Biota
Biologi dan Pendidikan Biologi
http://biota.ac.id/index.php/jb
DOI: https://doi.org/10.20414/jb.v12i2.210

Research Article

Habitat Characteristic and Conservation of Amphibians in Lombok Island

Muhammad Syazali*, Agil Al Idrus, Gito Hadprayitno
Universitas Mataram, West Nusa Tenggara, Indonesia

**Corresponding author:* gitohadiprayitno@unram.ac.id

Abstract

Amphibians in Lombok Island are 12 species. Four species, *Oreophryne monticola*, *Limnonectes kadarsani*, *Limnonectes dammermani* dan *Hylarana florensis*, are endemic of Lesser Sunda Islands. The potentials sow that conservation effort where needed. The information required to do it is habitat characteristic which can support species survival. The aim of this study is knowing of habitat characteristic base on amphibian diversity in Lombok Island. Habitat classified into 3 types are Non-forest, secondary forest and primary forest. The survey was conducted at 9 locations (3 of habitat type) from March to July 2016. The data collected are species composition and the sum of individuals of species. Amphibian diversity was analyzed using relative abundance and the Shannon-Wiener index. Study result sows that nonforest habitat types appropriate for 5 species, while secondary and primary forest habitat type appropriate for 7 species. Diversity of species index directly proportional to the natural level of habitat (H' Nonforest = 1.3; H' Secondary Forest = 1.7; H' Primary Forest = 1.8). The highest species abundance is *Bufo melanostictus* (23.9%), and the lowest species abundance is *Oreophryne monticola* (0.9%). According to the distribution and relative abundance, species that require conservation priorities are *Oreophryne monticola* and *Hylarana florensis*.

Keywords: amphibians; conservation; habitat characteristics; Lombok Island

1. Introduction

Lombok Island, administratively, is a part of the Province of West Nusa Tenggara (BPS NTB, 2015). If viewed from its location against the Wallace and Weber lines, Lombok Island is a transitional area, or also called the Wallacea area (Ellicot and Gall, 2003). In particular, Lombok Island is also included in the small Sundanese archipelago. Its "special" geographical location has much endemic flora and fauna, including amphibians (Monk et al., 2000). Amphibians on Lombok Island number 12 species (Syazali et al., 2016). The twelve species are the Anura order and can be classified into five families, to be specific Bufonidae, Ranidae, Dicroglossidae, Microhylidae, and Rachophoridae. Four species, *Oroephryne monticola, Hylarana florensis, Limnonectes kadarsani*, and *Limnonectes dammermani*, are endemic to Lesser Sunda Islands (Monk et al., 2000). Oreophrynemonticola is only found on the islands of Lombok and Bali (Iskandar, 1998). Three other species are distributed in the Nusa Tenggara islands and beyond (Iskandar et al., 1996; Zug and Kaiser, 2014).

Other species, *Duttaphrynus melanostictus, Ingerophrynus biporcatus, Hylarana erytraea, Fejervarya cancrivora, Fejervarya limnocharis, Kaloula baleata, Phrynoglosus laevis* and *Polypedates leucomystax*, are amphibians that are generally distributed in the Alza region (Yani et al., 2015). *Hylarana erytraea* itself is a species that is relatively new

in Lombok Island. These species are not distributed on the island of Lombok (Iskandar, 1998; Monk et al., 2000).

Amphibians act as predators and prey in their habitat. The food is various types of invertebrates such as earthworms, millipedes, and insects (Hardy and Crnkovic, 2006; Caldas et al., 2016). Insects are the most composition found in amphibians (Plitsi et al., 2016; Kopecky et al., 2016; Gutierrez-Cardenas et al., 2016). On the other hand, amphibians themselves are preyed on by other vertebrates such as reptiles and birds. The double function positions amphibians as an essential biotic component, in the energy flow and biogeochemical cycles in ecosystems. In addition to ecological aspects, amphibians can also be a source of nutrition for humans (Ohler and Nicolas, 2017). Some species have high economic value because they become export commodities. Amphibians can also play a role as a bioindicator. In general, the presence of amphibians in a habitat indicates that the carrying capacity of the environment is still high. Low amphibian diversity means environmental damage (Martin et al., 2015; Gillespie et al., 2015); this phenomenon suggests the need for prevention of factors that interfere with the presence of amphibians. Common confounding factors are human activities such as agriculture (Jeliazkov et al., 2013), habitat destruction, and pollution (Blaustein and Wake, 1995). In some instances, these factors cause the phenomenon of amphibians to decline (Bridges and Semlitsch, 2000; Rohr, 2008; Barret et al., 2010).

The action needed to avoid reducing amphibian diversity is conservation (Iskandar and Erdelen, 2006). Lombok Island was reflected in the stipulation of several areas as Nature Conservation Areas and Nature Reserve Areas (BKSDA NTB, 2010). Conservation areas are generally functioned as ecotourism areas, for example, Gunung Rinjani National Park (TNGR). In this region, *Oreophryne monticola* was found that is distributed only on the islands of Lombok and Bali (Iskandar, 1998). Based on IUCN, the species is endangered, where the population trend has decreased (Iskandar and Mumpuni, 2004). This case indicates that more intensive conservation activities are a necessity. The target is not limited to 1 endangered species, but all amphibian species on the island of Lombok. These activities can be carried out more optimally if there is information about the habitat characteristics of each species, especially those related to their interactions with the abiotic environment. Some studies analyze the effect of habitat biotic and abiotic factors (Syazali et al., 2017), but have not included the element of natural habitat level. The study also collected abundant data to see the relationship between population size and habitat type.

2. Material and Method

The method used is a visual encounter survey (VES), referring to Heyer et al. (1994). The sample size was determined based on the number of amphibians found in the cruising area of 500 {0 m} ^ 2 for each study site (15000 m ^ 2 per habitat type). In each roaming area, amphibious searches were carried out in various amphibian microhabitats, both arboreal, aquatic, semi-aquatic, and terrestrial. Field observations

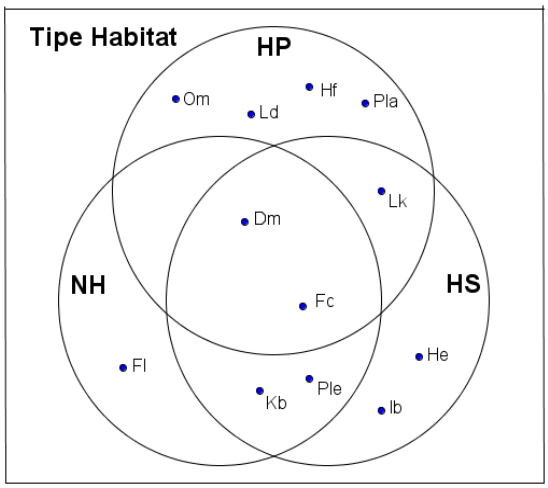
are carried out at night, starting at 08.30 – 12.00 pm during March - July 2016. The data collected is the species composition and the number of individuals of each species.

3. Results and Discussion

3.1. Results

The presence of species indicates that the Non-forest type habitat is suitable for five species, while the Secondary Forest and Primary Forest are seven species each (Figure 1). There is one species, *Fejervarya limnocharis*, which is only found in non-forest habitat types. Two species, *Ingerophrynus biporcatus* and *Hylarana erytraea*, are only found in secondary forest type habitats. Four species, *Oreophryne monticola*, *Limnonectes dammermani, Hylarana florensis* and *Phrynoglosus laevis*, are only found in habitats of Primary Forest types. Figure 1 also shows that there are two species found in non-forest and secondary forest habitats, *Kaloula baleata* and *Polipedates leucomystax*. There are one species found in the habitat of secondary forest and primary forest types, *Limnonectes kadarsani*. No species were found in the Non-Forest and Primary Forest habitat types at one time, or no species were found in the slices between the two habitat types. *Duttaphrynus melanostictus* and *Fejervarya cancrivora* are two species that were found in all habitat types.

Species that have the highest abundance are *Duttaphrynus melanostictus* (23.9%), then *Limnonectes kadarsani* (19.6%), and *Fejervarya cancrivora* (17.9%). Amphibians with the lowest abundance were Oreophrynemonticola (0.9%), *Hylarana florensis* (2.1%), and *Phrynoglosus laevis* (2.3%). The abundance of other species ranges from 3.2% to 10.5% (Figure 2).



Where,

Dm	=	*Duttaphrynus melanostictus*
Ib	=	*Ingerophrynus biporcatus*
He	=	*Hylarana erytraea*
Hf	=	*Hylarana florensis*
Fc	=	*Fejervarya cancrivora*
Fl	=	*Fejervarya limnocharis*
Lk	=	*Limnonectes kadarsani*
Ld	=	*Limnonectes dammermani*
Kb	=	*Kaloula baleata*
Om	=	*Oreophryne monticola*
Pla	=	*Phrynoglosus laevis*
Ple	=	*Polypedates leucomystax*

Figure 1. The suitability of the amphibian habitat on the island of Lombok is based on the presence of species in each habitat type.

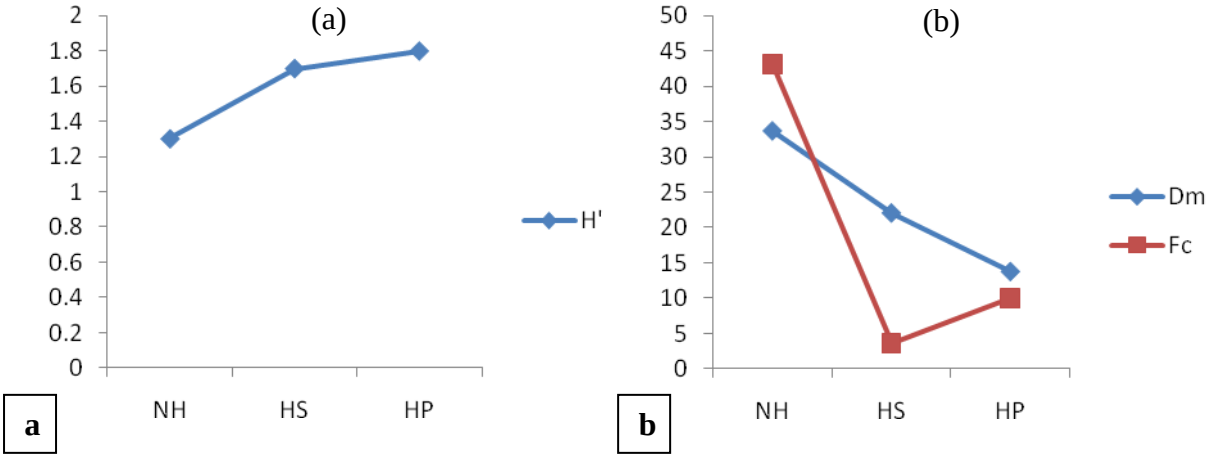


Figure 2. a) Species diversity of amphibians; b) The relative abundance of Duttaphrynusmelanostictus (Dm) and Fejervaryacancrivora (Fc) in 3 habitat types.

3.2. Discussion

Amphibian species richness in Lombok Island is directly proportional to the level of naturalness of the habitat (Figure 1). When viewed from its characteristics, the habitat with the lowest level of naturalness is the non-forest type due to disturbance by human activities. Some of the negative social impacts on amphibians are reduced availability and quality of habitat. Reduced habitat availability includes habitat loss (Plante et al., 2018), habitat fragmentation and isolation (Cosentino and Brubaker, 2018), and habitat restoration and modification (Nowakowski et al., 2018). The decline in habitat quality can be assessed from vegetation (Sanches et al., 2019), hydro-period (Riley et al., 2017; Reyes et., 2017), predators and competitors (Kaczmarek et al., 2018), water quality and pollution (Borzee et al., 2018).

In addition to external factors, adaptability also has an important role (Greenberg et al., 2018). For example, Duttaphrynusmelanostictus is a species that can adapt to habitats that are disturbed by human activities. Therefore, this species can easily be found in urban areas. This adaptability gives it the advantage of having a more extensive tolerance range, so that it can be found in all habitat types (Figure 1), and contributes to its relative abundance compared to other species. The composition of amphibian species in primary forests is higher than in secondary forests when viewed from the aspect of species that are only found in each of these habitats (Figure 1). This phenomenon is related to the heterogeneity of composition and spawning sites (Li et al., 2018), as well as environmental stability, both of which act as resources and conditions. Water which is both a resource and a requirement for amphibians (Ecrement and Richter, 2017) can be found throughout the year in primary forest streams, and not in secondary forests. The rivers in TWA Kerandangan and TWA Suranadi are seasonal which will dry out in the dry season.

The hydrological cycle is very influential on amphibians that have larval phases in water (Valerio et al., 2016). Amphibians on Lombok Island are entirely Anura with tadpoles that swim freely in water (Monk et al., 2000; Syazali et al., 2016), except for

larvae from Oreophrynemonticola (Iskandar, 1998). Water availability throughout the year causes amphibian communities in primary forests to be more stable than in secondary forests (Tournier et al., 2017). Disruption by more significant human activity in secondary and non-forest forests can also trigger the entry of foreign substances into water bodies, thereby reducing their quality (Cavia et al., 2016; Shaikh et al., 2018). This has a negative effect on amphibians, especially for species with a narrow tolerance range (Onadeko, 2016).

Environmental conditions such as humidity and canopies in primary forests are also more suitable for amphibians, compared to secondary and non-forest forests (Jachowski and Hopkins, 2018). These two factors are the most essential component of the amphibian community on Lombok Island (Syazali et al., 2018). The greater richness of tree species also positively influences the availability of feed resources in the form of detritus for larvae (Asrafuzzaman et al., 2018). Diverse plants play an essential role in the presence of various types of insects, which are the main feed of the amphibious juvenile and adult phases (Sanches et al., 2018). Other abiotic factors, which affect species richness, are height and temperature. The height of the place measured from sea level can be a natural barrier to amphibians (Novia et al., 2015). Species Oreophrynemonticola even can only be found at altitudes above 1000 masl. This species itself is only spread on the islands of Lombok and Bali. Optimum water temperature is very important for larval survival. If the temperature is too high, it can cause death (Kasmeri and Safitri, 2014). Air temperatures that can support amphibian survival are relatively low, so they prefer to be active at night to avoid water loss due to evaporation through the skin.

Biotic factors such as the presence of competitors, predators, and parasites also affect species richness in a habitat (Kaczmarek et al., 2018). These three factors have a negative effect. Competitors are formed because of the scope of the niche in the form of resources. For example, *Limnonectes kadarsani* has a niche in the form of feed resources with *Limnonectes dammermani*. Natural predators of amphibians include snakes, fish and several species of birds (Kaczmarek et al., 2018). The parasites found in amphibians are viruses, bacteria, fungi, and other animals (Bower, 2018; Ruso et al., 2018). Parasitic fungi, *Batrachochytrium dendrobatidis,* and *B. salamandrivoranus*, have been reported to cause mortality and decreased amphibian populations (Bower et al., 2017).

Species richness, with all the factors that influence it, both internally and externally, plays an essential role in diversity. The species diversity index is directly proportional to the level of naturalness of the habitat (Figure 2a). Although the species richness in primary and secondary forest habitats is the same (S = 7), the variable that causes differences in the diversity index is the factor of evenness in population size. The higher the regularity, the higher the species diversity index of the amphibian community (Yani et al., 2015). Population size is directly affected by natality, mortality, immigration, and emigration. On Lombok Island, the species with the highest density in *Duttaphrynus melanostictus* (Syazali et al., 2017).

An interesting fact is that the relative abundance of *Duttaphrynus melanostictus* is inversely proportional to the level of naturalness of the habitat (Figure 2b). The advantage of this species compared to other amphibians found on Lombok Island is its ability to adapt to habitat disturbance by human activity, and a wide tolerance range for various conditions of environmental factors (Syazali et al., 2017). At the same time, many other amphibian species that are intolerant of habitat change will experience a decline in population (Martin et al., 2015; Gillespie et al., 2015). The spatial resources created can be utilized by this species to increase its population size. This benefits from the aspect of conservation.

Conclusion

The species richness and diversity index is directly proportional to the level of habitat naturality on Lombok Island. Species that require conservation priority are *Oreophryne monticola*, and *Hylarana florensis*.

Acknowledgment

Thank you to the BKSDA officer at the research location with permission from the data collection. Thanks to the friends also who were members of the team in the field.

References

Asrafuzzaman, S., Mahapatra, S., Rout, J., & Sahoo, G. (2018). Dietary assessment of five species of anuran tadpoles from Northern Odisha, India. *Journal of Threatened Taxa*, 10(10), 12382-12388. https://doi.org/10.11609/jott.3902.10.10.12382-12388

Barret, K., Helms, B.S., Guyer, C., & Schoonover, J.E. (2010). Linking process to pattern, causes of stream-breeding amphibian decline in urbanized watersheds. *Biological Conservation*, 143, 1998-2005. https://doi.org/10.1016/j.biocon.2010.05.001

BKSDA NTB. 2010. *Panduan Wisata Alam di Kawasan Konservasi Nusa Tenggara Barat*. Mataram, Balai Konservasi Sumber Daya Alam Nusa Tenggara Barat.

Blaustein, A.R., Wake, D.B., & Sousa, W.P. (1995). Amphibian declines, judging stability, persistence, and susceptibility of populations to local and global extinctions. *Consent Biol.*, 8, 60-71.

Borzee, A., Kyong, C.N., Kil, H.K., & Jang, Y. (2018). Impact of water quality on the occurrence of two endangered Korean anurans, *Dryophyte ssuweonensis* and *Pelophylax chosenicus*. *Herpetological*, 74(1). https://doi.org/10.1655/Herpetologica-D-17-00011

Bower, D., Mengersen, K., Alford, R., & Schwarzkopf, L. (2017). Using a Bayesian network to clarify areas requiring research in a host-pathogen system. *Conservation Biology*, 31(13), 73–82. https://doi.org/10.1111/cobi.12950

Bower, D., Brannelly, L., McDonald, C., Webb, R., Greenspan, S., Vickers, M., Gardner, M., & Greenlees, M. (2018). A Review of the role of parasites in the ecology of reptiles and amphibians. *Austral Ecology*, 1-16. https://doi.org/10.1111/aec.12695

Bridges, C.M., & Semlitsch, R.D. (2001). Variation in pesticide tolerance of tadpoles among and within species of Ranidae and patterns of amphibian declines. *Conservation Biology*, 14(5), 1490-1499. https://doi.org/10.1046/j.1523-1739.2000.99343.x

Caldas, F.L.S., da Silva, B.D., dos Santos, R.A., De-Carvalo, C.B., Santana, D.O., Gomes, F.F.A., & Faria, R.G. (2016). Autoecology of *Phyllomedus anordestina* (Anura, Hylidae) in areas of the Caatinga and Atlantic Forest in the State of Sergipe, Brazil. *North-Western Journal of Zoology*, 12(2), 271-285.

Cavia, N.P., Burraco, P., & Mestre, I.G. (2016), Low levels of chemical anthropogenic pollution may threaten amphibians by impairing predator recognition. *Aquatic Toxicology*, 172, 30–35. https://doi.org/10.1016/j.aquatox.2015.12.019

Cosentino, B.J., & Brubaker, K.M. (2018). Effects of land-use legacies and habitat fragmentation on salamander abundance. *Landscape Ecology*, 33, 1573-1584. https://doi.org/10.1007/s10980-018-0686-0

Ecrement, S.M., & Richter, S. (2017). Amphibian use of wetlands created by military activity in Kisatchie National Forest, Louisiana, USA. *Herpetological Conservation and Biology*, 12(2),321–333.

Ellicot, K., & Gall, S.B., 2003. *Junior worldmarken cyclopedia of physical geography, Indonesia to Mongolia*. Detroit: Thomson Learning Inc.

Gardner, T.A., Barlow, J., & Peres, C.A. (2007). Paradox, presumption, and pitfalls in conservation biology, the importance of habitat change for amphibians and reptiles. *Biology Conservation*, 138, 166–179.

Gillespie, G., Howard, S., Stroud, J.T., UI-Hasanah, A., Campling, M., Lardner, B., Scroggie, M.P., & Kusrini, M. (2015). Responses of tropical forest herpetofauna to moderate anthropogenic disturbance and effect of natural habitat variation in Sulawesi, Indonesia. *Biological Conservation*, 192, 161-173. https://doi.org/10.1016/j.biocon.2015.08.034

Greenberg, D.A., Palen, W.J., Chan, K.C., Jetz, W., & Moores, A. (2018). Evolutionarily distinct amphibians are disproportionately lost from human-modified ecosystems. *Ecology Letter*, 1-12. https://doi.org/10.1111/ele.13133

Gutierrez-Cardenas, P.D.A., Castillo, K., Martinez, D., Rocha, C.F.D., & Rojas-Rivera, M.A. (2016). Trophic Ecology of *Pristimantis labiosus* (Anura, Craugastoridae) from South-Western Colombia. *North-Western Journal of Zoology*, 12(2), 102-109.

Hardy, L.M., &Crnkovic, A.C. (2006). Diet of amphibians and reptiles from the engareondare river region of central Kenya, during the dry season. *African Journal of Herpetology*, 55(2), 143-159.

Heyer, W.R., Donnelly, M.A., McDiarmid, R.W., Hayek, L.C., & Foster, M.S. (1994). *Measuring and Monitoring Biological Diversity-Standard Methods for Amphibians*. Washington DC: Smithsonian Institution Press.

Iskandar, D.T. 1998. *The Amphibians of Java and Bali*. Jakarta: Pusat penelitian dan Pengembangan Biologi LIPI.

Iskandar, D.T., &Erdelen, W.R. (2006). Conservations of amphibians and reptiles In Indonesia, Issues, and Problems. *Amphibian and Reptile Conservation*, 4(1), 60-87.

Iskandar, D.T., Mumpuni. (2004). *Limnonectes kadarsani*. The IUCN Red List of Threatened Species. (online), (www.iucnredlist.org), diakses pada tanggal1 Juni 2018.

Jachowski, C.M.B., & Hopkins, W.A. (2018). Loss of catchment-wide riparian forest cover is associated with reduced recruitment in a long-lived amphibian. *Biological Conservation*, 220, 215-227. https://doi.org/10.1016/j.biocon.2018.02.012

Jeliazkov, A., Chiron, F., Garnier, J., Besnard, A., Silvestre, M., & Jiguet, F. (2013). Level dependence of the relationships between amphibian biodiversity and environment in pond system within an intensive agriculture landscape. *Hydrologia*, 723, 7-23. https://doi.org/10.1007/s10750-013-1503-z

Kaczmarek, J.M., Kaczmareki, M., Mazurkiewicz, J., & Kloskowski, J. (2018). A matter of proportion? associational effects in larval anuran communities under fish predation. *Oceologia*,187, 745-753. https://doi.org/10.1007/s00442-018-4141-3

Kasmeri, R., & Safitri, E. (2014). Induksi kejutan suhu 360 ^{o}c terhadap perkembangan embrio dan keberhasilan poliploidisasi katak (*Rana cancrivora*). *Jurnal Pelangi*, 6(2), 152-162.

Kopecky, O., Novak, K., Vojar, J., & Susta, F. (2016). Food composition of alpine newt (*ichthyosaura alpestris*) in the post-hibernation terrestrial life stage. *North-Western Journal of Zoology*, 12(2), 299-303.

Li, B., Zhang, B., Shu, X., Pei, E., Yuan, X., Wang, T., & Wang, Z. (2018). Influence of breeding habitat characteristics and landscape heterogeneity on anuran species richness and abundance in Urban Parks of Shanghai, China. *Urban Forestry and Urban Greening*, 32, 56-63. https://doi.org/10.1016/j.ufug.2018.03.017

Martin, L.J., Rainford, S., & Blossey, B. 2015.Effects of plant litter diversity, species, origin, and traits on larval toad performance. *Oikos*, 124, 871-879.

Monk, K.A., De Fretes, Y., & Reksodiharjo-Lilley, G. (2000). *Ekologi Nusa Tenggara dan Maluku*. Jakarta: Prenhallindo.

Novia, Sanjaya, M., &Gusman, D. 2015. Distribusi vertikalanura di gunung seblat Kabupaten Lebong, Bengkulu. *Prosiding Semirata 2015 bidang MIPA BKS-PTN Barat*. Universitas Tanjung pura Pontianak.

Nowakowski, A.J., Watling, J.I., Thompson, M.E., Brusch IV, G.A., Catenazzi, A., Whitfield, S.M., Kurz, D.J., Suarez-Mayorga, A., Aponte-Gutierrez, A., Donelly, M.A., & Todd, B.D. (2018). Thermal biology mediates responses of amphibians and reptiles to habitat modification. *Ecology Letters*, 21, 345-355.

Ohler, A., & Nicolas, V. (2017). Which frog's legs do *froggies* eat? The use of DNA barcoding for identification of deep-frozen frog legs (dicroglossidae, amphibia) commercialized in France. *European Journal of Taxonomy*,271, 1–19.

Onadeko, A.B., Egonmwan, R.I., & Saliu, J.K., 2011. edible amphibian species, local knowledge of their consumption in Southwest Nigeria, and their nutritional value. *West African Journal of Applied Ecology*,19, 67-76.

Plante, S., Dussault, C., Richard, J.H., & Cote, S.D. (2018). Human disturbance effects and cumulative habitat loss in endangered migratory caribou. *Biological Conservation*, 224, 129-143.

Plitsi, P., Koumaki, M., Bei, V., Pafilis, P., & Polymeni, R.M. (2016). Feeding ecology of the Balkan Water Frog (*Pelophylax kurtmuelleri*) in Greece with emphasis on habitat effect.*North-Western Journal of Zoology*, 12(2), 292-298.

Reyes, M.J., Beynen, P.E.V., & Haven, M.R. (2017). Identifying small depressional wetlands and using a topographic position index to infer hydroperiod regimes for pond-breeding amphibians. *Tropical Ecology*, 58(2), 369-377.

Riley, J.W., Calhoun, D.L., Barichivich, W.J., & Wals, S.C. (2017). Identifying small depressional wetlands and using a topographic position index to infer hydroperiod regimes for pond-breeding amphibians. *Wetlands*, 37, 325-338.

Rohr, J.R., Raffel, T.R., Romansic, J.M., McCallum, H., & Hudson, P.J. (2008). Evaluating the links between climate, disease spread, and amphibian declines. *PNAS*, 105(45), 17436-17441.

Ruso, C.J.M., Ohmer, M.E.B., Cramp, R.L., & Franklin, C.E. (2018). A pathogenic skin fungus and sloughing exacerbate cutaneous water loss in amphibians. *Journal of Experimental Biology*, 221, 1-9.

Sanches, A.V., Schmidt, B.R., Peres, C., Altamirano, T., Toledo, V., Perez, I., Teillier, S., Cunningham, A.A., &Azat, C.S. (2019). Assessing Habitat quality when forest attributes have opposing effects on abundance and detectability, a case study on darwin's frogs. *Forest Ecology and Management*, 432, 942-948.

Sanches, M.T.O., Pineda, E., & Manzano, R.L. (2018). Population characteristics, habitat, and diet of the large-crested toad (*inciliuscristatus*; anura, bufonidae), a critically endangered species endemic to Mexico. *Herpetological Conservation and Biology*, 13(3),558–568

Shaikh, K., Yusuf, M., Gachal, G.S., &Memon, S.Q. (2018). A study of habitats for amphibians in District Larkana, Sindh-Pakistan. *Journal of Entomology and Zoology Studies*, 6(1), 1178-1181.

Shannon, C.E. (1948). A mathematical theory of communication. *The Bell System Technical Journal*, 27, 379-423.

Syazali, M., Idrus, A.A., &Hadiprayitno, G. (2016). Kekayaan spesies amfibi di Pulau Lombok, Indonesia. *Proceeding Biology Education Conference*, 13(1), 730-735.

Syazali, M., Idrus, A.A., & Hadiprayitno, G. (2018). *Amfibi Pulau Lombok*. Yogyakarta, Bening Pustaka.

Tournier, E., Besnard, A., Tournier, V., & Cayuela, H. (2017). Manipulating waterbody hydroperiod affects movement behavior and occupancy dynamics in an amphibian. *Fresh Water Biology*, 1-15.

Valerio, L.M., Rodrigues, T.F.D., Chupel, T.F., Penha, J., & Strussman, C. (2016). Vegetation structure and hydroperiod affect anuran composition in a large neotropical wetland. *Herpetologica*, 72(3), 181-188.

Yani, A., Said, S., &Erianto. (2015). Keanekaragaman jenis amfibi ordo anura di Kawasan Hutan Lindung Gunung Semahung Kecamatan Sengah Temila Kabupaten Landak Kalimantan Barat. *Jurnal Hutan Lestari*, 3(1), 15-20.

Zug, G.R., & Kaiser. H. (2014). A New Species of four-toed skink (Squamata, Scincidae, *Carliaperonii* species group) from Pulau Sukur, Indonesia, and biogeographic notes on the herpetofauna of Flores and Komodo. *Proceedings of the Biological Society of Washington*, 126(4), 379-392.