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Herpetofaunal community structure and habitat associations in Gunung Ciremai National Park, West Java, Indonesia

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ABSTRACT

Riyanto A (2011) Herpetofaunal community structure and habitat associations in Gunung Ciremai National Park, West Java, Indonesia. Biodiversitas 12: 38-44. Community structure and habitat associations of amphibians and reptiles on both rainy and dry seasons of six habitat types of three sites in Gunung Ciremai National Park, West Java were investigated in March and October 2008. The data of herpetofauna was obtained by opportunistic searches. Herpetofaunal diversity for each habitat was determined by using Shannon Wiener index, the species abundance per unit area was calculated by using Margalef's index, and the homogeneity of distribution of species in relation to other species in a sampled per unit area was evaluated using Evenness index. The similarity in herpetofauna communities among habitat types was determined using Sorensen's coefficient, meanwhile the Jaccard's index was used to estimate similarities in habitat utilization. Thus, both community similarities and habitat utilization displayed in cluster dendrogram. A total of 46 amphibian and reptile taxa were recorded, comprising 16 anurans, 22 lizards and 8 snakes. Of the total taxa, four anurans are endemic and unusual specimens probably new in sciences referred to the genus *Cyrtodactylus* and *Eutropis*. There were differed in sequential of biological indices among habitat types but not much different in their values. The result of cluster analysis showed different patterns on the community similarity among habitat type and habitat utilization during rainy and dry seasons.

Key words: community, habitat utilization, amphibians, reptiles, Gunung Ciremai, Indonesia.

INTRODUCTION

Mount Ciremai is the highest (3,078 m above sea level) mountain in West Java and is one of the most important assets for Kuningan and Majalengka Districts. The mountain has extensive natural resources including rich agricultural land and a natural, spring-fed water supply. However, the extinctions of forest dependent amphibians and reptiles due to forest loss and degradation as well as the isolation of once continuous populations are serious problems. Along with decree of the Ministry of Forestry No.424/Menhut-II/2004, the area of approximately 15,500 ha on mount Ciremai should be set aside as a national park. However, very few data are available regarding the biota of this region. Herpetofauna is not an exception despite the fact that amphibians and reptiles form an important part of the ecosystem as significant predators on invertebrates as well as smaller vertebrates, and are themselves important food items for birds and mammals (Howell 2002).

Knowledge of biodiversity and organization of its communities is essential for the development of conservation policies and a sustainable environmental management system. Given the limited conservation resources, such knowledge provides the basis for identifying important areas to be conserved and threats that needs to be mitigated. This may only be achieved if sound knowledge exists of systematic, taxon distributions and habitat associations (Gillespie et al. 2005). The data of their diversity and abundance are needed and essential for planning effective conservation and resource management strategies (Das 1997). Furthermore, documentation of the biodiversity of this area would enable better understanding of its community organization and the impact of disturbance processes. The only available data on diversity of herpetofauna come from the recent study of Riyanto (2007, 2008a, b).

This study intends to promote future conservation efforts in this area by providing biodiversity and ecological data on the herpetofauna. The aimed of this study is to investigate structure community and habitat associations of different species on rainy and dry seasons in Gunung Ciremai National Park, West Java, Indonesia.

MATERIALS AND METHODS

Study area. Gunung Ciremai National Park is located in West Java and a proximally 200 km southeast of Jakarta with altitude between 500 and 3,078 above sea level. Annually rain fall in this area is 2,000 to 4,500 mm. The survey were focused on three sites, they are Palutungan, Linggarjati and Seda, Kuningan District, West Java (Figure 1).

Palutungan site is southern part of mount Ciremai and begin from 1,400 m in elevation. The habitat types of this site are included agro-ecosystem, shrub-old pine forest, secondary and primary forest. Linggarjati site is eastern

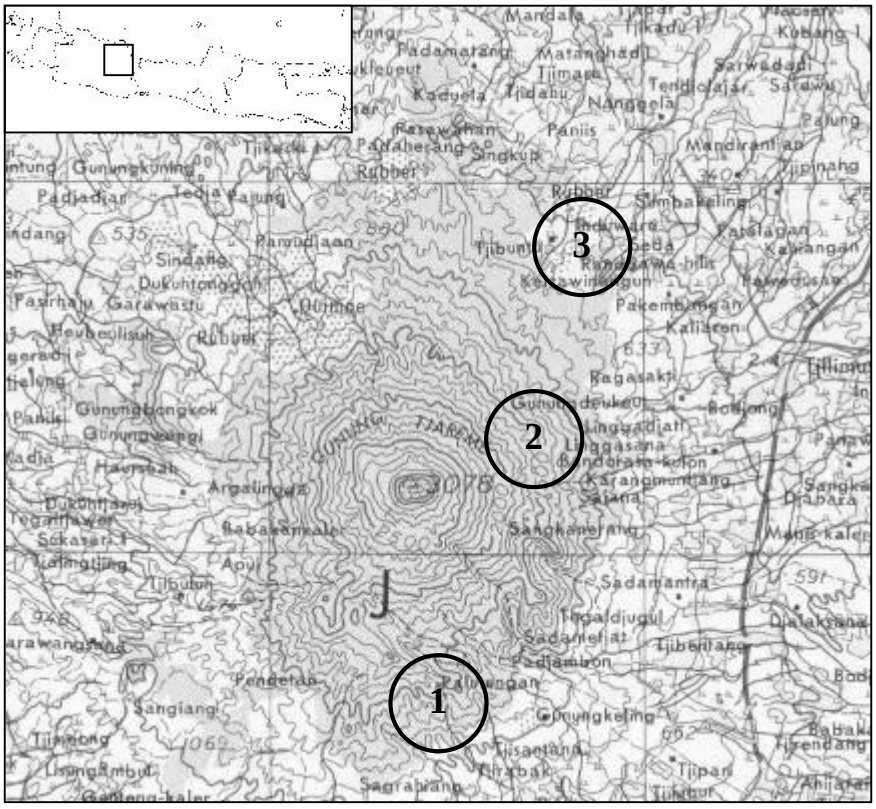

Figure 1. Map showing position of the study sites of (1) Palutungan, (2) Linggarjati and (iii) Seda at Gunung Ciremai National Park and around.

part on the mount and begin from 600 m in elevation with habitat type included agro-ecosystem, pine forest, secondary and primary forest. Meanwhile, Seda site is a lowland area with elevation about 550 m asl., two habitat types was identified from this area, they are agro-ecosystem and primary lowland forest. The lowland forest in Seda has been holy by the local society so this forest was protected and in good condition, composing by big trees.

Canopy cover was classified into three categories based on qualitative description: full cover, semi cover and open. A location were note as full cover if the canopy is dense enough to shade out the majority (>50%) of sunlight. Semi cover was noted if the canopy broken where the sunlight penetrated to the forest floor, and open was noted if no canopy existed at all. The habitat were classified into six types: (i) agro-ecosystem in low elevation (AE 1), 600-900 m asl.; (ii) agro-ecosystem in high elevation (AE 2), 1100-1500 m asl.; (iii) lowland forest (LF), 550-600 m asl.; (iv) shrub-old pine forest (SOP); 1500-1600 m asl., (v) secondary forest (SF), 1600-1700 m asl.; and (vi) primary forest (PF), 1700-2000 m asl. Agro-ecosystem included all areas under cultivation outside of villages but in the border of national park, including plantations (cabbages, potato, onions, banana, coffee and durian) and crop (young pine). Majority the canopies were open, except at durian and coffee plantations were semi covered. The agro-ecosystem habitat especially in Palutungan site includes a small water fall as a micro habitat (the water fall is named Curug Ciputri). Lowland forest was defined as forest area with canopy height 20 up to 30 m with large diameter up to 2.5 m, classified as full cover; include a small stream with rocky substrate. Shrub-old pine forest was defined as old pine forest with full shrub, historically this habitat is pine plantation in the long time ago. Secondary forest was defined as regenerating forest historically cleared for coffee and pine plantation, the canopy was semi covered. The secondary forest habitat also included a small stream with rocky substrate. Primary forest in this study included the forest area with canopy height 20 up to 50 m, full cover canopy and these areas have variety gentle ground and also included small stream with rocky substrate.

Field sampling. The surveys were conducted in March and October 2008. The March sampling period was represented rainy season, meanwhile the October sampling period was represented dry season. All habitat types in every survey sites were surveyed by active opportunistic searches twice both of during days or during nights. The active opportunistic search is the researcher active looking for the herpetofauna on all microhabitats such as under logs, debris, rocks etc. Night census was undertaken by four people wearing headlamp, slowly walking across an area of broadly consistent habitat type with time duration. The time searching was consistently applied seven hours for day censuses and three hours for night censuses.

Species identification. The following literature was consulted for identification, taxonomy and nomenclature Rooij (1915, 1917), Brongersma (1942), Musters (1983), Manthey and Grossmann (1997), Stuebing and Inger (1999), Iskandar and Colijn (2000, 2001) and Mausfeld et al. (2002) for reptiles; and van Kampen (1923), Inger and Stuebing (1989), Iskandar (1998, 2004), Manthey and Grossmann (1997) and Frost et al. (2006) for amphibians.

Data analysis. All data collected was separated in wet and dry periods to analysis. The species diversity for each habitat was determined by using the Shannon Wiener Index (H'). The higher value of H', the greater the diversity and supposedly the cleaner the environment (Ludwig and Reynolds 1988; Metcalfe 1989).

$$H' = -\Sigma \left[\left(n_i / N \right) \ln \left(n_i / N \right) \right]$$

H' = Shannon -Wiener index
N = Total individuals of population sampled
ni = Total individuals belonging to the i spesiec

Richness Index that has been used was Margalef's Index (R). This index indicates the number of species in a sample or the abundance of the species per unit area (Ludwig and Reynolds 1988; Metcalfe 1989).

R = S -1 / ln (N)

R = Margalef richness index
S = Total of species
N = Total of individuals sampled

Homogeneity or pattern of distribution of species in relation to other species in a sampled per unit area was calculated using Evenness Index (E) (Southwood 1971).

E = H' / ln S

E = Evenness index
H' = Shannon -Wiener diversity index
S= Total of species

To assess degree of similarity in herpetofauna communities among habitat types surveyed, Sorensen coefficient were used. Meanwhile, the Jaccard's index was used to estimate similarities in habitat utilization based on presence/absence of each taxon in each habitat types. Thus, both of community similarities and habitat utilization displayed in cluster dendrogram were produced by using unweighted pair group methods using arithmetic averages (UPGMA) (Gillespie et al. 2005) using NTSYSpc 2.1. (Rohlf 2000).

RESULTS AND DISCUSSION

Species composition

A total of 46 amphibian and reptile species were recorded during both of rainy and dry season in 2008 (Table 1) comprising 16 anurans, 22 lizards and 8 snakes. Of the 46 species recorded, four anurans are endemic to Java (*Huia masonii, Megophrys montana, Microhyla achatina* and *Rhacophorus margaritifer*) and two reptiles are listed in CITES app. II (*Varanus salvator* and *Python reticulatus*). Unidentified and possibly undescribed lizards species of unusual specimen referred to the genus *Cyrtodactylus* and *Eutropis*.

Rainy season

In the rainy season, a total of 15 amphibians and 22 reptiles were recorded that comprising 15 anurans, 16 lizards and 6 snakes. The Dicroglossidae was dominated the frog fauna (four species, 26.67%), followed by Ranidae and Rhacophoridae (each three species, 20%), Bufonidae and Megophryidae (each two species, 13.33%), and Microhylidae (one species, 6.67%). Meanwhile for lizards, Agamidae and Scincidae were dominant with each represented six species (37.5%), and followed by Gekkonidae (four species, 25%). Snake species was represented by two families, Colubridae (five species, 83.33%) and Pythonidae (one species, 16.67%).

A total of 26 species were associated with agro-ecosystem (non forest habitation) comprising 11 anurans, 11 lizards and 4 snakes. Twelve species were restricted to lowland agro-ecosystem consisted by five anurans (*Fejervarya cancrivora, Leptobrachium hasseltii, Limnonectes macrodon, M. achatina* and *Polypedates leucomystax*), three lizards (*Dasia olivacea, Draco volans* and *Eutropis* sp.A), and four snakes (*Ahaetulla prasina, Dendrelaphis pictus, Oligodon bitorquatus* and *Xenodermus javanicus*). Meanwhile, only one species was restricted to high land agro-ecosystem (*H. masonii*). Six species were restricted to both of low and high land agro-ecosystem consisted by three anurans (*Duttaphrynus melanostictus, Phrynoidis aspera* and *Rhacophorus reinwardtii*) and three lizards (*Cosymbotus platyurus, Gehyra mutilata* and *Eutropis multifasciata*).

In the lowland forest, ten species were found consisted by three anurans (*Rana chalconota, Limnonectes kuhlii* and *Occidozyga sumatrana*), six lizards (*Gonocephalus chamaeleontinus, Cyrtodactylus fumosus, Hemidactylus frenatus, Eutropis* sp.B, *Sphenomorphus sanctus* and *Sphenomorphus temminckii*) and one snake (*P. reticulatus*). Four of them were countered restrict to lowland forest (*Eutropis* sp.B, *G. chamaeleontinus, P. reticulatus* and *O. sumatrana*). Eight species were encountered in shrub old pine forest comprising three anurans (*M. montana, Rana hosii* and *Philautus aurifasciatus*), four lizards (*Gonocephalus kuhlii, Pseudocalotes tympanistriga, C. fumosus* and *S. temminckii*) and one snake (*Calamaria virgulata*). *R. hosii* was recorded restrict to this habitat type. Two species of anurans associated with the secondary forest include *M. montana* and *P. aurifasciatus*; meanwhile the reptiles represented by seven species, include six lizards (*B. jubata, B. cristatella, G. kuhlii, Pseudocalotes tympanistriga, C. fumosus* and *S. temminckii*) and one snake (*C. virgulata*). *B. cristatella* was restricted to secondary forest. In the primary forest, only one anuran was encountered that is *P. aurifasciatus*, three lizards (*G. kuhlii, P. tympanistriga* and *S. temminckii*) and one snake (*C. virgulata*).

Dry season

In the dry season, a total of 14 amphibians and 23 reptiles were recorded; comprising 14 anurans, 19 lizards and 4 snakes. The Rhacophoridae was dominated the frog fauna (four species, 28.57%), followed by Ranidae (three species, 21.43%), Bufonidae, Dicroglossidae and Megophryidae (each two species, 14.26%) and Microhylidae (one species, 7.14%). Meanwhile for lizards, Agamidae was dominant with represented by eight species (42.1%), followed by Gekkonidae (six species, 31.58%), Scincidae (three species, 19.79), Lacertidae and Varanidae (each one species, 5.26). Snake species was represented by two families, Colubridae (three species, 75%) and Elapidae (one species, 25%).

A total of 25 species were associated with the agro-ecosystem comprising 10 anurans, 12 lizards and 3 snakes. Eleven species were restricted to lowland agro-ecosystem (*D. melanostictus, Microhyla achatina, L. hasseltii, H. masonii, F. cancrivora, Polypedates leucomystax, R. reinwardtii, B. jubata, Draco fimbriatus, D. volans, C. platyurus, G. mutilata, E. multifasciata, Taxidromus sexlineatus, V. salvator, A. prasina, Calamaria schlegeli* and *Bungarus fasciatus*). Two species were only found on highland agro-ecosystem (*H. masonii* and *Calamaria schlegeli*). Five species were associated both of high and

Table 1. Species of amphibians and reptiles recorded on six different habitat types during rainy and dry season 2008 in Gunung Ciremai National Park, West Java.

Taxa	Habitat Types and elevation											
	AE1		LF		AE2		SOP		SF		PF	
	(600-900)		(550-600)		(1,100-1500)		(1500-1600)		(1600-1700)		(1700-2000)	
	R	D	R	D	R	D	R	D	R	D	R	D
Bufonidae												
Duttaphrynus melanostictus	8	6	0	0	7	6	0	0	0	0	0	0
Phrynoidis aspera	13	7	0	0	10	3	0	5	0	0	0	0
Microhylidae												
Microhyla achatina	13	15	0	0	0	0	0	0	0	0	0	0
Megophryidae												
Leptobrachium hasseltii	7	3	0	0	0	0	0	0	0	0	0	0
Megophrys montana	0	0	0	0	0	0	1	0	7	5	0	0
Ranidae												
Huia masonii	0	0	0	0	13	15	0	0	0	0	0	0
Rana chalconota	15	20	23	15	8	5	0	5	0	0	0	0
Rana hosii	0	0	0	0	0	0	12	8	0	0	0	0
Dicroglossidae												
Limnonectes macrodon	1	0	0	0	0	0	0	0	0	0	0	0
Limnonectes kuhlii	20	16	8	3	9	7	0	7	0	0	0	0
Fejervarya cancrivora	15	13	0	0	0	0	0	0	0	0	0	0
Occidozyga sumatrana	0	0	14	0	0	0	0	0	0	0	0	0
Rhacophoridae												
Philautus aurifasciatus	0	0	0	0	0	0	5	23	16	13	16	13
Polypedates leucomystax	7	3	0	0	0	0	0	0	0	0	0	0
Rhacophorus margaritifer	0	0	0	0	0	0	0	1	0	0	0	0
Rhacophorus reinwardtii	6	4	0	0	4	0	0	0	0	0	0	0
Agamidae												
Bronchocela jubata	19	16	0	0	3	2	0	0	3	0	0	0
Bronchocela cristatella	0	0	0	0	0	1	0	0	1	1	0	0
Draco fimbriatus	0	1	0	0	0	0	0	0	0	0	0	0
Draco haematopogon	0	0	0	0	0	0	0	3	0	0	0	0
Draco volans	20	12	0	0	0	0	0	0	0	0	0	0
Gonocephalus kuhlii	0	0	0	0	0	0	2	2	10	7	3	4
Gonocephalus chamaeleontinus	0	0	5	6	0	0	0	0	0	0	0	0
Pseudocalotes tympanistriga	0	0	0	0	0	0	31	21	57	29	28	7
Gekkonidae												
Cosymbotus platyurus	6	4	0	0	5	3	0	0	0	0	0	0
Cyrtodactylus fumosus	0	0	8	5	4	3	2	1	4	3	0	0
Cyrtodactylus sp.A	0	0	0	2	0	0	0	1	0	5	0	0
Cyrtodactylus sp.B	0	0	0	0	0	0	0	2	0	0	0	0
Gehyra mutilata	3	2	0	0	1	1	0	0	0	0	0	0
Hemidactylus frenatus	3	2	2	1	2	2	0	0	0	0	0	0
Scincidae												
Dasia olivacea	2	0	0	0	0	0	0	0	0	0	0	0
Eutropis multifasciata	19	12	0	0	19	11	0	0	0	0	0	0
Eutropis sp.A	1	0	0	0	0	0	0	0	0	0	0	0
Eutropis sp.B	0	0	1	0	0	0	0	0	0	0	0	0
Sphenomorphus sanctus	2	1	24	21	0	0	0	0	0	0	0	0
Sphenomorphus temminckii	8	0	2	3	0	0	5	0	30	23	9	1
Lacertidae												
Taxidromus sexlineatus	0	3	0	0	0	0	0	0	0	0	0	0
Varanidae												
Varanus salvator	0	1	0	0	0	0	0	0	0	0	0	0
Colubridae												
Ahaetulla prasina	1	1	0	0	0	0	0	0	0	0	0	0
Calamaria schlegeli	0	0	0	0	0	1	0	0	0	0	0	0
Calamaria virgulata	0	0	0	0	0	0	1	0	2	2	2	0
Dendrelaphis pictus	1	0	0	0	0	0	0	0	0	0	0	0
Oligodon bitorquatus	1	0	0	0	0	0	0	0	0	0	0	0
Xenodermus javanicus	1	0	0	0	0	0	0	0	0	0	0	0
Elapidae												
Bungarus fasciatus	0	1	0	0	0	0	0	0	0	0	0	0
Pythonidae												
Python reticulatus	0	0	1	0	0	0	0	0	0	0	0	0
Number of species	24	21	10	8	12	13	8	12	9	9	5	4
Number of Individuals	192	143	88	56	85	60	59	79	130	88	58	25
Shannon (H')	2.804	2.653	1.870	1.680	2.252	2.226	1.448	1.984	1.608	1.778	1.265	1.118
Pielou (E)	0.882	0.871	0,812	0.808	0.906	0.868	0.696	0.798	0.732	0.809	0.786	0.807
Margalef (R)	4.375	4.030	2.010	1.739	2.476	2.931	1.717	2.517	1.644	1.787	0.955	0.932

Note: AE1-agro-ecosystem in low elevation, LF-lowland forest, AE2-agro-ecosystem in high elevation, SOP-shrub old pine forest, SF-secondary forest, PF-primary forest, R-rainy season and D-dry season.

lowland agro-ecosystem (*D. melanostictus, Bronchocela jubata, C. platyurus, G. mutilata* and *E. multifasciata*).

Eight species were associated with lowland forest comprising two anurans (*R. chalconota* and *L. kuhlii*) and six lizards (*G. chamaeleontinus, C. fumosus, Cyrtodactylus* spA., *H. frenatus, S. sanctus* and *S. temminckii*). *G. chamaeleontinus* was restricted to lowland forest. Twelve species were encountered in shrub old pine forest consisted of six anurans (*P. aspera, R. chalconota, R. hosii, L. kuhlii, P. aurifasciatus* and *R. margaritifer*), and six lizards (*Draco haematopogon, G. kuhlii, P. tympanistriga, C. fumosus, Cyrtodactylus* sp.A and *Cyrtodactylus* sp.B). Four of them were found restrict to this habitat type (*R. hosii, R. margaritifer, D. haematopogon* and *Cyrtodactylus* sp.B). Nine species were recorded associated to secondary forest comprising two anurans (*M. montana* and *P. aurifasciatus*), six lizards (*Bronchocela cristatella, G. kuhlii, P. tympanistriga, C. fumosus, Cyrtodactylus* spA., and *S. temminckii*) and one snake (*C. virgulata*). Two of them were restrict to secondary forest (*M. montana* and *C. virgulata*). Four species were encountered associated to primary forest, comprising one anuran (*P. aurifasciatus*) and three lizards (*G. kuhlii, P. tympanistriga* and *S. temminckii*).

Biological indices

Calculations of biological indices presented in Table 1. During rainy season, the agro-ecosystem in low elevation demonstrated the highest value of richness index (R) which was 4.375 followed by agro-ecosystem in high elevation (R = 2.476), lowland forest (R=2.010), shrub old pine forest (R=1.717), secondary forest (R=1.644), and primary forest (R=0.955). Meanwhile in the dry season, the highest value of richness index was demonstrated by lowland agro-ecosystem (R= 4.030), followed by highland agro-ecosystem (R=2.931), shrub old pine forest (R= 2.517), secondary forest (R=1.787), lowland forest (R= 1.739), and primary forest (R= 0.932). These values showed that between rainy and dry season the distribution changes of the species was not much influenced on species richness.

During rainy season in this study, the highest diversity was recorded in lowland agro-ecosystem (H'=2.804), agro-ecosystem in high elevation (H'= 2.252), lowland forest (H'= 1.870), secondary forest (H'= 1.608), shrub old pine forest (H'= 1.448), and primary forest (H'= 1.265). Meanwhile in the dry season, the agro-ecosystem in low elevation was demonstrated the highest diversity (H'= 2.653), followed by agro-ecosystem in high elevation (H'= 2.226), shrub old pine forest (H'= 1.984), secondary forest (H'= 1.778), lowland forest (H'= 1.680), and primary forest (H'= 1.118). Sequentially any difference of diversity between rainy and dry season, but in the value was not much different.

For the homogeneities among habitat types based on species distribution during rainy season, the agro-ecosystem in high elevation was demonstrated highest homogeny (E= 0.906), followed by agro-ecosystem in low elevation (E= 0.882), lowland forest (E= 0.812), primary forest (E= 0.786), secondary forest (E= 0.732), and shrub old pine forest (E= 0.696). In dry season, the most homogeny was demonstrated by agro-ecosystem in low elevation (E= 0.871), followed by agro-ecosystem in high elevation (E= 0.868), secondary forest (E= 0.809), lowland forest (E= 0.808), primary forest (E= 0.807), and shrub old pine forest (E= 0.798). Like as richness and diversity indices, the evenness index also showed same phenomena. Although change in sequential, the value of index was not much different in both of rainy and dry season.

Community similarities and habitat utilization

The cluster of the herpetofaunal community among habitat types based on Sorensen index presented in Figure 2. With respect to Sorensen's coefficient at the point 60.00 that was shown a difference cluster between during dry and rainy seasons. During dry season the habitat types were pooled in five main groups with secondary and primary forest pooled in one group at point 62.00 meanwhile there was only consisted four main groups during rainy season with three habitat types (shrub old pine, secondary and primary forest) pooled in one group. The differences of clustering between dry and rainy seasons probably were caused by distribution changes of the herpetofauna as the response of climate difference in two seasons.

The cluster of habitat utilization displayed in Figure 3. This cluster was also shown changes in habitat utilization between dry and rainy season, except for *G. chamaeleontinus.* This lizard is specialist low land forest.

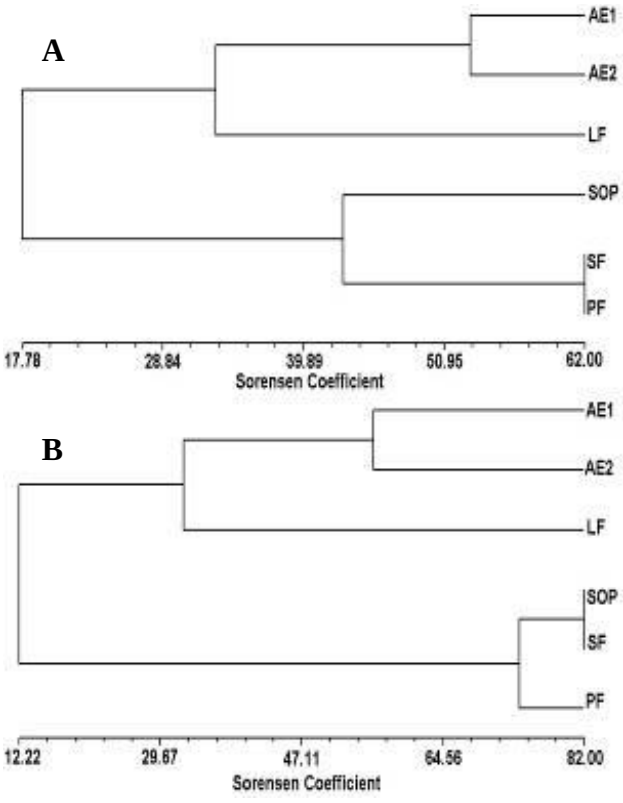

Figure 2. Dendrogram of the similarity of herpetofaunal community among habitat types based on Sorensen coefficient during dry (A) and rainy (B) season. AE1-lowland agro-ecosystem, LF-lowland forest, AE2-highland agro-ecosystem, SOP-shrub old pine forest, SF-secondary forest, and PF-primary forest.

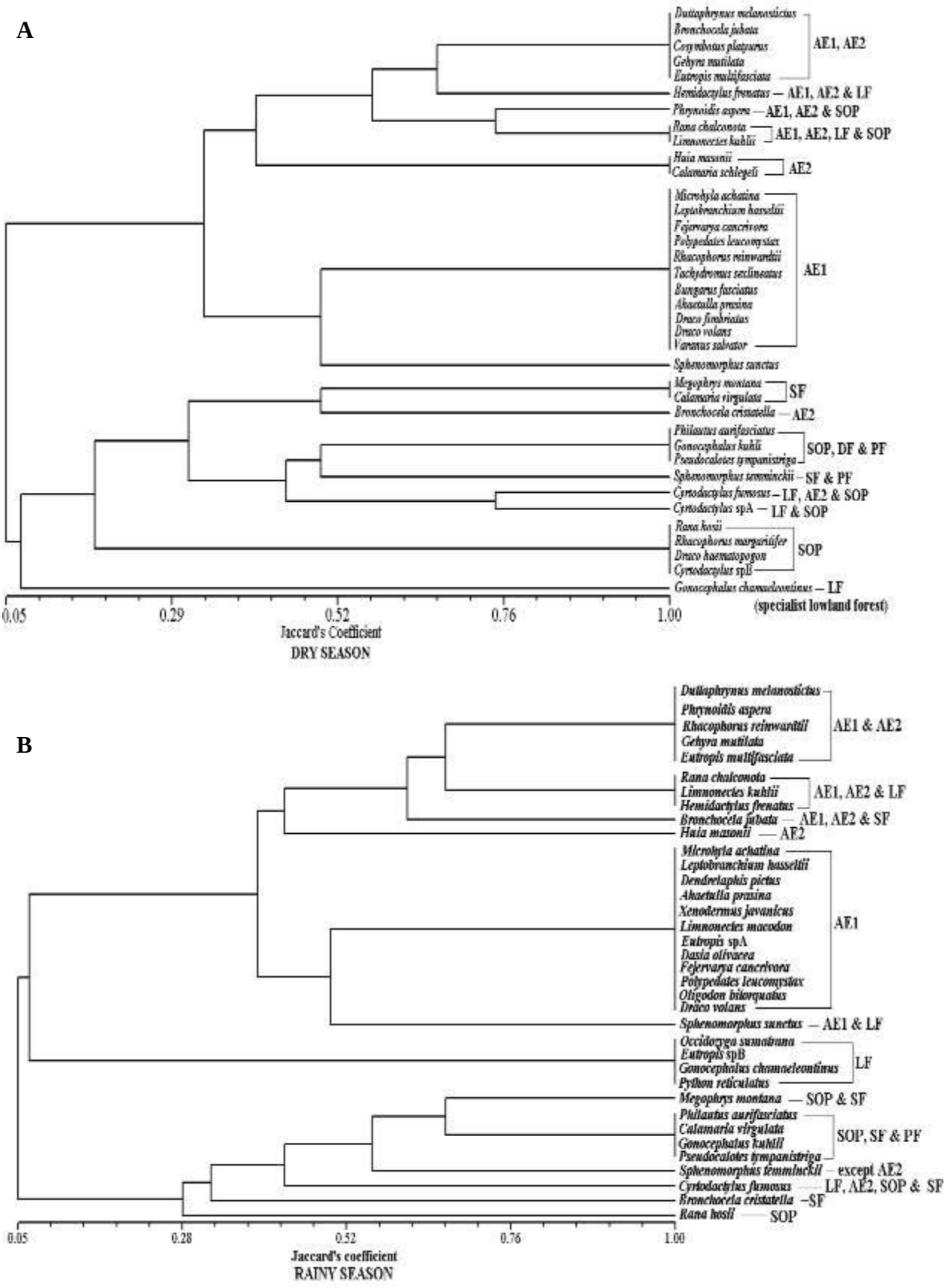

Figure 3. Dendrogram of the similarities in habitat use among taxa based on Jaccard's coefficient during dry season (A) and (B) during rainy season. AE1-lowland agro-ecosystem, LF-lowland forest, AE2-highland agro-ecosystem, SOP-shrub old pine forest, SF-secondary forest, PF-primary forest, R-rainy season and D-dry season.

CONCLUSION

A total of 46 amphibian and reptile taxa were recorded, comprising 16 anurans, 22 lizards and 8 snakes. Of the total taxa, four anurans are endemic and unusual specimens probably new in sciences referred to the genus *Cyrtodactylus* and *Eutropis*. This finding can be used as baseline data for further researches and manage on the fauna of the Gunung Ciremai National Park. There were differed in sequential of biological indices among habitat types but not much different in their values between rainy and dry seasons. It means all habitat types in Gunung Ciremai National Park are important for herpetofaunal life both in rainy and dry seasons. The distribution change of the herpetofauna is the consequence of the climate change between rainy and dry season. This distribution change was reflected in difference of cluster patterns of the community similarity among habitat types. It seems that in order considered the seasonal variation and to understand on herpetofauna distribution patterns as reflection of biological adaptations of thermal requirements, the study should be continued or done monitoring seasonally year to year.

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