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## RECORDS OF FLORAL VISITATION BY DIPTERANS ON MALABOÔ, *Rafflesia lagascae* Blanco (RAFFLESiaceae), MAINLY IN MOUNT MAKILING, LAGUNA, PHILIPPINES

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### ABSTRACT

Floral visitors of *Rafflesia lagascae* Blanco are identified and recorded as actual or potential pollinators. The most commonly observed was the metallic blue blow fly, *Chrysomya megacephala* (Fabricius), while two other blow flies, observed but not collected include a dull-colored, bristly species that probably belongs to *Bengalia*, and the greenish-blue species *Lucilia fumicosta* Malloch. The red-eyed flesh fly, *Sarcophaga* sp., was also observed to visit and possibly larviposits some of its tiny maggots into the perigone. The common housefly, *Musca domestica* L., vinegar flies *Drosophila* spp., and undetermined dolichopodids and phorids were also observed. The phorids probably play a greater role toward the decay of the more matured flowers. Video-documentation and other field studies are recommended for this threatened *Rafflesia* species in a forest reserve that has witnessed a recent rise in tourist visits.

**Key words:** blow flies, Calliphoridae, flesh flies, floral visitors, Mount Makiling, Muscidae, *Rafflesia lagascae*, Sarcophagidae

### INTRODUCTION

The genus *Rafflesia* (Rafflesiaceae) is composed of parasitic plants that produce what are known to be the giants among flowers (Barcelona et al. 2006; Pelser et al. 2013). The plants are entirely dependent on *Tetrastigma* (Vitaceae) vines that grow mainly in lowland forests. Among many other unique features, at least one species of *Rafflesia* is believed to have entirely lost its chloroplast genome (Molina et al. 2014). Locally, the genus has gained renewed interest among biodiversity scientists since the discovery of *R. speciosa* Barcelona & Fernando (2002). From only two before 2002, the number of Philippine species has increased to 13 (Barcelona et al. 2009, 2014; Pelser et al. 2011 onwards; David et al. 2012; Galindon et al. 2016).

Among the Philippine species, the one in Mount Makiling was the most widely known when there used to be only two species recognized from the country, i.e., compared to the more elusive *Rafflesia schadenbergiana* Göppert ex Hieron. It was formerly referred to as *R. manillana* Teschem. and was regarded

for a long time as the smallest of all *Rafflesia* species (e.g. Pancho 1983, Fernando et al. 2004) at least up to the works of Barcelona et al. (2006, 2009). The species has also been included as early as 1986 by Tan et al. among endangered Philippine plants. After a thorough study by Pelser et al. (2013), the Makiling population, locally called “malaboô,” is now properly known as *R. lagascae* Blanco. Endemic to Luzon, it is now the most widely distributed among the Philippine *Rafflesia* from Cagayan Province in the north to Albay Province in the south (Barcelona et al. 2018).

In the Philippines, as in most of Southeast Asia where *Rafflesia* species occur, conservation of the remaining populations is of utmost concern (Pelser et al. 2017, 2018). Studies of floral biology and ecology (e.g., those reviewed by Hidayati & Walck 2016) have been initiated. All of these aim to contribute to basic knowledge that will help in conservation efforts at the species and habitat levels.

*Rafflesia* flowers are known to be visited and/or pollinated by carrion flies, probably attracted to the scent they emit that mimics decaying meat (e.g. Beaman et al. 1988, Nais 2001, Wee et al. 2018). In what is probably, so far, the best documented pollination of a *Rafflesia* species, Beaman et al. (1988) confirmed that carrion flies, specifically calliphorids of the genera *Lucilia* and *Chrysomya*, are the pollinators of *R. pricei* Meijer. *R. pricei* is endemic to the Crocker Range in Sabah (north Borneo) and based on their field experiments, they concluded that both visual and olfactory cues are important in attracting flies to the flowers. The olfactory aspects of pollination in *Rafflesia* species were clearly demonstrated by Wee et al. (2018) for *R. cantleyi* Solms-Laubach and its visiting calliphorids in Peninsular Malaysia. Beaman et al. (1988) further illustrate morpho-anatomical features of *R. pricei* that guide flies to the inside of the flowers and assure that they capture pollen from the male and transfer them to the female flowers. The pollination syndrome was classified as sapromyophily in which the flower provides no reward for the pollinating carrion flies but deceives them by an apparent offering of food or possible brooding place.

The only local study on the floral biology of the Makiling *Rafflesia*, i.e., Yahya et al. (2010), however, made no clear mention of flies other than larvae of insects associated with *R. lagascae*. Their results are further discussed later, vis-à-vis the insects identified in this paper.

Since the early 1990s, observations of flies visiting malaboô have been made during occasional hikes to the upper slopes of Makiling and when the local population bloomed, usually between late February and June. Restrictions on collections of associated organisms were stipulated in permits as regulators were worried about damaging these plants that are regarded as rare. Hence, collections and records of visual observations have remained largely occasional or opportunistic, and fragmentary. This paper aims to consolidate the bits of information gathered through the years in the hope of stimulating interest in studying the role of insects and other arthropods in the biology of *R. lagascae* and of other *Rafflesia* species. Such roles may not be limited to being potential pollinators but also as consumers and ultimately, as decomposers.

## METHODOLOGY

Earlier observations of the insect visitors/pollinators of *R. lagascae* flowers were mainly composed of visual counts and recorded in notebooks, with occasional light sweeps using an insect net over the open flowers. Being fairly common, most of the collected flies (mainly *Chrysomya*) were released and only a few were kept as vouchers. The few vouchers are deposited in the Entomology Section of the UPLB Museum of Natural History. Recently, a camera was used when available. Photographs of malaboô in Mount Makiling taken by the late Ms. Mary Ann O. Cajano also proved valuable. These are presently supplemented by two photographs of *R. lagascae* on Mount Labo, Camarines Sur Province taken by Dr. Julie F. Barcelona and those taken recently by Mr. Cristian C. Lucañas (Figures 1 and 2). The list of flies included in Baltazar's (1990) inventory and other references on Diptera were consulted for identification and updates on nomenclature.

## RESULTS AND DISCUSSION

### Brief Species Accounts

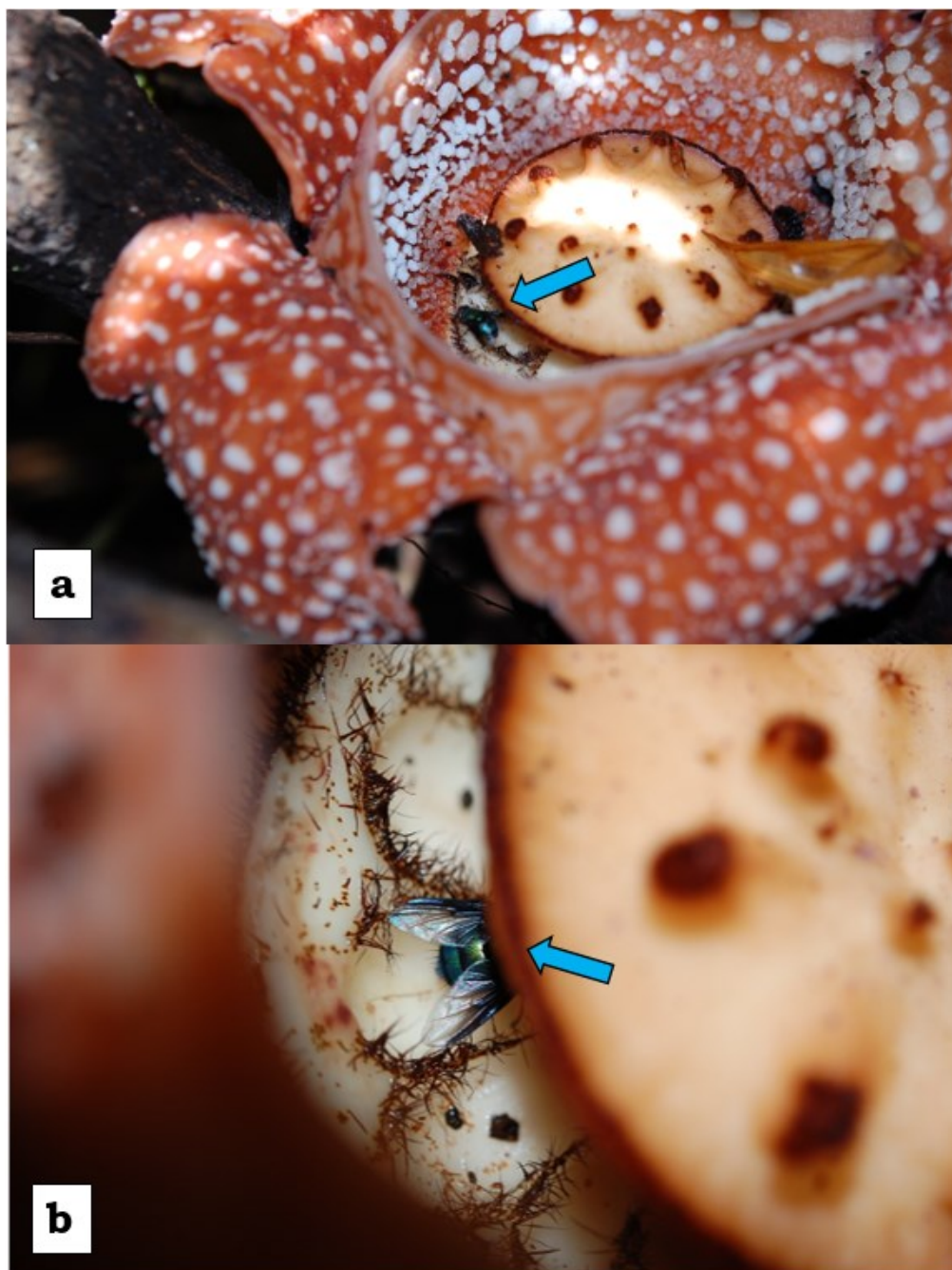
#### Family CALLIPHORIDAE (Blow Flies)

##### 1. *Bengalia* sp.

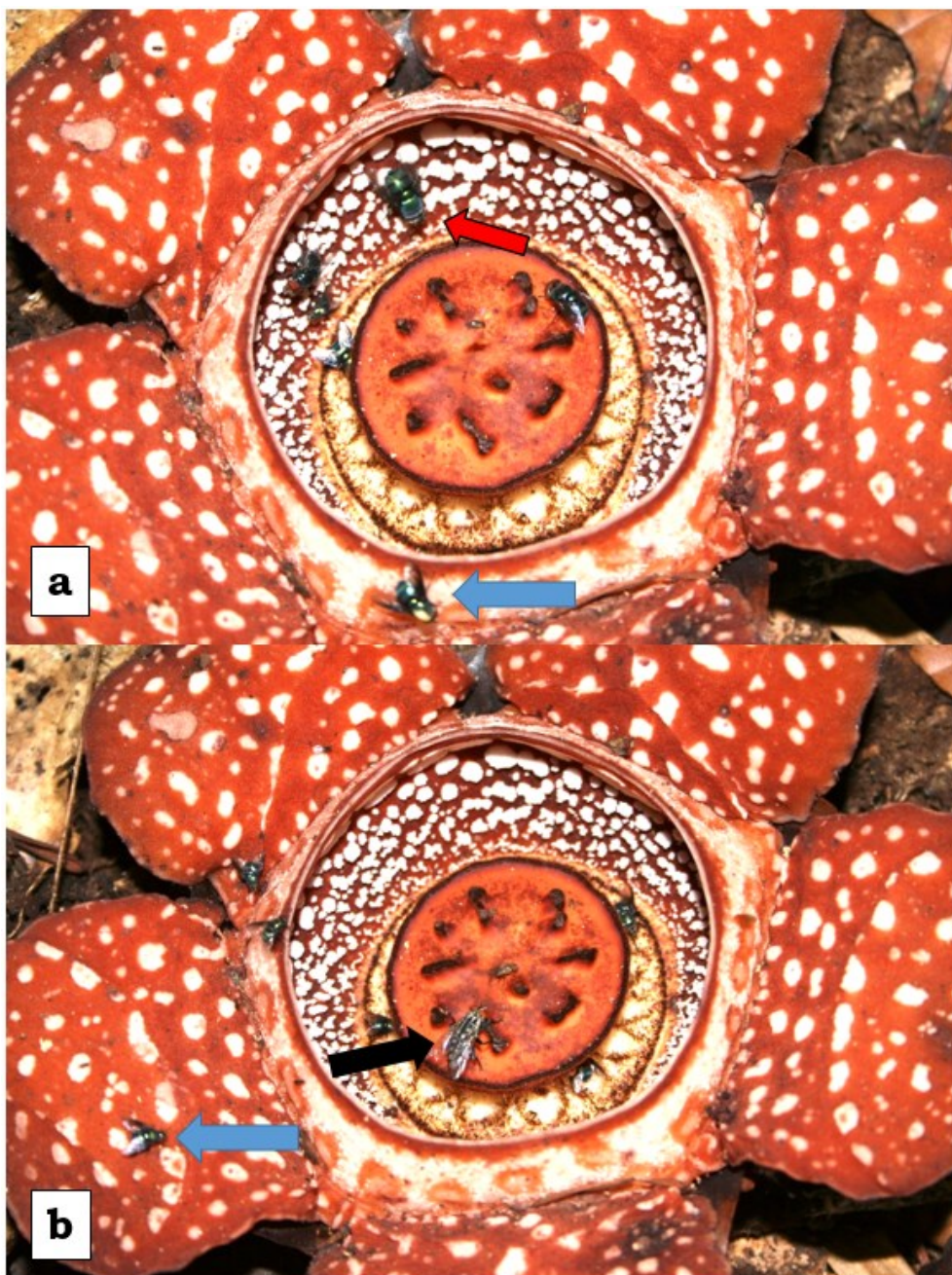
This blow fly, has been observed to land on fully bloomed malaboo on two occasions. Unfortunately, no specimen has been collected. It is a dull-colored and bristly species that probably belongs to this genus. Baltazar (1990) included the following species from Mount Makiling: *B. calilungae* Rueda, *B. inermis* Malloch, *B. recurva* Malloch, and *B. lyneborgi* James (as determined by Rognes 2009, based on the illustrations of *B. varicolor* (Fabricius) by Rueda 1985a). *Bengalia* species are believed to be kleptoparasitic on ants. Nonetheless, they have also been reported as among those collected using dung bait. Their presence among malaboo flowers, therefore, may be due to their attraction either to the ants that crawl nearby or to the scent of the flowers.

##### 2. *Chrysomya megacephala* (Fabricius)

*Chrysomya megacephala* is commonly known as the Oriental latrine fly and varies from the common metallic blue to metallic green or blue-green. This has been the most common among species observed to visit malaboô flowers and those collected using sweep nets, particularly when observations were conducted a few days after Holy Week, the season where tourist visits usually peak. [N.B. all voucher specimens with the following collection data: PHILIPPINES: LUZON: Laguna Province, Mount Makiling, ex. *R. lagascae*, between 1992 and 1993; and 2003 to 2009; leg. I.L. Lit, Jr., UPLBMNH DIP-02416 to 02424]. Flies have been observed to go inside the central parts of the flower, with many having yellowish sticky pollen stuck on their backs upon coming out.



**Figure 1.** Dipteran floral visitors on *Rafflesia lagascae* in Mount Makiling, Laguna: Blow flies (Calliphoridae) particularly *Lucilia fumicosta* (blue arrows, identified by Mr. Ronniel D. Pedales). **a.** view of the entire flower with one of the flies. **b.** close-up showing the posterior abdomen visible as the blow fly enters the inside of the flower. Photographs by Cristian C. Lucañas, 01 April 2017.



**Figure 2.** Dipteran floral visitors on *Rafflesia lagascae* in Mount Labo, Camarines Sur: Blow flies (Calliphoridae) including: the Oriental latrine fly, *Chrysomya megacephala* (red arrow in **a**) and the green bottle fly, *Lucilia fumicosta* (blue arrows in **a** & **b**, identified by Mr. Ronniel D. Pedales) and flesh flies or sarcophagids, *Sarcophaga* sp. (Sarcophagidae) (e.g. fly at lower center in **b**, pointed by black arrow). Photographs by Julie F. Barcelona, 2007.

Being widely distributed, this species will probably be among the most commonly encountered visitors of *Rafflesia* species and other flowers that produce scents to mimic decaying animal matter. Several other *Chrysomya* species being also widespread (see also Baltazar 1990; Rueda 1985b) maybe likely candidate pollinators in other places where *Rafflesia* species occur.

This blow fly species, being considered of importance to public health and forensic science, is often overlooked by beginning students as important pollinators, even of other flowers. It is, so far, the only calliphorid studied in the Philippines for gene sequences (Pedales & Fontanilla 2018), which are thought mainly as forensically important. Nonetheless, they could be useful for future studies that may involve matching larvae or maggots with their pollinating adult flies.

### **3. *Lucilia fumicosta* Malloch**

This species was kindly identified by Mr. Ronniel D. Pedales of the Institute of Biology, University of the Philippines Diliman, from the photographs of *R. lagascae* in Mount Labo taken by Dr. J.F. Barcelona (Figures 1 & 2). *Lucilia* species are commonly known as green bottle flies. Like most Philippine calliphorids, little is known about its biology and ecology. Nonetheless, it rivals *C. megacephala* as the predominant floral visitor of *R. lagascae*. Its widespread congener, *Lucilia sericata* (Meigen), like other blow flies, is attracted to carrion and excrement where they lay eggs and their larvae feed on decomposing tissue or fecal matter. Beaman et al. (1988) documented that most of the pollinating flies of *R. pricei* in Sabah were females of *L. papuensis* Macquart.

### **Family DOLICHOPODIDAE (Long-legged Flies)**

#### **4. ?*Condylostylus* spp.**

Long-legged flies were observed on flowers with or without the blow flies. They have not been collected but based on gross morphology, they are tentatively referred to near *Condylostylus*. There are possibly two species, with one being smaller and metallic black and the other, metallic green. They are possibly predatory on smaller invertebrates that are present within or near the *Rafflesia* flowers.

### **Family DROSOPHILIDAE (Vinegar Flies)**

#### **5. *Drosophila* spp.**

Several species of the genus *Drosophila* have been observed especially among malaboô flowers in their later stages of maturity, almost nearing the first stages of decay. Although many people call *Drosophila* species as fruit flies they more appropriately known as vinegar flies to avoid confusion with the Tephritidae as well as to take into account their attraction to fermenting fruits

and other decaying plant matter. Ruiz-Fiegalan (2003 & 2004) described several *Drosophila* species from Mount Makiling and the species encountered on malaboô flowers may or may not have been included yet in her taxonomic account.

### **Family MUSCIDAE (House Flies)**

#### **6. *Musca domestica* L.**

This species, the common housefly, is probably the most widespread insect and next to humans, as the most widespread animal. Its presence among malaboô flowers can be attributed to both intrinsic or inherent, and human-associated factors. First, it is naturally attracted to decaying organic matter such as food waste, carrion, or feces. There were more house flies among the flowers in later stages of maturity and among the decaying ones. Second, the site where the blooms occur are only a few kilometers away from the nearby human settlement at Barangay Bagong Silang, and a few meters from the (now former) usual tourist hiking trail. Third, they have been observed twice to be more abundant during Holy Week when more people climb to the peak area of the mountain. However, they were not observed to go inside the perigone.

### **Family PHORIDAE (Humpbacked Flies)**

#### **7. ?*Megaselia* sp.**

The Phoridae constitute a large family of small, hump-backed flies. This group of flies is probably the most diverse among Diptera in terms of food habits and habitats. The species observed is similar to the common scuttle fly in gross appearance, which was the sole basis for its tentative identification as near *Megaselia*. Specimens need to be collected for further examination. Individuals of this fly have been observed on the more mature flowers and they probably play greater role toward the decay especially of the fleshy parts of the flowers.

### **Family SARCOPHAGIDAE (Flesh Flies)**

#### ***Sarcophaga* sp.**

The red-eyed flesh fly, *Sarcophaga* sp. was also observed to visit and possibly larviposits some of its tiny maggots into the perigone. Some maggots were already observed in more mature flowers but sampling would involve destruction of floral parts and was not allowed. Among those listed by Baltazar (1990), *Sarcophaga albiceps* Meigen (= *Parasarcophaga albiceps*) seems to be the most common in the Philippines. Illustrations provided by Sharma et al. (2017) for this species suggests that the observed floral visitor on *R. lagascae* may be this species. The individual “checkered” fly at the center of the flower as

photographed on *R. lagascae* in Mount Labo by J.F. Barcelona (Figure 2b) also apparently belongs to this species.

## GENERAL DISCUSSION

The foregoing list is consolidated from fragmentary data accumulated through years of irregular visits to the *Rafflesia lagascae* populations on Mt. Makiling, supplemented by photographs taken by Barcelona and Cajano. There have been at least eight species of dipterans. Other insects belonging to various orders like Hymenoptera (mainly ants), Lepidoptera (lycaenid butterflies and one or two moths), and Coleoptera (ground-dwelling beetles) as well as spiders have also been observed at or within the vicinity of the malaboõ blooms in various stages of floral maturity, from buds to advanced decay. The presence of tinier arthropods like mites and collembolans were noticed through their movements e.g. jumping among springtails and crawling or running among mites and spiders. The latter were especially noticed in decaying flowers. Although fruits were also seen, the pollination aspects or fruit set possibly resulting from insect visits were not evaluated and was beyond the objective of those opportunistic observations. These dipterans and the other arthropods present among malaboõ flowers have various roles toward the floral development or decay. Along this line of thought, the observations and inferences made by Yahya et al. (2010) may need reconsideration.

Noting similarities of their observations with those of Brown (1912), Yahya et al. (2010) mentioned that they “also observed insects and larvae infesting buds in the subpopulations of *R. manillana* in Mt. Makiling.” One of their photographs showed “unopened fleshy petals of *R. manillana* with larvae inside.” The photograph as reproduced on the online copy of the article was not quite clear but the larvae look like maggots and probably belong also to muscoid Diptera. Both papers by Brown (1912) and Yahya et al. (2010) looked at the insects as mainly “infesting” the buds or “damaging” the seeds. This outlook or viewpoint is normal or expected when only the plant or flower is the main focus or when only plant scientists constitute the team conducting the investigation. On a more holistic ecological view, there are alternative methods of study as well as other possible relationships between *Rafflesia* flowers on the one hand, and the visiting and/or infesting insects and other arthropods on the other. It should be noted that many insects differ in feeding habits during their larval and adult stages. Thus, in some species of flowering plants, there could be associated mutualists which are “infesting” or “damaging” during their larval stage but pollinating in their adult stage. Classic examples would be the relationship between the yucca plant and the yucca moth (Pelmyr et al. 1996) as well as the figs and fig wasps (Galil & Eisikowitch 1968, Gullan & Cranston 2014). The presence of sticky, powdery material that look like pollen (needs to be confirmed) on visiting blow flies could be a clue to the possible role of calliphorids as pollinators. At the same time, the presence of larvae that are maggot-like point clearly to the consumption of fleshy parts of malaboõ by dipterans during their development.



Video-documentation that can include documentation of nocturnal visitors is highly recommended. More thorough collection during fieldwork should employ various collecting techniques. When the number of plants or flowers permit, a few of them may be sacrificed for isolation experiments as well as periodic sampling for dissections for insect larvae. The larvae should be reared to the adult stage for proper identification. Other field studies focusing on the diversity of associated arthropods are recommended for this threatened *Rafflesia* species, especially that the Makiling Forest Reserve has witnessed recent rise in tourist visits.

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