



Development of Malaysian Mammal Online Database

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Abstract: Malaysia is one of 17 mega diverse countries in the world. Despite this fact, there is still no online standalone database that focuses on Malaysian mammals. Creation of a mammalian database would allow researchers and conservationists to utilize the database for research, policy making and to answer broad scale of biodiversity questions. Human development has contribute to the depleting of mammal population and species extinction rate is faster than the effort of cataloguing them. The aim of this study is to 1) identify online database features and the type of data required for mammal database, 2) collect and populate database from existing mammal data to assist the said database and 3) to test the acceptance of the database by user of this study. The secondary data from existing database such as Global Biodiversity Information Facility (GBIF), Animal Diversity Web (ADW) and Malaysia Biodiversity Information System (MyBIS) was collected to determine the required features needed in the database. The database adhered to TDWG standard that facilitates exchange of biological information. Examination on GBIF have been made to observe their data presentation since GBIF used TDWG Standard. Rapid Prototype Model was utilized as development method and Omeka Classic was used as platform of Content Management System. The mammal data was collected online and populate into the database. The acceptance testing in form of questionnaire were distributed to verify whether the database is function properly and meet the requirement of the study. We present MYMODS, a comprehensive mammal database with 361 mammal species in Malaysia deposited in the database. The development of this database will enable the researcher and conservationist to seek and identify mammal information based on species' scientific name, description and IUCN Red List. We believe that MYMODS will contribute to the digital knowledge that provide tools for mammal research and contributes in management of biodiversity and conservation in Malaysia. MYMODS is available at <https://cercom.uthm.edu.my/mymods/>

Keywords: Database, mammal database, database field, TDWG standard, biodiversity

1. Introduction

In this digital era, various technologies such as the Internet of Things (IoT), digital machines, computing technologies and cloud computing make information delivering become easier and effective [1]. The increasing need for biodiversity databases to store information in the digital age has led to the development of numerous databases under many conservation initiatives [2]. Therefore, information on mammal diversity including their taxonomy, morphology, geographical distributions, habitat and ecology and species status is vital in providing an action plan to

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conserve mammals [3]. Development, maintenance and update of a biodiversity information storage facility, mobilization of data and information for different users are very important to aid reporting and decision-making related to sustainable mammals conservation and management in Malaysia [4]. It is also critical to develop systems that allow data interoperation and knowledge synthesis to serve a global audience in its knowledge construction and planning [5].

Biological diversity or biodiversity refers to the variety of life living on earth in which they interact with each other [6]. In recent years have witnessed biological diversity loss due to human development such as land-use change, climate change and pollution. This will result in the extinction of mammals and reduce their population if there are no actions taken in preventing this problem [7]. Malaysia has the potential to provide the best biodiversity data and be one of leading countries to cater the mammal’s database due to its have complex tropical rainforest ecosystem containing an abundance of mammal species that are still undiscovered yet. Malaysia is one of the 17 megadiversity countries that responsible to conserve its natural resources and mammal information within it [4][7].

The sharp increase in the demand for biological information can be seen in the past year where the researcher and conservationist realize the importance to document all the living of life on the earth [8] The increase of biodiversity conservation action makes it possible to develop biodiversity information, especially mammal information as they have been facing a vast extinction due to human activities [9]. Among various biodiversity databases, there is no local mammal database for systematic data management present up until now. Therefore, there is a need to keep track of mammal information for knowledge and research purposes. Mammal information also gives rise to knowledge of biodiversity, conservation actions, public awareness in the understanding of the importance of protecting the national natural heritage [8][9]. Mammal databases play a crucial role in providing researchers or conservationists further references, policy making, conservation action, and answering broad-scale of biodiversity questions. Although there is an abundance of data available but only a few specific databases cater to mammals [10][11][12].

2. Methodology

A rapid prototyping method was chosen as a development method that enables rapid construction and improvement of the website. This method saves enormous time and cost by reiteratively changing the design to rapidly improve the design in multiple short cycles to fulfil the requirement of the database [13].

2.1 Survey of Existing Database

Analysis was performed via a survey of the existing biodiversity databases that hold data on mammalian species. This provides an overview of how the mammal database is currently being presented. Content similarities between the web database were highlighted as indicators that a database should have and were further supported via scientific papers. The available databases were compared to each other and highlighted the most required features in a database such as photos, common name, scientific name, taxonomy, geographical distribution, habitat and ecology, species threats, IUCN Red List of Threatened Species, citation and author. The features were adhered to TDWG standards to ensure effective data sharing. TDWG Standard focus on various aspects of structuring and maintenance of different types of biodiversity data such as biological description, collections of similar data, collections of field observation data, geospatial data, globally unique identifiers, multimedia illustrations of organisms, phylogenetics and the system for labelling organisms. Global Biodiversity Information Facility (GBIF) actively used this standard to share biological information. Thus, GBIF has been used as a reference to develop MYMODS because GBIF adheres to TDWG standards.

2.2 Secondary Data Collection

The data collection process is the source of core data. Therefore, the design of the database depends on what data was collected to be featured in the system. In this study, secondary data collection was obtained via secondary sources such as web databases and scientific papers. All the 361 mammal species in Malaysia were tabulated in Google sheets Document but only 30 species were filtered out for exemplar pages to be populated in the database. The 30 species of mammals were randomly filtered out from the list of 361 mammal species to be in exemplar pages in MYMODS. The species information was analyzed based on cross-references in the existing database.

Table 1 - List of 30 species of exemplar pages in MYMODS

No	Scientific Name	Common Name / Vernacular Name
1	<i>Nyctalus noctula</i>	Common Noctule Bat
2	<i>Manis javanica</i>	Sunda Pangolin, Malayan or Javan Pangolin. Tenggiling, Pengguling
3	<i>Tupaia glis</i>	Common Treeshrew, Kenchong ,Malaysian Tree Shrew, Tupai Moncong

	Besar
4	<i>Suncus etruscus</i> Etruscan shrew, Etruscan pygmy shrew, white-toothed pygmy shrew, Cencurut Terkecil
5	<i>Nasalis larvatus</i> Proboscis monkey, long-nosed monkey Bangkatan, Bekantan Bentangan,
6	<i>Echinosorex gymnurus</i> Moonrat
7	<i>Hylomys suillus</i> Lesser Gymnure, Short-tailed Gymnure, Tikus Babi
8	<i>Aeromys tephromelas</i> Black Flying Squirrel, Tupai Terbang Hitam
9	<i>Aeromys thomasi</i> Thomas's Flying Squirrel
10	<i>Aethalops aequalis</i> Borneo Fruit Bat
11	<i>Aethalops alecto</i> Pygmy Fruit Bat
12	<i>Aonyx cinerea</i> Oriental Small-Clawed Otter
13	<i>Arctictis binturong</i> Bearcat
14	<i>Balaenoptera physalus</i> Small-Toothed Palm Civet, Musang Akar , Three-striped Palm Civet
15	<i>Arctonyx collaris</i> Hog Badger
16	<i>Arielulus circumdatus</i> Black Gilded Pipistrelle
17	<i>Arielulus cuprosus</i> Coppery Pipistrelle, Kelawar Hidung Pendek Tembaga
18	<i>Arielulus societatis</i> Benom Pipistrelle, Kelawar Benom, Social Sprite
19	<i>Aselliscus stoliczkanus</i> Stoliczka's Trident Bat
20	<i>Atherurus macrourus</i> Asiatic Brush-tailed Porcupine, Brush-tailed Porcupine (English), Landak Batu, Landak Nibong, Landak Nibung. Landak Padi
21	<i>Balaenoptera acutorostrata</i> Common Minke Whale
22	<i>Balaenoptera borealis</i> Sei Whale
23	<i>Macaca fascicularis</i> Long-Tailed Macaque, Beruk (Bajau), Kera (Malay)
24	<i>Balaenoptera edeni</i> Bryde's Whale. Eden's Whale, Luulumbo (Kadazan)
25	<i>Balaenoptera musculus</i> Blue Whale
26	<i>Balaenoptera omurai</i> Omura's Whale, Dwarf Fin Whale
27	<i>Balaenoptera physalus</i> Fin Whale, Fin Whale Common Rorqual
28	<i>Balionycteris maculata</i> Spotted-Winged Fruit Bat
29	<i>Bandicota bengalensis</i> Lesser Bandicoot Rat, Indian Mole-rat, Sind Rice Rat , Wirok Ekor Pendek
30	<i>Bandicota indica</i> Greater Bandicoot Rat, Large Bandicoot Rat , Wirok Hitam

2.3 Database Construction and Population

The database was applied using open-source technology to make the information publicly available over the internet. This mammal database was built using Omeka Classic. Omeka Classic is an open-source web publishing platform that aims for sharing digital collections and create a digital exhibit. The database was constructed based on the required metadata that have been collected. All the requirements and mammal data were populated in the database.

2.4 Database Acceptance Test

The complete database was tested using two-stage which are the Alpha test and Beta test. Alpha testing involves testing the database by the developer itself. Then, it is followed by Beta testing after the working system is accepted. The Beta test usually performed by users to verify whether the database is function properly and meet the requirement of the study or not. User Acceptance Test (UAT) in form of a questionnaire was distributed to the user as final verification to meet the objectives. The questions are generally to observe the acceptance of potential users toward

MYMODS. The questions are to verify the effectiveness of the database and whether the information in MYMODS is sufficient to support any research studies on mammal. Recommendation given by the respondents also have been taken to improve the database.

3. Result

Table 1 show the list of existing biodiversity and mammal databases with their features

Table 2 - List of existing biodiversity database and their features

Online Database	Database summary	Features	
ASM Mammal Diversity Database https://www.mammaldiversity.org/	The database is managed by the American Society of Mammalogists (ASM) for tracking the latest taxonomic changes to living and recently extinct (since 1500 Common Era) species and higher taxa of mammals [14]	<ul style="list-style-type: none"> • Common name • Nominal name • Scientific name • Taxonomy • Type locality 	<ul style="list-style-type: none"> • Geographical distribution • Species status • IUCN Status • Citation
Global Biodiversity Information Facility (GBIF) http://www.gbif.org/	The Global Biodiversity Information Facility is a worldwide network that aimed to provide data about biodiversity. It was managed by headquarter located in Copenhagen, Denmark [15]	<ul style="list-style-type: none"> • Photos • Common name • Nominal name • Scientific name • Taxonomy • Type locality • Geographical distribution 	<ul style="list-style-type: none"> • Habitat and ecology • IUCN Red List • Citation • Author/bibliography • Specimen list
International Union for Conservation of Nature (IUCN) Red List http://www.iucnredlist.org/	International Union for Conservation of Nature (IUCN) Red List was established in 1964 and become a comprehensive database that provides extinction risk status to various species worldwide. It becomes a tool to provide conservation action and policy making [16]	<ul style="list-style-type: none"> • Photos • Common name • Scientific name • Taxonomy • Geographical distribution • Habitat and ecology 	<ul style="list-style-type: none"> • IUCN Status • Conservation action • Citation • Author • Economic importance • Species status/threats
Encyclopedia of Life (EOL) http://eol.org/	Encyclopedia of Life (EOL) aimed to create good perception and awareness of living things. EOL provides broad knowledge in open digital resources [17].	<ul style="list-style-type: none"> • Photos • Common name • Scientific name • Taxonomy • Geographical distribution 	<ul style="list-style-type: none"> • Habitat and ecology • Morphology • IUCN status • Conservation action • Citation • Author
Malaysia Biodiversity Information System (MyBIS) https://www.mybis.gov.my/sp/20149	Malaysia Biodiversity Information System (MyBIS) aimed to be a repository database system that provides access to biodiversity information and management in Malaysia [18]	<ul style="list-style-type: none"> • Photos • Common name • Scientific name • Taxonomy 	<ul style="list-style-type: none"> • Habitat and ecology • IUCN Status • Citation • Author

<p>Mammal Species of the World 3rd edition (MSW3) https://www.departments.bucknell.edu/biology/resources/msw3/</p>	<p>Mammal species of the World, 3rd edition (MSW3) was compiled by the American Society of Mammalogists. The database can be used as an online reference for verifying recognized scientific names and taxonomic research [19]</p>	<ul style="list-style-type: none"> • Common name • Scientific name • Taxonomy • Type locality • Geographical 	<ul style="list-style-type: none"> • Distribution • IUCN status • Citation • Author •
<p>National Inventory of Marine Mammals (NOAA fisheries) https://www.fisheries.noaa.gov/national/marine-mammal-protection/national-inventory-marine-mammals</p>	<p>NOAA Fisheries provide ways on sustainable fishing to conserve fish in the ocean and ensure a healthy ocean ecosystem [20]</p>	<ul style="list-style-type: none"> • Photos • Common name • Scientific name • Taxonomy • Geographical distribution 	<ul style="list-style-type: none"> • Habitat and ecology • Morphology • Species threats • Conservation status • Citation • Author • Related article
<p>Integrated Digitized Biocollection (iDigBio) https://www.idigbio.org/portal/search</p>	<p>iDigBio provide biological data and biological specimen in digital format that is accessible to the research community, conservationist, student and researcher [21]</p>	<ul style="list-style-type: none"> • Photos • Scientific name • Taxonomy • Type locality • Geographical distribution 	<ul style="list-style-type: none"> • Citation • Author • Recordset
<p>Catalogue of Life (COL) https://www.catalogueoflife.org/</p>	<p>Catalogue of Life (COL) provides taxonomic information to the world-known species. The information is to assist the policymaker and researcher in getting up to date information regarding particular species [22]</p>	<ul style="list-style-type: none"> • Common name • Scientific name • Nominal name • Taxonomy • Geographical distribution 	<ul style="list-style-type: none"> • Species status • Citation • Author • Source dataset
<p>Fauna Europaea http://www.faunaeur.org/</p>	<p>Fauna Europaea provide access to data via a public web portal as well as a link to other biodiversity services [23]</p>	<ul style="list-style-type: none"> • Common name • Scientific name • Taxonomy • Distribution map 	<ul style="list-style-type: none"> • Citation • Author
<p>Animal Diversity Web (ADW) https://animaldiversity.org/</p>	<p>Animal Diversity Web (ADW) become online data that provide information on animal history, distribution and many more [24]</p>	<ul style="list-style-type: none"> • Photos • Common name • Scientific name • Taxonomy • Type locality • Distribution map • Habitat and ecology • Morphology • Genomes 	<ul style="list-style-type: none"> • Ecosystem role • Economic importance • Species threats • IUCN status • Conservation status • Citation • Author • Contributor • Related article

<p>Integrated Taxonomic Information System (ITIS) https://www.itis.gov/</p>	<p>Integrated Taxonomic Information System (ITIS) is systematic fundamental to ecosystem management and biodiversity conservation. ITIS is also a partner of Species 2000 and the Global Biodiversity Information Facility (GBIF) [25]</p>	<ul style="list-style-type: none"> • Common name • Scientific name • Taxonomy • Geographical distribution • Species status 	<ul style="list-style-type: none"> • Citation • Author • Recordset
<p>iNaturalist https://www.inaturalist.org/</p>	<p>iNaturalist is a partner initiative by the California Academy of Science and National Geographic Society. iNaturalist help to identify plants and animal species in the surrounding and get connected with millions of scientists and naturalist around the world [26]</p>	<ul style="list-style-type: none"> • Photos • Common name • Scientific name • Taxonomy • Distribution map • Habitat and ecology • Morphology 	<ul style="list-style-type: none"> • Ecosystem role • Economic importance • Species threat • IUCN status • Conservation status • Genomes and clones • Citation • Author
<p>Ecology Asia https://www.ecologyasia.com/</p>	<p>Ecology Asia provides a simple introduction to the biodiversity of Southeast Asia's vertebrates. The website was established in 2001 and provide 800 factsheets that are accessible in a top-down menu system [27]</p>	<ul style="list-style-type: none"> • Photos • Common name • Scientific name • Taxonomy • Geographical distribution 	<ul style="list-style-type: none"> • Habitat and ecology • Morphology • Citation
<p>Thai National Park https://www.thainationalparks.com/</p>	<p>The website was managed by GibbonWoot license. It is not an official website of the Department of National Parks. It is an initiative to provide knowledge about wildlife conservation areas with its visitors [28]</p>	<ul style="list-style-type: none"> • Photos • Common name • Scientific name • Taxonomy • Geographical distribution 	<ul style="list-style-type: none"> • Habitat and ecology • Morphology • IUCN Red List of Threatened Species • Citation
<p>A-Z Animals https://a-z-animals.com/</p>	<p>A-Z Animals provide high standard research to ensure the accuracy of the materials to readers. It also provides animal information such as scientific name, diet, threats and many more [29]</p>	<ul style="list-style-type: none"> • Photos • Common name • Scientific name • Taxonomy • Geographical distribution • Habitat and ecology • Morphology • Ecosystem role 	<ul style="list-style-type: none"> • Species threats • Conservation status/ action • Citation • Related document/ specimen / articles

<p>MarineBio https://www.marinebio.org/</p>	<p>MarineBio is a nonprofit volunteer marine conservation and science education aimed to educate the world about ocean life, marine biology, marine conservation and sea ethics [30]</p>	<ul style="list-style-type: none"> • Photos • Scientific name • Taxonomy • Geographical distribution • Habitat and ecology 	<ul style="list-style-type: none"> • Morphology • Species status/threats • IUCN Red List of Threatened Species • Conservation action/status • Citation • Author
<p>Batslife https://batslife.eu/</p>	<p>The project focused on Eastern Rhodopes Mountains, Southeast Bulgaria. This project applies measures to mitigate the negative impact and compensate for the damages on the bat habitats and populations [31]</p>	<ul style="list-style-type: none"> • Photos • Common name • Nominal name • Scientific name • Taxonomy • Geographical distribution 	<ul style="list-style-type: none"> • Habitat and ecology • Morphology • Species status/threats • IUCN Red List of Threatened Species • Citation • Author
<p>National Center for Biotechnology Information (NCBI) https://www.ncbi.nlm.nih.gov/</p>	<p>The National Center for Biotechnology Information aimed to provide information for genomic and biomedical information [32].</p>	<ul style="list-style-type: none"> • Common name • Scientific name • Taxonomy 	<ul style="list-style-type: none"> • Genomic information and biomedical uses - Literature - Genes - Proteins - Genomes - Clinical - PubChem

3.2 Data Type

Examination of 19 databases showed a variety of the types of mammalian associated data stored. Although the Biodiversity Information Standards (TDWG) open standards for the exchange of biodiversity data have been designed to facilitate biodiversity informatics, not all databases uniformly adhered to the TDWG standard. In this study, we use the TDWG standard as the reference and guidance to create MYMODS. Global Biodiversity Information Facility GBIF has actively used this standard to enable free and open online access to occurrence data. All relevant standards regarding biodiversity data management have been applied in their system thus making it become the best model in a biodiversity information system. Examination of GBIF has been made to observe their data presentation, structure and type of data used as a benchmark to create MYMODS.

3.3 Secondary Data Collection

A total of 361 mammals species was successfully collected from the existing database. Table 3 shows the example of data collection for species *Macaca fascicularis*.

Table 3 - The example of data collection of species *Macaca fascicularis*

Scientific name	<i>Macaca fascicularis</i>
Common Name/ Vernacular Name	Long-Tailed Macaque, Beruk (Bajau), Kera (Malay)
Nominal Name	<i>Macaca fascicularis</i> (Raffles, 1821)

Photos



Fig. 1 - Photo of species *Macaca fascicularis*

Taxonomy Kingdom : Animalia
 Phylum : Chordata
 Class : Mammalia
 Order : Primates
 Family : Cercopithecidae
 Genus : *Macaca*
 Species : *Macaca fascicularis*

Type Locality Indonesia, Sumatra, (Bengkulu)
 Coordinates 3.9N,100.6E

Geographical Distribution

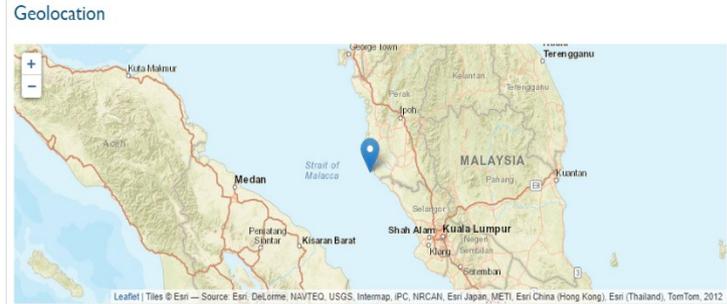


Fig. 2 - Distribution map of *Macaca fascicularis*

Habitat and Ecology

Some of the habitats in which they have been found are primary forests, disturbed and secondary forests, and riverine and coastal forests of nipa palm and mangrove. Long-tailed macaques live most successfully in disturbed habitats and on the periphery of forests. This species has been observed drinking much water and eating crabs, they often live near bodies of water. Of the various habitats occupied by long-tailed macaques, the swamp forests seem to have the highest density of them.

https://animaldiversity.org/accounts/Macaca_fascicularis/
 Vulnerable <https://www.iucnredlist.org/species/12551/204494260>

IUCN Red List of Threatened Species
 Morphology/ Physical Description

The body fur of long-tailed macaques tends to be grey-brown to reddish-brown. These colours are always paler ventrally. The face is brownish-grey with cheek whiskers. The eyes are directed forward for binocular vision. The nose is flat and the nostrils are narrow and close together (catarrhine condition). Long-tailed macaques have shovel-shaped incisors, conspicuous canines, and bilophodont molars.

https://animaldiversity.org/accounts/Macaca_fascicularis/#physical_description

Conservation status/action

There are nine national parks, nine reserves, and two sanctuaries in which some long-tailed macaques reside. Regardless of the type of habitat, there must be at least 500 squared kilometres of habitat necessary to support a viable population of 5,000 long-tailed macaques. This is the minimum size for a reserve for this species.

https://animaldiversity.org/accounts/Macaca_fascicularis/

Ecosystem role

To the extent that these animals are prey for other species, they may affect populations of those species. *Macaca fascicularis* may be an important predator in its ecosystem and may have some impact on prey species.

https://animaldiversity.org/accounts/Macaca_fascicularis/#ecosystem_roles

Economic importance

Long-tailed macaques, along with other species of macaques, have benefited humans through their use as research models in immunology, surgery, toxicology, and

pharmacology. They are also important members of ecosystems and may serve as a basis for ecotourism ventures. They are sometimes still hunted for food. https://animaldiversity.org/accounts/Macaca_fascicularis/#economic_importance_positive

3.4 Data Population in MYMODS

Data was sorted out in MYMODS. The addition, deletion and editing of the content were according to the template of Omeka Classic. The data was inserted into the template using HTML format in the tab 'Dublin core'. The distribution map was also populated based on the coordinate of secondary data collection in the tab 'map'. The picture of mammals was uploaded in the tab 'file'. The keyword of particular species that show the identity of the species were populated in the tab 'tags'. All the species will be publicly available in MYMODS. The exemplar pages of *Macaca fascicularis* in MYMODS can be surfed at <https://cercom.uthm.edu.my/mymods/items/show/172>.



Fig.3 - Population of species *Macaca fascicularis* into MYMODS

3.4.1 Web Graphical User Interface (GUI) Design for MYMODS

The web database was named as Malaysian Mammal Online Database System (MYMODS) with a tiger logo representing Malayan Tiger. The dashboard of MYMODS consists of three types is Header that consists of a logo, search engine and main page. Second is featured item, kingdom and exhibit that is located in the left-hand sight and thirdly is Recently added item that located in right-hand sight

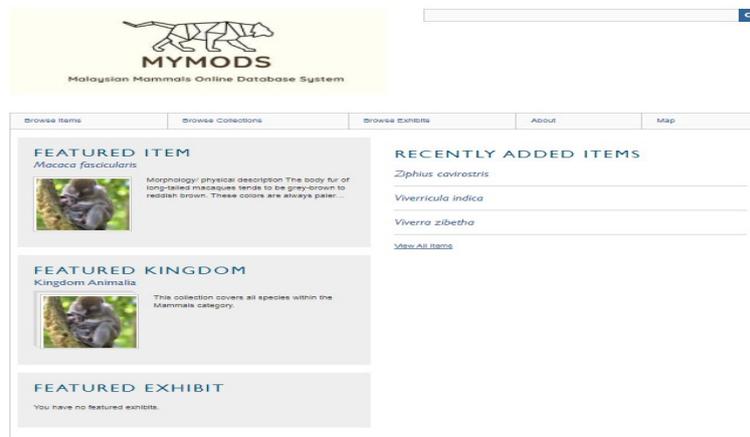


Fig. 4 - The Dashboard of MYMODS

Table 4 - Description of the main menu of MYMODS

Menu	Description
About	Explanation on MYMODS function that contributes to a centralized biodiversity database through a collection of standardized metadata. MYMODS aims to provide a sustainable biodiversity research ecosystem that is facilitated by data sharing with a centralized chain from collecting, verifying, and disseminating biodiversity data in UTHM.
Exhibits	Consist of exhibit item or specimen item
Collection	Collection of Kingdom Animalia
Items	Consist of 361 mammals species data
Map	Distribution map of mammals species in Malaysia

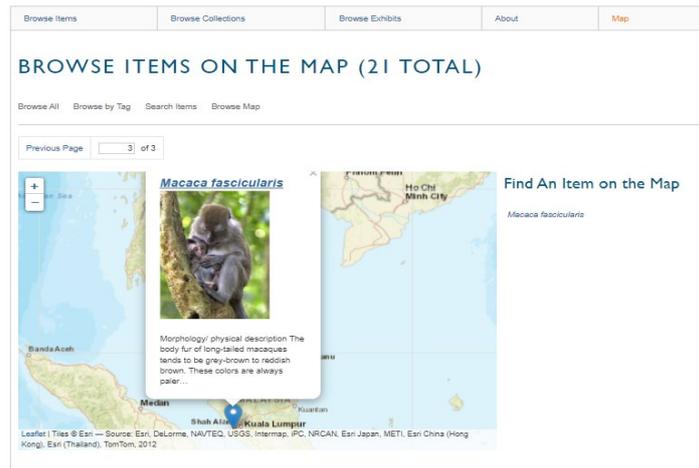


Fig. 5 - The Coordinate of *Macaca fascicularis* on the map

3.4.2 Exemplar Page of Species *Macaca Fascicularis*

Browse Items	Browse Collections	Browse Exhibits	About	Map
<p>MACACA FASCICULARIS</p> <p>Title Macaca fascicularis</p> <p>Subject</p> <p>Taxonomy Kingdom : Animalia Phylum : Chordata Class : Mammalia Order : Primates Family : Cercopithecidae Genus : Macaca Species : Macaca fascicularis</p> <p>Common Name/ Vernacular Name</p> <ul style="list-style-type: none"> Long-Tailed Macaque (English) Bawak (Baku) Nata (Melay) Crab-eating Macaque (English) Longtail Macaque Sumatran Long-tailed Macaque Con Song Long-tailed Macaque Dark-crowned Long-tailed Macaque Hampden Long-tailed Macaque Laskia Long-tailed Macaque Marau Long-tailed Macaque Nicobar Long-tailed Macaque Philippine Long-tailed Macaque Simeulue Long-tailed Macaque <p>Description Morphology/ physical description The body fur of long-tailed macaques tends to be grey-brown to reddish brown. These colors are always paler ventrally. The face is brownish-grey with cheek whiskers. The eyes are directed forward for binocular vision. The nose is flat and the nostrils are narrow and close together (sarcotreme condition). Long-tailed macaques have shovel-shaped incisors, conspicuous canines, and bilophodont molars.</p> <p>Habitat and Ecology Some of the habitats in which they have been found are primary forests, disturbed and secondary forests, and riparian and coastal forests of nipa palm and mangrove. Long-tailed macaques live most successfully in disturbed habitats and on the periphery of forests. This species has been observed drinking much water and eating crabs, they often live near bodies of water. Of the various habitats occupied by long-tailed macaques, the swamp forests seem to have the highest density of them.</p> <p>Type locality Indonesia, Sumatra, (Bangkulu)</p> <p>IUCN Red List of Threatened Species Vulnerable</p> <p>Conservation status/conservation There are nine national parks, nine reserves, and two sanctuaries in which some long-tailed macaques reside. Regardless of the type of habitat, there must be at least 600 squared kilometers of habitat necessary to support a viable population of 5,000 long-tailed macaques. This is the minimum size for a reserve for this species.</p> <p>Ecosystem role To the extent that these animals are prey for other species, they may affect populations of those species. Macaca fascicularis may be an important predator in its ecosystem, and may have some impact on prey species.</p> <p>Economic importance Long-tailed macaques, along with other species of macaques, have benefited humans through their use as research models in immunology, surgery, toxicology and pharmacology. They are also important members of ecosystems and may serve as a base for ecosystem services. They are sometimes still hunted for food.</p> <p>Creator Macaca fascicularis (Raffles, 1821)</p> <p>Source</p> <ul style="list-style-type: none"> https://animaldiversity.org/accounts/Macaca_fascicularis/ https://www.ncbi.nlm.nih.gov/taxonomy/12541704444309 https://animaldiversity.org/accounts/Macaca_fascicularis/ <p>Publisher Iman Rabbiah Mustafa</p> <p>Contributor Iman Rabbiah Mustafa</p>				

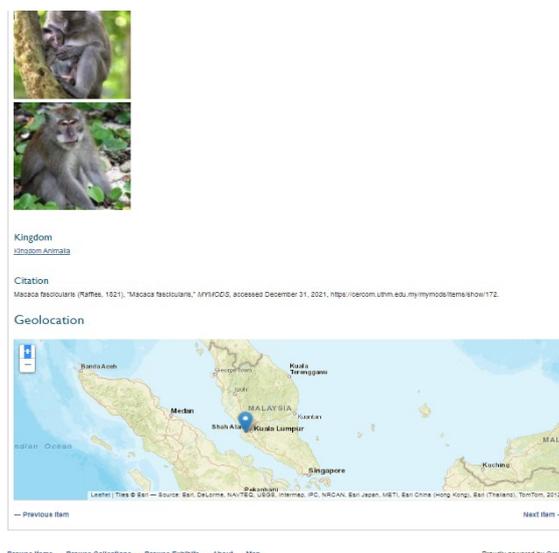


Fig. 6 - The exemplar pages of *Macaca fascicularis* in MYMODS

3.5 Database Acceptance Test

The online database system will be evaluated via a User Acceptance Test (UAT). Acceptance testing was done by presenting the web database to the potential user of this study. A questionnaire in form of Google Form was distributed. The expected user of this study has tested the database and give recommendations in Google Form. The acceptance testing has successfully conducted and achieved the requirement of this study. 20 respondents have answered the user acceptance test and recommendations have been taken to improve the system. The respondents involve UTHM lecturer and student particularly in Biodiversity and Conservation as they will expected to use MYMODS for conservation action for mammal.

4. Discussion

The database survey revealed 19 databases available online (Table 1). The available databases were examined to benchmark the functionalities of our database. The similarities between databases represent the required features that a mammal database should have. From the data compiled in Table 1, we analyse the required features to be included in our database. We decided to include all the listed features to achieve a comprehensive mammal database compared to other existing databases. Most mammal database studies were conducted in the western area such as the United States of America and not Third World such as Egypt or tropical countries such as Malaysia, Thailand, Singapore that have significantly more mammalian biodiversity. This apparent paradox probably occurred due to the access to existing technology such as internet connectivity, digitisation of archival data, data capturing technologies such as trackers, satellite access to make availability of the data onto online databases easier.

Examination of these databases showed a variation of the types of data stored. Although the Biodiversity Information Standards (TDWG) open standards for the exchange of biodiversity data that has been designed to facilitate biodiversity informatics, not all databases adhered to the TDWG standard. Therefore, in this study, we ensure that the TDWG standard is adhered to when creating MYMODS. The Global Biodiversity Information Facility (GBIF) actively using this standard to ensure effective data sharing. With the establishment of GBIF, effort to publish primary biodiversity data has gained momentum. Data portal in GBIF network already facilitate access to over 377 million records from more than 400 data publisher [33]. GBIF create bonding that connect scientist, innovative technologies, conservation practitioners and policies makers to tailor upon human needs and nature conservation [15]. Same goes to MYMODS, the creation of MYMODS aimed to provide information to support research studies and conservation actions.

MYMODS was built using Omeka Classic. Omeka Classic is web publishing for sharing digital content and creating online exhibits. It standardizes data about digital objects. It adheres to the Dublin Core standard that is designed for scholars, museums, libraries, archives and enthusiasts. Omeka Classic is one of the Content Management systems (CMS) that allows developers to manage digital content by adding, editing and publishing in a user-friendly environment [34]. The population of 361 mammals species into MYMODS was done but 30 species were filtered out in this study as exemplar pages of MYMODS.

The database should cater huge size of data. The database should be able to handle large sizes of data with efficiency and whenever there are updates in the future, the database can support more data with complication-free. The

database also has several levels of users to ensure the security of the database. MYMODS also serve data type such as data information from other databases, author and bibliography to ensure an efficient user experience when exploring MYMODS. Data management are very crucial because of the multiple types of content in the database. Data addition, edition and deletion, creation of new content type and submitted data is provided by Omeka Classic. To create content, administrators have to key in or populate data to save the data into the database. The user management function came from Omeka Classic. It is important to ensure security in MYMODS. The wrong permission to edit the database could lead to jeopardizing the whole content of the database.

Acceptance testing was done by presenting the web database to the potential user of this study. A questionnaire in form of Google Form was successfully distributed and conducted. 15 students and 5 lecturers from biodiversity and conservation background have answered the google form. All respondents are aware that mammal species are declining at a rapid rate. They realize the importance to document mammal species in Malaysia to help in conservation action. For the section on system application, 75 % of respondents answered that the features in the database are sufficient. The next question is regarding the effectiveness of the database. 65% answered that the database is effective to provide information to researchers, conservationists and students. It can be concluded that most of the respondents accepted that MYMODS can be one of the comprehensive mammal databases in Malaysia.

5. Conclusion

The objectives of this study have now been fulfilled to develop a comprehensive mammal database in Malaysia. MYMODS is a comprehensive mammal database that hosted 361 mammal species with various features deposited in the database. MYMODS now has the most comprehensive data features compiled from 19 separate databases. It can be used to assist the researcher and conservationist with further references and conservation action. The content in MYMODS hopefully will be useful to the researcher for better management of mammals in the future. MYMODS will always be updated if there are new species, the addition of taxonomic class or the status of IUCN Red List. It is hoped that MYMODS will be continuously active to add or manage data to assist the conservationist for conservation action.

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