NEW RECORDS OF POWDERY MILDEW FUNGI (ERYSIPHACEAE, ASCOMYCOTA) AND RUST FUNGI (PUCCINIALES, BASIDIOMYCOTA) FOR VIETNAM

DUDKA V. A. [(1)], POPOV E. S. [(1)], NGUYEN DANG HOI [(2)]

1. INTRODUCTION

On the territory of Vietnam, about 12 000 plant species are cited [1], which are potential hosts for parasitic fungi. Despite the richness of the plant world, reliably known data for obligate parasitic fungi, in powdery mildew (Erisiphales) and rust fungi (Pucciniales), are insufficient for Vietnam. No purposeful study of these groups was carried out on the territory of Vietnam. The main literature is old lists of species [2 - 4], which require repeated confirmation and revision, and the modern literature is not numerous and also fragmentary (for example [5, 6]). Despite this, there are many modern studies on the territory of Vietnam devoted to phytopathogens of fungi on agricultural crops [7 - 9]. This paper presents part of the results of a joint expedition by the staff of the Joint Vietnam-Russia Tropical Science and Technology Research Centre and the Komarov Botanical Institute (BIN RAS) in 2021.

2. MATERIALS AND METHODS

In this work, samples collected by the authors during the work on the territory of North (Lao Cai Province, Bat Xat District, Bat Xat Nature Reserve and Cao Bang Province, Nguyen Binh District, Phia Oac-Phia Den National Park) and South Central Coast (Khanh Hoa Province, Nha Trang, Hon Tre Island) Vietnam in 2021 were used. The material for studying the structure of microstructures was used from dried samples. To do this, the dry material was cut by hand with a blade to obtain a series of thin slices. After the slices were placed in a 5% solution of lactophenol Color (cotton blue) or 3% solution KOH. After that, the prepared specimens were studied using light microscopy on an Axio Scope A1 LED (Carl Zeiss, Germany) and a Zeiss AxioCam MRc5 digital camera with AxioVision SE64 software version 4.8.3.0. Microstructure measurement was carried out on the basis of electronic images using the Perimeter program version 5.10 R 1541.

Fresh collected specimens were deposited in the Mycological Herbarium of the V.L. Komarov Botanical Institute (LE-F).

3. RESULTS AND DISCUSSION

Ascomycota

Leotiomycetes

Helotiales

Erysiphaceae

*1. ***Erysiphe trifoliorum*** (Wallr.) U. Braun, in Braun, Kruse, Wolcan & Murace, Mycotaxon 112: 175 (2010).

Mycelium on the upper side of the leaf in the form of white spots, often merging (Fig. 1A). The base of the leaf forms a solid white layer between the veins. **Conidiophores** are erect with a length of 85.5-88.0 × 5-6.5 µm (N=5, width was measured in the middle) (Fig. 1B). **Foot-cell** is followed by three cells. Clear outlines of the **foot-cell** are difficult to establish. **Conidia** are ellipsoidal (21) 25.5-34 (37.0) × (11.0) 11.3-16.0 (17.0) µm (N=20) (Fig. 1C, D). **Chasmothecia** not observed.

Specimens examined: Vietnam. Southern Vietnam, Khanh Hoa province, Nha Trang city area. Hon Tre Island, near Dam Bay marine climate station. Near the coast. On *Acacia mangium* Willd. (Fabaceae). 12.19659 N 109.28932 E, elev. 13 m., Col. & Det. V.A. Dudka (VET-445-21), 2021/05/26, LE F-341101.

Host species: Fabaceae: *Acacia*, *Albizia*, *Amorpha*, *Anthyllis*, *Arachis*, *Chamaecytisus*, *Coronilla*, *Cytisus*, *Dorycnium*, *Genista*, *Gueldenstaedtia*, *Hippocrepis*, *Lathyrus*, *Lembotropis*, *Lotus*, *Melilotus*, *Onobrychis*, *Ononis*, *Psoralea*, *Sarothamnus*, *Scorpiurus*, *Securigera*, *Tephrosia*, *Tetragonolobus*, *Trifolium*, *Trigonella*, *Wisteria* [10].

Distribution: Africa: Canary Islands, Egypt, Ethiopia, Mauritius, South Africa; North America: Canada, USA; Asia: Asia Minor, Central Asia, China, Cyprus, India, Iran Iraq, Israel, Japan, Korea, Vietnam (this study), Lebanon, Mongolia, Pakistan, Russia, Saudi Arabia, Turkey; Europe: all; South America: Argentina; Oceania: Australia, New Zealand [10].

Comments: A wide range of hosts of one type of parasite is always questionable. Most likely, this species is a complex and will be further divided into complex taxa. *E. trifoliorum* may be of practical importance because this species can be found on peanuts.

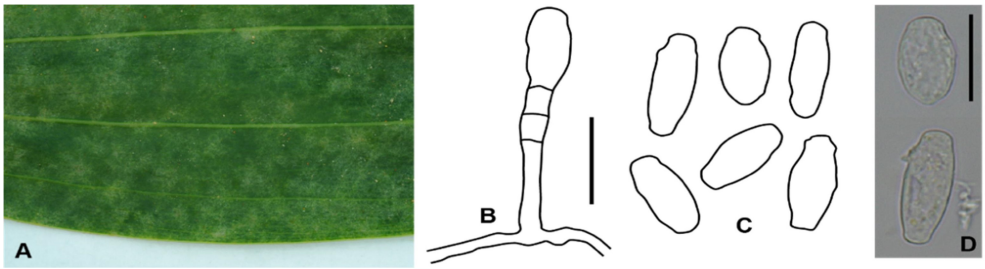

Fig. 1. *Erysiphe trifoliorum* on *Acacia mangium* (LE F-341101). **A** - Mycelium on the upper side of the leaf in the form of white spots; **B** - linear drawing of a conidiophore; **C** - linear drawing of a conidiophore; **D** - conidia (LM). Scale bar: 20 µm

2. *Pseudoidium cocculus (Puzari, A.K. Sarbhoy, N. Ahmad & D.K. Agarwal) U. Braun & R.T.A. Cook [as 'cocculi'], Taxonomic Manual of the Erysiphales (Powdery Mildews): 603 (2012).

Mycelium on the upper and lower sides of the leaf in the form of white spots, rarely merging (Fig. 2A, B). **Conidiophores** are erect in length (N=5, width was measured in the middle) (Fig. 2C). **Foot-cell** is followed by two cells. Clear outlines of the **foot-cell** are difficult to establish. **Conidia** are ellipsoidal (26) 30.5-35.5 (36.5) × (11.0) 12.0-16.0 (18.0) µm (N = 30) (Fig. 2D, E). **Chasmothecia** not observed.

Specimens examined: Vietnam. Southern Vietnam, Khanh Hoa province, Nha Trang city area. Hon Tre Island, near Dam Bay marine climate station. Disturbed forest, bank of dry riverbed. On *Tiliacora triandra* (Colebr.) Diels (*Cocculus triandrus*) (Det. M.S. Nuraliev) (Menispermaceae). 12.19788 N 109.28963 E, elev. 20 m, Col. & Det. V.A. Dudka (VET-426-21), 2021/05/22, LE F-341089.

Host species: Menispermaceace (*Cocculus laurifolius* and *Tiliacora triandra* (*Cocculus triandrus*).

Distribution: Asia: India, Vietnam (this study).

Comments: This is one of the first finds outside the territory of the described type of this species. It is also the first finding of *Pseudoidium cocculus* on *Tiliacora triandra*.

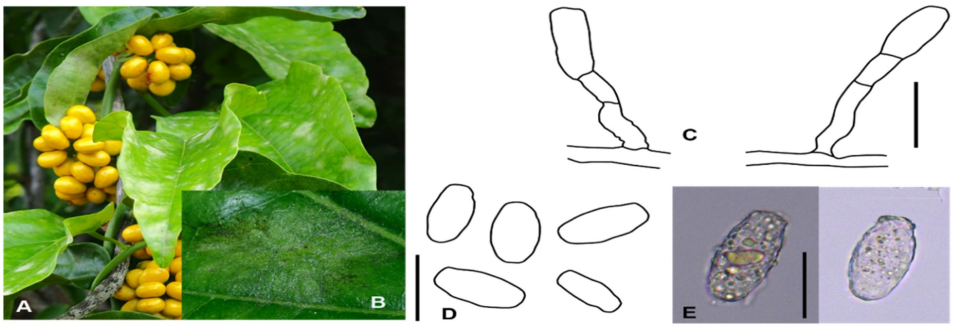

Fig. 2. *Pseudoidium cocculus* on *Tiliacora triandra* (LE F-341089). **A** - Mycelium on the upper side of the leaf in the form of white spots; **B** - mycelium with obvious radial growth; **C** - linear drawing of conidiophores; **D** - linear drawing of conidia; **E** - conidia (LM). Scale bar: 20 µm

Basidiomycota
Pucciniomycetes
Pucciniales
Phragmidiaceae

*3. ***Phragmidium potentillae*** (II) (Pers.) P. Karst., Bidr. Känn. Finl. Nat. Folk 31: 49 (1878).

Uredinia on the underside of the leaves. Uredinia are scattered, bright orange in color, (in the herbarium they discolor to pale yellow, almost white) (Fig. 3A). Spots from light green to yellow are noticeable on the upper part of the leaf. Mostly single. **Urediniospores** are spherical from ellipsoidal to broadly ellipsoidal tapering towards the base, (15.0) 16.0-20.5 (22.5) × (11.0) 12.5-16.0 (17.0) µm (N=100) bright orange (completely discolored in the herbarium) (Fig. 3B). The cell wall is 1-1.5 µm, rarely spiny. **Telia** not observed.

Specimens examined: Vietnam. Northern Vietnam, Lao Cai prov., Bat Xat distr., Bat Xat Nature Reserve 2 km to the south of Y Ty village Disturbed forest, near A De guesthouse. On *Potentilla indica* (Andr.) Wolf (=*Duchesnea indica*) (Rosaceae), 22.62208N 103.63278 E, elev. 1785 m, Col. & Det. V.A. Dudka (VET-407-21),

2021/04/23, LE F-341103; Cao Bang prov., Nguyen Binh distr. Thanh Cong, 1 km south of restaurant Ca Hoi. On *P. indica*, 22.59313N 105.88140 E, elev. 1250 m, Col. & Det. V.A. Dudka (VET-315-21), 2021/04/12, LE F-341104.

Host species: Rosaceae: *Potentilla* spp. (0, I, II, III).

Distribution: Asia: China, Iran, India, Japan, Turkey, Korea, Mongolia, Nepal, Pakistan, Russia, Vietnam (this study); Central America: Guatemala; Europe: all; North America: Canada, USA Alaska; Oceania: Australia, New Zealand.

Comments: Perhaps this species has already been noted for the territory of Vietnam, but from the literature available to us, we could not find it in the lists.

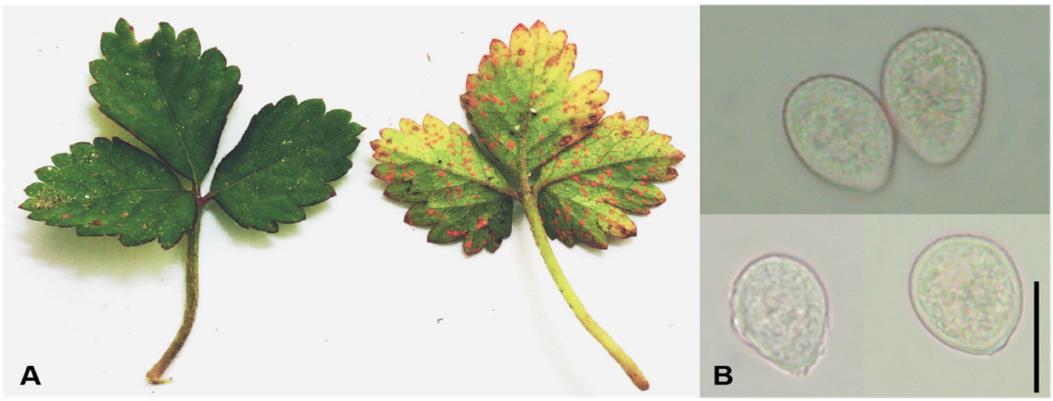

Fig. 3. *Phragmidium potentillae* on *Potentilla indica* (LE F-341104). **A** - Healthy *P. indica* leaf (left) and affected leaf (right). Uredinia is bright orange on the underside of the leaf (leaf on the right); **B** - discolored Urediniospores (LM). Scale bar: 12 µm.

Pucciniaceae

*4. ***Puccinia oxalidis*** (II) Dietel & Ellis, in Dietel, Hedwigia 34: 291 (1895)

Uredinia are solitary, but often merge into small heaps of bright orange color (in the herbarium they eventually become pale yellow, almost white). They form on the underside, rarely on the top. With the lesion, chlorosis of the leaf is noticeable in the places of leaf lesion. **Urediniospores** are spherical, ellipsoidal, broadly ellipsoidal often tapering towards the base (15.0) 16.0-18.5 (19.5) × (12.5) 14.0-16.0 (17.5) µm (N=100), bright orange in color, become colorless during herbarization. The cell wall is 1-1.5(-2) µm thick with sparse spikes. The paraphyses are cylindrical, curved, rounded or club-shaped (35.0) 36.0 - 45.0 (53.5) × (2.5) 3.0 - 4.0 (4.5) µm (N=10, width was measured in the middle). **Telia** not observed.

Specimens examined: Vietnam. Northern Vietnam, Cao Bang prov., Nguyen Binh distr. The intersection of the DT212 and QL34 highways, around Restaurants - Vacation Shandong. On *Oxalis debilis* subsp. *corymbosa* (DC.) O.Bolòs & Vigo (Oxalidaceae) 22.62808N 105.91185 E, elev. 1735 m, Col. & Det. V.A. Dudka (VET-291-21), 2021/04/06, LE F-341102.

Host species: Berberidaceae: *Berberis* spp. (0, I); Oxalidaceae: *Oxalis* spp. (II, III).

Distribution: Africa: Uganda; Asia: China, India, Japan, Korea, Nepal, Taiwan, Vietnam (this study); Central America: Costa Rica, Jamaica, Puerto Rico, Virgin Islands; Europe: Czech Republic, Georgia, United Kingdom; North America: Canada, Mexico, USA; South America: Bolivia, Brazil, Colombia, Uruguay; Oceania: Australia, New Zealand [11].

Comments: In Brazil, work was carried out using *P. oxalidis* in biological control of the invasive weed *Oxalis latifolia* [12]. While in India, *Oxalis* species have agricultural significance [11].

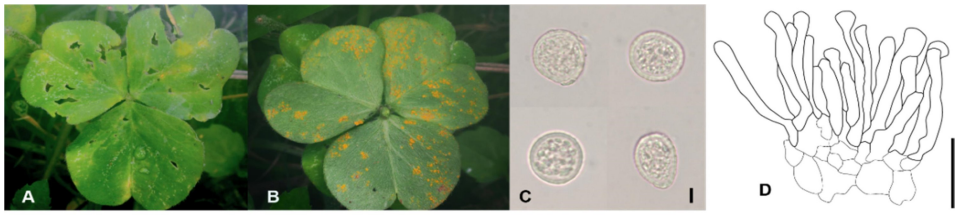

Fig. 4. *Puccinia oxalidis* (LE F-341102). **A** - The upper part of the affected leaf. Small light - yellow spots and Uredinia are noticeable; **B** - The lower part of the affected leaf. Noticeably a lot of Uredinia; **C** - Discolored Urediniospores (LM); D - Paraphyses. Scale bar: C - 6 μm, D - 20 μm

4. CONCLUSION

This work is devoted to the study of phytopathogenic fungi in Vietnam. During the field work, about 50 specimens of phytopathogenic fungi were collected. Most of them belonged to rust fungi. Work on the identification of the collected material continues. Plant pathogenic fungi are difficult to detect in established natural communities. Most of them are confined to disturbed habitats and roadsides.

In the course of this work, four new species of parasitic fungi were identified in Vietnam. Among the powdery mildew (Erisiphales): *Erysiphe trifoliorum* on *Acacia mangium*. For *Pseudoidium cocculus*, a new host species *Tiliacora triandra* is cited. Both types of powdery mushrooms were found in an anamorphic state characteristic of the tropical region. Among rust fungi in the uredo (II) stage (Pucciniales), *Phragmidium potentillae* is a widespread species from the genus *Phragmidium* on *Potentilla* spp. and *Puccinia oxalidis* on *Oxalis debilis* subsp. *corymbosa*. The diversity of living organisms, including plant parasites, is constantly growing, due to the description of new taxa. On the other hand, it is declining due to the reduction of natural unique communities. This is due to the expansion of the territory necessary for human activity. Any data is necessary to expand our understanding of the diversity and conservation of fungi in Vietnam and in the world as a whole. The tasks of preserving and replenishing collected samples from the tropical region are also important for replenishing collections. For a frequent list of species for this region, enter the lists. Old herbarium specimens may be lost, and descriptions are very short. Photos and drawings of microstructures to the described taxa from tropical regions are also often missing. Subsequent work with this material using molecular methods contributes to a better understanding of the evisceration of species and their identification.

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SUMMARY

For Vietnam, a small number of obligate parasitic fungi are given, in powdery mildew (Erisiphales) and rust fungi (Pucciniales). Basically, these are old lists of species that require confirmation or revision. In 2021, a joint expedition was conducted by the staff of the Joint Vietnam-Russia Tropical Science and Technology Research Centre and the Komarov Botanical Institute (BIN RAS). During this expedition, several new species of parasitic fungi were identified for Vietnam. Among the powdery mildew fungi (Erysiphales): *Erysiphe trifoliorum* and *Pseudoidium cocculus* were found in an amorphous state characteristic of the tropical region. Among the rust fungi (Pucciniales), *Phragmidium potentillae* is a widespread species from the genus *Phragmidium* on *Potentilla* spp. and *Puccinia oxalidis* on *Oxalis debilis* subsp. *corymbosa*.

Keywords: *Powdery mildew, Erysiphaceae, rust fungi, Pucciniales, phytoparasites, Vietnam.*

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