# Foliar fungal diseases on rubber, *Hevea brasiliensis,* planted in selected non-traditional areas in the Philippines

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**Key words:** *Colletotrichum, Phomopsis.* – Rubber, non-traditional areas, foliar fungal diseases, leaf spot, leaf blight, brown spot disease. – Funga of the Philippines.

**Abstract:** Rubber is a top commodity export that contributes to economic growth and development of the Philippines. It is therefore important that rubber production is increased through expansion to non-traditional areas of plantation. The objective of this research is to identify fungal pathogens that infect foliage of rubber in non-traditional production areas. There are no existing reports on fungal disease occurrence in rubber planted in non-traditional areas in Luzon. Two and three municipalities in Quezon and Laguna, respectively, were surveyed for presence of foliar diseases. A total of 28 fungal pathogens were isolated and confirmed pathogens of rubber leaves. All isolates were subjected to DNA sequencing and molecular genetic identification through the use of internal transcribed spacer (ITS). Results revealed that majority of fungi were *Phomopsis* anamophic taxa in all plantation sites, followed by *Diaporthe*. *Colletotrichum* (incl. *Glomerella*), *Nodulisporium*, *Xylaria*, *Leiotrametes*, *Nigrospora*, and *Pestalotiopsis* were also isolated. This is the first report that these genera cause foliar diseases on rubber in the Philippines. However, *Colletotrichum gloeosporioides* was already reported to cause anthracnose leaf disease in most trees in rubber-producing regions in Mindanao.

**Zusammenfassung:** Kautschuk ist ein Top-Rohstoffexportprodukt, das zum Wirtschaftswachstum und zur Entwicklung der Philippinen beiträgt. Es ist daher wichtig, dass die Kautschukproduktion durch die Ausweitung auf nicht traditionelle Plantagengebiete gesteigert wird. Das Ziel dieser Forschung war es, Pilzpathogene zu identifizieren, die das Laub von Gummibäumen in nicht-traditionellen Produktionsgebieten infizieren. Es gibt bisher keine Berichte über das Auftreten von Pilzkrankheiten an Kautschuk, der in nicht-traditionellen Gebieten in Luzon gepflanzt wurde. Zwei bzw. drei Gemeinden in Quezon und Laguna wurden auf das Vorhandensein von Blattkrankheiten untersucht. Insgesamt wurden 28 Pilzpathogene isoliert und als Pathogene von Gummiblättern bestätigt. Alle Isolate wurden zwecks molekluargenetischer Identifizierung einer DNA-Sequenzierung unter Verwendung des internen transkribierten Spacers (ITS) unterzogen. Die Mehrheit der Pilze in allen Plantagen waren asexuelle *Phomopsis*-Morphen, gefolgt von *Diaporthe*. *Colletotrichum* (inkl. *Glomerella*), *Nodulisporium*, *Xylaria*, *Leiotrametes*, *Nigrospora* und *Pestalotiopsis* wurden ebenfalls isoliert. Dies ist der erste Bericht, dass diese Gattungen auf den Philippinen Blattkrankheiten von Gummibäumen verursachen. Bisher war nur bekannt, dass *Colletotrichum gloeosporioides* bei den meisten Bäumen in kautschukproduzierenden Regionen in Mindanao eine Anthracnose-Blattkrankheit verursacht.

Natural rubber, *Hevea brasiliensis* (WILLD.) MULL. ARG., originating from Amazon watershed in South America, is an important crop worldwide. Natural rubber is known in the world market and the demand has dramatically increased that leads to expansion of rubber plantations throughout non-traditional environment.

According to PHILIPPINE STATISTIC AUTHORITY (2017), Philippines had 217,687 ha of rubber plantations as of 2014. It is traditionally cultivated in Mindanao, mainly in Region 9, which accounted 40 % or around 86,542 ha of rubber plantation. Region 12 had 60,516 ha, while the Autonomous Region in Muslim Mindanao (ARMM) had 38,115 ha. These regions were the major rubber producers in the country.

In the international market, it was projected that natural rubber consumption will soon reach 13.8 million t and the volume of production by that time will be 13.3 million t. Therefore, there will be a demand gap of 500,000 t. To cope with the increasing demand for natural rubber, the Philippine government is looking toward the expansion of plantations to non-traditional areas in the country. Taking advantage of this promising economic benefit, farmers in Luzon and Visayas started to venture in rubber plantation establishment (NATIONAL AGRICULTURAL AND FISHERY COUNCIL 2014).

According to Dr. EUGENIO ALCALA, one of the renowned rubber farmer and former head of the Plantation Crops Department of the University of Southern Mindanao (USM), rubber can also be profitably grown in Luzon, which is a non-traditional area for cultivation. He reported that there were already existing rubber farms and few farmers were making money from the production. He visited Sta. Maria and Sta. Cruz in Laguna where rubber trees were productively grown from seedlings (SARIAN 2011). There were also reports of the existence of rubber plantations in Palawan, Cagayan Valley, Oriental Mindoro and Negros Oriental (FORMOSO 2013, SARIAN 2014).

Rubber, like other important crops were subjected to disease infection. Diseases affecting rubber trees in the different producing regions in Mindanao were surveyed. According to the report of TANGONAN (2012), diseases found affecting rubber leaves were powdery mildew caused by *Oidium heveae* STEIN., *Corynespora* leaf fall caused by *Corynespora cassiicola* (BERK. & CURT.) WEI., *Helminthosporium* leaf spot or bird's eyespot caused by *Helminthosporium heveae* PETCH., anthracnose leafspot caused by *Colletotrichum gloeosporioides* PENZ. & PETCH. and leaf blight caused by *Fusarium oxysporum* f. sp. *vasinfectum* SNYD. & HANS.

There were no reported diseases affecting rubber planted in non-traditional areas in Luzon. Thus, this study was conducted in order to identify fungi causing foliage diseases of rubber in non-traditional plantations, particularly in the provinces of Laguna and Quezon in support to the Philippine rubber expansion project.

**Materials and methods**

**Collection site of diseased samples.** The study was part of the project of the Department of Agriculture Regional Field Office 9-Research Division, titled "Assessment of the Growth and Yield Performance of Rubber Planted in Non-traditional Areas (NTAs) of the Philippines". Site of collection was based on the recommendation of the implementer of the project. These include the municipalities of Cavinti, Sta. Maria, and Magdalena in the province of Laguna (N 14.48, E 121.39) and Tayabas and Padre Burgos in Quezon (N 14.04, E 121. 64). These municipalities have existing rubber plantations. Top 3 rubber producing barangays in each selected municipality were screened for the presence of foliar disease symptoms.

**Morphological survey.** Ocular surveys on foliar diseases of rubber planted in non-traditional areas in Laguna and Quezon were done. Collection of diseased leaf samples were randomly. Samples of diseased leaves were put in a clean polyethylene bag and brought to the laboratory. Prior to isolation of the associated fungal pathogens, the symptoms were characterized and photographed. Number of infected trees were not accounted during the ocular inspection.

**Isolation of fungal pathogen.** Three leaf cuts along lesions (about 0.5 cm) were surfaced sterilized in 1:10 dilution of sodium hypochlorite and distilled water for about 1–3 min, rinsed in three changes of sterile distilled water and blot dried. Afterwards, cut leaves were aseptically planted in a petri dish with Potato Dextrose Agar (PDA) with 2–3 drops of lactic acid and incubated at room temperature. Fungal growth from the leaf sections was picked and transferred to test tubes with fresh PDA slant.

**Pathogenicity test.** Inoculation was done through detached leaf following the technique of TANGONAN & PECHO (2009) with modifications. Healthy rubber leaves were immersed in 1:10 dilution of sodium hypochlorite and distilled water for 1 min, then rinsed with distilled water and blot dried with filter paper. Mycelial discs of 5 mm in size were taken from the edges of actively growing cultures in PDA plates. The mycelial discs were placed on wounded healthy rubber leaf, with the mycelia facing downwards. For the negative control, fresh sterile 5 mm PDA agar blocks were placed in the wounded rubber leaf. The set up was maintained inside a clear plastic with distilled water at the bottom of the tray to provide humid condition, then incubated for 1–2 weeks under room temperature or until appearance of infection.

**Re-isolation of suspected pathogen.** Fungi from treated leaves with infection were re-isolated for identification. Three leaf cuts along lesion were surfaced sterilized in 1:10 dilution of sodium hypochlorite for about 1–2 min, rinsed in three changes of distilled water, blotted dry, and planted aseptically in petri dishes with PDA medium. Three drops of lactic acid were added and then incubated at room temperature. Fungal growth from the leaf sections were picked and transferred to fresh PDA slants in test tubes and incubated until sporulation.

**Identification.** The re-isolated fungal pathogens were sent to Macrogen Korea for DNA sequencing and molecular genetic identification using the internal transcribed spacer (ITS) region as universal DNA barcode marker for fungi.

## Results

Twenty-eight fungal pathogens were isolated from diseased leaves of rubber in Quezon and Laguna (Tab. 1).

In Quezon, eight of the total isolates were collected from Tayabas and six from Padre Burgos. In Laguna plantations, five fungal isolates were from Magdalena, five from Cavinti, and four from Santa Maria (Fig. 1). The occurrence of *Phomopsis* asexual morphs was observed in all five municipalities. On the other hand, the respective sexual morph *Diaporthe* was noted in three municipalities except in Magdalena and Padre Burgos. *Colletotrichum* spp. were present only in Tayabas and Padre Burgos, and its sexual morph *Glomerella* was seen in Cavinti. Likewise, *Nodulisporium*, *Xylaria*, *Leiotrametes,* and *Pestalotiopsis* were recorded from Tayabas, Padre Burgos, Magdalena and Santa Maria, respectively.

The number of isolates belonging to the different pathogenic fungal genera from the five municipalities is presented in Fig. 2. *Phomopsis* was dominantly recorded with 13 species, followed by *Diaporthe* and *Colletotrichum* with six and three species, respectively. *Nodulisporium*, *Xylaria*, *Leiotrametes*, *Nigrospora*, *Glomerella*, and *Pestalotiopsis* had only one species isolated in each.

Tab. 1. Fungal pathogen isolates from diseased leaves of rubber in nontraditional planting areas.

| **Fungal pathogen** | **Isolate code** | **[1]NCBI Accession No.** | **[2]Depository Accession No.** | **Site of collection** | |
|---|---|---|---|---|---|
| | | | | **Province** | **Municipality** |
| *Diaporthe* sp. | BLA-T1-2 | EF423549.1 | MCC-MNH 2578 | Quezon | Tayabas |
| *Nodulisporium* sp. | BLA-T5-3 | KF494820.1 | MCC-MNH-2579 | Quezon | Tayabas |
| *Colletotrichum gloeosporioides* PENZ. & SACC. | BLA-T4-1 | KX022505.1 | MCC-MNH-2580 | Quezon | Tayabas |
| *Colletotrichum gloeosporioides* | BLA-T4-2 | JN198429.1 | MCC-MNH-2581 | Quezon | Tayabas |
| *Diaporthe perseae* (ZEROVA) GOMES, GLIENKE & CROUS | BLA-T2-1 | KC343173.1 | MCC-MNH-2582 | Quezon | Tayabas |
| *Phomopsis* sp. | BLA-T1-1 | GU592007.1 | MCC-MNH-2583 | Quezon | Tayabas |
| *Diaporthe longicolla* (HOBBS) SANTOS, VRANDECIC & PHILLIPS | BLA-T3-2 | LN552212.1 | MCC-MNH-2584 | Quezon | Tayabas |
| *Diaporthe* sp. | BLA-T3-1 | GU066697.1 | MCC-MNH-2585 | Quezon | Tayabas |
| *Xylaria feejeensis* (BERK.) FR. | BLA-PB4-2 | GU322452.1 | MCC-MNH-2586 | Quezon | Padre Burgos |
| *Phomopsis heveicola* MA, XIANG & CHI | BLA-PB2-2a | KY379053.1 | MCC-MNH-2587 | Quezon | Padre Burgos |
| *Phomopsis* sp. | BLA-PB2-2b | GU066685.1 | MCC-MNH-2588 | Quezon | Padre Burgos |
| *Colletotrichum gloeosporioides* | BLA-PB5-2 | JN198429.1 | MCC-MNH-2589 | Quezon | Padre Burgos |
| *Phomopsis* sp. | BLA-PB3-1 | KJ627846.1 | MCC-MNH-2590 | Quezon | Padre Burgos |
| *Phomopsis heveicola* | BLA-PB5-1 | KY379053.1 | MCC-MNH-2591 | Quezon | Padre Burgos |
| *Leiotrametes lactinea* (BERK.) WELTI & COURTEC. | BLA-M1-1 | JN048769.1 | MCC-MNH-2592 | Laguna | Magdalena |
| *Nigrospora* sp. | BLA-M2-1 | JF694936.1 | MCC-MNH-2593 | Laguna | Magdalena |
| *Phomopsis* sp. | BLA-M3-1 | DQ780436.1 | MCC-MNH-2594 | Laguna | Magdalena |
| *Phomopsis* sp. | BLA-M3-2 | KJ627846.1 | MCC-MNH-2595 | Laguna | Magdalena |
| *Phomopsis* sp. | BLA-M1-2 | GU066663.1 | MCC-MNH-2596 | Laguna | Magdalena |
| *Diaporthe* sp. | BLA-C3-1 | EF423549.2 | MCC-MNH-2597 | Laguna | Cavinti |
| *Phomopsis* sp. | BLA-C4-1 | KM405639.1 | MCC-MNH-2598 | Laguna | Cavinti |
| *Glomerella cingulata* (STONEMAN) SPAULDING & VON SCHRENK | BLA-C3-3a | EF488441.1 | MCC-MNH-2599 | Laguna | Cavinti |
| *Phomopsis heveicola* | BLA-C3-3 | KY379053.1 | MCC-MNH-2600 | Laguna | Cavinti |
| *Phomopsis heveicola* | BLA-C2-1 | KY379053.1 | MCC-MNH-2601 | Laguna | Cavinti |
| *Pestalotiopsis diploclisiae* MAHARACHCH., HYDE & CROUS | BLA-SM2-1 | KU529818.1 | MCC-MNH-2602 | Laguna | Santa Maria |
| *Diaporthe pseudomangiferae* GOMES, GLIENKE & CROUS | BLA-SM5-1 | KT97131.1 | MCC-MNH-2603 | Laguna | Santa Maria |
| *Phomopsis* sp. | BLA-SM3-2 | KP050609.1 | MCC-MNH-2604 | Laguna | Santa Maria |
| *Phomopsis eucommii* SACC. & ROUM. | BLA-SM3-3 | JN198406.1 | MCC-MNH-2605 | Laguna | Santa Maria |

[1]National Center for Biotechnology Information (NCBI)- U.S. National Library of Medicine
[2] Museum of Natural History (MNH)- University of the Philippines-Los Baños (UPLB)

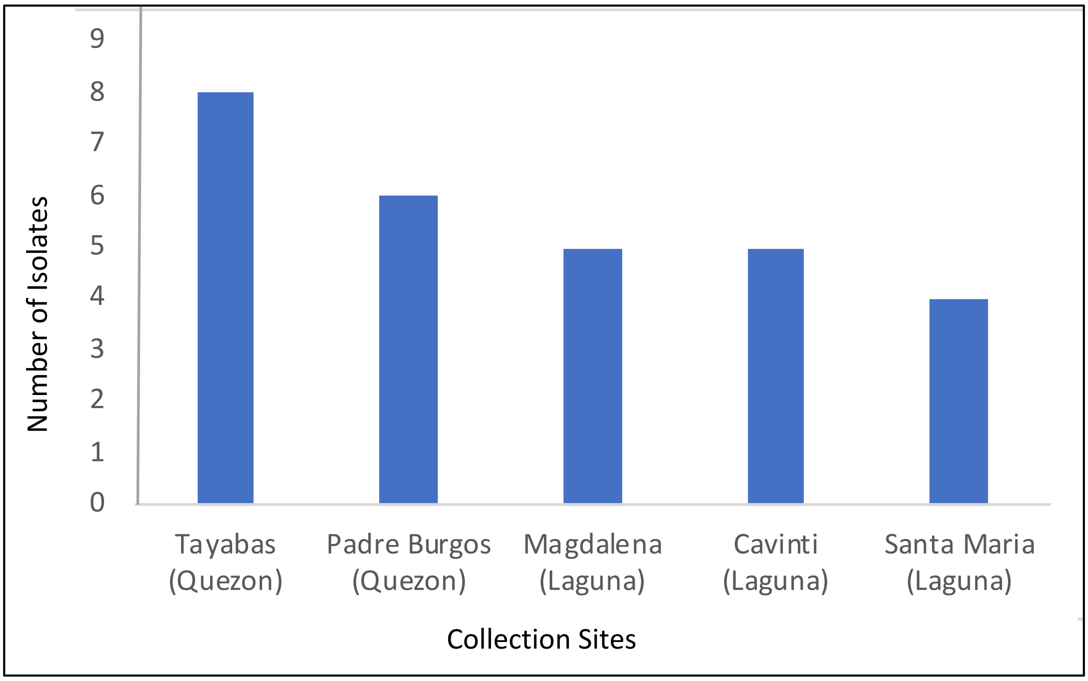


Fig. 1. Number of fungal pathogens causing foliar diseases of rubber in different municipalities surveyed.

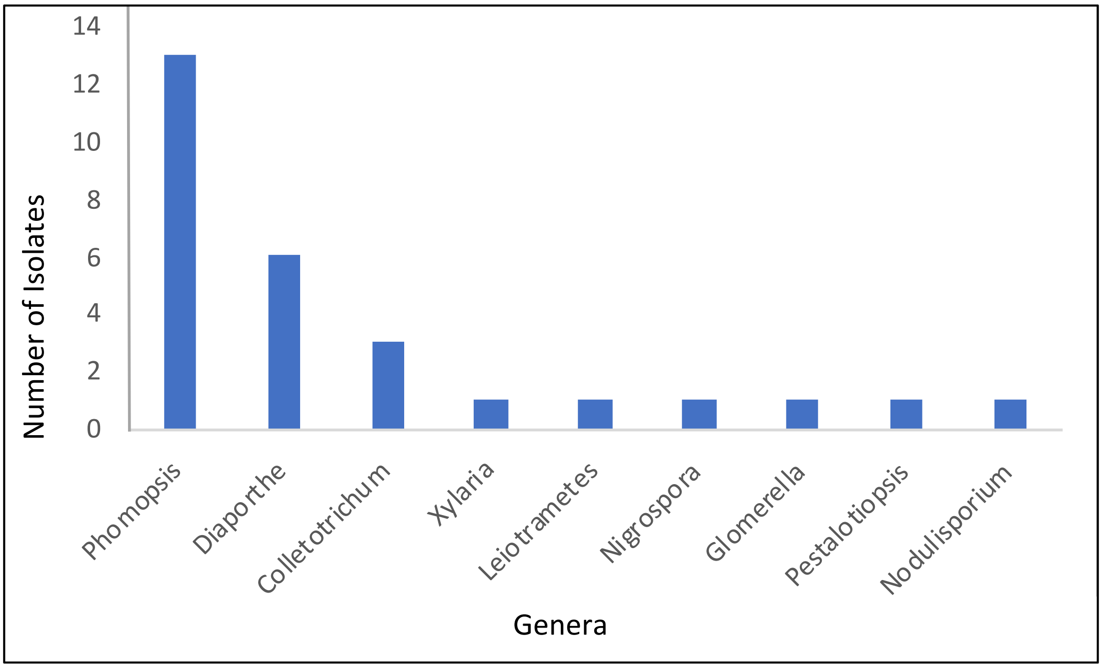


Fig. 2. Number of pathogenic fungi infecting rubber leaves.

## Disease symptoms

Commonly observed symptoms were leaf spots and blighting.

## *Diaporthe* and *Phomopsis* brown leaf spot in Tayabas, Quezon

It was characterized by numerous circular dark brown leaf spots ranging from 2–5 mm in diameter, with yellowish advancing portion (Fig. 3).


Fig. 3. Brown leaf spot caused by species of *Diaporthe* and *Phomopsis,* ***A*** numerous brown spots and ***B*** close up of the dark brown leaf spot.

### *Diaporthe* sp. and *Diaporthe longicolla* brown blotch from Tayabas, Quezon

Lesions appear as light brown spots with yellowish margin, which later expand to form irregularly shaped lesions. Coalesced lesions result in irregular blotches with light brown centre (Fig. 4).

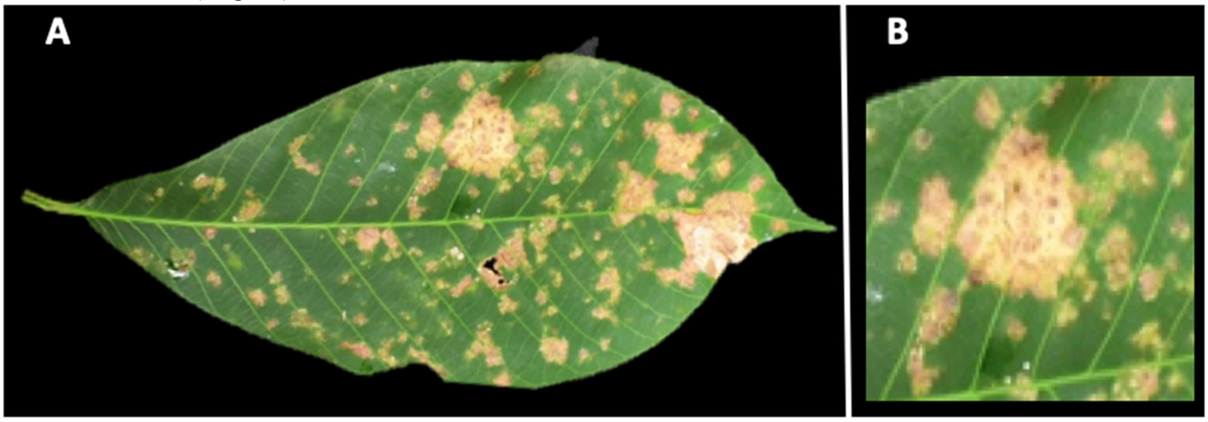


Fig. 4. Irregular, brown blotches caused by *Diaporthe* sp. and *Diaporthe longicolla*; ***A*** irregularly shaped lesions and ***B*** close up of the lesion.

### *Diaporthe pseudomangiferae* brown spot from Cavinti, Laguna

Symptoms are characterized by necrotic lesions with margin, circular to irregular shape, ranging from 4–12 mm in diameter, with grayish centre (Fig. 5).

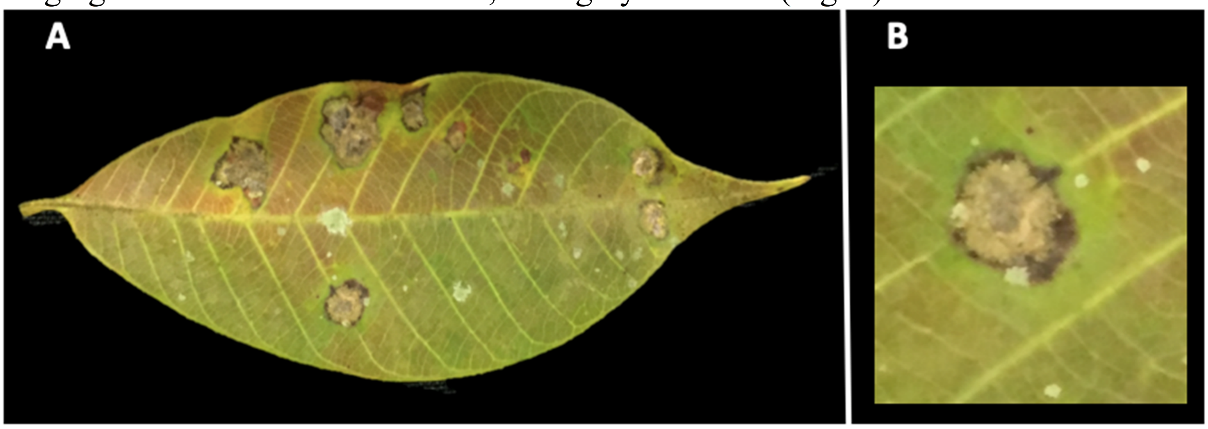


Fig. 5. Brown spot caused by *Diaporthe pseudomangiferae*; ***A*** necrotic lesion with brown margin and ***B*** close up of lesion.

### *Phomopsis heveicola* and *Colletotrichum gloeosporioides* leaf spot from Padre Burgos, Quezon

The symptoms are irregular lesions with brown to off-white centre and surrounded by a brown margin. The advancing portion is yellowish, which later merges and coalesces with the adjacent lesion becoming large. The lesion size ranges from 3–10 mm in diameter (Fig. 6).


Fig. 6. Irregular leaf spot caused by *Phomopsis heveicola* and *Colletotrichum gloeosporioides*; ***A*** lesion with off-white centre and ***B*** close up of the lesions.

### *Phomopsis eucommii* and *Phomopsis* sp. brown spot from Santa Maria, Laguna

The symptom is characterized by light brown, irregular necrotic lesions 54–8 mm in diameter, with brown margin and ash grey centre. The necrotic lesion may disintegrate to have a shot-hole appearance (Fig. 7).


Fig. 7. Brown spot caused by *Phomopsis eucommii* and *Phomopsis* sp.*;* ***A*** light brown, irregular necrotic lesion and ***B*** close up of the lesion.

### *Phomopsis heveicola* leaf spot from Cavinti, Laguna

Symptoms appear as yellowish to brownish patches on the leaf. As infection progresses, adjacent patches merge resulting in larger, irregular necrotic tissue with greyish centre (Fig. 8).


Fig. 8. Leaf spot caused by *Phomopsis heveicola*; ***A*** numerous yellow spots and ***B*** close up of the symptoms.

### ***Phomopsis*** **sp. and** ***Leiotrametes lactinae*** **leaf blight from Magdalena, Laguna**

Initial symptoms are pinhead-size lesions with yellowish advancing portion. Infected leaf appears pale yellow. Lesions later coalesce with adjacent lesions resulting in blighting. The leaf becomes wrinkled (Fig. 9).

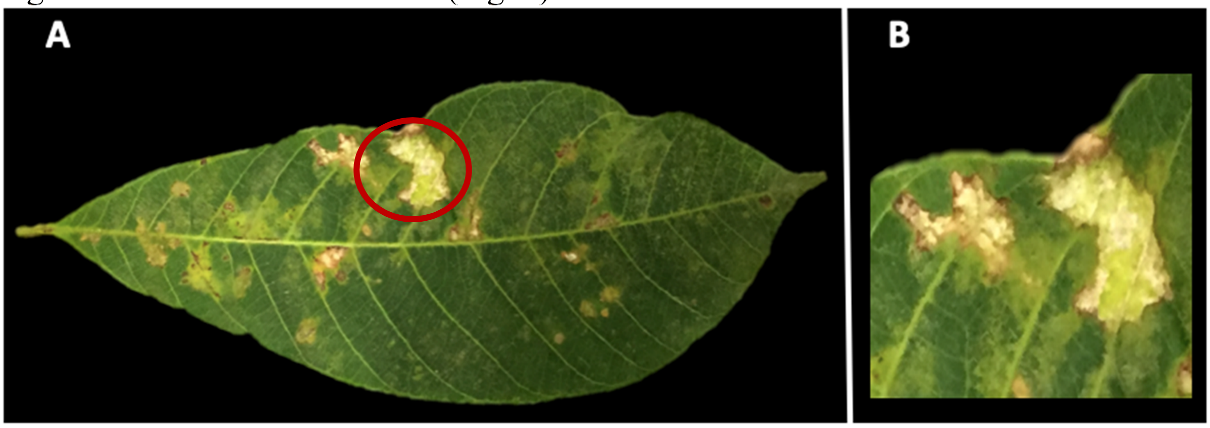


Fig. 9. Leaf blight caused by *Phomopsis* sp. and *Leiotrametes lactinae*; ***A*** leaf blight and wrinkled leaf and ***B*** close up of the affected tissue.

### ***Colletotrichum gloeosporioides*** **and** ***Glomerella cingulata*** **anthracnose from Cavinti, Laguna**

Infection begins with numerous circular, brown, pinhead-sized spots and yellowish advancing portion. Lesions follow major veins and progress inwards. Adjacent spots coalesce and develop to blight. In severe cases, leaflets turn chlorotic, starting from the leaf margin inward (Fig. 10).


Fig. 10. Anthracnose and leaf blight caused by *Colletotrichum gloeosporioides* and *Glomerella cingulata*; ***A*** numerous leaf spots and blight and ***B*** close up of the spots.

## ***Nodulisporium*** sp. brown spot from Tayabas, Quezon

Numerous, brown, pin-head sized spots with prominent yellowish halo around the spot appear. As symptom progresses, spots merge and enlarge, become rusty brown, dry, and range in size from flecks to larger areas (Fig. 11).


Fig. 11. Rusty brown spot caused by *Nodulisporium* sp.; ***A*** pin-head sized spots later merging to form rusty brown spots and ***B*** close up of the coalesced spots.

## ***Xylaria feejeensis*** brown spot from Padre Burgos, Quezon

The symptom is characterized by larger (–5 mm in diam.), individual brown spots. These spots can aggregate, are slightly protruding, and give the leaf a rough surface (Fig. 12).


Fig. 12. Brown spot caused by *Xylaria feejeensis*; ***A*** aggregated brown spot and ***B*** close up of the symptom.

## *Nigrospora* sp. brown spot from Magdalena, Laguna Province

It is characterized by brown lesions along the midrib of the leaf with yellowish margin and advancing portion. Infected tissue becomes necrotic and burnt-like and slowly falls off leaving the midrib (Fig. 13).


Fig. 13. Irregular brown spot caused by *Nigrospora* sp.; ***A*** necrotic lesion along the midrib and ***B*** close up of the necrotic lesion along the vein.

## *Pestalotiopsis diploclisia* leaf spot from Santa Maria

Symptoms are numerous circular to irregular, dark brown spots ranging from 2–3 mm in diameter (Fig. 14).

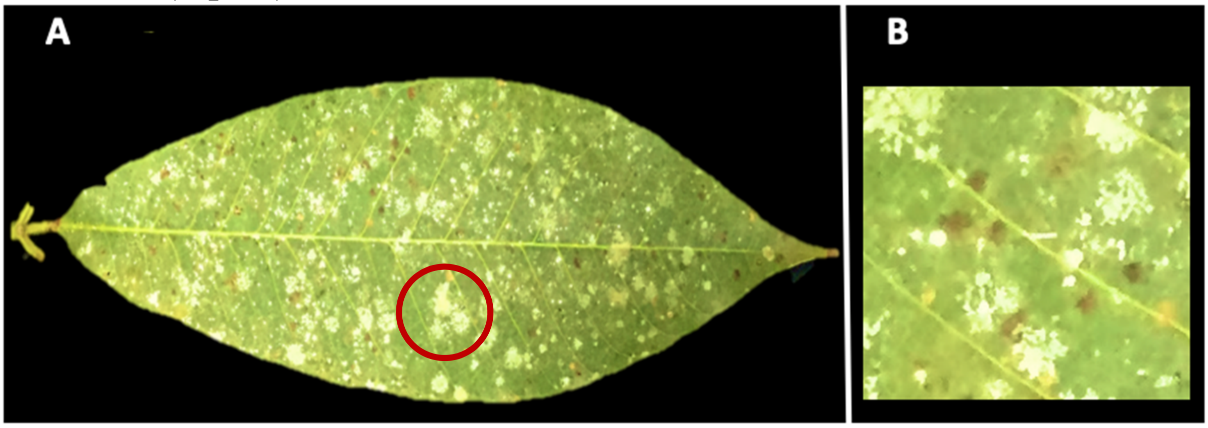


Fig. 14. Leaf spot caused by *Pestalotiopsis diploclisia*; ***A*** numerous, irregular, dark spots and ***B*** close up of the dark spots.

## Discussion

Among the different genera of pathogens identified, the asexual *Phomopsis*-states were dominant with 13 isolated species, followed by its sexual morph *Diaporthe* with six species. On the other hand, asexual *Colletotrichum*-morphs and its sexual morph *Glomerella* have been recorded also. The least isolated fungal pathogens belonged to genera *Nodulisporium*, *Xylaria*, *Leiotrametes*, *Nigrospora*, *Glomerella*, and *Pestalotiopsis* with only one species in each. All were recorded as new pathogens affecting rubber in the Philippines, except for *Colletotrichum gloeosporioides* that was previously reported

(Tangongan 2012) to cause leaf disease in rubber trees in Mindanao's rubber-producing regions.

The genus *Diaporthe* with its *Phomopsis*-morph comprises phytopathologically important microfungi with diverse host associations and worldwide distribution. Many species were isolated as pathogens of crops, as endophytes from healthy tissues of the same or different hosts or even as saprobes from dead materials (UDAYANGA & al. 2011, YANG & al. 2018). In China, *Phomopsis heveicola* was reported to cause root disease of rubber (MA & al. 2004). HOLLIDAY 1980 and ZHUANG 2001 as cited by UDAYANGA & al. (2011) reported that *Phomopsis heveae* causes dieback of young tissues of rubber seedlings and is a severe problem in rubber-growing places in Brazil, China, India, Indonesia, Malaysia, Sri Lanka, and Thailand.

In addition to rubber, avocado is threatened by branch cankers and stem-end rot diseases caused by *Diaporthe foeniculina* SACC. and *Diaporthe sterilis* L. (GUARNACCIA & al. 2016). *Diaporthe longicolla* was first reported to cause stem disease on dry edible beans and dry edible peas, and stem disease on soybean in North Dakota (MATHEW & al. 2015). In Puerto Rico, it was first reported by SERRATO-DIAZ & al. (2014) that *Diaporthe pseudomangiferae* caused inflorescence rot and flower abortion of mango.

*Colletotrichum* species are pathogens that cause anthracnose, foliar blight of fruit/stem, and rot on more than 3,000 plant species. The occurrence of this disease results in large economic losses worldwide (LIANG & al. 2018). *Colletotrichum gloeosporioides* is one of the most common fungal pathogens that causes diseases to a variety of crops worldwide, particularly perennials in the tropical regions (Waller 1992). LIU & al. (2018) reported anthracnose, caused by *Colletotrichum*, as one of the most severe diseases of rubber in China. *Colletotrichum gloeoporioides* has been observed in most rubber plantations in Mindanao (TANGONAN 2012) and even in rubber-producing countries in Southeast Asia (LIU & al. 2018). BROWN & SOEPENA 1994 and SAHA & al. 2002 as cited by CAO & al. (2017) reported that *Colletotrichum gloeoporioides* and *C. acutatum* Simmonds are causal agents of anthracnose of rubber trees.

*Glomerella cingulata* is the sexual morph while the more commonly referred to asexual morph is called *C. gloeosporioides*. Both morphs may be present on a host plant (FREEMAN & al. 1998). *Glomerella cingulata* was first reported to cause fruit rot of strawberry in Florida (HOWARD & ALBREGTS 1984). It was also the pathogen of common rotting of apple and pear and can cause anthracnose of mango (TUMANG 2019). In India, *G. cingulata* is the causal organism of anthracnose in olive fruits (MUGNAI & al. 1993). In the Philippines, *G. cingulata* was reported to cause dieback of avocado, anthracnose of black pepper, and berry blight of coffee (TANGONAN 1999).

*Xylaria* species are principally known to occur in soil and as saprotrophs of wood and other dead plant parts, but are also common as endophytes associated with crops such as soybean and barley (CHEN & al. 2013). *Xylaria feejeensis* was first reported in Nigeria to cause postharvest dry rot of raphia palm fruit (ESIEGBUYA & al. 2013).

*Nigrospora* species are widely distributed plant pathogens, endophytes or saprobes on a wide host range and have been shown to be very interesting for metabolites discovery (WANG & al. 2017). *Nigrospora sphaerica* Mason causes leaf spot and twig and shoot blight of blueberry (WRIGHT & al. 2008). It was also reported in China as the pathogen of mulberry leaf's shot-hole disease that reduces mulberry leaf yields. Likewise, it also caused leaf spot of kiwi (Chen & al. 2016) and leaf blight of sugarcane in

China (CUI & al. 2018). ABASS & al. (2013) reported *N. sphaerica* as potential pathogen on date palm. In the Philippines, *N. oryzae* is the pathogen of seed-borne rot of corn grains (TANGONAN 1999).

*Nodulisporium* species are distributed worldwide and have been isolated from different habitats, as endophytes in decaying plants such as bark and branches of different parts of tropical plants. Moreover, a pathogenic *Nodulisporium* species was recovered from a small, dying lemon tree in 1999 that had internal, white wood rot (MATHERON & al. 2006). According to LO PRESTI & al. (2015) some endophytes become pathogens when they are influenced by certain environmental factors that lead to pathogenicity.

*Pestalotiopsis* is a species-rich genus occurring as pathogens, endophytes, and saprobes of considerable attention in recent years (JOSHI & al. 2009, IVANOVA 2016). NGOBISA & al. (2017) reported that rubber trees in South West Cameroon were affected by a leaf blight disease. The causal pathogen was later identified as *Pestalotiopsis microspora* Speg. In the Philippines, *Pestalotiopsis* spp. were recorded to cause leaf blight of cashew, brown spot of guava, and leaf spot and fruit rot of mango (TANGONAN 1999).

*Leiotrametes* comprises two species of poroid white rot fungi, formerly placed in the genus *Trametes* (WELTI & al. 2012). *Leiotrametes lactinea* (BERK.) WELTI & COURTEC. is widely distributed in Australia, Ceylon, and Java and also widespread in Asian countries such as Pakistan, Philippines, and India. It was earlier recorded on axlewood, *Anogeissus latifolia* (ROXB. ex DC.) WALL. ex GUIL. & PERR. (TIWARI & al. 2013). It was also observed on a living branch of *Mangifera indica* L. (DE 1997) and on the root of *Terminalia ajuna* (ROXB.) WIGHT & ARN. causing white rot disease in India (Verma & al. 1950). In the Philippines, it was reported to cause wood decay of Moluccan Sau, *Falcataria falcata* (L.) GREUTER & R. RANKIN (TANGONAN 2012).

## Conclusion

The majority of the pathogens of foliar diseases of rubber leaves in non-traditional areas belonged to *Phomopsis*. This marks the first report that this genus causes foliar diseases on rubber in the Philippines. Further a unique diversity of diseases recorded between the traditional and non-traditional areas was revealed. Immediate study on its severity and distribution including disease management strategies is highly recommended in support to rubber industry expansion.

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