

RESEARCH PAPER

**Introduction to Documentation of *Nepenthes* Species in
Bako National Park, Sarawak**

Mohamad Fhaizal Mohamad Bukhori*, Rohaiza Daud, Christharina S. Gintoron,
Roberta Chaya Tawie Tingga, Raziman Iman Ghazali

Biology Unit, Centre for Pre-University Studies, Universiti Malaysia Sarawak,
94300 Kota Samarahan, Sarawak

*Corresponding author: mbmfhaizal@unimas.my

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Abstract

In order to accomplish the learning objectives of ecology, biodiversity and environment course, *in situ* activities remain the finest key to complement by conducting real fieldwork experiments. The specific objectives of the fieldwork are to ensure sustainable learning, adopting best practice in scientific documentation, and implementing holistic and integrated learning approach in the course. Therefore, related field topic was given to the students and resulted with the following attributes. Four different species of pitcher plants were identified and classified throughout the study. The recent biology educational trip to Bako National Park had documented various well-known species of *Nepenthes*. Information on *Nepenthes* species present in the parks is useful for educational and research purposes, developing a conservation plan and management and also helps in promoting ecotourism. The trip was conducted to introduce a comprehensive learning experience to the students in biodiversity-related discipline.

Keywords: Biodiversity, ecology, field trip, national park, pitcher

Abstrak

Untuk mencapai matlamat pembelajaran ekologi, biodiversiti dan alam sekitar, aktiviti *in situ* tetap menjadi modus terbaik untuk melengkapkan kursus dengan menjalankan eksperimen kerja lapangan sebenar. Objektif khusus kerja lapangan ini adalah untuk memastikan pembelajaran secara lestari, mempraktikkan cara sebenar melakukan dokumentasi saintifik, dan melaksanakan pendekatan pembelajaran yang lebih holistik dan bersepadu dalam kursus. Oleh itu, topik dalam bidang berkaitan diberikan kepada para pelajar dan telah memberikan beberapa dapatan seperti berikut. Empat spesis tumbuhan periuk kera telah dikenal pasti dan diklasifikasikan sepanjang kajian ini. Kerja lapangan biologi yang telah dijalankan di Taman Negara Bako ini telah mendokumentasikan pelbagai spesis *Nepenthes* yang terkenal. Maklumat mengenai spesis *Nepenthes* yang terdapat di taman negara ini adalah berguna untuk tujuan pendidikan dan penyelidikan, pembangunan pelan pemuliharaan dan pengurusan serta membantu dalam mempromosikan ekopelancongan. Lawatan yang dijalankan ini juga adalah untuk memperkenalkan pengalaman pembelajaran yang komprehensif kepada pelajar dalam bidang berkaitan biodiversiti.

Kata kunci: Biodiversiti, ekologi, kerja lapangan, periuk kera, taman negara

INTRODUCTION

In order to promote, nurture and preserve awareness of the importance of ecology, biodiversity and environments to the students, among the action taken was by introducing the relevant topic and issues in the academic syllabus. Further measures need to be adopted

towards the sustainable utilisation of the biodiversity resource on dissemination of ecology, biodiversity and environment education such as Bako National Park (BNP).

Internationally recognized as one of the mega biodiversity areas, Sarawak's rich heritage of natural beauty and diversity has been a major factor for tourism as well as research and development (R&D) related activities (Abu Bakar et al., 2016; Demies et al., 2008). The BNP which was gazetted in 1957, became the Sarawak's oldest and smallest national park and has contributed to the growing success of local and international R&D and education purposes (Hanan, 2014; Das & Charles, 1993; Yee & Chin, 1984).

The park possesses a remarkable diversity of natural landscapes and biological wealth at all levels of biodiversity (Hanan, 2014; Mahidin & Sofwan, 2012; Yee & Chin, 1984). In addition, a variation in soil types have provides a diverse vegetation communities which offer a wide range of habitats and ecosystem for plants and animals including *Nepenthes* sp, *Oncosperma* sp, *Licuala* sp., *Myrmecodia* sp., *Johannesteijsmannia* sp, *Areca* sp, *Pinanga* sp, *Drosera* sp, *Licuala* sp, *Pholidocarpus* sp, *Salacca* sp, *Eleiodoxa* sp, *Hydnophytum* sp, *Lecanopteris* sp and *Cycas* sp (Chin et al., 2014; Wahab, 2012; Adam, 2002; Lee, 2002; Jebb & Chee, 1997; Adam et al., 1992).

Recognized widely for its unique and captivating characteristic features such as great diversity of colours, and growth forms and shapes, making *Nepenthes* comes attractive to both collectors and researchers interested (Chin et al., 2014; Clarke et al., 2011; Adam & Wilcock, 1991). Over 150 species were recognised under genus of *Nepenthes* to date, ranging throughout Southeast Asia, with the high density of speciation located in Borneo, Sumatra, and the Philippines (Clarke et al., 2011; Adam et al., 1992).

Recent discoveries have revealed that although *Nepenthes* have believed to be carnivorous, some are specialised to exploit other means of acquiring food. It is more on mutuality relationship between some of the plants and insects (Chin et al., 2014). When it comes to threats to *Nepenthes*, fortunately the plants are able to grow in unusual habitats such as mountain summits, rocky cliffs and degraded soils. For that reasons, they are spared from the majority of habitat loss that we see in Borneo (Adam et al., 1992). These problems do not usually affect *Nepenthes* population directly. There is other important threat for pitcher plant which is illegal collection. Then there was a huge interest in pitcher plants as ornamentals domestic collection (Adam & Hamid, 2006). The interest has resulted in a lot of problems. The species is not going to go extinct but population can get wiped out by collectors. Therefore, documenting and recording the existence of *Nepenthes* in BNP has come to time.

Students from Life Sciences Unit, Centre for Pre-University Studies, Universiti Malaysia Sarawak, Sarawak were given a task to conduct a study entitle Introduction to Documentation of *Nepenthes* Species in Bako National Park, Sarawak to experience *in situ* evaluation related to their syllabus, Learning Units 5: Biodiversity and Learning Units 6: Ecology and Environment. The study was conducted to observe and document various *Nepenthes* species which was listed as the precious natural heritage in Sarawak (Chin et al., 2014; Adam et al., 1992). The park was chosen since it promotes conservation education and nature study and serves as a recreational facility (Abu Bakar et al., 2016; Boyce & Yeng, 2008; Pearce, 1992).

Nepenthes, which is also known as the tropical pitcher plant, is a genus of carnivorous plants in the monotypic family *Nepenthaceae* (Lee, 2002; Adam & Wilcock, 1991). The genus comprises approximately 150 species, which include natural and cultivated hybrids (Chin et al., 2014). Wahab (2012) has reported that they are mostly liana-forming plants of the old world tropics, ranging from South China to Malaysia, Madagascar and Australia. The greatest diversity occurs in Borneo including Sarawak national

parks, Sumatra and the Philippines, with many endemic species (Wahab, 2012). *Nepenthes* can be found in hot, humid, lowland areas, but the majority are tropical montane plants (Adam et al., 1992). The plants received warm to cold temperatures and humid nights all year around (Lee, 2002; Adam et al., 1992). Some *Nepenthes* species can be considered as tropical alpine, with cold days and nights near freezing (Lee, 2002; Adam et al., 1992).

The study conducted is to ensure the students understanding and are able to relate the concept of biodiversity, ecology, evolution and environment by observing the natural ecosystems of the various *Nepenthes* species in BNP. Other than that, the students are also able to understand and appreciate the significant contributions of the plant in BNP towards scientific studies and documentation, and promote student's attentiveness towards the biodiversity and sustainable conservation approaches in Sarawak specifically.

The objective of this study is to align with the course learning outcomes by promoting a comprehensive understanding and perception of the student's learning unit in the class towards biodiversity, ecology and environment including identification, protection, prevention and preservation of *Nepenthes* species in BNP. At the same time to introduce a fundamental of conducting scientific studies related to biodiversity, ecology and environment by observing and identifying the diversity of *Nepenthes* species in BNP.

MATERIALS AND METHODS

Pre-study Preparation

The study was conducted by 14 students from the Life Sciences Unit, Centre for Pre-University Studies, Universiti Malaysia Sarawak. There was a day trip visit to the assigned location in order for them to conduct trekking, observation, documentation and recording pertaining to the topic given.

Prior fieldwork, the students attended a series of lecture encompasses Learning Units 5 (LU5): Biodiversity and Learning Units 6 (LU6): Ecology and Environment. In LU5, they have learned about ecological diversity, taxonomy and classification of plant, kingdom system as well as threat and conservation of biodiversity. Meanwhile, in LU6, they have learned about ecological principles, ecosystems, quantitative ecology, ecology and environment in Sarawak, and conservation status of the environment in Malaysia.

In addition, a brief discussion with the lecturer was also conducted before the visit in order for the students to engage with a proper plan of study, including time, selection of location, type of plants, and distance or area of documentation. The students were also prepared with literature review and pre-analysis of BNP, *Nepenthes* species in order for the students to establish a framework of selected studies.

Study Site

The study area was located in Bako National Park (1° 42' 59.99" N, 110° 27' 59.99" E) (Figure 1). The park comprises approximately 2,742 hectares (ha) of a rugged sandstone peninsula in the south western region of Sarawak, at the tip of Muara Tebas Peninsula, about 30 kilometres (km) northeast of Kuching city centre, and an altitude ranging from sea level to 244 m (Yee & Chin, 1984). Denudation over long periods of time has created this plateau into a unique landscape which offers excellent opportunities for field studies in geology and biology (Bodos et al., 2014; Adam & Hamid, 2006; SF, 2003; Vincent, 2002; Soepadmo et al., 1995).

The park has invited pertinent people who admire to promote natural environment sustainable development, conservation and well-being (Teo et al., 2013). Various research

in BNP had been carried out by the Sarawak Forestry (SF) and many other leading educational and research institution in order to support, promote and enable conservation and sustainable development while highlighting the eco-education of Sarawak (Abang Bohari, 2015; Kamri, 2013; MRPE, 2012; Demies et al., 2008; SF, 2003; Vincent, 2002; Sarawak Government Gazette, 1998; Soepadmo et al., 1995).

Field Observation

The students conducted the observation and documentation activities on *Nepenthes* species by trekking; beginning from the Telok Pandan Kecil trail up to the Park Headquarters, Teluk Assam at 1.6 km journey, with the details documentation and records was done in every 100 m (Figure 2). The trekking passes through a sandy beach surrounded by sandstone formation, climbing through the forest until it reaches onto an open plateau covered in a shrub, which takes about 2 hours of walking from the trail. The trail demonstrated the cliff vegetation, dips in and out of the tall kerangas forest, and damping at certain areas (Das & Charles, 1993; Yee & Chin, 1984).



Figure 1. Aerial map of Bako National Park, Sarawak (Mahidin & Sofwan, 2012)

Known and unknown *Nepenthes* species observed along the trekking journey were recorded. The observation and documentation were made by written reports, taking photographs and videos. Preliminary identification was made during the visit, but the detailed analysis was made once the students have returned to the campus.

Species Identification

Records of *Nepenthes* species in BNP which were initially recorded was further categorized according to the scientific name. A brief analysis of the collected data was done based on reference metadata, scientific and academic books, articles, journals and official-related website to finalize the obtained results.

Each *Nepenthes* species were identified using keys including plant form or shape, size, the area or habitat of growing, and area or habitat characteristics (Chin et al., 2014; Clarke et al., 2011; Lee, 2002; Jebb & Chee, 1997; Adam & Wilcock, 1991). The samples were also compared with Sarawak Herbarium, Sarawak Forestry (Jebb & Chee, 1997; Soepadmo et al., 1995; Yee & Chin, 1984).

Nepenthes species usually consist of a shallow root system and a prostrate or climbing stem, often several metres long and up to 15 metres (m) or more, and usually 1 centimetres (cm) or less in diameter (dia), although this may be thicker in a few species (Adam & Wilcock, 1991; Jebb & Chee, 1997; Lee, 2002; Lee, 2002). Originally from the stems will arise the alternate, sword-shaped leaves with entire leaf margins (Lee, 2002). An extension of the midrib (the tendril), which in some species aids in climbing, protrudes from the tip of the leaf; at the end of the tendril the pitcher forms. The pitcher starts as a small bud and gradually expands to form a globe- or tube-shaped trap (Lee, 2002; Jebb & Chee, 1997; Adam & Wilcock, 1991).

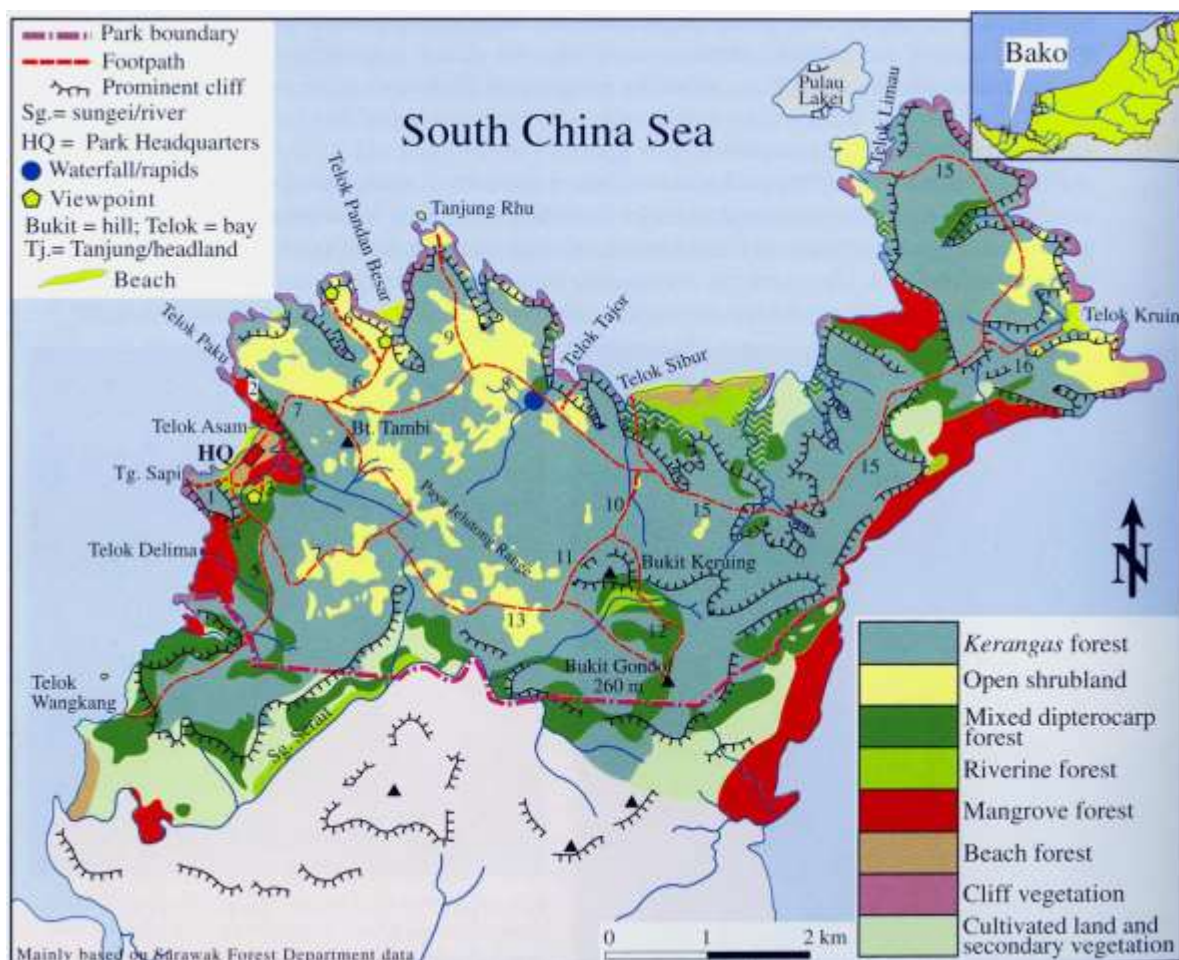


Figure 2. Trail of the study area (Kamri & Radam, 2013)

RESULTS

Learning Unit Output

Students were able to demonstrate the attentiveness towards ecology, biodiversity and environment learning outcome through the formative and summative assessments including quizzes, short test, examination, scientific article writing and poster presentation.

Site Characteristics

The study area along the Telok Pandan Kecil trail has variety of terrain and different vegetation richness including mangrove, tropical rainforest, scrubland, peat swamp, and onto the beach providing with a fascinating patch of plants adapted to those ground (Hanan, 2014; SF, 2003; Yee & Chin, 1984) (Figure 2). In terms of the geomorphology, probably the most distinctive features of BNP are the sandstone cliffs and rugged coast (Yee & Chin, 1984).

Nepenthes species

A large and interesting variety of plant types and habitats is found within this area. The open scrub and padang support an assemblage of plants with many attractive adaptations for species survival (Das & Charles, 1993; Yee & Chin, 1984). The pitcher plants or *Nepenthes* are abundant on the kerangas scrub. The characteristics of the plants offer an insight into some fascinating aspects of the plant and its environment.

The study has discovered that BNP are home to at least four species of *Nepenthes*. As reported by Jebb and Chee (1997) there are 74 *Nepenthes* species were recognized in this region including *Nepenthes mirabilis*, *Nepenthes reinwardtiana*, *Nepenthes trichocarpa*, *Nepenthes tentaculata*, *Nepenthes maxima*, *Nepenthes gymnamphora*, *Nepenthes hookeriana* and many more (Adam et al., 1992). The *Nepenthes* species identified in BNP includes *Nepenthes albomarginata*, *Nepenthes ampullaria*, *Nepenthes gracillis*, and *Nepenthes rafflesiana* (Chin et al., 2014; Wahab, 2012; Lee, 2002; Jebb & Chee, 1997; Adam et al., 1992; Adam & Wilcock, 1991) (Figure 3, A to D).

DISCUSSION

Nepenthes albomarginata (white-collared pitcher plant) was first found and is easily distinguished by its white band of trichomes (Jebb & Chee, 1997) (Figure 3, A). The species is widespread, occurring in Borneo, Peninsular Malaysia, and Sumatra. It is also found on smaller islands such as Nias and Penang (Lee, 2002; Jebb & Chee, 1997; Adam et al., 1992). *Nepenthes ampullaria* (flask-shaped pitcher plant), has a unique characteristic in which is missing a big lid that covers the top of the pitcher (Lee, 2002; Jebb & Chee, 1997; Adam et al., 1992) (Figure 3, B). Lids on *Nepenthes* used to shield the pitcher from rain, which can dilute the digestive liquid. Therefore, this species is not carnivorous, but rather acquires most of its nutrients from digesting leaf litter that falls to the ground (Wahab, 2012). The species generally grow in forms of clusters in damp, shady forest from sea-level to 2,100 m altitude (Wahab, 2012; Adam, 2002). In Borneo, it occurs usually on the relatively flat terrain in kerangas forest, peat swamp forest, and degraded swamp forest, at elevations of 50 to 150 m (Abang Bohari, 2015; Pakhriazad & Mohd Hasmadi, 2010; Soepadmo et al., 1995; Adam et al., 1992). This species is normally in green, spotted dark brown and red colours (Wahab, 2012). *Nepenthes ampullaria* differs from the other species by possessing particulate inflorescence, bracteolate flowers, having only lower pitchers which are

urceolate in shape, the lids sizes are distinctly smaller than the mouth of the pitcher, lower lid surface glandless and trifold spurs (Ismaili et al., 2016; Adam, 2002; Vincent, 2002; Soepadmo et al., 1995).



Figure 3. Several species of *Nepenthes* in Bako National Park. A. *Nepenthes albomarginata*; B. *Nepenthes ampullaria*; C. *Nepenthes gracilis*; and D. *Nepenthes rafflesiana*.

Small elongated *Nepenthes gracilis* (slender pitcher plant) were also discovered at 100 m altitude and was sighted as far away as Thailand (Lee, 2002; Adam et al., 1992; Jebb & Chee, 1997) (Figure 3, C). The species appears relatively unremarkable and has a very thin peristome. Nevertheless, the species is unusual (and possibly unique) in that the underside of the pitcher lid bears an uneven layer of wax crystals (Chin et al., 2014). *Nepenthes gracilis* differs from the other species by its sessile leaves, where the leaves base being decurrent into two wings, the stem triangular in shape, inconspicuous peristome teeth, very thin peristome (<1 mm) and inner surface of pitcher wall covered with exposed digestive glands (Chin et al., 2014; Wahab, 2012; Adam, 2002;).

The largest pitcher plant and certainly the most attractive was *Nepenthes rafflesiana* (Raffles' pitcher plant) (Lee, 2002; Jebb & Chee, 1997; Adam et al., 1992) (Figure 3, D). This species is known as highly variable, recorded at 100 m altitude and it is usually green with beautiful dark purple, pink, red or brown-coloured markings (Clarke et al., 2011). The species is a scrambling vine. The stem may climb to a height of 15 m and is

up to 10 mm thick. Internodes are up to 20 cm long. Tendrils may be over 110 cm long. Its large frilled wings attached to the front of pitcher (Chin et al., 2014; Wahab, 2012; Adam, 2002).

CONCLUSIONS

Four species of pitcher plants were identified and classified throughout the study. Three species were found near dry areas while one was found further on the trail near the damp area, leading up to the other site of beach forest. The remaining untouched BNP by mankind will allow the parks to be preserved at its best and remain as natural cultivation and protected area for *Nepenthes* sp.

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