

STUDIES IN RUSTS (UREDINALES) ON *ASTRAGALUS* (FABACEAE)

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Four *Uromyces* species are described as new, viz. *U. astragali-alopecuri* sp. nov. on *Astragalus alopecurus* from Turkey, *U. astragali-atropilosuli* sp. nov. on *A. atopilosulus* subsp. *bequaertii* var. *bequaertii* from Kenya, occurring also in Ethiopia and Tanzania, *U. astragali-pseudoutrigeris* sp. nov. on *A. pseudoutriger* from Turkey, and *U. semnanensis* sp. nov. on *A. fridae* from Iran. Several new hosts (marked *) are reported for *U. punctatus*. This rust is reported as new to S America (in Chile).

INTRODUCTION

The genus *Astragalus* with its c.2000 species (Willis, 1973) is widely distributed in more or less dry areas, but is not known in Australia. Especially in dry areas in western Asia the number of species is very high.

Such a large genus, split up into several sections (e.g. Komarov (1946) has 103), might be expected to carry many rust species. However, only eight species are so far known to me (several more have been described, but are reduced to synonyms), seven of which belong to the genus *Uromyces* and one which was described as an *Aecidium* (*A. phacae* Jørstad). One species, viz. *U. lapponicus* Lagerh. is autoecious, lacking uredinia, thus being an opsis- or demicyclic form, and one species, viz. *U. punctatus* Schroet., is heteroecious, alternating with *Euphorbia* spp. For other species only uredinia and/or telia are known.

The spore measurements are made on spores mounted in lactophenol. The material presented below has mostly been picked out from phanerogram sheets in the herbaria of K, E, and O, where also the specimens are preserved.

ENUMERATION OF SPECIES

***Uromyces astragali-alopecuri* Gjørnum, sp. nov. Fig. 1A.**

Spermogonia, aecidia et uredinia ignota. *Urediniosporae* in teliis intermixtae, 18–21 x 16–21µm, ellipsoideae vel globoideae, pariete 1µm crasso, hyalino vel pallide flavo, echinulato, 3(–4) poris equatorialibus instructis, obscuris. *Telia* c.0.5–0.8mm diametro, hypophylla, cinnamomea, pulverulenta. *Teliosporae* 17–22(–24) x 18–20 (–23)µm, globoideae, raro subgloboideae vel ellipsoideae, pariete 1–1.5µm crasso, flavo-brunneo,

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verruculoso, verrucis in lineas longitudinales, 0.5 μ m diametro, poro apicali papilla hyalina humili tecto; pedicello brevi, pariete tenui, hyalino, deciduo.

Type: Turkey, Erzurum, 29km from Hınıs towards Pasinler, 1800m, on *Astragalus alopecurus* Pall., 12 vii 1966, Davis 46412 (K).

U. astragali-alopecuri differs from other *Astragalus* rusts especially in having thin-walled, hyaline to pale yellow urediniospores.

The host occurs in S Ural, Central European USSR and in N and W Asia.

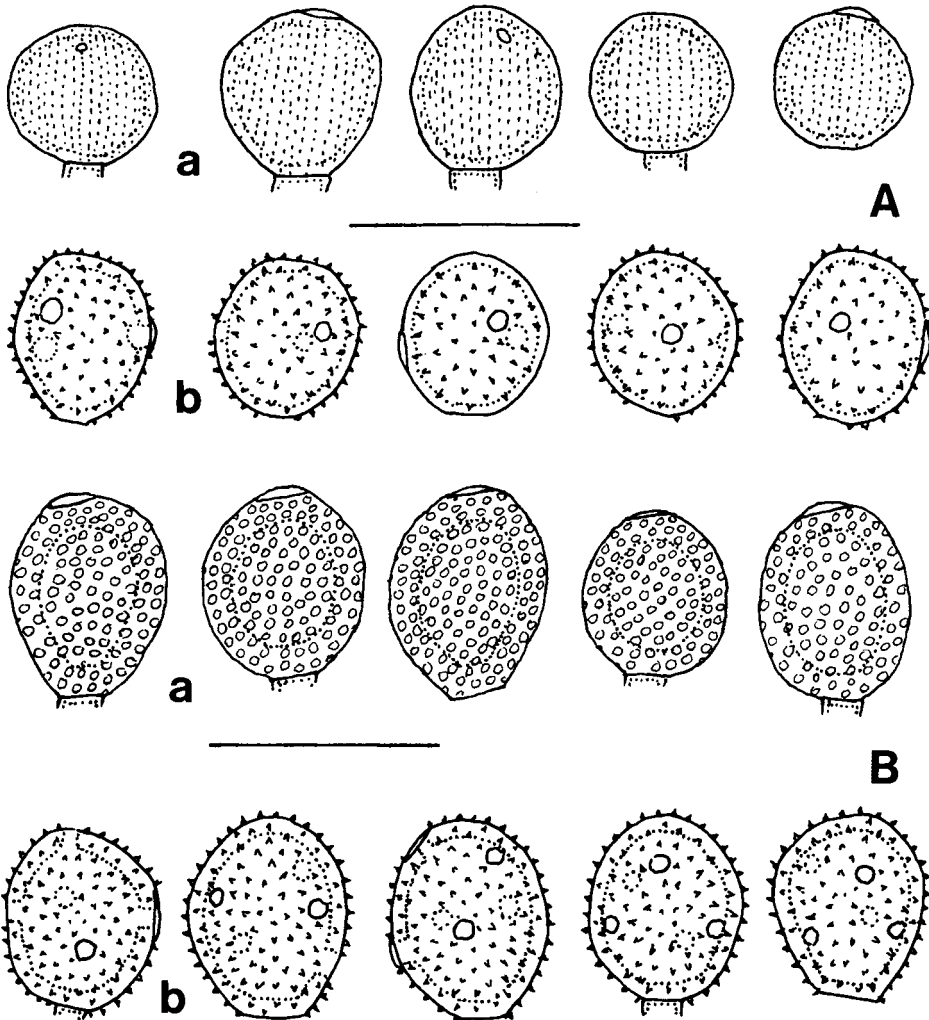


FIG. 1. A, *Uromyces astragali-alopecuri* Gjørum. a, teliospores; b, urediniospores. From type. B, *Uromyces astragali-atropilosuli* Gjørum. a, teliospores; b, urediniospores. From type. Scale bars = 30 μ m.

Uromyces astragali-atropilosuli Gjørum, sp. nov. Fig. 1B.

Spermogonia et aecidia ignota. Uredinia amphigena, cinnamomea. *Urediniosporae* 26–30 x 25–29µm, ellipsoideae vel subgloboideae, pariete 2.5–3µm crasso, bistrato, externo cinerescenti-flavo, interiore flavo-virenti, 3–5 poris, 3–4 saepe equatorialibus, vel ubi 5 quatuor equatorialibus et uno apicali vel totis dispersis instructis. *Telia* 0.5–1mm diametro, in caulibus confluentia, amphigena, atrocinnamomea, pulverulenta. *Teliosporae* 21–27 x 17–21µm, ellipsoideae, obovoideae, raro ovoideae, pariete 2–2.5µm crasso, brunneo, dense verruculoso, verrucis c. 0.8–1µm diametro, partim in lineas longitudinales, poro apicali papilla hyalina humili tecto; pedicello usque 20µm longo, prope sporam fracto, pariete tenui, hyalino.

Type: Kenya, Kitale, 1850m, on *Astragalus atropilosulus* (Hochst.) Bunge subsp. *bequaertii* (De Willd.) Gillett var. *bequaertii*, v 1933, C. Maker 2509 (K),

Other specimens examined (all *A. atropilosulus*):

On subsp. *atropilosulus* var. *atropilosulus*: ETHIOPIA. 7km N of Addis Ababa on the Gojam road, 2900m, 22 x 1970, M. G. & S. B. Gilbert 1925 (K), II+III.

On subsp. *atropilosulus* var. *mooneyi* Gillett: ETHIOPIA. Mt Borulucco, 30km SE of Asella, 4 xii 1965, W. J. S. O. de Wilde & E. E. de Wilde 9108 (K), II.

On subsp. *bequaertii* (De Willd.) var. *elgonensis* (Bullock) Gillett: KENYA. Mt Elgon, 3840m, xii 1930, E. J. & C. Lugard (K), III.

On subsp. *burkeanus* (Harv.) Gillett: ETHIOPIA. NE of Lake Alemaya (Haramaia), 15km NW of Harar, 2000m, 26 vii 1963, *Jesselia Berke* 13 (K), II.

On subsp. *burkeanus* (Harv.) Gillett var. *pubescens* Gillett: TANZANIA. Kilalo, 04 iii 1970, K. & S. Fuller 136 (K); Mbulu distr., Elanairobi volcano, 3000m, 20 ix 1932, B. D. Burt 4183 (K), II+III.

This new species differs from other *Astragalus* rusts especially in the more regularly and densely warted teliospore walls.

A. atropilosulus s. lat. is distributed in Yemen and in eastern Africa from Ethiopia south to Transvaal (S Africa).

Uromyces astragali-pseudotriggeris Gjørum, sp. nov. Fig. 2A.

Spermogonia et aecidia ignota. Uredinia c.1mm diametro, hypophylla, cinnamomea. *Urediniosporae* 23–27 x 20–24µm, ellipsoideae vel subgloboideae, pariete 1–1.5µm crasso, flavescenti, echinulato, (3–)4 poris papillis humilibus tectis equatorialibus instructis. *Telia* c. 1mm diametro, hypophylla, cinnamomea, pulverulenta. *Teliosporae* 17–23 x 16–19µm, ellipsoideae, subgloboideae vel raro globoideae, pariete 1–1.5µm crasso, pallide brunneo, verruculoso, verrucis c. 0.8–1µm diametro, plus minusve in lineas dispositis, poro apicali papilla hyalina humili tecto; pedicello usque 40µm longo prope sporam fracto, pariete tenui, hyalino.

Type: Turkey, c.30km NE of Caldiran, 2400–2700m, on *Astragalus pseudotriggeris* Grossh., 7 vii 1982, Sorger & Buchner 82-47-58 (E),

U. astragali-pseudotriggeris differs from *U. astragali-alopecuri* in having larger urediniospores. The warts on the teliospores are more distinct than those on *U. astragali-alopecuri*.

The host is distributed in Armenia, NE Anatolia, Transcaucasia and N Iran.

Uromyces lapponicus Lagerh., Bot. Notiser 1890: 274 (1890).

On *Astragalus shinanensis* Ohwi (syn. *A. membranaceus* Bunge var. *obtusus* Makino): JAPAN. Honshu, Prov. Kai, Hôzsan mts, 26 viii 1906, *Takeda* (K), III.

U. lapponicus has a wide distribution in N America, Europe and Asia. In Japan it has previously been reported from Central Honshu. This rust is also reported on *Oxytropis* spp. in the three continents mentioned above.

Uromyces punctatus Schroet., Abh. Schles. Ges. Vaterl. Cult. Abth. Nat. Med. 1869–1872: 10 (1870).

Syn.: *U. astragali* Sacc., Mycoth. Veneta 208 (1873).

On *Astragalus atropilosulus* (Hochst.) Bunge subsp. *abyssinicus*: KENYA. Naivasha distr., Bed of the Karati River, 2500m, x 1933, *Mrs Albrechtsen* 6028 (K), II. ZAIRE. Orientale Prov., Mahagi territory, Luga (Nioka), 5 xi 1952, *L. Liben* 419 (K), II.

On *Astragalus atropilosulus* (Hochst.) Bunge subsp. *abyssinicus* (Hochst.) Gillett var. *venosus* (Hochst.) Gillett: ETHIOPIA. Eritrea, Saganeiti, 2200m, 7 iv 1892, *G. Schweinfurth* & *D. Rivas* (K).

* On *Astragalus aduncus* Willd.: TURKEY. Van Prov., NE of Baskale, 2300m, 10 vi 1966, *Davis* 44514 (K), II.

* On *Astragalus amatus* Clos: CHILE. Coquimbo Prov., Ovalle Dept., Fray Jorge, 400m, xi 1925, *E. Werdermann* 916 (K), II.

On *Astragalus alopecuroides* L.: ITALY. Piemont, Vallée de Cogne, near Epinal, 1400m, vii 1901, *Wilczeth* (O), III.

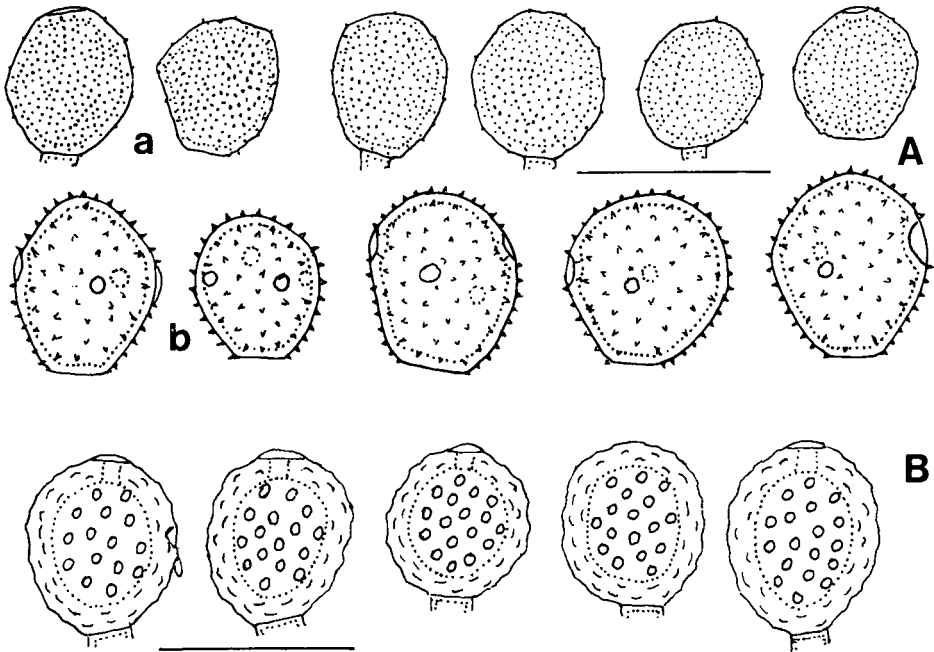


FIG. 2. A, *Uromyces astragali-pseudotrigeris* Gjørum. a, teliospores; b, urediniospores. From typ. B, *Uromyces semnanensis* Gjørum. Teliospores. From type. Scale bars = 30µm.

- * On *Astragalus angustidens* Freyn & Sint.: AFGHANISTAN. Herat Prov., 40km S of Herat, on the main road, 1700m, 14 v 1969, *Hedge, Wendelbo & Ekberg* W 7966 (E), II.
On *Astragalus austriacus* Jacq.: USSR. Altai, before 1867, *Ledebom* (K), II.
- * On *Astragalus* cf. *baghlanensis* Deml.: AFGHANISTAN. Prov. Badakshan, Yawarsan, c.30km S of Qeshm, 30 vi 1969, *Hedge & Wendelbo* 9276 (E), III.
- * On *Astragalus brevidens* Rydb.: IRAN. Lake Rezaiyeh, 1300–1400m, no date, *M. Jacobs* 6667 (K), II.
- * On *Astragalus caprinus* L.: ISRAEL. 10km S of Beersheba, 15 iv 1928, *E Eig et al.* (E); II.
- * On *Astragalus cartilagineus* Gontsch.: AFGHANISTAN. Kandahar Prov., 50km NW of Kandahar, 2050m, 19 iv 1969, *Hedge & Ekberg* W 7140 (E), II+III; Herat Prov., between Obek and Khodja Chisht, 1650m, 10 v 1969, *Hedge, Wendelbo & Ekberg* W 7787 (E), II+III.
- * On *Astragalus cephalanthus* DC.: IRAN. Kerman Prov., Khabr va Rouchun protected region, 50km SSW of Baft, E side of Kuh-e Khabr, 12km E of Khabr, 2800m, 8 vii 1977, *Assadi, Edmonton & Miller* 1672 (E), (II+)III.
On *Astragalus fruticosus* Pall.: EGYPT. N Siani, Nahat Dikla, 15km SW of Rafah, 13 v 1973, *A. Danin* (K), II.
- * On *Astragalus gombo* Coss. & Dur. ex Bunge: TUNISIA. Between El Djem and Sfax, 24 iii 1939, *N. Y. Sandwith* 2001 (K), II.
On *Astragalus hololeios* Bormm.: AFGHANISTAN. Teng, Geran gorge, between Kabul and Sarobi, 19 vii 1966, *P. Furse* 8617 (K), II+III.
- * On *Astragalus hosackioides* Benth. ex Baker: INDIA. Kumaon, Naini Tal, iv 1844, *Thomson* 586 (K), II.
On *Astragalus humboldtii* Gray: MEXICO. Chihuahua, 1 iv 1885, *C. G. Pringle* (K), II.
- * On *Astragalus kahiricus* DC.: PAKISTAN. Baluchistan, Quetta, between Bosten and Khanozai, 10 v 1965, *Rechinger Iter Orientale* 1965 29144 (K), III.
- * On *Astragalus koschukensis* Boiss.: PAKISTAN. Baluchistan, Qilla Abdulla, 1500m. 24 v 1969, *Zaffar Ali* (Gordon College Herb. 5603) (K), III.
- * On *Astragalus kotschyanus* Boiss.: TURKEY. Tunceli Prov., Hozak, 1700m, 14 vii 1957, *Davis & Hedge* 31121 (K), II.
- * On *Astragalus kurdicus* Boiss. var. *kurdicus*: TURKEY. Erzincan Prov., 2200m, 27 vii 1957, *Davis & Hedge* D 31704 (E), II.
On *Astragalus macrocephalus* Willd. subsp. *finitimus* (Bunge) Chamberl.: USSR. Armenia. Mikojanski rayon, E of the village Khatchik, 20 vii 1959, *Ida Mandenova* (E), II+III.
- * On *Astragalus mollis* Bieb.: IRAN. Azarbaijan Prov., Gōja Bel-Pass, 1650m, 29 v 1971, *J Lamond* 5063 (E), II. TURKEY. Kars Prov., Kars-Selim, 1800m, 6 vii 1957, *Davis & Hedge* D 30665 (E), II+III. MEXICO. Chihuahua, Colonia, 20 ix 1899, *E. W. Nelson* 6448 (K), II.
- On *Astragalus monspessulanus* L.: ITALY. Near Florentina, 1872, no coll. given (O), II.
On *Astragalus onobrychis* L.: TURKEY. Erzurum Prov., Kop Dag Pass, 2400m, 10 viii 1962, *P. Furse* 3838 (K), III.
- * On *Astragalus ophiocarpus* Benth.: AFGHANISTAN. In desert 100 miles S of Herat, 1200m, 12 iv 1970, *J. E. Carter* 827 (K), III.
- * On *Astragalus ovinus* Boiss.: IRAN. Bachtiani Co., Kuhreng, 2400m, 31 v 1959, *P. Wendelbo* 958 (E), II.
- * On *Astragalus penicillatus* Podlech: AFGHANISTAN. Takhar Prov., 17 ix 1965, *D. Podlech* 12661a (E), III.
On *Astragalus podolobus* Boiss. & Hohen.: IRAN. Prov. Semnan, c.15km W of Semnan on road to Firuzkuh, 1400m, 19 vii 1975, *P. Wendelbo & G. Cobham* 14693 (NPPI), III.
- On *Astragalus ponticus* Pall.: TURKEY. Van Prov., Hosap distr., Kepir Dag, 2800m, 30 vii 1954, *Davis* 23348 (E), II; Erzurum Prov., Illicia-Tercan, 2000m, 10 vii 1959, *Davis & Hedge* D 30866 (E), II.
- * On *Astragalus* aff. *prusianus* Boiss.: TURKEY. 3–4km N of Pozanti, 200m, 3 vii 1971, no coll. given, *MI* 969 (E), II.
- * On *Astragalus schizopterus* Boiss.: TURKEY. Adana Prov., between Kozan and Feke (Anti-Taurus), 11 iv 1957, *Davis & Hedge* 26584 (K), II.
- * On *Astragalus squarrosus* Boiss. var. *sangonensis* (Sirj. & Rech. f.) Ali: PAKISTAN. Herat Prov., S of Andraskan, 1430m, 8 v 1969, *Hedge, Wendelbo & Ekberg* W 7709 (E), III; Herat

Prov., between Obeh and Khodja Chisht, 1430m, 9 v 1969, *Hedge, Wendelbo & Ekberg* W 7763 (E); Kandahar Prov., 50km NW of Kandahar, 2050m, 19 iv 1969, *Hedge & Edberg* W 7115 (E), II.

* On *Astragalus stocksii* Benth. ex Bunge: PAKISTAN. Baluchistan, Vrak, 2100m, 11 v 1952, *H. Crookshank* 64 (K), II.

* On *Astragalus suffulcatus* Bunge: AFGHANISTAN. Between Girishk and Kandahar, 750m, 25 iv 1964, *P. Furse* 5580 (K), III.

* On *Astragalus teheranicus* Boiss. & Hohen.: IRAN. Azarbaijan Prov., near Tabriz, 1000m, 16 vi 1924, *A. Grossheim & B. Schichki* (Planta orient. Exsicc. 288) (K), II.

* On *Astragalus turbinatus* Bunge: AFGHANISTAN. Herat Prov., 30km S of Herat, 1480m, 14 v 1969, *Hedge, Wendelbo & Edberg* W 7995 (E), III.

On *Astragalus* spp.: IRAN. Tehran, Tehran Farahabad, c. 1300m, 29 vi 1975, *P. Wendelbo & Ann Ala* (NPPD). USSR. Kazakhstan, Akmolinskaja obl., Atbaserskij u.R. Sary-su, 8 vi 1971, *H. Kraschennikov* 5257 (O), II+III. TURKEY. Karabas, 6 miles SE of Van, 500m, 9 vi 1966, *Davis* 44616 (K), II+III.

Judging from the descriptions given by various authors, *U. punctatus* is a variable species. The urediniospores, (15–)18–25(–30) x (14–)15–22 μ m, are mostly given as globoid, subgloboid or ellipsoid, but also as obovoid, with a wall thickness 1.5–2.5 μ m. The number of pores varies from 3–4 up to 3–6, the lower number often equatorial, the higher ones more scattered.

The teliospores, (14–)17–25 x (13–)15–22 μ m, are said to be globoid, subgloboid or ovoid, wall (1–)1.5–2.5 μ m thick, verrucose, sometimes the warts are arranged in lines against the base of the spores.

The material studied by me shows variation, but in my opinion fits well within the descriptions mentioned above, and also with material seen identified by other mycologists.

No other *Astragalus* rust has been reported on so many host species as *U. punctatus*. More than 100 species belonging to a wide range of sections have been mentioned. In addition to *Astragalus* some species of *Oxycarpus*, *Phaca*, *Medicago* and *Caragana* have also been cited. After inoculation with aeciospores of *U. punctatus* (as *U. astragali*) from *Euphorbia cyparissias* L. Jordi (1904) obtained uredinia on species of *Astragalus*, *Oxytropis* and *Lotus*, on the last, however, only in one experiment. He therefore wondered if the aeciospores used belonged to different forms. The heteroecious nature of the rust species were proved by Jordi (1903) and Bubák (1904).

U. punctatus has been reported from northern USA to Central America, Central and South Europe, more rarely in Africa, and in Asia eastwards to Japan. In the above list species marked with * are new reported hosts for the rust. *A. amatus* seems to be the first host reported from S America. *U. patagonicus* Speg. was described on *Astragalus* sp., but the host specimen is now listed under *Glycyrrhiza astragalina* (Rabh.) Mag. (cf. Lindquist, 1982). *U. patagonicus* is easily separated from *U. punctatus* having only two pores in the urediniospores.

U. punctatus is very similar to *U. pisi* (DC.) Oth. Gäumann (1959) recognized it as a member of the 'Formenkreis des *Uromyces pisi* (Persoon) Winter' while Wilson & Henderson (1966) and Henderson & Jørstad (1967) listed it under *U. pisi* (DC.) Oth.

It should, however, be mentioned that this species should probably be split up into varieties, maybe even into species, but as there are variations within the same specimens, more material has to be studied.

***Uromyces semnanensis* Gjørum, sp. nov. Fig. 2B.**

Spermogonia, aecidia et uredinia ignota. *Telia* c. 1mm diametro, saepe irregulariter, confluentia, amphigena, subgloboidea, atrobrunnea, pulverulenta. *Teliosporae* 25–32 x 22–28 μ m, globoideae vel subgloboideae, raro ellipsoideae, pariete (2.5)3–4(–4.5) μ m crasso, castaneo, verruculoso, verrucis 1.3–1.6mm diametro, poro apicali papilla flavescenti humili tecto; pedicello usque 40 μ m longo, pariete tenui, hyalino, collabente, deciduo.

Type: Iran, Prov. Semnan, 1300–1350m, on *Astragalus fridae* Rech. f., 24 v 1974, P. Wendelbo & H. Foroughi 13000 (NPPI).

U. semnanensis differs from other *Astragalus* rust species by its large, thick-walled teliospores. The warts are slightly larger and also more pointed than those on *U. punctatus* Schroet. The host is endemic to Iran.

***Uromyces wartoensis* Petr., Ann. Nat. Hist. Mus. Wien 52(1941): 309 (1942).**

On *Astragalus wartoensis* Boiss.: No locality given, 26 viii 1859, *Kabely* 411 (E), III.

U. wartoensis was described on *A. wartoensis* from the district Varto (in German Warty) in Turkey, collected by Kotschy at the same date as the specimen mentioned above, the only record so far.

KEY TO THE *ASTRAGALUS* RUST SPECIES

1. With aecia _____ 2
- + Without aecia _____ 3
2. Aeciospore wall nearly smooth or smooth ____ ***Uromyces lapponicus***
- + Aeciospore wall with large warts _____ ***Aecidium phacae***
3. With uredinia and telia _____ 4
- + Only telia known _____ 10
4. Teliospores without papillae _____ ***Uromyces astragali-lasiosemi***
- + Teliospores with papillae _____ 5
5. Urediniospore wall hyaline to pale yellowish
- Uromyces astragali-alopecuri***
- + Urediniospore wall cinna-mon- to chestnut-brown _____ 6
6. Urediniospore wall bilaminate ____ ***Uromyces astragali-atropilosuli***
- + Urediniospore wall not laminate _____ 7

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