

# Pre-research of Breadfruit (*Artocarpus altilis* (Parkinson) Fosberg) Phylogeny between Ternate and Maitara Island Based on Morphology

Suparman\*, Zulkifli Ahmad, Nurhasanah

Biology Department, Khairun University, Ternate. INDONESIA

\*Corresponding Author's Email: suparman\_bio@yahoo.com

**Abstract** – *Artocarpus altilis* (Parkinson) Fosberg belongs to Moraceae family and it is well known in Indonesia, it is also popular as breadfruit. The plant is estimated as a native plant of Southeast Asia between Moluccas and Philippines. Herein we conducted and combined morphological character of breadfruit from Ternate Island and Maitara Island in Moluccas archipelago. The most important objective is to make relationship among the population (intra-species) of breadfruit between both islands. Five populations in Ternate and two in Maitara were taken as material source. Then, morphological was done for scoring in binary data i.e. 1 for present character and 0 for absent. It was continued with similarity index analysis and building a dendrogram with UPGMA method using NTSys 2.02i software. The most similar population are between Akebay and Kaulupa, with SI is 0.75, and it was predictable because both of them are in one Island, Maitara. In the other hand, the lowest SI is 0.43 i.e. between Kaulupa (Maitara) and Sasa (Ternate). The dendrogram from UPGMA method had divided seven populations into two groups that is Maitara group and Ternate group.

**Keywords** – Sukun, *Artocarpus altilis* (Parkinson) Fosberg, Ternate, Maitara.

## I. INTRODUCTION

Sukun or breadfruit is named as *Artocarpus altilis* (Parkinson) Fosberg 1941 [1] and it is a member of Moraceae family. It is estimated as native plant in South East Asia, about some island in Moluccas-Indonesia but specifically unknown place [2]. The wild breadfruit with seeds is its ancestral, it is origin from New Guinea and it is indicated come from Moluccas archipelago. The plant was distributed by human migration about 3000 years ago especially around Pacific archipelago [2]. The distribution map of breadfruit is showed on picture 1.

Breadfruit is very common in Indonesia; it is estimated as native plant in South East Asia to the Polynesia. In Pacific archipelago (especially in Hawaii, USA), lot of scientist have cultivated it widely and produced lot of varieties product from it. They also built research centre for breadfruit in *National Tropical Botanical Garden - Tropical Plant Research - the breadfruit institute*. In 2013, they had collected at least about 150 varieties of breadfruit (NTBG, 2013).

Breadfruit is future plant for security food and alternative crop because of its yield and nutrition. It has 25% carbohydrate, protein 1.5 % and 0.3 % lipid of its weight [3]. As crop, breadfruit has wider environment adaptation than rice [4].

The recent publication [5] reveals that breadfruit contains high complex carbohydrates, low in fat, and cholesterol and gluten free. Compared to white potato, white rice, white, bread and taro, it has a moderate glycemic index (blood sugar shock).

Planting process, harvest, and product processing of breadfruit is easier than rice. Therefore, the plant is very appropriate as alternative crop in Indonesia in master plan of Acceleration and Expansion of Indonesia Economic Development (MP3EI) 2011-2025 especially in food and agricultural focus in Papua-Kepulauan Maluku Economic Corridor. The plant is also officially stamped in international attachment of "Treaty on Genetic Resource for Food and Agriculture" and it contributed in global rescue for food security and novel food [6]. It also has been chosen as one of some species in Forest and Land Rehabilitation National Movement [7].

Although it is very important for human in food security, some information about breadfruit spreading, phylogenetic, distribution route, and product in North Moluccas are very low. Then a research whereas focus on location map, phylogenetic, and potentiality of its product are necessary for conducting in North Moluccas particularly in Ternate and Maitara Island. Thus island are located on the east of Webber line, and have lot of specific tropic vegetations include from family Moraceae, genus *Artocarpus*.

It is because of lacking information about relationship in the plant, and its variety in North Moluccas, so tracking the origin and spreading some plants are difficult.

Furthermore, phylogenetic analysis in plant is necessary to be done and it can be started by the easiest method i.e. using morphological analysis. In this paper we conducted a simple phylogenetic analysis about breadfruit in Ternate and Maitara Island based on morphology i.e. leaf, flower, fruit, and stem.

## II. MATERIALS AND METHOD

### Materials

All the samples are taken from two islands that are Ternate and Maitara in North Moluccas Archipelago. Five populations of them represent of Ternate Island. In the other hand, two populations of breadfruit are from Maitara.

The population of breadfruit as samples can be red on table 1.

Table 1: Breadfruit Populations and Island where it was taken

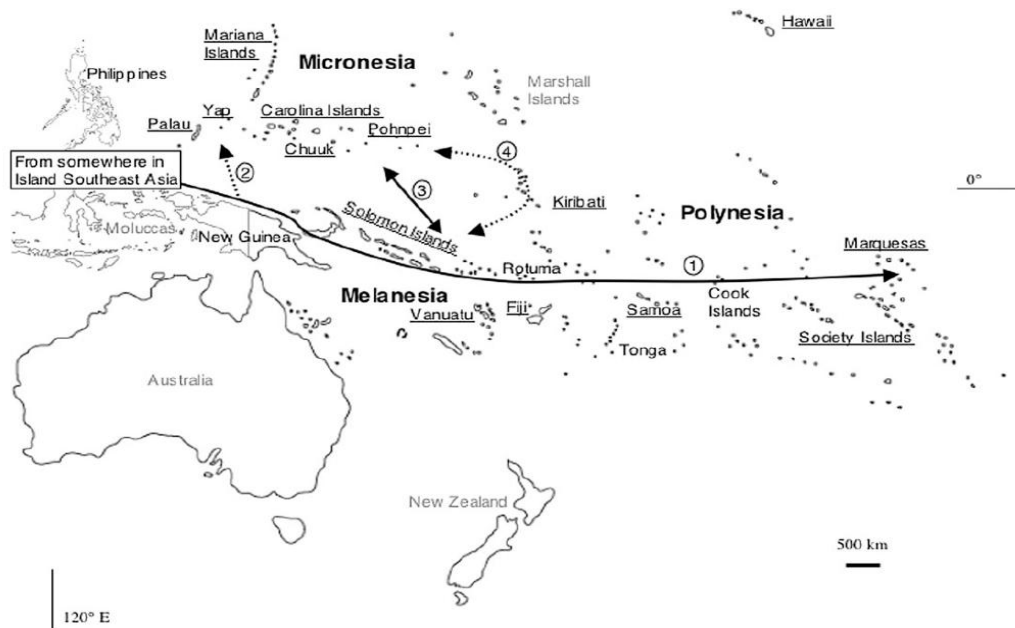
No.	Population	Island
1.	Takome	Ternate
2.	Tarau	Ternate
3.	Sasa	Ternate
4.	Ngade	Ternate
5.	Kulaba	Ternate
6.	Akebay	Maitara
7.	Kaulupa	Maitara

### Method

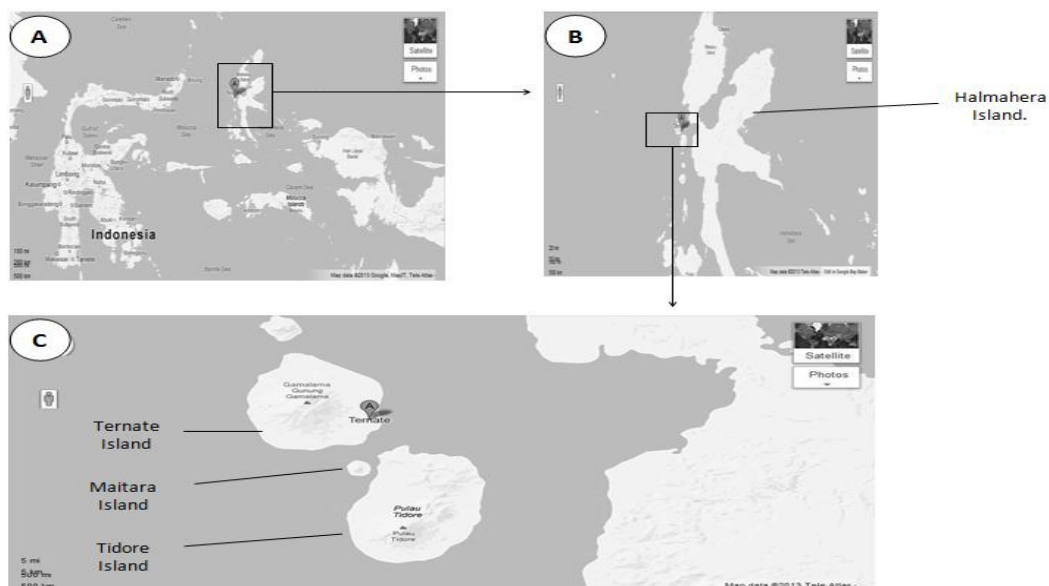
The first morphology data was taken from every single sample represents single population. The data were input into binary data as 1 and 0; one was written if the sample had that character and zero it had not. Then, all data were analyzed to know the similarity index between two populations. The formula reference to *Sorenson*:

$$SI = \frac{2C}{A+B} \times 100\%$$

Whereas SI: *similarity index*, C is amount of character that is present in booth population, A is character that is present in sample A, and B is character that is present in sample B.



Picture 1: Map of distributing and spreading of Breadfruit. It is estimated as native to Southeast Asia. The spreading is from somewhere around North Moluccas and Philippine [2]



Picture 2: Location of Ternate Island and Maitara Island (Map data @2014 Tele atlas).  
a. Map of Indonesia (East part of Indonesia) b. Halmahera Island and another island in North Moluccas.  
c. Map of Ternate and Maitara

Population codes or names were used for Operational Taxonomic Unit (OTU's) in making dendrogram of phylogenetic. Dendrogram constructing was made based on phenetic method that called *Un-weighted Pair Group Method using Arithmetic average*, UPGMA [8]. The process of analysing and making dendrogram used NTsys 2.02i software [9]. The phonetic method is an approach based on similarity for describing relationship in living organism. The assumption is two or more organism that had high SI, it is also had had high relationship [10].

### III. RESULT AND DISCUSSION

#### *Similarity index (SI)*

Similarity Index of Sorenson among OTU's was obtained from calculation of morphological data. The values are showed on table 2. Two OTU's of highest SI are Akebay and Kaulupa, both of them are in Maitara Island and the SI is 0.75. It can be assumed that Akebay and Kaulupa have higher relationship compared other OTUs.

Table 2: Matrix of Similarity Index among OTUs based on Sorenson formula in Ternate and Maitara Island

	Takome	Tarau	Sasa	Ngade	Kulaba	Akebay-Mtr
Tarau	0.5625000	*	*	*	*	*
Sasa	0.5312500	0.6562500	*	*	*	*
Ngade	0.5000000	0.6250000	0.7187500	*	*	*
Kulaba	0.5312500	0.6562500	0.6875000	0.5937500	*	*
Akebay-Mtr	0.6562500	0.4062500	0.5000000	0.5937500	0.5625000	*
Kaulupa	0.7187500	0.6562500	0.4375000	0.5312500	0.5625000	0.7500000

From the table, it can be seen clearly that the lowest Similarity index is between Akebay-Maitara and Tarau-Ternate with SI is only 0.406. SI value for all population in average is 0.592. It is high SI, yet it is really different for infra-species. For varieties, the value (0.592) is low because similarity for variety more than 75%. In this case, the different between OTU's is lower because morphology were used are tentative.

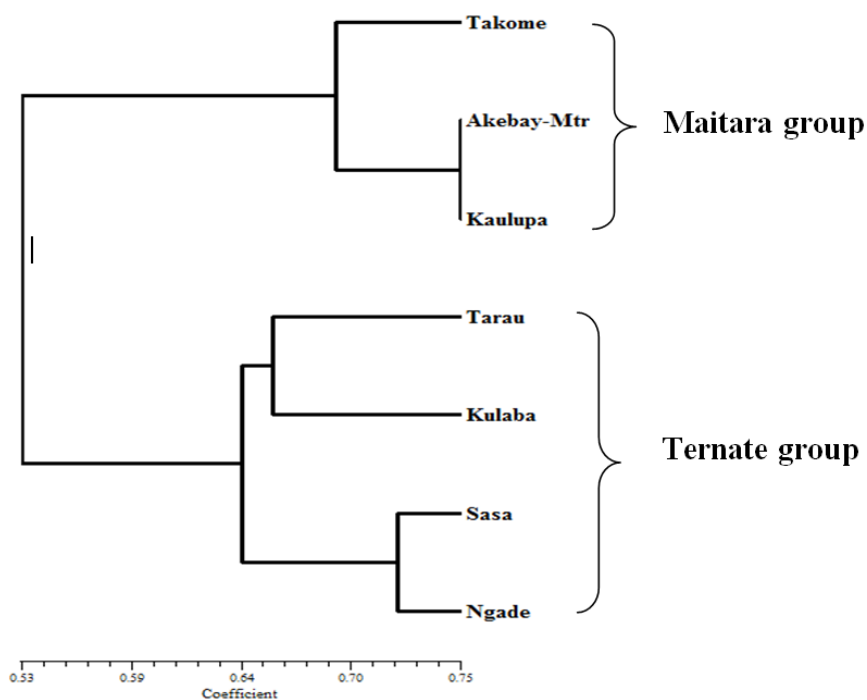
#### *Dendrogram of construction of Ternate and Maitara*

Result of dendrogram construction is showed on picture one. The population are divided into two main groups. The first group is Maitara group and consist of Takome, Akebay, and Kaulupa. Maitara population dominates the

group. Second group is Ternate group and consist of Tarau, Kulaba, Sasa and Ngade. All member of this group are from Ternate population. It means all population make a group with the population from same island.

Similarity index between breadfruit from Akebay-Mtr and Kaulupa is very high and it assumes that sample of Akebay is very similar to Kaulupa sample or have closer phylogenetic relationship than other.

In phylogenetic analysis, there are two kind approach i.e. phenetic, the approach based on similarity of morphology and second is cladistic, the approach based on evolutionary and character of homology [10],[11]. Both of them are valid approach in analysis and acceptable.



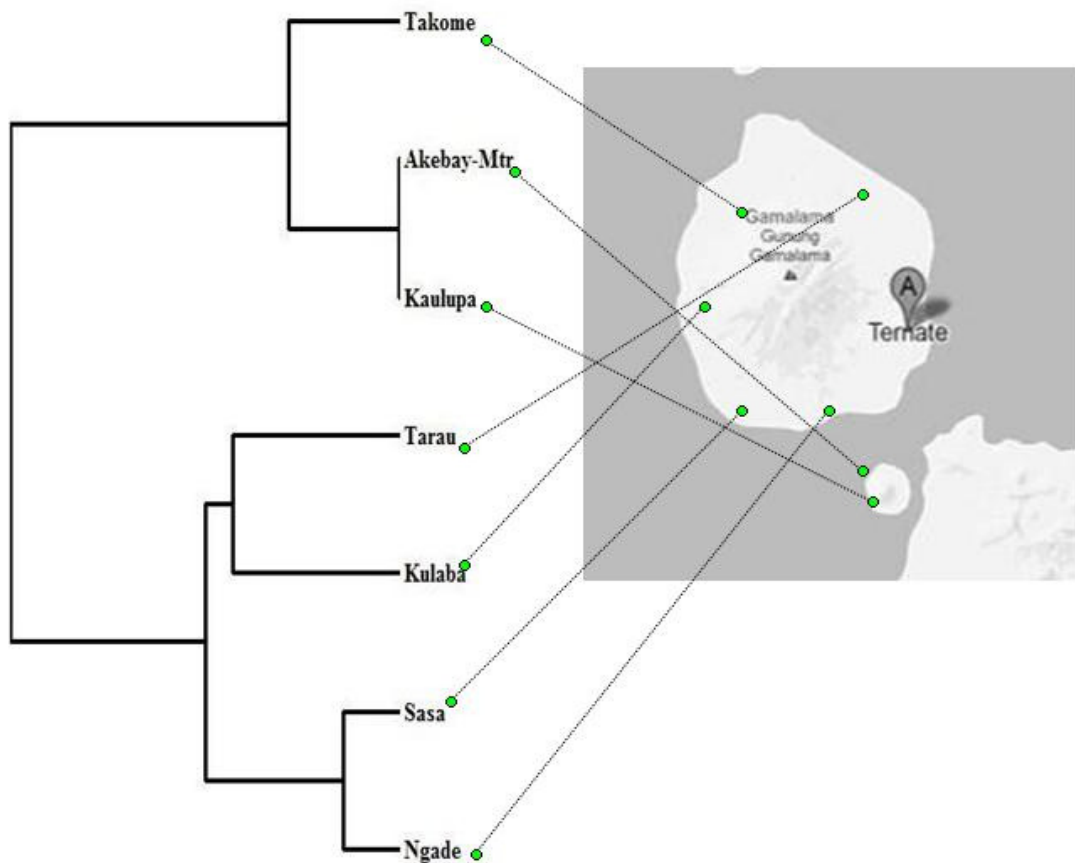
Picture 3: Phylogeny of breadfruit population in Ternate and Maitara base on morphology. Dendrogram was designed by UPGMA method using NTsys 2.02i programme.

Based on phylo-geography in picture 4, there are two assumptions. The first is that Ternate and Maitara had different ancestor. Those polyphyletic characters are specifically showed on dendogram in picture 4. All the member of Ternate group is in Ternate and it was inheritance from one ancestor. This condition is slightly different from Maitara group. In second group, the members are not only Maitara populations but also Ternate. Special for Takoma population, it is about the same with Maitara population and the similarity index between Takome and Maitara populations is little bit higher compare to Takome and Ternate population.

The topology of dendogram indicates human role in distributing breadfruit. The second assumption is that all the breadfruit in both islands had the same ancestor. It can be assumed that the ancestor came from Ternate and brought by human being. That ancestor in Maitara is

divided into two by convergent evolution and change the character. The first offspring became Takome breadfruit and the other became the ancestor of Maitara breadfruit. The assumption is tentative and to reveal the true evolution need more information about phylogeny based on DNA marker.

Maternal analysis with molecular method on breadfruit is simpler than another plant because the plant is generally spread by budding whereas it inheritance only from one maternal. This analysis can also to trace the ancestor and colonisation route of breadfruit in Maluku archipelago. Other plant from Myrtaceae family i.e. *Eucalyptus urophylla* had been analyzed for colonisation route and ancestor tracer around Indonesia archipelago [12]. Advanced analyzed on that method is phylo-geography, which is a science focus on geographic distribution of organism in species level [13], [14].



Picture 4: Phylo-geography of breadfruit based on population origin.

#### IV. CONCLUSION

The similarity index between breadfruit population in Ternate and Maitara based on morphology is low. It means the variety in species is high. The highest index of all is Akebay population and Kaulupa. It is acceptable because both are from one island and have lot of similarity and relationship. In the other hand, the lowest index is between Kaulupa (Maitara) and Sasa (Ternate). It is clear because it is from different island.

Dendogram topology describes two main Groups that are Maitara Group and Ternate Group. In Maitara group,

there is one unusual population. Takome Population joined to Maitara Group instead of Ternate. In generally, it is still complicated problem to determine the ancestor of the plant from the islands.

#### REFERENCES

- [1] Ragone, D. 2006. *Artocarpus altilis* (breadfruit). [www.traditionaltree.org](http://www.traditionaltree.org)
- [2] Zerega, N. J. C., Ragone, D., and Motley, T. J. 2004. Complex Origins of Breadfruit (*Artocarpus altilis*, Moraceae): Implications for Human Migrations in Oceania. *American Journal of Botany*, 91(5): 760–766.



- [3] Hendri, Marlina, L., and Liferdi. 2010. *Diversifikasi Pangan dan Gizi dengan Alpukat, Pisang dan Sukun*. Seminar nasional program dan strategi pengembangan buah nusantara. Solok.
- [4] Effendie, K. 2011. *Lokakarya Sukun Nasional*. Balai Penelitian Tanaman Buah. Solok.
- [5] Ragone, D. 2014. *Breadfruit Nutritional Value and Versatility*. Breadfruit Institute of the National Tropical Botanical Garden, and Hawai'i Homegrown Food Network. Hawaii
- [6] Jones, A.M.P., Ragone, D., Tavana, N.G., Bernotas, D.W., dan Murch, S.J. 2011. *Beyond the Bounty: Breadfruit (Artocarpus altilis) for food security and novel foods in the 21st Century*. Etnobotany, [www.ethnobotanyjournal.org/vol9/i1547-3465-09-129.pdf](http://www.ethnobotanyjournal.org/vol9/i1547-3465-09-129.pdf)
- [7] Hendalastuti, H., and Rojidin, A., 2006. *Karakteristik Budidaya dan Pengolahan Buah Sukun : Studi Kasus di Solok dan Kampar*. Prosiding Seminar Hasil, Litbang Hasil Hutan 2006 : 220-232.
- [8] Xiong, J. 2006. *Essential Bioinformatics*. Cambridge University Press: New York.
- [9] Rohlf, F.J. 2000. *NTSYSpc: Numerical Taxonomy and Multivariate Analysis System, version 2.1*. Department of Ecology and Evolution, State University of New York.
- [10] Heywood, V., H., and Mcneil, J., 1964. Phenetic and Phylogenetic classification. *Nature*, 203. Nature Publishing Group.
- [11] Lipscomb, Diana. 1998. *Basic of Cladistic Analysis*. Washington, George Washington University.
- [12] Payn, K.G., Dvorak, W.S., dan Myburg, A. A. 2007. Chloroplast DNA phylogeography reveals the island colonisation route of Eucalyptus urophylla (Myrtaceae). *Australian Journal of Botany*. 55 : 673–683. [www.publish.csiro.au/journals/ajb](http://www.publish.csiro.au/journals/ajb).
- [13] Avise, J.C. 1998. The hysory and perview of phylogeografi. : a personal reflection. *Molecular ecology*, 7, 371-379.
- [14] \_\_\_\_\_. 2009. Phylogeography: retrospect and prospect. *Journal of Biogeography* (J. Biogeogr), 36, 3–15.

## AUTHOR'S PROFILE

### **Suparman.**

Lecturer and researcher in Biology Department of Khairun University Indonesia. Some of his research concern in plant and animal Phylogeny; biodiversity and education method.

### **Zulkifli Ahmad.**

Lecturer and researcher in Biology Department of Khairun University Indonesia. His research most in Physiology and entomology

### **Nurhasanah.**

Lecturer and researcher in Biology Department of Khairun University Indonesia. Her research most concern in microbiology and biodiversity.