

Turnitin Originality Report

Processed on: 13-Sep-2019 15:56 WIB

ID: 1171992861

Word Count: 4756

Submitted: 1

Ecological Informatics Approach
to Analyze Habitat Preferences of
Auricularia delicata (Italic) in
Bingungan Forest, Turgo Natural
Forest Conservation Area By Tien Aminatun
3% match (Internet from 05-Nov-2018)

Similarity by Source	
Similarity Index	
11%	
Internet Sources:	7%
Publications:	6%
Student Papers:	4%

<http://www.worldagroforestry.org/downloads/Publications/PDFS/b13695.pdf>

2% match (publications)

[Agustina E. Susanti, Shanti Ratnakomala, W. Mangunwardoyo, Puspita Lisdiyanti. "Antimicrobial Activity of Lichens-Associated Actinomycetes Strain LC-23", Proceedings of the 2019 9th International Conference on Bioscience, Biochemistry and Bioinformatics - ICBBB '19, 2019](#)

1% match (publications)

[Dighton, John. "Introduction", Mycology, 2016.](#)

1% match (publications)

[D. Prasetya, T. Aminatun. " Population dynamics of fruit bodies in Bingungan forest, Turgo ", Journal of Physics: Conference Series, 2019](#)

1% match (Internet from 09-Mar-2016)

<http://msed.vse.cz/files/2011/Prokop.pdf>

1% match (publications)

[Dighton, John. "Role of Fungi in Reducing Primary Production", Mycology, 2016.](#)

1% match (Internet from 29-Sep-2016)

<https://www.scribd.com/doc/244760923/21st-Century-Guidebook-to-Fungi-by-David-Moore-Geoffrey-D-Robson-and-Anthony-P-J-Trinci>

1% match (Internet from 04-Aug-2019)

http://www.davidmoore.org.uk/21st_Century_Guidebook_to_Fungi_PLATINUM/Ch10_01.htm

< 1% match (Internet from 15-May-2015)

http://etheses.dur.ac.uk/3367/1/dcs3mmn_phd_thesis.pdf

< 1% match (publications)

[Tien Aminatun, Nugroho Susetya Putra. "The effect of habitat modification on plant-pollinator network", AIP Publishing, 2017](#)

< 1% match (Submitted to Arizona State University)

[Submitted to Arizona State University](#)

< 1% match (Internet from 17-May-2019)

<http://www.worldnewsnaturalsciences.com/wp-content/uploads/2019/01/WNOFNS-23-2019-306-320.pdf>

< 1% match (publications)

[Asther, M.. "An improved method for the purification of lignin peroxidases from phanerochaete chrysosporium INA-12: properties of two major isoforms", International Journal of Biochemistry, 199209](#)

< 1% match (student papers from 13-May-2013)

[Submitted to University of Bristol on 2013-05-13](#)

Ecological Informatics Approach to Analyze Habitat Preferences [of *Auricularia delicata*](#) (Italic) [in Bingungan Forest, Turgo](#) Natural Forest Conservation Area Dwiki Prasetya Tien Aminatun Department of Biology, Yogyakarta [Department of Biology, Yogyakarta State University State University](#) [Jl. Colombo No.1, Karangmalang, Jl. Colombo No.1, Karangmalang](#), Yogyakarta, Indonesia [Yogyakarta, Indonesia](#) +6281239193032 +6282138267965 dwiki412fmipa@student.uny.ac. tien_aminatun@uny.ac.id id **ABSTRACT** agarics macrofungi group, with sequences of 89% and 138% of Based on our previous research, *Auricularia delicata* has been total 300%. *Auricularia delicata* had the highest frequency (0.7), detected as unique and important local mushroom in economic with an ecological importance value of 71%. Interestingly, and ecological values which were newly recorded in Turgo *Auricularia delicata* was only found in Bingungan forest, not tropical forest ecosystem, with exactly restricted distribution only distributed in the other forests of Turgo area such as Tritis forest in Bingungan forest. This research aimed to know habitat or Turgo forest. This fungus undergoes a process of fruiting in the preferences of *Auricularia delicata* by using ecological rainy season to the early dry season. informatics approach regarding to management forest-fungi efforts. To yield communicative interpretation, we used some The [importance of fungi in ecosystems](#) is [in the following four](#) analyses from Pearson correlation among physical and chemical [major functions: \(1\) As decomposers, fungi drive the global](#) characteristics of substrate as *Auricularia delicata* habitat, Bray- [carbon cycle. \(2\) As mycorrhizal symbionts, they form absorptive](#) Curtis similarity and distance indices, NMDS (Non-Metric [accessories to roots](#), linking [the activities of separate plants and](#) Multidimensional Scaling) ordination, hierarchical clustering with [underpinning primary production in forests, heathlands, and](#) UPGMA (Unweighted Pair Group Method with Arithmetic Mean) grasslands. (3) Food sources for many wildlives. (4) As parasites, and non-hierarchical clustering with K-means, till we could they regulate population dynamics of their hosts [2][3]. categorize habitat preferences from the very good, good, poor, and The forest fungi management is a concept to conserve priority very poor categories. macrofungi in edible, rare, or unique categories [4]. Monitoring is CCS Concepts done in terms of habitat preferences and population dynamics. Those methods are suitable to the concepts of macrofungi habitat Applied computing → Life and medical sciences → modeling. Therefore, we may describe clearly enough about Bioinformatics where macrofungi grow, and what kind of habitat characteristics would influence the fruiting

process. Thus, the habitat and Keywords ecosystem management which support sporocarp formation of *Statistical Ecology*, *Auricularia delicata*, Habitat Preferences *Auricularia delicata* can be maintained.

1. INTRODUCTION The decision to monitor *Auricularia delicata* macrofungi species in Bingungan forest is one effort of macrofungi conservation in tropical rainforest ecosystems. In addition, the forest being protected and conserved by Mount Merapi National Park (TNGM). *Auricularia delicata* is known as "keprok" mushroom which has potential values to fulfill nutrition for Turgo people. *Auricularia delicata* is a type of macrofungi belonging to the jelly macrofungi group. The results of the survey conducted by Prasetya et al. in 2017[1] showed that macrofungi jelly in Bingungan forest had a second ecological importance value after © [2019 Association for Computing Machinery. ACM acknowledges that this contribution was authored or co-authored by an employee, contractor or affiliate of a national government. As such, the Government retains a nonexclusive, royalty-free right to publish or reproduce this article, or to allow others to do so, for Government purposes only. ICBBB '19, January 7–9, 2019, Singapore, Singapore © 2019 Association for Computing Machinery. ACM ISBN 978-1-4503-6654-0/19/01...\\$15.00 DOI: <https://doi.org/10.1145/3314367>. 3314382](#)

2. METHODS 2.1 Study Area Figure 1. Map of permanent sampling plots. The mushrooms symbols show sampling plots area This research was carried out in Bingungan forest, Turgo Natural Forest Conservation Area, Mount Merapi National Park. Bingungan Forest is located at the altitude of 1169-1193 m above the sea level with the coordinate points of 04° 36.422' South Latitude - 04° 36.450' South Latitude, 916° 19.06' West Longitude - 916° 18.70'. The data were collected on nine permanent plots that had been predetermined and [coded as D01, D02, D03, D04, D05, D06, D07, D08, and D09](#) that showed in Figure 1.

2.2 Data Analysis To determine habitat preferences, the Pearson correlation analysis is used for among variables, those are tree species, decay class, C organic, N total, C/N ratio, holocellulose, alphacellulose, betacellulose, gammacellulose and lignin. Then these variables are analyzed further using the Bray-Curtis distance and similarity indices. Afterwards visualized by NMDS ([Non-Metric Multidimensional Scaling](#)) ordination method. After knowing the distance and similarity among plots/habitats, clustering is done using UPGMA (Unweighted Pair Group Method with Arithmetic Mean) and K-means based on Bray-Curtis distance and similarity indices. Finally, habitat preferences can be categorized ranging from the very good, good, poor, and very poor categories.

3. FINDINGS AND DISCUSSION 3.1 Habitat Preferences Analysis Firstly, we are looking forward correlation between physical and chemical characteristics of substrates as *Auricularia delicata* habitat. Table 1. All measured variables of substrates as *Auricularia delicata* habitat. This table represents characteristics of each plot sampling

Plot	Species	C %	N %	C/N %	Holo %	Alfa %	Gam %	ma %	Beta %	Lignin %	Decay	Dtot
D01	Mallotus paniculatus	52,89	1,37	38,60	53,11	33,63	19,48	46,89	42,58	4	2668	
D02	Erythrina sp.	55,83	0,86	64,91	43,01	23,07	19,94	56,99	50,84	3	247	
D03	Mallotus paniculatus	50,16	2,42	20,72	25,28	16,79	8,49	74,72	46,40	3	703	
D04	Mallotus paniculatus	52,38	2,02	25,93	45,75	15,91	29,84	54,25	39,78	4	3018	
D05	Macaranga triloba	57,55	0,76	75,72	56,27	23,9	32,37	43,73	25,86	4	1393	
D06	Mallotus paniculatus	50,89	1,19	42,76	55,03	33,46	21,57	44,97	37,91	0	55	
D07	Podachaenium sp.	49,56	3,33	14,88	64,54	32,72	31,82	35,46	31,98	0	60	
D08	Mallotus paniculatus	49,3	1,42	34,71	53,79	27,21	26,58	46,21	27,43	4	953	
D09	Macaranga triloba	56,81	0,79	71,91	54,03	25,19	28,84	45,97	45,68	3	264	

Table 2. Pearson correlation analysis among variables of substrates as *Auricularia delicata* habitat. The numbers marked with the blue color that mean strong-very strong positive correlation between variables. Meanwhile the numbers marked with the red color that mean strong-very strong negative correlation between variables

Variables	C	N	C/N	Holo	Alfa	Gamma	Beta	Lignin	Decay	Species	Dtot	C/N	Holo	Alfa	Gamma	Beta	Lignin
C																	
N	-0,72																
C/N	0,91	-0,88															
Holo	0,07	-0,04															
Alfa	-0,19	-0,01															
Gamma	0,27	-0,05															
Beta	-0,07	0,04															
Lignin	0,20	-0,11															
Decay	0,39	-0,42															
Species	0,35	0,16															
Dtot	0,06	-0,02															
C/N	0,07	-0,19															
Holo	0,27	-0,07															
Alfa	0,20	-0,88															
Gamma	-0,04	-0,01															
Beta	-0,05	0,04															
Lignin	0,04	-0,11															
Decay	0,16	-0,01															
Species	0,25	-															

0,16 0,07 0,16 0,73 0,80 -1 -0,59 -0,01 0,73 0,18 -0,73 -0,27 0,25 0,80 0,18 -0,80 -0,61 -0,16 -1 -0,73 -0,80 0,59 0,07 -0,59 -0,27 -0,61 0,59 0,30 -0,33 -0,52 -0,03 0,33 0,02 0,27 0,54 0,21 0,59 -0,54 -0,24 -0,16 -0,09 -0,27 0,09 0,09 -0,06 Decay 0,39 -0,42 0,30 -0,33 -0,52 -0,03 0,33 0,02 -0,34 0,66 Species 0,35 0,16 0,27 0,54 0,21 0,59 -0,54 -0,24 -0,34 -0,43 Dtot 0,06 -0,02 -0,16 -0,09 -0,27 0,09 0,09 -0,06 0,66 -0,43 Table 2 shows a positive (simultaneous) or negative (inverse) relationship among the variables of habitat preferences of substrates which were overgrown with *Auricularia delicata* based on the Pearson correlation analysis of calculated number from Table 1. The closer the values to +1 or -1, the greater the correlation between those variables. According to Sugiyono [5], the interpretation of correlation coefficients can be categorized into very low ($\rho = 0.00 - 0.199$), low ($\rho = 0.20 - 0.399$), medium ($\rho = 0.40 - 0.599$), strong ($\rho = 0.60 - 0.799$), and very strong ($\rho = 0.80 - 1,000$). From Table 2 we would focus more on the correlation of number of fruit bodies production during observation (Dtot) to the other variables. According to Table 2 a strong correlation with production of *Auricularia delicata* fruit bodies is decay class, which means that the higher the decay class, the more fruit bodies may be produced on the substrates. The correlation analysis is still continued to see the significance between variables through the p value ($p \text{ value} < 0.05$). If the p value is <0.05, the relationship between these variables can be generalized to all *Auricularia delicata* population, if the p value is > 0.05 , the relationship between two variables is not significant. Table 3 proves that the p value of the correlation between the decay class and the total density of *Auricularia delicata* fruit bodies is more than 0.05, that is 0.050062, which means that there is no significance correlation between these two variables, no causal relationship. This means that strong relationship between these two variables may occur on a particular substrate/plot or period. The correlation between habitat preference variables can also be concluded through the correlation plot in Figure 2, which states that if the color of the variable plot gets closer to blue, the correlation becomes stronger and more positive (simultaneous), and if the color of the variable plot gets closer to red, the correlation becomes stronger and negative (inverse). The plot which is crossed means that the correlation between variables is not significant. Table 3. P values of Pearson Correlation analysis among variables of substrates as *Auricularia delicata* habitat. The numbers marked with the blue color that mean strong (positive)-significant correlation between variables. Meanwhile the numbers marked with the red color that mean strong(negative)-significant correlation between variables

Variables	C	N	C/N	Holo	Alfa	Gamma	Beta	Lignin	Decay	Species	Dtot
C	0,02691	6	0,00060	36	0,84257	0,61846	0,4659	0,84257	0,59319	0,29705	0,34306
N	0,02691	0,8767	4	0,02	0,00136	32	0,90263	0,97091	0,88486	0,90263	0,75874
C/N	0,00060	0,8767	0,9533	9	0,00136	3	0,90263	0,97091	0,88486	0,90263	0,75874
Holo	36	0,02	0,9533	0,00060	4	0,84257	0,61846	0,4659	0,84257	0,59319	0,29705
Alfa	0,84257	0,00136	0,9533	0,84257	0,59319	0,00136	3	0,90263	0,97091	0,88486	0,90263
Gamma	0,61846	32	0,9533	0,61846	0,4659	0,84257	0,59319	0,00136	3	0,90263	0,97091
Beta	0,4659	0,90263	0,9533	0,4659	0,84257	0,59319	0,00136	3	0,90263	0,97091	0,88486
Lignin	0,84257	0,97091	0,9533	0,84257	0,59319	0,00136	3	0,90263	0,97091	0,88486	0,90263
Decay	0,59319	0,88486	0,9533	0,59319	0,00136	3	0,90263	0,97091	0,88486	0,90263	0,75874
Species	0,29705	0,90263	0,9533	0,29705	0,34306	0,66438	0,47195	0,13076	0,5835	0,08821	0,13076
Dtot	0,34306	0,75874	0,9533	0,34306	0,66438	0,47195	0,13076	0,5835	0,08821	0,13076	0,52676
C	0,02691	0,34306	0,9533	0,02691	0,66438	0,47195	0,13076	0,5835	0,08821	0,13076	0,52676
N	0,02691	0,8767	0,9533	0,02691	0,66438	0,47195	0,13076	0,5835	0,08821	0,13076	0,52676
C/N	0,00060	0,8767	0,9533	0,00060	0,66438	0,47195	0,13076	0,5835	0,08821	0,13076	0,52676
Holo	36	0,02	0,9533	36	0,84257	0,61846	0,4659	0,84257	0,59319	0,29705	0,34306
Alfa	0,84257	0,00136	0,9533	0,84257	0,59319	0,00136	3	0,90263	0,97091	0,88486	0,90263
Gamma	0,61846	32	0,9533	0,61846	0,4659	0,84257	0,59319	0,00136	3	0,90263	0,97091
Beta	0,4659	0,90263	0,9533	0,4659	0,84257	0,59319	0,00136	3	0,90263	0,97091	0,88486
Lignin	0,84257	0,97091	0,9533	0,84257	0,59319	0,00136	3	0,90263	0,97091	0,88486	0,90263
Decay	0,59319	0,88486	0,9533	0,59319	0,00136	3	0,90263	0,97091	0,88486	0,90263	0,75874
Species	0,29705	0,90263	0,9533	0,29705	0,34306	0,66438	0,47195	0,13076	0,5835	0,08821	0,13076
Dtot	0,34306	0,75874	0,9533	0,34306	0,66438	0,47195	0,13076	0,5835	0,08821	0,13076	0,52676

Figure 2. Pearson correlation plot of all measured variables of substrates as *Auricularia delicata* habitat. Analysis of habitat preferences is deeply interpreted through analysis of similarity and distance Bray-Curtis indices to determine how similar habitats of the substrates which overgrown with *Auricularia delicata* fruit bodies. Explanation: SI : Similarity index W : The smallest value of parameters measured in the A : The total value of parameters measured at plot A B : The total value of parameters measured at

plot B The selection of the Bray-Curtis similarity index is based on the goodness of applying this index to calculate various parameters, whether it be species abundance or physical and chemical factors of various sampling [6]. To get dissimilarity or distance index we have to use an equation $DI = (1 - SI) \times 100\%$, DI (dissimilarity index) and SI (similarity index). two points / plots that are compared Table 4. Habitat preferences similarity based on Bray-Curtis index. The numbers marked with the blue color mean the highest similarity among plots

Plot	D01	D02	D03	D04	D05	D06	D07	D08	D09
D01	0,293785	0,469798	0,934495	0,708181	0,203075	0,182113	0,58135	0,307021	0,293785
D02	0,627462	0,260902	0,463403	0,701053	0,626877	0,55302	0,944918	0,469798	0,627462
D03	0,435581	0,673723	0,403647	0,384077	0,829393	0,621306	0,934495	0,260902	0,435581
D04	0,654606	0,165235	0,158358	0,530199	0,269208	0,708181	0,463403	0,673723	0,654606
D05	0,311177	0,294957	0,827414	0,497404	0,203075	0,182113	0,58135	0,701053	0,626877
D06	0,55302	0,403647	0,384077	0,829393	0,165235	0,158358	0,530199	0,311177	0,294957
D07	0,827414	0,497404	0,203075	0,182113	0,58135	0,701053	0,626877	0,55302	0,403647
D08	0,384077	0,829393	0,165235	0,158358	0,530199	0,311177	0,294957	0,827414	0,887972
D09	0,403175	0,887972	0,382591	0,403175	0,382591	0,708616	0,65494	0,583118	0,307021

Table 5. Habitat preferences dissimilarity index based on Bray-Curtis index. The numbers marked with the red color that mean the highest distance among plots

Plot	D01	D02	D03	D04	D05	D06	D07	D08	D09
D01	0,706215	0,530202	0,065505	0,291819	0,796925	0,817887	0,41865	0,692979	0,706215
D02	0,372538	0,739098	0,536597	0,298947	0,373123	0,44698	0,055082	0,530202	0,065505
D03	0,372538	0,739098	0,564419	0,564419	0,326277	0,345394	0,596353	0,834765	0,615923
D04	0,841642	0,170607	0,469801	0,378694	0,730792	0,291819	0,796925	0,817887	0,536597
D05	0,298947	0,373123	0,44698	0,055082	0,530202	0,065505	0,372538	0,739098	0,564419
D06	0,326277	0,345394	0,596353	0,834765	0,841642	0,170607	0,469801	0,378694	0,730792
D07	0,298947	0,373123	0,44698	0,055082	0,530202	0,065505	0,372538	0,739098	0,564419
D08	0,688823	0,705043	0,112028	0,705043	0,112028	0,172586	0,596825	0,617409	0,502596
D09	0,291819	0,796925	0,817887	0,41865	0,692979	0,055082	0,378694	0,730792	0,502596

From Table 4 we can see how similar the plots which are represented by the index values, while Table 5 we can find out among plots that have high or low dissimilarities. We try to interpret plot D01 that is very similar to D04 with the value of 93.44%, and D01 has the largest distance to D06 and D07 with the values of 79.69% and 81.78 %; plot D02 is very similar to D09 with the value 94.91% and D02 has the largest distance to D01 and D04 with the values of 70.62% and 73.90%; plot D03 is very similar to D08 with the value of 82.93% and D03 has the largest distance to D06 and D07 with the values of 59.63% and 61.59%; plot D04 is very similar to D01 with the value of 93.44% and D04 has the largest distance to D06 and D07 with the values of 83.47% and 84.16%; plot D05 is very similar to D08 with the value 82.74% and D05 has the largest distance to D06 and D07 with the values of 68.88% and 70.5%; plot D06 is very similar to D07 with the value 88.79% and D06 has the largest distance to D01 and D04 with the values of 79.69% and 83.47%; plot D07 is very similar to D06 with the value 88.79% and D07 has the largest distance to D01 and D04 with the values of 81.78% and 84.16%; plot D08 is very similar to D03 and D05 with the values of 82.93% and 82.74% and D08 has the largest distance to D06 and D07 with the values of 59.68% and 61.74%; plot D09 is very similar to D02 with the value of 94.91% and D09 has the largest distance to D01 and D04 with the values of 69.29% and 73.07%. The results of these similarity and dissimilarity data analyses will be very helpful for multidimensional ordination techniques. This ordination is a way to summarize data in the coordination form. The results of the ordinated data analysis will be presented in the form of a graph that displays the points as the representative of the sampling plot studied. The plots or sampling points are placed with their position directly close to the level of similarity, so that the coordinate points can explain whether they have a clustering pattern or not. In addition, deciding the pattern of group or cluster formation is based on personal considerations which

apparently also depend on the researchers' understanding of the habitat conditions of study [7]. Ordination decided to visualize plots coordinates is NMDS (Non-Metric Multidimensional Scaling). Figure 3. NMDS ordination of all plots based on Bray-Curtis similarity index with abiotic factors imaging (C, N, C/N ratio, lignin, alphacellulose, holocellulose, gammacellulose, betacellulose and decay class). Symbols: •Mallotus paniculatus; *Erythrina sp.; ■Macaranga triloba; ΔPodochaenium sp From the result of NMDS ordination graphs in Figure 3, it can be seen that there are clustering patterns in each quadrant. In quadrant I there is clustering formation between plot D02 and plot D09; clustering among plot D03, plot D05, and plot D08 in quadrant II; clustering between plot D01 and plot D04 in quadrant III; clustering between plot D06 and plot D07 in quadrant IV. It also can be summarized significance correlation between environmental variables and plot similarities. To ensure how similar and dissimilar among plots, the graph can be represented in Table 6 and Table 7 as follows: Table 6. Plots coordination numbers based on NMDS graph. Each cluster has to be marked with representative color in graph: the blue color for cluster in quadrant I, the red color for cluster in quadrant II, the yellow color for cluster in quadrant III, and the aqua color for cluster in quadrant IV

Name	Coordinate 1	Coordinate 2
D01	-0.30246	-0.17669
D02	0.19916	0.21164
D03	-0.1267	0.19137
D04	-0.31199	-0.20797
D05	-0.2589	0.012553
D06	0.41705	-0.19394
D07	0.41156	-0.15881
D08	-0.20034	0.11341
D09	0.17263	0.20843

Table 7. The environmental variables coordination number based on NMDS graph

Name	Coordinate 1	Coordinate 2
C_%	-0.1204	0.33621
N_%	0.16401	-0.34358
C/N_rasio_%	0.0064486	0.44056
Holo%	0.31738	-0.47228
Alfa%	0.46176	-0.42225
Gamma%	0.056858	-0.3146
Beta%	-0.31738	0.47228
Lignin%	0.17243	0.33739
Decayclass	-0.90053	0.32828

Figure 4. Sheppard plot of NMDS analysis shows that there is no stress in ranking process of the results. Stress value=0 NMDS can make [few assumptions about the nature of the data. For example, the principal component analysis assumes linear relationships and reciprocal averaging assumes modal relationships.](#) However, NMDS [makes neither of these assumptions, so is well suited for a wide variety of data](#) including environmental variables [8]. The [best result is the one that reflects the rank-order of distances in the original](#) dissimilarity and similarity calculation. The statistics [that reflects how well the configuration represents the distances is called „stress“.](#) A smaller stress value [means that a better NMDS ordination is calculated.](#) Figure 4 shows [final stress values](#) which [should ideally be smaller than 10% and not larger than 30%](#) [9]. In NMDS visualization above we only made a summary of the plots which are clustered, but unable to measure which cluster is the best and the worst and how many clusters really there are. To solve this distraction, it is recommended to do an analysis of the ecological distance by clustering methods. Clusters are formed with hierarchical clustering methods with the UPGMA ecological distance evaluation based on similarity Bray-Curtis index. [Hierarchical clustering methods do not only cluster sites](#) by species composition on each site, but it can [also cluster the various clusters](#) from various parameters [that were formed earlier in the clustering process.](#) Thus, [hierarchical clustering methods provide a hierarchy for the similarity of sites](#) [9]. [The results of a hierarchical clustering can be used to classify](#) plots as *Auricularia delicata* [into groups. The classification is defined by choosing a certain distance level, or by choosing a fixed number of clusters](#) as an alternative way of using non- hierarchical clustering methods such as K-means. Figure 5. Clustering analysis result using hierarchical clustering (UPGMA method) based on Bray-Curtis similarity index. The plots are classified into 5 clusters, but from NMDS gives 4 representative clusters. N Bootstraps = 1000; Cophenetic correlation = 0, 8458 Table 8. Clustering analysis result using non hierarchical clustering (K-means) that classify plots into 4 groups when we choose 4 as fixed number clusters

Item	Cluster	Category
D01	1	Very good
D02	3	Poor
D03	2	Good
D04	1	Very good
D05	2	Good
D06	4	Very poor
D07	4	Very poor
D08	2	Good
D09	3	Poor

Based on the value of cophenetic correlation that classical dendrogram in

Figure 5 is very good and is a representative of the formed clusters. The closer value to 1 the more representative the relationship of the closeness of cluster [10]. From the results of the clustering in Table 8 we can conclude after approaching the method that there are four habitat categories of *Auricularia delicata* in Bingungan forest, The Very Good group consists of plots D01 and D04; The Good group consists of plots D03, D05, and D08; The Poor group consists of plots D02 and D09; The Very Poor group consists of plots D06 and D07.

3.2 Habitat Characteristics and Fungal Strategies

Most of Basidiomycota group fungi can be categorized into white-rot fungi which prefer degrading lignin in the down woods to cellulose; the texture of down woods after being decayed would be fibrous and the color would be bleached [11]. *Auricularia delicata* produces a white rot on dead and decaying wood. It produces class II heme peroxidases such as [lignin peroxidases LiP](#) and [manganese peroxidases MnP](#). dye- decolorizing [peroxidases](#) with [manganese- independent peroxidases](#) activities have been demonstrated [12]. In fact the succession of the fruiting process of white-rot macrofungi was able to occur in all decay classes [13]. We found *Auricularia delicata* macrofungi were thriving on 3 and 4 decay classes at 3 species. They are *Mallotus paniculatus*, *Macaranga triloba*, and *Erythrina* sp. also as parasite at some tree species, like *Podachaenium* sp. and *Mallotus paniculatus*. Previous studies showed *Auricularia delicata* associated and form fruit bodies at rubber plantation (*Hevea brasiliensis*) and oak trees (*Quercus griffithii*) [14]. *Auricularia delicata* possibly can be found growing on fallen trees trunks or branches, and occasionally on the moss of living trees [15] and it is primarily found in wet forest [16]. In Bingungan Forest, most of all substrates as *Auricularia delicata* habitat are trunks which after being colonized some macrofungi not only *A. delicata* (some agarics and *Xylaria polymorpha* have been found), the trunks texture would be soft and fibrous, because of much lignin loss. Another case, evidently *A. delicata* is able as epiphyte organism (living on the surfaces of plants) on primary branches of *Mallotus paniculatus* and a trunk of *Podachaenium* sp. but their hosts are still alive. This fungal strategy is called biotroph which in [the latter case one might be expected that though local digestion of host tissue may be necessary for penetration or establishment of the pathogen, only simple nutrients would be removed from the host](#) [17]. This phenomena may explain the reason why that living tree (D06 and D07) belongs to the very poor category habitat for epiphyte *Auricularia delicata*; [some show special adaptations to the plant surface, which is a challenging environment, being dry, waxy and exposed to direct sunlight and the natural response of plants to fungal pathogens is to produce defensive plant hormones such as salicylic acid, jasmonates, and ethylene](#) [17][3]. So epiphytes are [often pigmented \(particularly melanised\) to protect them from UV radiation, and](#) the energy is most using in terms of survival. Thus, fruit bodies of *A. delicata* are not many to be produced. If we take a look at the very good category habitat for *Auricularia delicata* those are D01 and D04 to produce fruit bodies, we will realize there are some similar characteristics of tree species (*Mallotus paniculatus*), chemical contents, decay class, and finally taking effect to fruit bodies production. Their characteristics is also close D05 (*Macaranga triloba*), but plot D05 has high C/N ratio about 75.7%. [By increasing the C/N ratio of](#) wood materials, it may reduce the [ability of saprotrophic ormycorrhizal fungi to decompose the](#) substrates [18].

4. CONCLUSION

We have determined successfully which the best substrate as *Auricularia delicata* in Bingungan Forest, Turgo Natural Forest Conservation Area based on ecological informatics approach that we use; from Pearson correlation, similarity and dissimilarity indices, ordination, and clustering methods. We suggest to use this approach to analyze another macrofungi habitat the next forward. Choosing ordination and clustering methods depends on particular conditions and the researchers's consideration.

5. ACKNOWLEDGMENTS

Thanks to the best partners who involved in this research on the same research team, Suryo Arif Setyawan and Junita Kurniawati.

6. REFERENCES

[1] Prasetya, D., et al. 2017. Eksplorasi

Keanekaragaman Makrofungi Edible dan Non-Edible di Kawasan Hutan Hujan Tropis Bukit Turgo Merapi. Research Report of PKM DIKTI-2017, Yogyakarta State University (Unpublished). [2] Molina R., Pilz, D., Smith J., Dunham S., . Dreisbach, T., O'dell T., and Castellano M. 2001. Conservation and Management of Forest Fungi in The Pacific Northwestern United States: An Integrated Ecosystem Approach. Department of Agriculture United States, Forest Service, Pacific Northwest Research Station, Portland, Oregon, US. [3] Dighton, J. 2016. Fungi in Ecosystem Processes. Second Edition. CRC press, Taylor & Francis Group, US. [4] Pilz D., and Molina R. 1996. Managing Forest Ecosystem to Conserve Fungus Diversity and Sustain Wild Mushroom Harvests. Department of Agriculture United States, Forest Service, Pacific Northwest Research Station, Portland, Oregon, U.S. [5] Sugiyono. 2007. Statistik untuk Penelitian. Alfabeta, Bandung. [6] Barbour, M.G., Burk, J.H., and Pilts, W.D. 1987. Terrestrial Plant Ecology. Second Edition. The Benjamin Cummings Publ., Co., Inc., California. [7] Djohan, T.S. 2016. Petunjuk Praktikum Ekologi Lanjut. Universitas Gadjah Mada, Yogyakarta, Indonesia. [8] Holland, S.M. 2008. Non-Metric Multidimensional Scalling. Department of Geology, University of Georgia, Athens. [9] Kindt, R. and Coe, R. 2005. Tree Diversity Analysis: A Manual and Software for Common Statistical Methods for Ecological and Biodiversity Studies. World Agroforestry Centre, Nairobi, Kenya. [10] Hammer, O. 2011. Ecological Cluster Analysis with Past. Natural History Museum, University of Oslo. [11] Srivastava, S., Kumar, R., and Singh, V.P. 2013. Wood Decaying Fungi. LAP Lambert Academic Publishing, New Delhi, India. [12] Floudas, D., et al. 2012. The Paleozoic Origin of Enzymatic Lignin Decomposition Reconstructed from 31 Fungal Genomes. Science. 336, 1715-1719. [13] Rajala, T. et al. 2012. Fungal Community Dynamics in Relation to Substrate Quality of Decaying Norway Spruce (*Picea abies* [L.] Karst.) Logs in Boreal Forests. FEMS Microbiol. Ecol. 81, 2 (Aug, 2012), 494-505. [14] Xing-Hong, W., Chaobin, Z., Pedro, F. and Changhe, Z. 2016. Screening and Characterization of *Auricularia delicata* Strain for Mushroom Production under Tropical Temperature Conditions to Make Use of Rubberwood Sawdust. Research Journal of Biotechnology. 11, 11 (Nov, 2016), 26-37. [15] Mata, M. 1999. *Macrohongos de Costa Rica*. Instituto Nacional de Biodiversidad (INBio), Santo Domingo, Heredia, Costa Rica. [16] Museo Nacional de Costa Rica. 2013. *Auricularia delicata*. In: Ecobiosis 2013. National Biodiversity Portal. Downloaded on 30 September 2018. <http://ecobiosis.museocostarica.go.cr/especies/ficha/1/3404> [17] Moore, D., Robson, G.D. and Trinci, A.P.J. 2011. 21st Century Guidebook to Fungi. Cambridge University Press, UK. [18] Hättenschwiler, S. and Vitousek, P.M. 2000. The role of polyphenols in terrestrial ecosystem nutrient cycling. TREE 15, 238–243. 102 103 105 106 107 108