PRINCIPAL COMPONENTS DECOMPOSITION OF PHYSICAL FEATURES OF ANURAN HABITATS

Rodrin R. Rivera[1]
https://orcid.org/0000-0002-5725-7443
nirdor_ariver@yahoo.com

Vincent T. Lapinig[2]
https://orcid.org/0000-0003-1838-5300
vincent.lapinig@nmsc.edu.ph

Ralphinno G. Sanchez[3]
https://orcid.org/0000-0002-0110-2880
ralphpinno.sanchez@nmsc.edu.ph

[1,2,3] Northwestern Mindanao State College of Science and Technology
Tangub City, Misamis Occidental, Philippines

Celia Judith Vasquez[4]
Universidad Nacional Agraria La Molina, Peru

ABSTRACT

This study looks into the relationship between habitat complexity and its physical environmental features. In order to treat the variables considered, principal components analysis (PCA) was used to reduce the number of dimensions in a given data set. Correlation of the habitats of Anurans to its physical features was done by nominal logistic regression. The study presents a data on the habitat preference of anurans species. Moreover, the habitat of anuran species is greatly influenced by its physico-chemical parameters that make up its complexity thus, promoting species abundance and diversity.

Keywords*: Habitat, species, anurans, principal component analysis*

1.0 Introduction

In biological studies, determining the relationship of the anuran species to their habitat often require a tedious and time-consuming work. Further, actual field work also requires the use of specific and accurate methods to determine the types of habitat in which organisms live. This strategy becomes laborious considering that few variables have to be considered during data gathering (physico-chemical components, location, and habitat preference). The use of principal components analysis allows for a parsimonious representation of several variables into fewer principal components.

Principal component analysis is now widely used as a systematic procedure in different biological scaling. This technique uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values (Padua, 2017).

The Philippine amphibian diversity presently consists of 112 species (Diesmos 2014, 2015), most of which are known to thrive in the forests of the archipelago (Brown *et al.,* 2000; Diesmos*et al.,* 2004; Siler *et al.,* 2010). Among these species, 85% are found in the country and nowhere else in the world. Further, the discovery rate of endemic species in the country has been progressively increasing (Brown *et al.,* 2013; Brown and Stuart 2012; Diesmos*et al.,* 2015). Up to 30% of the 85% were recently described since last two decades (Diesmos & Brown 2011; Brown, 2015; Diesmos *et al*., 2015).

On the island of Mindanao, anuran endemism is 42% where seven of the 11 recorded species are found in the mainland Mindanao; nine species are under the threatened category; eight species are vulnerable; and one species is under the endangered category (Nuñeza *et al.,* 2010). Despite the chances of increasing rate of endemism, assessment of the world's amphibians highlighted that a population of at least 42 % of the known amphibian species are declining and nearly one-third of them are globally-threatened leading to extinction, like other animals, since amphibians are assaulted through continuous environmental insults, which are rampant in today's present situation (Albutra, Mugot & Demayo, 2015). These challenges include habitat loss and alteration, catastrophes, invasive species, hunting for food and the spread of chytrid fungus (Sodhi*et al.,* 2004; Diesmos *et al.,* 2006, 2012; Rowley *et al.,* 2010; Brown *et al.,* 2012). In fact, more than a third of the archipelago's species have been found to qualify for formal threatened status at some level (Diesmos*et al.,* 2014).

Amphibians are keystone species since these organisms are biological indicators of ecosystem (Wahbe & Bunnell 2003). To date, several species are still waiting for formal descriptions (Brown *et al.,* 2004). Moreover, these organisms are popularly known to be sensitive to environmental changes (Stuart *et al.,* 2004), because these organisms are strongly influenced by abiotic factors such as rainfall, temperature, and vegetation (Gascon, 1991; Eterovick, 2003; Parris, 2004; Werner *et al.,* 2007) which can also affect their breeding and reproduction. Any change and alteration in these abiotic factors lead to the disturbance of the life cycle. In addition, anuran's skin is highly permeable. In fact, a study has shown that most anurans located in polluted ecosystem exhibit malformation of organs and body parts (Dey, 2010), proving that these animals are indicators of habitat degradation (Alfrod & Droege, 2001). Amphibians give a concrete evaluation of the effects of human disturbances on whole communities and ecosystems (Davic & Welsh, 2004). This study investigates the relationship between the anuran habitat complexity and its physical features.

2.0 Conceptual Framework

The study is anchored on the principle that the distribution of organisms is highly dependent on the type of habitat they thrive in. Anuran is one of the populations of amphibians that serve as biological indicators because they dictate and affect the balance in the ecosystem. The conceptual diagram of the study is shown below.

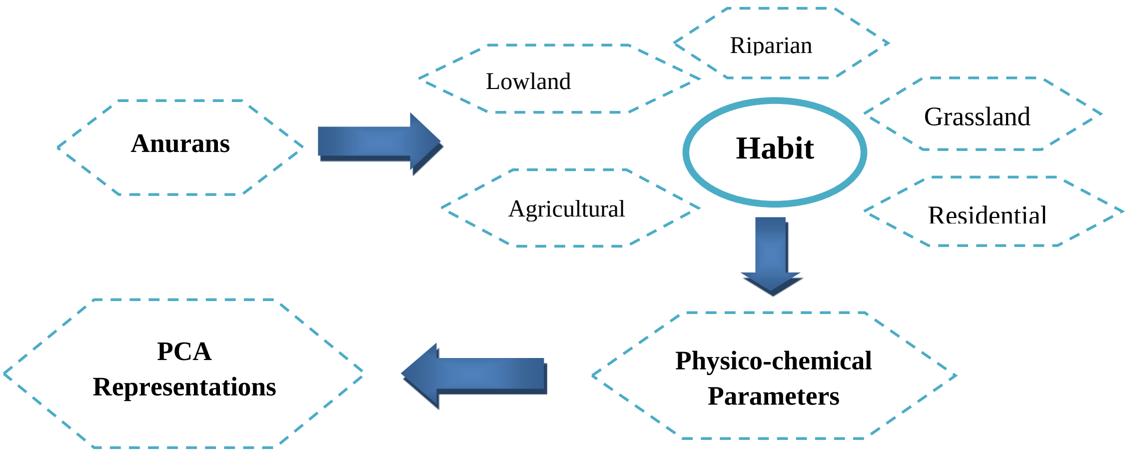

Figure 1. Research Paradigm

Toads and frogs collectively known as anurans belong to the group of amphibians which can live in both land and water. These characteristics of anurans are distinctly unique from the other group of organisms because of the permeability of their skin which also served as their respiratory tract. One of the manifestations of their unique characteristics is that they are highly sensitive to their external environment that they have to maintain moisture in their skin in order to sustain the metabolic processes in the body.

Additionally, the ability of the anurans to adapt to their external environment is affected by the kind of habitats such as agricultural areas, grassland ecosystem, lowland forest, residential areas, and riparian zone. Interestingly, the distribution of anurans in each kind of habitat varies with the complexity of the habitat. Thus, habitat complexity dictates the abundance of organisms in the ecosystem (Brown, 2017).

An important determinant of habitat complexity is determined by its physico-chemical components through which different organisms like anurans would successfully inhabit. These physical factors (humidity, soil temperature, air temperature, and soil pH) contribute to the ecological success of organisms.

3.0 Research Methodology

Habitat Assessment

Taking and noting down the habitat description and assessment of anurans took place after their harvest. Documenting the habitat occupied by target taxa during the survey process, and a site description, would add value to the survey at minimal extra expense (NSW DEC, 2004). Habitat variables, such as relative humidity, soil temperature, and air temperature, were taken twice in each sampling site at 7:30 in the evening with the use of a thermometer and psychrometer, respectively. Soil pH was determined using pH meter with pH chart.

Table 1. Variables, units, and habitat description used for the assessment of anuran habitats.

Variables	Units	Description
Air Temperature	C°	measured with thermometer, the day and night temperature of air in every sampling points and every micro-habitat of riverine frogs
Water Temperature	C°	measured with thermometer, day and night temperature of water in every sampling points and every micro-habitat riverine frogs
Relative Humidity	%	% of dampness in every point
Soil Ph		determined with pH meter the range how acidic or basic water is in every sampling point

Sampling Methods

Anuran Diversity Survey and Mapping

Cruising method was used to assess the diversity and distribution of anurans in the area. The researcher walked through the defined area or distance for a period of time and undertook a systematic search for land vertebrates such as anurans. This sampling technique requires the observer to search at constant speed and intensity (Campbell & Christman 1982; Corn & Bury 1990). Sampling was done for 4 hours per day and it was usually made from 7o'clock to 11 o'clock in the evening. Frogs were caught with bare hands and placed in a herpetology bag. After the harvest of frogs, marker was placed in the area and geographic coordinates were taken to map out the different distribution of anurans in the area using hand-held GPS and geo-cam.

Data Analysis

In order to treat the variables considered, principal components analysis (PCA) was used to reduce the number of dimensions in a given data set. Correlation of the habitats of Anurans to its physical features was done by nominal logistic regression.

4.0 Results and Discussion

Six variables were considered as a subject for principal components analysis. Considering the results of the scree- plot, up to four factors were derived based on the computed cumulative proportion of the variables which add up to 90%.

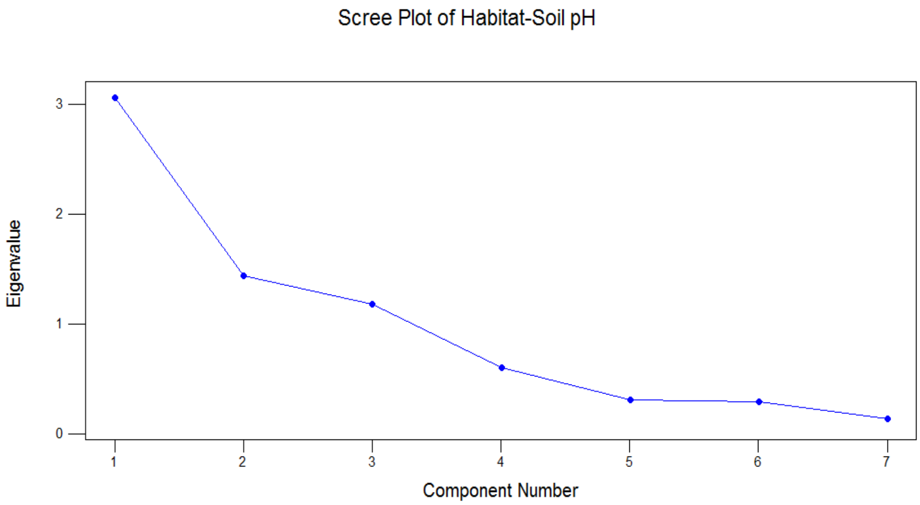

Figure 2. Scree- plot

Table 2. Eigen value of the variables

Eigen value	3.0670	1.4403	1.1753	0.5989	0.3042	0.2849
Proportion	0.438	0.206	0.168	0.086	0.043	0.041
Cumulative	0.438	0.644	0.812	0.897	0.941	0.982

Table 2 shows the computed eigenvalues of the variables representing the variances along each of the variable. The largest eigenvalue is 3.0670 which accounts for about 43.8% of the total variance. It can be seen from the tabular values that the first four principal components already account for 89.70% of the total system variance.

Based on the scree-plot (figure 2), the minimum number of principal components is two (2), where the first elbow occurred, to a maximum of four

(4) principal components. Four principal components appear to sufficiently represent the entire system.

Table 3. Principal Component Representations

Variable	PC1	PC2	PC3	PC4
Habitat	0.165	-0.711	0.195	-0.276
Lat	-0.497	-0.220	0.184	0.073
Long	0.364	-0.418	0.109	0.639
Humidity	0.333	-0.043	-0.648	0.303
Air Temp	-0.249	-0.258	-0.698	-0.307
Soil Tem	-0.460	0.173	-0.066	0.542
Soil pH	0.456	0.416	0.068	-0.175

In table 3, the loadings of the variables on each of the four principal components are shown. For the first principal component, the variables such as habitat, longitude (height), and the humidity had positive loadings while the rest of the variables were contrasting negative loadings. These observations suggest that PC1 can be renamed as **"height-area habitat difference"** of the physical parameters. On the other hand, PC2 had positive loadings for the variables, namely; soil temperature, and soil pH, while the rest of the variables showed a negative loadings based on the physical parameters, which denotes that PC2 can be renamed **"soil index"**. In PC3, the variables, viz: humidity, air temperature, and soil temperature showed negative loadings for while the rest showed a positive loading, which can be renamed as **"temperature index".** Lastly, the variables in PC4 showed positive loadings for the variables such as latitude (area), longitude (height), humidity, and soil temperature while the rest of the variables showed positive loadings, that can be renamed as **"height-temperature index"**.

Table 4. Minimum and Maximum value of the PCA representations

Variable	Minimum	Maximum	Q1	Q3
pc1	37.770	53.921	44.726	50.763
pc2	44.568	65.855	50.323	53.937
pc3	0.884	6.014	2.744	4.990
pc4	20.225	51.660	29.622	37.243

The indices of each PCA representations were derived by dividing each column by its corresponding maximum value. By getting the indices of each proportion, we can then now identify the distance of each variable as well as the perpendicularity of the x and y axis.

Correlations: height-area habitat difference, Humidity

Correlation coefficient shows a highly significant correlation (**.981**) between habitat area versus its humidity. This means that in an area where there is a high relative amount of humidity, most of the anuran species are likely to inhabit. Accordingly, anurans have to maintain moisture in their body in order to efficiently respire and easily adapt to changes in the environment (Brown, 2000).

```
Pearson correlation of height-area habitat difference and Humidity =
-0.981
P-Value = 0.000
```

Regression Analysis: Habitat versus height-area habitat, soil index, ...

Regression analysis showed that habitat is a good determinant of the different physico-chemical parameters considered in this study. Conversely, habitat complexity is determined by the optimal measurement of its physico-chemical components which dictates an ideal environment for anuran species to inhabit.

```
The regression equation is
Habitat = 98.8 - 58.4 height-area habitat difference - 51.4 soil
index
           + 1.01 temperature index - 7.24 height temp index

Predictor        Coef     SE Coef          T        P
Constant       98.795       2.612      37.83    0.000
height-a      -58.407       2.042     -28.61    0.000
soil ind      -51.414       5.840      -8.80    0.000
temperat       1.0095      0.5089       1.98    0.050
height t       -7.242       4.150      -1.75    0.084

S = 0.2960      R-Sq = 95.7%     R-Sq(adj) = 95.5%

Analysis of Variance

Source            DF          SS          MS         F        P
Regression         4     186.955      46.739    533.41    0.000
Residual Error    96       8.412       0.088
Total            100     195.366

Source       DF      Seq SS
height-a      1       9.792
soil ind      1     176.816
temperat      1       0.080
height t      1       0.267
```

```
Unusual Observations
Obs   height-a    Habitat          Fit       SE Fit    Residual    St
Resid
 45       0.70     0.0000      0.4115      0.1265     -0.4115       -
1.54 X
 46       0.71     0.0000     -0.1428      0.1412      0.1428
0.55 X
 47       0.70     0.0000      0.4151      0.1268     -0.4151       -
1.55 X
 48       0.70     0.0000      0.4063      0.1252     -0.4063       -
1.51 X
 49       0.70     0.0000      0.4069      0.1252     -0.4069       -
1.52 X
 73       0.95     1.0000      0.3732      0.0540      0.6268
2.15R
```

5.0 Conclusion

The study presents a data on the habitat preference of anurans species. Habitat is an important ecological component that supports the diversity of anurans. Physico-chemical parameters are considered key component in establishing the optimal form of habitats. Moreover, the habitat of anuran species is greatly influenced by its physico-chemical parameters that make up its complexity therefore promoting species abundance and diversity.

References

Begon, M., C. R. Townsend, And J. L. Harper. (2006). Ecology from Individuals to Ecosystems. Wiley-Blackwell, Oxford.

Brown R. M., Mcguire J. A., and Diesmos A. C. (2000). Status of Some Philippine Frogs Referred to *Ranaeveretti* (Anura: Ranidae), Description of a New Species and Resurrection of *Ranaigorota* Taylor 1922. Herpetologica 56 (1):81-104.

Diesmos A. C., Brown R. M., and Alcala A.C. (2004). New Species of Narrow Mouthed Frog (Amphibia: Anura: Microhylidae; Genus Kaloula) From the Mountains of Southern 53: 171-181.

Diesmos, A. C., and Brown R. M. (2011). Diversity, Biogeography and Conservation of Philippine Amphibians. Pages 26–49.

Eterovick, P.C. (2003). Distribution of Anuran Species among Montane Streams in South-Eastern Brazil. Journal of Tropical Ecology 19: 219-228.

Gascon, C. (1991). Population and Community – Level Analyses of Species Occurrences of Central Amazonian Rain Forest tadpoles. Ecology 72 (5): 1731-1746.

Moreno-Rueda, G. and Pizzaro, M. (2007). The Relative Influence of Climate, Environmental Heterogeneity and Human Population on the Distribution of Vetebrate Species Richness in South-Eastern Spain. Actaoecological 32 (1): 50-58.

Nuñeza O. M., Ates F. B., and Alicante A.A. (2010). Distribution of Endemic and Threatened Herpetofauna in Mt. Malindang, Mindanao, Philippines. Biodivers conserve 19:503-518.

Parris, K.M. (2004). Environmental and Spatial Variables Influence the Composition of Frogs Assemblages in Sub-Tropical Eastern Australia. Ecography 27 (3): 392-400.

Siler C. D., Diesmos A. C., Linkem C. W., Diesmos M. L., and Brown R. M. (2010). A New Species of Limestone-Forest Frog, Genus *Platymantis* (Amphibia: Anura: *Ceratobatrachidae*) From Central Luzon Island, Philippines. Zoo taxa 2482:49-63.