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Herpetofauna community establishment on the micro habitat as a result of land mines fragmentation in East Kalimantan, Indonesia

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Abstract. *Muslim T. 2017. Herpetofauna community establishment on the microhabitat as a result of land mines fragmentation in East Kalimantan, Indonesia. Biodiversitas 18: 709-714.* Herpetofauna community is established because of habitat suitability or adaptation process that forces a species to survive. In the mining region, herpetofauna habitat change has occurred. The loss of natural habitat and the creation of an artificial habitat result in severance of corridor as a connecting line between herpetofauna habitats so that only microhabitat remains. Microhabitats of herpetofauna survive on limited food resources. The process of surviving of herpetofauna in microhabitats is reflected on the phenomenon of the food chain i.e. reptiles act as predators (top) and amphibians are as preys and as insect predators (middle). In the mining area, an area with a source of water is the destination for all animals, especially herpetofauna, and it even becomes the microhabitat for certain species. The purpose of this study is to determine the species of herpetofauna, its communities and its domination on the water area its microhabitats within the mine area. The exploration is carried out by direct observation (visual encounter surveys). The survey location determination is done intentionally (purposive sampling) on the potential habitat in some locations of water sources, such as pit dam, settling pond, man-made lake (*embung*), rivers and swamps. Based on the similarity index, there are five species of herpetofauna dominating the life in microhabitats and playing role in the formation of food chain community. *Enhydris enhydris* and *Dendrelaphis pictus* are species of snake and act as predator of frog *Fejervarya cancrivora* and *Polypedates leucomystax.*

Keywords: Herpetofauna, microhabitat, fragmentation, mining area

INTRODUCTION

Species diversity is one of the useful variables for management purposes in conservation. The change in species richness could be used as a basis for predicting and evaluating the community's response to the management activities (Nichols et al. 1998). The change in species richness is influenced by habitat. The habitat of an organism can have broad or narrow area. Differences in habitat area are related to the vast geography that influences the environmental conditions within these habitats.

Herpetofauna is one of the constituent components of the ecosystem and has a very important role, both ecologically and economically (Kusrini et al. 2003). Herpetofauna also has an important role in maintaining the balance of the ecosystem, because most herpetofauna constellates as a predator at the food chain in an ecosystem. Found only in certain specific habitat, some species of herpetofauna can be used as bio-indicators of environmental conditions for herpetofauna responds the environmental changes (Stebbins and Cohen 1997; Iskandar and Erdellen 2006).

As one of the major islands, Borneo Island has only done a little research on herpetofauna, especially in the area of mine reclamation. Around the mine area, there is forest fragmentation, the reclamation area and forest area outside the mine area. The presence and the diversity of herpetofauna are also affected by the surrounding forest areas outside the mining area, since the species of herpetofauna from this area may get into the mine area. Therefore, the species diversity of herpetofauna in the mine area may vary in each location. But a succession of herpetofauna is dynamic and evolves in line with the succession of plants as forming habitats. The rate of succession herpetofauna relies heavily on reforestation efforts (Rios-Lopez and Aide 2007). If the purpose of rehabilitation is to establish a sustainable native ecosystem, then it must take into account the needs of fauna habitat. Recolonisation of fauna species into rehabilitated areas can be encouraged by the provision of suitable habitat. The establishment of vegetation communities which are similar to the previous one before the existence of mining activities should ensure that most species will be back (recolonisation) as time goes by. The presence of herpetofauna is as an identifier of an ecosystem, which also means that it can be used as indicators of the quality of reclamation area that can be used as an illustration of the success of reclamation activities (Boer et al. 2014). Therefore, it is necessary to monitor the presence of herpetofauna species in degraded areas e.g. mining areas and the reclamation area to find out the level of environmental capacity to form microhabitat of herpetofauna.

Efforts to protect the biological component corresponding conservation purposes are indispensable in the shifting function of the forest. Changes in habitat conditions influence the diversity of wildlife including herpetofauna. Herpetofauna has an important role in maintaining the balance of the ecosystem, in addition, the presence of

herpetofauna in mine reclamation area can be used as bio-indicators of environmental changes and the success in reclamation. The food chain is formed because there are a food source and prey. In the herpetofauna community, the reptile family, such as snakes, is generally the predator of some frogs. This study aims to compare the naturally-formed-microhabitat to the microhabitat formed by mining activities as well as the community formed in a microhabitat (aqueous) in the area of the mining concession.

MATERIALS AND METHODS

Study area

The location of research is the coal mining area of PT Pratama Singlurus East Kalimantan. The research location is situated in two concession areas, namely Merdeka Block and Mutiara Block (Figure 1), which generally have different biophysical characteristics. Merdeka Block is the mining area of conversion of forest areas through schemes of *Ijin Pinjam Pakai Kawasan Hutan* (IPPHK; the Permit to Borrow-to-Use Forest Areas) covering an area of 1209.4 hectares, while Mutiara Block is an area of *Area Penggunaan Lain* (APL; Area of Other Usage), and it is previously the public land with vegetation of garden plants, shrubs, palm and secondary forest. At the time of observation, the mining activities are generally taking place.

Procedures

The survey was conducted by determining the sample plots intentionally (purposive) in particular microhabitat

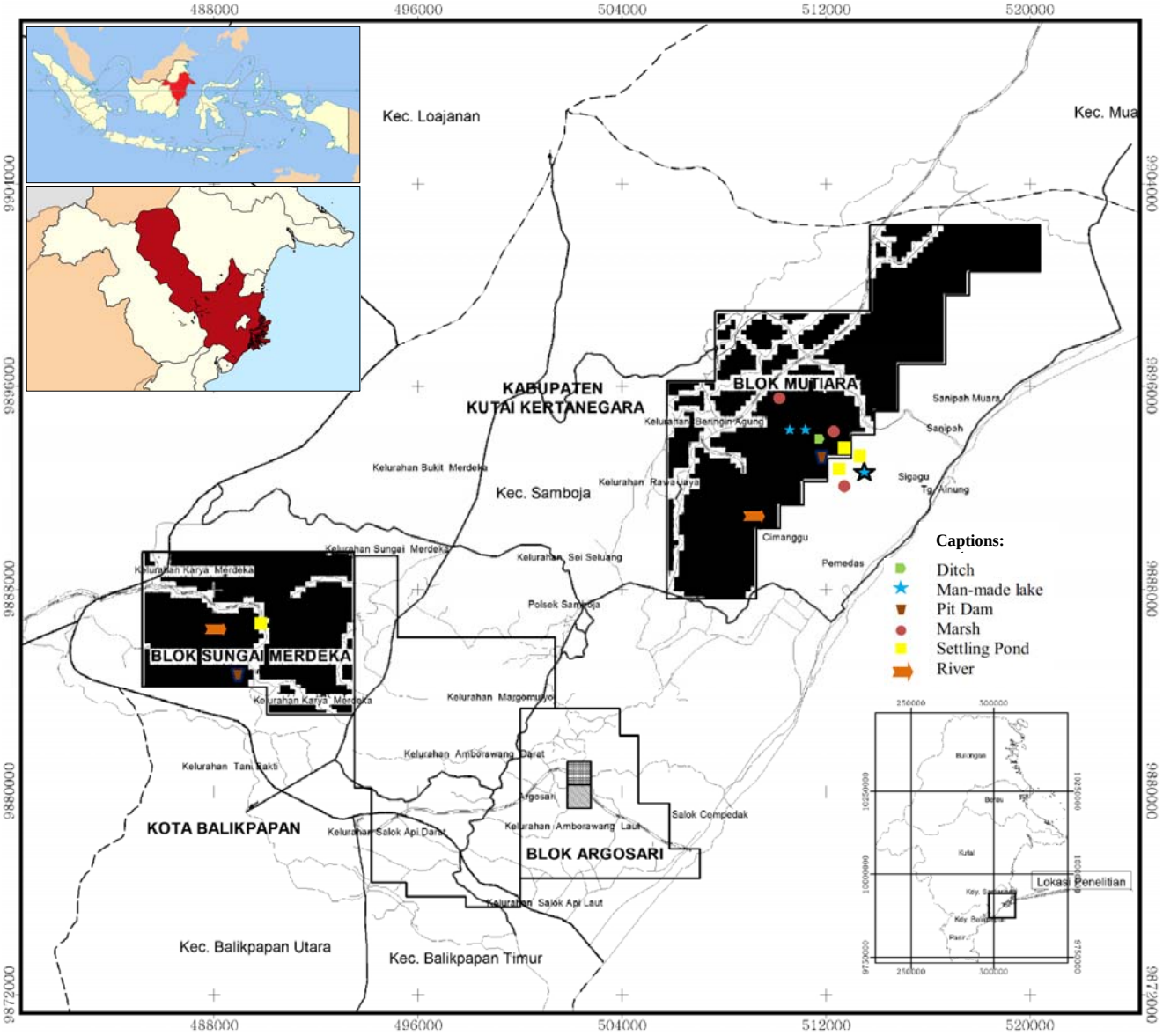

Figure 1. Location of research at mining area of PT Singlurus Pratama, Sungai Merdeka and Mutiara Block of Kutai Kartanegara, East Kalimantan, Indonesia. Location in shaded black is the location of sampling plots of herpetofauna community (PT. Singlurus Pratama 2015)

(Patch sampling) at locations having water sources, for example, pit dam, settling pond, ponds, rivers, and swamps. The sample plots are at 15 points in two locations of concession areas, namely 9 points are on Merdeka Block and 6 points are on Mutiara Block. Merdeka Block has more points of sample plots than the Mutiara Block since mining activities created more water spots in Merdeka Block than in Mutiara Block.

The data collection of herpetofauna species was conducted by direct search method (Visual Encounter survey). To determine the species of herpetofauna, the identification is based on books of a field guide of herpetofauna, i.e. Inger and Stuebing (2005), Das (2004) and Mistar (2008). To determine the biophysical conditions in general around microhabitats, it was conducted the observation, identification, and measurement of habitat width, vegetation covering land and the base substrate waters. Herpetofauna exploration was conducted in the morning at 5: 00 to 11: 00 pm and in the evening at 17: 00 to 22: 00 pm. To assist the surveys, materials, and equipment were used, such as roll meter, GPS, location map, grab stick, camera, herpetofauna species identification guide books.

Data analysis

The collected data is analyzed using similarity index (Jaccard index) and dissimilarity index (BrayCurtis index) with the following formula:

The coefficient of similarity:
Jaccard's index (J)= $a/a+b+c$
a= both species (j and k) were found together
b= species j was found without species k
c= species k was found without species j

Distance measure (dissimilarity):
Bray-Curtis (B)= $\Sigma |Xij - Xik| / \Sigma(Xij + Xik)$

RESULTS AND DISCUSSION

Community of Herpetofauna

At 15 locations of observation, species of herpetofauna were found in 80% of locations surveyed. The survey found five species of herpetofauna consisting of two amphibians and three reptiles. The five species were Fejervarya cancrivora toad and Polypedates leucomystax toad (amphibians) and eutropis multifasciata lizard, Dendrelaphis Pictus snake and Enhydris enhydris snake (reptiles). From all these observations points, five species were found simultaneously in six locations, only 1-2 species were found in other locations, but none were found on other three observation points. The herpetofauna species are easier to find on the artificial habitats which are formed intentionally from the mining activities than on natural habitat. Two species are found on Pit DAM, three species on Settling Pond, three species on water reservoirs (*Embung*) and one species were found in the ditch. While in natural habitats, such as marsh, herpetofauna species is found only one and two species are found on the river (Figure 2).

Based on the species comparison, the reptile class is higher than the amphibian class, but the number of amphibian individuals is higher than reptile individuals. So, the value of similarity index (Jaccard index) is not always higher than the dissimilarity index (Bray-Curtis index) which is based on the comparison of the number of individuals. Five species of herpetofauna which were compared based on similarity index have a value ranging

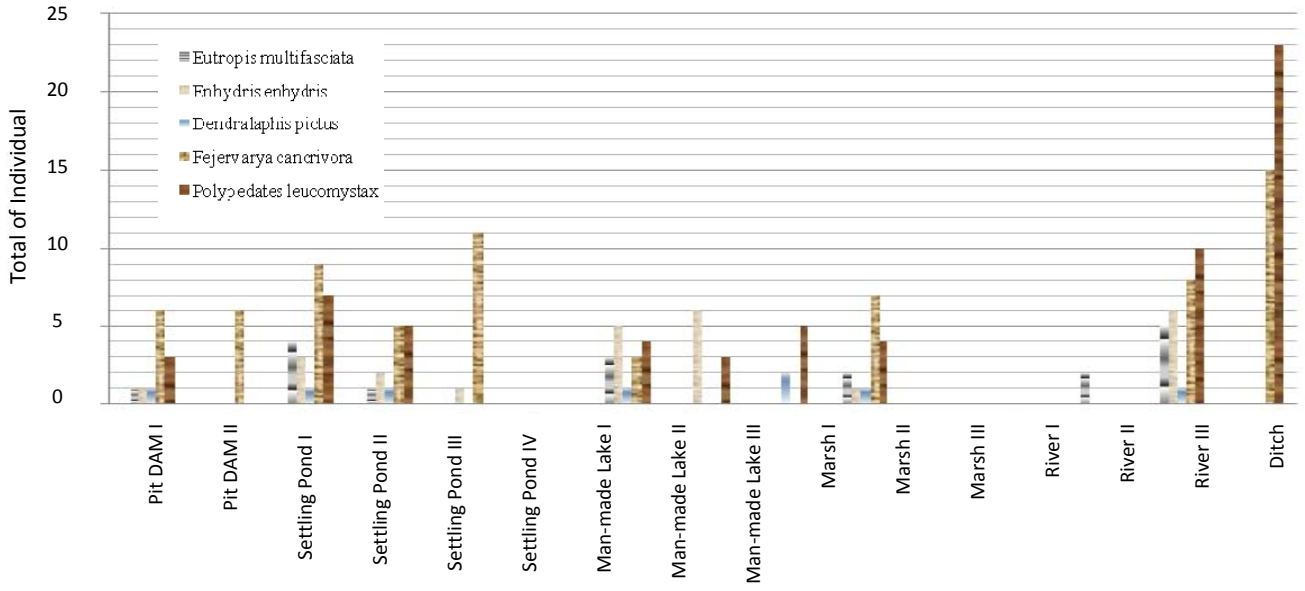

Figure 2. Number of herpetofauna species found in several survey locations

Table 1. Value of similarity index (Jaccard Index) of herpetofauna species

><	1	2	3	4	5
1	x	0.6	0.75	0.6	0.6
2	x	x	0.67	0.7	0.7
3	x	x	x	0.6	0.8
4	x	x	x	x	0.6
5	x	x	x	x	x

Note: 1. *Eutropis multifasciata*, 2. *Enhydris enhydris*, 3. *Dendrelaphis pictus*, 4. *Fejervarya cancrivora*, 5. *Polypedates leucomystax*

Table 2. Value of dissimilarity index (Bray-Curtis index) which is based on the ratio of the number of individuals among species

><	1	2	3	4	5
1	x	0.29	0.54	0.64	0.61
2	x	x	0.64	0.64	0.55
3	x	x	x	0.85	0.78
4	x	x	x	x	0.33
5	x	x	x	x	x

Note: 1. *Eutropis multifasciata*, 2. *Enhydris enhydris*, 3. *Dendrelaphis pictus*, 4. *Fejervarya cancrivora*, 5. *Polypedates leucomystax*

Table 3. Characteristic of microhabitat of surveyed herpetofauna

Characteristic	Location														
	Pit DAM		Settling Pond				Man-made lake (*Embung*)			Marsh			River		Ditch
	I	II	I	II	III	IV	I	II	III	I	II	III	I	II	
Width (M^2)	13750	15000	600	400	300	500	64	100	36	200	300	1000	800	600	200
Vegetation cover															
Scleria puspurascens	√	√	√	√	√	√	√	√	√	√	√	√		√	√
Melastoma malabatricum	√	√	√	√	√	√	√	√	√	√	√	√	√	√	
Mimosa pudica	√	√	√				√	√			√				
Alpinia sp.							√								
Ageratum conyzoides			√												
Eupatorium odoratum							√								
Echinocloa colonum			√				√								
Bauhinia lingua													√		
Paspalum conjugatum			√							√					
Pandanus sp.			√										√	√	
Solanum torvum							√	√	√	√	√				
Stenochlaena palutris							√								
Lygodium microphyllum							√								
Clidemia hirta							√								
Lycopodium cernum									√						
Gleichenia linearis									√						
Thespesia populnea							√		√						
Percentage of covered area (%)	4.36	6.66	30	15	5		40	25	32	40	50	35	20	7	1,5
Water color															
Brown			√				√								
Yellow	√	√		√	√	√				√	√		√		√
Clear								√	√			√		√	
Substrate of water base															
Mud	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Sand	√	√		√				√	√				√	√	√
Rock														√	

from 0.6 to 0.8. It shows that the chance for several different species to be discovered in the same location is relatively large (Table 1). The value of dissimilarity index which is calculated based on the number of individuals of each species is from 0.29 to 0.85 (Table 2). It shows that the number of individual of each species found together in a single location varied and tends to be in larger differences.

Microhabitat

The characteristics of habitat as the observation point and as a place of herpetofauna encounter are natural puddle and artificial puddle, such as Pit DAM, Settling Pond, man-made lake (*embung*), marsh and ditch with undergrowth vegetation dominance of *Scleria puspurascens*, *Melastoma malabatricum*, *Mimosa pudica*. While the vegetation around the river is dominated by *Pandanus* sp. and *Scleria puspurascens* (Table 3).

The percentage of covered area vary among locations with a range from 4% to 50%. The vastness of watery area being surveyed ranges from 200 to 15,000 M^2. Pit DAM has a large area but with only small vegetation cover, whereas marsh has a smaller size than the Pit DAM but with a greater percentage of coverage, and man-made lake (*embung*) has an area of only 64 $meter^2$, but with vegetation coverage of almost 50 % of the acreage.

Discussion

The low number of species in a particular habitat may indicate a low environmental quality since one of the causes of declining populations is habitat destruction (Denoël 2012). Fragmentation of land is an obvious example of habitat destruction in mining areas, especially on the use of forest areas with the schemes of the borrow-to-use permit. Fragmentation of land resulted in the dissolution of herpetofauna habitat by a network of mining roads, sediment in the river, the closing of the water catchment areas such as swamps and rivers. And also, the change and the reduction of vegetation-covered land affect the micro-climate such as temperature and humidity which can break the food chain in the ecosystem. It will lead to the decline of herpetofauna biodiversity and the natural habitat may be replaced by a new microhabitat having different species composition. In the natural habitat and the artificial habitat formed by the mining activities with narrower vastness, the survived herpetofauna form a new limited ecosystem. Herpetofauna which has exothermic properties and has relatively narrow exploration power due to limited capabilities (Walton 2012), so it takes some time in rehabilitation and revegetation of the presence of herpetofauna in the final sequence of succession. (Sudarmadji et al. 2016). For certain types of herpetofauna, it can also be interpreted as a special habitat (microhabitat). A habitat can be used to predict how the selection and preferences of these animals in their habitat (Garshelis 2000). A selection of resources by wildlife could become important information to determine the relationship between nature with wildlife and the way they find their needs to survive (Manly et al. 2002). The vast size of the habitat does not guarantee the habitat has a better carrying capacity of the environment, as shown by the result of exploration on the location of Pit DAM that has wider size of area than the Settling Pond or the man-made lake (*embung*) (Table 3) and only has a few individuals of herpetofauna. Even, only one species is found on Pit DAM II. In Pit DAM, the percentage of covered area is also relatively smaller and tends to be dominated by only 1-2 species of vegetation. The small percentage of covered area in the Pit DAM brings to the lack of protection for herpetofauna species, and it becomes the reason why there are only a few number of herpetofauna species live in this habitat. Meanwhile, according to the assumption of Walton (2012) that the broad aqueous areas within the mine area are a source of population for many species of herpetofauna. It takes a long time to restore the wealth of the species as the initial conditions with the consideration that the process of rehabilitation and revegetation is done appropriately, and with the priority, to the area around the pit DAM. (Walton 2012). Because of the length of revegetation or restoration process, a good prediction in restoring the species richness of herpetofauna, especially amphibians, can not be done (Lehtinen et al. 2001). Wanda et al. (2012) explain that the heterogeneity of vegetation types in a habitat also affects the diversity of frogs (Anura). The same opinion is also expressed by Rios-Lopez and Aide (2007) which states to increase the wealth of species; it is necessary to increase the heterogeneity of types of vegetation. The number of reptile species is higher than the number of amphibian species, but the number of individuals of amphibians is far greater than reptiles. Muslim et al. (2016) mentions the highest number of individual of the amphibians class is dominated by species *Polypedates leucomystax* (Rhacophoridae) and *Fejervarya cancrivora* (Ranidae). The higher number of amphibian individuals than reptile individuals are likely to show the phenomenon of healthy ecosystems since species of reptiles, especially snakes, play role as a predator for most amphibians.

The impact of mining activities is clearly to minimize herpetofauna habitat into homogeneous and fragmented microhabitat with the declining of species richness (Loughman 2005). The similarity index generally indicates that the location used as habitat for five species of herpetofauna is suitable habitat, so it is possible that habitat with such characteristics is a microhabitat. The index of similarity also shows that in the species being compared, the highest value is found on paired species. The value can also mean the association of the two species, namely when one species of the pair is found in a habitat then the chance for its paired species to be found in that same habitat is very big. In other words, it is bioindicator for other species (Simon et al. 2012). Some of these phenomena are also found in the field in the form of predation of frog *Fejervarya cancrivora* by snake *Enhydris enhydris* and snakes *Dendrelaphis pictus* which is suspected as the main predator of frog *Polypedates leucomystax* because these species are found in vegetation. While lizards *Eutropis multifasciata* allegedly only prey on insects around the area so that it can be regarded as a competitor for the two species of frogs. *Polypedates leucomystax* which is a tree frog species highly depends on the presence of vegetation and water. Also mentioned by Gunzburger and Travis (2004) that a tree frog is positively associated with the presence of aquatic vegetation. Meanwhile, a lizard eating habits are based on research by Kurniati et al. (2000). Kurniati et al. (2000) state that the primary feed source of lizard is insects (84.59%), although there are different species of lizards that prey on house lizards as revealed by Paulino et al. (2015). In the reproductive behavior of lizards, the presence of water is an ideal condition (Teyssier et al. 2014). *Enhydris enhydris* is often found in waterways, fish pond, rice fields, swamps and small rivers with calm current, feed on small fish, and often become pests in pisciculture (Wiguna et al. 2009).

Many factors influence the formation of an ecosystem within a habitat. There are many factors that can affect the selection of resources. These factors include population density, competition with other species, natural selection,

chemical composition and texture of food plants, heredity, predation, patch size and distance between patches (Manly et al. 2002). From some of the results of this study, it can be concluded that the presence of water and the vegetation-covered area has an important role as the main factor of forming an ecosystem and starting the new life of a succession. Solsky et al. (2014) mention that a certain species which natural habitat is terrestrial/arboreal should migrate towards the source of water during spawning. Some species of herpetofauna particularly amphibians will be rare, or even, extinct when they have to live away from the water source (Vitt et al. 2009). Habitat with stagnant water conditions as a result of mining activities is same with natural habitat with the stagnant waters as a microhabitat for certain species. As the time goes, the succession will evolve naturally and the species will be more diverse with the same species richness but not the same composition of species (Walton 2012)

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