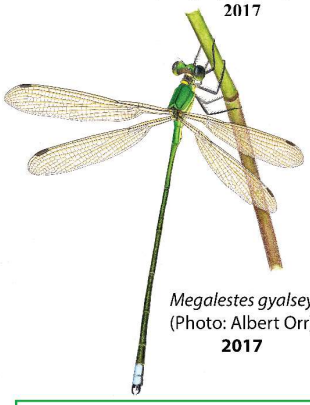
Species Discoveries in Bhutan
(2010-2020)



Meconopsis gakyidiana (Photo: NBC) **2017**

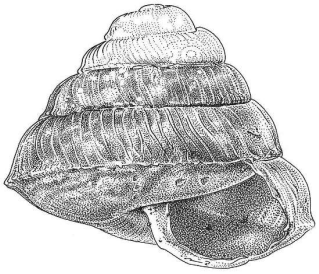
Spathoglottis jetsuniae (Photo: NBC) **2017**

Meconopsis bhutanica (Photo: Lhendup Tharchen) **2017**



Megalestes gyalsey (Photo: Albert Orr) **2017**

Thitarodes namnai (Photo: Norbert Maczey) **2010**



Rahula trongsaensis (Photo: NBC) **2017**

Not all new species are included here. Issued in the public interest by the National Biodiversity Centre, MoAF.

Moths:
Thitarodes caligophilus (2010)
Notodonta dedmazai (2013)
Eupoecilia jakarana (2019)
Eupoecilia gedui (2019)
Lumaria phuntschona (2019)
Borneogena trashiyana (2019)
Bactra cophinana (2019)
Penthostola subnigrantis (2019)
Metendothenia brunnofasciana (2019)
Peridaedala nigrifasciana (2019)
Epiblema albulusana (2019)
Pterophorus karmawangdi (2018)

Plants:
Roscoea megalantha (2017)
Meconopsis elongata (2016)
Meconopsis merakensis (2017)
Prunus harae (2010)
Aconitum bhutanobulbilliferum (2010)
Astragalus paroensis (2010)
Dysphania bhutanica (2012)
Dactylicapnos platycarpa (2010)
Prunus gongshanensis (2012)
Chiloschista gelephuense (2019)
Bulbophyllum trongsaense (2020)
Chiloschista densiflora (2020)

Snails:
Rahula kleini (2017)
Erhaia wangchuki (2017)
Endothyrella bhutanensis (2018)
Endothyrella spirostriata (2018)
Endothyrella pemagatshel (2018)
Truncatellina bhutanensis (2013)
Pseudopomatias harnai (2019)
Erhaia jannei (2020)
Cylindrophaedusa parvula (2019)
Cylindrophaedusa tenzini (2019)
Phaedusa adrianae (2019)
Phaedusa chimiae (2019)
Phaedusa sangayae (2019)

Species discoveries are made by researchers from various agencies.

Chiloschista himalaica (Photo: NBC) **2020**

Parachiloglanis bhutanensis (Photo: D.B. Gurung) **2014**

Erhaia pelkiae (Photo: NBC) **2020**

8. National Invertebrates Program

Although the invertebrate project/program started around 2012, the National Invertebrate Repository was established in 2017 to coordinate the collection and documentation of invertebrates including insects among the various relevant stakeholders. Since its inception, many new species discoveries such as *Megalestes gyalsey,* Gyalsey Emerald Spreadwing (dragonfly), *Truncatellina bhutanensis* (one of the world's smallest snails), etc were made. Numerous journals and field guides were published. The repository was initially funded by BTFEC with technical support from the Naturalis Biodiversity Center, The Netherlands.

The objective was to update the knowledge of invertebrate fauna of Bhutan, as hardly anything is known about the largest biodiversity component, the invertebrates. On the other hand it has been increasingly and strongly realized that lack of up-to-date knowledge of the invertebrate fauna hampers dealing with serious environmental and climate change issues. A recent alarming example is the introduction and rapid spread of the Giant African Land Snail, which was noticed only very late.

Currently, the repository and inventory is themated on molluscs, bees and wasps, moths and butterflies, dragonflies and damselfies, beetles including lady beetles, and few other macro-invertebrates. During the initial phase of the development of the repository, project partners such as College of Natural Resources (CNR), Sherubtse College, National Plant Protection Centre (NPPC), Ugyen Wangchuck Institute for Conservation and Environmental Research (UWICER), and the Naturalis Biodiversity Centre contributed towards the invertebrates collections.

Current Status

Currently, the repository has more than 25,000 collections of invertebrates. The collection of snails, bees and wasps, and moths and documentation are still on-going with many new species discoveries.

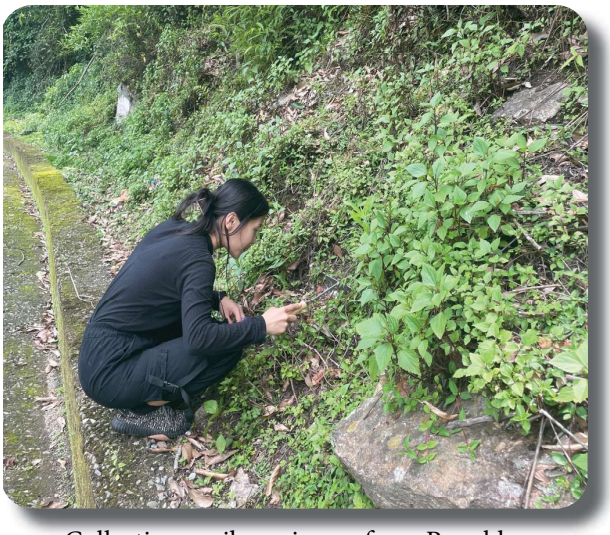
Apis laboriosa

Oenopia mimica

Achievements

1. Snail collections

A total of 62 species of snail specimens from Samdrup Jongkhar, Mongar, Trashi Yangtse and Punakha regions and are deposited at the National Invertebrate Repository. These places were were less explored previously. The species difficult to determine the epithets were sent to the Naturalis Biodiversity Centre in the Netherlands for DNA analysis, which would also determine its status as a new species or a new record.



Collecting snail specimens from Punakha

2. Discovery of new aquatic snail species

A new aquatic snail species named as *Erhaia norbui* is discovered from Uesu, Haa at 2,700 meters above sea level. The study paper is published in the ZooKeys February 2022 issue. The shell is pale greyish with a globular body whorl and a roundish aperture.

The tiny snail was discovered and collected by Sangay Norbu working at the Bhutan Livestock Development Corporation (BLDC) in the spring of 2020. Since then, the snail samples were jointly studied by a team from the National Biodiversity Centre (NBC), Naturalis Biodiversity Centre in the Netherlands, and Justus Liebig University Giessen in Germany. The description of the new snail samples were carried out based on the molecular (DNA) and morphological studies.

The snail is named after Sangay Norbu, who discovered the species. With this addition, Bhutan has now four species of *Erhaia* species and around 78 recorded snail species. The discovery indicates the good health of the ecosystem in the country.

The type specimens are deposited at the National Invertebrates Repository at the National Biodiversity Centre in Serbithang, Thimphu.

Erhaia norbui Gittenberger, Gyeltshen & Stelbrink, a new aquatic snail species discovered from Haa.

3. A thought-provoking record of a snail species in Bhutan

Galba schirazensis was recorded in the Kingdom of Bhutan, Thimphu district, west of Geneykha at an altitude of 2,750 meters above sea level. The specimens collected from Geneykha were identified through DNA analysis.

The occurrence of *Galba schirazensis* ia an isolated dead-end of valley in Bhutan, which is around 3,500 km east of Iran and nearly 2,500 km southeast of Tajikistan, without any connection to livestock transport routes, is in conflict with the biogeographical narratives from the literature.

Its unique presence in Bhutan was published the journal Basteria, December 2021 issue. The research was collaboratively conducted by NBC and the Naturalis Biodiversity Center in the Netherlands.

Galba schirazensis, recorded from Thimphu

4. Publications

A total of four journal articles were published on snails, wasps and macroinvertebrates during this fiscal year. An article with four new snail species has been submitted to the journal (Annex. 1)

Buli Tsho, Zhemgang

9. Annual Performance Agreement (APA) 2021 – 2022

Objective: To enhance management of natural resources for sustainable utilization of ecosystem goods and services.

Success Indicators, Targets and Achievements for APA 2021 - 2022.

Action	Success Indicator	Unit	Weight	Target	Achievement
Enhance conservation and sustainable utilization of biological resources	Access and benefit sharing initiatives developed	Nos.	5	1	*Swertia chirayita* - ABS prototype product developed & the supply chain for the ABS product has been formalised at Lauri, Samdrup Jongkhar with the formation of community cooperative (Pedmai Tshothang Ngomen Khalu Bedrur Dey) along with the community bylaw & executive members.
	Germplasm and biological resources conserved	Nos.	16	4327	5695 germplasm & biological resources conserved against the target of 4327. They are as follows: A) 105 crop accession (target 100), B) 2 seed (garlic & potato) (target 2), C) 4852 doses of animal semen (target 3500), D) 603 doses of animal DNA (target 600), E) 103 no. of herbarium specimens (target 100), F) 25 native plant seeds (target 25).
Generate biodiversity information and improve access	Number of species pages curated on the Bhutan Biodivesity Portal	Nos.	4	450	454 species pages curated on the Bhutan Biodiversity Portal against the target of 450.

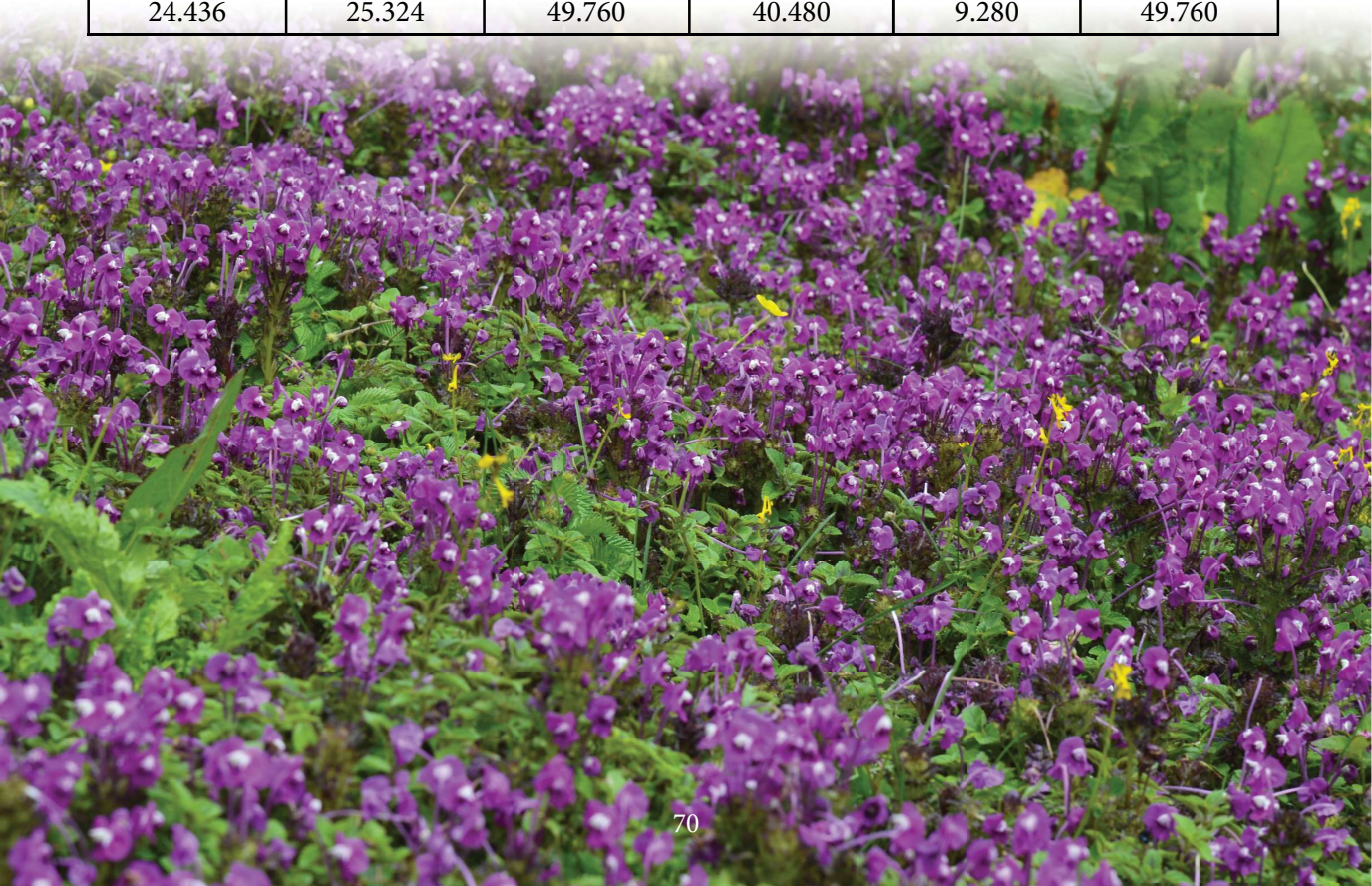
Trend values of Success Indicators for 12th Five Year Plan

Success Indicator	Unit	Actual Values [FY 2018-19]	Target Values [FY 2019-20]	Projected Values [FY 2020-21]	Projected Values [FY 2021-22]	Projected Values [FY 2022-23]
Access and benefit sharing initiatives developed	Nos.	1	1	1	1	1
Germplasm and biological resources conserved	Nos.	3892	1842	4357	4327	4327
Number of species pages curated on the Bhutan Biodivesity Portal	Nos.	0	0	450	450	450

10. Budget Outlay for the Fiscal Year 2021 – 2022

Budget outlay for National Biodiversity Centre (in millions)

Budget (Nu.)			Funding (Nu.)		
Current	*Capital*	*Total*	*RGoB*	*External*	*Total*
24.436	25.324	49.760	40.480	9.280	49.760



11. Biodiversity Overview Articles

Biorepository & Bioinformatics for Biodiversity Conservation

Choki Gyeltshen, Tshering Pem, Reena Gurung & Karma Dema Dorji

Biodiversity conservation in Bhutan has come a long way since the country became party to the United Nations Convention of Biological Diversity (CBD) in 1995. Since then the country has over 50% of its land cover under Protected Areas, and has recorded more than 11,000 species which is almost 1% of the world's biodiversity indicating a rich biodiversity comparatively to the country's small size.

Almost all the species were recorded scientifically from the following (biodiversity) kingdoms: Animalia, Plantae, Chromista, Eubacteria, Fungi, and Protista. The two largest known kingdoms are Plantae and Animalia, which together account for 93% of all species. The smallest kingdom is Protista, which accounts for only two species (less than 1% of all species). However, the kingdoms Chromista, Eubacteria, and Protista are severely underexplored and much exploration is required in order to gain a better understanding of the diversity and significance of species within these groups.

With increase in research and explorations, many new species discoveries are made almost every year. From 2010 till 2022 (June), the country has discovered more than 80 species new to science which includes flora and fauna. The specimens of new discoveries are deposited accordingly at the recognized biorepositories along with the data and information.

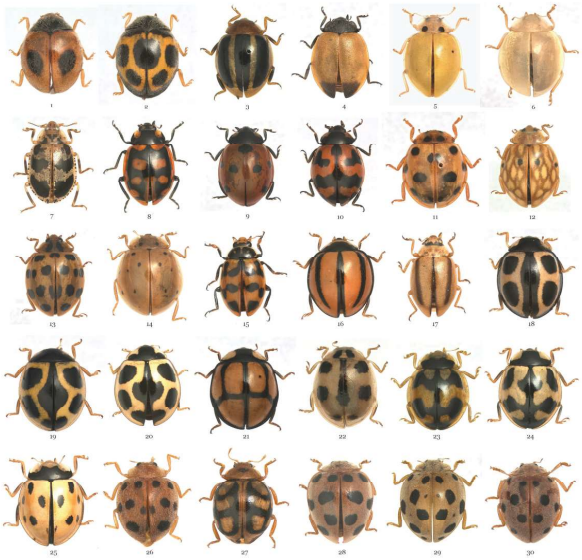


Fig. 1. Lady beetle collections.

Fig. 2. Molluscs collections.

Biorepositories and biodiversity information systems in Bhutan.

Biorepositories and biodiversity information systems in Bhutan were instituted since 1990s, and has contributed towards biodiversity conservation and sustainable utilization efforts in the country including the recent citizen-science initiatives. The biorepository and bioinformatics were initiated along with other biodiversity conservation programs in line with the Aichi Targets and the National Biodiversity Action Plan targets. The bioinformatics in Bhutan is still in its initial stage, however some biorepositories has already incorporated information systems for their collections for effective planning, curation and management.

Biorepositories are the facilities (similar to that of museums) that collects, stores, catalogs and curates samples of plant and animal species for research or museum purposes. Biorepositories collects and curates specimens from plants, animals, insects, and other living organisms.

Bhutan has established biorepositories such as the National Herbarium for wild plants, National Plant Gene Bank for crops and seeds, National Animal Gene Bank for livestock, Taxidermy for wild animals, National Invertebrates Repository for invertebrates including insects, and other repositories distributed at various institutions covers the taxonomic groups such as fishes, amphibian and reptiles, butterflies and moths, mushrooms, bryophytes, agricultural pests, among others. Biorepositories now may also include the molecular digital information on biological diversity, which largely enhances the effective management and curation of the specimens, and greatly improving access to information.

Fig. 3. Collection of insects using insect boxes.

Digitized Specimens

Biorepositories are one of the key source of biodiversity data and information contributing towards building scientific evidences. Thus, the National Herbarium and National Invertebrates Repository has initiated digitizing its age old plants and invertebrates specimens. The digitized specimens are initiated to make their information freely accessible to all through the Bhutan Biodiversity Portal (www.biodiversity.bt) and Bhutan Biodiversity Specimen Portal (www.bhutanbiodiversity.net) managed by the National Biodiversity Centre (NBC). Bhutan Biodiversity Portal is an online consortium-based platform for biodiversity documentation through citizen-science and collections. Bhutan Biodiversity Specimen Portal is an online system for documenting herbarium specimens especially from the National Herbarium. The specimen collections in the biorepositories act as evidences and references for any biodiversity research or management, where most of the taxonomic and systematic studies rely or base on the specimens collected over the years. Any new species discovered should have specimens collected and properly determined and deposited at an internationally recognized museum or a biorepository. For instance, Bhutan has the

internationally accredited National Herbarium under NBC acting as the collection center for all plant discoveries or records with the international code THIM.

Other major information use and sharing system related to biodiversity in Bhutan include National Biodiversity Clearing House, National Access and Benefit Sharing Clearing House, National Biosafety Clearing House, Forest Information Reporting and Monitoring System, and Pests of Bhutan database. Some of the collection-based systems include Royal Botanical Garden Database, National Traditional Knowledge Database, National Plant Gene Bank Information System, National Animal Gene Bank Information System, National Invertebrates Database, and other institutional databases.

Citizen-science initiatives in Bhutan

Citizen-science initiatives in Bhutan are increasing annually with major participations from the youths and tour guides. The contribution from the youths is playing a major role in biodiversity documentation and data use in the country. Most used applications include iNaturalist, eBird, Bhutan Biodiversity Portal, Global Biodiversity Information Facility (GBIF), and social media sites such as Facebook (groups and pages) and blogs. The citizen-science initiatives are helping conservationist to discover new species and new records, also new distributional range, and more importantly, awareness on the importance of biodiversity conservation and capacity building.

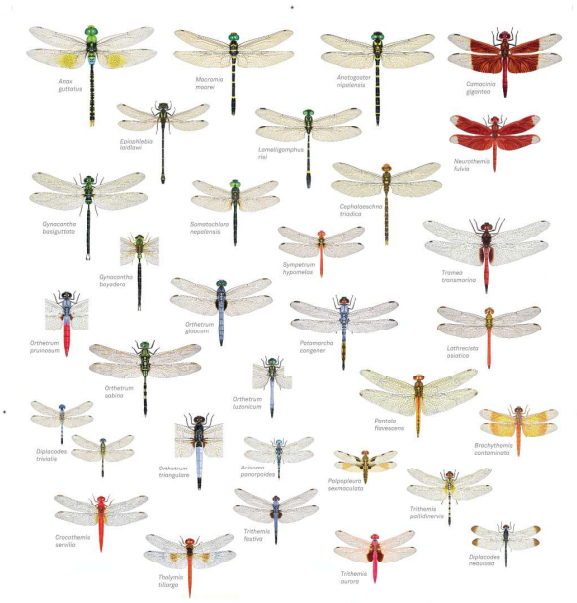


Fig. 4. Dragonflies collections

Molecular data and information on species are limited in the country, however through collaboration with international partners, some molecular information especially for new species are available to public, through the use of Barcode of Life Database (BOLD). There exists only handful of basic molecular laboratories conducting studies on biodiversity in the country. For advanced molecular analysis, the country mostly depend on the foreign experts and laboratories, which is expensive. The country's molecular information is in a dire need of improvement with the establishment of advanced molecular laboratories and capacities in bioinformatics. Advancement in bioinformatics would also contribute towards enhancing accessibility of specimens collections distributed around the country and the world. Other major challenges include non-availability of experts in some taxonomic groups especially for some of the understudied groups.

It is also imperative to have a coordination mechanism for sharing of specimens and information related to biodiversity for conservation and management of threatened species.

As of 2019, according to the International Union for Conservation of Nature (IUCN) Red List, at least 21 species are Critically Endangered, 43 species Endangered, 70 species Vulnerable, one plant is Extinct in the Wild and an orchid is Extinct in Bhutan. A total of 513 species are protected by Convention on International Trade in Endangered Species of Fauna and Flora (CITES) against over-exploitation through international trade. It includes 40 species of fauna and three species of flora, plus 56 species of fauna and 414 species of flora. Globally around 8,500 species of fauna and 30,000 species of flora are protected by CITES.

Botanical Expedition at the Dungshingang Mountains (Black Mountains)

Phuentsho & Rinchen Dorji

History of the botanical exploration of the Black Mountain.

Scottish horticulturist and curator of Edinburgh's Royal Botanic Garden, Roland Edgar Cooper (1890–1967) conducted a number of botanical trips in Sikkim, Bhutan, North-West India, and Myanmar before beginning his job as the curator. With the approval of the first King, His Majesty Sir Ugyen Wangchuck, he made extended trips throughout Bhutan between June and November 1914 and April and November 1915 (Long, et al., 2018). From September 15 to September 21, 1915, he visited the Black Mountains, also known as the Jowo Dungshing and referred to as Joedawnchi. Later in 1937, George Sheriff followed the trails of R. E. Cooper and climbed the mountains of Jowo Dungshing from Phobjikha after his unsuccessful attempt from the south from Nabji in Trongsa District.

Among the very interesting plants collected by R. E Cooper on the mountain includes around 17 species with the discovery of rare and endemic *Primula chasmophila* I. B. Balfour ex Hutch. for the first time. Since it was quite late, Cooper found the plants in seed and thus couldn't be used to describe the species. The plant was later described, using the plant grown from the seeds collected by Cooper ex-situ. Cooper was not able to collect many plants which may be due to the continuous bad weather he experienced throughout his days on the Black Mountain. However, according to Long et al. 2018, Cooper managed to collect some of the striking and undescribed species such as *Primula chasmophila, Gentiana lacerulata* Harry Sm., and *Allium rhabdotum* Stearn.

Later in 1937, along with the rare *Primula chasmophila*, Sheriff collected a variety of

Fig. 1. *Primula chasmophila*

intriguing plants, some of which were subsequently described as new to science, some of which are *Corydalis chasmophila* Ludlow, *Hackelia obtusifolia* R.R.Mill, *Pedicularis ludlowiana* Tsoong, *Phlomis rotata* Hook.f. *subsp. bhutanica* R.A. Clement, *Rhododendron succothii* Davidian, *Saxifraga andersonii* Engl. and *Saxifraga clivorum* Harry Sm.. He took the first image of the *Primula chasmophila*. Later in 2017, a Bhutanese-European joint excursion was held to do a site visit for inception for a project which unfortunately didn't materialize. *Primula chasmophila* was rediscovered in August 2019 by the foresters of Jigme Singye Wangchuck National Park (Duba, 2020).

While *Allium rhabdotum, Pedicularis ludlowiana*, and *Saxifraga saxorum* are known to be endemic to Bhutan, *Primula chasmophila* is only found on the highest points of the Black Mountain.

Unfortunately, we were not able to trace some of these plants despite our efforts. We were quite late into the summer to catch some of them in flowers, without which alpine plants are quite difficult to identify but we were able to catch many previously unrecorded plants from the Black Mountain area.

Objectives of the excursion:

- Enhance the specimen collections in the National Herbarium
- Collect the specimens with the least collections or no specimens in the herbarium
- Collect plant specimens from places with little or no collections
- Collect and explore places with rare plant species.
- Make good photographs of the rare and endemic species which may be required later for any publications.

The Journey

The journey began by traveling from Thimphu to Phobjikha, from where the main excursion will take place on foot. Three main routes are available for anyone going towards the Black Mountain from Phobjikha. Mr. Abir Man Sinchuri, Forestry Officer from the JSWNP joined us at Phobjikha. Since the tour involves the transportation of some research equipment and cookware, ponies had to be hired. Ponies were able to travel along the Zizi-Wangchekha route via Sala La. As a result, the

Fig. 2. Collectors from the NH taking rest at Drechoe Lhasa, meaning where devils read scriptures. The rocks in this picture are thought to be stolen Buddhist scriptures that the devils carrying them met with daybreak when they arrived at this location, turning them into stones.

Fig. 3. Ap Trongchu, our local guide crossing Yenduchhu

excursion chose to travel via the route from Zizi to Wangchekha via Sala La.

From Sala La, the mule track which is also used by the yak herders passes through Wangcheting, Maniting, Jaribuso, and then to Yakchu. A herder hut made of stone slabs exists as Yakchu, which we used as a camp. From Yakchu, the mule track traverses through the alpine shrubs of Rhododendrons and meadows until Yendupang is reached. In Yendupang, the officials from the Jigme Singye Wangchuck National Park (JSWNP) have built a log cabin which they use as a camp for various activities including high-altitude patrolling. We also met the team from the JSWNP carrying out the national forest inventory data collection in the Black mountains.

Locals that live close to this mountain range refer to the Black Mountain, which the Geological Survey of India gave the name "Black Mountain," as "Dungshingang," as they consider it to be the home of the deity Jowo Dungshing.

Yendupang is located in the *Abies densa* forest and thus much lower than the surrounding peaks. After crossing Yenduchhu, females are not permitted to visit the true peaks of the Jowo Dungshing La, according to local belief. Despite being on the same path leading to the Black Mountain, the locations near the mountain fall into distinct Gewogs and Dzongkhags because the Black Mountain is located on the border of the Trongsa and Wangdue Phodrang Districts. The mountain range currently falls inside the Jigme Singye Wangchuck National Park (JSWNP) which was earlier called as Black Mountain National Park.

Keeping Yendupang as the base camp, the expedition towards the main peaks of the Black Mountain was undertaken. Ap Trongchu, a Yak herder who stays nearby was hired as a local guide to take the team to the peaks of the Dungshingang. We used a cave that was used by the local "Phajo" for meditation at a place called Tshamdra as one of the camps. The cave was dry and was able to accommodate us, though it was quite congested inside.

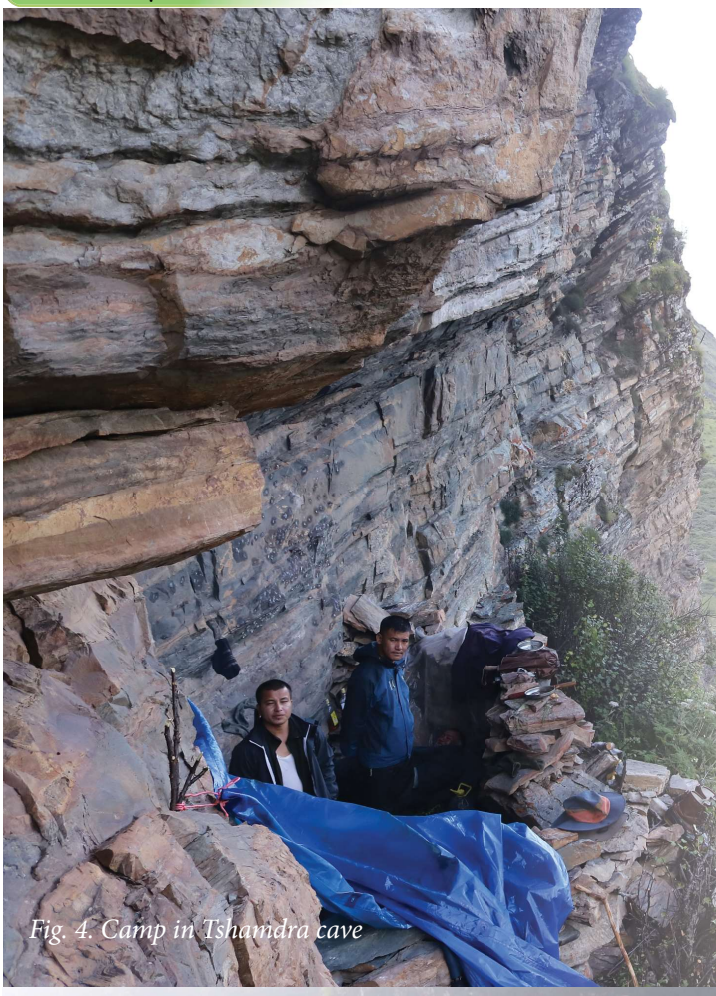
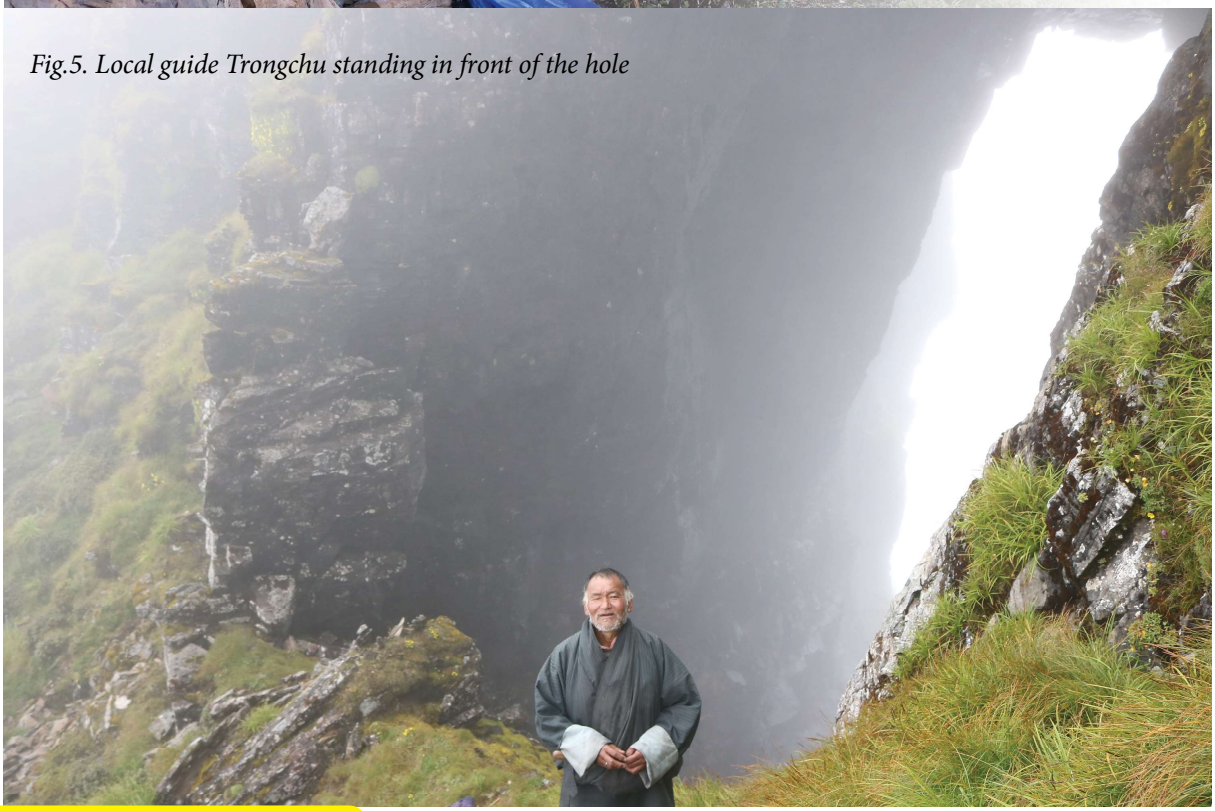


Fig. 4. Camp in Tshamdra cave

The Door of Jowo Dungshing (Dungshing Go)

Since the Black Mountain range in central Bhutan is revered by the locals as the home of the god Jowo Dungshing, they also hold the belief that a hollow in the mountain represents the Door of the Jowo Dungshing. George Sherriff was the first to report this hollow in 1937. He wrote "Over the first huge hill, we came to what they call the Door to Dungshingang, a huge hole through the hill, about 70 feet by 20 feet. Away below us on the Rhododendron-clad hillside, we could see the shadow of our hill, and this huge hole showing up in it". This hole was one of the highlights of the tour and the team took around 2 hours to reach the hole from camp at Tshamdra cave.

Fig.5. Local guide Trongchu standing in front of the hole



Plants collected during the expedition.

The mission was successful in collecting flowering plant specimens from roughly 40 different species, 9 of which were brand-new to the National Herbarium (Table 1). We were fortunate in locating *Primula chasmophila* during the excursion, a rare and endemic plant that can only be found on the Black Mountain's true peaks. It is named after its habitat which is mainly rocky crevices on cliffs. Around 10 species of pteridophytes were collected. We have also come across a good distribution and population of *Nardostachys jatamansi* (D.Don) DC. which is a critically endangered plant. It is frequently gathered from the wild and is known locally as "Pangpoe". It is used as a medicine and to make incense. Majority of the plants collected belong to the family Asteraceae (Daisy family).

Rain was a daily challenge for the plant collection team, and this had a significant impact on how well we performed. Additionally, many occurrences of *Allium rhabdotum*, a type of wild onion that is currently only known to occur in Bhutan, were noted. This species of wild onion is edible and we cooked the flower heads as curry. The flower heads are widely consumed by the yak herders and as per our local guide, it tastes best when fried in yak butter. There is also a species of bacteria which forms clumps in the alpine marshes. Locals think it as a species of fungus but it is actually a cyanobacteria belonging to the genus *Nostoc*. *Nostoc* has been used traditionally in cuisines in many parts of the globe. We also consumed it as curry and it is similar to Wood ear fungus. Such encounters in the field, particularly when it is a pain to carry fresh vegetables to the high altitude and declining food stock brings much relief to us.

Table 1. List of plants collected during the expedition.

S.No.	Collection No.	Species	Family	Remarks
1	BTN505	*Nardostachys jatamansi*	Caprifoliaceae	Critically Endangered
2	BTN506	*Cremanthodium reniforme*	Asteraceae	
3	BTN507	*Swertia wardii*	Gentianaceae	
4	BTN508	*Primula sikkimensis*	Primulaceae	
5	BTN509	*Silene nigrescens*	Caryophyllaceae	
6	BTN510	*Primula primulina*	Primulaceae	
7	BTN511	*Gerbera nivea*	Asteraceae	New to NH, new location
8	BTN512	*Arenaria ciliolata*	Caryophyllaceae	
9	BTN513	*Potentilla eriocarpoides*	Rosaceae	New to NH
10	BTN514	*Cremanthodium palmatum*	Asteraceae	
11	BTN515	*Saxifraga sp.*	Saxifragaceae	New to NH
12	BTN516	*Salix lindleyana*	Salicaceae	New to NH
13	BTN517	*Saxifraga engleriana*	Saxifragaceae	
14	BTN518	*Saxifraga caveana*	Saxifragaceae	
15	BTN519	*Primula chasmophila*	Primulaceae	Rare endemic
16	BTN520	*Meconopsis horridula*	Papaveraceae	
17	BTN521	*Aconitum orochryseum*	Ranunculaceae	
18	BTN522	*Corydalis crispa*	Papaveraceae	
19	BTN523	*Saussurea graminifolia*	Asteraceae	
20	BTN524	*Veronica cephaloides*	Plantaginaceae	New to NH
21	BTN525	*Sedum oreades*	Crassulaceae	
22	BTN526	*Allium wallichii*	Amaryllidaceae	
23	BTN527	*Delphinium nepalense*	Ranunculaceae	
24	BTN528	*Campanula argyrtricha*	Campanulaceae	

25	BTN529	*Pedicularis trichoglossa*	Orbanchaceae	
26	BTN530	*Nardostachys jatamansi*	Caprifoliaceae	
27	BTN531	*Ligularia hookeri*	Asteraceae	
28	BTN532	*Cremanthodium thomsonii*	Asteraceae	
29	BTN533	*Lonicera myrtillus*	Caprifoliaceae	
30	BTN534	*Corydalis ecristata*	Papaveraceae	
31	BTN535	*Saussurea obvallata*	Asteraceae	
32	BTN536	*Corydalis stracheyi*	Papaveraceae	New to NH
33	BTN537	*Ligularia retusa*	Asteraceae	New to NH, Roots used for medicinal purposes. Local name Tachup.
34	BTN538	*Utricularia brachiata*	Lentibulariaceae	
35	BTN539	*Saxifraga kingiana*	Saxifragaceae	
36	BTN540	*Dipsacus atratus*	Dipsacaceae	New location
37	BTN541	*Rubus fragarioides*	Rosaceae	
38	BTN542	*Saussurea pachyneura*	Asteraceae	
39	BTN543	*Primula hopeana*	Primulaceae	
40	BTN544	*Doronicum roylei*	Asteraceae	New to NH
41	BTN545	*Pleurospermum amabile*	Apiaceae	
42	BTN546	*Primula primulina*	Primulaceae	
43	BTN547	*Primula bellidifolia* subsp. *hyacintha*	Primulaceae	New to NH
44	BTN548	*Cremanthodium reniforme*	Asteraceae	
45	BTN549	*Bistorta griffithii*	Polygonaceae	
46	BTN550	*Codonopsis subsimplex*	Campanulaceae	
47	BTN551	*Tipularia josephi*	Orchidaceae	New to NH

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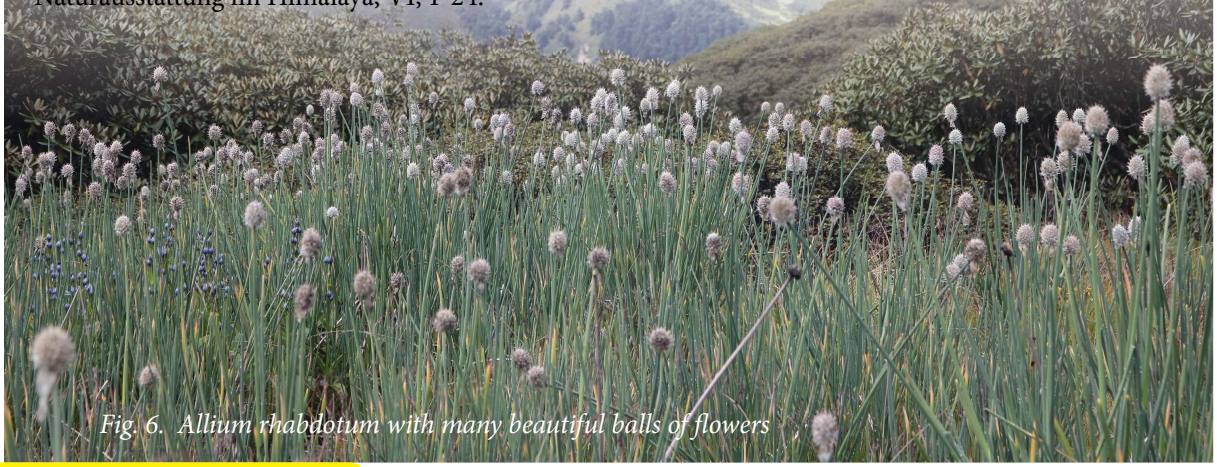


Fig. 6. Allium rhabdotum with many beautiful balls of flowers

Formalization of the *Swertia chirayita* farmers' group at the Lauri Gewog in Samdrup Jongkhar Dzongkhag

Mani Prasad Nirola, Leki Wangchuk & Karma Dema Dorji

A four-day consultation meeting has been convened through a participatory approach to formalize the *Swertia chirayita* cultivation group at the Lauri Gewog in Samdrup Jongkhar Dzongkhag for the cultivation and marketing of Swertia chirayita for the nature-based product development under the Access and Benefit Sharing (ABS) regime in January 2022. After the end of the four days of series of discussions and deliberations, a fifty-eight-member farmers' group has been formalized as the *Pedmai Tshothang Ngomen Khalui Bedrur Dey* with the election of the chairperson, secretary, treasurer, and six village coordinators from the villages. Further, a Bylaw has been developed for the proper functioning and management of the group as well as ensure quality assurance of the *Swertia chirayita*. The meeting was facilitated by the officials from the National Biodiversity Centre (NBC), Jomotsangkha Wildlife Sanctuary, Lauri Gewog Administration and Agriculture Extension, Lauri Gewog.

Historically, the communities of Lauri gewog have been involved in the collection of Swertia chirayita from the wild and sell to the traders in India, however, since 2015, NBC and the community in collaboration with the Department of Agriculture had initiated the cultivation trials for the domestication of the chirayita on their farmland to ensure sustainability and reduce pressure on the wild. Annually, NBC facilitates the procurement of 2,000 kg of *Swertia chirayita* (dried) from the group and ship it to the company in France as per the ABS agreement executed between NBC and the company. The community gets the premium price for the domestically grown chirayita which is approximately five times higher than the price they get for the wild chirayita in the existing market.

Fig. 1. Members of the Pedmai Tshothang Ngomen Khalui Bedrur Dey

Fig. 2. Participants working in groups to develop the Bylaw

In addition to the formalization of the group, the meeting also agreed on the benefits sharing mechanism as per the ABS regime whereby the community agreed to contribute 6.7 % of the money they get from the sale of the Swertia chirayita to the community fund to make the fund vibrant. Further, the meeting agreed to contribute an equivalent percentage (6.7%) to the Bhutan ABS Fund as a symbolic contribution to the conservation and sustainable utilization of Bhutan's Biodiversity. For the 2020 and 2021, the community contributed 185,500.00 as a contribution to the Bhutan ABS Fund.

NBC has been working closely with the national and international companies as well as local communities to sustainably utilize Bhutan's biodiversity and traditional knowledge under the ABS regime to derive tangible economic benefits and enhance rural livelihood.

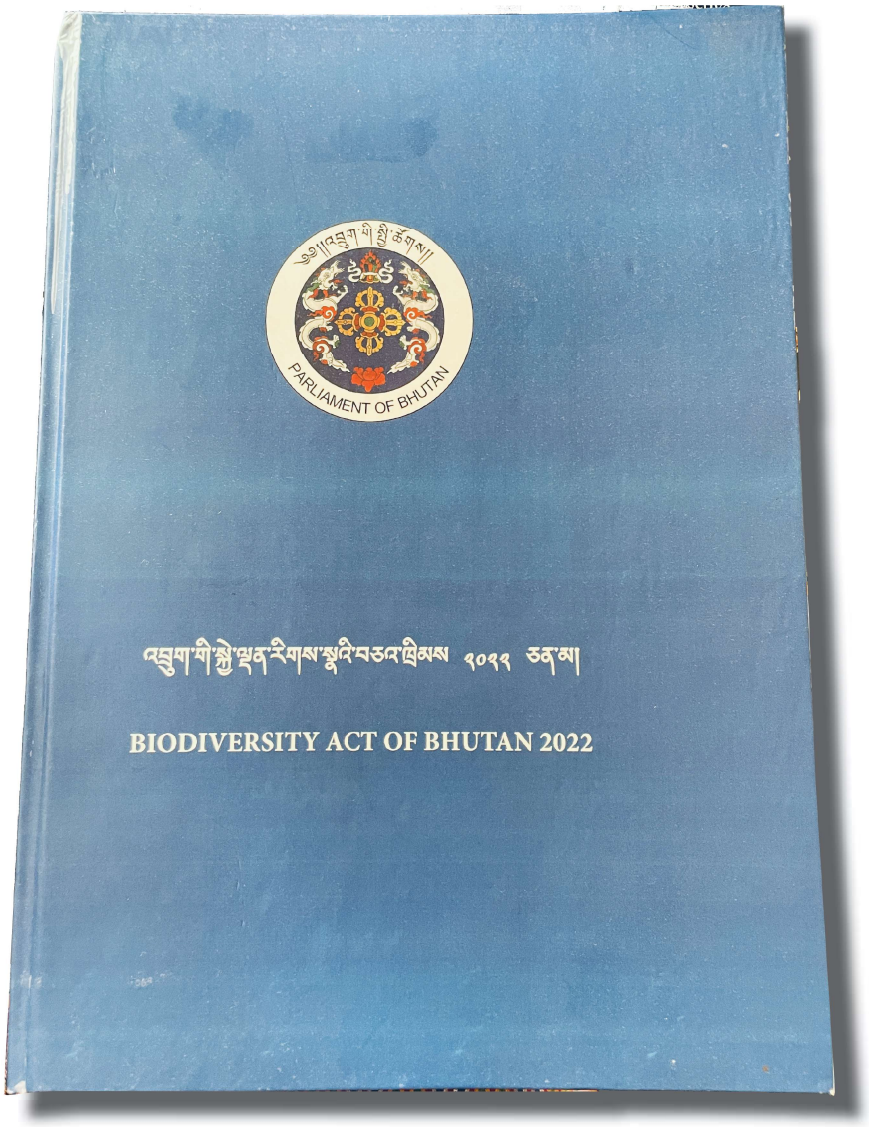
Fig. 3. Executive Members of the Pedmai Tshothang Ngomen Khalui Bedrur Dey

The Biodiversity Act of Bhutan 2022 passed by the seventh session of the Parliament of Bhutan.

Mani Prasad Nirola, Leki Wangchuk, Jamyang Choden, Kezang Wangchuk & Karma Dema Dorji

After being introduced in the fifth session of the National Assembly of Bhutan in June 2021, the much-awaited Biodiversity Bill of Bhutan 2021 has been passed by the sixth session of the National Assembly of Bhutan in December 2021. Both houses of the Parliament of Bhutan passed the Bill in their seventh session in June 2022 and formally received the Royal Assent on 15th July 2022.

The Biodiversity Act of Bhutan 2022 specifically repeals the Biodiversity Act of Bhutan 2003. The Ministry of Agriculture and Forests started the formulation of the Bill in 2015 and after seven years, the Bill was passed in June 2022. The Bill will ensure the wise use of natural resources as a development asset to contribute to the sustainable social and economic development of the country and the benefit of humankind. In particular, the Act will promote the conservation and sustainable use of biological resources and covers the research and commercial utilization of Bhutanese genetic resources, their derivatives and traditional knowledge, and ensure a fair and equitable sharing of benefits arising from their utilization. This will result in opportunities for the state to derive tangible economic benefits from the access to and utilization of Bhutanese genetic resources and rich traditional knowledge and at a local level, this will also result in opportunities for communities to benefit from the access to and utilization of biological resources and traditional knowledge. The Act will also provide the protection of plant varieties and the rights of breeders to encourage the development of new varieties as well as protect the rights of farmers in respect of their contributions made in conserving, improving and making available the plant and animal genetic resources.



and making available the plant and animal genetic resources.

The Act is also significant in terms of Bhutan's commitment and obligations to the implementation of the international conventions, treaties, and protocols such as the Convention on Biological Diversity, Nagoya Protocol on access and benefit-sharing and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA).

The Biodiversity Act of Bhutan 2022 was formulated with the technical support from the Fridtjof Nansen Institute (FNI), Norway, Garuda Legal Services, Legal Division of the Ministry of Agriculture and Forests, with the financial support from the Nagoya Implementation Fund Project, GEF-UNDP Co Bhutan.

Biodiversity & Science: The story of successful micropropagation of *Chiloschista gelephuense*

Pem Zam, Nima Gyeltshen & Kezang Tobgay

The Royal Botanical Garden, with the support from the Thailand International Cooperation Agency initiated the micropropagation activities mainly aimed at the rare and endangered orchid species in 2020. Several prioritized orchid species were micro propagated and promising results were achieved with the orchids both within the lab and at the orchid house after being taken out for ex-vitro acclimatization.

Of the several species being propagated, *Chiloschista gelephuense* C.Gyeltshen & Dalström was one of the species selected for micropropagation. *Chiloschista gelephuense* is found in North of Gelephu Tshachu hot springs along the road to the abandoned limestone quarry, alt. ca. 300 m, and is epiphytic in shade on smaller trees (Gyeltshen, et. al. 2019). The new species discovered and named was also found to be endemic to Bhutan as it has not been recorded from any other place. Seed germination of the *Chiloschista gelephuense* has not been reported so far.

In February 2020, a team from the National Biodiversity Centre and Stig Dalström went back to the same area to survey the health and distribution of the only known *Chiloschista gelephuense* population. During the trip it was found that the original habitat suffered some degradation and the plant seems to have been lost to that. However, one plant was found hugging a branch of a dense bush. The plant was leafless, as expected during the drier months of the year, but had two inflorescences carrying several seed capsules. One naturally-pollinated un-dehisced capsule of *Chiloschista gelephuense* was brought back to the National Biodiversity Centre and micropropagation of the seed pod was initiated.

Fig. 1. Seed pod and seeds of Chiloschista gelephuense.

Seed germination and ex-vitro acclimatization of *Chiloschista gelephuense.*

The micropropagation of the *Chiloschista gelephuense* started on 19th Feb, 2020.

Methodology

a. Media Preparation.

To prepare 1L of 1/5MS+ 20 g/l of sucrose + 8 g/l of agar, pH 5.7 of the Germination medium for seeds of slow-growing orchids we use: 0.82 g of PT018 (MS media), 0.066 g of CaCl2, 20 g of sucrose and 8 g of agar and the adjust the pH of the media to 5.7. Fill 1/3rd of the dishes with the prepared media and seal the dishes with cling film all under the sterile condition of the laminar air flow and the spirit lamp.

b. Sterilization.

The un-dehisced seed pod was surface sterilized using 95% ethanol and flame sterilization techniques where the capsule was soaked in in a 95% ethanol and flamed in a laminar air flower hood. The seeds were then removed from the capsule in a wide petri dish using a fine point forceps.

c. Inoculation.

In a laminar air flow, transfer the seeds onto the media with the help of a fine point forceps to sprinkle the seeds evenly. Wrap the Petri dishes using the Saran wrap (Examine the seeds on one randomly chosen Petri dish under a stereomicroscope.)

d. Culture.

Keep the inoculated petri dishes at 20-23˚C, 16-h-light/8-h-dark cycle light condition in the culture room. Examine the seed germination and protocorm developmental stages under a stereomicroscope every four weeks.

e. Subculture.

After two months of culture, on 20th May, 2020, some of the protocorms from original dishes were transferred to MS + 20 g/l of sucrose + 8 g/l of agar. On 28 Jul, 2020, a total of 32 plantlets in 5 bottles were obtained after subculturing.

On 8th Feb, 2021, a total of 31 plantlets were sub cultured from the tissue culture bottles into individual 8-ounce bottles of MS + 20 g/l of sucrose + 8 g/l of agar, pH 5.7 with one plantlet each. These plantlets were cultured for three months and were ready for ex-vitro acclimatization after a total of 512 days being in the culture room.

f. Ex-vitro acclimatization.

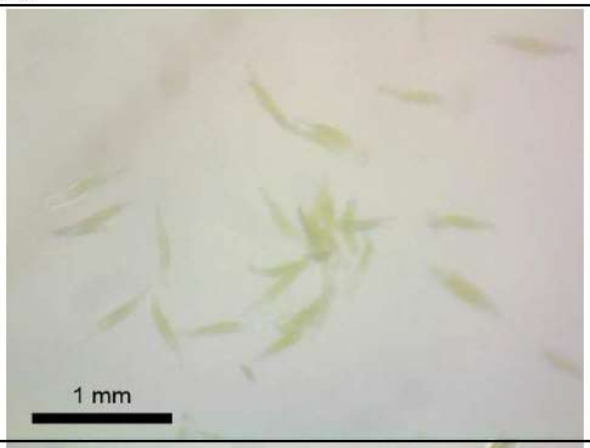
The seedlings were taken out of the lab on 3rd June, 2021 and planted at the orchidarium in sterile media prepared of bark and charcoal. The seedlings were initially covered with a temporary greenhouse to maintain humidity and temperature. After few days, they were taken out and kept within the orchidarium without any extra protection. The seedling showed promising growth and started to get attached to the media and the plastic pots.

By September 2021, the seedlings started producing flowering spikes which took two months to finally bloom into flowers in November to December. The total number of days taken for a complete lifecycle (seed to flowering) for the orchid is 700 days. A total of 30 healthy plants were obtained from this experiment which could possibly save this plant from going extinct. The current status of the health and distribution of the orchid in its native habitat has not been studied since our last expedition in 2020. The plantlets obtained will be further studied for its viability and growth success and could potentially be used to reintroduce the plants back to its habitat in case of a local extinction of the orchid.

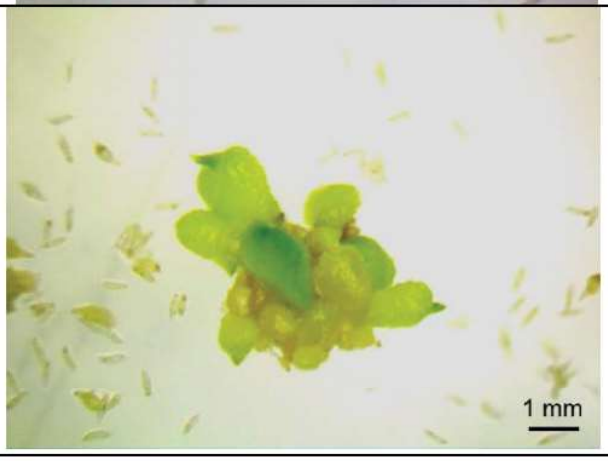
Reference:

Gyeltshen, C., Dalstrom, S., Gyeltshen, N. & Tobgay, K. (2019). A New spotted Chiloschista (Orchidaceae: Aeridinae) from Bhutan. LANKESTERIANA. 19(1); 23-29.

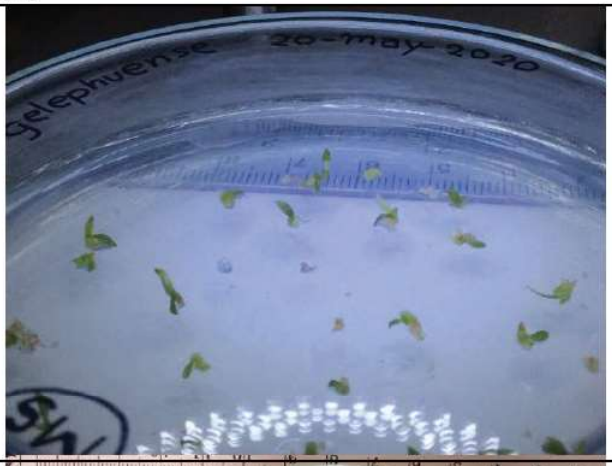
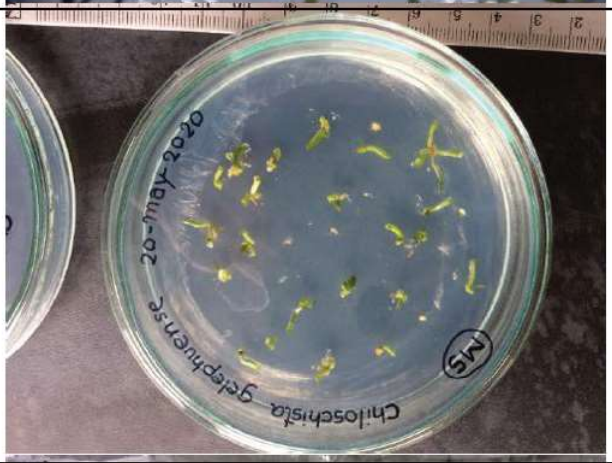
Results of seed germination of *Chiloschista gelephuense*

	Picture	Remark
0 day (19-Feb-2020)		Initial phase of the seeds
14 days (04-Mar-2020)		Enlargement of embryos was observed. Enlarged embryos are green.
23 days (13-Mar-2020)		Germination was observed.

Results of seed germination of *Chiloschista gelephuense*

	Picture	Remark
34 days (24-Mar-2020)		
51 days (10-Feb-2020)		
68 days (27-Apr-2020)		Protocorms in the clusters seem to grow faster.

Results of seed germination of *Chiloschista gelephuense*

	Picture	Remark
103 days (1-Jun-2020)		On 20-May-2020, subculture protocorms to MS.
124 days (22-Jun-2020)		
140 days (8-Jul-2020)		Subculture some of the plantlets to MS in bottles on 9-Jul- 2020.

Results of seed germination of *Chiloschista gelephuense*

	Picture	Remark
202 days (8-Sep-2020)		A total of 32 plantlets in 5 bottles were obtained.
231 days (7-Oct-2020)		

Results of seed germination of *Chiloschista gelephuense*

355 days **(8 Feb 2021)**		11 plantlets sub cultured in bottles with one plantlets in each bottle on 8 Feb, 2021 22 plantlets sub cultured in bottles with one plantlets in each bottles on 9 Feb 2021 Total: 31 plantlets obtained.
375 days (1-Mar-2021)		
512 days. (03-June-2021)		Seedlings taken out of lab condition and planted in the sterile media prepared of barks and charcoal.

Results of seed germination of *Chiloschista gelephuense*

624 days (24-Sept-2021)		Seedlings started producing flowering spikes
683 days (22-Nov-2021)		Seedling started blooming
700 days (10-Dec-2021)		Full bloom.

Bhutan Access & Benefit Sharing (BABS) Fund: Enhancing conservation and rural livelihood through sustainable use of Bhutan's biodiversity.

Mani Prasad Nirola, Leki Wangchuk, Kezang Wangchuk, Jamyang Choden & Karma Dema Dorji

Introduction

Bhutan is a contracting party to the Convention on Biological Diversity (CBD) and the Nagoya Protocol on Access and Benefit Sharing (ABS). These international instruments and the Biodiversity Act of Bhutan 2003 stipulates the requirement of the that appropriate mechanisms be put in place governing the access to biological/genetic resources and associated traditional knowledge as well as the sharing of the benefits arising from their utilisation. In fulfillment of the above commitment, the Bioprospecting program was instituted in 2009 to facilitate access to Bhutan's biological/genetic resources and associated traditional knowledge for research and development. The whole principle of the ABS regime is to ensure that tangible benefits-monetary or non-monetary are accrued from access to genetic resources and associated traditional knowledge and these benefits are ploughed back into conservation. As the ABS regime generates monetary benefits from the access and utilisation of Bhutan's genetic resources and associated traditional knowledge, the BABS fund was established mainly to channel monetary benefits arising to the fund and in turn use to support the enhancement of conservation and rural livelihood through sustainable use of biodiversity.

The BABS fund has been established in 2010 as CD account upon the approval of the Ministry of Finance vide letter no. DPA/TMD/Bank-Accts (CD)/2010-11/1225 dated 24th August, 2010.

Objectives of the Fund

- Support impactful project that contributes to foster conservation and rural livelihood.
- Encourage contribution from international bioprospecting companies, conservationists and citizens to support small scale biodiversity conservation and sustainable utilization initiatives at the community level.
- Create opportunities for local communities to enhance their livelihood through engagement in the sustainable utilization of biological resources.
- Garner support and strong ownership from local communities for the conservation and sustainable utilization of biological resources.
- Create a self-sustaining program which does not depend heavily on scarce government resources and become a successful model for the sustainable use of biodiversity through community participation and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

Management of the Fund

The overall Fund Management is being guided by the Hon'ble Secretary, Ministry of Agriculture and Forests as the Competent National Authority. The funds will be used only for the conservation and sustainable use of Bhutan's Biodiversity; and enhancement of rural livelihoods after seeking approval from the Hon'ble Secretary. The account is jointly operated by the Program Director and

Fig. 1. Farmer at Samtengang harvesting the domestically grown *Cymbidium erythraeum.*

Accounts Officer of the National Biodiversity Centre. However, in the future, as the BABS Fund grows, it is foreseen that a better management structure would need to be institutionalized.

Examples of support from the Fund

Under the ABS regime, the primary focus is to ensure our biological resources are conserved well, sustainably utilized, and the benefits are shared fairly and equitably with the real custodians. Engagement and empowerment of the local communities are of paramount importance and so far, in the past decade of the implementation of the ABS regime in Bhutan, the activities supported mainly includes, programs and projects related to conservation and sustainable livelihood. Some of the activities supported by the BABS fund are:

- **Domestication of the *Cybmidium erythraeum* (Olatse) at Samtengang, Nyisho, Wangduephodrang:** The benefits received from the research and development of the olatse was used to train local communities to sustainably grow and harvest olatse at the polyhouse or farmyard instead of collecting from the wild. Communities understand the value of olatse because they receive tangible benefits from their use and makes them understand the value of conservation as well as their willingness to support conservation initiatives. Currently, farmers in Samtengang doesn't harvest wild olatse but harvest domestically grown olatse thereby reducing pressure on the wild olatse. The olatse is used to produce antigaing cream called REDEEM in collaboration with the Quantum Pharmaceuticals, Switzerland.

- **Domestication of the *Cymbidium hookarianum* at Simphu, Nubi, Trongsa:** The BABS fund supported the community in Simphu in the sustainable management of *C. hookarianum* through the training of farmers and the establishment of a propagation house. Currently, farmers in Simphu domestically grow

Fig. 2. Aum Wangmo with Dr. Atila Dahlgren of Quantum Pharmaceutical, Switzerland displaying *Cymbidium erythraeum*

C. hookerianum and supply flowers to the. local as well as urban consumers and make a modest income. Dzongkhag administration Trongsa has further supported the communities with additional facilities.

• **Establishment of Orchid garden at Jangbi, Langthel, Trongsa:** The BABS fund supported establishment of orchid garden in Jangbi.

• **Research on Bhutanese Ophiocordyceps sinensis:** The BABS fund supported the research on Bhutanese *Ophiocordyceps sinensis* in order to compare it with the Tibetan cordyceps. Generally, in the world cordyceps market, Tibetan cordyceps are believed to be superior and fetch good prices as compared to Bhutanese cordyceps, thus in break this barrier and prove that Bhutanese cordyceps are equally good or even better, this study was conducted. The results of the study showed that, Bhutanese cordyceps are equally good as Tibetan cordyceps in terms of chemical properties. This result is expected to help Bhutanese cordyceps fetch a better price in the world cordyceps market.

Contributions to the Fund

- Monetary benefits arising out of research and commercial utilization of Bhutanese genetic resources and/or associated traditional knowledge.
- Processing fee and commitment fee payable at the Scoping phase or during the execution of an Access and Benefit Sharing Agreement.
- Grants, donations or financial assistance from domestic or external sources.
- Such other sources as may be determined by the Competent National Authority.

Current Status of the Fund

In terms of revenue generated from the ABS regime, the BABS fund has accumulated close to Nu. 12.0 million after its establishment in 2010. The source

of money for the fund mainly comes from the scoping/processing fee, security deposit, and from the supply of processed biological resources mainly *C. erythraeum* for the production of REDEEM cream. Out of 12.0 million, Nu. 7.26 million came from the supply of processed *C. erythraeum,* Nu. 2.87 million from the scoping/processing fee and security deposit, 1.5 million as a monetary benefit from the ABS project and Nu. 0.37 million as an annual contribution from REDEEM project.

Apart from the above, Nu. 0.23 million has been accrued as royalty from the sale of REDEEM cream and has been deposited into the government's RGR account.

Fig. 3. Member of the Simphu Orchid management group inside the green house supported by Bhutan Access & Benefit Sharing Fund (BABS Fund).

Bhutan's First National Moth Week

Tshering Pem & Choki Gyeltshen

National Moth Week is commemorated on last full week of every July to appreciate the beauty and the life cycle of moths. It is a worldwide citizen science project where people are encouraged to observe, learn and document moths within their vicinity. National Moth Week also aims to encourage people to become a citizen scientist by contributing the scientific data to the citizen science effort such as iNaturalist and Bhutan Biodiversity Portal. Bhutan participated the country's first ever worldwide citizen science project "National Moth Week" in 2022 along with 69 other countries around the globe to sensitize the public on importance of the moths which are often misidentified as their sister order, Butterfly.

Moths share the same order "Lepidoptera" with butterfly. Although moths outnumber butterflies by a ratio of 9 to 1, they are least acknowledged by the public as many of them are nocturnal. However, there are countless day-flying moths which are yet again misidentified as butterflies. People who have diminutive familiarity with moths have impression that moths are small and overly drab, thus they are considered as a nuisance. Regardless of the misconception about them, moths are diverse with varying sizes and colors. Moths and their caterpillar play a preeminent role in an ecosystem as a nutrient recycler and a diet for birds, animals, and other insects. They also help in pollinating the flower that opens at night. It is apparent that moths are the most misunderstood species despite their ecological importance.

Fig. 1. Moth observations contributed by the citizens during the National Moth Week. (Photo: Tandin Jamtsho & Sangay Chhophel)

As a citizen science effort, Bhutan Biodiversity Portal organized National Moth Week event with an aim to create awareness on the existence and importance of moths. Prior to actual National Moth Week, following efforts were taken:

1. Sensitization of National Moth Week by circulating a poster on Bhutan Biodiversity Portal Facebook page and both the official website and Facebook page of National Biodiversity Centre. The poster was also shared to "Butterfly and Moths of Bhutan" and "Bhutan Biodiversity Portal (BBP) User Community" group in Facebook to reach wider audience.

2. Digital citizens were encouraged to sign up on

Bhutan Biodiversity Portal and National Moth Week's official page to register their event for moth observation.

3. Digital Citizens were provided suggestions on how to attract, observe and photograph moths.

4. Digital citizens were sensitized on facts and importance of moths in official pages.

Numerous inquiries were answered and daily update of National Moth Week along with observations made by the participants were reflected on Bhutan Biodiversity Portal Facebook Page.

Fig. 2. Posters shared through website and social media handles during the moth week.

Participants included individuals from various background from students to government working officials, nature guide and NGO officials. Various institutions and offices were also observed to conduct their own moth observation in their office backyard.

In recognition to participants contribution towards citizen-science data, the top three leading contributors of moth observations were awarded with monetary reward and a statistics book. In addition, top five leading contributors were also awarded with certificates of recognition for their outstanding and active participation during the event.

A total of 71 participants registered their event at National Moth Week. An estimated total of 4,722 observations were made in Bhutan Biodiversity Portal from all around the country, 1,191 observations being the highest moth observation contributed by a single individual.

Fig. 3. A snippet of a social media post by the Bhutan Biodiversity Portal Facebook page sharing an moth observation by a citizen.

Fig. 4. Photographing moths using white sheet and lights at night by one of the National Moth Week participant, Mr. Karma Wangdi in Bumthang.

Access & Benefit Sharing (ABS) on the ground: An impact of ABS Regime on the Rural Communities in Lauri, Samdrup Jongkhar

Mani Prasad Nirola, Leki Wangchuk, Jamyang Choden, Kezang Wangchuk & Karma Dema Dorji

Introduction

The National Biodiversity Centre (NBC) in collaboration with the Chanel Parfums Beaute (Chanel PB) is working on the access and utilization of *Swertia chirayita* (Jatig/Khalu) in the cosmeceutical Industries under the Access and Benefit Sharing (ABS) regime since 2013. After years of research, planning collaboration, the SUBLIMAGE L'EXTRAIT (an antiaging serum) using the active ingredient from *S. chirayita* has been launched in October 2022.

S. chirayita is one of the potential non-wood forest products and is the source of income for the local communities in Lauri for years. Local communities use to collect the chirayita plants from the wild and sell them to India through an open auction and earn Nu. 150-200/ kg of dried *S. chirayita* depending upon the quality. Historically, *S. chirayita* has been growing abundantly in the forest in open ground or slash and burned forests with any management plans, however, it has been reported that availability of chirayita has been declining mainly due to over or unsustainable harvesting as it involves uprooting of the whole plant before they release seeds for regeneration. Cultivation trials were never tried before and local communities were very optimistic about the success of domestication.

In 2013, when Chanel PB approached NBC to work on the potential Bhutanese medicinal plants, *S. chirayita* was selected as a plant of interest among five others. Since the main objective of the ABS regime is to ensure our biological resources are conserved well and sustainably utilized, NBC in collaboration with the Department of Agriculture started cultivation trials of *S. chirayita* in the farmers' field. Currently, after the successful cultivation trials, Lauri farmers grow *S. chirayita* in their field along with the other crops and this was possible mainly due to efforts from the research team from the Department of Agriculture and NBC.

A formal group of chirayita growers mainly from Tshothang, Rashithang, Betshaling, Wongthi, Lauri, Momring and Dungmanma under Lauri Gewog was formed with fifty-eight members and it is known by the name *Pedmai Tshothang Ngomen Khalui Bedrur Dey.* It is a community-based natural resource management (CBNRM) group sourcing the domestically grown *S. chirayita* to Chanel PB and hence the plant now has a secured market under the contractual (Access and Benefit Sharing) agreement between Chanel PB and Ministry.

Livelihood Opportunity

The group is guided by a by-law which obliges the group to supply a required quantity of quality *S. chirayita* to Chanel PB annually and in the event that they have excess chirayita they are allowed to explore additional markets to which the National Biodiversity Centre is constantly exploring. This creates a win-win situation whereby the group does not have to worry about the market of their produce and Chanel PB has a secured supply of the raw materials in the process. A minimum of 2000 kg of chirayita is supplied to Chanel PB annually at the rate of Nu. 750 per kg (dried) which is a much higher price as compared to the price when sold through auction in the neighboring markets. In addition to the monetary benefits, the group also receives various non-monetary benefits such as capacity-building training and the supply of tools and implements required for growing *S. chirayita*. From the monetary benefits they receive from the Chanel PB, annually, the group contributes Nu.

100,000.00 to the Bhutan Access and Benefit Sharing Fund (BABS) as a symbolic contribution towards biodiversity conservation efforts. In addition to the above, the group also receives various other supports that benefits the whole community in the Lauri Gewog. This venture has immensely benefited the group in enhancing their livelihoods, particularly in terms of supporting their children's education. This secured income proved to be their lifeline, especially during the COVID-19 pandemic when the borders were closed and the region was declared a high-risk zone with the restriction of movement outside the region.

Till, 2017, 2018 and 2019, the price was Nu. 550 per kg but considering the principle to pay the premium price for sustainably grown chirayita, the price was increased to Nu. 750 per kg earning Nu. 1.5 million annually. This is a huge increase from the Nu. 25,850.00 from the first harvest in 2017 (Fig 1).

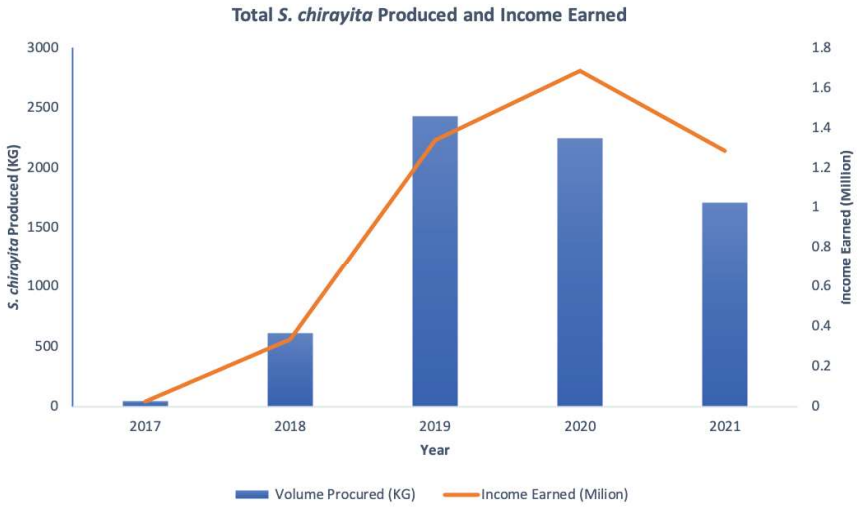


Fig. 1: Total *Swertia chirayita* produced and income earned by the group from 2017-2021

SUBLIMAGE L'EXTRAIT

Case Study of Sonam Dorji

This is the particular case of Mr. Sonam Dorji, who is one of the progressive farmers and the chairperson of the group. His annual income from the sale of the chirayita rose from Nu. 49000.00 in 2018 to Nu. 130,000.00 in 2021. According to him, the income earned helped him to meet his family's need such as procurement of dairy cattle, education expense of children, medical treatment, etc.

Fig. 2. Testimony from Sonam Dorji on the impact of ABS initiative.

Fig. 3. *Swertia chirayita*.

Fig. 4. Sonam Dorji with the chirayita plant.

Fig. 5. Members of the group carrying the domestically grown *Swertia chirayita* to a collection point.

Fig. 6. Barbed wire and other facilities provided to the members.

Fig. 7. Sherab jamtsho, a member of the group from Betshling with his produce.

Fig. 8. *Swertia chirayita* field.

Fig. 9. Community group work

Fig. 10. Meeting with the community

Contributions of Australian Volunteers to the National Biodiversity Centre, Bhutan

Choki Gyeltshen & Karma Dema Dorji

Since 2017, the National Biodiversity Centre under the Ministry of Agriculture and Forests started to host Australian Volunteers as a part of Australian Volunteers Program (AVP). Till date the Centre has hosted four volunteers including contract extension and remote volunteering. Volunteers were assigned with specific tasks to advise and assist the Centre on various programs on biodiversity conservation in Bhutan. Centre has hosted the volunteers successfully, which enhanced the efficiency and productivity for some program of works.

In 2017 till 2018, **Danielle Northey** and **Hugh Stahel** joined to Centre as a part of the Australian Volunteers Program. Danielle was attached to the Biodiversity Information Management Program (BIMP), while Hugh volunteered at the Animal Genetic Resources (AnGR) Program.

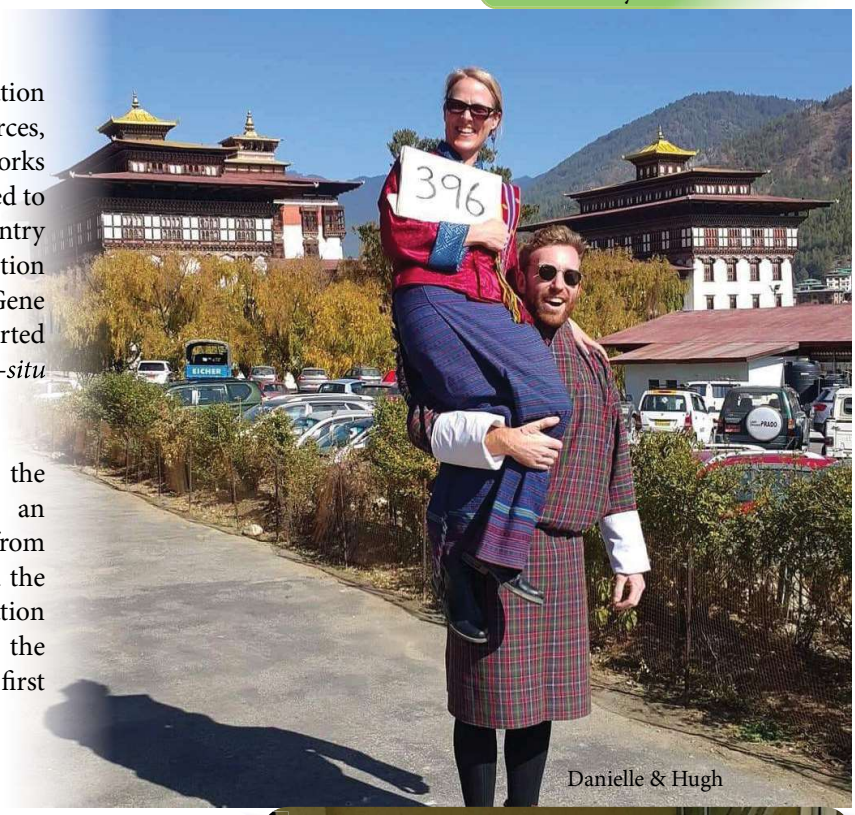
Danielle contributed mostly towards the citizen science initiative, the Bhutan Biodiversity Portal functioning and its outreach, and the field works. She has conducted numerous portal awareness programs around the colleges, schools, tourism sector and national parks. She has led the celebration of the International Biodiversity Day on 22nd May 2018 at the Youth Development Fund campus in collaboration with various agencies including UNDP, WWF-Bhutan, Royal Society for Protection of Nature (RSPN), Department of Forests and Park Services (DoFPS) and National Environment Commission (NEC). The day included BioBlitz, base camping, seminars, quiz and launching of books related to biodiversity.

Danielle also worked extensively on biodiversity data and information, which ultimately led to the publication of Bhutan's first Biodiversity Statistics of Bhutan. She led the national awareness campaigns on portal which includes Busy Butterfly BioBlitz and the Wild River BioBlitz. The Centre is still in touch with the QuestaGame in Australia since Danielle made the connection between the Centre, QuestaGame and the Royal University of Bhutan (RUB). QuestaGame is a citizen science-based application to document biodiversity through mobile gaming.

Danielle Northey with the Centre's staff during the International Biodiversity Day, 2018 in Thimphu.

Hugh worked on the conservation of animal genetic resources, conducting numerous field works across the country. He travelled to the remotest part of the country for animal germplasm collection for the National Animal Gene Bank at the Centre. He supported both the *ex-situ* and *in-situ* conservation programs.

He assisted in obtaining the Crawford Fund along with an animal genetic expert from Australia. Where, he also led the cattle embryo cryoconservation at the Centre from trials to the implementation, which is the first of it's kind in the country.



Danielle & Hugh

Danielle & the team at Sakteng, Trashigang


Danielle & Hugh

Danielle at the International Biodiversity Day

After the term periods of Danielle and Hugh was completed, the Centre hosted another two more volunteers from 2019, **Karunya Prasad** and **Maggie Wheeler**. Karunya was attached to the BIMP, while Maggie volunteered for the Plant Genetic Resources Program (PGR) at the Centre.

Karunya assisted & advised the program to publish the Biodiversity Statistics of Bhutan in continuation to the Danielle's work, which finally got published in 2019 reporting more than 11,000 recorded species of all biodiversity groups in the country. She mostly worked on biodiversity data, developing maps and building capacities of the staff. She assisted and advised on publication of biodiversity data onto Global Biodiversity Information Facility (GBIF), assisted in obtaining grants (National Geographic Society grant and GBIF-Biodiversity Information Fund for Asia (BIFA) grant), specimen collection field works, awareness programs, and developing visual User Manual for the portal.

She contributed to the following publications:

i. **Biodiversity checklist for Bhutan**, *published in Biodiversity Data Journal, 2022.*
ii. **Bhutan Biodiversity Portal User Manual,** *published by NBC, 2021.*
iii. **Number of species in Bhutan,** *published in Conservation Science and Practice, 2019.*
iv. **Bhutan Biodiversity Portal: Citizen science initiative in Bhutan**, *published in Roots (Botanic Gardens Conservation International), 2019.*

Karunya & Jamyang Choden (Photo: AVP)

Karunya with the Camp RUF participants at Panbang, Zhemgang during an awareness campaign in 2019.

Maggie (1st from right) with the former Program Director of NBC, Dr. Tashi Yangzome Dorji (3rd from right), the head of PGR Program, Dr. Asta Maya Tamang (3rd from left), and other officials in 2019.

Karunya (1st from right) & Maggie (2nd from right) with a friend.

Maggie & Wang Tshering (Photo: AVP)

Karunya briefly worked for the Royal Botanical Garden Serbithang to develop the map of the garden. She continued to volunteer remotely after the global pandemic till 2022 and continues to assist whenever requested by the Centre.

Maggie, while volunteering at the PGR Program, revamped the plant micro-propagation laboratory and advised on crop conservation at the National Plant Gene Bank under NBC. She assisted the staff of the Centre to micro-propagate some rare orchids including a new orchid species. She also supported to grow vulnerable wild rice species using tissue culture techniques and trained the laboratory staff while keeping in place the laboratory protocol. She was involved in various field works including the control and eradication trials of invasive plant species such as *Lantana camara* and other invasive species in southern Bhutan.

The capacity of the Centre has been enhanced especially in the field of developing maps, analyzing biodiversity data and visualization, seeking grants, editing articles, cryoconservation, tissue culture, advocacy, and managing invasive plant species. In terms of facilities, the Royal Botanical Garden Serbithang, has developed disable friendly sign boards, walking trails and railings through the AVP Impact Fund (AVPIF). The Centre has recently obtained an AVP Impact Fund to develop the Garden into a disable friendly environment in collaboration with Disabled People's Organization (DPO) and other partners.

Bhutan's First National Butterfly Week

Tshering Pem, Choki Gyeltshen & Reena Gurung

Butterflies are the most well-known and studied group of insects. Owing to their striking patterns and vibrant colors, butterflies are the most acquainted insect to humans. Unlike moths, whose antennae comes in diverse shapes, butterfly's antenna are slender and clubbed shaped at the end. They are widely distributed with more than 17,500 species of butterflies around the world, 750 species found in Bhutan. However, approximately 3 % of the butterfly species are at the risk of extinction due to urbanization and agriculture. One cannot be complacent just because there is high butterfly population census around the world. The population keeps on declining. It is imperative that the monitoring of its population is kept in loop.

Currently, there is no designated international date for National Butterfly Week. National Biodiversity Centre in collaboration with the nature guides hosted Bhutan's first ever own National Butterfly Week from 17th to 31st August 2022.

National Butterfly Week is a citizen science initiative where participants may range from diverse backgrounds and age groups, which meant that not all the participants may own high spec devices. Taking such aspect into consideration and to make the event inclusive, participants were encouraged to upload their observations regardless of the pictures taken from any devices. A quick pictorial guide on how to participate in National Butterfly Week was formulated and shared to the public via official website and Facebook page of National Biodiversity Centre and Bhutan Biodiversity Portal.

Results

Forty-three participants contributed an estimated total of 9,476 observations of butterfly during National Butterfly Week held from 17th of August to 31st August 2022. The highest number of observations contributed by an individual was 4,949. Majority of the butterfly observations were contributed by Department of Forest and Park Services (83.4%) followed by individuals working under Government sector (5.7%) and students (3%). It was also observed that students from various college contributed butterfly observations as a team.

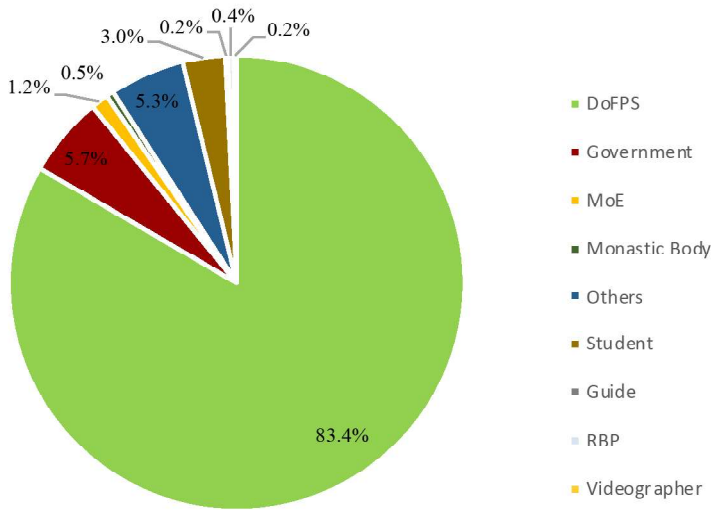


Fig. 1. Classification of participants during the National Butterfly Week.

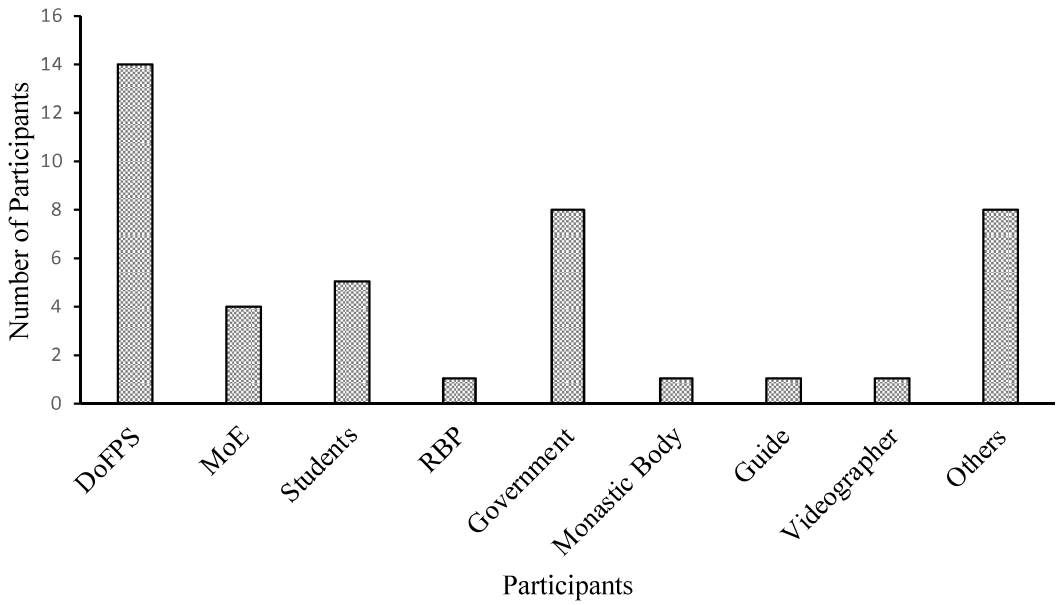
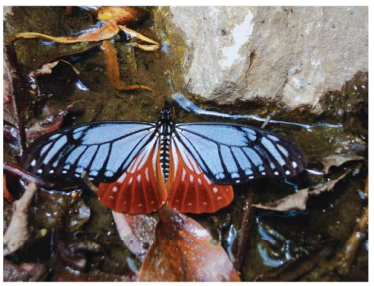


Fig. 2 Number of participants classification during the National Butterfly Week.

While the highest number of participants worked under Department of Forest and Park Services (DoFPS), the Bhutan Biodiversity Portal observed participants from film industry, monastic body and even from Royal Bhutan Police. Looking into the past record of participants, this comes as huge achievement to the Centre. However, there still exists a lack of minority participation and the Centre should thrive in engaging diverse communities in citizen science initiatives.





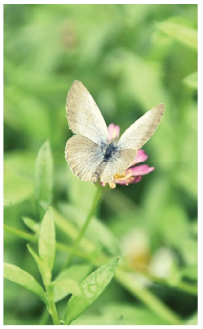


National Butterfly Week

Observations uploaded by the citizens.

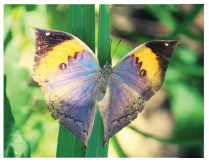











International Biodiversity Day celebration

Tshering Pem, Pem Zam & Choki Gyeltshen

Biodiversity is declining at an unprecedented scale of 1000 times faster than its normal extinction rate. The ecosystem degradation is occurring more than ever before. There are more than 40,000 species deemed to be threatened with extinction. Over last five decades, anthropogenic activities have driven more than 800 species into extinction. The world is in the brink sixth mass extinction, implying that not only the natural asset of the earth, plant and animal are at risk but also the humans. All the life on the earth is interconnected and correspondingly, humans are likely to face food and water insecurity.

In response to biodiversity crisis, United Nation sanctioned International Day for Biological Diversity (IDB) to promote, educate and create awareness on biodiversity issues. International Day for Biological Diversity is celebrated every year on May 22nd. The theme for International Day for Biological Diversity 2022 was "Building a shared future for all life", elected in support of post-2020 global biodiversity framework. National Biodiversity Centre (NBC) is a focal agency mandated for "Effective conservation, sustainable utilization, and equitable sharing of benefits arising from access and use of biological resources". The Centre celebrates IDB every year to educate and create awareness on biodiversity matters.

"Conservation begins at home. Conservations begins with you and what you do at home every day." For 2022, the Centre celebrated IDB in Royal Botanical Garden Serbithang, Thimphu.

Fig. 1. Zhenphen Group visiting the Royal Botanical Garden during the International Biodiversity Day.

Fig. 2. (Left) Visitors at the Biodiversity Interpretation Centre located at the Garden. (Right) Poster on the International Biodiversity Day.

Knowledge and information sharing is prerequisite for building community stewarded towards conservation. To create awareness to the community, the Royal Botanical Garden Serbithang was made freely accessible on the day with guided tours to various elements of garden. The Centre were able to instill awareness on biodiversity to more than 350 individuals.

Fig. 3. (Left) Zhenphen Group at the Garden. (Right) Goodie bags distributed to the visitors. The public were also provided goodie bags constituting a brochure, Buckwheat cookies from Bumthang, Zhinor balm from Logchina, Biodiversity portal manual and bookmarks, among others.

Pteridophytes (Ferns) Collections from Eastern Bhutan

Rinchen Dorji, Kencho Dorji & Phuentsho

Bhutan is situated in the Eastern Himalayan zone with the Tibetan Autonomous Region of China to the North, and northwest and the Indian state of Sikkim, West Bengal, Assam, and Arunachal Pradesh to the southwest, south, and east. The country is almost entirely mountainous with nearly 95 percent of the country being above 600m. The terrain is rugged and steep, with altitudes declining from above 7500m to under 100 m within a short north-south distance of 170km. The inner Himalayas consist of the main river valleys and steep mountains with altitudes ranging from 2000 to 4000. The diverse ecosystem and eco-floristic zones of Bhutan harbor a rich array of vascular plants. The Flora of Bhutan records more than 5600 species of seed plants out of which approximately 94 percent are native species. A total of 101 species of new plants were recorded in the Flora of Bhutan between 2009 and 2017. Around 16 plant species new to science were discovered in Bhutan from 2009 to 2017.

The National Herbarium serves as the country's national botanical repository and reference centre. The National Herbarium currently houses over 20,000 specimens mostly of the vascular plants and 3000 specimens of Pteridophytes. However, given the large diversity of flora of the country, the herbarium is short of many species of plants. Specimens are also lacking from many remote places in the country where road access is not available. These gaps need to be filled and collections and botanical expeditions need to be done in unexplored and remote areas in the country. Filed excursions throughout the country need to be done to collect the specimens which are absent from the Herbarium.

Fig. 1. Field expedition

In Bhutan, the distribution of ferns covers most of the regions all over the country. Ferns can grow in many different types of habitats like epiphytes, terrestrial, lithophytes, and rare aquatic. Fern diversity is noted primarily in high humid vegetation and is known to the community from wild edible vegetables. In Bhutan, yet pteridophytes flora endure as one of the least explored individuals and understudied. Generally, the study of Pteridophytes in Bhutan has not been carried out in the past, thus limited kinds of literature are accessible on the diversity of ferns, and their important part in the ecosystem. A poor study focusing on the use of Pteridophytes has been stated and the limited use of pteridophytes as food and medicine is known in Bhutan with some of the fern species being used as food listed in non-

Fig. 2. Herbarium pressing in the field.

wood forest products. A survey and collection of ferns were carried out alongside with the other flora gatherings. The ongoing collection attempts to document and examine the information on the diversity of ferns in the country. Over the period of one fiscal year, the team from the national herbarium could be managed to cover some of the regions which are the least explored places in the central regions of Bumthang Dzongkhag and some places on the eastern side of Mongar and Trashiyangtse Dzongkhags.

Materials and Methodologies

In an expedition conducted in the remote areas of Mongar, Trashiyangtse, Bumthang, Trongsa, and Zhemgang dzongkhags by a team from the National Herbarium under the National Biodiversity Centre, Bhutan, various plant specimens belonging to 153 distinct species were collected. Among the 153 species, 29 species were found to be new for the National Herbarium and six of them were found to be a new record for Bhutan. Additionally, 29 species of ferns were collected although the species specimens are already collected from different

regions and three species were found to be new records for National Herbarium. The fern species which are collected from these regions will represent the distribution. However, some ferns grown in the regions are common and the specimens were not collected as they already outnumbered in the herbarium. Some of the places like the Brigdungla range is located on the boundaries of Zhemgang, Trongsa, and Bumthang dzongkhags. The mountain range, like other inner Himalayan ranges, is surrounded by hot and humid sub-tropical forests and under the Phrumsengla National Park, most of the vegetation fall in sub-alpine and temperate areas. Most of the expeditions conducted in remote areas under different dzongkhags are accompanied by field officials from the Park office and division office of the Department of Forest and Park Services.

Results

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Fig. 3. Specimen collections in the field.

Table 1. The list of plants collected from Bumthang region.

S.No.	Species Name	Location	Latitude	Longitude	Elevation
1	*Pyrrosia sp.*	Towards Nagor	27.02315329	91.17009116	1333
2	*Microlepia sp.*	Towards Nagor	27.02319493	91.17014378	1319
3	*Pyrrosia boothii*	Towards Nagor	27.02356589	91.16915105	1331
4	*Belvisia henryi*	Towards Nagor	27.0236467	91.16922802	1341
5	*Selaginella monospora*	Towards Nagor	27.0237128	91.16914771	1342
6	*Dicranopteris linearis*	Towards Nagor	27.02388575	91.16899176	1346
7	*Pteris aspericaulus*	Towards Nagor	27.03352502	91.16071777	1322
8	*Lycopodiella cernua*	Towards Nagor	27.03447651	91.16052319	1301
9	*Dryopteris peranema*	Towards Nagor	27.03661286	91.15874168	1280
10	*Selaginella sp.*	Towards Nagor	27.04297847	91.16054631	1235
11	*Cheilanthes grisea*	Towards Nagor	27.04396733	91.16645918	1301
12	*Theylpteris nudata*		27.04230642	91.19074312	337
13	*Pteris vittata*		27.03461148	91.19492927	643

Table 2. Herbarium specimens of ferns belonging to 12 distinct species collected from Trashiyangtse region.

S.No.	Collection No.	Species Name	Remarks
1	R900	*Selliguea griffithiana*	
2	R901	*Asplenium ensiforme*	
3	R902	*Pyrrosia stenophylla*	
4	R903	*Asplenium yoshinagae*	New to NH
5	R909	*Pyrrosia boothii*	
6	R910	*Haplopteris linearifolia*	New to NH
7	R911	*Osmunda claytoniana*	
8	R912	*Osmunda regalis*	
9	R922	*Athyrium sp.*	
10	R923	*Oleandra sp.*	
11	R924	*Selaginella sp.*	
12	R925	*Huperzia hamiltonii*	

Table 3. The list of ferns collected from the Bumthang area.

S.No.	Species Name	Remarks
1	*Hymenophyllum badium*	
2	*Lycopodium clavatum*	
3	*Osmunda cinnamomea* subsp. *asiaticum*	
4	*Athyrium* sp.	
5	*Polystichum neolobatum*	New Record

Reflections from the Leadership Development Program

Choki Gyeltshen

The Value-based Leadership Development Program (LDP) held at Royal Institute of Management (RIM), Thimphu on 27th and 28th October 2022 has greatly assisted me in identifying my values, principles, strengths and weaknesses. It also helped me to identify the improvements I need to make while climbing the ladder of leadership in my professional career and also my personal growth as a leader or a good team member. This training workshop has taught me how to make a good and effective decisions while identifying the styles of decision making in multiple contexts and also how to face the problems arising from it.

My Moral DNA indicated that I am more of a Governor in both personal and work lives. It has indicated to me that I would follow the rules more often and it would be based on my values and principles. I would also let my team to follow rules and realize their values as well. I have never thought or learned of value-based leadership previously, however after the training workshop on LDP at RIM, I realized how Moral DNA can influence in decision making and while leading a team. Moral DNA values can include: Wisdom, Honesty, Humility, Hope, Self-Control, Trust, Fairness, and Excellence. Therefore, I need to be aware of my Moral DNA especially while making decisions or during the meetings and workshops.

The exercise on Tourism Infrastructure development in Bora Tora exactly showed how meetings and decisions are held while comprising numerous stakeholders. Bora Tora exercise also showed what a good leader's values should be and how RIGHT framework can help in making a good decisions and negotiations, which will benefit all and agreed by everyone. It also shows how stakeholders' values and emotions navigates during the course of discussions.

Fig. 1. Leadership Development Program training at Royal Institute of Management , Thimphu.

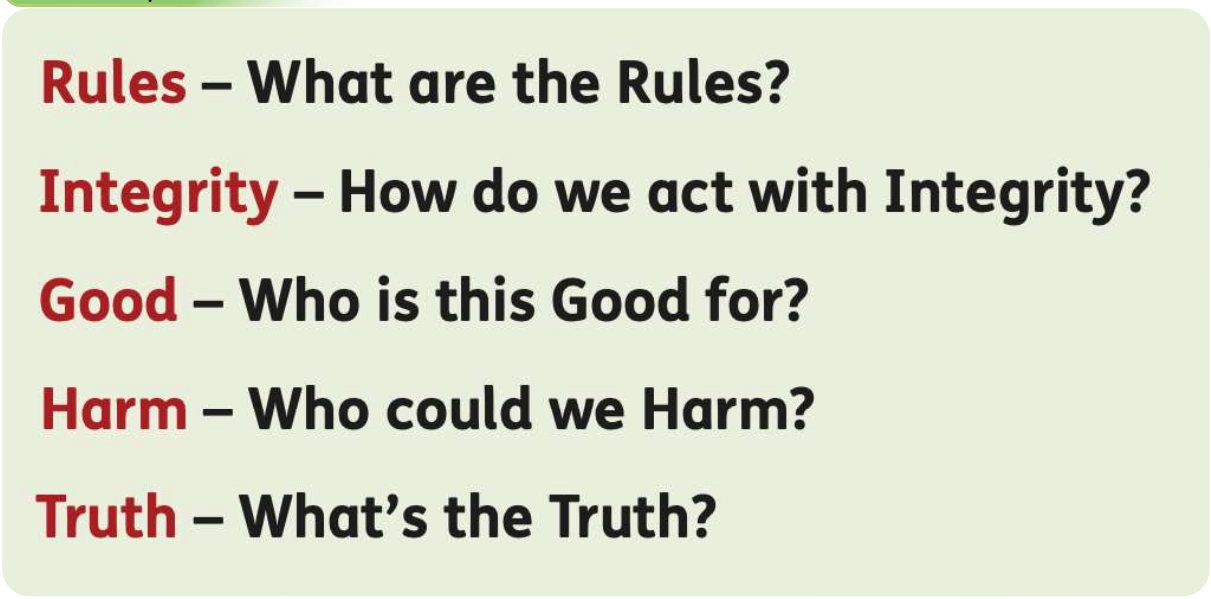

Fig. 2. RIGHT Framework: R- Rules, I- Integrity, G- Good, H- Harm & T- Truth

Currently, I am not so much involved in making major decisions for my office and the ministry, however my colleagues at office has developed a culture of discussing with all staff members for their views and opinions while making important decisions. This really helped me to contribute towards making some of the office decisions. However, I make most of the decisions regarding the program I am heading. My program has two wonderful and motivated staff working with me. Thus, in any future decisions I need to make or contribute, I would certainly apply RIGHT Framework and Cynefin Framework starting with the program I am heading, and if possible will try to improve the overall program climate.

The RIGHT framework – Rules, Integrity, Good, Harm and Truth, is a very useful tool and its easier for me to remember this framework, so that I can apply it instantly and effectively. I would like to horn my values and principle-based decision making while applying RIGHT framework. I am usually involved in numerous field works, where I have to led the team that may consists of both national and international partners. I have led several teams for the field works, training workshops and publishing reports and scientific manuscripts. Thus as a team leader, I can relate the importance of RIGHT framework and Cynefin Framework based on the values and moral DNA.

Cynefin Framework is a new concept to me and I think it will benefit me to make important choices during the course of my career progression. While leading teams, I sometimes face issues and problems at varying degree. Thus, I would prefer to use Cynefin Framework in my work especially while leading the team and contributing towards decision makings. I am remaining hopeful that I can identify the context of the decisions or the issues using Cynefin framework.

Cynefin framework reports five domains: Complex, Complicated, Simple, Chaotic and Disorder, where different domain requires different plan of actions. For Complex context, it requires probing, sensing and responding. While Complicated requires sensing, analyzing and then responding. Simple requires sensing, categorizing and responding. Finally the Chaotic requires us to act, sense and then respond. The fifth context is disorder, which is difficult to identify while one is in that category. Thus as a leader, one has to carefully identify the context and use the tools to make decisions based on the context's characteristics.

I found that the Seismic Shifts is very important especially during the career progression towards becoming a good and motivational leader. As I discussed my Seismic Shifts with my colleague during the training, I would like to transit myself from a Specialist to a Generalist in order to develop me leadership skills. Currently, I am specialized in the field of biodiversity, and further on bioinformatics and taxonomy. Thus, my work is too specific on my specialization. I think that it is now the right time to transit myself from a Specialist to a Generalist, thus I am now getting involved in other tasks outside of my program. Even if I become a Generalist, I would not leave my field of specialization, which I will be working on it in sideways or during my free time. I also believe that a leader should possess some basic knowledge of several subjects to make good decisions and develop a great team.

To transit from Problem Solver to Agenda Setter, I would need to work on my weakness to improve my problem-solving skills and setting the agenda for the office/program. I would need to prioritize and focus on identifying and understanding the right problems, and mobilizing resources. As an Agenda Setter for my program, I would need to have a clear sense of priorities and directions. In addition, one needs to be ready to face both foreseen and unforeseen challenges while setting agendas. Therefore, to transit from Problem Solver to Agenda Setter, one need to focus less on fixing the problems but more towards understanding what a program or an agency is doing and is heading to.

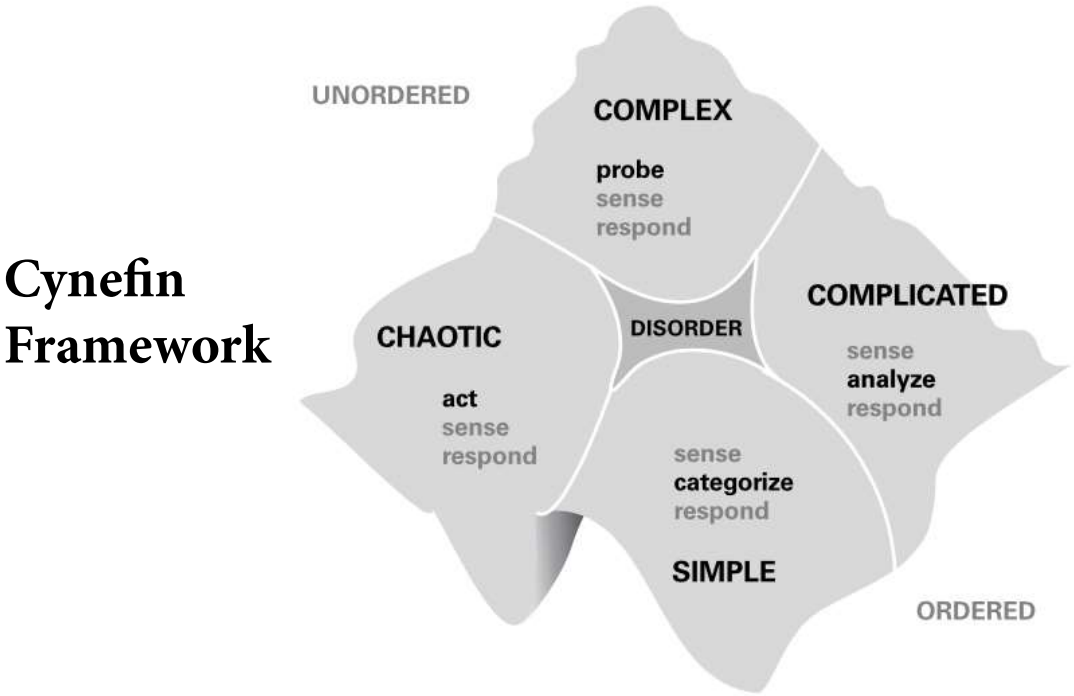

Fig. 3. The Cynefin Framework: It helps leaders determine the prevailing operative context so that they can make appropriate choices (Source: Snowden & Boone, Harvard Business Review, 2007).

In order to achieve agency's mission and goals, the agency should have an enabling climate and culture. A good climate at our workplace would be to have a clear understanding of vision, goals, sense of agency's purposes and resources. To have clarity, I would emphasize on agency's mission of sustainable conservation and utilization of biological resources and equitable sharing of benefits arising from it. So, whatever decisions I make or I work on, it should ultimately contribute towards the sustainable conservation and utilization of Bhutan's biodiversity. Other factors for a good climate at work place is to be flexible, motivational, encourage team members, adaptive,

Fig. 4. The Seven Seismic Shifts: To make transition successfully, leaders must navigate a tricky set of changes in their leadership focus and skills, which are the seven seismic shifts. Its involves learning new skills and cultivating new mindsets. (Source: Watkins, M., Harvard Business Review, 2012).

have mutual accountability, standards and team commitments, inclusive, growth and recognitions. In addition to a good climate at work place, a good work culture also should be taken into account. A good culture too shall have growth and open mindset, succession grooming, a good team spirits and morals, a good working policies and strategies, cooperative, dynamic, knowledge-based and tech-driven working environment. In a nutshell, a good culture is created by a good leader and the team.

In general, I learned that the leaders should be open-minded, always exploring and learning, good at identifying issues and solving it, resolve conflicts, motivate and encourage team members, use RIGHT framework based on one's values, good at decision making which will benefit the nation and the people ultimately, create enabling climate, respect one's integrity and the nation's law and legislations. In this regard, I would plan to start applying RIGHT, Moral DNA and Cynefin decision making starting from my program on Biodiversity Information Management and Invertebrates Repository.

Local Buckwheat Poem

Dr. Asta Maya Tamang

Cultivated and preserved by our farmers for very **long**
Was a staple crop for some and consumed it for **yearlong**

It is an integral part of Bhutanese culture and **tourism**
Grandparents describe that it improves health **condition.**

Information indicates it has numerous medical **properties**
Normalizing high BP, blood glucose and other **abnormalities**

Internet sources says it contains Rutin which is an **antioxidant**
When consumed regularly maintains body young and **elegant**

Flowers of different shades, nature look so **beautiful**
Honey bees and other pollinators feel very **delightful**

Pollinators' paradise is honey producers' **happiness**
Enhancing crop pollination thereby production **increases**

But evidence suggested buckwheat diversity is **declining**
Loss of crop diversity, erosion of culture is the **meaning**

Welcome to Bumthang and Haa to observe these **initiatives**
for livelihood and conservation, progress is **appreciative.**

Find there different buckwheat varieties in **cultivation**
as a part of MoAF-UNDP agrobiodiversity heritage **conservation**

These initiatives have contributed to maintaining/restoring **diversity**
contributing to increasing resilience of climate change **adversity.**

Restoring diversity is preserving buckwheat **culture**
Contributed to income generation and sustainable **agriculture**

They are grown using organic practice free of **chemicals**
good for environment, human health both physical and **mental**

Join us to contribute to food security through enhanced **production**
Join us to preserve this diversity through **conservation.**

Join us in this venture so they are in the fields with our holy **act**
to pass on this resource to our children and grand children **intact.**

12. Abstracts of Published Journal Articles from July 2021 – June 2022

The genus *Erhaia* (Gastropoda, Truncatelloidea, Amnicolidae), with a new species from Bhutan

Edmund Gittenberger, Choki Gyeltshen & Björn Stelbrink

The distribution of the five *Erhaia* (Gastropoda, Truncatelloidea, Amnicolidae) species that are diagnosed by both morphological and molecular data is combined with several records of less completely diagnosed nominal *Erhaia* species. The resulting distribution pattern is summarized in a map and is discussed herein. *Erhaia norbui* sp. nov. is described from Bhutan on the basis of shell morphology and two mitochondrial DNA barcoding markers. A molecular phylogeny is presented for the five *Erhaia* species for which molecular data are available, three of which form a separate clade and are from Bhutan.

Published in ZooKeys 1085: 1–9, 2022, https://doi.org/10.3897/zookeys.1085.77900

Biodiversity checklists for Bhutan

Choki Gyeltshen & Karunya Prasad

The checklists showcase 11,175 species from the kingdoms Plantae, Animalia, Fungi, Chromista and Eubacteria. Research conducted into identifying species from the kingdoms Protista and Archaebacteria revealed zero records. These checklists include at least 33 species new to science and 566 species new to Bhutan, discovered between 2009 and 2017. Unidentified species are not taken into account in this publication.

Published in Biodiversity Data Journal 10: e83798, 2022, https://doi.org/10.3897/BDJ.10.e83798

Orchids of Bhutan: The genus *Cypripedium*

Pem Zam, Stig Dalstrom, Choki Gyeltshen, Nima Gyeltshen & Kezang Tobgay

The genus *Cypripedium* L. is represented by five distinct looking species in Bhutan, constituting of *Cypripedium cordigerum* D.Don, *Cypripedium elegans* Rchb.f., *Cypripedium guttatum* Sw., *Cypripedium himalaicum* Rolfe and *Cypripedium tibeticum* King ex Rolfe. *Cypripedium cordigerum* is widely distributed in Bhutan and associated with wet and shady woods, open *Abies densa, Picea spinulosa, Pinus wallichiana,* and *Tsuga dumosa* forest; *Juniperus* and dwarf bamboo scrub. The orchid is characterized by flowers with snowy white lip.

Published in Orchids, 358-363, American Orchid Society, May 2022

The first record of the rare fern *Pteris griffithii* (Polypodiales: Pteridaceae: Pteridoideae) in the Bhutan Himalayas

Rinchen Dorji, Sangay Dema, Mani Prasad Nirola & Choki Gyeltshen

Bhutan hosts ten genera and 59 species from around 300 species of the genus Pteris belonging to subfamily Pteridoideae and family Pteridaceae. *Pteris griffithii* is recognized as a critically endangered species in some of the countries. However, there are no assessments on the International Union for Conservation of Nature (IUCN) Red List for this species. The species was discovered in from one location Bhutan from the water accumulated habitat near the river connected to hydroelectricity project. The habitat of *Pteris griffithii* was observed to be vulnerable to submerging from increased level of water during summer soon, which meant that the species could only grow winter when the water level are minimal. Therefore, *ex-situ* conservation and reassessment of the species were carried out.

Published in Korean Journal of Plant Taxonomy, 52(1): 24-28, 2022 https://doi.org/10.11110/kjpt.2022.52.1.24

Tetrastigma planicaule (Vitaceae): a new record for Bhutan

Rinchen Dorji, Gyeltshen, Phuentsho & A. Trias-Blasi

Tetrastigma planicaule (Hook.f.) Gagnep. is an economically important woody liana sharing its family Vitaceae among 95 other species with its primary distribution in South-east Asia. A total of ten species of *Tetrastigma* including *Tetrastigma planicaule* are documented in Flora of Bhutan. However, T*etrastigma planicaule* remained undocumented from Bhutan up until recently. The species were first discovered in two locations of Tongling Kuenphen Community Forest in Gangzur Gewog, Lhuentse district, during a field revisit to flowering sites of *Sapria himalayana* Griff. The species were found in association with Acer oblongum Wall. ex DC. and a rare holoparasitic species, *Sapria himalayana*.

Published in RHEEDEA Journal of the Indian Association for Angiosperm Taxonomy, 2022. https://dx.doi.org/10.22244/rheedea.2022.32.02.02

Rediscovery of rare *Rhododendron pogonophyllum* Cowan & Davidian after a gap of 84 years in Bhutan

National Biodiversity Centre

Rhododendron pogonophyllum Cowan & Davidian is a rare endemic *Rhododendron* species along with 45 other species described in Flora of Bhutan. A book "Wild Rhododendrons of Bhutan" describes *Rhododendron pogonophyllum* by its flower, leaf, flowering time, habitat, altitude, distribution, with a remark stating as an endemic and rare plant species not seen since 1937,

but without any photographic evidence. A team from National Herbarium and Royal Botanical Garden Serbithang, National Biodiversity Centre started an expedition following the routes taken by George Sheriff, who first discovered R*hododendron pogonophyllum* in Kyitsugang, which sheriff documented is as Chizukang. The team discovered *Rhododendron pogonophyllum* growing on the rocks and rocky soils on open hill sides of Kyitsugang at an elevation of 4.452 masl.

Published in Windows on Bhutan, Issue XVIII 2021: 35-39, 2021

Galba schirazensis in Bhutan (Gastropoda: Pulmonata: Lymnaeidae), a thought-provoking record

Edmund Gittenberger, Adriaan Gittenberger, Kezang Tobgay & Choki Gyeltshen

Galba truncatula and conchologically sibling species *Galba schirazensis* is slightly different and may have overlapping shell characters. The recent rediscovery of the *Galba schirazensis* from Bhutan with a nearly equally large distribution as that of *G. truncatula*, raises a critical reconsidering of the literature, as publications on "*G. truncatula*" might partially be on *G. schirazensis* or a combination of both species. One hypothesis claims the spread of *G. schirazensis* from an area in the Near East by hitch-hiking with ancient livestock into Asia and similarly with cattle via southern Europe to the New World. The other contradicting hypothesis claims the native range of the species in the New World with the Old-World populations resulting from recent introductions. Both biogeographical scenarios are unlikely in light of discovery of *G. schirazensis* in an isolated dead-end valley in Bhutan, ca 3,500 km east of Iran and nearly 2,500 km southeast of the record in Tajikistan, without any connection to livestock transport routes.

Published in Basteria, 85 (2): 154–156, 2021

Habitat preference of freshwater fishes along the Gamri River, Trashigang, Bhutan

Tandin Wangchuk, Sushila Rai & Choki Gyeltshen

The fish diversity and its distribution in relation to habitat type occupancy for pre-monsoon and post-monsoon season were assessed along the Gamri River in Trashigang, eastern Bhutan. A total of eight species belonging to eight genera in four families and two orders were recorded. The relative abundance of fishes was highest in the pool habitat (41.2%) with a mean rank of 196.92. The total number of fishes encountered was highest during post-monsoon with 964 counts. The chirpine zone displayed the highest diversity (H' = 1.77). The species richness (SR = 3) was highest in Riffle habitat and the evenness (EH = 2.2) was highest in the run habitat. While the temperature increased from 15°C to 18°C, the pH and DO readings decreased from 7.6 to 6.8 and 6.3 mg/l to 6 mg/l respectively. The findings indicated that, within the temperature range of 15°C to 18°C, species richness, evenness and distribution of fishes was highest in warmer

habitats. The relationship between these water parameters with the habitat and seasons could have affected the diversity and distribution of fishes. Therefore, these wide ranges of water parameters must be considered in the freshwater ecology while studying habitat preferences of freshwater fishes.

Published in Biodiversität und Naturausstattung im Himalaya VII. – Erfurt, 119-126; 2021

Species and status of bamboo known for the conical hat of northwestern Laya: a unique culture in Gasa, Bhutan

Sangay Dorjee, Sherub Tenzin, Phuentsho & Kezang Tobgay

Montane bamboo is a necessary component of high-altitude temperate forest ecosystems and of cultural and ecological importance not only to the country but also to indigenous people inhabiting mountains of the Himalayas. Particularly, in Laya, Montane bamboo is commonly used for weaving conical hat and other implements. Despite its cultural and ecological importance, the detailed assessment of the social and conservation significant inventory of bamboo species distribution especially in natural forests is limited. This study assessed the species and status of bamboo known for the conical bamboo. *Thamnocal amusspathiflorus* (Trin.) Munro bamboo was documented as a main element of the conical hat making, displaying the highest altitude frost hardy bamboos in mixed coniferous forest.

Published in International Journal of Engineering Applied Sciences and Technology, 2022, ISSN No. 2455-2143

An annotated checklist of the Vespidae (Hymenoptera: Vespoidea) of Bhutan with new records

Phurpa Dorji, Tshering Nidup, Wim Klein, Cheten Dorji, Anthony Daglio & Choki Gyeltshen

This checklist covers each of the 73 social and solitary wasps of the family Vespidae currently known from Bhutan. Of these, 11 species in the subfamily Eumeninae, five species in Polistinae and one species in Vespinae are reported as new records for the country.

Published in Zootaxa, 5150 (3), June 2022. https://doi.org/10.11646/zootaxa.5150.3.1

Ecological Conditions of Luetshokha Lake and its Recharge Potential using Rooftop Rainwater Harvesting, Samtengang, Wangdue Bhutan

Tshering Pem, Dhan Bdr. Gurung, Kelzang Dawa & Rupesh Subedi

Luetshokha lake harbors invasive aquatic plants and experiences reduction in water level. Change in composition of aquatic plant can adversely affect the biodiversity of lake by

replacing its native aquatic plants species as well as impact aquatic organism's dependent on them. Reduction of the water level experienced by lake could also be due to abundant presence of invasive aquatic plants. This research assessed the water variables and floristic and macroinvertebrate compositions of Luetshokha lake in Samtengang, Wangdue and its potential to increase water level using rooftop rainwater harvesting (RWH) that may help in submerging the emergent and invasive aquatic plants that could be useful in improving the environment and water level of the lake. Presence of invasive aquatic plants and macroinvertebrate indicated organic pollution of water. The total potential for the rise in water level calculated was 0.05 m. This means that if the rooftop rainwater from the school infrastructure are harvested and diverted to the lake, the lake has the potential to raise its water level by 5 cm annually.

Published in BJNRD, 9(1): 62-73, 2022. https://doi.org/10.17102/cnr.2022.73

Orchids of Bhutan: *Arachnis* (the "Esmeraldas")

Stig Dalstrom, Choki Gyeltshen, Nima Gyeltshen, Kezang Tobgay, Pem Zam, Tandin Wangchuk, Kezang Rinzin & Bhakta Bdr. Ghalley

This article describes the genus *Arachnis (Esmeralda)* in Bhutan. *Arachnis cathcartii* (Lindl.) J.J.Sm., was originally described as *Vanda cathcartii* by John Lindley, based on a collection by Joseph Dalton Hooker at 3,000 feet (1,000 m) in the hot jungles of the state of Sikkim, India. It is a striking species that unfortunately is seldom seen in cultivation. It also appears to be rather rare in the wild, at least in Bhutan. We have seen plants in the warmer region of the country in the forests surrounding the town of Nganglam, not far from the border with the state of Assam, India. It seems to prefer a shadier and well-protected habitat growing as an epiphyte rather close to the ground.

Published in Orchids, 199-202, American Orchid Society, March 2022

Ipomoea campanulata L. (Convolvulaceae) – a new record to the flora of Bhutan

Phuentsho, Rinchen Dorji & Lungten Norbu

Presence of the large shrubby plant called *Ipomoea campanulata* is reported for the first time in Bhutan. It was found during an invasive alien plant survey conducted in the Jomotsangkha Wildlife Sanctuary in February 2020. Specimens were collected from the Deorali roadside between Phuntshothang and Samrang in Samdrup Jongkhar district. A brief diagnosis along with its distribution and color photographs are provided.

Published in BJNRD (2021), 8(1): 37-40. DOI: https://doi.org/10.17102/cnr.2021.64

Perception of farmers towards Invasive Alien Plant Species: A case study from Punakha andSamtse Dzongkhags, Bhutan

Tshering Dorji, Rinchen Yangzom, Kencho Dorji, Rinchen Dorji, Choki Wangmo, Dago Dorji, Jamyang Choden & Choki Gyeltshen

We conducted a study to evaluate the perception of farmers towards invasive plant species, and the impact of invasive plants on local livelihoods in Punakha and Samtse Dzongkhags. Data were collected from 291 respondents selected through stratified random sampling using a semi-structured questionnaire. A total of 11 invasive plant species were recorded. Invasive species posed the greatest threat to agricultural land, and reduced crop production. The impact of Invasive Alien Species (IAS) on the livelihood of people is more prominent in Samtse than in Punakha, mainly because of *Lantana camara* and *Mikania micrantha*. Although manual control measures are carried out, they are either unsuccessful or only provide temporary relief. Awareness of the effects of invasive species needs to be raised, focusing on the impacts on ecosystem and grazing areas. Possible avenues for utilization of IAS may be explored for integrated and adaptive management.

Published in Biodiversitat und Naturausstattung im Himalaya VII, Erfurt, December, 2021

Citrus medica L. 'Sarcodactylis

Jamyang Choden, Choki Gyeltshen & Tshering Dorji

Citrus medica L. is a small tree belonging to the Rutaceae family. It has a yellowish-orange round or oblong fruit of size varying from 8 cm to 12 cm in length and irregularly arranged branches with sharp spines. The plant is believed to have originated in India and China, spread to the western countries by passing through Persia and is available in India, China, Japan, Bangladesh, Arabia, Australia, Africa, tropical and subtropical areas. It is a very important plant with many culinary and medicinal uses. This chapter on *C. medica* focuses on nutritional and phytochemical composition and pharmacological activities, and other uses of the plant.

Chapter Published in Himalayan Fruits and Berries - Bioactive Compounds, Uses and Nutraceutical Potential, Elsevier, 2022

Understanding *Primula bracteosa* Craib

Pam Eveleigh & Phuentsho

Plant hunting these days is much more than randomly finding plants in the wild. We can arm-chair travel, covet wild plants shown in forum images, and discuss their identity. Phuentsho had recognized images posted on Facebook and in the citizen science web portals iNaturalist.org and biodiversity.bt as the same plants he had seen multiple times around Trongsa and

Wandue Phodrang in Bhutan. Pam identified them as *Primula bracteosa.* We wanted to know more and decided to collaborate to understand more about *P. bracteosa*, with Pam researching historical documents online from Canada, and Phuentsho doing field studies in Bhutan.

Published in The Rock Garden, 147, July, 2022

Description of *Arisaema* (Araceae) found in Bhutan and new additions to the Flora of Bhutan

Phub Gyeltshen, Dendup Tshering & Phuentsho Phuentsho

The seven sections of the genus *Arisaema* found in Bhutan are described based on the morphological evidences of 16 species of *Arisaema* known from the Bhutan Himalaya: sect. *Anomala* Gusman & L. Gusman, sect. *Arisaema,* sect. Dochafa (Schott) H. Hara, sect. *Nepenthoidea* (Engler) H. Hara, sect. *Sinarisaema* Nakai and sect. *Tenuipistillata* Engler, sect. *Tortuosa* (Engl.) Nakai. of the seven recognised sections, sect. *Arisaema* is the most diverse section with eight species recorded from Bhutan. In this paper *Arisaema petiolulatum* Hook.f. and *Arisaema anatinum* Brugg. are documented as newrecords for Bhutan

Published in BJNRD (2021), 8(2): 12-20. DOI: https://doi.org/10.17102/cnr.2021.2.65

Flavonoids in the flowers of *Primula ×polyantha* Mill. and *Primula primulina* (Spreng.) H. Hara (Primulaceae)

Fumi Tatsuzawa, Takayuki Mizuno, Ryo Kikuchi, Kazuhisa Kato, Toru Ota, Yoshinori Murai, Rinchen Yangzom & Tsukasa Iwashina

Two undescribed anthocyanins and two undescribed flavonols were isolated from the flowers of *Primula ×polyantha* Mill., along with five known anthocyanins and four known flavonols. The two undescribed anthocyanins and the two undescribed flavonols were determined to be hirsutidin 3-O-β-galactopyranoside-5-O-β-glucopyranoside, 7-O-methyl-petunidin 3-O-β-galactopyranoside-5-O-β-glucopyranoside, quercetin 3-O-β-[(6””-acetylglucopyranosyl)-(1 2)-β-glucopyranosyl-(1 6)-β-glucopyranoside], and kaempferol 3-O-β-[(6””-acetylglucopyranosyl)-(1 2)-β-glucopyranosyl-(1 6)-β-glucopyranoside] using chemical and spectroscopic methods. They were also found in the flowers of the Himalayan wild species, *Primula primulina* (Spreng.) H. Hara except for quercetin 3-O-β-[(6””-acetylglucopyranosyl)-(1 2)-β-glucopyranosyl-(1 6)-β-glucopyranoside]. The flower color variations of *P. ×polyantha* cultivars, reflected by the hue values (b*/a*) of the colors, were due to the glycosidic patterns in the anthocyanins and their concentrations in the petals. Moreover, in the *P. ×polyantha* cultivars with violet-blue flowers, both the intermolecular copigmentation occurs between hirsutidin 3-O-β-galactopyranoside-5-O-β-glucopyranoside and another flavonol, quercetin 3-O-β-glucopyranosyl-(1 2)-β-glucopyranosyl-(1 6)-β-glucopyranoside. Moreover, the flower color variation was affected by the pH value.

Published in Phytochemistry 189:112827, September 2021. DOI: http://dx.doi.org/10.1016/j.phytochem.2021.112827

Phenolic Compounds from Three Alpine *Anaphalis* Species in Japan and Bhutan

Yoshinori Murai, Rinchen Yangzom, Choki Wangmo & Rinchen Dorji

Phenolic compounds of *Anaphalis alpicola* in Japan, and *A. nepalensis* and *A. cooperi* in Bhutan, were surveyed. Three phenylpropanoids (chlorogenic acid, isochlorogenic acid A, and isochlorogenic acid C) were isolated together with several flavonoids. A novel bioactive compound chlorogenic acid, and its derivative isochlorogenic acid A, were the main components in *Anaphalis* leaves. The flavonoid composition of *A. alpicola* was similar to that of *A. cooperi.* In addition, the overall content of phenolic compounds in the leaves of *A. alpicola* decreased when plants were cultivated in a glasshouse, compared to plants grown in their natural habitat. The paper describes the chemotaxonomic and ecological significance of the isolated compounds.

Published in Bull. Natl. Mus. Nat. Sci., Ser. B, 47(2): 109-114

Phebalium calcicola (Rutaceae: Boronieae): a species described as new, restricted to south-eastern South Australia, is proposed as Critically Endangered

Sangay Dema, Ian R.H. Telford, Rose L. Andrew, Daniel J. Duval & Jeremy J. Bruhl

Phebalium calcicola, a multi-stemmed shrub from south-eastern South Australia, is segregated from the *P. squamulosum* subsp. *squamulosum* assemblage and described here as new, based on phenetic distinctness, habitat preference and geographical disjunction. It is compared with *P. squamulosum* subsp. *squamulosum s.str.* from the Sydney region, as well as the geographically closest populations from Victoria, which are currently referred as *P. squamulosum* subsp. *squamulosum.* A recommendation for the conservation status of this species as Critically Endangered is proposed. An amended key to species of *Phebalium* in South Australia is provided.

Published in Swainsona 35: 43–53, 2021. flora.sa.gov.au/swainsona

Discovery, distribution and conservation of the rare parasitic plant *Sapria himalayana* (Rafflesiaceae) in Bhutan

Rinchen Dorji, Phuentsho, Ugyen Dechen, Gyeltshen, Tshering Samdrup, Kinley Dorji, Reta B. Powrel, Phub Dorji, Krishna P. Dhimal & David G. Long

Sapria himalayana Griff. (Rafflesiaceae) and its biology are described. Its distribution in Bhutan is mapped, taking inot account recent records.

Published in Curtis's Botanical Megazine, 39(3): 541-554, 2022

Biodiversity Data Use & Repositories in Bhutan

Choki Gyeltshen & Tshering Pem

Biodiversity information and biorepositories in Bhutan were instituted in the 1990s, and have contributed towards biodiversity conservation efforts in the country including citizen-science initiatives. Bioinformatics in Bhutan is still in its initial stage, and some biorepositories have incorporated information systems for their collections. Some major biorepositories in the country include the National Herbarium, National Animal Gene Bank, National Plant Gene Bank, National Invertebrates Repository, and Taxidermy. Other repositories distributed at various institutions cover the taxonomic groups such as fishes, amphibian and reptiles, butterflies and moths, mushrooms, bryophytes, agricultural pests, among others. Biorepositories are one of the major sources of biodiversity data and information, where the National Herbarium and National Invertebrates Repository have initiated digitizing its plant and invertebrate specimens.

Published in Biodiversity Information Science and Standards 6, 2022.
DOI: http://dx.doi.org/10.3897/biss.6.93884

Clock tower in winter at the Royal Botanical Garden Serbithang

List of Publications

S.No.	PUBLICATIONS	AUTHORS/EDITORS	YEAR
	BOOKS/REPORTS		
1	A pictorial book of the ornamental plants and orchids of Royal Botanical Garden, Serbithang, Vol. I.	Nima Gyeltshen, Sangay Dema & Kezang Tobgay	2013
2	National Biodiversity Strategy and Action Plan (NBSAP).	National Biodiversity Centre	2014
3	Access and Benefit Sharing Policy 2015.	National Biodiversity Centre/RGoB	2015
4	The History of the introduction and adoption of important food crops in Bhutan (Rice, Maize, Potato and Chili).	Tashi Y. Dorji, Asta M. Tang & Ronnie Vernoy	2015
5	Plant Genetic Resources, Bhutanese Perspective.	Karma Tsering, Asta M. Tamang, Bhag Mal, P.N. Mathur & Rinchen Dorji	2000
6	Plant Genetic Resources of Bhutan Vol. I: Field Crops.	National Biodiversity Centre	2008
7	HARVESTS, Farmers Success Stories.	National Biodiversity Centre	2016
8	Endemic plants of Bhutan Himalaya.	Rinchen Yangzom & David. G. Long	2015
9	A century of new orchid records of Bhutan.	Stig Dalstrom, Choki Gyeltshen & Nima Gyeltshen	2016
10	National Cereals Conservation Strategic Action Plan.	National Biodiversity Centre	2016
11	Conservation, Development and Sustainable Use of Crop Genetic Resources for Livelihood and Food Security.	National Biodiversity Centre	2016
12	A field guide to the selected trees, shrubs and herbs of Tangsibji hydropower porject area.	Nima Gyeltshen, Sangay Dema, Kezang Tobgay, Tandin Wangchuk & Choki Gyeltshen	2017
13	A pictorial guide to the trees and shrubs of Royal Botanical Garden, Serbithang. Vol. II.	Nima Gyeltshen, Sangay Dema, Kezang Tobgay, Tandin Wangchuk & Choki Gyeltshen	2017
14	A field guide to the common dragonflies and damselflies of Bhutan.	Thinley Gyeltshen, Vincent Kalkman & Albert Orr	2017
15	A field guide to the common bees and wasps of Bhutan.	Phurpa Dorji, Tshering Nidup & Wim Klein	2017
16	A field guide to the common moths of Bhutan.	Karma Wangdi & Cees Gielis	2017
17	A field guide to the common molluscs of Bhutan.	Edmund Gittenberger, Pema Leda, Choki Gyeltshen, Sherub & Sangay Dema	2017
18	A field guide to the common lady beetles of Bhutan.	Cheten Dorji, Oscar Vorst & Phuntsho Loday	2017
19	Animal Genetic Resources of Bhutan.	National Biodiversity Centre	2008
20	Access and Benefit Sharing Toolkit for the Management of Genetic Resources and Associated Traditional Knowledge.	Tashi Y. Dorji, Sangay Dema, Chencho Dorji, Mani P. Nirola, Kencho Dorji & Leki Wangchuk	2018
21	A Pictorial Guide to Major Invasive Plants of Bhutan.	Rinchen Yangzom, Kencho Dorji, Tshering Dorji, Rinchen Dorji, Choki Wangmo & Choki Gyeltshen	2018
22	A Pictorial Guide to Alpine Plants of Bhutan Himalaya.	Rinchen Yangzom	2018
23	Pteridophytes of Bhutan.	C.R. Fraser-Jenkins, S. Matsumoto & Tandin Wangdi	2009

S.No.	PUBLICATIONS	AUTHORS/EDITORS	YEAR
24	NBC Vision 2030.	National Biodiversity Centre	2018
25	Biodiversity Statistics of Bhutan 2017.	Choki Gyeltshen, Sangay Dema, Danielle Northey & Karunya Prasad	2019
26	Bhutan Biodiversity Portal User Manual.	National Biodiversity Centre	2021
27	Biodiversity Conservation and Management Initiatives in Bhutan.	National Biodiversity Centre	2006
28	Characterization Catalogue and Pictorial Varietal Descriptions on Traditional Paddy Varieties *(Oryza sativa)* Conserved in the National Crop Genebank.	Choki Wangmo, Tashi Yangzom & Choki Gyeltshen	2020
RESEARCH PAPERS/ARTICLES			
29	Morphological variations of native chicken types in backyard farms of Bhutan.	Jigme Dorji, Sonam Tamang, Tshewang & Tashi Y. Dorji	2017
30	Genetic diversity of population structure of traditional horse breeds of Bhutan.	Jigme Dorji, Sonam Tamang, Tshewang Tshewang, Tshering Dorji & Tashi Y. Dorji	2018
31	Community Perspectives on the On-Farm Diversity of Six Major Cereals and Climate Change in Bhutan.	Tirtha Bdr. Katwal, Singay Dorji, Rinchen Dorji, Lhab Tshering, Mahesh Ghimiray, Ganesh B. Chhetri, Tashi Y. Dorji & Asta Maya Tamang	2015
32	Immunological tolerance of Bhutanese native chicken to Infectious Bursal Disease Virus infection.	Jigme Dorji, Tshering Dorji, Tshewang, Tashi Y. Dorji, Sangay Tenzin & R.B. Gurung	2016
33	Mountain communities workshops on climate change and biocultural heritage.	Krystyna Swiderska & Alejandro Argumedo	2014
34	Dancing butterflies of the East Himalayas: New *Meconopsis* species from East Bhutan, Arunachal Pradesh and South Tibet.	Toshio Yoshida, Rinchen Yangzom & David Long	2017
35	A new species of blue poppy.	Toshio Yoshida & Christopher Grey-Wilson	2016
36	*Roscoea megalantha* (Zingiberaceae), A new species from eastern Bhutan and India.	Toshio Yoshida, Rinchen Yangzom & M.F. Newman	2017
37	Decline of Jakar sheep population in pastoral communities of Bhutan: A consequence of diminishing utility, alternate income opportunities and increasing challenges.	Jigme Dorji, Sonam Tamang & Tashi Yangzome Dorji	2017
38	Assessment of genetic diversity of Mithun *(Bos frontalis)* population in Bhutan using microsatellite DNA markers.	Sangay Tenzin, Jigme Dorji, Tashi Dorji & Yoshi Kawamoto	2017
39	Flower pigments Black Pea *Thermopsis barbata* (Fabaceae) in Bhutan.	Yoshinori Murai, Rinchen Yangzom, Choki Gyeltshen, Kencho Dorji, Choki Wangmo & Tsukasa Iwashina	2017
40	Morphological diversity of principal horse populations of Bhutan.	Jigme Dorji, Sonam Tamang, Tshewang Tshewang, Tshering Dorji & Tashi Dorji	2017
41	Phenotypic and genetic parameters for milk yield in traditional Nublang cattle *(Bos indicus)* of Bhutan.	Jigme Dorji, Dhendup & Iona M. MacLeod	2015
42	A new striking *Spathoglottis* (Orchidaceae: Collabiinae), Honoring Her Majesty The Queen of Bhutan.	Nima Gyeltshen, Kezang Tobgay & Stig Dalstrom	2017
43	Orchids of Bhutan - The genus *Vanda.*	Stig Dalstrom, Dhan Bdr. Gurung, Choki Gyeltshen & Nima Gyeltshen	2015
44	An expected alleged natural *Vanda* hybrid.	Stig Dalstrom, Dupchu Wangdi & Kezang Tobgay	2017

S.No.	PUBLICATIONS	AUTHORS/EDITORS	YEAR
45	Orchids of Bhutan - The genus *Phaius.*	Stig Dalstrom, Dhan Bdr. Gurung, Choki Gyeltshen & Nima Gyeltshen	2015
46	Orchids of Bhutan - To be or not to be a *Chamaegastrodia.*	Stig Dalstrom, Ngawang Gyeltshen, Choki Gyeltshen, Thomas Hoijer & Jangchu Wangdi	2014
47	*Erhaia* Davis & Kuo (Gastropoda, Rissooidea, Amnicolidae) also in Bhutan.	Edmund Gittenberger, Sherub Sherub & Bjorn Stelbrink	2017
48	Gastropods in Bhutan, the genus *Rahula* (Pulmonata: Helicarionidae).	Edmund Gittenberger, Pema Leda & Sherub Sherub	2017
49	The first record of the cosmopolitan slug, *Deroceras laeve* (Gastropoda, Pulmonata, Agriolimacidae) in Bhutan.	Edmund Gittenberger, Choki Gyeltshen, Pema Leda, Tshelthrim Zangpo & Rieks Dekker van Klinken	2018
50	Orchids of Bhutan: *Phalaenopsis* Blume.	Stig Dalstrom, Choki Gyeltshen, Nima Gyeltshen, Kezang Tobgay, Pem Zam, Tandin Wangchuk & Kezang Rinzin	2021
51	Two high-altitude species of molluscs, new for Bhutan (Bivalvia, Sphaeriidae – Gastropoda, Lymnaeidae).	Edmund Gittenberger, Kezang Tobgay, Choki Gyeltshen & Hasko Nesemann	2021
52	The families Streptaxidae and Diapheridae (Gastropoda, Pulmonata) in Bhutan, with notes on some species occurring in Nepal and North-east India.	Edmund Gittenberger, Pema Leda, Sherub Sherub & Choki Gyeltshen	2021
53	*Rahula* revisited (Pulmonata: Euconulidae), with data for Bhutan, India (Assam), Laos, Vietnam and Indonesia, including two new species.	Edmund Gittenberger, Pema Leda, Sherub Sherub & Choki Gyeltshen	2021
54	Flavonol Glycosides from the Whitish Flowers of *Primula alpicola* and *P. sikkimensis* var. *hopeana* in Bhutan.	Takayuki Mizuno, Rinchen Yangzom, Hari. P/ Devkota, Yoshinori Murai, Rinchen Dorji, Kencho Dorji, Choki Wangmo, Choki Gyeltshen & T. Iwashina	2020
55	Orchids of Bhutan: The genus *Spathoglottis.*	Stig Dalstrom, Choki Gyeltshen, Nima Gyeltshen, Kezang Tobgay, Ngawang Gyeltshen, Bhakta Bdr. Ghalley	2020
56	Climate change effects on wildfire hazards in the wildland-urban-interface – Blue pine forests of Bhutan.	Lena Vila-Vilardell, Willian S. Keeton, Dominik Thom, Choki Gyeltshen, Kaka Tshering & Georg Gratzer	2020
57	Bhutan Biodiversity Portal: Citizen Science initiative in Bhutan.	Choki Gyeltshen, Karunya Prasad, Sangay Dema & Tashi Yangzome Dorji	2019
58	Bhutan's Challenges in Biodiversity Informatics.	Choki Gyeltshen & Sangay Dema	2019
59	Anthocyanins and flavonols from the blue flowers of six *Meconopsis* species in Bhutan.	Tsukasa Iwashina, K. Yokoyama, Rinchen Yangzom, T. Mizuno, H.P. Devkota, Y. Murai, Kencho Dorji, Choki Wangmo & Choki Gyeltshen	2019
60	A new spotted *Chiloschista* (Orchidaceae: Aeridinae) from Bhutan.	Choki Gyeltshen, Stig Dalstrom, Nima Gyeltshen & Kezang Tobgay	2019
61	Orchids of Bhutan: the genus *Thunia.*	Stig Dalstrom, Choki Gyeltshen, Kezang Tobgay, Ngawang Gyeltshen & Bhakta Bdr. Gurung	2019
62	Orchids of Bhutan: the genus *Diplomeris.*	Stig Dalstrom, Choki Gyeltshen, Nima Gyeltshen, Kezang Tobgay, Ngawang Gyeltshen, Bhakta Bdr. Ghalley & Kinley Rabgay	2019

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63	Distribution and habitats of *Paphiopedilum* Pfitzer known to occur in Bhutan.	Dhan Bdr. Gurung, Nima Gyeltshen, Kezang Tobgay, Stig Dalstrom, Jangchu Wangdi, B.B. Ghalley, Lekey Chaida, Phuntsho, Ngawang Gyeltshen, K. Dawa, T. Wangchuk, Rebecca Pradhan, T. Hoijer & Choki Gyeltshen	2019
64	*Pentasacme wallichii* Wall. & Wight. (Family: Apocynaceae): A first record to Bhutan.	Kezang Tobgay, Nima Gyeltshen, Sangay Dema, Tandin Wangchuk & Choki Gyeltshen	2019
65	New species discoveries and records in Bhutan Himalaya.	Choki Gyeltshen, Kezang Tobgay, Nima Gyeltshen, Tshering Dorji & Sangay Dema	2018
66	Distributional patterns of molluscan taxa in Bhutan.	Edmund Gittenberger, Pema Leda, Choki Gyeltshen & Sherub Sherub	2018
67	Flavonol glycosides in the flowers of the Himalayan *Meconopsis paniculata* and *Meconopsis integrifolia* as yellow pigments.	Kazutaka Yokoyama, Rinchen Yangzom, Takayuki Mizuno, Yoshinori Murai, Kencho Dorji, Choki Wangmo, Choki Gyeltshen & Tsukasa Iwashina	2018
68	Development of a national repository for aquatic biodiversity in Bhutan.	Sangay Dema, Choki Gyeltshen, Thomas Vattakaven & Prabhakar Rajagopal	2017
69	The superfamilies Pupilloidea and Enoidea (Gastropoda, Eupulmonata) in Bhutan.	Edmund Gittenberger, Choki Gyeltshen, Pema Leda & Sherub Sherub	2021
70	Bhutanese snails, the smallest one: *Truncatellina bhutanensis* spec. nov. (Gastropoda, Pulmonata, Vertiginidae).	Edmund Gittenberger, Pema Leda & Sherub Sherub	2013
71	The genera *Erhaia* and *Tricula* (Gastropoda, Rissooidea, Amnicolidae and Pomatiopsidae) in Bhutan and elsewhere in the eastern Himalaya.	Edmund Gittenberger, Pema Leda, Jigme Wangchuk, Choki Gyeltshen & Bjorn Stelbrink	2020
72	*Rhaphiolepis bengalensis* (Roxb.) B.B.Liu & J.Wen: A New Record of Plant to Bhutan.	Dhan Bdr. Gurung, Pema Tobgay, Tshering Dendup, Summit Subba, Wangchuk Blon, Phuentsho, Rinchen Dorji & Kencho Dorji	2020
73	Two new spotted *Chiloschista* species (Orchidaceae: Aeridinae) from Bhutan.	Nima Gyeltshen, Choki Gyeltshen, Kezang Tobgay, Dhan Bdr. Gurung, Ngawang Gyeltshen & Bhakta Bdr. Gurung	2020
74	*Utricularia furcellata* (Lentibulariaceae): A new record to Bhutan.	Phub Gyeltshen & Sangay Dema	2020
75	Flavonoids from the leaves and flowers of the Himalayan *Cathcartia villosa* (Papaveraceae).	Tsukasa Iwashina, Rinchen Yangzom, Hari P. Devkota & Takayuki Mizuno	2021
76	Flavonoids From the Flowers and Leaves of the Himalayan *Megacodon stylophorus* (Gentianaceae).	Tsukasa Iwashina, Rinchen Yangzom, Hari P. Devkota & Takayuki Mizuno	2021
77	*Amblyanthopsis bhotanica* rediscovered in Bhutan after 181 years.	Phuentsho & David G. Long	2020
78	Flavonoids in the flowers of *Primula ×polyantha* Mill. and *Primula primulina* (Spreng.) H. Hara (Primulaceae).	Fumi Tatsuzawa, Takayuki Mizuno, Ryo Kikuchi, Kazuhisa Kato, Toru Ota, Yoshinori Murai, Rinchen Yangzom & Tsukasa Iwashina	2021
79	Anthocyanins from the Red Flowers of *Meconopsis wallichi* in Bhutan.	Tsukasa Iwashina, Rinchen Yangzom, Yoshinori Murai, Kencho Dorji, Takayuki Mizuno & Choki Wangmo	2018
80	Elevational seed plants richness patterns in Bhutan, Eastern Himalaya.	Jurgen Kluge, Sebastian Worm, Simon Lange, David Long, Jurgen Bohner, Rinchen Yangzom & Georg Miehe	2017

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81	Biodiversity inventories in high gear: DNA barcoding facilitates a rapid biotic survey of a temperate nature reserve.	Angela C. Telfer, Monica R. Young, J. Quinn, K. Perez, C.N. Sobel, J.E. Sones, V.L. Beaudin, R. Derbyshire, Kencho Dorji, et. la.	2015
82	New Herpetofaunal Records from the Kingdom of Bhutan Obtained through Citizen Science.	J.T. Wangyel, D.S. Bower, S. Tshewang, D. Wangdi, K. Rinchen, Phuentsho, et. al.	2020
83	Number of species in Bhutan.	Choki Gyeltshen, Karunya Prasad & Sangay Dema	2019
84	Himalayan Alpine Vegetation, Climate Change and Mitigation.	Jan Salick, Suresh K. Ghimire, Zhendong Fang, Sangay Dema & Katie M. Konchar	2014
85	Orchid Explorers on the Trail of Gaurs and Elephants.	Dhan Bdr. Gurung, Stig Dalstrom, Thomas Hoijer, Nima Gyeltshen, Ngawang Gyeltshen & Drupchu Wangdi	2016
86	Thunder Dragon Orchids: A Conservation Project Takes Root in Bhutan.	Stig Dalstrom, Choki Gyeltshen, Ngawang Gyeltshen & Nima Gyeltshen	2012
87	National Action Plan Biodiversity Persistence and Climate Change.	National Biodiversity Centre	2011
88	Farm animal genetic resources in Bhutan.	A.K.F.H. Bhuiyan, Jigme Dorji, A.K. Srivastava, K.R. Rijal, Abdul Ghaffar & S.H.G. Wickramarathna	2013
89	The subfamily Phaedusinae in Bhutan (Gastropoda, Pulmonata, Clausiliidae).	Edmund Gittenberger, Pema Leda, Sherub Sherub & Choki Gyeltshen	2019
90	The family Pupinidae in Bhutan (Gastropoda: Caenogastropoda: Cyclophoroidea).	Edmund Gittenberger, Pema Leda, Sherub Sherub & Choki Gyeltshen	2019
91	*Endothyrella* Zilch, 1960 in Bhutan (Gastropoda: Pulmonata: Plectopylidae), with a description of three new species.	Edmund Guttenberger, Pema Leda, Sherub Sherub & Barna Pall-Gergely	2018
92	First record of *Carychium* in Bhutan (Gastropoda, Ellobiodea).	Edmund Gittenberger, Pema Leda, AJ. (Ton) De Winter & Adrienne Jochum	2017
93	Conspicuously sculptured small shells from Bhutan: *Philalanka bhutana* sp. nov. and *Sculpteuconulus obliquistriatus* gen. et sp. nov.	Edmund Gittenberger, Choki Gyeltshen & Sherub Sherub	2021
94	New records of social wasps (Hymenoptera: Vespinae: Vespa and Provespa) from Bhutan.	Phurpa Dorji, Thinley Gyeltshen, Wim Klein & Tshering Nidup	2017
95	The Honey Bees (Hymenoptera: Apidae) of Bhutan with a key to the *Apis* species.	Tshering Nidup & Phurpa Dorji	2016
96	New record of Carpenter bees (Hymenoptera: Apidae: Xylocopinae) from Bhutan.	Phurpa Dorji & Tshering Nidup	2016
97	Study of Paper wasps (Hymenoptera: Vespidae: Polistinae) of Bhutan.	Phurpa Dorji, Wim Klein & Tshering Nidup	2016
98	Taxonomic study of social vespid wasps (Hymenoptera: Vespidae: Vespinae & Polistinae) in Bhutan.	Phurpa Dorji, Wim Klein & Tshering Nidup	2017
99	New records of petiolate potter wasps (Hymenoptera: Vespidae: Eumeninae) from Bhutan	Tshering Nidup, Thinley Gyeltshen, P. Girish Kumar, Wim Klein & Phurpa Dorji	2016
100	New record of scoliid wasps (Hymenoptera: Scoliidae: Scoliinae) from Bhutan.	Tshering Nidup & Phurpa Dorji	2017
101	A survey of Odonata from eastern Bhutan, with nine new national records.	Thinley Gyeltshen	2017

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102	Odonata records from western Bhutan, with six new records and a note on the synonymy of *Himalagrion* with *Coenagrion.*	Thinley Gyeltshen & Vincent J. Kalkman	2017
103	Bibliography and checklist of the dragonflies and damselflies of Bhutan.	Thinley Gyeltshen, Tshering Nidup, Phurpa Dorji, Tshering Dorji & Vincent J. Kalkman	2017
104	Records of dragonflies from western Bhutan collected in October 2015.	Thinley Gyeltshen & Vincent J. Kalkman	2016
105	Honouring His Royal Highness the Crown Prince of Bhutan: *Megalestes gyalsey* (Odonata: Synlestidae).	Thinley Gyeltshen, Vincent J. Kalkman & Albert G. Orr	2017
106	Taxonomic review of the superfamily Pyraloidea in Bhutan (Lepidoptera).	Jatishwor S. Irungbam, Meenakshi S. Chib & Karma Wangdi	2016
107	A preliminary checklist of the Coccinellidae of Bhutan (Insecta: Coleoptera).	Cheten Dorji, Phuntsho Loday & Oscar Vorst	2019
108	A new species of *Eumerus* (Diptera, Syrphidae) from the Kingdom of Bhutan, the easternmost representative of the *bactrianus* subgroup.	John Smit, Theo Zeegers & Phurpa Dorji	2020
109	Additional reports of solitary potter wasps (Hymenoptera: Vespidae: Eumeninae) in Bhutan.	Tshering Nidup, Wim Klein, P. Girish Kumar & Phurpa Dorji	2018
110	First report of the ectoparasitoid wasp of genus *Leucospis* (Hymenoptera: Chalcidoidea: Leucospidae) from Bhutan.	Tshering Nidup, Wim Klein & Phurpa Dorji	2017
111	New records of hover wasps (Hymenoptera: Vespidae: Stenogastrinae) from Bhutan	Tshering Nidup, Wim Klein & Phurpa Dorji	2017
112	Checklist of the dragonflies and damselflies (Insecta: Odonata) of Bangladesh, Bhutan, India, Nepal, Pakistan and Sri Lanka.	Vincent J. Kalkman, R. Babu, M. Bedjanic, K. Conniff, T. Gyeltshen, M.K. Khan, K.A. Subramanian, Z. Zia & A.G. Orr	2020
113	*Tetrastigma planicaule* (Vitaceae): a new record for Bhutan.	Rinchen Dorji, Gyeltshen, Phuntsho & A. Trias-Blasi	2022
114	Species and status of bamboo known for the conical hat of northwestern Laya: a unique culture in Gasa, Bhutan.	Sangay Dorjee, Sherub Tenzin, Phuentsho & Kezang Tobgay	2022
115	Orchids of Bhutan: The genus *Cypripedium.*	Pem Zam, Stig Dalstrom, Choki Gyeltshen, Nima Gyeltshen & Kezang Tobgay	2022
116	The first record of the rare fern *Pteris griffithii* (Polypodiales: Pteridaceae: Pteridoideae) in the Bhutan Himalayas.	Rinchen Dorji, Sangay Dema, Mani P. Nirola & Choki Gyeltshen	2022
117	The genus *Erhaia* (Gastropoda, Truncatelloidea, Amnicolidae), with a new species from Bhutan.	Edmund Gittenberger, Choki Gyeltshen & Bjorn Stelbrink	2022
118	Rediscovery of rare *Rhododendron pogonophyllum* Cowan & Davidian after a gap of 84 years in Bhutan.	National Biodiversity Centre	2022
119	*Galba schirazensis* in Bhutan (Gastropoda: Pulmonata: Lymnaeidae), a thought-provoking record.	Edmund Gittenberger, Adriaan Gittenberger, Kezang Tobgay & Choki Gyeltshen	2021
120	Habitat preference of freshwater fishes along the Gamri River, Trashigang, Bhutan.	Tandin Wangchuk, Sushila Rai & Choki Gyeltshen	2021
121	Perception of farmers towards Invasive Alien Plant Species: A case study from Punakha and Samtse Dzongkhags, Bhutan.	Tshering Dorji, Rinchen Yangzom, Kencho Dorji, Rinchen Dorji, Choki Wangmo, Dago Dorji, Jamyang Choden & Choki Gyeltshen	2021
122	Phenolic Compounds from Three Alpine Anaphalis Species in Japan and Bhutan.	Yoshinori Murai, Rinchen Yangzom, Choki Wangmo & Rinchen Dorji	2021

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123	*Phebalium calcicola* (Rutaceae: Boronieae): a species described as new, restricted to south-eastern South Australia, is proposed as Critically Endangered.	Sangay Dema, Ian R.H. Telford, Rose L. Andrew, Daniel J. Duval & Jeremy J. Bruhl	2021
124	Biodiversity checklists for Bhutan.	Choki Gyeltshen & Karunya Prasad	2022
125	An annotated checklist of the Vespidae (Hymenoptera: Vespoidea) of Bhutan with new records.	Phurpa Dorji, Tshering Nidup, Wim Klein, Cheten Dorji, Anthony Daglio & Choki Gyeltshen	2022
126	Ecological Conditions of Luetshokha Lake and its Recharge Potential using Rooftop Rainwater Harvesting, Samtengang, Wangdue Bhutan.	Tshering Pem, Dhan Bdr. Gurung, Kelzang Dawa & Rupesh Subedi	2022
127	Orchids of Bhutan: *Arachnis* (the "Esmeraldas").	Stig Dalstroms, Choki Gyeltshen, Nima Gyeltshen, Kezang Tobgay, Pem Zam, Tandin Wangchuk, Kezang Rinzin & Bhakta Bdr. Ghalley	2022
128	*Ipomoea campanulata* L. (Convolvulaceae) – a new record to the flora of Bhutan.	Phuentsho, Rinchen Dorji & Lungten Norbu	2021
129	Biodiversity data uses and repositories in Bhutan.	Choki Gyeltshen & Tshering Pem	2022
130	Description of *Arisaema* (Araceae) found in Bhutan and new additions to the Flora of Bhutan.	Phub Gyeltshen, Dendup Tshering & Phuentsho Phuentsho	2021
131	Understanding *Primula bracteosa* Craib	Pam Eveleigh & Phuentsho	2022
132	*Citrus medica* L. 'Sarcodactylis	Jamyang Choden, Choki Gyeltshen & Tshering Dorji	2022
133	Nineteen new records of plant species including two new genera recorded from the Bhutan Himalayas.	Rinchen Dorji, Phuentsho Phuentsho, Kencho Dorji, Sangay Tshewang, Phuntsho Wangdi, Kezang Tobgay, Nima Gyeltshen & Choki Gyeltshen	2022
134	Discovery, distribution and conservation of the rare parasitic plant *Sapria himalayana* (Rafflesiaceae) in Bhutan.	Rinchen Dorji, Phuentsho, Ugyen Dechen, Gyeltshen, Tshering Samdrup, Kinley Dorji, Reta B. Powrel, Phub Dorji, Krishna P. Dhimal & David G. Long	2022

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Annexures

Annexure 1:

List of species new to science from 2010-2022

S.No.	Species	Authors	Year
Plants			
1	*Spathoglottis jetsuniae*	Nima Gyeltshen, Kezang Tobgyel & Stig Dalstrom	2017
2	*Roscoea megalantha*	Toshio Yoshida, Rinchen Yangzom & M. F. Newman	2017
3	*Meconopsis elongata*	Toshio Yoshida, Rinchen Yangzom & David G. Long	2016
4	*Meconopsis gakyidiana*	Toshio Yoshida, Rinchen Yangzom & David G. Long	2017
5	*Meconopsis merakensis*	Toshio Yoshida, Rinchen Yangzom & David G. Long	2017
6	*Meconopsis bhutanica*	Toshio Yoshida & Grey-Wilson	2012
7	*Prunus harae*	H. Ohba & S. Akiyama	2010
8	*Aconitum bhutanobulbilliferum*	Yuichi Kadota	2010
9	*Astragalus paroensis*	D. Podlech	2010
10	*Dysphania bhutanica*	A. Sukhorukov	2012
11	*Dactylicapnos platycarpa*	Liden	2010
12	*Prunus gongshanensis*	J. Wen	2012
13	*Chiloschista gelephuense*	Choki Gyeltshen, Stig Dalstrom, Nima Gyeltshen & Kezang Tobgay	2019
14	*Bulbophyllum trongsaense*	Phub Gyeltshen, Dhan Bahadur Gurung & Pankaj Kumar	2020
15	*Chiloschista densiflora*	Nima Gyeltshen, Choki Gyeltshen, Kezang Tobgay, Stig Dalstrom, Dhan Bdr. Gurung, Ngawang Gyeltshen & Bhakta Bdr. Ghalley	2020
16	*Chiloschista himalaica*	Nima Gyeltshen, Choki Gyeltshen, Kezang Tobgay, Stig Dalstrom, Dhan Bdr. Gurung, Ngawang Gyeltshen & Bhakta Bdr. Ghalley	2020
17	*Phlomoides longidentata*	C.A. Pendry	2021
18	*Begonia bhutanensis*	Phub Gyeltshen, M. Hughes & S. Jamtsho	2021
19	*Begonia menchunaensis*	Phub Gyeltshen, Mark Hughes, Pema Zangpo, Sherab Jamtsho, Tashi Phuntsho, Tshering Choden, Cheten La & Tandin Wangchuk	2022
20	*Chiloschista bhutanensis*	Bhakta Bdr. Ghalley, Stig Dalstrom, Laxmi Sagar & Mer Man Gurung	2022
Snails (Molluscs)			
21	*Rahula kleini*	Edmund Gittenberger, Pema Leda & Sherub Sherub	2017
22	*Rahula trongsaensis*	Edmund Gittenberger, Pema Leda & Sherub Sherub	2017
23	*Erhaia wangchuki*	Edmund Gittenberger, Pema Leda & Bjorn Stelbrink	2017
24	*Endothyrella bhutanensis*	Edmund Gittenberger, Pema Leda, Sherub Sherub & Barna Pall-Gergely	2018
25	*Endothyrella spirostriata*	Edmund Gittenberger, Pema Leda, Sherub Sherub & Barna Pall-Gergely	2018
26	*Endothyrella pemagatshel*	Edmund Gittenberger, Pema Leda, Sherub Sherub & Barna Pall-Gergely	2018
27	*Truncatellina bhutanensis*	Edmund Gittenberger, Pema Leda & Sherub Sherub	2013

28	*Pseudopomatias barnai*	Edmund Gittenberger, Pema Leda, Sherub Sherub & Choki Gyeltshen	2019
29	*Erhaia jannei*	Edmund Gittenberger, Pema Leda, Jigme Wangchuk, Choki Gyeltshen & Bjorn Stelbrink	2020
30	*Erhaia pelkiae*	Edmund Gittenberger, Pema Leda, Jigme Wangchuk, Choki Gyeltshen & Bjorn Stelbrink	2020
31	*Cylindrophaedusa (Montiphaedusa) parvula*	Edmund Gittenberger, Pema Leda, Sherub Sherub & Choki Gyeltshen	2019
32	*Cylindrophaedusa (Montiphaedusa) tenzini*	Edmund Gittenberger, Pema Leda, Sherub Sherub & Choki Gyeltshen	2019
33	*Phaedusa adrianae*	Edmund Gittenberger, Pema Leda, Sherub Sherub & Choki Gyeltshen	2019
34	*Phaedusa chimiae*	Edmund Gittenberger, Pema Leda, Sherub Sherub & Choki Gyeltshen	2019
35	*Phaedusa sangayae*	Edmund Gittenberger, Pema Leda, Sherub Sherub & Choki Gyeltshen	2019
36	*Philalanka bhutana*	Edmund Gittenberger, Choki Gyeltshen & Sherub Sherub	2021
37	*Sculpteuconulus obliquistriatus*	Edmund Gittenberger, Choki Gyeltshen & Sherub Sherub	2021
38	*Pupisoma (P.) paroense*	Edmund Gittenberger, Choki Gyeltshen, Pema Leda & Sherub Sherub	2021
39	*Pseudonapaeus occibhutanus*	Edmund Gittenberger, Choki Gyeltshen, Pema Leda & Sherub Sherub	2021
40	*Laevozebrinus parvus*	Edmund Gittenberger, Choki Gyeltshen, Pema Leda & Sherub Sherub	2021
41	*Rahula namgayae*	Edmund Gittenberger, Pema Leda, Sherub Sherub & Choki Gyeltshen	2021
42	*Sinoennea bhucylindrica*	Edmund Gittenberger, Pema Leda, Sherub Sherub & Choki Gyeltshen	2021
43	*Sinoennea nimai*	Edmund Gittenberger, Pema Leda, Sherub Sherub & Choki Gyeltshen	2021
44	*Erhaia norbui*	Edmund Gittenberger, Choki Gyeltshen & Bjorn Stelbrink	2022
Dragonflies & Damselfies (Odonata)			
45	*Megalestes gyalsey*	Thinley Gyeltshen, Vincent J. Kalkman & Albert G. Orr	2017
Fishes (Pisces)			
46	*Parachiloglanis bhutanensis*	R.J. Thoni & D.B. Gurung	2014
47	*Garra bimaculacauda*	R.J. Thoni, D.B. Gurung & Mayden	2016
48	*Garra parastenorhynchus*	R.J. Thoni, D.B. Gurung & Mayden	2016
49	*Creteuchiloglanis bumdelingensis*	R.J. Thoni & D.B. Gurung	2018
50	*Exostoma mangdechhuensis*	R.J. Thoni & D.B. Gurung	2018
51	*Parachiloglanis benjii*	R.J. Thoni & D.B. Gurung	2018
52	*Parachiloglanis dangmechhuensis*	R.J. Thoni & D.B. Gurung	2018
53	*Parachiloglanis drukyulensis*	R.J. Thoni & D.B. Gurung	2018
Beetles (Coleoptera)			
54	*Trilophidius gemmatus*	Michael Balkenohl	2017
55	*Thinodromus (Amisammus) tenebrius*	M. Yu. Gildenkov	2018

56	*Carpophilus (Askocarpolus) hartmanni*	A. G. Kirejtshuk	2018
57	*Allecula arunachalica*	Vladimir Novak	2017
Stoneflies (Plecoptera)			
58	*Claassenia drukpa*	Bill P. Stark & Ignac Sivec	2010
Moths (Lepidoptera)			
59	*Thitarodes namnai*	N. Maczey, K. Dhendup, P. Cannon, N. Hywel-Jones & T.B. Rai	2010
60	*Thitarodes caligophilus*	N. Maczey, K. Dhendup, P. Cannon, N. Hywel-Jones & T.B. Rai	2010
61	*Notodonta dedmazai*	Alexander Schintlmeister	2013
62	*Eupoecilia jakarana*	Frans Groenen & Karma Wangdi	2019
63	*Eupoecilia gedui*	Frans Groenen & Karma Wangdi	2019
64	*Lumaria phuntschona*	Frans Groenen & Karma Wangdi	2019
65	*Borneogena trashiyana*	Frans Groenen & Karma Wangdi	2019
66	*Bactra cophinana*	Frans Groenen & Karma Wangdi	2019
67	*Penthostola subnigrantis*	Frans Groenen & Karma Wangdi	2019
68	*Metendothenia brunnofasciana*	Frans Groenen & Karma Wangdi	2019
69	*Peridaedala nigrifasciana*	Frans Groenen & Karma Wangdi	2019
70	*Epiblema albulusana*	Frans Groenen & Karma Wangdi	2019
71	*Pterophorus karmawangdi*	Cees Gielis & Karma Wangdi	2018
72	*Torodora namgaydemae*	Kyu-Tek Park, Cornelis Gielis & Karma Wangdi	2021
73	*Thubana bhutanica*	Kyu-Tek Park, Cornelis Gielis & Karma Wangdi	2021
74	*Barsine pseudomactans*	Anton V. Volynkin & Karel Cerny	2016
Aphids (Hemiptera)			
75	*Sinolachnus elaeagnensis*	S. Chakrabarti & D. Das	2014
76	*Trichaitophorus acerifolius*	S. Chakrabarti, D. Das & S. Sarkar	2018
Bees and flies (Hymenoptera)			
77	*Tenthredo wangduensis*	Attila Haris	2010
78	*Tenthredo feijeni*	Attila Haris	2010
79	*Tamarixia drukyulensis*	Namgay Om, Yefremova, Yegorenkova, Beattie, Donovan, Holford	2017
Flies (Diptera)			
80	*Allodia caligata*	T. Magnussen, G.E.E. Soli & J. Kjaerandsen	2019
81	*Allodia dibolia*	T. Magnussen, G.E.E. Soli & J. Kjaerandsen	2019
82	*Eumerus druk*	John Smit, Theo Zeegers & Phurpa Dorji	2020

Annexure 2:

List of collections at the Royal Botanical Garden, Serbithang (FY 2021-2022)

S. No.	Species Name	Family	Place of Collection	Date of collection	Type of collection	GPS coordinate	Altitude	Place where it is planted/ stored	Collected by
1	*Ceropegia sp.*	Apocynaceae	Taktshang, Paro	6/6/22	Living	27.492861, 89.35772	3280m	RBGS	Kezang & Sampa
2	*Gastrochilus sp.*	Orchidaceae	Taktshang, Paro	6/6/22	Living	27.486827, 89.35727	2894m	RBGS	Kezang & Sampa
3	*Narvelia cf. picta*	Orchidaceae	Tendu, Samtse	6/20/22	Living	27.12987, 88.89465	930m	RBGS	Kezang & Sampa
4	*Ceropegia sp.1*	Apocynaceae	Tendu, Samtse	6/20/22	Living	27.08290, 88.88522	815m	RBGS	Kezang & Sampa
5	*Begonia sp.*	Begonaceae	Thikha, Norgaygang, Samtse	6/20/22	Living	27.15142, 88.85455	853m	RBGS	Kezang & Sampa
6	*Didymocarpus andersonii*	Gesneriaceae	Thikha, Norgaygang, Samtse	6/20/22	Living	27.15142, 88.85455	853m	RBGS	Kezang & Sampa
7	*Hoya sp.*	Asclepiadaceae	Thikha, Norgaygang, Samtse	6/20/22	Living	27.15263, 88.85447	865m	RBGS	Kezang & Sampa
8	*Globba clarkei*	Zingeberaceae	Tendu, Samtse	6/21/22	Living	27.08290, 88.88522	815m	RBGS	Kezang & Sampa
9	*Malaxis ophrydis*	Orchidaceae	Tendu, Samtse	6/21/22	Living	27.08290, 88.88522	815m	RBGS	Kezang & Sampa
10	*Thunia alba*	Orchidaceae	Tendu, Samtse	6/21/22	Living	27.13253, 88.9001	920m	RBGS	Kezang & Sampa
11	*Scutelaria sp.?*	Lamiaceae	Tendu, Samtse	6/21/22	Living	27.10598, 88.88505	950m	RBGS	Kezang & Sampa
12	*Begonia cf. palmata*	Begoniaceae	Panbari, Samtse	6/20/22	Living	26.89723, 89.12670	1050m	RBGS	Kezang & Sampa
13	*Begonia picta*	Begoniaceae	Panbari, Samtse	6/22/22	Living	26.89723, 89.12670	1050m	RBGS	Kezang & Sampa
14	*Begonia hatacoa*	Begoniaceae	Tendu, Samtse	6/22/22	Living	27.0647, 88.89428	659m	RBGS	Kezang & Sampa
15	*Begonia cf. persistens*	Begoniaceae	Samtse,	6/22/22	Living	26.89580, 89.11419	693m	RBGS	Kezang & Sampa
16	*Begonia sp.*	Begoniaceae	Panbari, Samtse	6/23/22	Living	27.14499, 88.86325	975m	RBGS	Kezang & Sampa
17	*Begonia annulata*	Begoniaceae	Panbari, Samtse	6/23/22	Living	26.88753, 89.16862	1490m	RBGS	Kezang & Sampa
18	*Begonia cathcartii*	Begoniaceae	Panbari, Samtse	6/23/22	Living	26.89743, 89.14001	1190m	RBGS	Kezang & Sampa
19	*Begonia sp.1*	Begoniaceae	Tendu, Samtse	6/24/22	Living	27.14428, 88.86257	970m	RBGS	Kezang & Sampa

20	*Begonia sp.2*	Begoniaceae	Panbari, Samtse	6/24/22	Living	26.88782, 89.17605	1450m	RBGS	Kezang & Sampa
21	*Begonia sp.3*	Begoniaceae	Panbari, Samtse	6/24/22	Living	26.88782, 89.17605	1450m	RBGS	Kezang & Sampa
22	*Globba cf. arracanensis*	Zingeberaceae	Samtse tar	6/24/22	Living	26.89495, 89.11522	763m	RBGS	Kezang & Sampa
23	*Caulokaempferia sikkimensis*	Zingeberaceae	Panbari, Samtse	6/24/22	Living	26.88782, 89.17605	1450m	RBGS	Kezang & Sampa
24	*Begonia sp.4*	Begoniaceae	Samtse tar	6/24/22	Living	26.89743, 89.14001	1190m	RBGS	Kezang & Sampa
25	*Hypericum sp.*	Hyperacaceae	View point, Samtse	6/24/22	Living	26.89484, 89.12871	1540m	RBGS	Kezang & Sampa
Seeds									
1	*Balakata sapium*	Euphorbiaceae	Yoseltse, Samtse	6/20/22	Seed	26.92958, 88.99392	349m	NBC	Kezang & Sampa
2	*Cordia grandis*	Boraginaceae	Tendu, Samtse	6/22/22	Seed	27.14428, 88.86257	975m	NBC	Kezang & Sampa
3	*Archidendron bigeminum*	Fabaceae	Ugyentse, Samtse	6/22/22	Seed	26.572758, 88.5748	376m	NBC	Kezang & Sampa
4	*Macaranga denticulata*	Euphorbiaceae	Panbari, Samtse	6/21/22	Seed	26.54762, 89.83788	1260m	NBC	Kezang & Sampa
5	*Coffea cf. arabica*	Rubaceae	Tashiling, Samtse	6/21/22	Seed	27.03389, 88.88047	518m	NBC	Kezang & Sampa
6	*Euonymus tingens*	Celastraceae	Lampelri/ Thimphu	2022	Seed			NBC	Nima & Kezang
7	*Meyna spinosa*	Rubiaceae	Orong, S/ Jongkhar	2022	Seed			NBC	Nima & Kezang
8	*Coriaria nepalensis*	Coriariaceae	Serbithang, Thimphu	2022	Seed			NBC	Nima & Kezang
9	*Cymbopogon bhutanicus*	Poaceae	Lingmathang, Mongar	2022	Seed			NBC	Nima & Kezang
10	*Rubus sengorensis*	Rosaceae	Sengor, Mongar	2022	Seed			NBC	Nima & Kezang

Annexure 3:

Nutritional values of the Evolutionary Plant Breeding (EPB) rice varieties

Location	Variety	Carbohydrate (g/100g)	Protein (g/100g)	Fat (g/100g)	Saturated Fatty-acid (g/100g)	Monounsaturated Fatty-acid (g/100g)	Polyunsaturated Fatty-acid (g/100g)	Ash (g/100g)	Crude Fibre (g/100g)	Iron (Fe) (mg/kg)	Zinc (Zn) (mg/kg)	Folic Acid (Folate) mcg/100g)	Riboflavin (Vitamin B2) (mg/100g)
Kabjisa (Punakha)	Ngabja	71.55	6.95	2.2	0.55	0.91	0.81	5.94	9.09	16.16	27.09	2.79	0.023
	Dawa	73.83	6.96	2.34	0.52	0.91	0.89	3.95	7.37	26.13	19.83	1.71	0.025
	Bonday	74.37	5.94	2.53	0.56	1.11	0.84	4.66	6.76	11.81	14.32	4.12	0.03
	Tan Tshering	74.94	5.96	1.83	0.45	0.71	0.64	4.3	7.96	16.37	14.30	6.56	0.019
	Bajo Maap-1	73.04	7.69	2.02	0.48	0.79	0.73	4.09	7.08	19.04	15.13	7.44	0.022
	IR 64	72.41	7.27	1.82	0.41	0.71	0.68	5.32	7.86	18.02	19.59	6.93	0.018
	Mixture	72.36	6.5	2.64	0.62	1.11	0.88	4.69	7.63	16.87	15.82	5.56	0.027
Mendrelgang (Tsirang)	Chottey Mashinu	71.23	6.94	2.70	0.69	1.08	0.91	4.12	7.15	14.99	15.71	3.66	0.038
	Gawri Mashinu	72.03	6.96	2.24	0.45	0.94	0.83	3.54	7.92	14.43	13.26	6.76	0.053
	Wengkhar Ray Kaap II	72.32	6.68	1.45	0.33	0.58	0.53	3.91	8.97	15.62	10.33	5.05	0.044
	Attey	72.09	6.53	2.78	0.66	1.17	0.92	3.48	7.86	19.23	20.97	3.43	0.048
	IR 64	70.94	7.77	1.96	0.43	0.79	0.72	1.86	9.37	24.63	23.35	6.24	0.044
	Mixture	73.44	6.99	1.99	0.40	0.87	0.69	3.84	7.23	18.49	17.31	6.08	0.077
Singgye (Sarpang)	Choti Masino	74.02	7.89	2.01	0.40	0.89	0.70	3.05	7.62	21.34	23.3	4.85	0.034
	Mansara	72.55	7.88	2.87	0.67	1.15	1.02	3.88	8.19	14.91	16.08	7.65	0.056
	Khamti	73.61	7.58	1.73	0.39	0.72	0.60	3.86	8.38	16.59	19.5	5.91	0.032
	Bhur Kamja 1	74.25	8.95	1.99	0.45	0.80	0.71	2.90	8.42	23.03	24.36	5.26	0.029
	Bhur Raykaap 2	72.78	7.5141	1.98	0.47	0.87	0.62	2.06	7.25	16.46	20	9.08	0.099
	Mixture	73.47	7.93	2.5	0.59	1.02	0.87	3.09	9.46	17.75	19.64	5.73	0.037
Tsento (Paro)	Khangma Maap	69.16	7.56	2.51	0.47	1.06	0.95	3.47	6.10	12.47	16.42	7.72	0.063
	Jakar Ray Naab	70.99	7.52	2.34	0.49	0.88	0.94	4.48	7.73	13.11	21.95	5.81	0.023
	Yusiray Maap 1	69.85	5.96	1.84	0.31	0.82	0.69	3.79	8.30	12.78	14.11	10.21	0.23
	Yusiray Kaap 3	71.47	6.72	1.98	0.40	0.85	0.72	3.57	6.90	10.75	17.29	9.25	0.192
	Dumbja	70.26	6.42	3.99	0.79	1.60	1.56	3.99	7.449	16.86	18.16	8.05	0.108
	Mixture (Janam, Dumbja, Themja, Zhuchum, Shabja-kuchum, Hungrel Maap)	69.64	6.10	2.1	0.44	0.85	0.80	3.68	8.19	20.61	19.04	8.09	0.174

Annexure 4:

Nutritional values of the Evolutionary Plant Breeding (EPB) bean varieties

Location	Variety	Carbohydrate (g/100g)	Protein (g/100g)	Ash (g/100g)	Crude Fibre (g/100g)	Iron (Fe) (mg/kg)	Zinc (Zn) (mg/kg)	Folic Acid (Folate) (mcg/100g)	Riboflavin (Vitamin B2) (mg/100g)
Tsangkha	Kalo Gew Bori (Climbing)	57.59	22.10	4.67	3	97.4606	47.20	15.02	0.319
	Kalo Chapto	54.92	23.39	4.21	2.46	40.54	20.35	8.06	0.142
	Pilow Bori	56.25	22.37	4.21	3.28	138.83	55.90	8.08	0.145
	Boshi Bori	56.34	21.09	3.85	3.37	127.89	52.35	8.53	0.146
	Gew Bori	55.98	20.07	3.64	3.30	99.31	54.69	15.06	0.142
	Kanchi	56.10	22.81	3.83	3.24	61.49	26.28	8.54	0.155
	Mixture	56.63	21.79	3.94	4.44	67.17	28.11	9.09	0.248
	Gew Bori (Dwarf)	54.95	18.58	3.75	3.11	81.32	36.81	9.03	0.33
	Azuki	57.09	23.43	3.28	3.39	130.45	43.52	9.02	0.337
	Sheto Potharay	59.10	20.37	3.68	3.14	188.93	42.28	9.06	0.332
	Rajma Bean	58.83	20.62	3.58	3.75	97.53	48.71	8.01	0.317
	Mixture	58.31	21.53	3.61	4.28	91.87	31.80	8.08	0.258
Mendrelgang	Pole Bean (White) (Climbing)	56.69	21.38	3.75	4.34	81.15	33.86	8.05	0.248
	Gew Bori	55.69	23.15	3.49	3.41	97.39	57.4	9.04	0.319
	Pole Bean (Grey)	59.29	17.58	3.49	4.49	65.57	35.01	8.09	0.289
	Boshi Bori	57.98	19.51	4.25	3.32	96.30	32.93	8.54	0.283
	Kalo Gew Bori	58.90	20.40	3.06	2.57	53.03	36.93	8.57	0.236
	Mixture	56.29	21.14	3.40	4.08	73.16	25.56	7.56	1.41
	Pink Rajma (Dwarf)	56.04	21.27	3.11	4.16	102.13	40.44	9.58	0.285
	Rajma Bean	56.30	21.28	3.23	4.12	70.88	31.7	9.07	0.293
	Gew Bori	57.44	20.36	3.46	3.16	103.44	48.37	9.01	0.309
	Azuki Bean (Japanese variety)	59.11	22.12	3.07	3.43	128.52	58.27	8.57	0.33
	Mixture	57.08	21.68	3.23	2.94	100.60	45.50	8.02	0.291

Annexure 5:

Contributors to the Status Report

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Annexure 6:

Abbreviations

ABS - Access & Benefit Sharing

AFACI - Asian Food & Agriculture Cooperation

AnGR - Animal Genetic Resources

APA - Annual Performance Agreement

ARDC - Agriculture Research & Development Centre

AVP - Australian Volunteers Program

AVPIF - AVP Impact Fund

BABS Fund - Bhutan Access & Benefit Sharing Fund

BAP - Biodiversity Action Plan

BBH - Bumthang Buckwheat House

BBP - Bhutan Biodiversity Portal

BCSB - Bumthang Community Seed Bank

BDJ - Biodiversity Data Journal

BFL - Bhutan for Life

BGCI - Botanic Gardens Conservation International

BIFA - Biodiversity Information Fund for Asia

BIMP - Biodiversity Information Management Program

BISS - Biodiversity Information Science & Standards

BLDC - Bhutan Livestock Development Cooperation

BM - British Museum

BOLD - Barcode of Life Database

BSF - Benefit Sharing Fund

BTFEC - Bhutan Trust Fund for Environmental Conservation

CBD - Convention on Biological Diversity

CBNRM - Coomunity-based Natural Resources Management

CGRFA - Commission on Genetic Resources for Food & Agriculture

Chanel PB - Chanel Parfums Beaute

CITES - Convention on International Trade of Endangered Species

CNR - College of Natural Resources

COP - Conference of Parties

CSB - Cummunity Seed Bank

CWR - Crop Wild Relatives

DAD-IS - Domestic Animal Diversity Information System

DANIDA - Danish International Development Agency

DC - Domesticated Crops

DoA - Department of Agriculture

DoL - Department of Livestock

DoFPS - Department of Forests & Parks Services

DNA - Deoxyribonucleic Acid

DPO - Disabled People's Organisation

EPB - Evolutionary Plant Breeding

EU-RDCCRP - European Union - Rural Development Climate Change Response Program

FAO - Food & Agriculture Organisation

FNI - Fridtjof Nansen Institute

FYP - Five Year Plan

GBIF - Global Biodiversity Information Facility

GBIS - Genebank Information System

GEF - Global Environment Facility

GEF-SGP - GEF - Small Grants Program

GLORIA - Global Observation Research Initiative in Alpine Environments

GNH - Gross National Happiness

GNHC - Gross National Happiness Commission

GPA - Global Plan of Action

GPSC - Global Strategy for Plant Conservation

HANAS - High Altitude Northern Areas of Bhutan

IAS - Invasive Alien Species

IBD - International Biodiversity Day

IFAD - International Fund for Agriculture Development

ILCCP - Integrated Livestock & Crop Conservation Project

ITPGRFA - International Treaty on Plant Genetic Resources for Food & Agriculture

IUCN - International Union for Conservation of Nature

JSWNP - Jigme Singye Wangchuck National Park

JWS - Jomotsangkha Wildlife Sanctuary

LDCF - Least Developed Countries Fund

MoAF - Ministry of Agriculture & Forests

MoE - Ministry of Education

MTA - Material Transfer Agreement

NAPA - National Adaptation Programme of Action

NASA - National Aeronautics & Space Administration

NBC - National Biodiversity Centre

NBP - National Biodiversity Program

NBSAP - National Biodiversity Startegies & Action Plan

NCOA - National Centre for Organic Agriculture

NDRC - National Dairy Research Centre

NEC - National Environment Commission

NGO - Non-Governmental Organisation

NGS - National Geographic Society

NH - National Herbarium of Bhutan

NMC - National Mushroom Centre

NNBC - National Nublang Breeding Centre

NPHBC - National Poultry & Heifer Breeding Centre

NPPC - National Plant Protection Centre

NSC - National Seed Centre

NSSRRDC - National Small Ruminants Research & Development Centre

NUS - Neglected & Underutilised Species

PAGR - Plant & Animal Genetic Resources

PGR - Plant Genetic Resources

PGRFA - Plant Genetic Resources for Food & Agriculture

Post-2020 GBF - Post-2020 Global Biodiversity Framework

QGIS - Quantum Geographic Information System

RBFE - Royal Bhutan Flower Exhibition

RBGS - Royal Botanical Garden Serbithang

RBP - Royal Bhutan Police

RGoB - Royal Government of Bhutan

RSPN - Royal Society for Protection of Nature

RTC - Royal Thimphu College

RUB - Royal University of Bhutan

SAARC - South Asian Association for Regional Cooperation

SBI - Subsidiary Body on Implementation for CBD

SBSTTA - Subsidiary Body on Scientific, Technical & Technological Advice for CBD

SDC - Smei-Domesticated Crops

SFN - Seed, Food & Nutrition

THIM - National Herbarium of Bhutan

TK - Traditional Knowledge

UNDP - United Nations Development Program

UNFCCC - United Nations Framework Convention on Climate Change

UNCCD - United Nations Convetion to Combat Desertification

UWICER - Ugyen Wangchuck Institute for Conservation & Environmental Research

WEP - Wild Edible Plants

WFO - World Flora Online

WIEWS - World Information & Early Warning System on Plant Genetic Resources

WWF - World Wide Fund for Nature

YDF - Youth Development Fund

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