A new record to rust fungi of South Western Province Kandahar, Afghanistan

Abstract

A rust fungus occurring on *Centaurea iberica* leaves from Arghandab district, southwestern province Kandahar Afghanistan is described and illustrated. A critical morphological and microscopical examination revealed it to be *Puccinia calcitrapae*. After conducting a literature survey, it was found that this fungus is the first record to be reported from southwestern province Kandahar. A detailed taxonomic description of this fungus along with its distribution is provided. Weeds cause serious problems in agriculture in Afghanistan especially in southwestern province Kandahar. These plants reduce yield and the quality of crops by competing for water, nutrients and sunlight. The improper or excessive usage of herbicides has led to development of resistance in some weed species while contaminating the environment; therefore, biological control has an increasing role as an alternative method for controlling special weed. Previous studies in other countries revealed that this rust fungus are good biological control agents for these weeds.

Key words – Centaurea – Puccinales – systematics - taxonomy

Introduction

Rust fungi are highly obligate parasites of plants belongs to the order Pucciniales (previously Uredinales) in the sub phylum Pucciniomycotina, phylum Basidiomycotina and possess 7,800 species, 166 genera and 14 families worldwide (Kirk et al. 2008). Thirteen out of the 14 families are well described and accepted. (Cummins and Hiratsuka, 2003). The majority of rust species belong to two genera *Puccinia* and *Uromyces* (Helfer 2013).

Rust fungi are obligate parasites of vascular plants, i.e., ferns, gymnosperm and most families of angiosperm (Helfer 2013), while currently about 30 species are successfully cultured on artificial media (Maclean 1982; Williams 1984; Yamaoka 2002). Since some of the species caused economically important diseases of crops, vegetable, orchard and trees. In addition, these fungi exhibit a wider diversity and broader host range and their infection are not only limited to agricultural crops but also to non-agricultural plants including medicinal herbs, shrubs, and even weeds (Dr. Kiran R Ranadive 2021). Biology and taxonomy of the rust fungi have been broadly studied and well cataloged from the beginning of last century**.** Especially, the rust fungi of North America, Europe, Brazil, Japan, Australia, New

Zealand, and Argentina (Cummins and Hiratsuka, 2003). However, some important new species and perhaps genera are still expected, especially in tropical and subtropical regions of Central and South America, Africa, and south Asia (Cummins and Hiratsuka, 2003).

Rust fungi are the most devastating and economically important pathogen of both domesticated and wild plants worldwide (Cummins and Hiratsuka, 2003). Rust fungi are responsible for some of enormous economic losses of trees and crops, including pines, poplars, grape, wheat, corn, coffee, sugarcane, and soybean rusts which are greater than any other single biotic stress. The improper or excessive usage of herbicides leads to the development of resistance in the target weed species as well as contamination of the environment; therefore, biological control has become an alternative method in the case of controlling a single weed species (Müller-Schärer and Frantzen 1996). Shortly biological control of weeds can offer alternatives on economically and environmentally safe approach to reach sustainable agricultural production.

Centaurea is a genus of herbaceous thistle like flowering plants comprise more than 300 species in the family of Asteraceae. Members of the genus are found in equator, mostly in the Eastern Hemisphere and the Middle East. There are 11 species of Centaurea including *Centaurea iberica* (Spreng., Syst Veg.3: 406.1826*)* identified in Afghanistan. Many species in particular those inhabiting more arid regions have a long top root system, mostly found in pastures or meadows, also found in mesotrophic grasslands. Due to their habit of dominating ecosystem under good conditions, many *Centaurea* species can become invasive weeds in region where they are not native meanwhile, is inedible to most livestock due to its spines and apparently outright poisonous to horses and equines. *Centaurea iberica* as a weed is a serious problem in Kandahar province. Previous studies in other countries revealed that this rust fungus are good biological control agents for these weeds.

Rust survey were performed two seasons, spring and early fall (May 2019 & September 2020). We collected rust fungi on *Centaurea iberica* leaves from Arghandab, Dand and Daman districts of south western province Kandahar, Afghanistan. After critical morphological examination of the diseased leaf samples revealed it to be a species of ***Puccinia***. A detailed and precise literature survey and comparative analyses (Henderson and Jørstad 1966, Wilson and Henderson 1966, Henderson 1970, Durrieu 1975) revealed that this fungus is the first record for southwestern province Kandahar. Therefore, a detailed taxonomic description of the species is provided.

Material & Methods

The survey of rust fungi was performed two times at two different seasons, spring (from May 05 to June 07, 2019) and early fall (from September 15 to October 05, 2020). Rust-infected leaf of *Centaurea iberica* were collected into plastic bags and were air-dried to make specimens of rust infected plants and taken to the laboratory for identification and taxonomical studies.

The rust sori were observed under stereo-microscope (MEJI TECHNO, EMZ-5TR; Japan). Free hand section of spores taken from the sori were mounted on a glass slide with lactic acid or lacto phenol for light microscopic observation. Thirty to 60 spores were randomly chosen from each specimen for observation under a light microscope (Olympus BX50F4 or Olympus BH2, Japan). Morphological characteristics of spores such as length, width, wall thickness, shape, surface ornamentation, color, number and location of germ pores were recorded. In case of teliospores, number of cells and pedicel were also recorded. Paraphysis and other structures included in sori were also observed. Ten to 30 spores of each spore states were measured by using an image analyzer PhotoRuler (Onishi 2009.2010). All

identified Specimen is kept in Afghanistan Agriculture and Sciences and Technology University Plant Sciences Herbarium (ANASTU-PLSH), Kandahar, Afghanistan.

Results

Initial symptoms of rust fungi were observed during May to June 2019, as grayish brown spots in the upper surface (adaxial) of leaves which later coalesced to form spindle shaped yellow to orange-yellow powdery pustules were noticed on corresponding lower (adaxial) surface. The infection was limited to mature leaves and no rust symptoms were found on juvenile or young leaves. The development of fungal sori was observed as dark brown longitudinal streaks mainly on the adaxial surface of the leaves. The detailed description and illustrations (Fig. 1) of the fungi along with a discussion on its taxonomy and distribution are presented below.

Taxonomy

Puccinia calcitrapae DC. 1805

Spermogonia and acia are known in other countries but not known in Afghanistan. Uredinia are amphigenous brown to dark-brown without paraphysis; rediniospores are yellowish brown to cinnamon brown, mostly globose to sub globose and 20-28 × 18-24 µm thick. Walls are 1.5-2 µm thick pale yellow to pale brown, echinulate, germ pores 3 rarely 2 sometimes or 4 equatorials.

Telia are amphigenous, chocolate brown to blackish brown; teliospores are dark-brown, 28-37 x 19-24 µm in size and ellipsoid. Walls are smooth 1.5-2 µm thick at sides; pedicels are hyaline 10-15 µm long.

Known Distribution - worldwide in distribution (Asia, America, Europe, Africa, Australia). This rust has been reported in Afghanistan from Kabul, Maymana, Bamyan, Baghlan, Herat, Badakhshan, Kanduz and Balkh (Mazar-i-Sharif) (Fig. 2).

Material examined – Afghanistan, Kandahar (1010 m) on leaves of *Centaurea iberica,* June 15, 2019, Hayatullah Ahmadi, & Qudratullah Ehsan, (ANASTU-PLSH-0019).

Discussion and conclusion

Rust fungus on *Centaurea* spp. collected in Afghanistan was identified *Puccinia calcitrapae* (Henderson and Jørstad 1966, Henderson 1970, Durrieu 1975, Gjaerum 1966) or *P. centaureae* (Petrak 1963, Brandenburger and Steiner 1972, Durrieu 1975). They are morphologically very similar and their taxonomic treatments were different among the uredinologists.

For example, Wilson and Henderson (1966) adopted very wide species concept for the rust fungi with similar morphology on similar host plants (*Arctium, Carduus, Centaurea, Circium and Cardina* in the tribe Cynareae of the family Compositae) and treated them as *P. calcitrapae*, which contained numbers of races or special forms. *Puccinia centaureae* was considered as synonym of *P. calcitrapae*. Records of *P. calcitrapae* in Afghanistan by Henderson and Jørstad (1966), Hederson (1970) and Gjaerum (1996) might be based on this wide species concept.

Savile (1970) considered these two species were distinguishable based on precise morphological composition and host plants. They differed in surface structures of urediniospores and teliospores, and germ pores position of urediniospores. *Puccinia calcitrapae* was found only on *Centaurea calcitrapeae* collected in Europe, while *P, centaureae* (as *P. centuraeae* var *centuareae*) was found on many other *Centaureae* species in Europe and U.S.S.R. Durrieu (1975) fallowed Savile's taxonomic treatment and identified the rust on *Centuraea iberica* as *P. calcitrapae* and the one on *C. condringtonni* as *P. centaureae*.

Cummins (1977) treated North American population on *Carthamus, Centaurae* and *Cirsium* as a variety, *P. calcitrapae* var. *centaureae* (= *P. centaureae*). Hiratsuka et al. (1992) followed Cummins and treated Japanese population on *Carduus, Carthamus* and *Cirsium* as *P. calcitrapae* var. *centuraeae.*

In the present study, two specimens were identified as *Puccinia calcitrapae sensu* Wilson and Henderson (1966). Sizes of urediniospores and teliospores on *Cardus crispus* were slightly larger than those on *Centaurea ibrrica.*

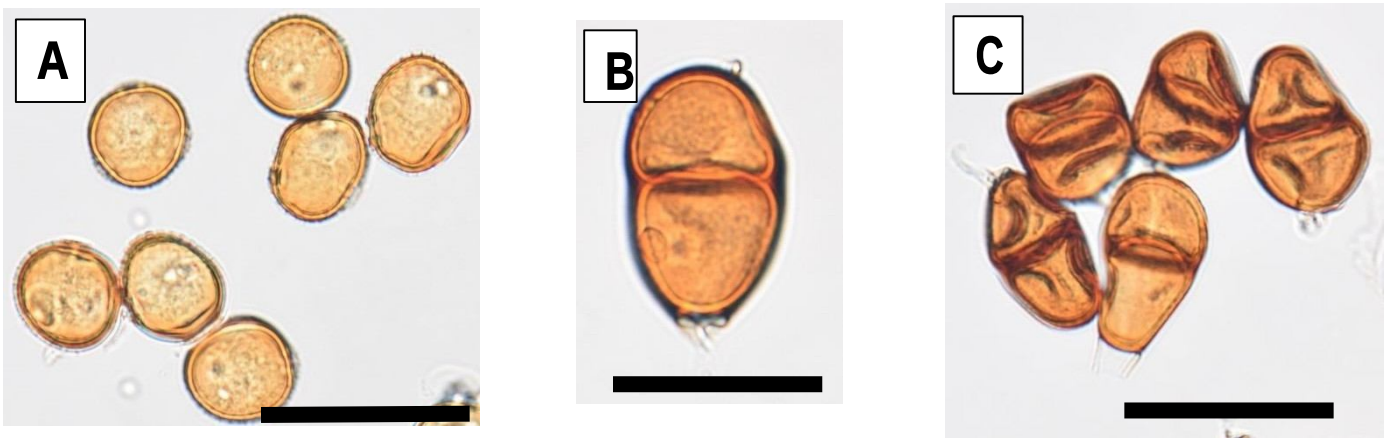

Figure 1. *Puccinia calcitrapae.* (A) Urediniospores. (B-C Teliospores. The scale bare for all pictures are 30 µm.

Centaurea ibrrica caused by rust fungi *Puccinia calcitrapae* has a worldwide distribution including Asia, America, Europe, Africa and Australia. Eleven species of the genus *Centaurea* has been reported from Afghanistan. Many *Centaurea* species can become invasive weeds in region where they are not native meanwhile, is inedible to most livestock due to its spines and apparently outright poisonous to horses and equines. *Centaurea iberica* as weed is a serious problem in Kandahar province. Previous studies in other countries revealed that this rust fungus are good biological control agents for these weeds.

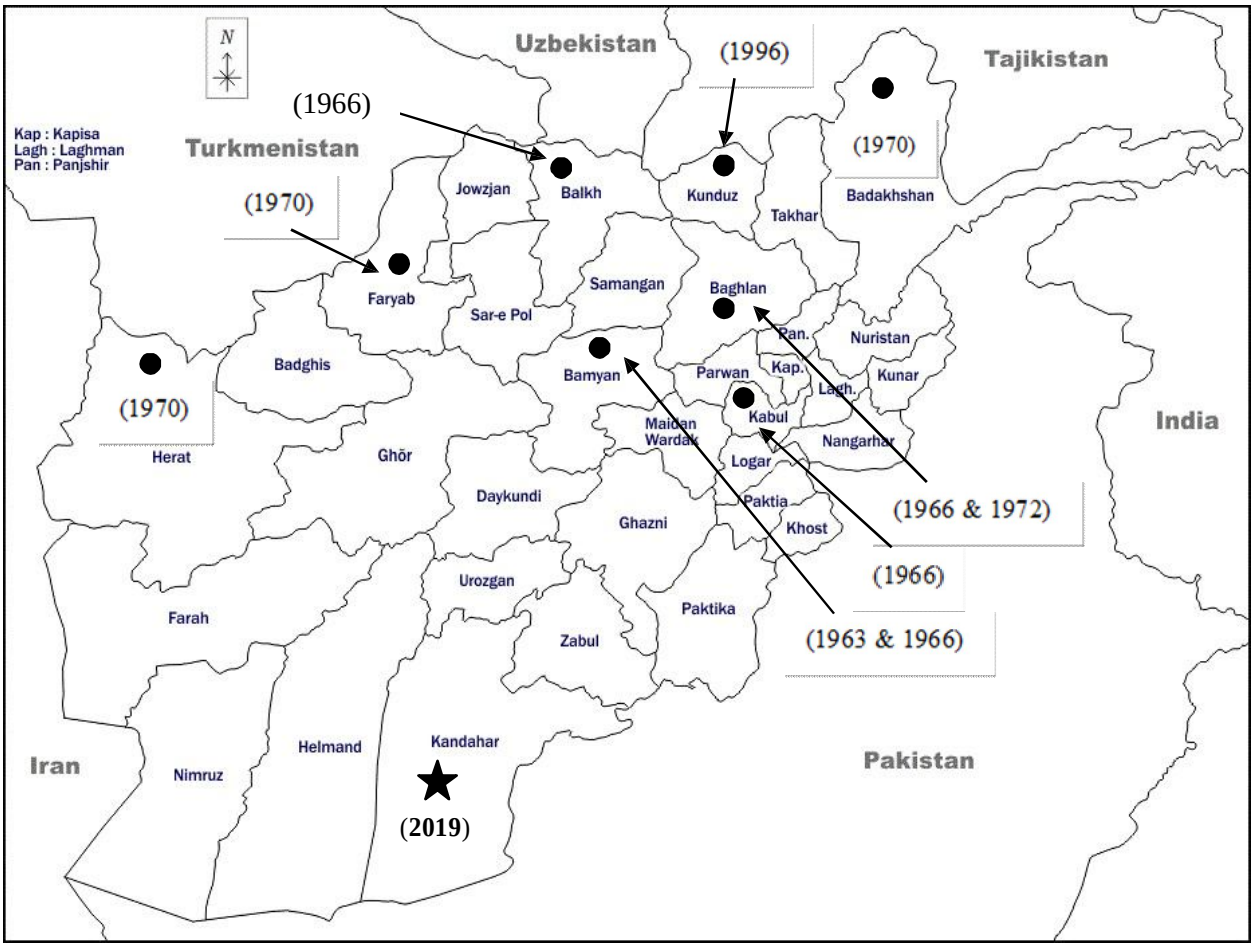

Fig. 2 Distribution map of *Puccinia calcitrapae* DC. 1805 in Afghanistan (Current report ★) .

Table 1 *Puccinia calcitrapae* recorded from Afghanistan, host, location and references.

Species	Host	Location	Reference
Puccinia calcitrapae DC.1805	*Acroptilon austral*	Mymana	Henderson and Jørstad.(1966)
	Acropilon repens	Mazar-i-Sharif	Henderson, D. M. and Joerstad.(1966)
	Carduus pycnocephalus	Fariab	Henderson,D.M.(1970)
	Centaurea iberica	Balkh	Gjaerum, H. B.(1996)
	Centaurea iberica	Mazar-i-Sharif	Henderson, D. M. and I. Joerstad.(1966)
	Centaurea iberica	Unknown province	H. B.(1996), Sydowia Durrieu, G.(1975)
	Centaurea pulchella	Kabul	Henderson, D. M. and I. Joerstad.(1966)
	Centaurea sp.	Kunduz	Gjaerum, H. B. (1996)
	Cousinia leptacatha	Mazar-i-Sharif	Henderson D. M. and I. Joerstad. (1966)
	Centaurea mirocarpa	Mymana	Henderson, D. M. and Joerstad.(1966)
	Centaurea mirocarpa	Mazar-i-Sharif	Henderson, D. M. and I. Joerstad (1966)
	Cousinia sp	Badakhshan	Henderson D. M. (1970)
	Cousinia sp	Herat	Henderson, D. M. (1970)
	Cousinia sp	Maymana	Henderson, D. M.and I. Joerstad. (1966)
	Cousinia sp		Henderson, D. M.and I. Joerstad. (1966)
	Cousinia sp	Bamyan	Henderson, D. M. and I. Joerstad.(1966)
	Cousinia sp.	Kabul	Henderson, D. M.and I. Joerstad.(1966)
	Cousinia sp.	Qataghan	Henderson, D. M. and I. Joerstad.(1966)
	Centaueea codringtonni	Unknown Province	Durrieu, G.(1975)
	Centaurea iberica	Baghlan	Henderson, D. M. and I. Joerstad.(1966)
	Centaurea iberica	Baghlan,	Brandenburger,W. and M.Steiner.(1972)
	Cousinia sp.	Unknown Province	Petrak, Franz. (1963)
	Cousinia sp.	Bamyan	Petrak, F. (1963)

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