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Flower-insect Visitor Interaction: Case Study on *Rhododendron inundatum* Sleumer in Bali Botanic Garden

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A B S T R A C T

The *Rhododendron*-insect relationship was quite well studied in the northern hemisphere. However, information on the flower-insect relationship of the Indonesian *Rhododendron* was limited. This study aims to find the interaction between *Rhododendron inundatum* Sleumer collected in Bali Botanic Garden and its flower-visiting insect. The study was conducted by observing insect visitation to the flower of *R. inundatum* for 1 hour a day and repeated for nine days. Data analysis was conducted by calculating the Visitation Rate (VR) of each visitor taxa to determine its frequency. Study result showed that *R. inundatum* in Bali Botanic Garden was visited mainly by *Chrysopa* sp., as well as members of the Vespidae, Curculionidae, Muscidae, Drosophilidae, and Tephritidae**.** The result of this study was dissimilar with the previous study of white-flowered *Rhododendron*, which was mainly visited by moths.

1. Introduction

Rhododendron is a Genus that contains more than 1000 species of Ericaceae Family (Jing *et al*., 2015). The genus is economically important as ornamental plants due to its beautiful and diverse flowers color and shape (Paul *et al.,* 2005; Gibbs *et al.*, 2011). Flowers shape and color was long being thought as the result of co-evolution between flower and its visitors. Even after being criticized recently, this concept was still adequate to understand floral diversification (Fenster *et al*., 2004).

Some recent studies indicated that *Rhododendron* flowers properties were in correspondence with their pollinator organisms. The study of *R. semibarbatum* and *R. ponticum* revealed that both species requires bumblebee (*Bombus*) to help it pollinate. Morphological properties of *R. semibarbatum* flowers enables the bee's body to have contact with the anther and pollen, thus indirectly facilitating pollination of this species (Ono *et al.,* 2008; Stout, 2007). Another study in *R. reticulatum* and *R. macrosepalum* found out that flowers of both species were visited by Hymenoptera, Lepidoptera and Diptera (Sugiura, 2012). Meanwhile, the study of *R. floccigerum,* an ornithophilous flower, showed that it was pollinated by 13 animal taxa, including two mammals and nine birds (Georgian *et al*., 2015).

Information regarding flower-insect relationships for Indonesian *Rhododendron,* however, was limited. Stevens (1976) and Stevens (1985) suggested that based on its flower morphological features, Papuanesia *Rhododendron* was pollinated by birds, moths and butterflies. Jolivet (1998) supported this claim by stating that at Mt. Wilhem, red-flowered *Rhododendron* were pollinated by birds, while white scented *Rhododendron* was pollinated by hawkmoths. More recent study regarding flower-insect relationships for Indonesian *Rhododendron*, on our best knowledge, was absent*,* especially for ex-situ *Rhododendron* species. This study aims to understand the interaction between ex-situ *R. inundatum* flowers with its insect visitor in Bali Botanic Garden. The result of this study was expected to give information regarding the interaction of *R. inundatum* grown in ex-situ conservation site, with its visiting insects.

2. Material and Methods

2.1. Time and Study Site

The study was conducted in September 2016 at the nursery unit of Bali Botanic Garden. The nursery was located about 1200 meters above sea level. *R. inundatum* grown in the nursery was preferred than the one grown in the field because it was less exposed to anthropological disturbance, mainly from the Botanic Garden visitors that may have affected visitor insect.

2.2. Plant Material

The study was conducted using two specimens of *R. inundatum* with accession number E20080930, collected from the Napua District, Jayawijaya Regency, Papua Province of Indonesia in 2008. *R. inundatum* was an endemic *Rhododendron* of New Guinea island. It belonged to the Sub Genus *Vireya* and *Siphonovireya* section (Argent, 2006). *R. inundatum* is a terrestrial shrub that can grow up to 1 m in height. The leaves were dark green and broadly elliptic, while the flowers were white, trumpet-shaped and had a pleasant scent.

2.3. Data Collection

Data collection was conducted by observing insect visitor of 21 flowers from three inflorescences of *R. inundatum*. The observation was conducted for an hour every day between 09.00-10.00 WITA. This respective time was selected because during the observation insects were found visiting *R. inundatum* only at this range of times. No insect was encountered before and was decreased both in number and diversity before finally disappeared at the end of the respective time range. The observation period was ended after nine days when there was no more insect visit the inflorescence. Insect visitor definition following Spackman *et al.* (2001) was all insect that conducting direct contact with any part of *R. inundatum* flowers. Insects were then documented and identified until its Family or Genus, number of flowers visited, and the insect visitor number was counted, insect activity during its visit in flower was noted to determine the insect pollinating potential.

2.4. Data Analysis

Data analysis was conducted by calculated Visitation Rate (VR) to determine most frequent insect visitor. VR formula for each insect taxa following Spackman *et al.* (2001) was as follow:

$$\frac{\text{Number of Visit by "x" insect Taxon}}{\text{Number of Open Corollas}}$$

The calculation was repeated in each observation days, an average of VR number for respective insect taxa was then calculated at the end of the observation.

3. Result and Discussion

3.1. *R. inundatum* flower

R. inundatum was reported to be flowering regularly twice a year (Argent, 2006). We started our observation when the corollas were in full anthesis period. At the beginning of the observation the corollas were fully open, fresh, white in colors and produced a pleasant odor. The stigma was slightly wet with lightly sticky substrates. At the end of the observation, the corollas dried up, the color turned brown, starting from the edge of the corolla. The odor was disappeared, and the stigma was also dried up. At the time when corolla started to dry, the visitor decreased until finally none was found on the tenth day.

3.2. *R. inundatum* flowers visitor

Rhododendron and pollinator interaction was affected by some factors such as flowers morphological feature (Stevens, 1976; Cruttwell, 1988). Based on its morphological feature *R. inundatum* was grouped as white, long, tubular and fragrant flowers (Craven, 2007). Pollination of this type of flowers was usually helped by moths, mainly from Sphingidae family (Stevens, 1976; Cruttwell, 1988). This statement was supported by Spira (2011) which stated that fragrantly white flowered *R. viscosum* was at its most pleasant smelt during the night to attract its moth pollinator.

During the study, flowers of *R. inundatum* was visited by six taxa of insects, namely *Chrysopa* sp. (Chrysopidae, Neuroptera), Vespidae (Hymenoptera), Curculionidae (Coleoptera), Muscidae, Drosophilidae, and Tephritidae (Diptera). From all those insect taxa, *Chrysopa* sp. holds the highest VR number of 0,058 followed by Muscidae and Drosophilidae with VR number 0,021 and 0,016 respectively (Fig. 1). Higher VR number means more visitation frequency to the flower by respective insect taxa. The more frequent visit would mean that respective insect taxa had more chance to pollinate the flowers. Adult *Chrysopa* spp. was not only a predatory insect but also feed on pollen (Bozsik, 1992). This might be the reason why in this study, adult *Chrysopa* sp. was found visiting *R. inundatum* flowers quite intensively.

Spira (2011) mentioned bees and butterflies were the diurnal pollinators of white, scented *Rhododendron* flowers. However, none of those taxa was visiting *R. inundatum* during the study. The difference might happen because there was different environmental condition between ex-situ habitat,

such as the Botanic Garden, and the natural habitat where *R. inundatum* was originated. Habitat difference caused the flowering plant to interact with different insect taxa. Richardson *et al*. (2000) stated that to be able to establish itself, introduced plant species must be able to form mutualism relationship with indigenous pollinator organisms in its new habitat. Failure to do so would hamper plant reproduction process and in turn affected the plant survival and dispersal in its new environment (Stout, 2007). This study indicates that *R. inundatum* might already have interacted with the indigenous insect of Bali Botanic Garden.

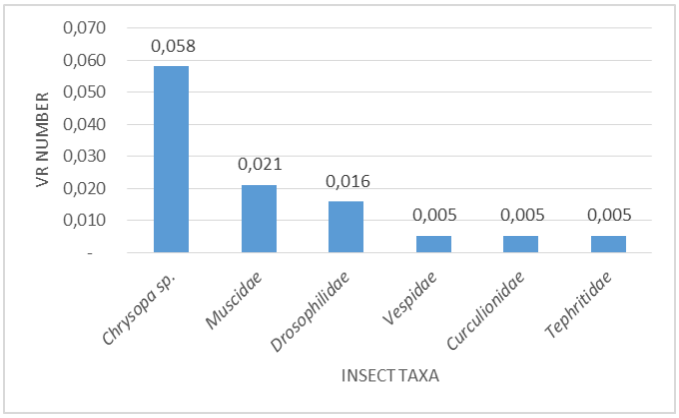

Figure 1. Visitation Rate (VR) number of insect taxa visiting *R. inundatum* flowers during the observation

3.3. *R. inundatum* Insect Visitor Pollinator Potential in Bali Botanic Garden

According to Stout (2007), an organism could be categorized as true pollinator if the respective organisms were able to both picked pollen from anthers and deposited it to the correct stigma. Some factors affected visitor to become a true pollinator organism, including visitor body size and its behavior when the organisms gathered pollen or nectar (Stout, 2000; Stout, 2007). Pollination could also be facilitated by a predatory insect. Cocopet insect (Dermaptera) was suggested not only serve as predatory but also pollinator insect due to its activity around coconut flowers that made Cocopet able to carry pollen to stigma (Rahma and Salim, 2014). Another example of pollinator potential of predatory insect was found in *Vespa velutina nigrithorax*. Ueno (2015) suggested that *V. velutina nigrithorax*, might be helping pollination process of some flowering plant species because the queens and workers of this wasp were often found visiting flowers of the same plant species in a single trip with pollen in its body.

Observing insect activity and behavior during its visit is one way to determine its potential in helping pollination process. This study found that only *Chrysopa sp.* (Fig. 2.) and wasp belong to Vespidae, were walking in and out of the corollas, and thus made direct contact with both the anther and stigma. Meanwhile the other insect visitors were found only walking on the outside part of the corollas and doesn't make any contact with the anther and stigma. This behavior might enable both *Chrysopa sp.* and Vespidae to indirectly transport *R. inundatum* pollen to its stigma. However, pollinator potential of both taxa in *R. inundatum* was still needed to be further assessed because *Chrysopa* spp. was reported to feed on pollen while *V. velutina nigrithorax* of Vespidae wasn't (Bozsik, 1992; Ueno, 2015).

Figure 2. *Chrysopa Sp*. Walked in and out of *R. inundatum* Flowers.

4. Conclusion

This study suggested that *R. inundatum* lived in Bali Botanic Garden was already interacted with indigenous flower visitors, proved by the different insect visitor species found between this and previous studies. Further study was needed to determine how the difference would have affected pollination ecology of *R. inundatum* in Bali Botanic Garden. That information would help conservation attempt of *R. inundatum* conducted in Botanic Garden.

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