

Study of Some Pucciniales Encountered on Leguminous Plants in Morocco

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

This particular work deals with the Pucciniales fungi (Basidiomycetes) of Morocco. Surveys in northern Atlantic Morocco have allowed collecting dozen species of plants (*Oxalis corniculata*, *Vicia sativa* and *Lotus edulis*) infected by rust. The different symptoms that have been observed are described in the laboratory and a microscopic study of spores, allowed to identify the responsible pathogens for these symptoms which are like: *Puccinia oxalidis*, *Uromyces ervi* and *Uromyces genistae-tincortoriae*. The obtained results help to know the diversification of host Pucciniales and the description of other new species for that cause the fungal diversity of Morocco is to be known.

Keywords: *Pucciniales*; *leguminous plants*; *symptoms*; *description*; *Morocco*.

1. INTRODUCTION

The Pucciniales, considered as obligatory parasites of plants, are represented by more than 7000 species [1,2,3]. The *Puccinia* genus has more than 4877 species [3] which are

widespread in all regions of the world, including 650 species are pathogenic to grasses [4] and others are pathogens for Lily, Umbelliferae and Compositae [5]. Most of these species are heteroxenous, especially those that feed on grasses [5]. In Morocco, *Puccinia* genus is

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represented by 250 species [6,7] while the *Uromyces* genus is represented by only 91 species [8] which can interfere with different plant species.

Leguminous plants refer to plants that belong to the Fabaceae family. They are dicotyledons that form a symbiotic association with *Rhizobium* bacteria. In good conditions of these nodulation, many of their nitrogen needs can be met by biological nitrogen fixation [9]. Leguminous plants are of great economic importance being a source of vegetable protein for animal or human food that does not require nitrogen fertilizer [10]. It is also a source of fat and wood. We also find species representing interests as ornamentals.

In Morocco, surveys were conducted & collected a dozen species of plants *Allium sativum* (Garlic), *Cicer arietinum* (chickpea), *Mentha viridis* (spearmint), *Phaseolus vulgaris* (beans) and *Saccharum officinarum* (sugarcane) which are infected by rust. The different symptoms observed have been described in the laboratory and the microscopic studies of spores which have allowed the identification of pathogens that are responsible for these symptoms of *Puccinia allii*, *Uromyces ciceris-arietini*, *Puccinia menthae*, *Uromyces appendiculatus* and *Puccinia melanocephala* [11].

For the continuation of the work on Pucciniales, several surveys are carried out along the North Atlantic region of Morocco in which three Leguminous plants are collected (*Oxalis corniculata*, *Vicia sativa* et *Lotus edulis*) those are infected by three species of the fungi responsible for rusts.

In this work, the induced symptoms by which are caused by these rusts on their hosts are morphological and structural characteristics of these fungi which are reviewed and discussed for further.

2. MATERIALS AND METHODS

Surveys carried out in Ouled Berjal and Mamora forest near the city of Kenitra and in the grassy roadside on the way to Oued El Makhazine near the city of Ksar El Kebir (Northwest of Morocco), during the period from 10th of March 2012 to 07th of May 2012, which had allowed collecting a dozen sick Leguminous plants: *Oxalis corniculata*, *Vicia sativa* et *Lotus edulis*. The

symptoms are observed in different parts of the host plants.

The description of the symptoms on the hosts were conducted through the use of a pocket magnifier or loupe to better visualizing the pustules that are observed on different parts of Leguminous plants.

In order to study the fungus, a scraping was performed in developed pustules on the leaves and stems of the host plants. Preparations were made for observing, through an optical microscope (X 400) urediniospores and especially teliospores, to determine the fungus, based their morphological characters.

The mounting liquid is tap water, but sometimes added to the preparation a drop of bleach to elucidate the spore wall. The measures of urediniospores, teliospores (at least 50 spores), and pedicel were made using an ocular micrometer.

The determination of the species that are responsible for rusts was done through consultation of different determination keys and bibliographic data related to specific studies in Mycology and Plant Pathology [12,13,14,15, 16,17,18,19].

3. RESULTS AND DISCUSSION

3.1 *Puccinia oxalidis* Dietel & Ellis 1895 on *Oxalis corniculata* (L.)

The encountered species on May 07th 2012 on *Oxalis corniculata* (L.) in the garden of the Faculty of Sciences (Ibn Tofail University) near Kenitra city (Mamora Forest).

Puccinia oxalidis Dietel & Ellis 1895. Current Name: *Puccinia oxalidis* Dietel & Ellis, in Dietel, *Hedwigia* 34: 291 (1895). Synonymy: *Dicaeoma oxalidis* (Dietel & Ellis) Kuntze, *Revis. gen. pl.* (Leipzig) 3(2): 469 (1898), *Trichobasis oxalidis* (Lév.) Lév., in Orbigny, *Dict. Univ. Hist. Nat.* 12: 785 [19 of extr.] (1849), *Uredo oxalidis* Lév., *Annls Sci. Nat., Bot.*, sér. 2 16: 240 (1841) and *Uromyces oxalidis* (Lév.) Lév., *Annls Sci. Nat., Bot.*, sér. 3 8: 371 (1847).

Oxalis corniculata (Fig. 1A), a geophytes that blooms in spring and summer, is a plant that grows on irrigated crops, rocks and shaded walls. It prefers the Semi-Arid soft, Sub humid

and wet. It was reported at the Anti-Atlas (Dar Cheikh in Aït Toudma), the High Atlas, the Middle Atlas, the average Atlantic Morocco, Morocco North Atlantic, the mountains of eastern Morocco (Bni Snassène) and Western Rif [20].

Puccinia oxalidis develops, on the underside of leaves of *Oxalis corniculata*, tiny sores possessing urediniospores also forming a powdery mass yellow-orange. These sores, from 0,15 to 1 mm in diameter, are rounded, exploded very close and confluent (Fig. 1B and 1C).

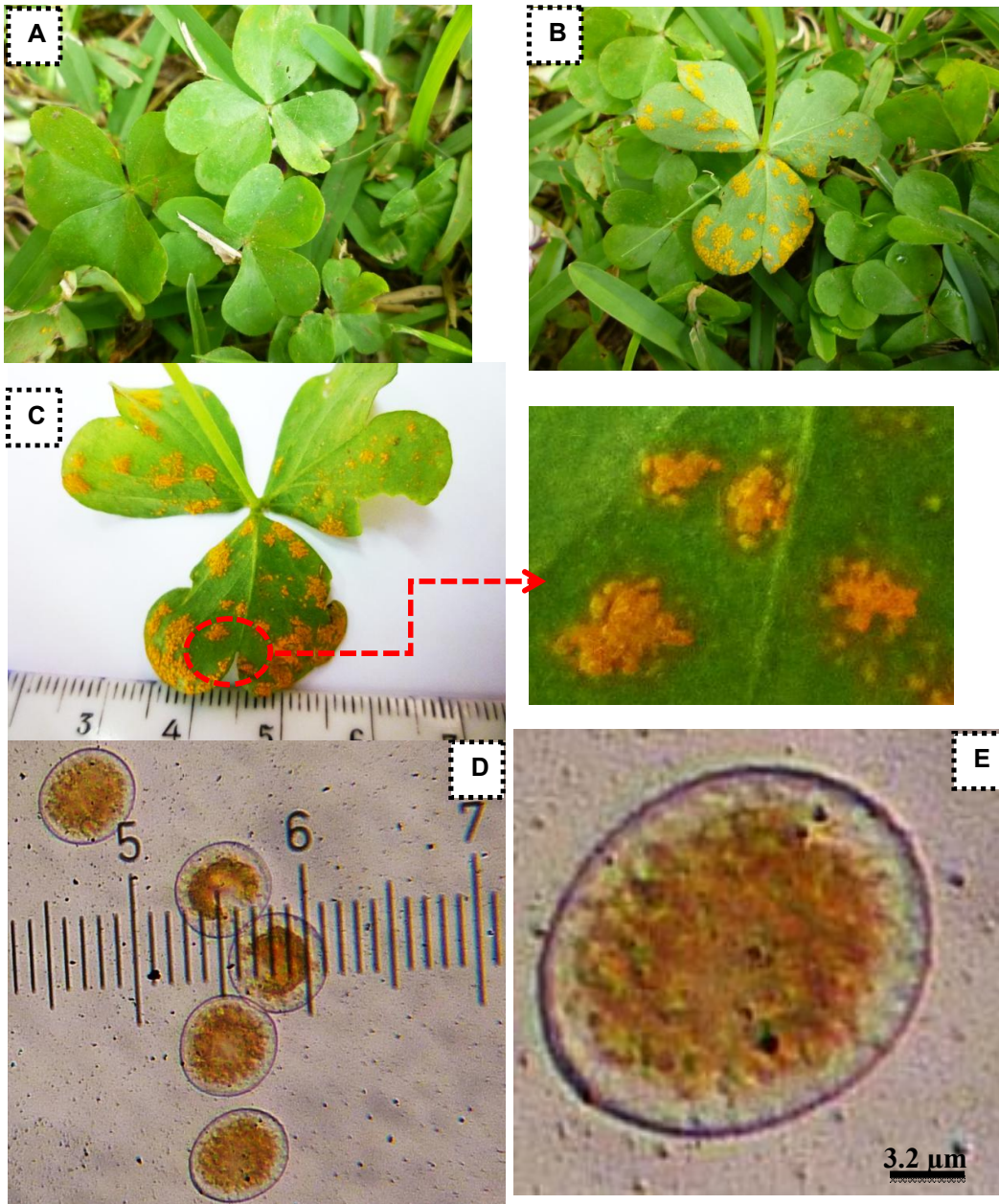


Fig. 1. General appearance of *Oxalis corniculata* (L.) (A). Uredia (B and C); Urediniospores (D and E) of *Puccinia oxalidis* Dietel & Ellis taken from the underside of the leaves of *Oxalis corniculata* (L.). Mounting liquid: tap water. Magnification: x400

Urediniospores (from 15 to 21.65 µm in length and from 16.65 to 19 µm in wide) are spherical or ovoid, yellowish-brown with transparent contour. The wall is thin, carefully echinulate, measuring 1 µm thickness and provided with two uncolored germinal pores (Fig. 1D and 1E).

Puccinia oxalidis is native America tropical and subtropical, and it was introduced in Australia, New Zealand and Japan [21,16]. However, it is noted that this fungus, observed for the first time in Morocco, can also be considered as a new species for North Africa.

Puccinia oxalidis is a rust that has never been reported in Morocco or in *Euphorbia peplus* or in other host plants.

In Morocco, *Oxalis corniculata* is attacked by *Aecidium oxalidis* [22], *Puccinia sorghi* and *Puccinia zaeae* [23] and *Puccinia maydis* [24,23] (locality and description of the fungus are not indicated).

Puccinia oxalidis is a heteroecious rust because of the pycnia and the aecia of this parasite produced on *Mahonia repens* (Berberidaceae), while the urediniospores and teliospores are observed in several species of the genus of *Oxalis* [25,16].

On the world scale, *Puccinia oxalidis* was reported on *Ionoxalis martiana* in Brazil [26], on *Mahonia repens* in Mexico [27] and on the several species belonging to the genus of *Oxalis* as a *Oxalis corymbosa* in Brazil [16] and Australia [28], *Oxalis vallicola* in New Zealand [29] and *Xanthoxalis* sp [23] in Venezuela [30].

3.2 *Uromyces ervi* (Wallr.) Westend. (1854) on *Vicia sativa* (L.)

The encountered species in 10th of March, 2012 on *Vicia sativa* (L.) in a grassy roadside on the way to Oued El Makhazine, near the city of Ksar El Kebir (Northwest of Morocco).

Vicia sativa (Fig. 2A), a therophyte species whose flowering is observed in spring, is found in the clear forests, matorrals, wasteland; Plains, low and medium mountains and prefers the following bioclimates: Saharan, Arid, Mild Semi-Arid, Cold Semi-Arid, Sub humid and Wet [20].

Uromyces ervi develops symptoms represented by pustules located on stems and the underside leaves of *Vicia sativa*. These sores are rounded

on leaves (measured 0.25 to 1 mm thickness) and lying on the stems (measured 1.25 to 4 mm in length and 0,25 mm in width), scattered or confluent, dark brown to black depending on the stage of development of the fungus, exploded, dusty and surrounded by the rest of the debris of a whitish skin (Fig. 2B and 2C).

Teliospores (measured 20 to 36 µm in length and 14 to 23 µm in width) are unicellular, smooth, isolated, verrucous, equipped with an apical germ pore, pointed at the top or flattened, have a yellow apiculus located in the apical level and larger (15 µm) than the height (10 µm). The episporium of teliospores is smooth, thick 2 to 3.33 µm and moderately thick (5 µm) at the top. Basically, teliospores is inserted a flavescent or colorless pedicel, larger 4 to 6.66 µm and up to 66,60 µm in length (Fig. 3A, 3B and 3C).

Urediniospores (15 to 26.65 µm in length and 12 to 20 µm in width) are ovoid or oblong, guttulate or biguttulate (the guttules are greenish) equipped with the thick wall (1.67 µm) and provided with two equatorial germ pores (Fig. 3D).

Uromyces ervi, autoecious and macrocyclic rust [5], differs from *Uromyces viciae-fabae* var. *viciae-fabae* by the number of germ pores in urediniospores. Indeed, *Uromyces ervi* has two equatorial germ pores, while *Uromyces viciae-fabae* var. *viciae-fabae* contains three to five germ pores [17].

In Morocco, *Uromyces ervi* was encountered on *Lens culinaris* in Fes, Sefrou, Oujda, Casablanca and Berkane [24]. Rieuf [23] cited the presence of this fungus on *Lens esculenta*, but without indication of locality.

Vicia sativa, is a new host to *Uromyces ervi* in Morocco. The harvest of this rust in the northwestern Morocco permits the expansion of its geographic range.

3.3 *Uromyces genistae-tincortoriae* (Pers.) Fuckel ex G. Winter (1884) on *Lotus edulis* (L.)

The encountered species in 19th of April, 2012 on *Lotus edulis* (L.) in the garden of the Faculty of Sciences (Ibn Tofail University) near Kenitra city (Mamora Forest).

Lotus edulis (Fig. 4A) is a therophyte species flowering in winter and spring. This plant is found

in lowland pastures and prefers the Semi-Arid sweet, Sub humid the Mediterranean Atlantic Morocco (Chaouia-Doukkala), North Atlantic Morocco (Gharb; Maâmora-Zemmour), the mountains from Eastern Morocco (Bni Snassènen), the Mediterranean coastline and the Rif [20].

Symptoms of *Uromyces genistae-tincortoriae* on *Lotus edulis* are represented by black pustules, or yet covered already by more or less exploded and numerous on the underside of the leaves of the host plant. These sores (0.4 to 2 mm in

length and 0.25 to 1 mm in width) are scattered, remote or very close together or confluent, dusty, surrounded by the debris of a whitish epidermis, oblong or angular (Fig. 4B and 4C).

Teliospores (measured from 19,98 to 23,31 μm in length and from 14.98 to 19.32 μm in width) are unicellular, globular or ovoid, rough, brown and pedicellate. Teliospores have the same shape and color. On its base is inserted a hyaline pedicel, sometimes quite warped and short (5 to 6.66 μm), but large (5.66 μm); on the top, a clear papilla that is higher (5 μm) and less

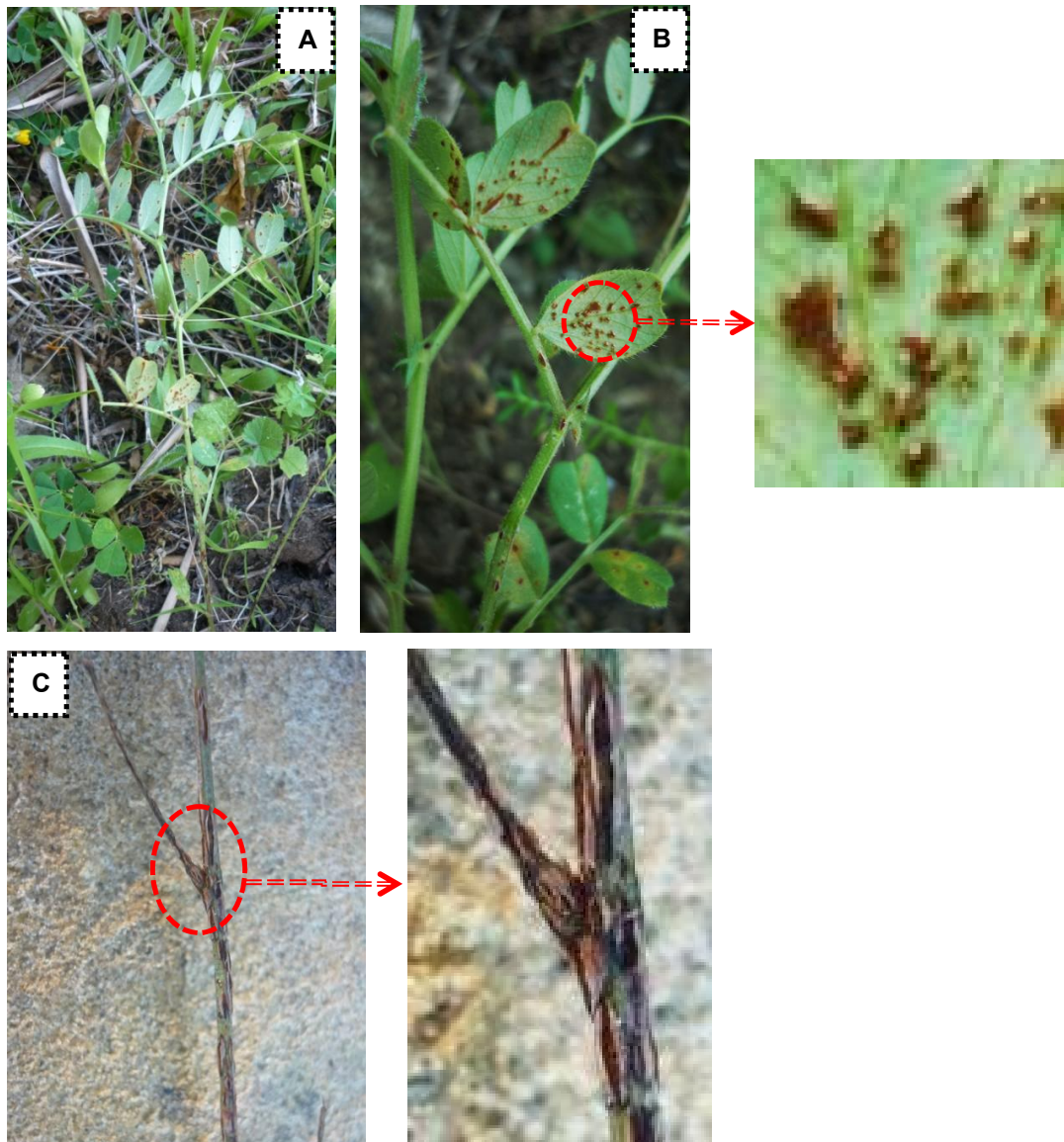


Fig. 2. General appearance of *Vicia sativa* (L.) (A). Symptoms on the underside of green leaves (B) and stems (C) of *Uromyces ervi* (Wallr.) Westend. (1854) on *Vicia sativa* (L.)

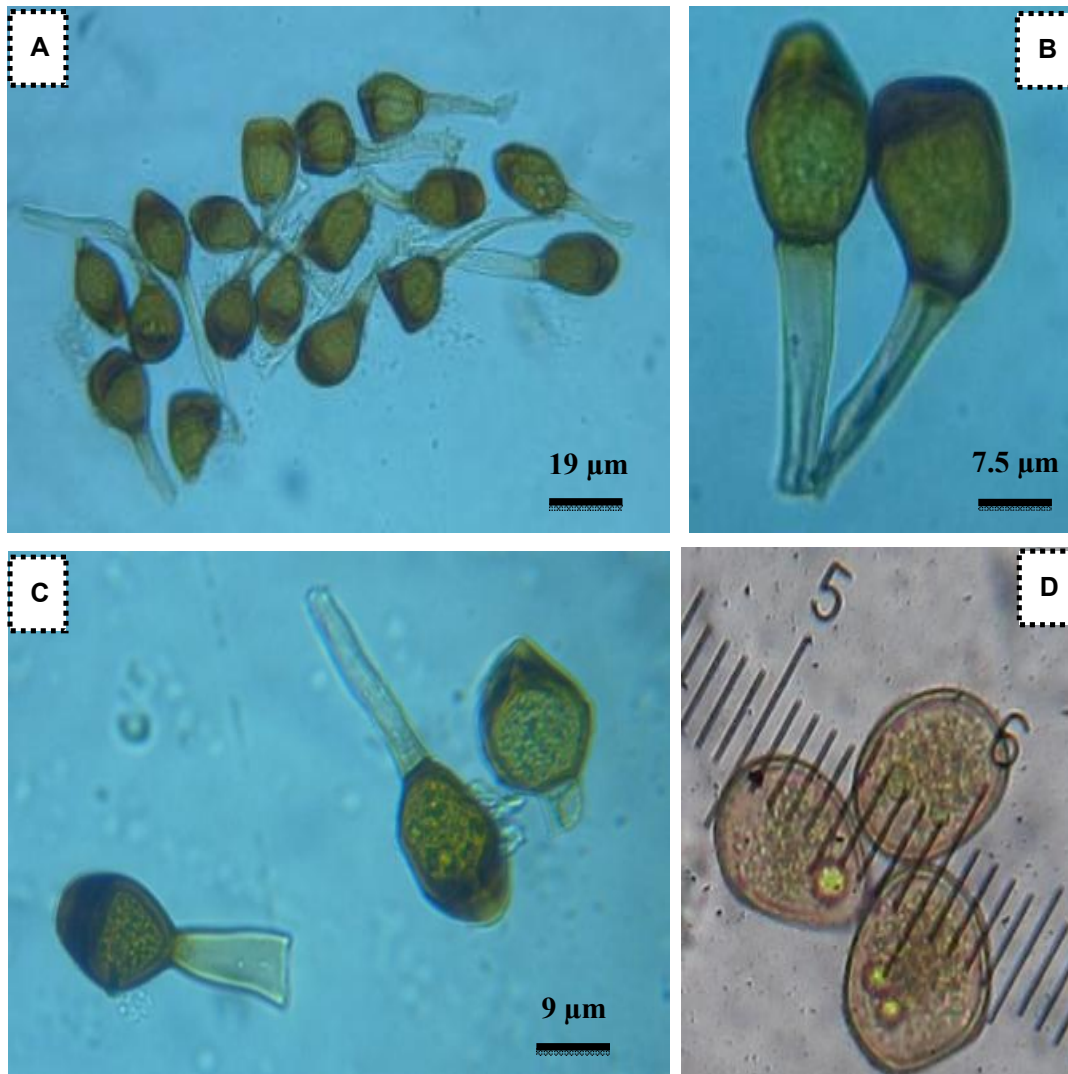


Fig. 3. Teliospores (A to C) and Urediniospores (D) of *Uromyces ervi* (Wallr.) Westend. (1854) taken from *Vicia sativa* (L.). Mounting liquid: chlorinated tap water. Magnification: x400

large (3.30 µm). The wall is chestnut hue brown, thick (2 µm) and thicker at the top (4.42 µm) (Fig. 5A, 5B, 5C and 5D).

Urediniospores (measured from 21.65 to 27.30 µm in length and from 15 to 20 µm in width), are very rare in the whole, seen in association with teliospores (Fig. 5E), rounded or subglobose, brownish, biguttulate and rough. The wall is thick (2.66 µm) provided three to six germ pores (three germinal pores in the majority of urediniospores), finely and loosely echinulate and a yellowish-brown tint uniform (Fig. 5F and 5G).

Uromyces genistae-tinctoriae is a heteroecious rust accustomed to live in Eurasia in fairly close

liaison with one or another of his supports possessing aeciospore (plant species belonging to the genus *Euphorbia*, particularly *Euphorbia cyparissias*, *E. gerardiana* and *E. virgata*); However, this host produces the teliospores of this rust is represented by the plant species which belong to different genres of Fabaceae [12,13,31,14,18,19].

Uromyces genistae-tinctoriae, cosmopolitan rust, has never previously been reported on *Lotus edulis* can be considered as a new host for this parasite in Morocco. The host plant (*Lotus edulis*) is therefore added to the Host's list of known parasites (*Uromyces genistae-tinctoriae*) in Morocco.

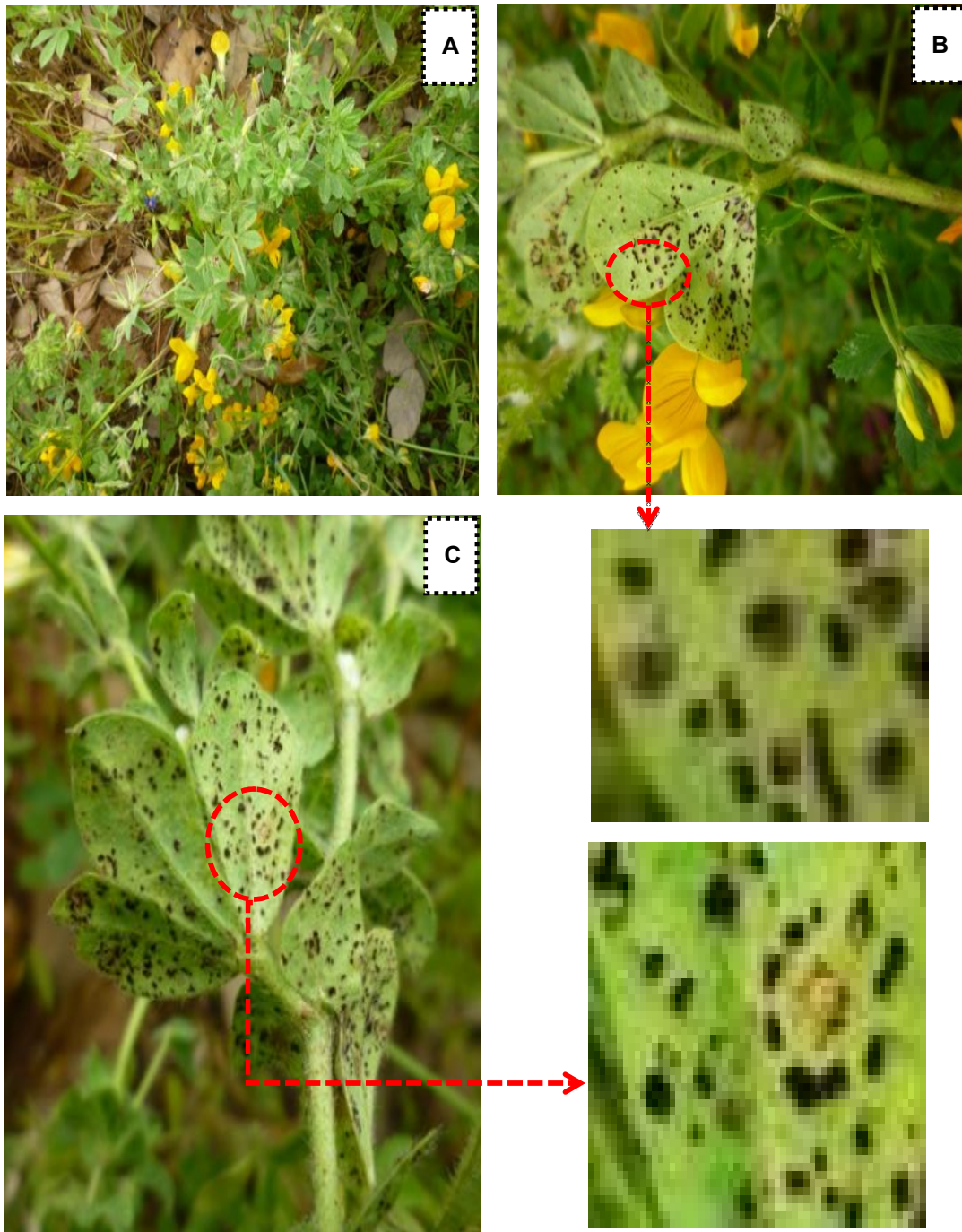


Fig. 4. General appearance of *Lotus edulis* (L.) (A). Symptoms (B and C) of *Uromyces genistae-tinctoriae* (Pers.) Fuckel ex G. Winter (1884) on *Lotus edulis* (L.)

In Morocco, *Uromyces genistae-tinctoriae* was found on *Cytisus triflorus* in El Harcha (Plateau Oulmès) [14]. [23] cited this parasite on *Cytisus triflorus* (no indication of locality and description of this rust).

In Morocco, the rusts that have been encountered on *Lotus edulis* are represented by *Uromyces anthyllidis* and *U. guerkeanus* [31].

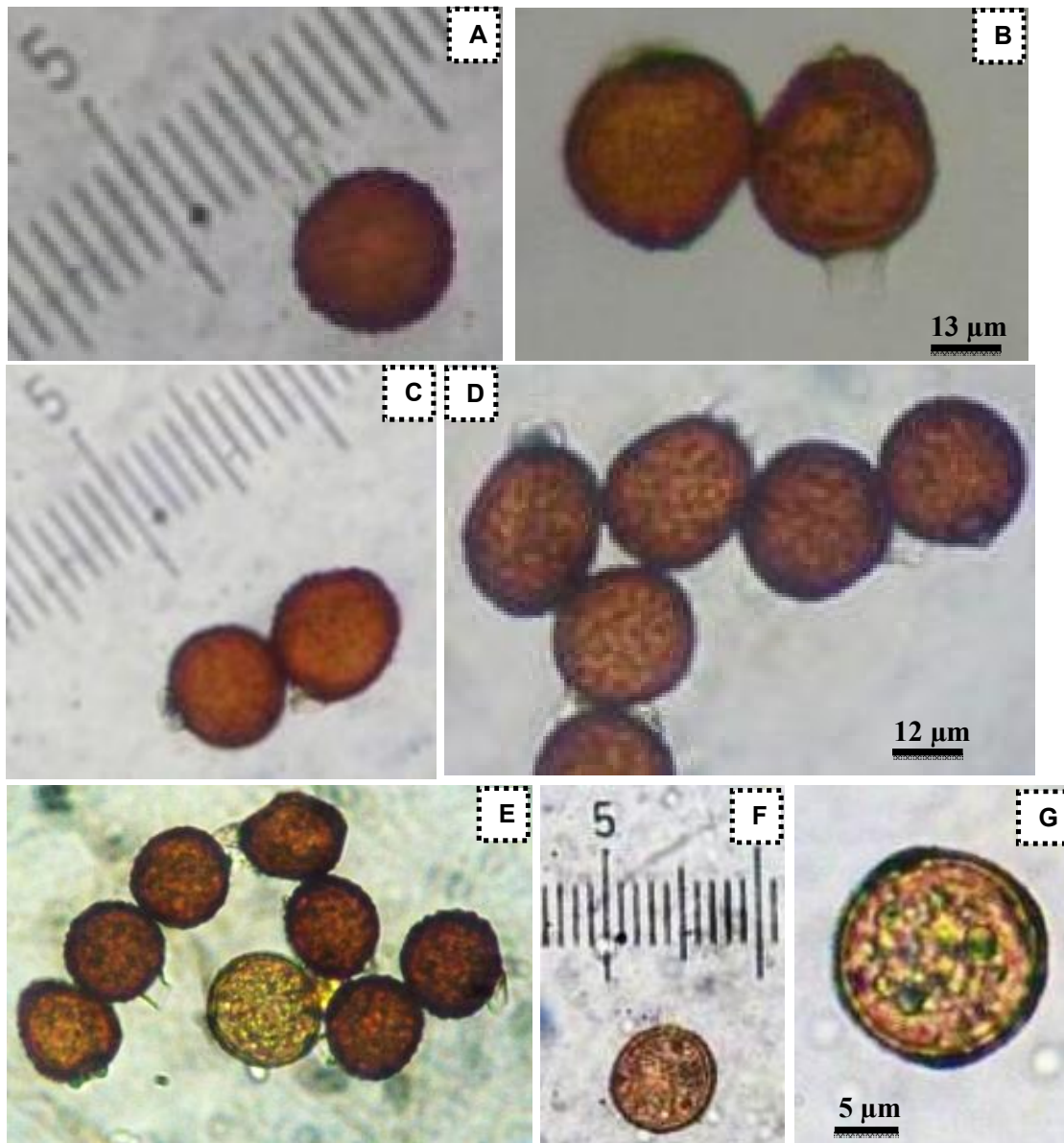


Fig. 5. Teliospores (A to D), urediniospores (F and G) and the rare urediniospores with teliospores (E) of *Uromyces genistae tinctoriae* (Pers.) Fuckel ex G. Winter (1884) taken from *Lotus edulis* (L.). Mounting liquid: chlorinated tap water. Magnification: x400

On the world scale, the attack on *Lotus edulis* was performed by *Uromyces anthyllidis* and *U. guerkeanus* in Algeria, Iraq, Tunisia and Italy [31] and *U. loti* in Italy and Cyprus [32].

4. CONCLUSION

The study of three rust fungal species, encountering on three leguminous plants, allowed depicting that:

- * *Puccinia oxalidis* is observed for the first time in Morocco on *Oxalis corniculata*.
- * *Lotus edulis* and *Vicia sativa* are new hosts, in Morocco, for *Uromyces genistae-tinctoriae* and *Uromyces ervi*.

These results can contribute to know the diversification of the hosts of the Pucciniales and the description of other new species for the fungal diversity of Morocco.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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