Short Communication: Wildlife species used as traditional medicine by local people in Indonesia

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Abstract. Mardiaastuti A, Mas'y'ud B, Ginoja LN, Sastranegara H, Sutopo, 2021. Short Communication: Wildlife species used as traditional medicine by local people in Indonesia. Biodiversitas 22: 329-337. Since a long time ago, wild animals (wildlife species) have been used by the local people as traditional medicine. Research has been conducted in some areas, but there was no study that incorporates all data. The objective of this research was to collect nation-wide information on the wildlife species (mammals, birds, reptiles, amphibians) used as traditional medicine, identify the species used the most, and collect information on the diseases that were believed can be cured by the wildlife species. Papers and reports from previous studies were collected and analyzed. Based on 55 published scientific papers, 114 wildlife species were known to be used by the local people as traditional medicine (59 species of mammals, 12 birds, 37 reptiles, 6 amphibians). Reptiles were used more intensively and believed may cure many diseases, mainly respiratory, digestive, skin, and musculoskeletal diseases. Among all species, Reticulated Python (Malayopython reticulatus), Common Water Monitor (Varanus salvator), Tokay Gecko (Gekko gecko), Common Sun Skink (Eutropis multifasciata), and Malayan Porcupine (Hystrix brachyura) were listed as the most popular species for traditional medicine. As some species have already listed as protected and endangered, a necessary precautionary program is needed to ensure the harvest sustainability and survival of the endangered species.

Keywords: Ethnomedicine, local knowledge, reptiles, VOSviewer, wildlife utilization

INTRODUCTION

Wildlife species (including their body parts and derived products) have been popularly used as a source of traditional medicine in Indonesia and in many other parts of the world, including in Brazil (Alves and Alves 2011, Barros et al. 2012), Argentina (Hernandez et al. 2015), Mexico (Jacob-Salcedo 2011), Nigeria (Ajagun et al. 2017), Ethiopia (Kendie et al. 2018), South Africa (Niemann et al. 2019), India (Jaroli et al. 2010, Borah and Prasad 2017), China (Still 2003), Korea (Kim and Song 2013), and the neighboring country of Malaysia (Halim et al. 2017). The use of wildlife species by the local people in Indonesia actually was not limited to traditional wildlife only. Many wildlife animals were also reported being used for consumption (Nijman 2016), as well as for traditional rituals and myths (Partasasmita et al. 2016). Food and medicine derived from wildlife have important nutritional values especially in times of crisis, although the wildlife food often regarded as supplementary to local peoples’ diet (Alves et al. 2013).

The use of wildlife species as medicines and other purposes is part of local people’s traditional knowledge. Traditional knowledge commonly refers to “the knowledge, innovations and practices of indigenous and local communities related to genetic resources, which has been developed through the experiences of communities over centuries, adapted to local needs, cultures and environments and passed down from generation to generation” (Ni 2011). Traditional knowledge is closely linked to ethnobiology, which can be grouped as ethnomedicine and ethnozoology, based on the subject of interest.

Ethnozoology is defined as “the study seeks to understand how humans have perceived and interacted with faunal resources throughout history” (Alves and Souto 2011). Within the ethnozoology, there is a topic that discussed traditional medicine, also known as folk medicine, indigenous medicine, or ethnomedicine (Barros et al. 2012, Ajagun et al. 2017). Traditional medicine used in this paper refers to “the knowledge and practices used in the diagnosis, prevention and elimination of various sickness (either physical, mental or social imbalances) and relying on practical experience and observation that passing down from generation to generation” (Yuan et al. 2016).

Studies about the use of wildlife species by the local people were mostly carried out in small geographic areas, due to the nature of information collected through direct interviews. Until now there has been to attempt to incorporate all information on the national scale. The objective of this paper was to collect nation-wide information on the wildlife species used as traditional medicine, identify the species used the most, and collect information on the diseases that were believed can be cured by the wildlife species. The taxa that will be analyzed in this paper were focused on wild mammals, birds, reptiles, and amphibians only. Fish and domesticated species were excluded.
MATERIALS AND METHODS

Study area

The study area of this research was in the Indonesian archipelago, a mega biodiversity hotspot, which was located in the tropical region (6º08' N to 11º15' S latitude and 94º45' E to 141º05' E longitude). Indonesia has 7 biogeographic regions from Sumatra, Java, Kalimantan, Sulawesi, Nusa Tenggara, Maluku, and Papua (Figure 1). These biogeographic regions comprise mountainous area with dense forests. There were also local people and ethnicities who live around the forests to exploit the resources to fulfill their daily needs. The notable ethnic who lives around the forests and exploit the local resources were Anak Dalam ethnic and Talang Mamak ethnic in Sumatra, Tengger ethnic and Osing ethnic in Java, Dayak ethnic in Kalimantan, Bada ethnic in Sulawesi, Sasak ethnic in Nusa Tenggara, Tobelo Dalam ethnic in Maluku, and Nduga ethnic in Papua.

Data collection

A comprehensive literature study was done by collecting all available journal articles, scientific reports, theses (doctoral, master’s, and bachelor level), and books that contain information on ethnozoology in Indonesia. All publications were searched and accessed via internet, by using the keyword of “ethnobiology”, “ethnozoology”, “wildlife utilization”, and some similar words in Indonesian language. If full publication is not available online, the articles were obtained through correspondence with the university librarian. Although there was no limitation of the published year, the results showed that the available literature were dated as far as 2001. Publications prior to that year might be available, but not posted in web.

There were 55 literature on ethnozoology in Indonesia, mostly (80%) were written in Indonesian language, of which only 34 literature were related to ethnomedicine. This literature was not distributed evenly in the 7 biogeographic regions in Indonesia (Figure 1). Most data were from the western part of Indonesia (Oriental Realm): Java (n=11, e.g. Uyeda et al. (2014), Partasasmita et al. (2016)), followed by Sumatra (n=11, e.g. Masy’ud et al. (2020)), and Kalimantan (n=6). Very few data were reported from Nusa Tenggara (n=1), Sulawesi (n=1), and Maluku (n=1). Three other papers were across region.

Figure 1. Location of wildlife uses by the local people in Indonesia.
The data were organized on a database and analyzed accordingly. The database contained location of the data collection, wildlife species, and its respective grouping, as well as the use of wildlife. Wildlife species were grouped based on their respective taxonomic grouping: amphibians (Anura), birds (Aves), mammals (Mammalia), and reptiles (Reptilia). Some taxa that were not able to be identified to species level, had to be identified at the genus level, making sure that there was no possible overlap with its corresponding species level. Number of wildlife species used by the local people was compared to the total number of its respective group in Indonesia. The total number of its respective group in Indonesia was referred to as the available wildlife checklist.

Data analysis
The data collected were analyzed by using Microsoft Excel (version 2019), Mendeley Desktop (version 1.19.4), and VOSviewer (version 1.6.16). VOSviewer was used to develop maps of collaboration based on co-occurrence type of analysis. VOSviewer is "a software tool for creating maps based on network data and for visualizing and exploring these maps", intended primarily for analyzing bibliometric data networks.

Data from all literature were extracted and collated in a database. For each species mentioned in the literature, a Relative Frequency of Citation (RFC) was estimated, by calculating the total number of references that mentioned the species of interest divided by the total number of papers being used for analysis.

RESULTS AND DISCUSSION

The medicinal wildlife species
There were 305 wildlife species that have been used by the local people for various purposes, of which 114 species (37.4%) were used as traditional medicines. Based on the main taxa, the number of mammal species was rank first (in terms of species diversity and percentage of all species), followed by reptiles (Table 1). This result was similar to the percentage of medicinal animals used in other countries/regions, e.g., Brazilian Amazon (Barros et al. 2012), Oyo State in South-western Nigeria (Ajagun et al. 2017), and North-western Ethiopia (Kendie et al. 2018). As for amphibians and birds, the diversity of amphibians being used was lower (i.e., only 6 species) than birds, but the percentage was still higher than birds. It was allegedly because the local people were better known for birds than reptiles.

For mammals, surprisingly various groups were used by the local people as traditional medicine (Table 2), including large-sized mammals (such as ungulates and elephant), whales, primates, and small-sized mammals (such as rodents and tree-shrews). Mammal species that was mentioned the most among the references, showed by a relatively high RFC, were Malayan Porcupine (Hystrix brachyura). Outside Indonesia, the Malayan Porcupine has been reported to have high value for medicinal values for their bezoar in the neighboring country of Malaysia (Tan et al. 2019) and Singapore (Heinricha et al. 2020).

Other mammalian species frequently used by the local people were Sun Bear (Helarctos malayanus), Sunda Pangolin (Manis javanica), Flying Fox (Pteropus sp.), and Long-tailed Macaque (Macaca fascicularis). These species were commonly used elsewhere as traditional medicine. Sun Bear, specifically its bile, has been used in Traditional Chinese Medicine for thousands of years (Gomez et al. 2020). The meat, scales and body parts of Sunda Pangolin and other seven other pangolin species have been widely used as traditional medicine worldwide (Wang et al. 2020). Flying fox and other 166 species of bats has been subjected to hunting for medicine and consumption in Asia, Africa, Oceania, and some Central and South American countries (Mildenstein et al. 2016). Furthermore, worldwide survey by Alves et al. (2010) revealed that at least 101 species of primates (38 genera and 10 families) were used in traditional folk practices and in magic-religious rituals, including Long-tailed Macaque, mostly in Cambodia.

Network-visualization image generated from VOSviewer (Figure 2), however, showed that the most visible species in the image were actually reptiles. Although the number of reptiles used by local people was ranked the second, many reptile species had high RFC values, and displayed clearly in the VOSviewer mapping. This result showed that there were more references for reptile usability as traditional medicine than other species. It means that the people were more believed in reptiles as traditional medicine than other classes, especially snakes, as also reported by Alves et al. (2013) in Brazil.

Four reptile species were stand out among others, namely Reticulated Python (Malayopython reticulatus), Common Water Monitor (Varanus salvator), Tokay Gecko (Gekko gekko), and Common Sun Skink (Eutropis multifasciata). All of these species were relatively easy to get from the local people’s premises. Relatively large-sized species might also be hunted for consumption, including Water Monitor and Reticulated Python. Furthermore, other species that were also popular to be used by the local people were Chinese Ratsnake (Ptyas korros), Indonesian Cobra (Naja sputatrix), King Cobra (Ophiophagus hannah), Common House Gecko (Hemidactylus frenatus), Flat-tailed House Gecko (Hemidactylus platyurus), Malayan Soft-shelled Turtle (Dogenia subplana), and Asian Softshell Turtle (Amida cartilaginea).

A quick glance at the remedy generated by reptile species (Table 3) indicated that the local people believe that reptiles, in general, were excellent as traditional medicine and able to cure various diseases. The use of reptiles for medicinal purposes has been commonly
practiced in many parts of the world, not only in Indonesia. Global reviews on wildlife use by local people elsewhere revealed that at least 284 species of reptiles have been used as traditional medicine (Alves et al. 2013). Brazil has been reported to use herpetofauna quite intensively (Alves et al. 2013, Fernandes-Ferreira et al. 2013, Mendonça et al. 2014), so does India (Das 2015). As for birds (Table 4) and amphibians (Table 5), some species were reported to be used, but only by very few references.

The diseases that can be cured by using wildlife species

The local people of Indonesia believed that there was 13 type of diseases that can be cured by using wildlife species. These local people mostly used wildlife species to cure respiratory diseases (68 species), digestive diseases (47 species), skin diseases (46 species), and musculoskeletal diseases (33 species), as shown in Figure 3. Those diseases were mostly involved mammal and reptile species, including respiratory diseases (36 species of mammals, 23 reptiles), digestive diseases (23 mammals and 15 reptiles), skin diseases (27 reptiles and 17 mammals), and musculoskeletal diseases (16 reptiles and 12 mammals). Outside Indonesia, mammals and reptiles as traditional medicine were also common to use in other countries such as Tanzania (Vats and Thomas 2015), South Africa (Nieman et al. 2019), and Brazil (Teixeira et al. 2020).

Based on RFC value, some reptiles have higher values, which means the diseases that can be cured by using reptiles were more diverse than other species. King Cobra was the species with the highest number of diseases (9 diseases) that can be cured by using this species (see Table 3). This species mostly was used to cure skin diseases such as eczema, skin allergies, and scab. Other popular species to cure diseases were Reticulated Python, Common Water Monitor, and Tokay Gecko.

The use of wildlife species, although in a subsistence basis, may raise some concerns on the conservation and harvest sustainability, as also noted by other researchers (e.g., Alves and Souto (2011), Ferreira et al. (2012)). Some species, mainly large mammals, are already protected by Indonesian law due to their rarity and their internationally threatened status. As the local people live in remote areas without any sufficient information exchanges, the local people might not do aware that the wildlife species they captured were protected by Indonesian law. Therefore, cautions need to be taken for several species that already threatened extinction.

In conclusion, the local people in Indonesia use many wildlife species from their environment, mostly reptiles, and mammals, as traditional medicines. The high number of species being used (114 species) indicated that wildlife species played important roles in traditional medicine and to maintain health of the local people. As some species (mostly mammals) have already listed as protected and endangered species, some necessary precautionary programs would be needed to ensure the harvest sustainability and survival of the endangered species.
Figure 3. Network-visualization map of diseases that can be cured by using wildlife species (13 diseases; 2 clusters; 71 links)

Table 2. Mammal species used by the local people in Indonesia as traditional medicine and their traditional remedy

| Species                        | Ref. | Freq. | Skin | Eye and adnexa | Sexuality  | Endocrine system | Infectious diseases | Neoplasms | Respiratory system | Digestive system | Musculoskeletal system | Circulatory system | Neuro system | Genitourinary system | Nutritious diseases |
|--------------------------------|------|-------|------|----------------|------------|------------------|--------------------|------------|-------------------|-------------------|----------------------|---------------------|-------------|----------------------|-------------------|
| **Even-toed Ungulates**        |      |       |      |                |            |                  |                    |            |                   |                   |                      |                     |             |                      |                   |
| Sumatran Serow *Capricornis sumatraensis* | 0.03 |  ✓    | ✓    | ✓             |            |                  |                    |            |                   |                   |                      |                     |             |                      |                   |
| Bawean Deer *Axis kuhlii*       | 0.03 |  ✓    | ✓    | ✓            |            |                  |                    |            | ✓                 |                   |                      |                     |             |                      |                   |
| Indian Muntjac *Muntiacus muntjak* | 0.06 |  ✓    | ✓    | ✓            | ✓          |                  |                    |            |                   |                   |                      |                     |             |                      |                   |
| Javan Rusa *Rusa timorensis*   | 0.03 |  ✓    | ✓    | ✓            |            |                  |                    |            |                   |                   |                      |                     |             |                      |                   |
| Sambar Deer *Rusa unicolor*     | 0.06 |  ✓    | ✓    | ✓            | ✓          |                  | ✓                  |            |                   |                   |                      |                     |             |                      |                   |
| Babirusa *Babirousa babyrussa*  | 0.03 |  ✓    | ✓    | ✓            |            |                  |                    |            |                   |                   |                      |                     |             |                      |                   |
| Bornean Bearded Pig *Sus barbatus* | 0.03 |  ✓    | ✓    | ✓            |            |                  |                    |            |                   |                   |                      |                     |             |                      |                   |
| Celebes Warty Pig *Sus celebensis* | 0.03 |  ✓    | ✓    | ✓            |            |                  |                    |            |                   |                   |                      |                     |             |                      |                   |
| Wild Boar *Sus scrofa*          | 0.09 |  ✓    | ✓    | ✓            | ✓          |                  | ✓                  | ✓          |                   |                   |                      |                     |             |                      |                   |
| Boar *Sus sp.*                 | 0.03 |  ✓    | ✓    | ✓            |            |                  |                    |            |                   |                   |                      |                     |             |                      |                   |
| Mouse-Deer *Tragulus sp.*       | 0.06 |  ✓    | ✓    | ✓            |            |                  |                    |            |                   |                   |                      |                     |             |                      |                   |
| **Carnivore**                  |      |       |      |                |            |                  |                    |            |                   |                   |                      |                     |             |                      |                   |
| Sumatran Tiger *Panthera tigris sumatrae* | 0.09 |  ✓    | ✓    | ✓            |            |                  |                    |            |                   |                   |                      |                     |             |                      |                   |
| Sunda Stink Badger *Mydaus javanensis* | 0.06 |  ✓    | ✓    | ✓            |            |                  |                    |            |                   |                   |                      |                     |             |                      |                   |
| Stink Badger *Mydaus sp.*       | 0.03 |  ✓    | ✓    | ✓            |            |                  |                    |            |                   |                   |                      |                     |             |                      |                   |
| Small-clawed Otter *Aonyx cinereus* | 0.03 |  ✓    | ✓    | ✓            |            |                  |                    |            |                   |                   |                      |                     |             |                      |                   |
| Sun Bear *Helarctos malayanus*  | 0.15 |  ✓    | ✓    | ✓            | ✓          |                  | ✓                  | ✓          |                   |                   |                      |                     |             |                      |                   |
| Asian Palm Civet *Paradoxurus hermaphroditus* | 0.03 |  ✓    | ✓    | ✓            | ✓          |                  | ✓                  | ✓          |                   |                   |                      |                     |             |                      |                   |
| **Whales**                      |      |       |      |                |            |                  |                    |            |                   |                   |                      |                     |             |                      |                   |
| Fin Whale *Balaenoptera physalus* | 0.03 |  ✓    | ✓    | ✓            |            |                  |                    |            |                   |                   |                      |                     |             |                      |                   |
### Bats
- Lesser Sheath-tailed Bat *Emballonura monticola* 0.03
- Fruit Bat *Cynopterus* sp. 0.03
- Fruit Bat *Pteropodidae* sp. 0.03
- Admiralty Flying Fox *Pteropus admiraltitatum* 0.03
- Black Flying Fox *Pteropus alecto* 0.03
- Flying Fox *Pteropus* sp. 0.15
- Large Flying Fox *Pteropus vampyrus* 0.06
- Least Horseshoe Bat *Rhinolophus pumilus* 0.03
- Whiskered Myotis *Myotis muricola* 0.06
- Lesser Bamboo Bat *Tylonycteris pachypus* 0.03

### Cuscuses
- Moluccan Cuscus *Phalanger ornatus* 0.03

### Rabbit and Hares
- Rabbit *Leporidae* sp. 0.03
- Indian Hare *Lepus nigricollis* 0.03
- Hare *Lepus* sp. 0.06

### Odd-toed Ungulates
- Sumatran Rhinoceros *Dicerorhinus sumatrensis* 0.03
- Javan Rhinoceros *Rhinoceros sondaicus* 0.03

### Pangolin
- Sunda Pangolin *Manis javanica* 0.12

### Primates
- Long-tailed Macaque *Macaca fascicularis* 0.18
- Celebes Crested Macaque *Macaca nigra* 0.03
- Macaque *Macaca* sp. 0.03
- Tonkean Macaque *Macaca tonkeana* 0.03
- White-fronted Surili *Presbytis frontata* 0.03
- Maroon Leaf Monkey *Presbytis rubicunda* 0.06
- Javan Lutung *Trachypithecus auratus* 0.06
- Sunda Slow Loris *Nycticebus coucang* 0.03

### Elephant
- Sumatran Elephant *Elephas maximus sumatranus* 0.03

### Rodents
- Malayan Porcupine *Hystrix brachyura* 0.24
- Thick-spined Porcupine *Hystrix crassispinis* 0.09
- Sunda Porcupine *Hystrix javanica* 0.06
- Sumatran Porcupine *Hystrix sumatrae* 0.09
- Long-tailed Porcupine *Trichys fasciculata* 0.03
- House Mouse *Mus musculus* 0.06
- Rice-field Rat *Rattus argentiventer* 0.03
- Rat *Rattus* sp. 0.15
- Plantain Squirrel *Callosciurus notatus* 0.03
- Prevost's Squirrel *Callosciurus prevostii* 0.03
- Squirrel *Callosciurus* sp. 0.03
- Three-striped Ground Squirrel *Lariscus insignis* 0.03

### Treeshrews
- Horsfield's Treeshrew *Tupaia javanica* 0.06
- Pygmy Treeshrew *Tupaia minor* 0.03
- Treeshrew *Tupaia* sp. 0.09

| Total species of each remedy category | 16 | 3 | 6 | 5 | 7 | 1 | 29 | 23 | 10 | 10 | 6 | 2 | 0 |
Table 3. Reptile species used by the local people in Indonesia as traditional medicine and their traditional remedy

| Species                              | Ref | Freq | Citation | Skin | Eye and adnexa | Sexuality | Endocrine system | Infectious system | Neoplasms | Respiratory system | Digestive system | Musculoskeletal system | Circulatory system | Neuro system | Genitourinary system | Nutritious diseases |
|--------------------------------------|-----|------|----------|------|----------------|-----------|------------------|-------------------|-----------|--------------------|-------------------|---------------------|----------------------|--------------|----------------------|-------------------|
| **Snakes**                           |     |      |          |      |                |           |                  |                   |           |                    |                   |                     |                      |              |                      |                   |
| Little File Snake *Acrochordus granulatus* | 0.03 | ✓    |          | ✓    |                | ✓         |                  |                   |           |                    |                   |                     |                      |              |                      |                   |
| Javan File Snake *Acrochordus javanicus* | 0.03 | ✓    |          | ✓    |                | ✓         |                  |                   |           |                    |                   |                     |                      |              |                      |                   |
| Gold-ringed Cat Snake *Boiga dendrophila* | 0.06 | ✓    |          | ✓    |                | ✓         |                  | ✓                 |           |                    | ✓                 |                      |                      |              |                      |                   |
| Radiated Ratsnake *Coelognathus radiatus* | 0.09 | ✓    | ✓    | ✓    | ✓    | ✓         | ✓                 | ✓             | ✓         | ✓                 | ✓                 | ✓                  |                      |              |                      |                   |
| Chinese Ratsnake *Ptyas korros*        | 0.06 | ✓    |          | ✓    |                | ✓         |                  | ✓                 |           | ✓                 | ✓                 | ✓                  |                      |              |                      |                   |
| Oriental Ratsnake *Ptyas mucosus*      | 0.03 | ✓    |          | ✓    |                | ✓         |                  |                   |           | ✓                 | ✓                 |                     |                      |              |                      |                   |
| Blue Krait *Bungarus candidus*         | 0.09 | ✓    | ✓    | ✓    | ✓    | ✓         | ✓                 | ✓             | ✓         | ✓                 | ✓                 | ✓                  |                      |              |                      |                   |
| Banded Krait *Bungurus fasciatus*      | 0.09 | ✓    | ✓    | ✓    | ✓    | ✓         | ✓                 | ✓             | ✓         | ✓                 | ✓                 | ✓                  |                      |              |                      |                   |
| Elapid Snake *Elapidae* sp.            | 0.03 | ✓    |          | ✓    |                | ✓         |                  |                   |           | ✓                 | ✓                 |                     |                      |              |                      |                   |
| Spitting Cobras *Naja* sp.             | 0.03 | ✓    |          | ✓    |                | ✓         |                  |                   |           | ✓                 | ✓                 |                     |                      |              |                      |                   |
| Indonesian Cobra *Naja sputatrix*      | 0.12 | ✓    | ✓    | ✓    | ✓    | ✓         | ✓                 | ✓             | ✓         | ✓                 | ✓                 | ✓                  | ✓                 |              | ✓                   |                   |
| Equatorial Spitting Cobra *Naja sumatranana* | 0.03 | ✓    |          | ✓    |                | ✓         |                  |                   |           | ✓                 | ✓                 | ✓                  | ✓                 |              | ✓                   |                   |
| King Cobra *Ophiophagus hannah*        | 0.12 | ✓    | ✓    | ✓    | ✓    | ✓         | ✓                 | ✓             | ✓         | ✓                 | ✓                 | ✓                  | ✓                 |              | ✓                   |                   |
| Linne's Water Snake *Homalopsis buccata* | 0.06 | ✓    |          | ✓    |                | ✓         |                  |                   |           | ✓                 | ✓                 | ✓                  | ✓                 |              | ✓                   |                   |
| Sumatra Python *Python curtus*          | 0.03 | ✓    |          | ✓    |                | ✓         |                  |                   |           | ✓                 | ✓                 | ✓                  | ✓                 |              | ✓                   |                   |
| Reticulated Python *Malayopython reticulatus* | 0.38 | ✓    | ✓    | ✓    | ✓    | ✓         | ✓                 | ✓             | ✓         | ✓                 | ✓                 | ✓                  | ✓                 |              | ✓                   |                   |
| Malayan Pit Viper *Calloselasma rhodostoma* | 0.06 | ✓    | ✓    | ✓    | ✓    | ✓         | ✓                 | ✓             | ✓         | ✓                 | ✓                 | ✓                  | ✓                 |              | ✓                   |                   |
| Pit Viper Snakes *Trimeresurus* sp.     | 0.03 | ✓    |          | ✓    |                | ✓         |                  |                   |           | ✓                 | ✓                 | ✓                  | ✓                 |              | ✓                   |                   |
| Sunbeam Snake *Xenopeltis unicolor*     | 0.03 | ✓    |          | ✓    |                | ✓         |                  |                   |           | ✓                 | ✓                 | ✓                  | ✓                 |              | ✓                   |                   |
| **Lizards and monitors**               |     |      |          |      |                |           |                  |                   |           |                    |                   |                     |                      |              |                      |                   |
| Common Flying Dragon *Draco volans*     | 0.03 | ✓    |          | ✓    |                | ✓         |                  |                   |           | ✓                 | ✓                 |                     |                      |              |                      |                   |
| Tokay Gecko *Gekko gecko*              | 0.32 | ✓    | ✓    | ¡    | ✓    | ✓         | ✓                 | ✓             | ✓         | ✓                 | ✓                 | ✓                  | ✓                 |              | ✓                   |                   |
| Common House Gecko *Hemidactylus frenatus* | 0.18 | ✓    | ✓    | ✓    | ✓    | ✓         | ✓                 | ✓             | ✓         | ✓                 | ✓                 | ✓                  | ✓                 |              | ✓                   |                   |
| Flat-tailed House Gecko *Hemidactylus platyurus* | 0.12 | ✓    | ✓    | ✓    | ✓    | ✓         | ✓                 | ✓             | ✓         | ✓                 | ✓                 | ✓                  | ✓                 |              | ✓                   |                   |
| House Gecko *Hemidactylus* sp.         | 0.06 | ✓    |          | ✓    |                | ✓         |                  |                   |           | ✓                 | ✓                 | ✓                  | ✓                 |              | ✓                   |                   |
| Lizards *Lacertidae* sp.               | 0.06 | ✓    |          | ✓    |                | ✓         |                  |                   |           | ✓                 | ✓                 |                     |                      |              |                      |                   |
| Asian Grass Lizard *Takydromus sexlineatus* | 0.03 | ✓    |          | ✓    |                | ✓         |                  |                   |           | ✓                 | ✓                 |                     |                      |              |                      |                   |
| Borneo Skink *Dasia vittata*           | 0.06 | ✓    |          | ✓    |                | ✓         |                  |                   |           | ✓                 | ✓                 |                     |                      |              |                      |                   |
| Olive Tree Skink *Dasia olivacea*      | 0.03 | ✓    |          | ✓    |                | ✓         |                  |                   |           | ✓                 | ✓                 |                     |                      |              |                      |                   |
| Common Sun Skink *Eutropis multifasciata* | 0.21 | ✓    | ✓    | ✓    | ✓    | ✓         | ✓                 | ✓             | ✓         | ✓                 | ✓                 | ✓                  | ✓                 |              | ✓                   |                   |
| Skink Lizard *Eutropis* sp.            | 0.03 | ✓    |          | ✓    |                | ✓         |                  |                   |           | ✓                 | ✓                 |                     |                      |              |                      |                   |
| Common Water Monitor *Varanus salvator* | 0.35 | ✓    | ✓    | ✓    | ✓    | ✓         | ✓                 | ✓             | ✓         | ✓                 | ✓                 | ✓                  | ✓                 |              | ✓                   |                   |
| **Turtles and tortoises**             |     |      |          |      |                |           |                  |                   |           |                    |                   |                     |                      |              |                      |                   |
| Turtles *Geoemydidae* sp.              | 0.12 | ✓    | ✓    | ✓    | ✓    | ✓         | ✓                 | ✓             | ✓         | ✓                 | ✓                 | ✓                  | ✓                 |              | ✓                   |                   |
| Tortoises *Testudo* sp.                | 0.03 | ✓    |          | ✓    |                | ✓         |                  |                   |           | ✓                 | ✓                 |                     |                      |              |                      |                   |
| Brown Tortoise *Manouria emys*         | 0.03 | ✓    |          | ✓    |                | ✓         |                  |                   |           | ✓                 | ✓                 |                     |                      |              |                      |                   |
| Asiatic Softshell Turtle *Amyda carrigalinea* | 0.12 | ✓    | ✓    | ✓    | ✓    | ✓         | ✓                 | ✓             | ✓         | ✓                 | ✓                 | ✓                  | ✓                 |              | ✓                   |                   |
| Malayan Soft-shelled Turtle *Dogania subplana* | 0.15 | ✓    | ✓    | ✓    | ✓    | ✓         | ✓                 | ✓             | ✓         | ✓                 | ✓                 | ✓                  | ✓                 |              | ✓                   |                   |
| **Crocodiles**                        |     |      |          |      |                |           |                  |                   |           |                    |                   |                     |                      |              |                      |                   |
| Saltwater Crocodile *Crocodylus porosus* | 0.06 | ✓    |          | ✓    |                | ✓         |                  |                   |           | ✓                 | ✓                 |                     |                      |              |                      |                   |
| **Total species of each remedy category** | 28  | 14  | 14  | 10  | 8  | 1  | 23  | 15  | 16  | 10  | 2  | 1  | 0    |
Table 4. Bird species used by the local people in Indonesia as traditional medicine and their traditional remedy

| Species                          | Ref. Freq. Citation | Skin | Eye and adnexa | Sexuality | Endocrine system | Infectious diseases | Neoplasms | Respiratory system | Digestive system | Musculoskeletal system | Circulatory system | Neuro system | Genitourinary system | Nutritious diseases |
|----------------------------------|---------------------|------|----------------|-----------|-----------------|---------------------|------------|-------------------|-------------------|----------------------|---------------------|--------------|----------------------|-------------------|
| Swiftlet                         | Edible-nest Swiftlet *Aerodramus fuciphagus* | 0.06 | √              | √         | √               |                     |            |                   |                   |                      |                     |              |                      |                   |
| Pigeon                           | Pigeon *Columbidae* sp. | 0.03 |                |           |                 |                     |            |                   |                   |                      |                     |              |                      |                   |
| Hornbill                         | Helmed Hornbill *Rhinoplax vigil* | 0.03 |                |           |                 |                     |            |                   |                   |                      |                     |              |                      |                   |
| Cuckoo                           | Short-toed Coucal *Centropus rectunguis* | 0.03 |                |           |                 |                     |            |                   |                   |                      |                     |              |                      |                   |
| Eagle                            | Black Eagle *Ictinaetus malayensis* | 0.03 |                |           |                 |                     |            |                   |                   |                      |                     |              |                      |                   |
| Junglefowls                      | *Bufo* sp.          | 0.06 | √              | √         |                 |                     |            |                   |                   |                      |                     |              |                      |                   |
|                                   | *Duttaphrynus melanostictus* | 0.03 |                |           |                 |                     |            |                   |                   |                      |                     |              |                      |                   |
| Frogs                            | *Fejervarya cancrivora* | 0.03 |                |           |                 |                     |            |                   |                   |                      |                     |              |                      |                   |
|                                   | *Occidozyga* sp.    | 0.03 |                |           |                 |                     |            |                   |                   |                      |                     |              |                      |                   |
|                                   | *Hylarana erythraea* | 0.03 |                |           |                 |                     |            |                   |                   |                      |                     |              |                      |                   |
|                                   | *Rana* sp.          | 0.03 |                |           |                 |                     |            |                   |                   |                      |                     |              |                      |                   |
| Total species of each remedy category |                       | 0 3 0 0 0 1 0 5 2 2 1 0 0 1 |

Table 5. Amphibian species used by the local people in Indonesia as traditional medicine and their traditional remedy

| Species                          | Ref. Freq. Citation | Skin | Eye and adnexa | Sexuality | Endocrine system | Infectious diseases | Neoplasms | Respiratory system | Digestive system | Musculoskeletal system | Circulatory system | Neuro system | Genitourinary system | Nutritious diseases |
|----------------------------------|---------------------|------|----------------|-----------|-----------------|---------------------|------------|-------------------|-------------------|----------------------|---------------------|--------------|----------------------|-------------------|
| Toads                            | *Bufo* sp.          | 0.06 | √              | √         |                 |                     |            |                   |                   |                      |                     |              |                      |                   |
|                                   | *Duttaphrynus melanostictus* | 0.03 |                |           |                 |                     |            |                   |                   |                      |                     |              |                      |                   |
| Frogs                            | *Fejervarya cancrivora* | 0.03 |                |           |                 |                     |            |                   |                   |                      |                     |              |                      |                   |
|                                   | *Occidozyga* sp.    | 0.03 |                |           |                 |                     |            |                   |                   |                      |                     |              |                      |                   |
|                                   | *Hylarana erythraea* | 0.03 |                |           |                 |                     |            |                   |                   |                      |                     |              |                      |                   |
|                                   | *Rana* sp.          | 0.03 |                |           |                 |                     |            |                   |                   |                      |                     |              |                      |                   |
| Total species of each remedy category |                       | 2 0 1 0 0 0 2 2 2 0 0 0 0 0 |
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