B I O D I V E R S I T A S
Volume 10, Number 4, October 2009
Pages: 201-205

ISSN: 1412-033X (printed edition)
ISSN: 2085-4722 (electronic)
DOI: 10.13057/biodiv/d100407

Population and Microhabitat Characteristic of *Homalomena bellula* Schott in Mount Slamet, Central Java, Indonesia

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Received: 3rd March 2009. Accepted: 16th June 2009.

ABSTRACT

The population and habitat characteristics of *Homalomena bellula* Schott in Java have received little attention. In this present study, the authors estimated the population density and habitat characteristic of *H. bellula* in Mount Slamet, Central Java, by means of random samplings of 2 x 2 m^2 plots. Two distinct populations were studied at two different altitude levels, i.e. below and above 1000 m asl. We used to suspect that there was a difference in both populations. But our result revealed that these two populations were actually similar in abundance, population density, and dispersion pattern and even in microhabitat characteristics.

Key words: *Homalomena bellula,* Araceae, population density, population structure, microhabitat. Introduction

Homalomena has a wide range of distribution throughout the world. About 150 species occur in Indo-Malesia to South China and Solomon Islands. Another eight species are found in the neotropics (Hay, 1999), although recent molecular evidence strongly questioning the generic status of the neotropical species (Gauthier et al., 2008). In Indonesia, *Homalomena* comprises of 42 species, distributed from Sumatra to Papua Barat and only eight of which are recorded in Java (Govaerts and Frodin, 2000). Another report stated that about 18 species of *Homalomena* exist in Java (Hay et al., 1995). However, all of these numbers must be regarded as provisional since there has been no critical revision of *Homalomena* for over a century. Recently initiated work in Sarawak suggests that for North Borneo alone the number of *Homalomena* species may exceed 200, with virtually all endemic.

At the present time no *Homalomena* species are a major priority for conservation and as none have been included in The Red List IUCN Data Book (IUCN, 2007). This may be loosely interpreted as that no *Homalomena* are threatened. However, considering the rate of forest degradation in Indonesia, some exception might be applied for species that have limited distribution such as *Homalomena bellula* Schott.

Homalomena bellula is distinct from other Javanese *Homalomena* in having a shoot organization that resembles a ginger in that flowering is both functionally and anatomically terminal, with the axis renewal taking place by the release of a dormant lateral bud. Thus the architecture of the rhizome resembles that of many gingers and most *Schismatoglottis* species allied to *S. calyptrata* (Roxb.) Zoll. & Moritzi. This shoot organization is in marked contrast to that of other Homalomena species where the shoot consists of a physiognomically unbranched sympodium. In common with most other *Homalomena,* the rhizome and aerial shoot tissue smells strongly of ginger when cut.

Homalomena bellula is ca. 40 cm high with a creeping rhizome. The leaves are narrowly ovate-hastate-sagittate, mid-green adaxially, pale green abaxially, 22 cm long and 10 cm wide, with acuminate to cuspidate apex. The spathe is erect, pale green, not constricted, slightly oblong, about 6.5 cm long, with caudate tip about 1.5 cm long. Spadix is stipitate for about 40 cm, sub-equal to spathe. This longer description was made by Yuzammi (2000). The species was described by Schott in 1863 based on a type specimen from Mount Halimun (Yuzammi, 2000).

Homalomena bellula is endemic to Java with limited distribution in West and Central Java (Yuzammi, 2000). A survey conducted in Mount Halimun by Bogor Botanic Garden team in 1997 and 1999, resulted in no records of the species, suggesting that the population may no longer exist in that area. A recent record of this species from an

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expedition in Mount Slamet done by Yuzammi and colleagues (Yuzammi, 2000). They found a single population of *H. bellula* in Baturraden, southern slope of Mount Slamet in Central Java, suggesting the existence of other *H. bellula* population in other parts of the area.

According to Yuzammi (2000), *H. bellula* is distributed within a narrow range of altitude of around 750 m asl. Thus, it also has a specific altitude beside its limited geographic distribution. A species with a confined distribution and considered as rare is vulnerable to environment changes, and consequently more vulnerable to extinction (Söderström et al., 2007). This study was aimed to estimate the current population of *H. bellula* and to describe its population structure and microhabitat characteristics. This information is very important in understanding the ecology of this species, and will also provide ecological data useful for deciding future conservation policy.

MATERIAL AND METHODS

Study sites

Mount Slamet, approximately 3,432 m asl, is the highest peak in Central Java. It is surrounded by five districts: Purbalingga, Banyumas, Pemalang, Tegal, and Brebes. It covers an area of about 50,000 ha of which about (10,000) ha has been allocated as protected forest. The forests are under the authority of the state company Perhutani (Indonesian State Forest Enterprise) as production forest, limited production forest and protected forest. The protected forests consist of three vegetation zones: sub montane (1,500-2,000 m asl), montane (2,000-2,400 m asl) and alpine (above 2,500 m asl), which providing a high biodiversity.

Field work for this research was conducted in September, 2007 in Pancuran Tujuh Area, the southern slope of Mount Slamet, a tourism area managed by Perhutani, the private holding company inside the forest area (Figure 1). The altitude of the study area was between 750 to 1,500 m asl (S $07^0$18’590” and E $109^0$13’088”). Total annual precipitation of this area is more than 5,000 mm/year, with temperature ranging between $20^0$and 30^0C. The soil type of the area is dominated by clay with dark reddish brown color.

Species composition in the protected forest is comprised of several taxa such as Lauraceae, Myrtaceae, Annonaceae, Leeaceae, Sterculiaceae, Sapindaceae, Euphorbiaceae, and Rubiaceae. In the understorey, species composition dominated by herbs and small trees. The understorey species that are also suspected to be associated with *H. Bellula* as their coexistence are *Schismatoglottis calyptrata*, *Elatostema rostratum*, *Cyrtandra* sp., *Curculigo* sp., and *Clidemia hirta*.

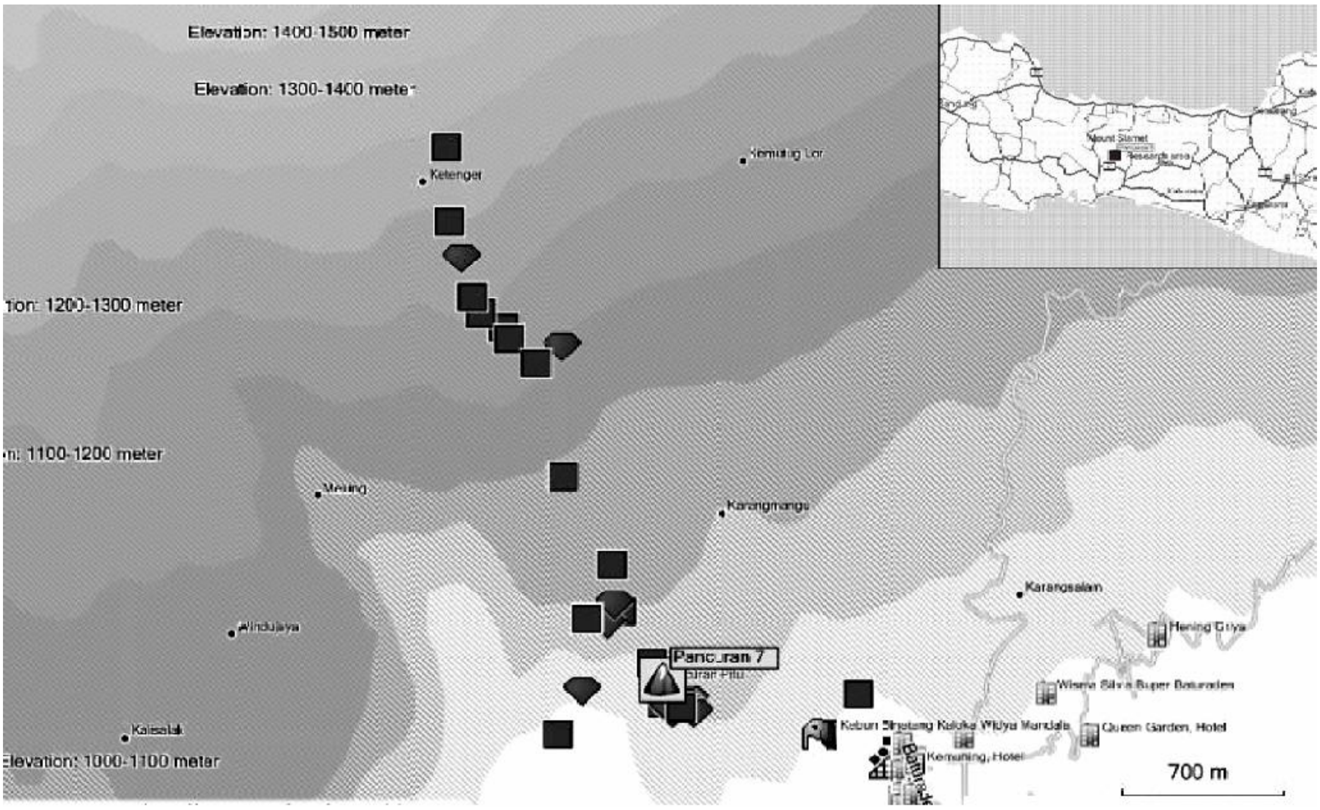

Figure 1. Map of research area in southern slope of Mount Slamet.

Methods

The populations of *H. bellula* were determined by random transect survey. All individuals were recorded and mapped by GPS (*Global Positioning System*). All groups of plant with at least 500 m distance apart were considered as a different population or regarded as subpopulations (Osunkoya, 1999). Natural or arbitrary boundaries such as a large stream or a cultivation area were also used to differentiate the populations.

Density of each population was determined by using quadrant plots (2 x 2 m^2) in which the presence and abundance of *H. bellula* were recorded and counted. Population density was determined by dividing the number of all individuals within the total plot sample by the total area of plot sampled in each population. In recording and counting all individuals within the sample plots, three different growth stages of the plant were distinguished, i.e. juvenile (including seedling), vegetative, and reproductive stage.

The dispersion pattern of each population was also calculated using Morisita's Index with an assumption that the population consisted of clumps or patches of individuals of different densities, and that within a clump individuals are randomly spaced (Poole, 1974).

As an addition data on microhabitat characteristics within sample plots for each population was also collected. These included temperature, humidity, soil temperature, soil humidity, light intensity, and canopy covering percentage. The microhabitat characteristics were used for estimating microhabitat preference of *H. bellula*.

Data were subsequently analyzed descriptively, except for comparison of population density and microhabitat characteristics between populations. This comparison were analyzed using nonparametric Kruskal-Wallis tests because the underlying distributions of these variables were unknown (Potvin and Roff, 1993). The statistics analysis was carried out by SPSS version 15.0 (SPSS Inc.)

RESULTS AND DISCUSSION

Population and density

Based on random transect survey two groups of *H. bellula* with different altitude level were identified. One group in the area below 1,000 m asl. (colline zone) was identified as Pancuran Tujuh population (PTP) and another group in the area above 1000 m asl (submontane zone) was identified as Hutan Rimba Population (HRP). The *Garmin mapsource* program was used to determine the distance between two groups and giving a result of 1.2 km, approximately. According to Osunkoya (1999) and Yakimowski and Eckert (2007) those groups were considered as two separate populations based on long distance between groups (more than 1 km) and also in difference of topography which included altitudinal and arbitrary boundary, a cultivated pine and *Agathis* forest among both groups.

The comparison of two populations using Kruskal-Wallis test shows that there was no significant difference in population density of PTP and HRP ($\rho \approx 0.09$; U=59.5). Even though, from the table it was clearly shown that there were differences in the frequency of occurrence and the population density, which was PTP relatively denser than HRP (table 1). Many factors, biotic and abiotic can affects the abundance of plant populations. At the local scale, however, biotic interactions often determine the abundance of plants (Medel-Narvaez et al., 2006)

Table 1. The population density of each population of *H. bellula*.

Site	Altitude (m asl)	Habitat Type	Plot numbers	Frequency of occurrences (%)	Population density (mean ± SE) (individual/m²)
Pancuran Tujuh (PTP)	< 1000	Mixed Forest	21	61.90	0.86 ± 0.28
Hutan Rimba (HRP)	> 1000	Mixed Forest	9	22.22	0.25 ± 0.16

In Araceae, the abundance can also be greatly affected by vegetative reproduction (stolons, offshoots, etc.). In Sarawak, *Schismatoglottis motleyana* often dominates the herbaceous layer of entire valleys and yet seldom flowers and fruits. Such super-clones appear to have almost entirely given up sexual reproduction. A similar situation is found with the helophytes *Homalomena rostrata* and *H. expedita* (P. Boyce, *pers. comm.*, 2009).

In accordance with our field observation there were several traits that we predicted to be possibly affecting the differences of abundance and population density between both populations: the pollination, population patterns and habitat characteristics.

Homalomena bellula, as the family of Araceae in general, has a unique inflorescence and required pollinator agent due to its protogynous anthesis. Araceae are generally pollinated by insects, principally beetles and flies but also bees and thrips (Gibernau et al., 1999). We suspected that pollination may play a crucial part in determining population density and relative abundance.

Population structure and dispersion pattern

The populations of *H. bellula* were quite different in the percentage number of each growths stage except in fruiting adult stage (Figure 1). About ten percent of both population members were at fruiting adult stage and eighty percent were in the other different stage classes. In contrast, the pattern of population structure of both populations was similar; both fitting the log-normal distribution. It revealed that the populations are expected for young growing populations under constant recruitment.

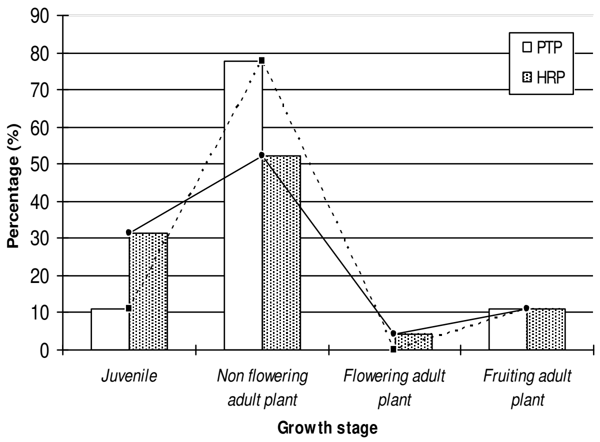

Figure 2. Population characteristic of *H. bellula.*

The difference in amount of flowering and fruiting individuals was not obvious (Figure 2). Both populations bear individuals producing fruits. However, further observation is needed to study the reproductive biology; because we suggest that the pollinator play an important rule in the successful pollination. It is in accordance with our observation of *H. bellula* collection in Bogor Botanic Garden in which mature fruit of *H. bellula* was not successfully produced.

In spite of producing fruit and seed, the species is likely favorable to use vegetative (clonal) reproduction in order to reproduce. Their creeping rhizomes are able to produce new shoots and develop to new individuals. Apparently reduced sexual reproduction and improved asexual reproduction is particularly common to plant in which sexual reproduction cannot occur (Eckert, 2002).

The altitudinal distribution of this species in this study area varied between 767 to 1287 m asl. Yuzammi (2000) recorded the altitude level of *H. bellula* as far as 750 m asl., but in this study we discovered individuals at an altitude of more than 1000 m asl (Figure 3). Compared to Araceae in general that have a broad ecological range (Leimbeck et al., 2004), this distribution was regarded as a narrow distribution in altitudinal level.

Density of plant populations can also be used to represent a function of the spacing between neighboring individuals (Kunin, 1997). This means that close distance of each individual within the population can increase the population density by stimulating accretion of population size. Spacing between neighboring individuals could be estimated using dispersion pattern of the population. Poole (1974) mentions that in field populations it is difficult to define sharply the population interactions, but sometimes by observing the dispersion patterns of the individuals some insight into the biological characteristics of the species and the reasons behind the changes in density of the population can be gained. Using Morisitha Index dispersion, both *H. bellula* populations are have the same type of dispersion, which is clump; the calculation yielded 4 and 2,853 for PTP and HTP, respectively.

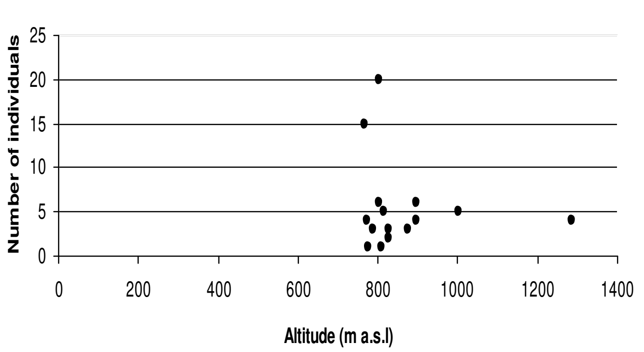

Figure 3. The distribution of *H. bellula* based on altitude level.

Habitat characteristics

The microhabitat characteristics in both populations were compared using Kruskal-wallis test and revealed not significantly different, except for slope degree (Table 2). This means that both populations tend to occupy similar microhabitat.

Degree of slope was the only significant habitat parameter that differs in both populations, leading to a difference in population density (Table 2). According to Boyce (2004), the aroids are overwhelmingly plants of humid and shaded forest which is easily found on steep slopes of stream valleys at low to mid-elevation (up to 850 m asl). The area in Pancuran Tujuh has more valleys than in Hutan Rimba, even though the valleys were steeper. Thus, the result confirm that steep slope within a certain degree, seems to be favored by *H. bellula*.

Table 2. The comparison of habitat characteristic in two *H. bellula* populations.

Site / Parameter	PTP (mean ± SE)	HRP (mean ± SE)	Asymp. Sig. (2-tailed)
Soil pH	6.8±0.04	6.9	.050
Soil humidity (% RH)	54.4±5.6	50	.566
Temperature (^{0}C)	24.3±0.6	24.5±0.5	.469
Humidity (% RH)	85±3.6	85±5	1.000
Light Intensity (Lux)	842.3±156	107.5±22.5	.145
Topography	Hilly	Hilly	-
Slope (^{o})	54.2±2.7	31±11	.024*
Canopy covering (%)	55.6±8	70±10	.247

Note: PTP (Pancuran Tujuh Population); HRP (Hutan Rimba Population). Data were automatic recoded to fill the assumptions. * significant in α=5%

CONCLUSIONS

There were two populations of *H. bellula* in Southern Slope of Mount Slamet; one occupy colline zone and the other occupy submontane zone. Both populations were similar in population density, population structure, dispersion pattern and microhabitat characteristics. The population seems to be in good condition due to its log-normal size distribution that expected for young, growing populations with constant recruitment, supported by many numbers of juveniles for population maintenance. Future study should focus on monitoring the population and estimating the population growth rate to address the best management system of the species.

ACKNOWLEDGMENTS

We would like to thank Sutrisno, Annisa Satyanti and Peter Boyce for their insightful remarks and constructive suggestions, which led to a substantial improvement in the paper. We grateful thank to Yuzammi for her helpful discussion during the paper writing. We also would like to thank Subroto Widyatmoko (Perhutani) for the permission and Kartam for help and enjoyable discussion during the field work.

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