



Smut fungi of Iran

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Abstract

A short history of the knowledge of Iranian smut fungi is given followed by an account of the 99 known smut fungus species (Ustilaginomycetes) from Iran. Each species is presented with its authors, place of publication, synonyms, description, host plants and geographic distribution. A key to the 16 genera, to which these smuts belong, and keys to the species within each genus are given. There is also a host plant – smut fungus index. The following six species are known only from Iran: *Anthracoidea songorica*, *Entyloma majewskii*, *Tilletia rostrariae*, *Tranzscheliella iranica*, *Urocystis behboudii* and *Urocystis phalaridis*.

Key words – Biodiversity – Iran – parasitic microfungi – smut fungi – synonyms – Ustilaginomycetes

Introduction

A short history of the knowledge of the Iranian smut fungi

Mycology in Iran started in 1830 with the report of *Parmelia esculenta* (Goebel 1830). Thirty years later Buhse (1860) published a comprehensive paper about plants, lichens and fungi of Transcaucasia and Persia. He reported 33 species of fungi from this area, but no smut. The first smut fungus, *Tilletia sorghi* (= *Sporisorium sorghi*) was reported on *Sorghum* sp. by Rabenhorst (1871). Wettstein (1885) reported *Ustilago ornithogali* (= *Vankya heufleri*) on *Tulipa kernerii* from Ghazvin area. *Urocystis orobanches* was reported on *Phelipaea* sp. from Bushehr Province, southern Iran (Magnus 1893). Magnus (1899) published four smut fungi from the south east of Persia (Kerman province), among them a new species, *Ustilago lanigeri* Magnus (= *Sporisorium lanigeri*) on *Andropogon laniger*. Bornmüller (1908) published an article about the flora of Alborz Mountain, and he reported one smut species viz. *Ustilago ischaemi* (= *Sporisorium andropogonis*) on *Andropogon ischaemum* from Gachsar and Taleghan. Sydow & Sydow (1908) reported *Ustilago vaillantii* (= *Antherospora tourneuxii*) on *Bellevalia glauca* from several localities in western Iran. González Fragoso (1916) reported *Sphacelotheca ischaemi* on *Andropogon hirtum* var. *pubescens* from Gotvand, in south west of Iran. Petrak & Esfandiari (1941) reported the following smut fungi, mainly from Central Alborz: *Cintractia caricis* on *Carex* sp., *Sphacelotheca andropogonis* on *Andropogon ischaemum*, *Sph. holci-sorghi* on *Sorghum halepense*, *Sph. schweinfurthiana* on *Imperata cylindrica*, *Tilletia hordei* on *Hordeum leporinum*, *Ustilago crameri* on *Setaria viridis*, and *U. cynodontis* on *Cynodon dactylon*. Esfandiari (1946) reported 14 smut species from different parts of the country. This was the first publication in Persian language (Farsi) about smut fungi. Esfandiari

(1948) published a paper describing the smut fungi of cereals in Iran. A new species, *Tuburcinia behboudii* (= *Urocystis behboudii*) was described on *Arrhenatherum kotschyi* from Iran (in Esfandiari & Petrak 1950). Esfandiari (1951), in his fourth list about Iranian fungi, reported four additional smut fungi. Khabiri (1952, 1956, 1958) published three lists about Iranian fungi. In the second list six smut species, and in the third list three smut species were enumerated. Viennot-Bourgin (1958) published 13 smut fungi from Iran. He also described a new species, *Tuburcinia ranunculi-muricati* (= *Urocystis ranunculi*) on *Ranunculus muricatus* (Viennot-Bourgin 1968). Jørstad (1960) mentioned two smut fungi from Iran viz. *Cintractia caricis* (= *Anthracoidea* sp.) on *Carex diluta*, and *Ustilago ornithogali* (= *Vankya ornithogali*) on *Gagea chomutovae*. Smut fungi on various cereals were published by Niemann & Bamdadian (1967), Mehrian (1984), Pourjam (1989), Sharifnabi & Hedjaroude (1993) and Torabi et al. (1996). Viennot-Bourgin et al. (1969) enumerated 13 smut fungi from Iran. Viennot-Bourgin et al. (1970) mentioned two smut fungi new to Iran, *Entyloma australe* and *Tuburcinia ixiolirii* (= *Urocystis ixiolirii*). Ershad (1977) published the first edition of Fungi of Iran. He listed 34 smut species. Vánky & Ershad (1993) reported three genera and 21 species of smut fungi new to Iran. Ershad (1994) enumerated six new smut fungi to Iran and made a new combination, *Sporisorium penniseti* (Rabenh.) Ershad. Ershad (1998 ('1997')) reported a new smut fungus to Iran and made the new combination *Sporisorium lanigeri* (Magnus) Ershad. Ershad (2000) proposed the new genus *Vankya* for some smut fungi on Liliaceae, based on the type species, *V. ornithogali*. In a comprehensive paper, Ershad (2001) published (in Farsi) 76 smut fungi from Iran belonging to 13 genera, giving also drawings of the infected plants as well as LM pictures of the spores. After Ershad's monograph, several new records of smut fungi were published by different authors, e.g. *Tilletia bornmuelleri* and *Urocystis fischeri* (Hedjaroude & Abbasi 2000), *Anthracoidea angulata* and *A. pratensis* (Kukkonen & Ershad 2002), *A. caryophylleae* and *A. tomentosae* (Ershad & Amini-Rad 2003), and *A. michelii* (Ershad & Amini-Rad 2004). Vánky & Ershad (2002) described a new *Tilletia* (*T. rostrariae*) from Iran. Ershad (2003) reported *Urocystis ornithogali* from Iran. Vánky et al. 2011('2010') published five smut fungi new to Iran.

Remarks – Host plants and geographic distribution in Iran are mainly based on herbarium specimens, deposited in the Fungal Reference Collection of the Ministry of Jihad-e Agriculture (IRAN) and in Herbarium Ustilaginales Vánky (HUV). Localities without indication of herbaria are taken from the literature. They are usually common smuts.

Key to the genera

1. On Cyperaceae..... 2
- Not on Cyperaceae..... 4
2. Sori on leaves forming striae; spores in pairs agglutinated in balls. ***Schizonella***
- Sori in flowers or around nuts; spores single 3
3. Sori in flowers, olivaceous brown, powdery, with fungal filaments..... ***Farysia***
- Sori around the nuts, black, hard, without fungal filaments..... ***Anthracoidea***
4. On Liliaceae (s. lat.) 5
- Not on Liliaceae..... 6
5. Sori on the leaves as pustules; indistinct sterile cells present among the spores..... ***Vankya***
- Sori in the flowers; sterile cells absent ***Antherospora***
6. Spores agglutinated in spore bass 7
- Spores single, not in spore balls 10
7. Spore balls formed of spores and sterile fungsl cells or hyphae 8
- Spore balls formed of spores only (when mature often single)..... ***Sporisorium***
8. Spore balls formed of an outer layer of spores and a central mass of hyphae..... ***Tracya***
- Spore balls formed of spores and sterile cells 9
9. Sterile cells surrounding the spores ***Urocystis***

- Sterile cells scattered among the spores *Moesziomyces*
- 10. Spores embedded in the host tissue, not powdery 11
- Spores not embedded in the host tissue, powdery 12
- 11. Spores subhyaline or pale yellowish brown *Entyloma*
- Spores olivaceous or blackish brown *Jamesdicksonia*
- 12. Sori on the surface of stems or floral axis; spores usually small (<8 µm) *Tranzscheliella*
- Sori not so; spores usually larger 13
- 13. Spore mass and spores violet tinted; on dicots (various families) *Microbotryum*
- Spore mass and spores not violet tinted; on monocots (Poaceae) 14
- 14. Basidium one-celled (holobasidium) *Tilletia*
- Basidium several-celled (phragmobasidium) 15
- 15. Spores mixed with sterile cells, spores single or in groups *Macalpinomyces*
- Spores not mixed with sterile cells, spores single *Ustilago*

***Antherospora* R. Bauer, M. Lutz, Begerow, Piątek & Vánky**

Key to the *Antherospora* species

- 1. Spores 7–15(–17.5) µm long; on *Bellevalia* *A. tourneuxii*
- Spores 6.5–12(–14) µm long; on *Muscari* *A. vaillantii*

1. *Antherospora tourneuxii* (A.A. Fisch. Waldh.) R. Bauer, M. Lutz, Begerow, Piątek & Vánky, in Bauer, Lutz, Begerow, Piątek, Vánky, Bacigálová & Oberwinkler, Mycol. Res. 112: 1302, 2008. *Ustilago vaillantii* Tul. & C. Tul. var. *tourneuxii* A.A. Fisch. Waldh. 1880. — *Ustilago tourneuxii* (A.A. Fisch. Waldh.) Maire 1931b. — *Yenia tourneuxii* (A.A. Fisch. Waldh.) T.N. Liou 1949.

Sori in all deformed, globose flowers of an inflorescence, in the anthers and on the surface of inner floral organs, producing blackish brown, powdery spore mass, for a long time enclosed by the outermost floral envelopes. *Spores* ovoid, ellipsoidal, elongate, often bent, usually irregular, rarely subglobose, 6.5–8 × 7–15(–17.5) µm, yellowish brown; wall even, c. 0.5 µm thick, finely, densely punctate-verruculose, spore profile smooth to finely wavy (Fig. 1).

On *Hyacinthaceae* (*Liliaceae* s. l.):

Bellevalia glauca (Lindl.) Kunth, Markazi Prov., Arak, Sefidkhane Mountain; Lorestan Prov., Shahu Mountain.

Bellevalia saviczii Woronow, Kermanshah Prov., 17 km SE of Paveh city, S slope of Shahu Mt., alt. 2200 m, 15.V.2006, M. Abbasi, R. Fritsch & M. Keusgen, IRAN 14782 F, HUV 21824.

2. *Antherospora vaillantii* (Tul. & C. Tul.) R. Bauer, M. Lutz, Begerow, Piątek & Vánky, **s. lat.**, in Bauer, Lutz, Begerow, Piątek, Vánky, Bacigálová & Oberwinkler, Mycol. Res. 112: 1304, 2008.

Ustilago vaillantii Tul. & C. Tul. 1847. — *Yenia vaillantii* (Tul. & C. Tul.) Liou 1949. — *Vankya vaillantii* (Tul. & C. Tul.) Ershad 2000.

Ustilago vaillantii forma *muscaria* Rabenh. 1876 (nom. nud).

Ustilago muscaria-botryoidis Cif. 1928.

Sori in all, slightly swollen flowers of an inflorescence, in the anthers and on the filaments, rarely also on gynoecium and in the ovaries, filling the flowers with a dark olive-brown, powdery mass of spores. Infection systemic. Distal, sterile flowers of an infected inflorescence develop anthers producing spores. *Spores* variable in shape and size, globose, subglobose, ovoid, curved, pyriform, tear-shaped, or irregularly elongate, 5.5–9.5 × 6.5–12(–14) µm, olive-brown; wall even or slightly uneven, c. 0.5 µm thick, finely, densely verruculose, spore profile finely wavy to irregularly verruculose-tuberculate, tubercles often irregularly fused. *Spore germination* results in 4-celled basidia, usually the uppermost three-celled part separating from the basal cell, producing laterally

and terminally elongate, sessile, budding basidiospores, or basidiospores develop on short sterigmata.

***Anthracoidea* Bref.**

Key to the *Anthracoidea* species based on host plant taxonomy

1. On *Carex* subgen. *Vignaea*, sect. *Stenophylla*, *Carex stenophylla*.....*A. eleocharidis*
- On *Carex* subgen. *Carex*2
2. On sect. *Acrocystis* (= *Montanae*), *Carex tomentosa*..... *A. tomentosae*
- Not on sect. *Acrocystis*3
3. On sect. *Glaucae*, *Carex flacca* ssp. *serrulata* *A. pratensis*
- Not on sect. *Glaucae*4
4. On sect. *Lamprochlaenae*, *Carex liparocarpos*..... *A. caryophylleae*
- Not on sect. *Lamprochlaenae*5
5. On sect. *Paludosae*, *Carex songorica* *A. songorica*
- Not on sect. *Paludosae*6
6. On sect. *Rhomboidales*, *Carex michelii*.....*A. michelii*
- Not on sect. *Rhomboidales*7
7. On sect. *Spirostachyae*, *Carex diluta* *A. caricetorum*
- Not on sect. *Spirostachyae*8
8. On sect. *Carex* s.lat., *Carex melanostachya* *A. melanostachyae*
- On various sections, *Carex* sp. *A. caricis* s. lat.



Fig.1 – *Antherospora tourneuxii* on *Bellevalia saviczii* (14782), infected plant (left) and teliospores (right)

On *Hyacinthaceae* (*Liliaceae* s. l.):
Muscari sp., Hormozgan Prov., Minab.

3. *Anthracoidea caricetorum* (Speg.) Nannf., Symb. Bot. Upsal. 22: 21, 1979.

Cintractia caricetorum Speg., 1925.

Sori in ovaries, black, compact. *Spores* small-sized, flattened, in side view elliptic, 8–11 μm wide, in plane view circular, elliptic to subangularly irregular, 12–16 × 12–17.5 μm, yellowish brown; wall even, 0.5–1 μm thick, no internal swellings, no protuberances and light-refractive areas, surface finely verruculose, the spore profile smooth to finely wavy, in SEM moderately dense and low verruculose.

On *Cyperaceae*: *Carex* (subgen. *Carex*, sect. *Spirostachyae*), *C. diluta* M. Bieb., Semnan Prov., Nezva Mt. area, near Orim village, 2100 m, 5.VII.1959, leg. P. Wendelbo, O.

Jørstad (1960:27) studied this collection (under the name of *Cintractia caricis*) and wrote: "Spores 17–20 μ in diam., more or less angulate, wall c. 1.5 μ thick, densely and finely verrucose."

The type of *A. caricetorum* is on *Carex fuscula* d'Urv. (subgen. *Carex*; sect. *Spirostachyae*), Argentina, Patagonia, Santa Cruz, Rio Santa Cruz, II.1882, C. Spegazzini. Additional host plant is *C. fuscula* var. *distenta* (Kunze) Kük. (Chile; Nannfeldt 1979:21).

4. *Anthracoidea caricis* (Pers.) Bref., Unters. Gesammtgeb. Mykol. 12: 144, 1895, s. lat.

Uredo caricis Pers. 1801. – *Caecoma caricis* (Pers.) Link, in Willdenow 1825. – *Ustilago caricis* (Pers.) Unger 1836. – *Cintractia caricis* (Pers.) Magnus 1896a('1895').

Uredo urceolorum DC. 1815 (nom. nov. superfl. pro *Uredo caricis* Pers.).

Cintractia caricis var. *intermedia* Savile 1952.

Sori in ovaries, scattered in the inflorescence, forming globose, black, hard bodies, 1–2 mm in diam., initially covered by a thin, greyish membrane, later black, powdery on the surface. *Spores* flattened, 11–15 µm wide, in plane view subcircular, angular or irregular, 14–20(–22) × 15–25(–28) µm, reddish brown; wall of uneven thickness, 1–3(–4) µm, thickest at the angles, 1–3 indistinct internal swellings may be present, light-refractive areas uncommon or lacking, surface conspicuously verrucose, spore profile wavy or finely serrulate, in SEM covered with low, rounded warts and minute, dense papillae between warts. *Spore germination* of *Anthracoidea*-type.

On *Cyperaceae*: *Carex* sp., Tehran Prov., Karaj-Chalus road, Asara village.

5. *Anthracoidea caryophylleae* Kukkonen, Ann. Bot. Soc. Zool.-Bot. Fenn. 'Vanamo' 34(3): 53, 1963.

Sori in some ovaries of an inflorescence forming globose, black, hard bodies, 1–2 mm in diam., when young covered by a thin, greyish membrane, later powdery on the surface, partly hidden by the utricles. *Spores* slightly flattened, in side view 11–13 µm wide, in plane view ovate, subpolygonal to irregular, 15–20 × 16–24(–27) µm, dark reddish brown; wall 1–3 µm thick, thickest at the angles, usually with 1–3 internal swellings and sometimes with light-refractive spots in the thickest areas, surface nearly smooth, sparsely punctate to finely verruculose, warts not fusing, spore profile appearing smooth or nearly so, in SEM sparsely to densely verruculose with rounded, low warts, between the warts minutely, densely verruculose. *Spore germination* of *Anthracoidea*-type (Fig. 2).

On *Cyperaceae*: *Carex* (subgen. *Carex*, sect. *Lamprochlaenae*), *C. liparocarpos* Gaud., East Azarbaijan Prov., Kaleibar, Ghaleh Babak ruin, IRAN 14047 F; East Azarbaijan Prov., Arasbaran protected area, Kaleibar city toward Ghaleh Babak ruin, IRAN 13989 F; East Azarbaijan Prov., Arasbaran protected area, Makidi valley, IRAN 11775 F.

6. *Anthracoidea eleocharidis* Kukkonen, Trans. Brit. Mycol. Soc. 47: 244, 1964.

Anthracoidea duriusculae L. Guo 2006a.

Sori in some ovaries of an inflorescence forming globose, black, hard bodies, 2–3 mm in diam., when young covered by a silvery membrane that flakes away exposing the black, agglutinated spore mass with a powdery surface. *Spores* moderately flattened, in plane view circular, ovoid or slightly irregular, 11–15(–17) × 13–20(–21) µm, medium reddish brown; wall even, 0.7–1.5 µm thick, without internal swellings, surface distinctly papillate, spore profile from almost smooth or very finely wavy to finely wavy or serrulate, in SEM papillae 0.1–0.5 µm high, with a rounded tip, forming short rows or groups, rarely fusing; wall surface between the papillae smooth. *Spore germination* of *Anthracoidea*-type (Fig. 3).

On *Cyperaceae*: *Carex* (subgen. *Vignaea*, sect. *Stenophylla*), *C. stenophylla* Wahlenb. (*C. pachystylis* J. Gay), Fars Prov., Fasa Forest, IRAN 13288 F; Fars Prov., Old road of Shiraz city to Esfahan city, after Sivand village, IRAN 13286 F; Fars Prov., Old road of Shiraz to Esfahan city, near Naghsh-e Rajab, historical sculpture, Rahmat Mountain, IRAN 13287 F; Tehran Prov., Khojir National Park, IRAN 2000 F; East Azarbaijan Prov., Mianeh city to Zanjan city, IRAN 8073 F; East Azarbaijan Prov., Mianeh city, at the Pole-Dokhtar historical bridge, IRAN 8072 F; West Azarbaijan Prov., Boundry of Iran & Turkey, Bazargan road to Cheshmeh Soraya, Yarom Ghiyah village, IRAN 8070 F; Zanjan Prov., Zanjan to Hamadan road, 75 Km N. Hamadan city, Ghariech village, Chahar

Boulagh Mt., IRAN 7965 F; Fars Prov., Sarvestan city, IRAN 8007 F; Kermanshah Prov., Nojivaran, N slope of Paru Mt., IRAN 14784 F.

On *Carex* sp., West Azarbaijan Prov., Salmas to Oroumieh, Ghushchi Pass, IRAN 8759 F; Mazandaran Prov., Karaj-Chalus road, IRAN 8235 F; Golestan Prov., Gorgan city, Golestan National Park, Sulgerd area, IRAN 8330 F; Kordestan Prov., Palangan village, IRAN 8297 F.

7. *Anthracoidea melanostachyae* Denchev & T. Denchev, Mycol. Balcan. 8: 153–155, 2011.

Sori in some ovaries, scattered in the inflorescence, forming black, hard, ovoid, 2–3 mm long bodies, dusty on the surface, when young covered by a white, thin fungal layer. *Spores* slightly flattened, in side view elliptic, 9.5–12 µm wide, in plane view from subcircular to usually irregular, 12–17.5 × 14–20(–22) µm, reddish brown; wall uneven, 0.8–3 µm thick, thickest at the angles and protuberances, some weak internal swellings and light-refractive spots may be present, surface evidently verruculose, spore profile smooth to wavy.

Spore germination unknown (Fig. 4).

On *Cyperaceae*: *Carex* (subgen. *Carex*, sect. *Carex* s. lat.), *C. melanostachya* M. Bieb. ex Willd., East Azarbaijan Prov., Kalibar to Khodaafarin, Govar village, IRAN 11967 F; Tehran Prov., Firuz-Kuh city to Ghaemshahr city, Gaduk, IRAN 11362 F; Golestan Prov., Gorgan city, Golestan National Park, Tange Gol, Sar-Cheshmeh, alt. 670–730 m, 22.VII.1991, M. Abbasi, IRAN 83233 F, HUV 20094; Golestan Prov., Azadshahr city IRAN 11645 F.

8. *Anthracoidea michelii* Vánky, Bot. Not. 132: 223, 1979.

Sori in ovaries, scattered in the inflorescence, forming subglobose, hard, black bodies, 2–3 mm in diam., partly hidden by the glumes and utricles. *Spores* moderately flattened, in side view 10–13 µm wide, in plane view variable in form, subangular to irregular, 13–20 × 14–24(–30) µm, medium to dark reddish brown; wall unevenly 1–3(–5) µm thick, thickest at the angles and protuberances, light-refractive areas common, 1–2 internal swellings as well as protuberances sometimes present, surface distinctly verruculose, spore profile papillate to serrulate, in SEM with moderately densely, somewhat irregularly dispersed, rounded warts (Fig. 5).

On *Cyperaceae*: *Carex* (subgen. *Carex*, sect. *Rhomboidales*), *C. michelii* Host, East Azarbaijan Prov., Kalaibar city, Makidi valley, IRAN 11966 F.

9. *Anthracoidea pratensis* (Syd.) Boidol & Poelt, Ber. Bayer. Bot. Ges. 36: 23, 1963.

Cintractia pratensis Syd. 1924.

Sori in ovaries, scattered in the inflorescence, forming subglobose to ovoid, black, hard bodies, 2–3 mm in diam., powdery on the surface. *Spores* flattened, in side view 13–15 µm wide, in plane view subcircular, broadly elliptic, subangular to irregular, often with protuberances, 17–27 × 19–30 µm, dark reddish brown; wall uneven, 1–4(–6) µm thick, thickest at the angles and protuberances, internal swellings low, 1–2(–3), only rarely seen, light-refractive areas often present, surface verruculose, the warts often forming short rows and sometimes partly confluent, spore profile almost smooth to finely serrulate, in SEM with low, rounded, often confluent warts. *Spore germination* of *Proceres*-type (Fig. 6).

On *Cyperaceae*: *Carex* (subgen. *Carex*, sect. *Glaucæ*), *C. flacca* Schreb. ssp. *serrulata* (Biv.) Malag., Golestan Prov., Gorgan city, Golestan National Park, Tange gol to Sar-Cheshmeh, IRAN 11539 F; Golestan Prov., Fazelabad city, Alestan village, IRAN 13928 F.

10. *Anthracoidea songorica* Vánky, in Vánky & Abbasi, Rostaniha 12(2): 182, 2012a.

Sori forming black, globose or ovoid, hard bodies in some ovaries in the inflorescence, powdery on the surface, 1.5–2.5 mm in diameter. *Spores* globoid, broadly ellipsoidal, subpolyhedrally irregular, occasionally elongated, with a subacute or acute tip, 13.5–22.5 × 19–27(–30) µm, dark reddish brown; wall uneven, 1–3.5(–5.5) µm thick, thickest at the angles, no internal swellings, light refracting spots occasionally present, surface densely, prominently verrucose, spore profile wavy to finely serrulate. *Spore germination* unknown (Fig. 7).

On *Cyperaceae*: *Carex* (subgen. *Carex*, sect. *Paludosae*), *C. songorica* Kar. & Kir., Golestan Prov., Gorgan city, Golestan National Park, alt. 1100 m, 22.VII.1991, leg. M. Abbasi, HUV 21968, IRAN 11642 F.

11. *Anthracoidea tomentosae* Vánky, Bot. Not. 132: 227, 1979.

Sori in ovaries, scattered in the inflorescence, forming hard, subglobose bodies, 1.5–2 mm in diam., when young covered by a silvery membrane that soon flakes away to reveal the agglutinated, black spore mass, partly hidden by the utricles. *Spores* slightly flattened, in side view 13–16 μm wide, in plane view subangular to irregular, (12–)13.5–23 \times (18–)20–28 μm , reddish brown; wall moderately uneven, 1.5–3(–4) μm thick, thickest at the angles and protuberances, rarely with light-refractive spots and 1–3 low internal swellings, surface finely, densely punctate, spore profile finely serrulate, in SEM with sparsely to dense, often confluent, rounded warts, the spaces between the warts extremely finely and densely verruculose. *Spore germination* of *Proceres*-type (Fig. 8).

On *Cyperaceae*: *Carex* (subgen. *Carex*, sect. *Acrocystis* = *Montanae*), *C. tomentosa* L., East Azarbaijan Prov., Arasbaran protected area, Khodaafarin village, Vaighan forked road, IRAN 11710 F.

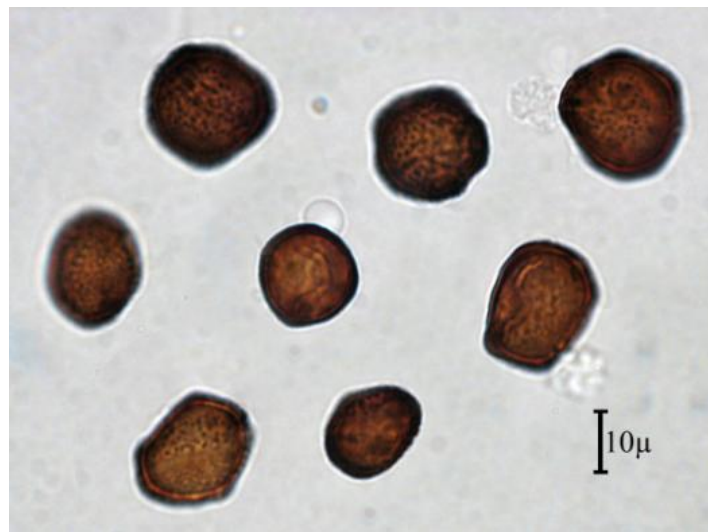


Fig.2 – *Anthracoidea caryophylleae* on *Carex liparocarpus* (14047)

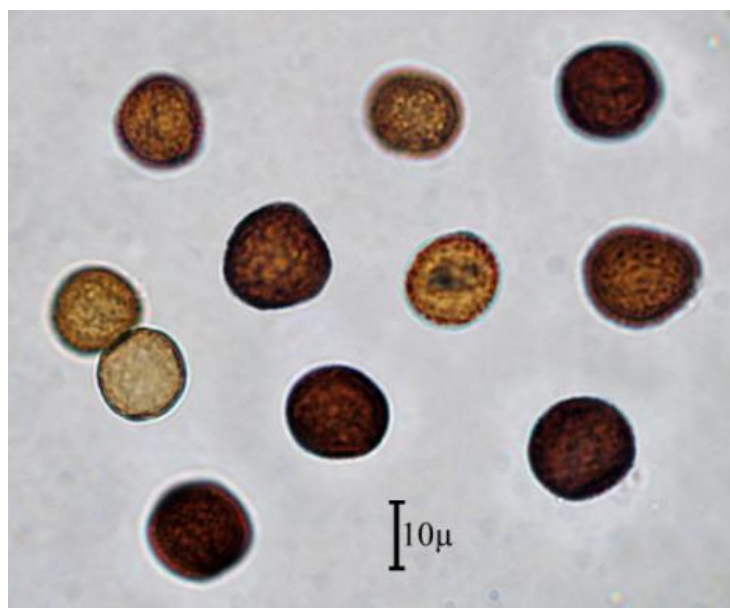


Fig.3 – *Anthracoidea eleocharidis* on *Carex pachystylis* (13286)

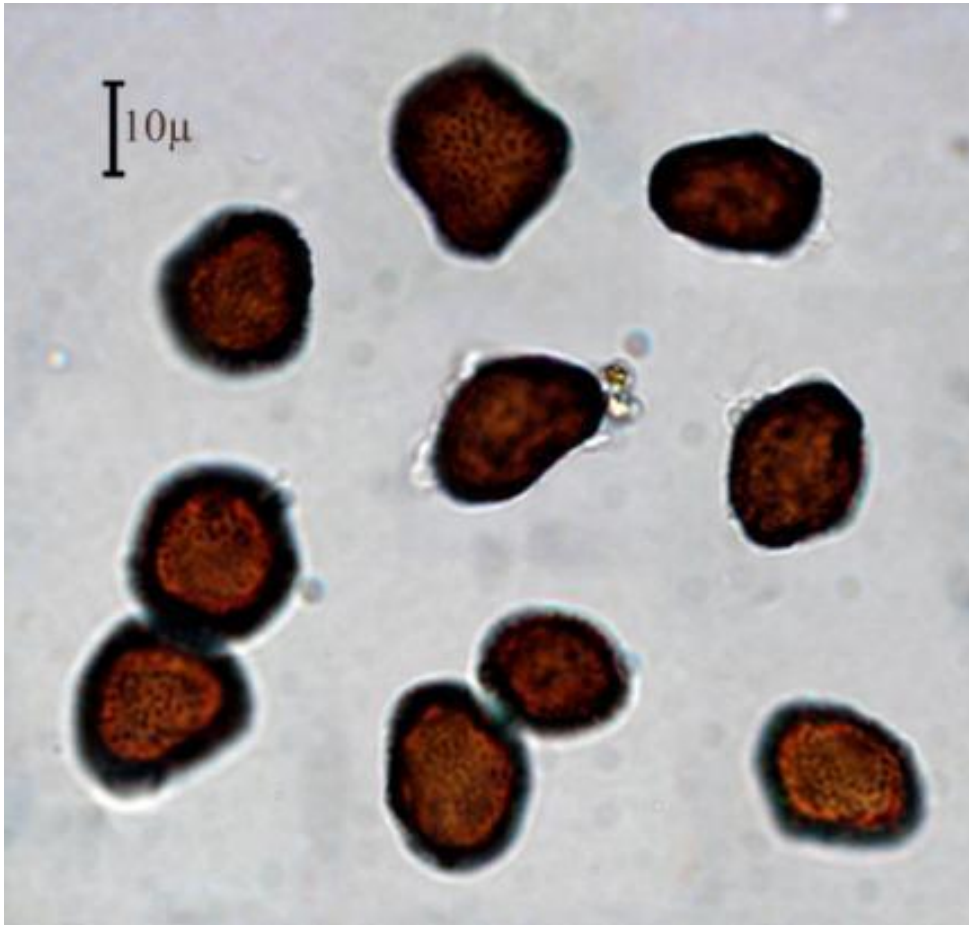


Fig.4 – *Anthracoidea melanostachyae* on *Carex melanostachya* (11362)

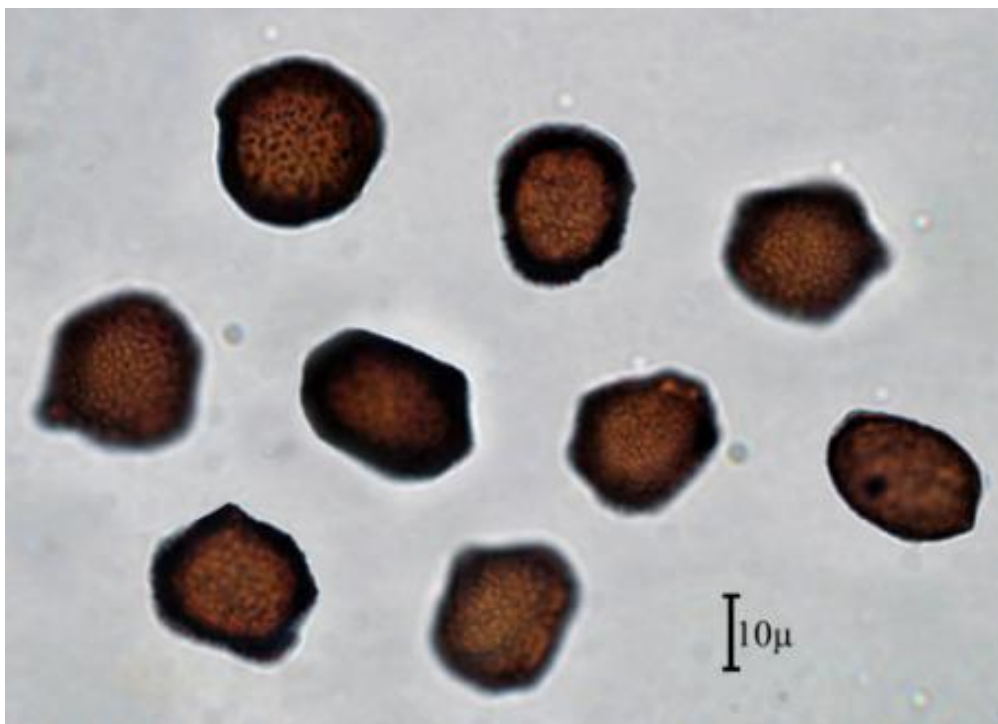


Fig.5 – *Anthracoidea michelii* on *Carex michelii* (11966)

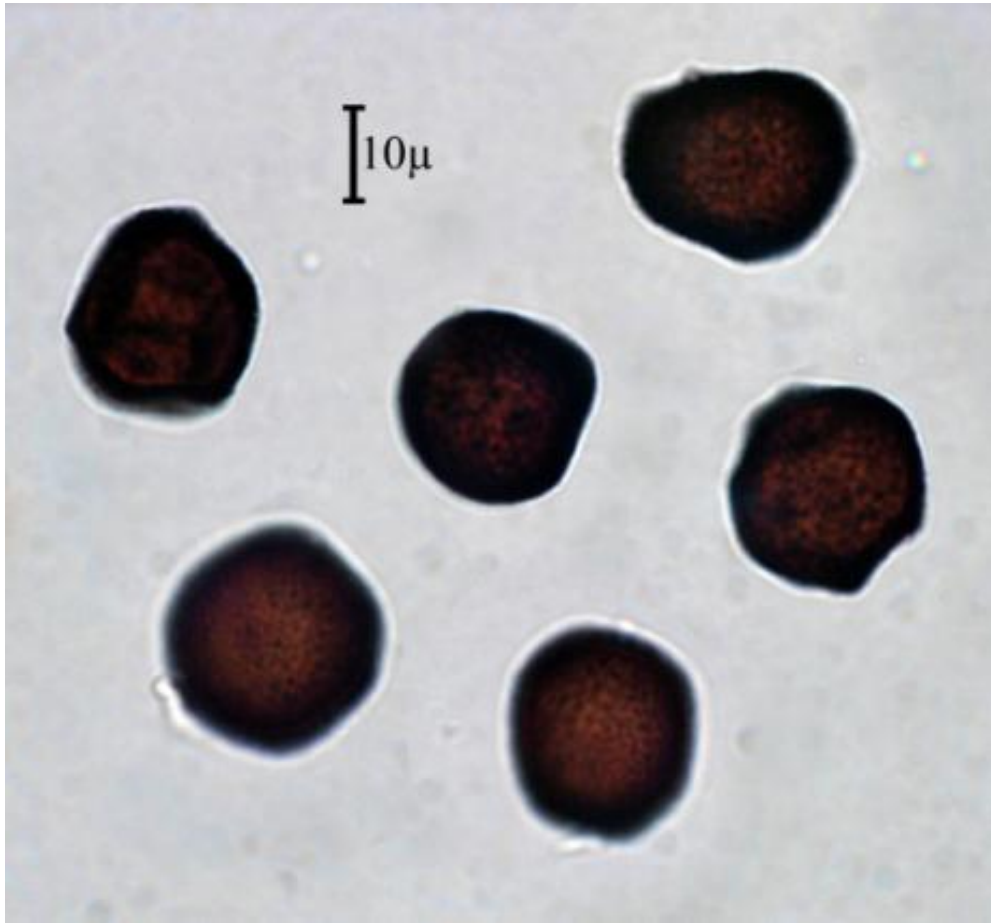


Fig.6 – *Anthracoidea pratensis* on *Carex flacca* ssp. *serrulata* (11539)

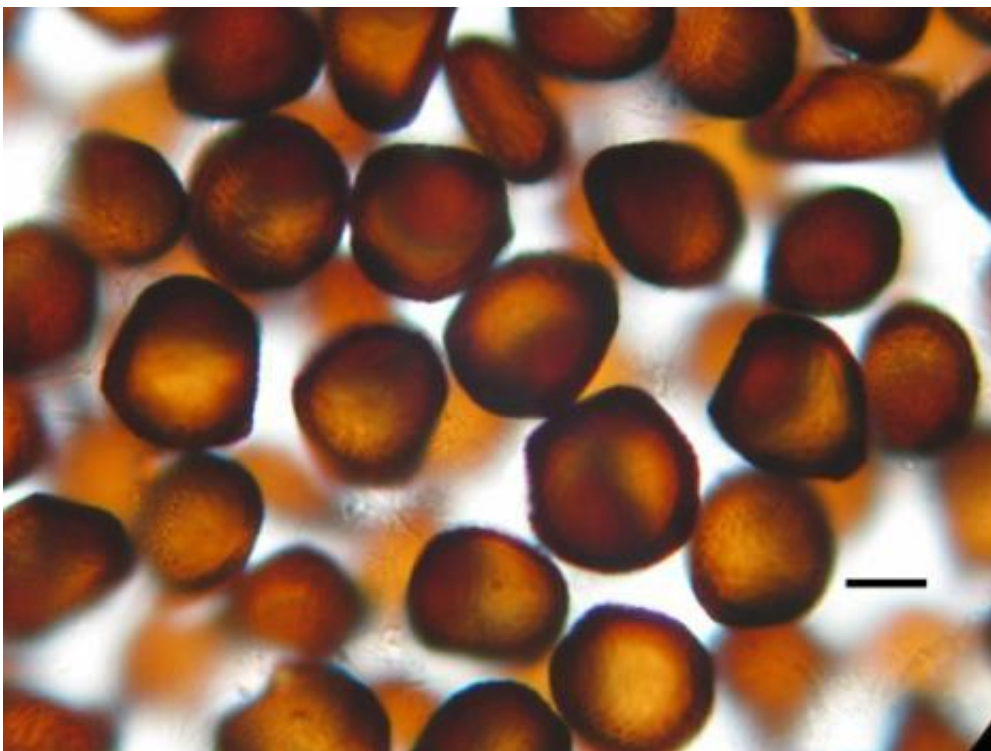


Fig.7 – *Anthracoidea songorica* on *Carex songorica* (11642), Bar=10 μm

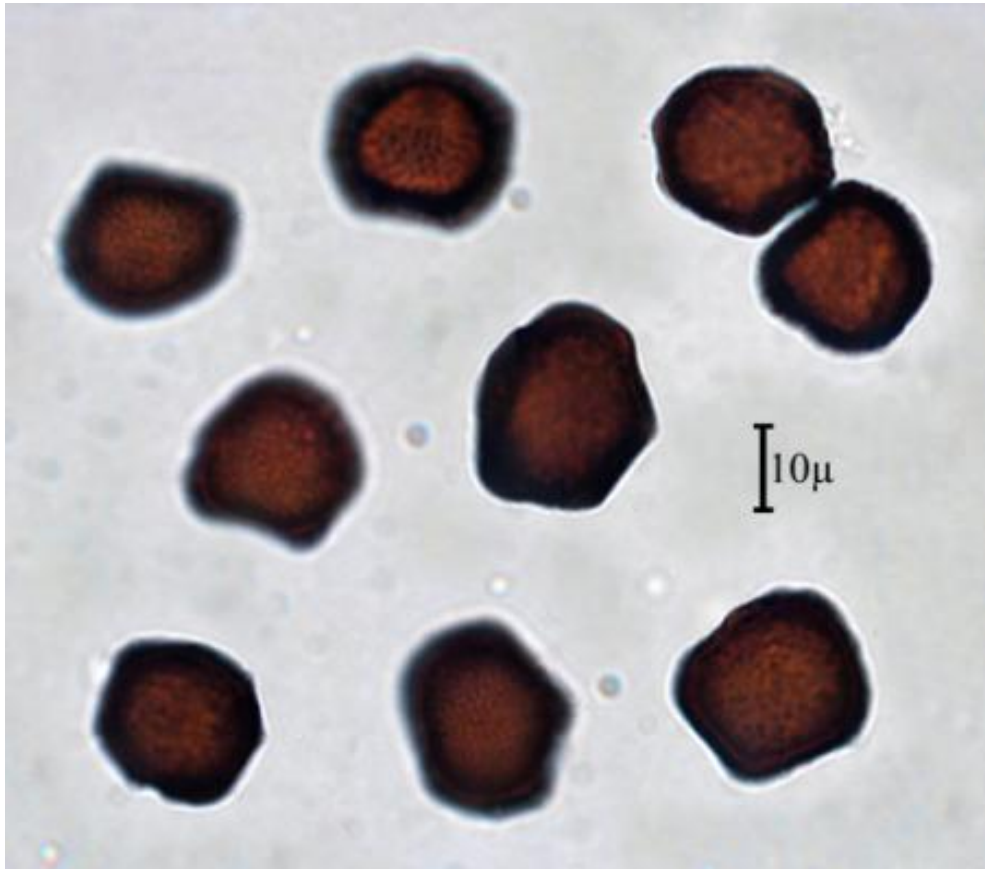


Fig.8 – *Anthracoidea tomentosae* on *Carex tomentosa* (11710)

***Entyloma* de Bary**

Key to the *Entyloma* species based on host plant taxonomy

- 1. On *Asteraceae*.....2
- Not on *Asteraceae*3
- 2. On *Rhagadiolus**E. rhagadioli*
- On *Tragopogon*..... *E. tragopogonis*
- 3. On *Boraginaceae* (*Myosotis*).....*E. fergussonii*
- Not on *Boraginaceae*4
- 4. On *Geraniaceae* (*Geranium*)..... *E. atlanticum*
- Not on *Geraniaceae*.....5
- 5. On *Ranunculaceae* (*Ranunculus*)6
- Not on *Ranunculaceae*.....8
- 6. Sori as pustules or swellings; spore wall uneven, 1.5–9.5 µm thick*E. microsporum*
- Sori flat or slightly bullate; spore wall even or uneven, 1–7 µm thick7
- 7. Sori slightly bullate; spore wall uneven, 2.5–7 µm thick*E. majewskii*
- Sori flat; spore wall even, 1–2 µm thick..... *E. ranunculi-repentis*
- 8. On *Scrophulariaceae* (*Linaria*) *E. linariae*
- On *Solanaceae* (*Physalis*)..... *E. australe*

12. *Entyloma atlanticum* Massenet, in Guyot, Malençon & Massenet, Rev. Pathol. Vég. Entomol. Agric. France 37: 187, 1958.

Entyloma geranii M.N. Kuznetzova & Schwarzman, in Schwarzman 1960.

Sori in leaves as slightly convex, yellowish white to violet tinted brown spots, 2–3 × 2–5 mm in diam. Spores densely agglutinated, variable in shape and size, occasionally subglobose, usually

subpolyhedrally irregular, 10–17 × 13–22 µm, subhyaline to pale yellow; wall 1–4.5 µm thick, two-layered, inner layer even, c. 0.5 µm thick, outer layer uneven, 0.5–3(–4) µm thick, smooth. *Anamorph* may be present (Fig. 9).

On *Geraniaceae*: *Geranium tuberosum* L., Tehran Prov., Hraz road, 60 km E of Tehran city, Elburz Mts., "Emamzadeh-Hashem", IRAN 7229 F; Esfahan Prov., Golpayegan, 140 km NW of Esfahan city, Golestan Kuh Mt., IRAN 7230 F; Ilam Prov., Ilam city, Renow park, IRAN 6429 F.

13. *Entyloma australe* Speg., Anales Soc. Ci. Argent. 10: 5, 1880.

Protomyces physalidis Kalchbr. & Cooke 1880.

– *Entyloma physalidis* (Kalchbr. & Cooke) G. Winter 1883.

Entyloma besseyi Farl. 1883.

Sori in leaves forming circular to angular spots, at first light yellow, later brown, 1–5 mm in diam. or larger when confluent. *Spores* globose, subglobose, ellipsoidal to somewhat polyhedral or irregular, 8–13 × 9–16 µm, hyaline or with a pale yellowish brown tint; wall even or uneven, 1–2.5(–3) µm thick, smooth. *Anamorph* present in whitish tufts within the spots; conidia linear, often curved, 1.5–2.5 × 24–50 µm.

On *Solanaceae*: *Physalis alkekengi* L., Mazandaran Prov., Ghaemshahr, Gharakhil Agricultural Station, IRAN 6428 F.

14. *Entyloma fergussonii* (Berk. & Broome) Plowr., Monogr. Brit. Ured. and Ust.: 289, 1889.

Protomyces fergussonii Berk. & Broome 1875.

Entyloma canescens J. Schröt. 1877.

Sori in leaves as circular, amphigenous, scattered spots, initially yellowish white, indefinite, later brown, 0.5–3(–5) mm in diam. *Spores* globose, ovoid to slightly irregular, 8–13 × 9–14(–16) µm, subhyaline to pale yellowish brown; wall smooth, even, 0.5–1.5 µm thick. *Anamorph* (*Entylomella myosotidis* (Sacc.) Höhn.) present.

On *Boraginaceae*: *Myosotis sylvatica* Hoffm., Mazandaran Prov., Chalous-road, Siah bisheh village.

15. *Entyloma majewskii* Vánky & M. Lutz, Polish Bot. J. 55: 276, 2010.

Sori on leaves as slightly bullate, circular or broadly elliptic spots, 1–1.5(–2) mm in diameter or larger by confluence, first white, later whitish-green or pale yellowish-brown, evident on both sides of the leaves. *Spores* crowded, globose, subglobose, ellipsoidal to slightly irregular, with one, rarely two flattened sides, 10.5–16(–17.5) × 10.5–17(–18.5) µm, subhyaline to pale yellowish tinted; wall even to usually unevenly thickened, two-layered, 2.5–7 µm wide, including the even, 0.8–1 µm thick endospore, spore surface smooth. *Anamorph* absent (Fig. 10).

On *Ranunculaceae*: *Ranunculus ficaria* L. (*Ficaria ranunculoides* Roth.). Tehran Prov., 60 km E of Tehran, Haraz road, Elburz Mts., "Emamzadeh-Hashem", alt. 2610 m, HUV 14888, IRAN 7272 F; Golestan Prov., 35 km SW of Gorgan city, alt. 2250 m, HUV 14887, IRAN 7273 F; Kuhgiluyeh va Buyrahmad Prov., Savers Mt., IRAN 8071 F.

Remarks – *Entyloma ficariae* mentioned by Vánky & Ershad (1993: 2), and by Ershad (2001: 48), on *Ficaria ranunculoides* from Iran, represents *E. majewskii*. The two species differ in their morphological and molecular phylogenetic characters. In *E. ficariae* the sori are flat, circular or angular, evident on both sides but more expressed on the abaxial side of the leaves. The spores in *E. ficariae* are loosely crowded or scattered in the host tissue, globose, subglobose, ovoid to broadly ellipsoidal, sometimes slightly irregular, 10–14.5(–15) × 11–16 µm, with an evenly 1–2.5(–3) µm thick, two-layered wall. *Anamorph* in *E. majewskii* absent, in *E. ficariae* usually present.

16. *Entyloma linariae* J. Schröt., in Cohn, Beitr. Biol. Pfl. 2: 371, 1877.

Sori in leaves as round, flat, amphigenous spots, 0.5–2(–3) mm in diam., initially white, later pale brown, with age the middle often becomes perforated. *Spores* globose, subglobose or sometimes

slightly irregular, $9.5\text{--}13 \times 10\text{--}14 \mu\text{m}$, subhyaline to pale yellow; wall two-layered, even, c. $1 \mu\text{m}$ thick, smooth. *Anamorph* present.

On *Scrophulariaceae*: *Linaria* sp., Golestan Prov., Shahvar Mt.

17. *Entyloma microsporum* (Unger) J. Schröt., in Rabenh., Fgi eur. no. 1872, 1874.

Protomyces microsporus Unger 1833. – *Entyloma ungerianum* de Bary 1874 (nom. nov. superfl. pro. *P. microsporus*).

Caeoma bullosum Sacc. 1915.

Entyloma microsporum (Unger) J. Schröt. var. *pygmaeum* Allesch., in Allesch. & Henn. 1897. – *Entyloma pygmaeum* (Allesch.) Cif. 1928.

Sori in leaves and petioles as hard pustules or swellings, at first yellowish white, disk-like, later brown, swollen, subglobose or fusiform, wart-like, with cracked surface. *Spores* embedded in the host tissue, crowded, globose, ovoid or irregular, $10\text{--}16 \times 11\text{--}23 \mu\text{m}$, light yellow; wall two-layered, inner layer yellow, uniformly c. $0.5\text{--}1 \mu\text{m}$ thick, outer layer hyaline, uneven, $1\text{--}9 \mu\text{m}$ thick, smooth. *Spore germination* results in aseptate basidium developing an apical whorl of 4–8 simultaneously produced basidiospores, which fuse in pairs giving rise to septate and ramified hyphae and/or to secondary ballistospores. *Anamorph* absent (Fig. 11).

On *Ranunculaceae*: *Ranunculus muricatus* L., Golestan Prov., Naharkhoran area, 10 km S of Gorgan city, IRAN 7271 F.

18. *Entyloma ranunculi-repentis* Sternon, L'hétérogénéité du genre *Ramularia*, These, Nancy: 34 & 45, 1925.

Entyloma wroblewskii Kochman 1934.

Entyloma ranunculi-sclerati Kochman 1936.

Entyloma ranunculacearum Kochman 1936.

Entyloma ranuncolorum Liro 1939

Similar to *Entyloma ficariae* (with which it was merged by several authors) but has smaller spores ($8\text{--}13 \times 9\text{--}14 \mu\text{m}$), thinner spore wall ($1\text{--}2 \mu\text{m}$) and usually fewer, more dispersed spores in the sori. *Anamorph* present.

On *Ranunculaceae*: *Ranunculus scleratus* L., Gilan Prov., Bandar-Anzali, Anzali lagoon, IRAN 7270 F.

19. *Entyloma rhagadioli* Pass., Nuovo Giorn. Bot. Ital. 9: 239, 1877.

Sori in leaves as orbicular, amphigenous spots, 1–3 mm wide, initially whitish, later reddish brown or brown. *Spores* often agglutinated in irregular groups, variable in shape and size, globose, ovoid, irregular, $8\text{--}12 \times 9\text{--}16 \mu\text{m}$, pale yellowish brown; wall uneven, $(1\text{--})2\text{--}3\text{--}(4) \mu\text{m}$ thick, smooth. *Anamorph* present (Fig. 12).

On *Asteraceae*: *Rhagadiolus stellatus* Gaertn., Kohgiluyeh va Buyerahmad Prov., Dehdasht city, Taleh Mt., IRAN 8034 F.

20. *Entyloma tragopogonis* Lagerh., Bull. Soc. Mycol. France 15: 100, 1899 (as '*tragopogi*').

Entyloma tragopogonis Wróbl. 1914.

Sori in leaves as flat, amphigenous, ovoid to elongate spots, initially yellow, later pale brown, 1–5 mm long or larger by confluence. *Spores* globose, subglobose, ovoid, subpolyhedral to irregular, $8\text{--}12 \times 10\text{--}14 \mu\text{m}$, pale yellow to pale yellowish brown, densely crowded; wall smooth, two-layered, even to slightly uneven, $1.5\text{--}2.5\text{--}(3) \mu\text{m}$ thick.

On *Asteraceae*: *Tragopogon graminifolius* DC., East Azarbaijan Prov., suburb of Tabriz city.



Fig.9 – *Entyloma atlanticum* on *Geranium tuberosum* (7230)



Fig.10 – *Entyloma majewskii* on *Ranunculus ficaria* (8071)

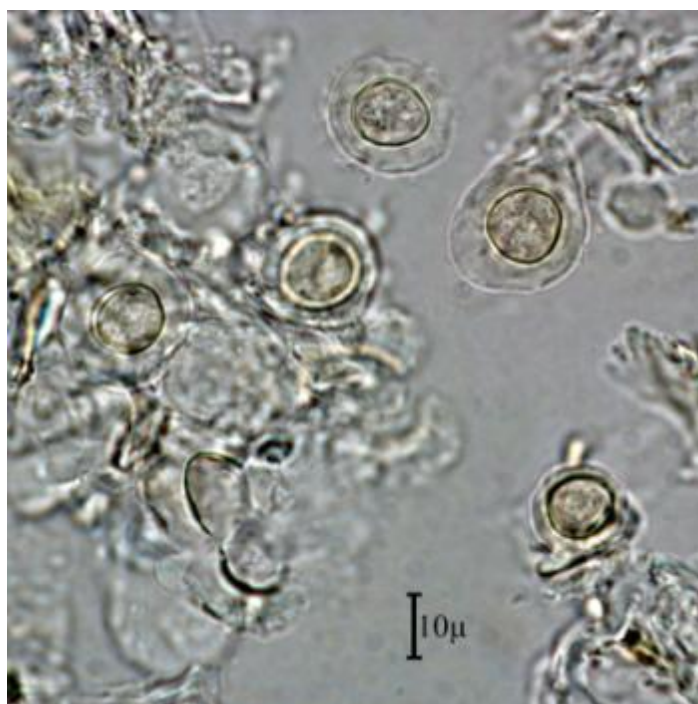


Fig.11 – *Entyloma microsporium* on *Ranunculus muricatus* (7271)



Fig.12 – *Entyloma rhagadioli* on *Rhagadiolus stellatus* (8034)

***Farysia* Racib.**

21. *Farysia thuemenui* (A.A. Fisch. Waldh.) Nannf., in Lindeberg, Symb. Bot. Upsal. 16(2): 51, 1959.

Ustilago thuemenui A.A. Fisch. Waldh. 1878.

Uredo segetum var. *caricis* DC. 1805. – *Uredo olivacea* DC. 1815. – *Caeoma olivaceum* (DC.) Schltldl. 1824. – *Erysibe olivacea* (DC.) Wallr. 1833. – *Ustilago olivacea* (DC.) Tul. & C. Tul. 1847. – *Elateromyces olivaceus* (DC.) Bubák 1912. – *Farysia olivacea* (DC.) Syd. & P. Syd. 1919 (later homonym). – *Farysia caricis* (DC.) Liro 1938.

Cintractia caricicola Henn. 1895.

Ustilago caricicola Tracy & Earle 1899.

Ustilago cariciphila Speg. 1925. – *Cintractia cariciphila* (Speg.) Cif. 1931.

Cintractia caricis (Pers.) Magnus f. *minor* Sousa da Camara & Oliveira 1945.

Sori in scattered flowers arising from the floral pedicels, initially as ovoid to cylindrical bodies, concealed by the utricle (perigynium), later protruding, covered by a greyish white to light brown fungal peridium that becomes shredded and exposes the olivaceous brown, dusty spore mass traversed by numerous, prominent fascicles of hyphae (elaters), commonly extending beyond the sori. *Spores* very variable in shape and size, globose, subglobose (3–7 µm in diam.), ovoid, elongate (3–12 µm long), often with truncate ends, irregular, curved, pyriform, or subtriangular, pale olivaceous brown, the surface finely but distinctly verruculose, in SEM the warts truncate or rounded, very dense, sometimes confluent. *Spore germination* results in 4-celled basidium (of 3 + 1 type, one cell remaining in the spore) budding off several ovoid basidiospores. Occasionally a long hypha is borne which was not seen to form basidiospores (Fig. 13).

On *Cyperaceae*: *Carex riparia* Curt., Gilan Prov., 10 km SE of Rasht city, IRAN 7263 F; Gilan prov., Langerud, Chamkhaleh, Talab-e Amir kelayeh, IRAN 8425 F.

***Jamesdicksonia* Thirum., Pavgi & Payak**

22. *Jamesdicksonia dactylidis* (Pass.) R. Bauer, Begerow, A. Nagler & Oberw., Mycol. Res. 105: 422, 2001, **s. lat.**

Thecaphora dactylidis Pass., in A.A. Fisch. Waldh. 1877a('1876'). – *Entyloma dactylidis* (Pass.) Cif. 1924. – *Melanotaenium dactylidis* (Pass.) Denchev 1995.

Entyloma crastophilum Sacc. 1879.

Entyloma crepinianum Sacc. & Roum., in Roum. & Sacc. 1881.

Entyloma catabrosae Johanson 1884.

Entyloma camusianum Har. 1896.

Entyloma schweinfurthii Henn. 1902.

Entyloma hieroëense Har. & Pat. 1904.

Entyloma phalaridis Speg. 1912. – *Ustilago phalaridis* (Speg.) Cif. 1931.

Entyloma cynosuri Gonz. Frag. & Cif., in Cif. 1925.

Tuburcinia castellana Gonz. Frag. 1926. – *Urocystis castellana* (Gonz. Frag.) Zundel 1953.

Entyloma korshinskyi Lavrov 1937.

Entyloma camusianum Har. var. *pratense* Lavrov 1937.

Entyloma polypogonis Vienn.-Bourg. 1937.

Entyloma alopecurivorum Lavrov 1938.

Entyloma holci Liro 1939.

Entyloma deschampsiae Liro 1939.

Entyloma lagerheimianum Liro 1939.

Entyloma nubilum Liro 1939.

Entyloma espinosae Unamuno 1940.

Tolyposporella semenoviana Lavrov 1934. – *Entyloma semenoviana* (Lavrov) Gutner 1941. – *Ustilago semenoviana* (Lavrov) Cif. 1959.

Entyloma gaudinae Vienn.-Bourg. 1954,'1953' (nom. inval.)

Entyloma anadelphiae Vienn.-Bourg. 1957.

Entyloma vulpiae Massenot, in Guyot, Malençon & Massenot 1960.

Sori in leaves and sheaths as short, linear to ovate, lead-coloured or black spots, 0.1–2(–3) mm long, scattered to sometimes confluent, often moderately swollen. *Spores* densely packed, tending to

cohere in irregular groups, variable in shape and size, from globose to irregularly polyhedral or elongate, 5–11 × 6–15(–20) µm, yellowish to blackish brown, with a smooth, c. 1–2 µm thick wall. *Spore germination* results in aseptate basidia bearing (2–)4(–6) short, apical, abaxially curved basidiospores on well-developed sterigmata. *Anamorph* usually absent (Fig. 14).

On *Poaceae*:

Dactylis glomerata L., Tehran Prov., Damavand.

Hordeum bulbosum L., Mazandaran Prov., Chalous road, IRAN 8133 F.

Hordeum spontaneum K. Koch, Khuzestan Prov., Behbahan.

Remarks. The great number of synonyms, enumerated above, represent certainly several species which have to be analysed with modern methods.

***Macalpinomyces* Langdon & Full.**

23. *Macalpinomyces neglectus* (Niessl) Vánky, Mycotaxon 89: 106, 2004.

Ustilago neglecta Niessl, in Rabenh., Fgi. eur. no. 1200, 1868. – *Sporisorium neglectum* (Niessl) Vánky 1985a.

Erysibe panicorum Wallr. var. *panici-glauci* Wallr. 1833. – *Ustilago panici-glauci* (Wallr.) G. Winter, in Rabenh. 1881.

Sori in all flowers of an inflorescence, ovoid, often acuminate, 2–4 mm long, partly enclosed by the glumes, covered by a thin, greyish peridium of fungal and host tissues that ruptures irregularly to expose the dark brown, powdery mass of spores mixed with irregular groups of sterile cells. Columella short, stout, formed of host tissues and fungal cells. Infection systemic. *Spores* subglobose, ovoid, elongate to slightly irregular, 8–11 × 9–14 µm, medium brown; wall uniformly c. 0.8 µm thick, prominently and abundantly echinulate, spore profile serrulate, in SEM the area between the spines with small, rounded, scattered warts. *Sterile cells* in groups, chains or solitary, in some specimens sparse, smaller than the spores, 5–12 µm long, round or irregular, collapsed in old specimens, hyaline, usually with a light-refractive droplet.

On *Poaceae*: *Setaria glauca* (L.) P. Beauv., East Azarbaijan Prov., suburb of Tabriz city.

***Microbotryum* Lév.**

Key to the *Microbotryum* species based on host plant taxonomy

- | | |
|-----------------------------------|---|
| 1. On <i>Asteraceae</i> | 2 |
| - On <i>Caryophyllaceae</i> | <i>M. dianthorum</i> |
| 2. On <i>Scorzonera</i> | <i>M. scorzonerae</i> |
| - On <i>Tragopogon</i> | <i>M. tragopogonis-pratensis</i> |

24. *Microbotryum dianthorum* (Liro) H. Scholz & I. Scholz, Englera 8: 206, 1988.

emend. Lutz, Göker, Piątek, Kemler, Begerow & Oberwinkler, Mycol. Progr. 4: 234, 2005.

Ustilago dianthorum Liro 1924. – *Ustilago violacea* (Pers. : Pers.) Rouss. var. *dianthorum* (Liro) Durrieu & Zambett. 1973 (invalidly published).

Ustilago dianthi-arenarii Hammarl., in Gram & Weber 1942 (nom. nud.).

Sori in swollen anthers. Spore mass violet tinted blackish brown, powdery. Infection systemic; all flowers of an infected plant affected, more rarely, infection semi-systemic and only flowers of certain branches affected. *Spores* globose to slightly ellipsoidal, 6–11 µm in diam., pale violet; wall reticulate, meshes rounded, 0.5–0.8 µm in diam., muri 0.2–0.5 µm high, in median view regular, with rounded edges. *Spore germination* results in 4-celled (3 + 1) basidia producing lateral and terminal sessile basidiospores. Basidial cells separating readily and continuing to produce basidiospores or, in nutrient media, yeast cultures (Fig. 15).

On *Caryophyllaceae*: *Dianthus caryophyllus* L., Tehran Prov., Varamin (from green house), IRAN 149 & 8354 F.

On *Dianthus orientalis* Adams, Tehran Prov., Shemshak, Dizin road, IRAN 8764 F; Tehran Prov., Karaj-Chalus road, Shahrestanak village, IRAN 8214 F.

On *Dianthus tabrisianus* Bienert ex Boiss., Ardabil Prov., between Sarab and Ardabil, Farhadgholi area.



Fig.13 – *Farysia thuemenii* on *Carex riparia* (8425)

25. *Microbotryum scorzonerae* (Alb. & Schwein.) G. Deml & Prillinger, in Prillinger, Deml, Dörfler, Laaser & Lockau, Bot. Acta 104: 10, 1991.

Uredo tragopogi Pers. β *scorzonerae* Alb. & Schwein. 1805. — *Ustilago scorzonerae* (Alb. & Schwein.) J. Schröt., in Cohn 1887. — *Bauhinus scorzonerae* (Alb. & Schwein.) R.T. Moore 1992.

Uredo receptaculorum DC. β *Uredo scorzonerae-humilis* DC., in Poiret 1808. — *Erysibe receptaculorum* (DC.) Wallr. β *scorzonerae* (DC.) Wallr. 1833. — *Microbotryum receptaculorum* (DC.) Lév. 1847.

Sori in flower heads transforming the florets into blackish violet, powdery spore mass. Infection systemic. *Spores* globose, subglobose, ovoid to slightly irregular or sometimes elongate, 8–13 \times 9–15(–16) μ m, pale brownish violet, often with a light-coloured, nearly hyaline area on one side; wall finely reticulate, 8–12 meshes per spore diam., muri 1–1.5 μ m high, in SEM a few warts appear on the lower part of the muri and interspaces. *Spore germination* of *Ustilago*-type (Fig. 16).

On *Asteraceae*: *Scorzonera caliculata* Boiss., Kermanshah Prov., 17 km SE of Paveh, S slope of Shahu Mt., alt. 2200 m, 15.V.2006, M. Abbasi, R. Fritsch & M. Keusgen, IRAN 14786 F, HUV 21825.

26. *Microbotryum tragopogonis-pratensis* (Pers.) R. Bauer & Oberw., in Bauer, Oberwinkler & Vánky, Can. J. Bot. 75: 1311, 1997.

Uredo tragopogi Pers. 1797. — *Uredo tragopogi-pratensis* Pers. 1801. — *Ustilago tragopogonis-pratensis* (Pers.) Roussel 1806. — *Ustilago tragopogonis* (Pers.) J. Schröt., in Cohn 1887. — *Bauhinus tragopogonis-pratensis* (Pers.) R.T. Moore 1992.

Uredo receptaculorum DC. (nom. nov. illegit. superfl.), var. *Uredo tragopogi-pratensis* (Pers.) DC., in Poiret, 1808 (as '*tragogi pratensis*'). — *Caeoma receptaculorum* (DC.) Schldtl. 1824 (comb. illegit.). — *Ustilago receptaculorum* (DC.) Fr. 1832 (comb. illegit.). — *Erysibe receptaculorum* (DC.) Wallr. var. *tragopogonis* (Pers.) Wallr. 1833 (comb. illegit.). — *Microbotryum receptaculorum* (DC.) Lév. 1847 (comb. illegit.).



Fig.14 – *Jamesdicksonia dactylidis* on *Hordeum bulbosum* (8133)

Sori in flower heads transforming all the florets into a blackish violet, powdery spore mass. Infection systemic; infected plants usually shorter and more ramified than the healthy ones. *Spores* globose, subglobose, ovoid to pyriform or somewhat irregular, sometimes elongate, $9\text{--}17 \times 13\text{--}19 \mu\text{m}$, brownish violet, paler on one side; wall finely, densely reticulate, 8–13 meshes per spore diam., muri 1–1.5 μm high, lower on the paler side, (28–)33–45 on the spore circumference, with blunt, rounded or flattened tips, in SEM interspaces and lower part of the muri with conspicuous, sometimes anastomosed warts. *Spore germination* results in 4-celled basidia producing laterally and terminally long-ellipsoidal basidiospores that may fuse two by two to form dikaryotic hyphae (Fig. 17).

On *Asteraceae*: *Tragopogon graminifolius* DC., Zanzan Prov., between Zanzan & Mianeh city, IRAN 9542 F.

Moesziomyces Vánky

27. *Moesziomyces bullatus* (J. Schröt.) Vánky, Bot. Not. 130: 133, 1977.

Sorosporium bullatum J. Schröt. 1869. – *Tolyposporium bullatum* (J. Schröt.) J. Schröt. in Cohn, 1887. – *Tolypoderma bullata* (J. Schröt.) Thirum. & M.J. O'Brien, in Thirum. & Neerg. 1978 '1977' (nom. inval.).

Thecaphora globuligera Berk. & Broome 1880. – *Tolyposporium globuligerum* (Berk. & Broome) Ricker 1905. – *Moesziomyces globuligerus* (Berk. & Broome) Vánky 1977. – *Tolypoderma globuligera* (Berk. & Broome) Thirum. & M.J. O'Brien, in Thirum. & Neerg. 1978 '1977' (nom. inval.).

Testicularia leersiae Cornu 1883.

Tolyposporium penicillariae Bref. 1895. – *Moesziomyces penicillariae* (Bref.) Vánky 1977. – *Tolyposporidium penicillariae* (Bref.) Thirum. & Neerg. 1978 '1977'.

Tolyposporium minus J. Schröt., in Henn. 1896.

Ustilago verrucosa J. Schröt., in Henn. 1896.

Tolyposporium senegalense Speg. 1915.

Tolyposporium evernium Syd., in Syd. & S. Ahmad 1939. – *Moesziomyces evernium* (Syd.) Vánky 1977. – *Tolyposporidium evernium* (Syd.) Thirum. & Neerg. 1978 '1977'.

Tolyposporium paspali Langdon 1948.

Sori in scattered ovaries, globose to ovoid, 2–4(–5) mm long, covered by a smooth, initially green, later brown peridium of host tissue. Infection floral, through the stigma and style. The entire sorus may fall off the host or first the peridium ruptures irregularly exposing a granular, dark brown mass of spore balls; columella absent. Hyphae intracellular. *Spore balls* variable in shape and size, globose, subglobose, ovoid, elongate to irregular, (35–)50–240 × (40–)60–320 μm in diam., dark brown, opaque, composed of numerous, up to several hundred spores, united by sterile fungal cells and spore processes, no cortex of sterile cells. *Spores* globose, ovoid to irregular, slightly polyhedral, subhyaline to pale yellowish brown, 6.5–9(–10) × 7–12(–13) μm in diam., usually with several, more or less well-developed extensions (spore processes) and also remnants of the broken walls of the sterile cells; wall 0.5–0.7 μm thick, smooth. *Sterile cells* empty at maturity, thin-walled, 0.1–0.2 μm, appearing as irregular meshes or wings on the spore surface when the spores are separated. *Spore germination* results in septate basidia producing basidiospores laterally and terminally, on well-developed sterigmata (Fig. 18).

On *Poaceae*: *Echinochloa crus-galli* (L.) P. Beauv., Gilan Prov., suburb of Astara city, in rice field; Gilan Prov., suburb of Rasht city, IRAN 1352 F.

Schizonella J. Schröt.

28. *Schizonella cocconii* (Morini) Liro, Ann. Acad. Sci. Fenn., Ser. A, 42(1): 52, 1938.

Tolyposporium cocconii Morini 1884.

Sori in leaves, mostly epiphyllous, as black, blister-like, intraepidermal streaks of various lengths, initially covered by the thin layer of cuticle that ruptures longitudinally to expose the initially agglutinate, later granular-powdery spore mass. *Spore balls* irregular, composed of 2–20 (or more?) spores, rather readily separating into single spores or pairs of spores. *Spores* heterogeneous in form and size, globose, hemiglobose, ovoid to elongate and subangular, irregular, 6–10(–12) × 8–16(–18) μm, light olive-brown to dark reddish brown; wall smooth, thin and light on the contact side, and thick, dark, often finely verruculose on the opposite side. *Spore germination* of *Ustilago*-type (Fig. 19).

On *Cyperaceae*: *Carex halleriana* Asso, East Azarbaijan Prov., Arasbaran protected area, Kaleibar city, Makidi valley, IRAN 13967 F.

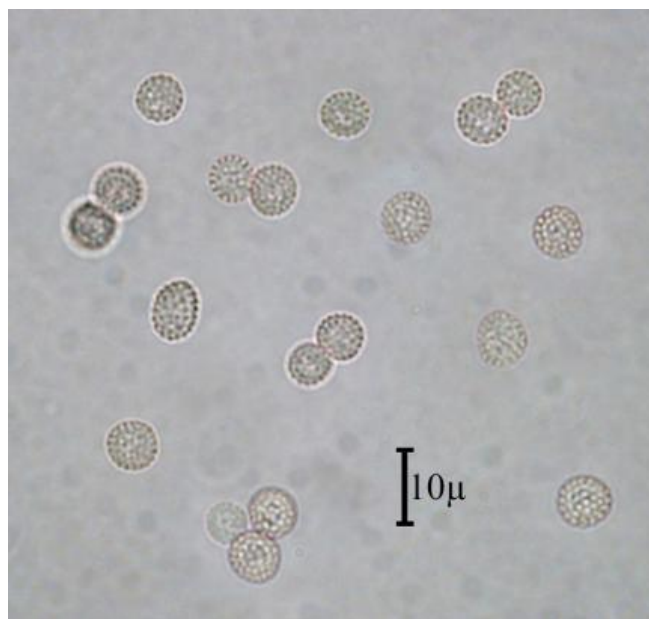


Fig.15 – *Microbotryum dianthorum* on *Dianthus caryophyllus* (149)

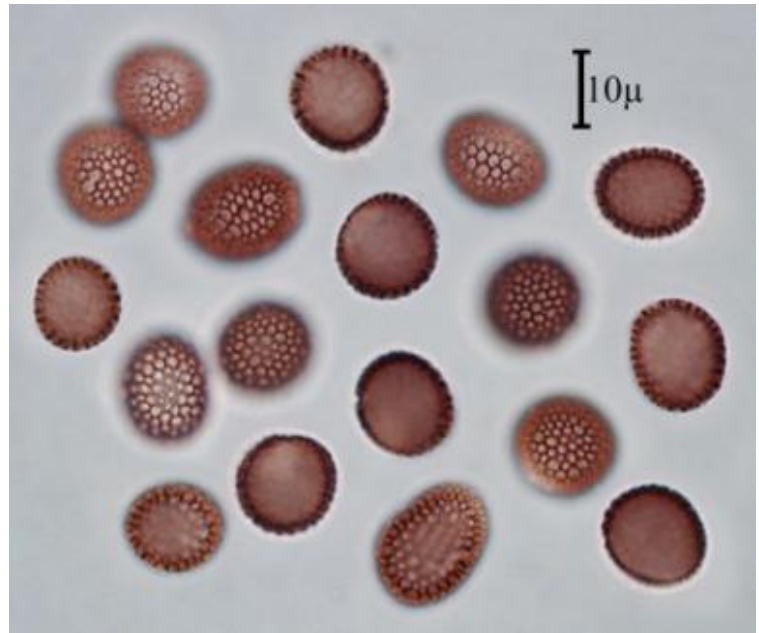


Fig.16 – *Microbotryum scorzonerae* on *Scorzonera caliculata* (14786), infected plant (left) and teliospores (right)

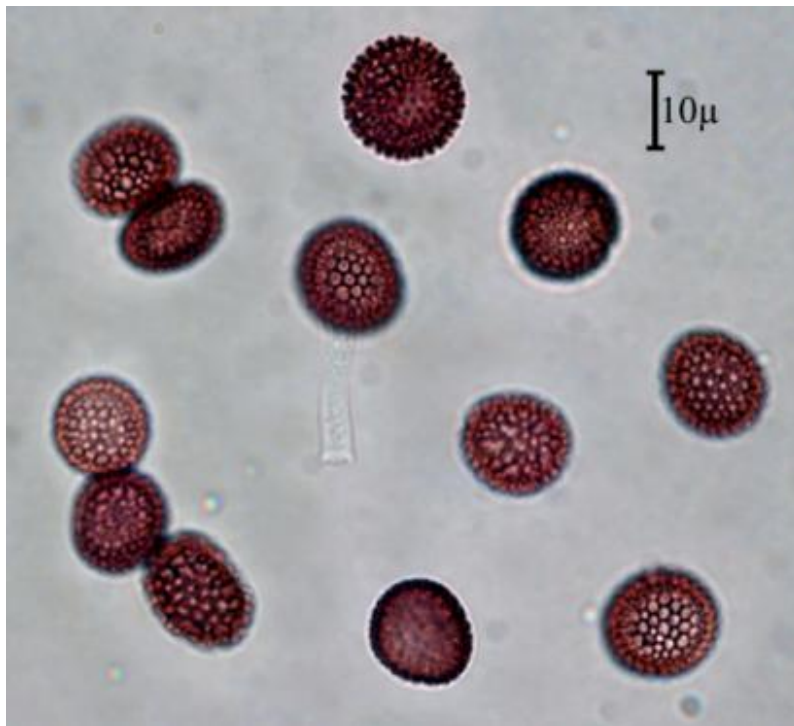


Fig.17 – *Microbotryum tragopogonis-pratensis* on *Tragopogon graminifolius* (9542)

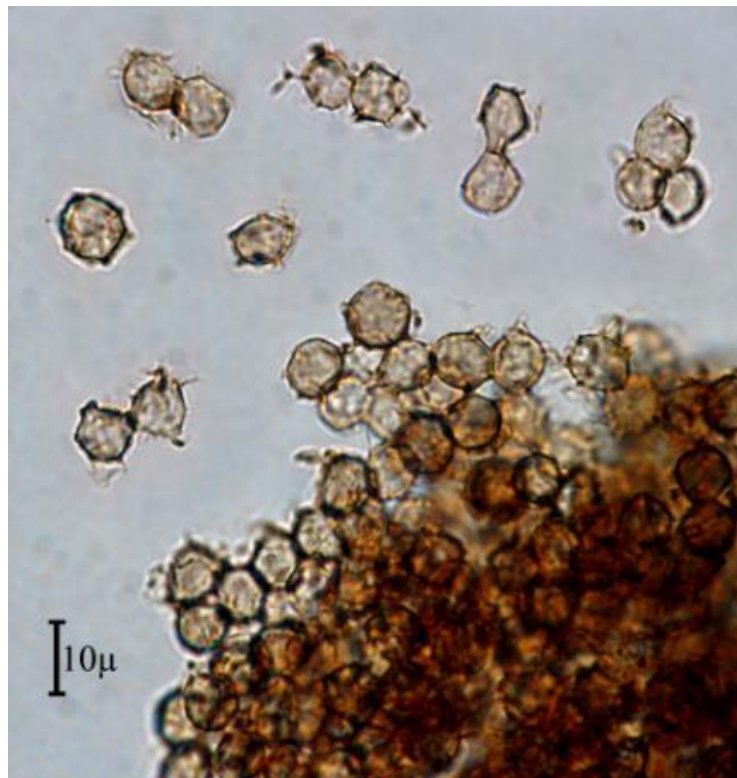


Fig.18 – *Moesziomyces bullatus* on *Echinochloa crus-galli* (1352)



Fig.19 – *Schizonella cocconii* on *Carex halleriana* (13967)

***Sporisorium* Ehrenb. ex Link**

Key to the *Sporisorium* species based on host plant taxonomy

1. On *Cymbopogon**S. lanigeri*
- Not on *Cymbopogon*2
2. On *Dichanthium*3
- Not on *Dichanthium*4
3. Spores 7.5–11 µm long, finely, densely punctate-verruculose.....*S. andropogonis*

- Spores 9–13 µm long, densely verruculose-echinulate *S. foveolati*
- 4. On *Hyparrhenia*..... *S. vanderystii*
- Not on *Hyparrhenia*.....5
- 5. On *Imperata**S. schweinfurthianum*
- Not on *Imperata*.....6
- 6. On *Lasiurus**S. desertorum*
- Not on *Lasiurus*7
- 7. On *Panicum**S. destruens*
- Not on *Panicum*8
- 8. On *Pennisetum*.....*S. penniseti*
- Not on *Pennisetum*.....9
- 9. On *Schismus**S. aegyptiacum*
- Not on *Schismus* 10
- 10. On *Sorghum* 11
- Not on *Sorghum*..... 14
- 11. Sori in whole inflorescence *S. reilianum*
- Sori in ovaries or spikelets.....12
- 12. Sori in considerably hypertrophied ovaries; spores 9.5–15 µm long *S. ehrenbergii*
- Sori in the spikelets; spores smaller 13
- 13. Peridium thin, dehiscent; spores 7.5–10 µm long, verruculose echinulate *S. cruentum*
- Peridium thick, persistent; spores 5–8(–8.5) µm long, apparently smooth to sparsely punctate or very finely verruculose. *S. sorghi*
- 14. On *Spodiopogon* *S. persicum*
- Not on *Spodiopogon* 15
- 15. On *Stipagrostis**S. aristidae-lanuginosae*
- On *Tricholaena*.....*S. tricholaenae*

29. *Sporisorium aegyptiacum* (A.A. Fisch. Waldh.) Vánky, Mycotaxon 33: 371, 1988b (as 'aegypticum').

Ustilago aegyptica A.A. Fisch. Waldh. 1879a, b.

Ustilago schismi Bubák 1914.

Sori in spikelets destroying the innermost floral organs leaving intact the glumes and the distal part of the inner floral envelopes, c. 1 × 2–3 mm, hidden by the glumes, initially covered by a yellowish brown peridium that ruptures irregularly from its basal part, flakes away together with the intact distal part of the floral envelopes, exposing the dark brown, powdery mass of spores and sterile cells surrounding a 2–3 mm long, simple, central columella sometimes with short lateral branches. Infection systemic; all spikelets of a plant infected. Diseased plants more or less stunted. Spores when mature single, subglobose, ellipsoidal to slightly irregular, 9–12 × 10.5–14.5 µm, often flattened, 6.5–8 µm wide, yellowish brown; wall even, 0.8 µm thick, densely, finely echinulate, spore profile almost smooth to finely serrulate. Sterile cells in irregular groups or chains or single, variable in shape and size, subglobose, ellipsoidal, elongate or slightly irregular, 5–6.5 × 5–10.5 µm, hyaline, contents homogeneous; wall thin, c. 0.5 µm, smooth. Spore germination results in 4-celled basidia (in a 3 + 1 arrangement), producing basidiospores or, after fusion of two compatible basidial cells, dikaryotic hyphae (Fig. 20).

On *Poaceae*: *Schismus arabicus* Nees, Golestan Prov., 6 km S of Maraveh tappeh village, IRAN 7232 F; Gilan Prov., c. 85 km S of Rasht city, east end of the lake White River dam, IRAN 7233 F.

30. *Sporisorium andropogonis* (Opiz) Vánky, Symb. Bot. Upsal. 24(2): 113, 1985a.

Uredo (Ustilago) andropogonis Opiz 1824 (as 'andropogi'). – *Sphacelotheca andropogonis* (Opiz) Bubák 1912. – *Cintractia andropogonis* (Opiz) Kochman 1936.

Ustilago ischaemi Fuckel 1860. – *Cintractia ischaemi* (Fuckel) Syd. & P. Syd. 1901. – *Sphacelotheca ischaemi* (Fuckel) G.P. Clinton 1902.

Ustilago cylindrica Peck 1882.

Sorosporium platense Hirschh. 1941. (as '*platensis*'). – *Sphacelotheca platensis* (Hirschh.) Hirschh. 1986.

Sphacelotheca chloridis Mundk. 1944a.

Ustilago bothriochloae-intermediae Padwick 1946. – *Sphacelotheca bothriochloae-intermediae* (Padwick) Naras., in Thirum. & Pavgi 1956.

Sphacelotheca heteropogonis-triticei L. Ling 1950.

Sorosporium baluchistani S. Ahmad 1956.

Sphacelotheca bothriochloae Y.C. Wang 1962. (later homonym, not Zundel).

Sori usually destroying the whole inflorescence, rarely confined to the spikelets, cylindrical or bifurcate at their distal part, 1–10 mm wide, 1.5–7 cm long, partly hidden by the terminal leaf sheath, initially covered by a well-developed, yellowish brown peridium that ruptures irregularly and flakes away exposing the dark brown, semi-agglutinated to powdery mass of spore balls, spores and groups of sterile cells surrounding a simple or ramified, irregular columella of the length of the sorus, the remnants of the floral axis and branches. Infection systemic. *Spore balls* loose, subglobose, ellipsoidal, elongate or irregular, 20–100 × 40–160 µm, dark reddish brown, composed of tens of spores that separate very easily. *Spores* when mature single, globose, ovoid, ellipsoidal to slightly irregular, (6.5–)7–10 × 7.5–11 µm, light olive-brown; wall even, 0.5–1 µm thick, finely, densely punctate-verruculose, spore profile smooth to wavy, in SEM spores minutely echinulate, between the spines finely and densely verruculose. *Sterile cells* in irregular groups or chains among the spores and also forming the peridium, globose to irregularly polyhedral, flattened on contact sides, 6–16(–22) µm long, subhyaline to yellow tinted, with numerous droplets, collapsed in old specimens; wall even, 0.5–1 µm thick, smooth. *Spore germination* results in 4-celled basidia on which lateral and terminal basidiospores are produced (Fig. 21).

On *Poaceae*: *Dichanthium annulatum* Stapf, Hormozgan Prov., Biaban, Gattan, IRAN 4424 F; Hormozgan Prov., Bandar-Abbas, Kahoorestan, IRAN 11243 F; Tehran Prov., Tehran city, Evin area, IRAN 7954 F.

On *Dichanthium ischaemum* (L.) Roberty (*Andropogon ischaemum* L.; *Bothriochloa ischaemum* (L.) Keng), Ghazvin Prov., Ebrahimabad village; Tehran Prov., Fasham city; Tehran Prov., Karaj-Chalus road, Gachsar; Tehran Prov., Taleghan city; Fars Prov., Shiraz city; Golestan Prov., Golestan National Park, Tange rah area, IRAN 11020 F; Yazd Prov., Banadaksadat village, IRAN 13877 F; Tehran Prov., Chalus road, Kalha village, IRAN 10992 F; Tehran Prov., Karaj city, IRAN 4422 & 4423 F; Gilan Prov., 1 km N of Lake White River dam, IRAN 7265 F.

31. *Sporisorium aristidae-lanuginosae* (Maire) Vánky, Mycotaxon 78: 304, 2001.

Sphacelotheca aristidae-lanuginosae Maire 1906.

Sori comprise the whole inflorescence destroying all of them in a plant, ovoid with acute tip, c. 0.5 × 1 cm, partly hidden by leaf sheaths, initially covered by a whitish to pale brown peridium that ruptures exposing the blackish brown, semi-agglutinated to powdery mass of spore balls and spores surrounding numerous, stout, 0.5–1 cm long columellae. *Spore balls* subglobose, ellipsoidal, elongate to irregular, 25–70 × 30–80 µm, dark reddish brown, composed of tens of easily separating spores. *Spores* subglobose, ellipsoidal, elongate, usually subpolyhedrally irregular, 8–12 × 9.5–13.5(–15) µm, yellowish brown; wall evenly thick, c. 1 µm, finely, densely verruculose, spore profile smooth to very finely serrulate. *Sterile cells* absent (Fig. 22).

On *Poaceae*: *Stipagrostis plumosa* (L.) Munro ex T. Anderson, Yazd Prov., Anar city, Bahramabad village, IRAN 8300 F, HUV 15311; Esfahan Prov., 45 km NW of Kashan, road towards Qom, 5.VIII.1974, leg. Wendelbo, Ráfii & Riazi, Herb. TARI 14441, HUV 7480; Kerman Prov., Rafsanjan city, 21.IV.1946, leg. Kriukhin, IRAN 4427 F; Sistan va Baluchestan Prov., Zabol, Dashtak Police Station, IRAN 14881 F.

Remarks – This species was treated in Ershad (2001: 99) under the name *Sporisorium saharianum* (Trotter) Karatygin.

32. *Sporisorium cruentum* (J.G. Kühn) Vánky, Symb. Bot. Upsal. 24(2): 115, 1985a.

Ustilago cruenta J.G. Kühn 1872. – *Sphacelotheca cruenta* (J.G. Kühn) Potter 1912.

Ustilago sorghi Passerini, in Thümen 1873.

Endothlaspis sorghi Sorokin 1890. – *Cintractia sorghi* (Sorokin) de Toni, in Sacc. 1888. –

Sphacelotheca sorokiniana (Sorokin) Cif. 1928 (nom. nov.).

Sphacelotheca holci H.S. Jacks. 1934 (n.v.).

Sori in all spikelets of the congested and stunted panicle, covered by a delicate peridium which easily ruptures to reveal the blackish brown, powdery spore mass, mixed with groups of sterile cells and a well-developed columella. Columella composed of host tissues permeated by hyphae producing spores and sterile cells. Mature spores single or in irregular, loose groups. *Spores* globose to ovoid, 6.5–8.5 × 7.5–10 µm, light olive-brown, finely and sparsely verruculose to minutely echinulate. *Sterile cells* much larger than the spores (8–16 µm long), in small, irregular groups or chains, hyaline or pale yellow, smooth. *Spore germination* results in 4-celled basidia which in WA give rise to hyphae, in nutrient media to ovoid or elongate basidiospores which bud (Fig. 23).

On *Poaceae*: *Sorghum bicolor* (L.) Moench. Only one record made by Khabiri (1956) from unknown locality.

On *Sorghum halepense* (L.) Pers., Kohgiluyeh va Buyerahmad Prov., Yasouj city, Babamaidan road, Tange-Tamoradi area, IRAN 8316 F; Ardabil Prov., Moghan city, Ultan village, IRAN 8212 F; Lorestan Prov., Boroujerd city, Khaayan village, IRAN 8238 F; Lorestan Prov., Khorramabad city, IRAN 4421 & 6585 F; Fars Prov., Darab city, IRAN 11538 F; Kermanshah Prov., Sahneh, IRAN 6634 F; Khuzestan Prov., Dezful, Safiabad, IRAN 6586 F; Yazd Prov., at Yazd city, Shahedieh, 14576 F; Lorestan Prov., between Khorramabad city & Alashtar city, IRAN 8757 F; Yazd Prov., Marvast city, IRAN 13878 F; Tehran Prov., Tehran city, Evin area, IRAN 9563 F; Fars Prov., Malusjan village, IRAN 13282 F; Kermanshah Prov., Bisotun area, IRAN 2534 F; West Azarbaijan Prov., IRAN 12835 F; Fars Prov., Shiraz city, Bagh-e Farhangshahr, IRAN 13188 F; Fars Prov., Sivand dam, Sar-e asiab spring, IRAN 13190 F; Esfahan Prov., Semirom city, Padena village, Bideh village, IRAN 11192 F, Guilan Prov., Lushan, IRAN 8237 F.

On *Sorghum* sp., Kermanshah Prov., Ghasre Shirin city, IRAN 4426 F; Yazd Prov., Abarkooh city, IRAN 13929 F.

33. *Sporisorium desertorum* (Thüm.) Vánky, Mycotaxon 74: 169, 2000.

Sorosporium desertorum Thümen 1879.

Sorosporium lasiuri S. Ahmad 1969.

Sorosporium lasiuri Zambett. 1970 (later homonym and nom. inval.).

Sori destroying the whole inflorescence (raceme), more rarely only a part of it or only a few spikelets in the raceme, fusiform, 1–2(–3) × 10–35 mm, partly hidden by leaf sheaths, covered by a thick, brown peridium that ruptures irregularly exposing the dark brown mass of spore balls, spores, sterile cells and several long, filiform columellae. All racemes or only some of them in a plant may be affected. *Spore balls* globose to irregularly ellipsoidal, 35–60(–75) µm long, dark reddish brown, easily separating into single spores. *Spores* globose, subglobose, ellipsoidal, slightly irregular, 8.5–10.5 × 9.5–12(–13) µm, reddish brown; wall uneven, 1–1.5 µm thick, thickest at the angles, outer spores coarsely verrucose-echinulate, especially on their free surface, inner spores finely punctate. *Sterile cells* single, globose, subglobose, ellipsoidal, usually more or less flattened, 8–16 µm long, hyaline; wall 1–1.5 µm thick, smooth (Fig. 24).

On *Poaceae*: *Lasiurus indicus* Henrard (*L. hirsutus* (Forssk.) Boiss.; *Coelorachis hirsuta* (Forssk.) Brongn.); Sisitan va Baluchestan Prov., Chabahar city, 2 km of Pasaband city towards Goatar port, IRAN 11288 F, HUV 21822.

Remarks – *Sporisorium desertorum*, treated in Ershad (2001: 83) as *S. andropogonis*, is known from a few countries in Africa (Chad, Egypt, Mauritania) and in S Asia (India, Pakistan).

34. *Sporisorium destruens* (Schltdl.) Vánky, Symb. Bot. Upsal. 24(2): 115, 1985a.

Caecoma destruens Schltdl. 1824. – *Uredo destruens* (Schltdl.) Duby 1830. – *Tilletia destruens* (Schltdl.) Lév. 1847. – *Ustilago destruens* (Schltdl.) Rabenh. 1857. – *Anthracoecystis destruens* (Schltdl.) Bref. 1912. – *Sphacelotheca destruens* (Schltdl.) J.A. Stev. & A.G. Johnson 1944.

Ustilago panici-miliacei (Pers.) G. Winter 1881. – *Sorosporium panici-miliacei* (Pers.) Takah. 1902. – *Sphacelotheca panici-miliacei* (Pers.) Bubák 1912. – *Uredo segetum* var. *panici-miliacei* Pers. 1801. – *Uredo carbo* var. *panici-miliacei* (Pers.) DC. 1815.

Uredo segetum Pers. var. *Uredo panici-miliacei* Pers. 1801. – *Uredo carbo* var. *panici-miliacei* (Pers.) DC. 1815. – *Erysibe panicorum* var. *panici-miliacei* (Pers.) Wallr. 1833. – *Ustilago panici-miliacei* (Pers.) G. Winter 1881. – *Sorosporium panici-miliacei* (Pers.) Takah. 1902. – *Sphacelotheca panici-miliacei* (Pers.) Bubák 1912.

Sorosporium manchuricum S. Ito 1935. – *Sphacelotheca manchurica* (S. Ito) Y.C. Wang 1962.

Sphacelotheca lioui W.Y. Yen 1937a.

Sori destroying the whole inflorescence, ovoid to elongate, 0.5–2 × 3–6 cm, partly concealed by leaf sheaths and covered by a well-developed, whitish peridium that ruptures irregularly and flakes away to expose the dark brown, dusty spore mass, sterile cells and numerous, long, filiform columellae composed of host tissues, mainly vascular bundles, and hyphae. Infection systemic, initiated in seedling stage of the hosts. *Spore balls* loose, ephemeral. *Spores* when mature single, subglobose, ovoid to elongate or irregular, 7–9 × 8–13 µm, pale reddish brown; wall even or nearly so, c. 0.5 µm thick, smooth to very finely punctate, spore profile smooth, in SEM very finely and densely verruculose. *Sterile cells* among the spores subhyaline or pale yellow, thin-walled, almost the size of the spores. *Spore germination* results in 4-celled basidia. In water, basidial cells fuse and produce hyphae, in nutrient media abundant basidiospores are produced (Fig. 25).

On *Poaceae*: *Panicum miliaceum* L., Fars Prov., Abadeh city, IRAN 4420 F; Khorasan Prov., Mashhad city, Tous city, IRAN 8313 F; Esfahan Prov., suburb of Esfahan city, IRAN 10320 F.

35. *Sporisorium ehrenbergii* (J.G. Kühn) Vánky, Mycotaxon 38: 270, 1990.

Sorosporium ehrenbergii J.G. Kühn 1877. – *Tolyposporium ehrenbergii* (J.G. Kühn) Pat. 1903.

Tolyposporium filiferum Busse 1905. – *Sorosporium filiferum* (Busse) Zundel 1930b.

Sorosporium andropogonis-sorghii S. Ito 1935.

Sori in occasional ovaries, cylindrical, elongate, often curved, 0.3–1 × 1–3 cm, covered by a thick, smooth, whitish to yellowish brown peridium which fissures apically or longitudinally to expose the black, granular mass of spore balls mixed with several, long, often ramified, filiform columellae, composed of host tissues and fungal cells. Peridium composed of chains of ovoid to 10–50 µm long, cylindrical, hyaline fungal cells. *Spore balls* variable in shape and size, subglobose to oblong or irregular, 40–100(–150) µm long, rather permanent, many-spored, dark brown, opaque. *Spores* globose or, more commonly subpolyhedral, 9–12 × 9.5–15 µm, dimorphic. Outer spores dark brown, verrucose on the free surface. Inner spores pale yellowish brown, thin-walled, smooth. *Spore germination* results in 2–4-celled basidia, producing laterally and terminally ovoid or fusiform basidiospores (Fig. 26).

On *Poaceae*: *Sorghum bicolor* (L.) Moench (*S. vulgare* Pers.), Khuzestan Prov., Dezful city; East Azarbaijan Prov., Mianeh; Khuzestan Prov., Ramin city; Zanzan Prov.; Esfahan Prov., Zavareh city; Esfahan Prov., Ardestan city, Gazla village, IRAN 10322 F; Kerman Prov., Jazmurian area, Kangru village, IRAN 4400 F; Sistan va Baluchestan, Iranshahr city, Bampoor city, IRAN 4399 F.

36. *Sporisorium foveolati* (Maire) Vánky, Mycotaxon 33: 367, 1988b.

Sphacelotheca foveolati Maire 1931a.

Sori destroying the whole inflorescence, 1–2 × 5–15 mm, partly hidden by the uppermost leaf sheath, initially covered by a yellowish brown peridium which flakes away revealing the dark brown, semi-agglutinated to powdery mass of spores and sterile cells surrounding a usually flagelliform columella. *Spores* rounded subpolyhedral, often irregular, 8–11 × 9–13 µm, olive-

brown; wall even, 0.5–0.8 μm thick, densely verruculose-echinulate, spore profile wavy to finely serrulate. *Sterile cells* in loose, irregular groups or solitary, globose, ellipsoidal to slightly irregular, 9–20 \times 13–22 μm , pale yellowish brown; wall 1.5–3 μm thick, smooth (Fig. 27).

On *Poaceae*: On *Dichanthium annulatum* (Forssk.) Stapf, Hormozgan Prov., Biaan, Gattan, 4.III.1949, IRAN 4424 F; Hormozgan prov., Bandar, Abbas, Kahoorestan, 5.III.2001, IRAN 11343 F.

On *Dichanthium foveolatum* (Delile) Roberty (*Andropogon foveolatus* Delile; *Eremopogon foveolatus* (Delile) Stapf), Hormozgan Prov., Persian Gulf, Lavan Island, IRAN 4425 F, HUV 21819.

Remarks – This smut, known from several countries in Africa, is new to Iran, and probably also to Asia. In Ershad (2001: 82) it was treated as *Sporisorium andropogonis*.

37. *Sporisorium lanigeri* (Magnus) Ershad, Iran. J. Pl. Pathol. 33: 59, 1998 '1997'.

Ustilago lanigeri Magnus 1899. – *Sphacelotheca lanigeri* (Magnus) Maire, in Zundel 1930b. – *Sporisorium lanigeri* (Magnus) Vánky 2003 (comb. superfl.).

Ustilago furcata Pat. & Har. 1900. – *Sphacelotheca furcata* (Pat. & Har.) Pat. & Har., in Har. & Pat. 1909.

Ustilago schoenanthi Syd., P. Syd. & E.J. Butler 1906. – *Sphacelotheca schoenanthi* (Syd., P. Syd. & E.J. Butler) Zundel 1930b.

Sphacelotheca moggii Zundel 1930b.

Sphacelotheca concentrica Zundel 1930b.

Sorosporium pretoriense Zundel 1930b.

Sphacelotheca natalensis Zundel 1930b.

Sphacelotheca columellifera (Tul. & C. Tul.) W.Y. Yen 1937b. (later homonym, not Cif. 1928). – *Sphacelotheca yenii* Zundel 1939.

Sphacelotheca cymbopogonis W.Y. Yen 1938a.

Sphacelotheca consueta Syd., in Syd. & S. Ahmad 1939.

Sorosporium ladharensis Syd. in Syd. & S. Ahmad 1939.

Sphacelotheca cymbopogonis-colorati Mundk. & Thirum., in Thirum. & Mundk. 1951. – *Sporisorium cymbopogonis-colorati* (Mundk. & Thirum.) Kakish. & Y. Ono, in Nakaike & Malik (eds.) 1993.

Sphacelotheca mutila Mundk. & Thirum., in Thirum. & Mundk. 1951.

Sporisorium martinii Bag & D.K. Agarwal 2001 (as '*martinae*').

Sori destroying all racemes of an inflorescence, more or less hidden by the enveloping spathae, cylindrical, tapering at the apex, 1–2 \times 5–16 mm, initially covered by a pale brown, thick peridium that ruptures irregularly exposing the dark brown, semi-agglutinated to powdery mass of spore balls, spores and sterile cells surrounding a stout, tapering, rarely flagelliform, sometimes bifurcate, central columella. *Spore balls* globose, ellipsoidal to irregular, 30–120 \times 40–140 μm , dark reddish brown to opaque, composed of numerous spores that separate under pressure. *Spores* globose, subglobose, ellipsoidal to slightly irregular, often slightly flattened, 5.5–8 \times 6–9 μm , yellowish to reddish brown; wall evenly thick, 0.5–1 μm , apparently smooth to finely, moderately densely verruculose-echinulate, spore profile smooth to finely wavy. *Sterile cells* in irregular groups, individual cells subglobose, ellipsoidal to irregular, 7–20 μm long, hyaline to pale yellowish brown tinted; wall 1–1.5 μm thick, smooth (Fig. 28).

On *Poaceae*: *Cymbopogon olivieri* (Boiss.) Bor, Kerman Prov., Tagh-ali Mt.; Hormozgan Prov., Minab, IRAN 12374 F, HUV 21970; Hormozgan Prov., Jask, Bashagard area, IRAN 12399 F, HUV 21983, also in Vánky, Ust. exs. no. 1291.

38. *Sporisorium penniseti* (Rabenh.) Ershad, Iran. J. Pl. Pathol. 30: 18, 1994.

Ustilago penniseti Rabenh. 1871. – *Sphacelotheca penniseti* (Rabenh.) Reichert 1921.

Ustilago pappiana Bacc. 1906. – *Sorosporium pappianum* (Bacc.) L. Ling 1953.

Sorosporium catharticum Maire 1931b. – *Sporisorium catharticum* (Maire) Vánky 1989.

Sphacelotheca panjabensis Syd., in Syd. & S. Ahmad 1939. – *Ustilago panjabensis* (Syd.) L. Ling 1950.

Sorosporium penniseti Mundk. 1939a.

Sphacelotheca stewartii Mundk. 1944b.

Ustilago penniseti var. *verruculosa* Massenot, in Guyot, Malençon & Massenot 1969.

Sori in all spikelets of an inflorescence, cylindrical, 1–1.5 × 2–7 mm, hidden by the outer floral envelopes, covered by a greyish brown peridium which flakes away exposing the semi-agglutinated to granular-powdery mass of spore balls and a central columella of the length of the sori, with a few, short, apical branches. *Spore balls* globose, ovoid to ellipsoidal, 40–110 µm long, dark reddish brown, composed of many spores that separate rather easily. *Spores* dimorphic. Outer spores globose to ellipsoidal, 9–13 × (9–)10–13.5(–14.5) µm, medium reddish brown, finely and densely echinulate. Inner spores subpolyhedral, smaller (7–10 µm), paler coloured and finely punctate or apparently smooth. *Sterile cells* of the peridium variable in shape and size, often elongate, 4–16 µm long, arranged in parallel rows, hyaline, smooth. *Spore germination* results in 2-celled basidia, each cell producing a long, ramifying hypha (Fig. 29).

On *Poaceae*: *Pennisetum orientale* Rich., Golestan Prov., Gonbad city, IRAN 4419 F; West Azarbaijan Prov., Khoy city, Ghotur area, IRAN 8234 F.

39. *Sporisorium persicum* Vánky & H. Scholz, *Nova Hedwigia* 72: 397, 2001.

Sori in all spikelets of an inflorescence, destroying the inner floral organs, protruding between the glumes, long ovoid or cylindrical, 1–2 × 3–8 mm, initially covered by a greyish brown peridium that ruptures irregularly exposing the blackish brown, powdery mass of spore balls, spores and sterile cells surrounding a stout, tapering columella. *Spores* in loose, many-spored balls, when mature single, subglobose, ellipsoidal or slightly irregular, variable in size, 5–8 × 5.5–9 µm, yellowish brown; wall even, c. 0.5 µm, finely, moderately densely punctate-verruculose, spore profile smooth. *Sterile cells* in irregular groups or in chains, individual cells variable in shape and size, subglobose, ellipsoidal or irregular, with one or several flattened contact sides, usually larger than the spores, 5–16 × 6–17 µm, hyaline; wall c. 1 µm thick, smooth.

On *Poaceae*: *Spodiopogon pogonanthus* (Boiss. & Bal. ex Bal.) Boiss.; Fars Prov., North of Kazeron, Bishapur, 23.IV.2000, W. Lang,

Remarks – Known only from the type collection in Iran.

40. *Sporisorium reilianum* (J.G. Kühn) Langdon & Full., *Mycotaxon* 6: 452, 1978.

Ustilago reiliana J.G. Kühn, in Rabenhorst 1875. – *Cintractia reiliana* (J.G. Kühn) Clinton 1900. – *Sphacelotheca reiliana* (J.G. Kühn) Clinton 1902. – *Sorosporium reilianum* (J.G. Kühn) McAlpine 1910.

Ustilago holci-sorghii Rivolta 1873 (nom. dub.). – *Sphacelotheca holci-sorghii* (Rivolta) Cif. 1938. – *Sorosporium holci-sorghii* (Rivolta) Moesz 1950. – *Sporisorium holci-sorghii* (Rivolta) Vánky 1985a.

Ustilago reiliana J.G. Kühn f. *zeae* Pass., in Rabenhorst 1876.

Ustilago pulveracea Cooke 1876.

Ustilago abortifera Speg. 1899.

Sorosporium simii Pole-Evans 1916.

Ustilago reiliana f. *sorghii* Geschele 1927 (nom. nud.). – *Sorosporium holci-sorghii* f. *sorghii* (Geschele) Sävul. 1957 (comb. illegit.).

Sori in inflorescence which are usually completely destroyed and transformed into blackish brown, granular-powdery spore mass, but sometimes only single flowers are infected and rarely the panicle rachis and leaves are infected. *Sori* initially covered by a white to pale brown peridium of fungal origin which ruptures irregularly and flakes away to expose the mass of spore balls mixed with groups of sterile cells and numerous long, sinuous, thread-like or stout columellae. *Spore balls* 60–100 µm long, composed of numerous, loosely connected spores. *Spores* globose, subglobose to ovoid or slightly irregular, 10–13 × 10.5–14.5 µm, light olive-brown, densely, minutely echinulate.

Sterile cells in irregular, persistent groups, rounded on the free surface, flattened on the contact surfaces, 8–16 µm long, hyaline to yellow tinted, smooth, with a few oil droplets in each cell. *Spore germination* results in 4-celled basidia on which lateral and terminal basidiospores are produced (Fig. 30).

On *Poaceae*: *Sorghum bicolor* (L.) Moench, East Azarbaijan Prov., Mianeh city; Ardabil Prov., Moghan area; Sistan va -Baluchestan Prov., Chah-Bahar port, Dashtiari area, IRAN 8031 F; Esfahan Prov., Kashanak city, Ardestan city, IRAN 10323 F; Zanjan Prov.

On *Sorghum halepense* (L.) Pers., Ardabil Prov., Moghan city; Mazandaran Prov., Neka city; Khuzestan Prov., Dezful city; Mazandaran Prov., Tonekabon city, IRAN 4417 F; Khuzestan Prov., Dezful city, Safiabad agricultural station, IRAN 6581 F; Yazd Prov., Marvast city, IRAN 13879 F; Tehran Prov., Varamin city, IRAN 4416 F; Tehran Prov., Karaj city, IRAN 4413 F; Lorestan Prov., Khorramabad city, Alashtar city, IRAN 4414 F; Kermanshah Prov., Gilan-Gharb city, IRAN 6633 F; Fars Prov., Malusjan village, IRAN 13283 F; Fars Prov., Shiraz city, Dinakan village, IRAN 13192 F; West Azarbaijan Prov., Oroumieh city, IRAN 4415 F; Mazandaran Prov., Sari city, Baye Kola village, IRAN 11191 F; Kermanshah Prov., Bisotun area, IRAN 2533 F; Fars Prov., Road of Sepidan, Pagah village, IRAN 13191 F; Esfahan Prov., Semirom city, Bide village, IRAN 11190 F.

On *Sorghum vulgare* Pers., Mazandaran Prov., Babol city, IRAN 4412 F.

On *Zea mays* L., Esfahan Prov., Esfahan city, IRAN 4418 F; Ardabil Prov., Moghan area.

Remarks. Khabiri (1958) reported this fungus as *Sphacelotheca holci-sorghii* on *Sorghum saccharatum* from unknown locality in Iran.

41. *Sporisorium schweinfurthianum* (Thüm.) Vánky, Publ. Herb. Univ. Uppsala 11: 12, 1983.

Ustilago schweinfurthiana Thüm. 1877. – *Sphacelotheca schweinfurthiana* (Thüm.) Sacc. 1908. – *Sporisorium schweinfurthianum* (Thüm.) Karatygin, in Karatygin & Azbukina 1989 (comb. superfl.).

Sori destroying all inner floral organs of an inflorescence, cylindrical, 4–6 mm long, protruding between the glumes, initially covered by a greyish brown peridium that ruptures apically exposing a dark brown, semi-powdery spore mass and a well-developed, central columella. Infection systemic. *Spores* when young in firmly adhering masses, single at maturity, globose, subglobose, ovoid, often slightly irregularly polyhedral, 10–13 × 11–14 µm, olive-brown; wall 0.8–1 µm thick, very finely punctate-verruculose. *Sterile cells* abundant among the spores, in groups or in chains, individual cells variable in size (smaller, the same size or larger than the spores), hyaline, thin-walled, smooth, collapsed in old specimens; those of the peridium 3–20 µm long, usually arranged in parallel chains. *Spore germination* of *Ustilago*-type. A spore produces one to several septate basidia which develop either basidiospores or, after conjugation of two basidial cells, hyphae (Fig. 31).

On *Poaceae*: *Imperata cylindrica* (L.) P. Beauv., Tehran Prov., Shahriar city, IRAN 8077 F; Khuzestan Prov., between Ahvaz city & Haft-Tappeh city; Golestan Prov., Aliabad city, IRAN 7127 F; Golestan Prov., Kalaleh city to Maraveh-tappeh city, Gogjeh village, IRAN 11361 F; Golestan Prov., Gonbad city, Galikesh village, IRAN 4408 F; Golestan Prov., Gorgan city, Agh-ghala village, Araghi Mahaleh agriculture station, IRAN 11178 F; Golestan Prov., Gorgan city, IRAN 10841 F; Golestan Prov., Gorgan city, 34 km SW of Maraveh tappeh city, IRAN 7264 F; Khuzestan Prov., Ahvaz city, IRAN 4409 F; Khuzestan Prov., Dezful city, Safiabad agriculture station, IRAN 4410 F; Tehran Prov., Karaj city, IRAN 4407 F; Sistan va –Baluchestan Prov., Saravan city, IRAN 8782 F; East Azarbaijan Prov., Arasbaran protected area, Tatar village toward Asheghloo village, Sotan area, IRAN 14217 F; Qazvin Prov., Takestan city, IRAN 10518 F; Kerman Prov., Rafsanjan city, Ravar village, IRAN 671 F.

42. *Sporisorium sorghi* Ehrenb. ex Link, Linné's Species Plantarum, Ed. 4, 6(2): 86, 1825.

Sphacelotheca sorghi (Ehrenb. ex Link) G.P. Clinton 1902. – *Cintractia sorghi* (Ehrenb. ex Link) Hirschh. 1939b.

Ustilago sorghicola Speg. 1902. – *Sphacelotheca sorghicola* (Speg.) Zundel 1930b.

Tilletia sorghi-vulgaris Tul. & C. Tul. 1847. – *Cintractia sorghi-vulgaris* (Tul. & C. Tul.) G.P.

Clinton 1897. – *Ustilago tulasnei* J.G. Kühn 1874 (nom. nov. superfl. pro *T. sorghi-vulgaris*).

Sori in spikelets as 3–10 mm long, ovoid or cylindrical, pale brown bodies protruding from the glumes, covered by a well-developed peridium of interwoven hyphae overlain by host tissue, which ruptures irregularly to expose the dark brown, powdery spore mass and the central columella composed of host tissues permeated by hyphae. The panicles may or not be congested and stunted. *Spores* when mature single, globose, subglobose, ovoid to slightly irregular, 5.5–7 × 5.5–8(–8.5) μm, light olive-brown, from apparently smooth to sparsely punctate or very finely verruculose. *Sterile cells* somewhat larger than the spores, in irregular groups or chains, hyaline, smooth. *Spore germination* results in 4-celled basidia (the 4th, basal cell usually remains in the spore) producing lateral and apical basidiospores in nutrient media, or infection hyphae in water (Fig. 32).

On *Poaceae*: *Sorghum bicolor* (L.) Moench, Azarbaijan Prov., IRAN 8589 F; Khuzestan Prov., Dezful city; Tehran Prov., Karaj city; Esfahan Prov., Kashan city; Zanzan Prov., Zanzan city; Esfahan Prov., Najafabad city, IRAN 6601 F; Esfahan Prov., Ardestan, Zavareh city, Aliabad village, IRAN 10321 F.

On *Sorghum cernuum* Willd., Sistan va Baluchestan Prov., IRAN 4406 F.

On *Sorghum halepense* (L.) Pers., Mazandaran Prov., Moghan city, IRAN 7123 F.

On *Sorghum* sp., Kordestan Prov.

A smut fungus was reported under the name *S. sorghi* by Sharif & Ershad (1966) on *Zea mays* L. from Lorestan Prov., Boroujerd city. Most probably it refers to *Sporisorium reilianum*.

43. *Sporisorium tricholaenae* (Henn.) Vánky, Mycotaxon 33: 367, 1988b.

Ustilago tricholaenae Henn. 1893a, b. – *Sphacelotheca tricholaenae* (Henn.) Mundk. 1944a.

Sphacelotheca panici-teneriffae Picb. 1932.

Sori in all flowers of an inflorescence, ovoid to long-cylindrical, 0.5–1 × 1.5–6 mm, partly hidden by the glumes, initially covered by a greyish brown, thick peridium of fungal and host origin, which later ruptures exposing the blackish brown, semi-agglutinated to powdery mass of spore balls, spores and sterile cells surrounding a central, flagelliform columella, c. the length of the sori. *Spore balls* subglobose, ovoid, ellipsoidal, elongate or irregular, 30–60 × 30–80(–100) μm, dark reddish brown, composed of many, easily separating spores. *Spores* subglobose, ellipsoidal or subpolyhedrally slightly irregular, (6.5–)7–9(–10) × 7–10(–11) μm, dark brown; wall even, c. 1 μm thick, densely punctate, verruculose to finely echinulate, spore profile smooth to rough. *Sterile cells* in irregular groups or chains, individual cells variable in shape and size, 5–12 μm long, hyaline, thin-walled. *Spore germination* results in 4-celled basidia producing laterally and terminally ovoid to elongate basidia or, after conjugation of two basidial cells, dikaryotic hyphae (Fig. 33).

On *Poaceae*: *Tricholaena teneriffae* (L. f.) Link, Hormozgan Prov., 15 km N of Bandare Lengeh port, IRAN 8770 F; Sistan va –Baluchestan Prov., Ghasre-Ghand city, IRAN 9249 F.

This smut was reported on *Hyparrhenia hirta* (L.) Stapf. by Karampour et al. (2008). This plant is not a host of *Sporisorium tricholaenae*.

44. *Sporisorium vanderystii* (Henn.) Langd. & Fullerton, Mycotaxon 6: 451, 1978.

Ustilago vanderystii Henn., in Wildeman 1907. — *Cintractia vanderystii* (Henn.) Zundel 1930b. —

Sphacelotheca vanderystii (Henn.) L. Ling 1951.

Ustilago hyparrheniae Beeli 1922. — *Sphacelotheca hyparrheniae* (Beeli) Zambett. 1980('1979').

Sphacelotheca evansii Zundel 1930b.

Sphacelotheca ritchiei Zundel 1930b.

Ustilago puellaris Syd. 1935. — *Sporisorium puellare* (Syd.) G. Deml, in Vánky, Deml & Oberwinkler 1988.

Sphacelotheca ruprechtii Syd. 1935.

Sphacelotheca kenya Zundel 1937.

Ustilago hyparrheniae J.C.F. Hopkins 1938 (later homonym, not Beeli 1922).

Sori comprising all raceme-pairs or racemes of an inflorescence, cylindrical, usually forked, Y- or V-shaped, 1–2(–2.5) × 4–8 mm, partly concealed by the spathae, initially covered by a thick, brown peridium that ruptures irregularly exposing the semi-agglutinated to powdery mass of spores and sterile cells surrounding a stout, bifurcate or a simple columella, c. the length of the sori, often with short branches. Rarely, the sori are restricted to the spikelet-pairs only. *Spores* when mature single, globose, ovoid, ellipsoidal to rarely elongate or slightly irregular, (6.5–)7–10.5 × (7–)8–11 μm, yellowish brown; wall evenly thick, 0.5–0.8 μm, finely, densely punctate-verruculose, spore profile smooth, in SEM spore surface finely, densely echinulate, between the spines finely, densely verruculose. *Sterile cells* in small, irregular groups, individual cells globose, ellipsoidal or irregularly polyangular with flattened side(s), 9–24(–30) μm long, hyaline or subhyaline; wall 0.5–1.5 μm thick, smooth. *Spore germination* results in a ramified, multicellular, monokaryotic hypha (Fig. 34).

On *Poaceae*: *Hyparrhenia hirta* (L.) Stapf, Kermanshah Prov., Rijab, Sahalan village toward Sarab-e Shalan, alt. 1100 m, 14.V.2006, leg. M. Abbasi, R. Fritsch & M. Keusgen, IRAN 14783 F, HUV 21826.

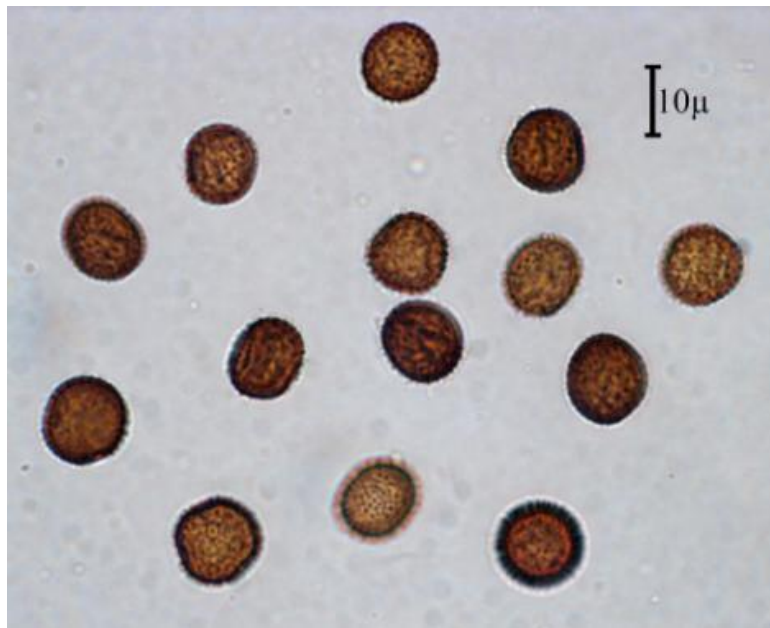


Fig.20 – *Sporisorium aegyptiacum* on *Schismus arabicus* (7233)

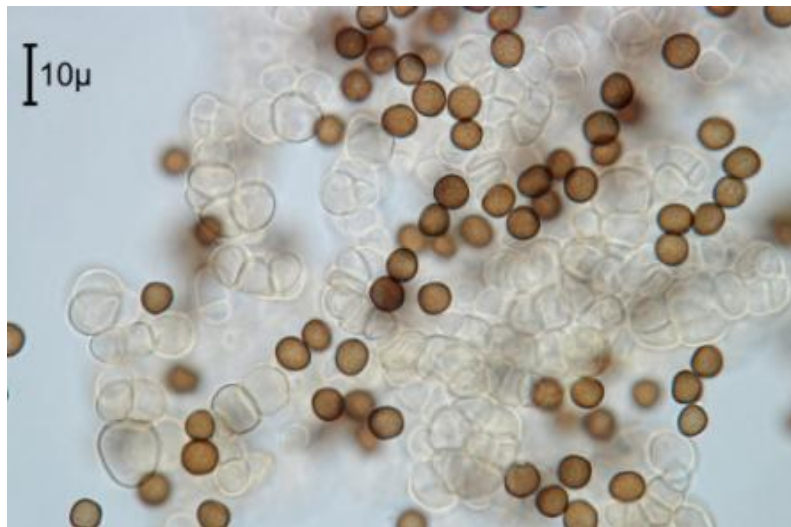


Fig.21 – *Sporisorium andropogonis* on *Dichanthium ischaemum* (11020)

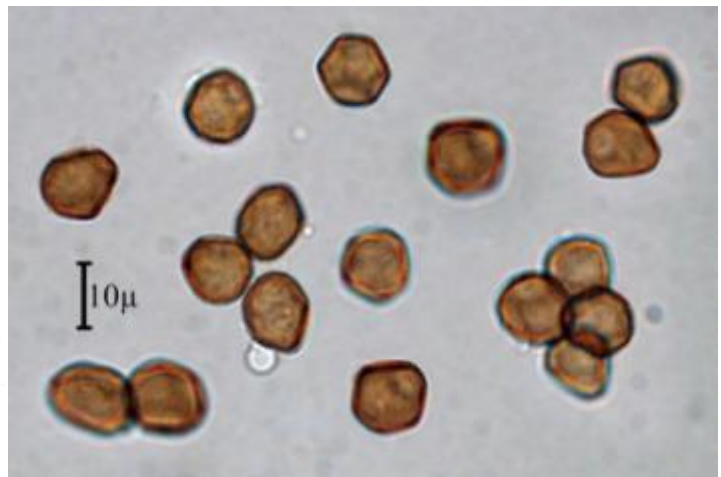
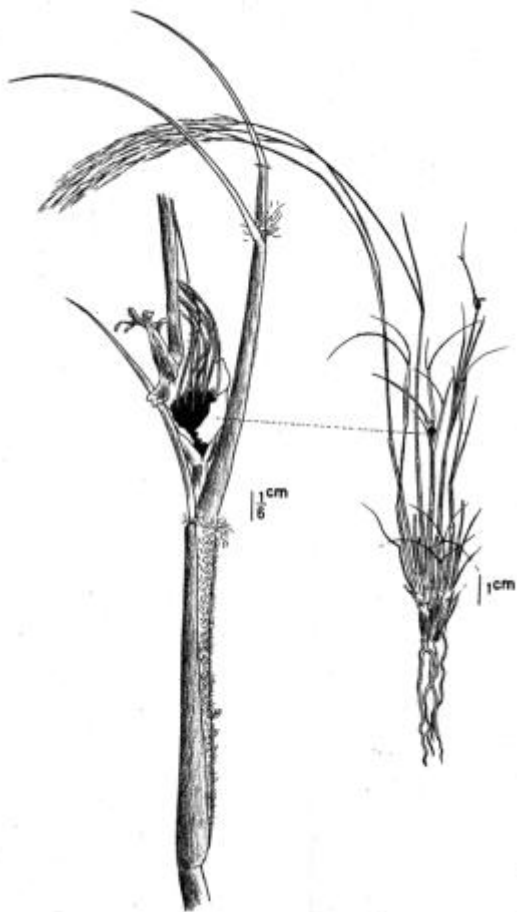


Fig.22 – *Sporisorium aristidae-lanuginosae* on *Stipagrostis plumosa*, infected plant (14881) (left) and teliospores (8300) (right)

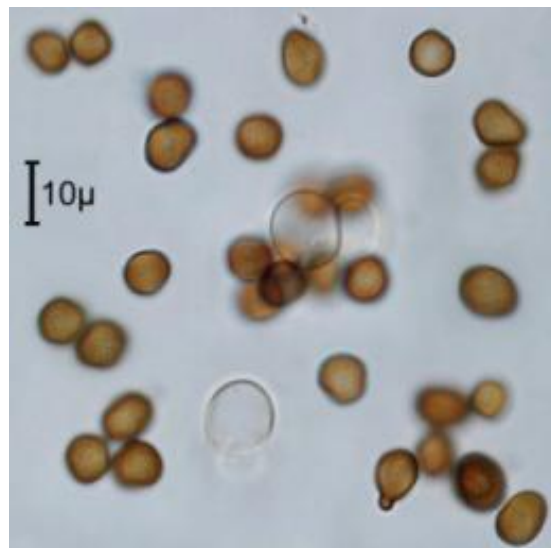


Fig.23 – *Sporisorium cruentum* on *Sorghum halepense* (9563)

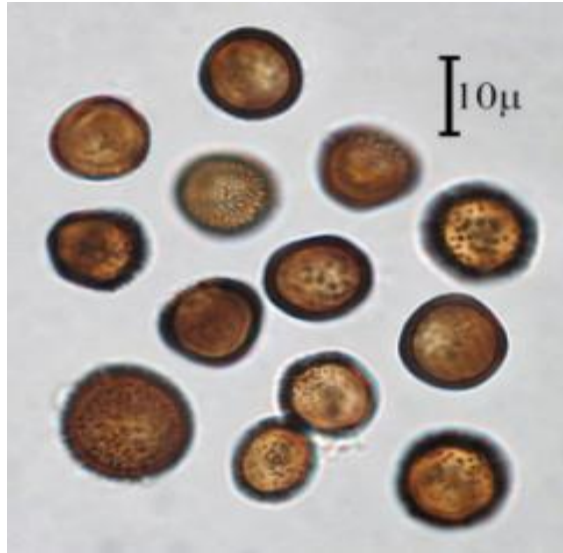


Fig.24 – *Sporisorium desertorum* on *Lasiurus indicus* (11288)

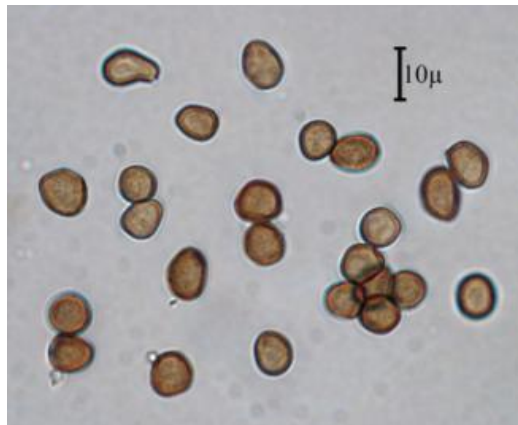


Fig.25 – *Sporisorium destruens* on *Panicum miliaceum* (10320)

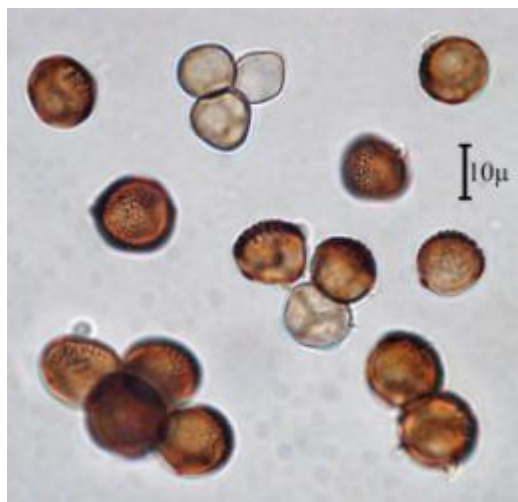


Fig.26 – *Sporisorium ehrenbergii* on *Sorghum bicolor* (10322)

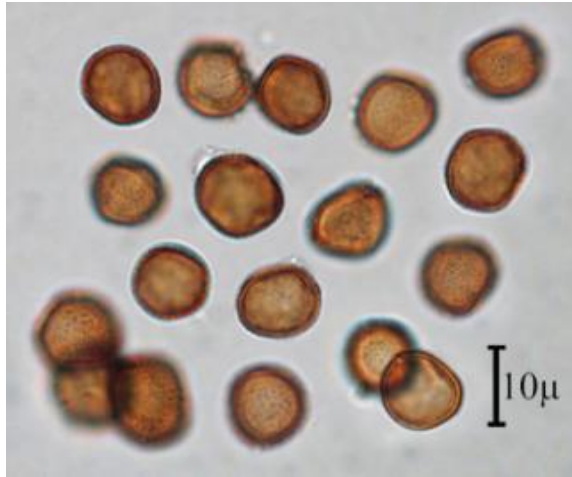


Fig.27 – *Sporisorium foveolati* on *Dichanthium foveolatum* (4425)

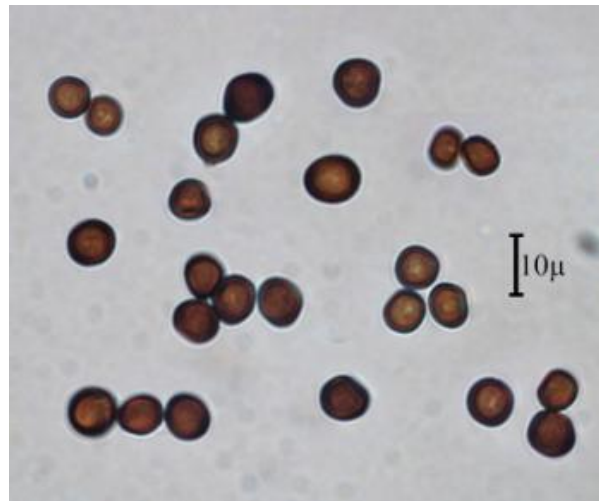


Fig.28 – *Sporisorium lanigeri* on *Cymbopogon olivieri* (12399)

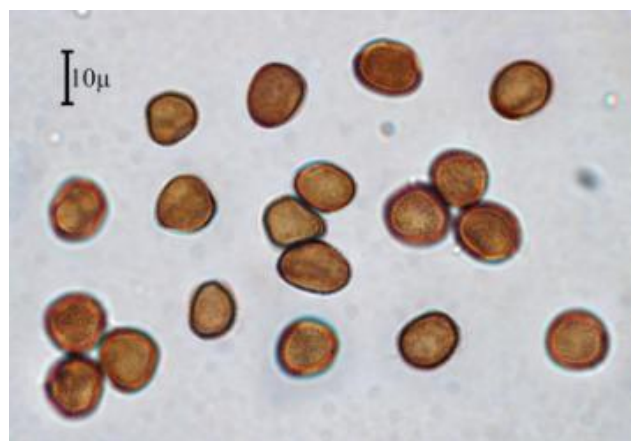


Fig.29 – *Sporisorium penniseti* on *Pennisetum orientale* (4419)

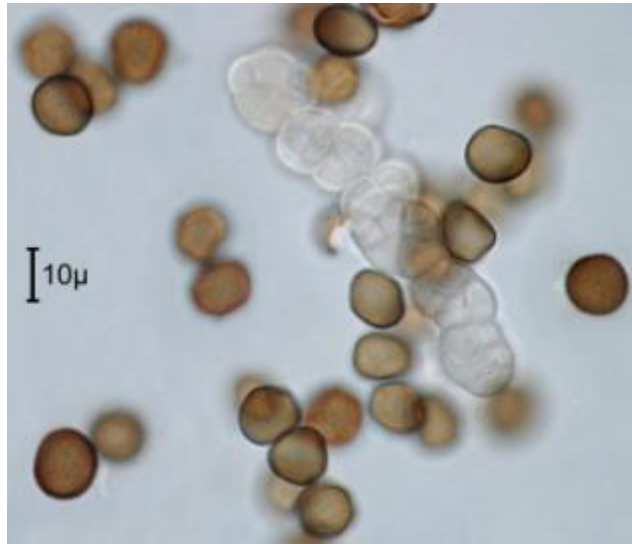


Fig.30 – *Sporisorium reilianum* on *Sorghum halepense* (13283)



Fig.31 – *Sporisorium schweinfurthianum* on *Imperata cylindrical* (14217)

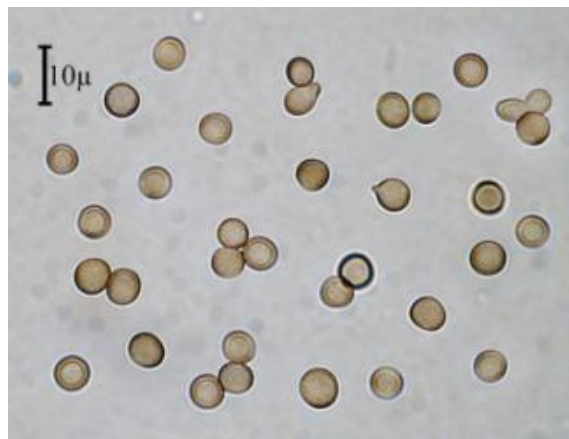


Fig.32 – *Sporisorium sorghi* on *Sorghum bicolor* (10321)

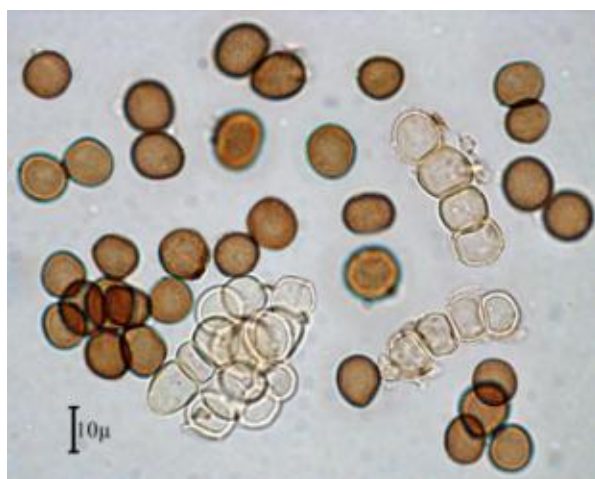


Fig.33 – *Sporisorium tricholaenae* on *Tricholaena teneriffae* (9249)

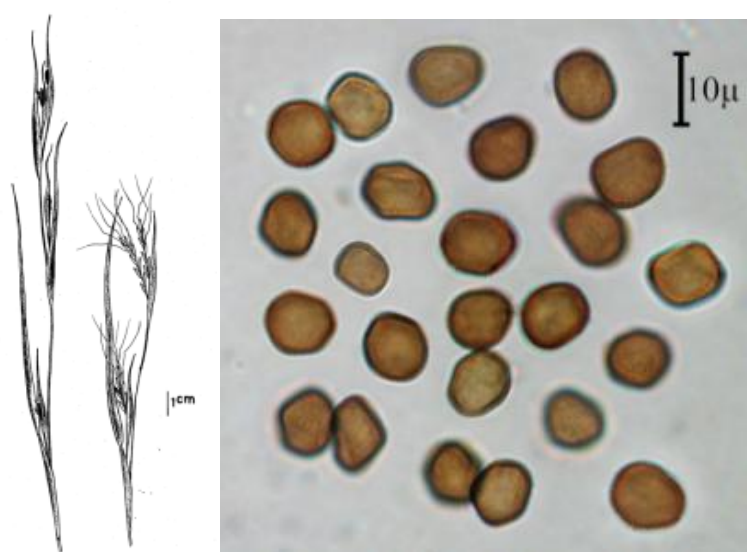


Fig.34 – *Sporisorium vanderystii* on infected plant (14783) (left) and teliospores (14783) (right)

***Tilletia* Tul. & C. Tul.**

Key to the *Tilletia* species based on host plant taxonomy

- 1. On *Aegilops*2
- Not on *Aegilops*3
- 2. Host plants more or less dwarfed; muri 1.5–3 μm high *T. contraversa*
- Host plants not dwarfed; muri 0.5–1.5 μm high.....*T. caries*
- 3. On *Critesion**T. hordei*
- Not on *Critesion*4
- 4. On *Elymus* *T. contraversa*
- Not on *Elymus*5
- 5. On *Hordeum* *T. contraversa*
- Not on *Hordeum*6
- 6. On *Lolium**T. lolii*
- Not on *Lolium*.....7

7. On <i>Lolium</i>	<i>T. lolii</i>
- Not on <i>Lolium</i>	8
8. On <i>Psathyrostachys</i>	<i>T. hordei</i>
- Not on <i>Psathyrostachys</i>	9
9. On <i>Rostraria</i>	<i>T. rostrariae</i>
- Not on <i>Rostraria</i>	10
10. On <i>Taeniatherum</i>	<i>T. bornmuelleri</i>
- Not on <i>Taeniatherum</i>	11
11. On <i>Triticum</i> ; spores smooth	<i>T. laevis</i>
- On <i>Triticum</i> Spores ornamented.....	12
12. Spores provided with blunt warts	<i>T. indica</i>
- Spores reticulate	13
13. Host plants more or less dwarfed; muri 1.5–3 µm high	<i>T. contraversa</i>
- Host plants not dwarfed; muri 0.5–1.5 µm high.....	<i>T. caries</i>

45. *Tilletia bornmuelleri* Magnus, Bull. Herb. Boissier 3: 574, 1903.

Sori in ovaries, swollen, ovoid to elongate, partly hidden by the glumes, initially greenish, later dark brown containing the indurate to semi-powdery, coppery brown mass of spores. *Spores* globose, ovoid to slightly subpolyhedrally irregular, 18–24 × 19–26 µm, light to medium reddish brown; wall reticulate, 6–9 meshes per spore diam., reticulum often incomplete to cerebriform, muri 1.5–2 µm high, 27–36 on the spore circumference. *Sterile cells* globose to ellipsoidal, smaller than the spores (13–20 µm long), subhyaline to pale yellow, contents finely granular; wall 1–2 µm thick, smooth (Fig. 35).

On *Poaceae*: *Taeniatherum asperum* (Simonk.) Nevski, Tehran Prov., Karaj-Calus road, Dizin road, near Velayat road, road side, IRAN 10907 F.

46. *Tilletia caries* (DC.) Tul. & C. Tul., Ann. Sci. Nat. Bot., Sér. 3, 7: 113, 1847.

Uredo caries DC. 1815.

Lycoperdon tritici Bjerck. 1775 (nom. nud.). – *Tilletia tritici* (Bjerck.) Wolff 1874. – *Tilletia tritici* (Bjerck.) Winter, in Rabenh. 1881 (comb. superfl.).

Uredo sitophila Ditmar, in Sturm 1816. – *Caeoma sitophilum* (Ditmar) Link 1825. – *Tilletia sitophila* (Ditmar) J. Schröt., in Cohn 1877.

Sori filling the ovaries with a reddish brown to dark brown, semi-agglutinated to pulverulent, foetid spore mass. *Spores* globose to subglobose, (14–)16–20(–25) µm in diam., pale yellow to reddish brown; wall reticulate, 5–8 meshes per spore diam., 2.5–6 µm wide, muri 0.5–1.5 µm high, 19–28 on the spore circumference. *Sterile cells* globose to subglobose, 10–18 µm in diam., hyaline to subhyaline, smooth, thin-walled (0.5–1.5 µm). *Spore germination* results in aseptate basidium on which 8–16, elongate basidiospores are produced apically. These fuse to produce dikaryotic hyphae which may directly infect host seedling coleoptiles or produce further ballistospores (secondary sporidia) (Fig. 36).

On *Poaceae*: *Aegilops triuncialis* (L.) Á. Löve, Ardabil Prov., Khalkhal city, Zinab village, IRAN 9848 F; East Azarbaijan Prov., Marand city; West Azarbaijan Prov., Orumieh-Salmas road, IRAN 8211 F.

On *Triticum aestivum* L., Esfahan Prov.; Khorasan Prov.; Lorestan Prov.; Zanzan Prov.; Ardebil Prov., Ardebil city, IRAN 8588 F; Ilam Prov., Dare-shahr (Abbas-abad) city, IRAN 10297 F; Tehran Prov., Damavand city, Ahmadabad village, IRAN 11587 F; Khuzestan Prov.; East Azarbaijan Prov., Maragheh city; Hamedan Prov.; Gilan Prov.

On *Triticum* sp., Khuzestan Prov., Ahvaz; Tehran Prov., Karaj.

Tilletia caries x *contraversa* (*T. intermedia* Gassner) on *Triticum aestivum*, Kohgiluyeh va Buirahmad Prov., Kordlaghari village, IRAN 7287 F.

Remarks – Hybridisation of *Tilletia* species on wheat is not uncommon. This is most evident in case of a hybrid between the smooth-spored *T. levis* with the reticulate-spored *T. caries*, described also as a separate species: *Tilletia triticoides* T. Săvulescu.

47. *Tilletia contraversa* J.G. Kühn, in Rabenh., Fgi. eur. no. 1896, 1874; Hedwigia 13: 188, 1874. *Uredo segetum* Pers. f. *tritici-repentis* DC., in Poiret 1808 (nom. nud.). – *Tilletia tritici-repentis* (DC.) Liro 1938 (comb. illegit.).

Tilletia calospora Pass. 1876.

Tilletia pancicii Bubák & Ranoj., in Bubák 1909.

Tilletia contraversa var. *elymi* Zaprom. 1926.

Tilletia elymicola Lavrov 1937.

Tilletia tritici [subsp.] *nanifica* F. Wagner 1950 (nom. inval.). – *Tilletia nanifica* (F. Wagner) Săvul. 1956 (comb. illegit.).

Tilletia contraversa Kühn var. *prostrata* Lavrov 1937. – *Tilletia prostrata* (Lavrov) Lavrov 1951.

Tilletia aegilopsidis Golovin 1952.

Tilletia brevifaciens G.W. Fisch. 1952.

Sori in swollen ovaries filled with semi-agglutinated to powdery, dark reddish to blackish brown, foetid spore mass. Infection systemic, usually dwarfing the host ("dwarf bunt"). *Spores* globose to subglobose, 17–21 × 18–23 µm, yellowish to reddish brown; wall deeply reticulate, (4–)5–6(–7) meshes per spore diam., areolae polygonal, usually rather large, regular (occasionally some spores have irregular to cerebriform ornamentation), 3–5 µm wide, muri 1.5–3 µm high, 15–21 on the spore circumference; a hyaline, gelatinous sheath present. *Sterile cells* globose or subglobose, 9–22 µm in diam., hyaline, smooth. *Spore germination* of typical *Tilletia*-type, at optimum of 3–8 C°, stimulated by light (Fig. 37).

On *Poaceae*: *Aegilops triuncialis* (L.) Á. Löve, Ardebil Prov., Khalkal city.

On *Critesion bulbosum* (L.) Á. Löve (*Hordeum bulbosum* L.). Reported by Esfandiari (1948) from unknown locality.

On *Elymus hispidus* (Opiz) Melderis (*Agropyron intermedium* (Host) P. Beauv.), Tehran Prov., Damavand; Zanzan Prov.

On *Elymus hispidus* subsp. *barbulatus* (Schur) Melderis (*Agropyron intermedium* subsp. *trichophorum* (Link) Asch. & Graebner; *A. trichophorum* (Link) K. Richt.). Mentioned by Durán & Fischer (1961:50) without locality.

On *Hordeum vulgare* L., Ghom Prov.; Tehran Prov., Tehran.

On *Triticum aestivum* L., Chaharmahal va Bakhtiari Prov.; Esfahan Prov., Faridan city; Esfahan Prov., Fereidunshahr city; Hamadan Prov., Hamadan; Kordistan Prov., IRAN 6702 F; Lorestan Prov.; Markazi Prov., Sarband area; Zanzan Prov.; Golestan Prov., Kalpoush plain, IRAN 10263 F; West Azarbaijan Prov., Oroumieh city, Heydarlou village, IRAN 8348 F.

48. *Tilletia hordei* Körn., Hedwigia 16: 30, 1877a.

Tilletia trabutii Jacz. 1893.

Tilletia hordeina Ranoj. 1914.

Sori in swollen ovaries filled with semi-agglutinated to powdery, dark reddish brown, foetid spore mass. Infection systemic, usually dwarfing the host. *Spores* globose, subglobose to broadly ellipsoidal, 19–22.5 × 19–23 µm, yellowish brown; wall deeply reticulate, (3–)4–5(–6) meshes per spore diam., areolae polygonal, usually rather large, regular (occasionally some spores have irregular to cerebriform ornamentation), 3–5 µm wide, muri 1.5–2 µm high, subacute to acute spiniform, 16–24 on the spore circumference, a hyaline, gelatinous sheath present. *Sterile cells*

globose to ellipsoidal, smaller than the spores, 9–16 × 10–16 µm, subhyaline; wall 1–3 µm thick, smooth (Fig. 38).

On *Poaceae*: *Critesion marinum* (Huds.) Á. Löve (*Hordeum marinum* Huds.; *H. maritimum* Stokes), Tehran Prov., Karaj-Chalus road, Kalha village, IRAN 10990 F.

On *Critesion murinum* (L.) Á. Löve subsp. *glaucum* (Steud.) W.A. Weber (*Hordeum murinum* subsp. *glaucum* (Steud.) Tzvelev; *H. glaucum* Steud.), West Azarbaijan Prov., Oshnavieh city, Khoroshow valley, IRAN 8086 F; Golestan Prov., Gorgan city, 6 km S of Moraveh tappeh village, IRAN 7261 F; Golestan Prov., Gonbad city, IRAN 4402 F.

On *Critesion murinum* subsp. *leporinum* (Link) Á. Löve (*Hordeum murinum* subsp. *leporinum* (Link) Arcangeli; *H. leporinum* Link), Golestan Prov., Gonabad city; Golestan Prov., Gorgan city.

Psathyrostachys fragilis (Boiss.) Nevski (*Hordeum fragile* Boiss.), Kordestan Prov., Pir Omar Kudrun Mt.

Remarks. Pascoe *et al.* (2005) used molecular phylogenetic and morphological criteria to show that the smut on *Critesion* in Australia is not the same as *Tilletia contraversa*. In Vánky (2011'2012':976) the correct name of *T. trabutii* Jacz. 1893 is *T. hordei* Körn.

The lectotype of *T. hordei* is on *Hordeum* (design. by Lindeberg 1959:70) *fragile* Boiss. (= *Psathyrostachys fragilis* (Boiss.) Nevski), Persia (= Iran), Mt. Pir Omar Gudrun [at present in Iraq, 30 km NW of Sulaymaniyah, c. 35°46' N, 45°14' E], alt. c. 1500 m, leg. H.K. Haussknecht, isolectotype HUV 7229!

49. *Tilletia indica* Mitra, Ann. Appl. Biol. 18: 178, 1931.

Neovossia indica (Mitra) Mundk. 1940.

Sori in some, often only partly destroyed seeds of a spike, concealed by the glumes. Spore mass blackish brown, powdery, held together by the pericarp. *Spores* globose, subglobose, ovoid to ellipsoidal, 28–40(–45) × 28–47 µm, yellowish to dark reddish brown, provided with 1.5–6 µm high, irregular, blunt warts, 9–17 per spore diam., often 2–4 warts are confluent into irregular groups, 32–52 on the spore circumference. Spores produced at the tip of sporogenous hyphae, their remnants on the spores appear sometimes as a hyaline papilla or a narrow appendage. *Sterile cells* globose, ellipsoidal, sometimes lacrymiform or irregular, variable in size, 8–28 × 10–40 µm, from subhyaline to pale yellowish brown; wall 1.5–4.5 µm thick, homogeneous or multilayered, smooth. Intermediate cells common. *Spore germination* results in holobasidia apically producing numerous, filiform basidiospores on which secondary sporidia are produced. These germinate developing infection hyphae which penetrate through the stomata producing local, floral infection (Fig. 39).

On *Poaceae*: *Triticum aestivum* L., Bushehr Prov., Bushehr; Kerman Prov., Jiroft city; Sistan va –Baluchestan Prov., Bam-poor city towards Iranshahr city, IRAN 9539 F; Fars Prov., Lar city, IRAN 9454 F; Fars Prov., IRAN 10266 F.

Remarks. Known as partial or Karnal bunt of wheat.

50. *Tilletia laevis* J.G. Kühn, in Rabenh. Fgi. eur. no. 1697, 1873; Hedwigia 12: 152, 1873.

Erysibe foetida Wallr. 1833 (nom. nov. illegit. pro *Caeoma sitophilum* (Ditmar) Link, et pro *Uredo caries* DC., i.e., *Tilletia caries*). – *Tilletia foetida* (Wallr.) Liro 1920 (comb. illegit.).

Ustilago foetens Berk. & M.A. Curtis, in Berk. 1874. – *Tilletia foetens* (Berk. & M.A. Curtis) J. Schröt., in Cohn 1877.

Sori in ovaries. Spore mass powdery, olive-brown, foetid. *Spores* globose, ovoid to irregular, 14–17 × 16–24 µm, pale yellowish to olive-brown, contents granular, guttulate or vacuolate; wall 1–1.5 µm thick, smooth, often with a short papilla or mycelial fragment. *Sterile cells* sparse to abundant, hyaline, globose to irregular, 11–18 µm in diam.; wall smooth, thin (0.5–1.2 µm). *Spore germination* of *Tilletia*-type. Spores attach to the grains at harvest, and then germinate in moist soil. Compatible basidiospores fuse and the resulting dikaryotic hyphae infect coleoptiles of seedlings (Fig. 40).

On *Poaceae*: *Triticum aestivum* L. (*Triticum vulgare* Vill.). Common in Iran.

51. *Tilletia lolii* Auersw. ex G. Winter, Rabenh. Krypt.-Fl., 2 Aufl., 1(1): 109, 1881.

Tilletia lolii Auersw., in Rabenh. 1855 (nom. nud.); 1855 (nom. nud.).

Sori in all ovaries of an inflorescence, covered by the pericarp, appearing between the glumes as light to dark brown bodies, 2–4 mm in diam. Spore mass light cinnamon brown to dark brown, semi-agglutinated to pulverulent, foetid. Infection systemic at seedling stage. *Spores* globose to subglobose, less frequently ovoid, 17.5–22 × 17.5–24 µm, pale yellow to pale yellowish brown; wall reticulate, rarely incompletely, (5–)6–8 meshes per spore diam., muri 1.5–3 µm high, spiniform with acute or subacute tip, 25–31 on the spore circumference, sheath absent. *Sterile cells* globose to ovoid, 13–19 µm long, pale yellow, contents granular; wall 1–2 µm thick, smooth. *Spore germination* results in holobasidia with a dichotomous apex on which 8–12, cylindrical, conjugating basidiospores are produced that develop ballistospores (Fig. 41).

On *Poaceae*: *Lolium rigidum* Gaudin, Golestan Prov., Gorgan city, 17 km S of Moraveh tappeh village, IRAN 7257 F; Gilan Prov., N. shore of Lake White River dam, IRAN 7258 F.

52. *Tilletia lolii* Vánky, Carris, Castl. & H. Scholz, in Vánky, Mycotaxon 91: 254, 2005.

Sori in all ovaries of an infected plant, visible between the spreading floral envelopes as ovoid or ellipsoidal, blackish brown bodies, 0.5–0.8 × 1–1.5 mm, initially covered by the thin pericarp which ruptures irregularly at maturity exposing the blackish brown, powdery mass of spores and sterile cells. *Spores* globose, subglobose to ellipsoidal, 20–24 × 21–27 µm, yellowish to chestnut brown, reticulate, meshes polyangular, variable in size and form, 6–10 per spore diam., muri 1–1.5 µm high, in optical median view acute, subacute or blunt, 30–39 on the spore circumference, embedded in a thin, hyaline, gelatinous layer. *Sterile cells* subglobose, ellipsoidal, ovoid or irregular, 9.5–15 × 12–18 µm, hyaline; wall 0.5–1 µm thick, smooth (Fig. 42).

On *Poaceae*: *Lolium subulatum* (Banks & Sol.) Eig (*Nardurus subulatus* (Banks & Sol.) Bor), Tehran Prov., Karaj city, Dashte Mt., IRAN 10548 F; Gilan Prov., c. 85 km S of Rasht city, East end of lake White River dam, 10 km NW of Lushan city, IRAN 7259 F.

Remarks. *Tilletia lolii* differs from *T. bromi* especially in having darker spores, more meshes per spore diam., lower and more muri on the spore circumference.

53. *Tilletia rostrariae* Vánky & Ershad, Rostaniha 3: 20, 2002.

Sori in all ovaries of an inflorescence, ovoid, with a short, acute tip, 0.5–0.8 × 1–1.5 mm, hidden by the floral envelopes and covered by a thin, dark brown peridium (pericarp) which ruptures at maturity exposing the blackish brown, powdery mass of spores mixed with sterile cells. *Spores* globose, subglobose to rarely broadly ellipsoidal, (23–)24–28 × 24–28(–29.5) µm, pale to dark smoky brown; wall 2.5–4 µm thick, completely, rarely incompletely reticulate, very rarely cerebriform, (7–)8–13(–14) meshes per spore diam., muri (0.8–)1–2.5 µm high, 27–37 on the spore circumference. *Sterile cells* globose, ovoid, ellipsoidal to slightly irregular, 14–17 × 15–21 µm, hyaline, contents homogeneous; wall c. 1.5 µm thick, smooth. Intermediate cells variable in size, colour and ornamentation, 16–36 µm long, from subhyaline to pale smoky brown, from almost smooth, finely verrucose to reticulate or often cerebriform; wall 1–5 µm thick (Fig. 43).

On *Poaceae*: *Rostraria cristata* (L.) Tzvelev (*Lophochloa phleoides* (Vill.) Rchb.), Golestan Prov., Gorgan city, 6 km S of Maraveh-tappeh village, HUV 14898, IRAN 7260 F.

***Tracya* Syd. & P. Syd.**

54. *Tracya hydrocharidis* Lagerh. in Vestergren, Bot. Not. 1902: 175, 1902 (as '*hydrocharitis*').

Doassansia reukaufii Henn. 1904.

Sori in leaves and petioles as whitish pale yellow to pale brown, rounded spots with indistinct margins, from a few mm to several cm in diam., sometimes coalescing to cover whole leaves, with

scattered or gregarious spore balls in the host tissue initially as white, later brown, minute, hypophyllous dots. *Spore balls* globose, ovoid to slightly irregular, 130–260 μm long, composed of numerous, firmly united spores arranged in a single layer on the surface, and a central network of filaments connected with the spores. *Spores* radially elongate, more or less prismatic, 13–16 μm long, yellowish brown, in surface view spores irregularly polygonal, (5.5–)7–10(–12) μm in diam, contents finely granular; wall finely and moderately densely verruculose on the free, outer surface, on contact surfaces smooth, 0.8–1 μm thick, thickest at the base (up to 2.5 μm). *Central network* composed of pale brown, branched, septate, 1.2–1.5 μm thick, hardened hyphae. *Spore germination* of *Tilletia*-type. *Anamorph* (*Savulescuella hydrocharidis* Cif.) reported but probably refers to basidiospores of in situ germinated spores.

On Hydrocharitaceae: *Hydrocharis morsus-ranae* L., Gilan Prov., Bandar-Anzali port, Anzali lagoon, HUV 14901, IRAN 7262 F.

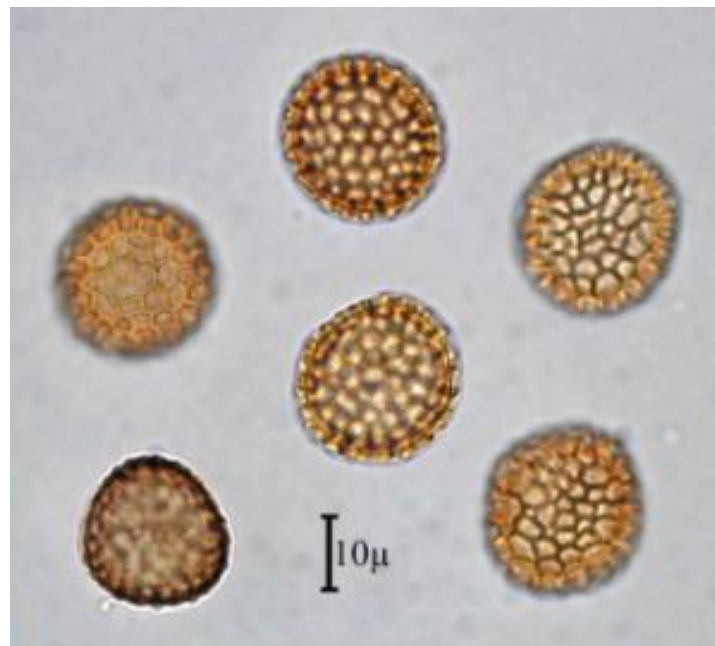


Fig.35 – *Tilletia bornmuelleri* on *Taeniatherum asperum* (10907)

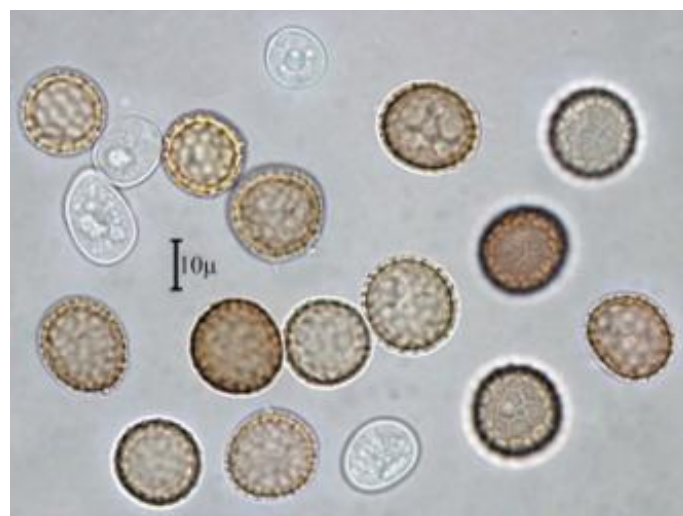


Fig.36 – *Tilletia caries* on *Triticum aestivum* (10297)

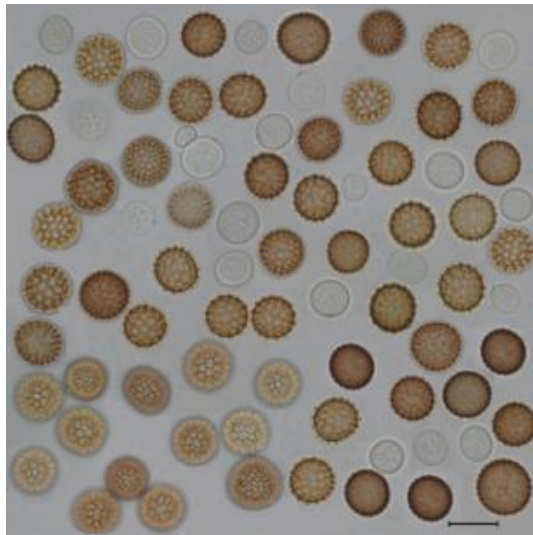


Fig.37 – *Tilletia contraversa* on *Triticum aestivum* (8348), Bar=20 μ m.



Fig.38 – *Tilletia hordei* on *Critesion murinum* subsp. *glaucum* (4402)

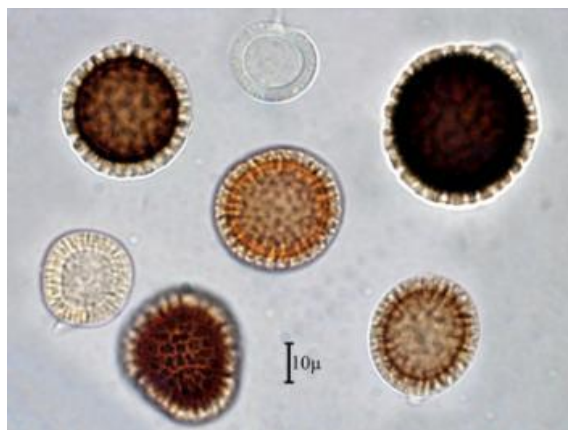


Fig.39 – *Tilletia indica* on *Triticum aestivum* (10266)

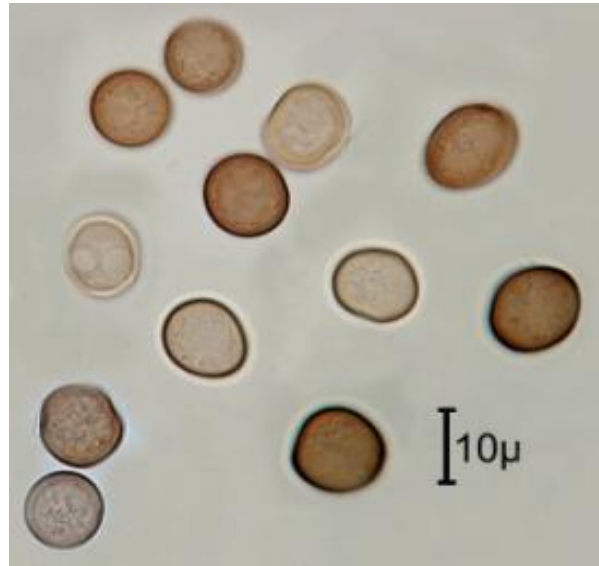


Fig.40 – *Tilletia laevis* on *Triticum aestivum* (7221)

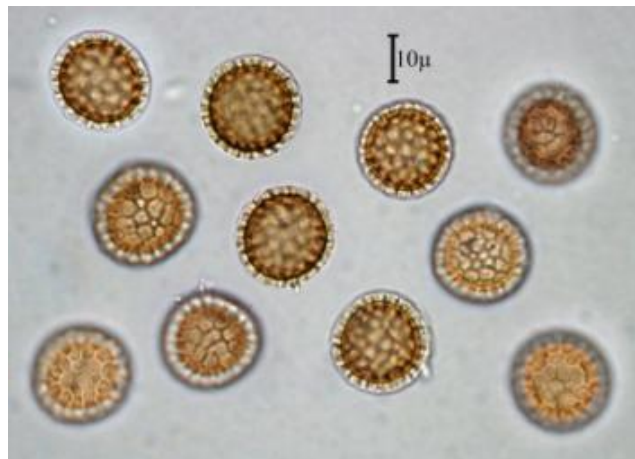


Fig.41 – *Tilletia lolii* on *Lolium rigidum* (7257)

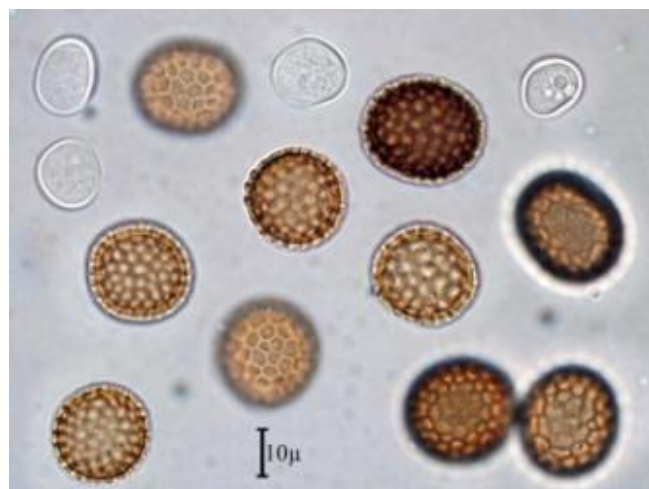


Fig.42 – *Tilletia lolioi* on *Lolium subulatum* (10548)

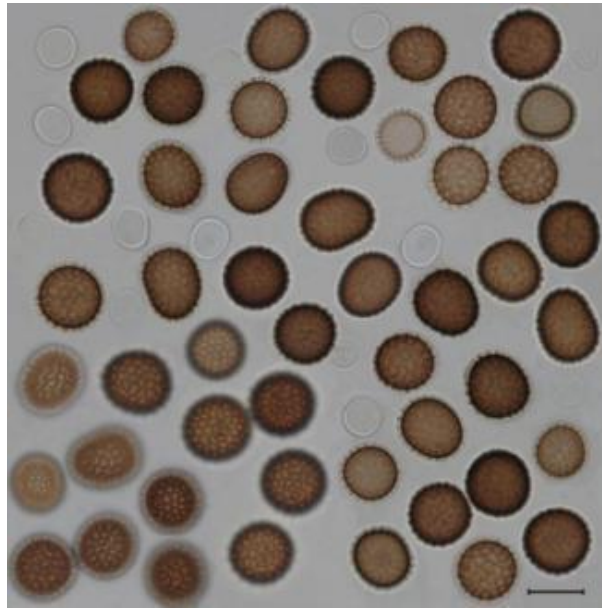


Fig.43 – *Tilletia rostrariae* on *Rostraria cristata* (7260), Bar=20µm

***Tranzscheliella* Lavrov**

Key to the *Tranzscheliella* species

1. Spores in LM with 2, large, bipolar appendages, in SEM operculate *T. williamsii*
- Spores not so.....2
2. Sori in culms surrounding the upper internodes; spores 4–6(–7) µm long; wall c. 0.5 µm thick, smooth *T. hypodytes*
- Sori destroying the entire inflorescence; spores 5–8 µm long; wall 0.5–1.5 µm thick, from apparently smooth to finely, densely verrucose *T. iranica*

55. *Tranzscheliella hypodytes* (Schltdl.) Vánky & McKenzie, *Smut Fungi of New Zealand*: 156, 2002, **s. lat.**

Caeoma hypodytes Schltdl. 1824. – *Ustilago hypodytes* (Schltdl.) Fries 1832. – *Erysibe hypodytes* (Schltdl.) Wallr. 1833. – *Uredo hypodytes* (Schltdl.) Desm. 1840. – *Cintractia hypodytes* (Schltdl.) Maire 1906.

Ustilago hypodytes var. *lolii* Thüm. 1874.

Ustilago sporoboli Ellis & Everh. 1897 (later homonym; not *U. sporoboli* Tracy & Earle 1896). –

Ustilago funalis Ellis & Everh. 1897 (nom. nov.).

Ustilago nummularia Speg. 1902.

Ustilago stipicola Speg. 1902.

Ustilago dactylidis Maire 1917.

Ustilago athenae Maire 1917.

Ustilago agrestis Syd. 1924. – *Ustilago spegazzinii* Hirschh. var. *agrestis* (Syd.) G.W. Fisch. & Hirschh. 1945.

Ustilago bromi-erecti Cif. 1931.

Ustilago sumnevicziana Lavrov 1936.

Ustilago spegazzinii Hirschh. 1939a.

Ustilago custanaica Lavrov 1951.

Ustilago hypodytes f. *sporoboli* Zambett. 1980 '1979' (nom. inval.).

Sori in culms as a blackish brown, semi-agglutinated to powdery spore mass surrounding the upper internodes (extending from the basal part of the internode sometimes to the next node) and occasionally in the axis of an abortive inflorescence. *Sori* initially protected by the leaf sheath, finally more or less naked, peridium absent. Upper internodes and leaves of host usually stunted. Infection systemic, inflorescence usually abortive. *Spores* globose, subglobose to ovoid, occasionally elongate, irregular or slightly flattened, $3.5\text{--}5.5 \times 4\text{--}6(-7) \mu\text{m}$, medium to dark olive-brown; wall c. $0.5 \mu\text{m}$ thick, smooth, usually with a small, inconspicuous, hyaline, smooth or finely punctate-verruculose cap at the poles, in SEM densely, minutely, uniformly verruculose on the entire surface. *Spore germination* results in slender, septate (three- or 4-celled, four-nucleate) basidia developing lateral, ramifying, septate, uninucleate branches producing, on nutrient media, clumps of aerial sporidia. Rarely ovoid basidiospores are produced on sterigmata, at the septa of the basidia (Fig. 44).

On *Poaceae*: *Elymus hispidus* (Opiz) Melderis (*Agropyron intermedium* (Host) P. Beauv.), Ardebil Prov., between Sarab and Ardebil city.

On *Elymus hispidus* subsp. *barbulatus* (Schur) Melderis (*Agropyron trichophorum* K. Richt.; *A. intermedium* (Host) P. Beauv.), Golestan Prov., Golestan National Park, Almeh, IRAN 8128 F.

On *Elymus repens* (L.) Gould (*Agropyron repens* (L.) P. Beauv.), Tehran Prov., Karaj city, IRAN 7299 F; West Azarbaijan Prov., Oshnavieh city, IRAN 8069 F.

On *Elymus* sp., Tehran Prov., Central Alborz, Azadbar village, IRAN 10500 F.

On *Stipa parviflora* Desf., Hormozgan Prov., Anveprody Mt., at Bastak city; Kerman Prov., Mahan city, IRAN 8292 F.

56. *Tranzscheliella iranica* (Syd.) Vánky, Mycotaxon 106: 137; 2008.

Ustilago iranica Syd. 1939.

Sori destroying the entire inflorescence, partly enclosed by the uppermost leaf sheaths, up to 7 cm long, with black or blackish brown, powdery spore mass, peridium absent. *Spores* subglobose, broadly ellipsoidal or rounded subpolyhedrally slightly irregular, $4\text{--}7 \times 5\text{--}8 \mu\text{m}$, yellowish- to olive-brown; wall $0.5\text{--}1.5 \mu\text{m}$ thick, from apparently smooth to finely, densely verrucose, spore profile smooth to finely wavy, no polar caps, in SEM with rounded, low warts fusing into irregular groups or short, irregular rows (Fig. 45).

On *Poaceae*: *Stipa tenerrima* Bornm. & Gauba, Alborz Mountains, Nemar Mt., 3.VI.1937, leg. D.E. Gauba 1233.

On *Stipa* sp., Yazd Prov., Dehe bala village, IRAN 14697 F.

Remarks – *Tranzscheliella iranica* is still "endemic" for Iran, known from only two localities.

57. *Tranzscheliella williamsii* (Griffiths) Dingley & Versluys, New Zealand J. Bot. 15: 477, 1977.

Sorosporium williamsii Griffiths 1902. – *Ustilago williamsii* (Griffiths) Lavrov 1936. – *Ustilago williamsii* (Griffiths) G.W. Fisch. & Hirschh. 1945 (comb. superfl.).

Ustilago appendiculata Speg. 1909. – *Tranzscheliella appendiculata* (Speg.) Lavrov 1936.

Tranzscheliella otophora Lavrov 1936. – *Ustilago otophora* (Lavrov) Gutner 1941.

Sori surrounding upper internodes and aborted inflorescence axes, initially protected by leaf sheaths, later naked, blackish brown, powdery, lacking a peridium. Infection systemic, infected plants usually not flowering. *Spores* globose to subglobose, $6\text{--}8 \times 7\text{--}10 \mu\text{m}$, olive-brown, exospore often deeply cracked, bearing two, hyaline, winged or cup-like, $1\text{--}2.5 \mu\text{m}$ thick, bipolar appendages, in SEM typically operculate. *Spore germination* results in 4-celled, often branched basidium producing elongate basidiospores (Fig. 46).

On *Poaceae*: *Stipa hohenackeriana* Trin. & Rupr., Esfahan Prov., 40–45 km S of Esfahan city, Kolah-Ghazi National Park, IRAN 8317 F.

On *Stipa pulcherrima* K. Koch, Golestan Prov., Gorgan city, Golestan National Park, IRAN 8298 F.

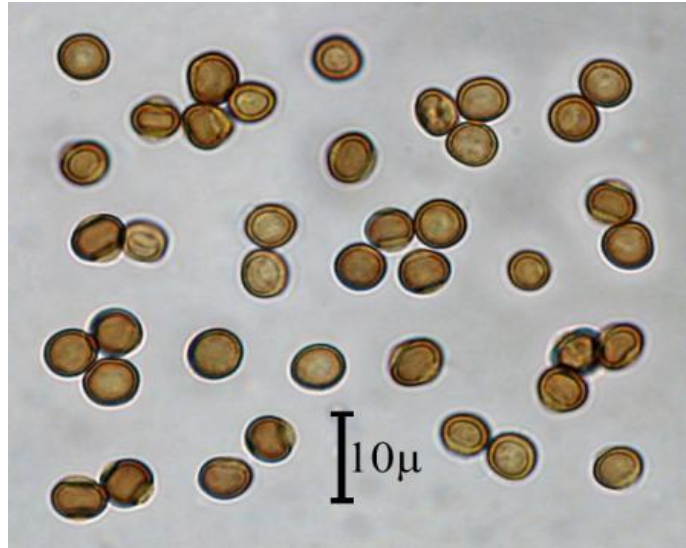


Fig.44 – *Tranzscheliella hypodytes* on *Elymus* sp. (10500)

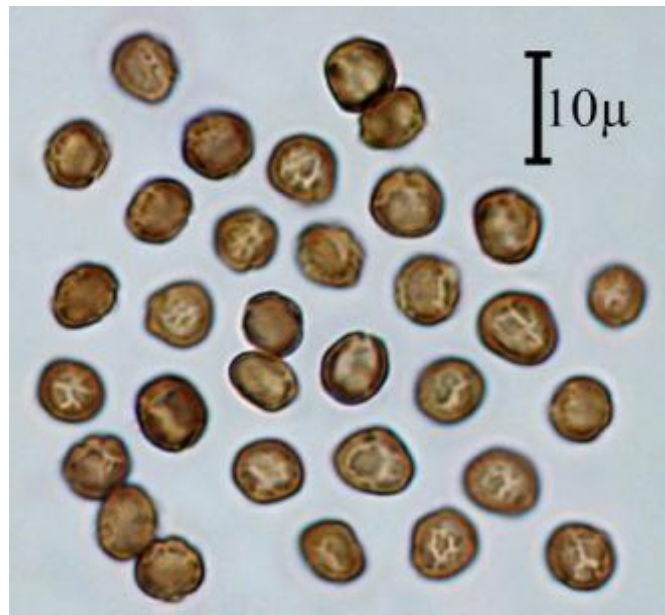


Fig.45 – *Tranzscheliella iranica* on *Stipa* sp. (14697)

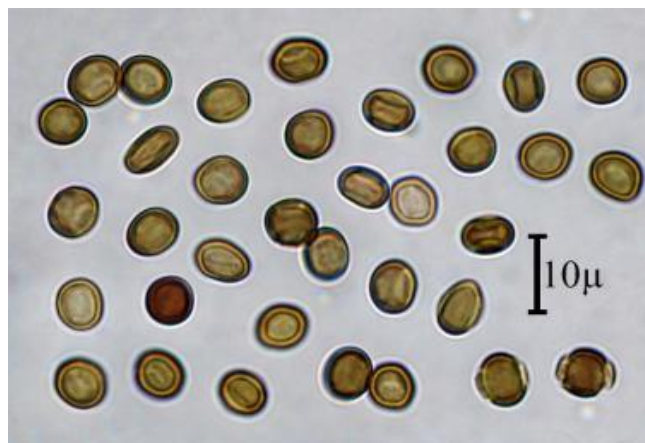


Fig.46 – *Tranzscheliella williamsii* on *Stipa hohenackeriana* (8317)

Urocystis Rabenh. ex Fuckel

Key to the *Urocystis* species based on host plant taxonomy

- | | | |
|-----|--|---------------------------|
| 1. | On <i>Alliaceae</i> (<i>Allium</i>)..... | <i>Ur. magica</i> |
| - | Not on <i>Alliaceae</i> | 2 |
| 2. | On <i>Amaryllidaceae</i> (<i>Ixiolirion</i>) | <i>Ur. ixiolirii</i> |
| - | Not on <i>Amaryllidaceae</i> | 3 |
| 3. | On <i>Colchicaceae</i> (<i>Colchicum</i>)..... | <i>Ur. colchici</i> |
| - | Not on <i>Colchicaceae</i> | 4 |
| 4. | On <i>Cyperaceae</i> (<i>Carex</i>)..... | <i>Ur. fischeri</i> |
| - | Not on <i>Cyperaceae</i> | 5 |
| 5. | On <i>Hyacinthaceae</i> | 6 |
| - | Not on <i>Hyacinthaceae</i> | 7 |
| 6. | On <i>Muscari</i> | <i>Ur. muscaridis</i> |
| - | On <i>Ornithogalum</i> | <i>Ur. ornithogali</i> |
| 7. | On <i>Iridaceae</i> (<i>Gladiolus</i>)..... | <i>Ur. gladiolicola</i> |
| - | Not on <i>Iridaceae</i> | 8 |
| 8. | On <i>Orobanchaceae</i> (<i>Orobanche</i>) | <i>Ur. orobanches</i> |
| - | Not on <i>Orobanchaceae</i> | 9 |
| 9. | On <i>Poaceae</i> | 10 |
| - | Not on <i>Poaceae</i> | 16 |
| 10. | On <i>Agropyron</i> | <i>Ur. agropyri</i> |
| - | Not on <i>Agropyron</i> | 11 |
| 11. | On <i>Arrhenatherum</i> | <i>Ur. behboudii</i> |
| - | Not on <i>Arrhenatherum</i> | 12 |
| 12. | On <i>Critesion</i> | <i>Ur. tianschanica</i> |
| - | Not on <i>Critesion</i> | 13 |
| 13. | On <i>Lolium</i> | <i>Ur. bolivarii</i> |
| - | Not on <i>Lolium</i> | 14 |
| 14. | On <i>Phalaris</i> | <i>Ur. phalaridis</i> |
| - | Not on <i>Phalaris</i> | 15 |
| 15. | On <i>Stipa</i> | <i>Ur. corsica</i> |
| - | On <i>Triticum</i> | <i>Ur. tritici</i> |
| 16. | On <i>Primulaceae</i> (<i>Primula</i>) | <i>Ur. primulae</i> |
| - | Not on <i>Primulaceae</i> | 17 |
| 17. | On <i>Ranunculaceae</i> | 18 |
| - | Not on <i>Ranunculaceae</i> | 21 |
| 18. | On <i>Ceratocephalus</i> | <i>Ur. ceratocephali</i> |
| - | Not on <i>Ceratocephalus</i> | 19 |
| 19. | On <i>Ranunculus</i> | 20 |
| - | On <i>Thalictrum</i> | <i>Ur. sorosporioides</i> |
| 20. | Spore balls surrounded by a continuous or discontinuous layer of sterile cells ... | <i>Ur. ficariae</i> |
| - | Sterile cells few or lacking | <i>Ur. ranunculi</i> |
| 21. | On <i>Scrophulariaceae</i> (<i>Pedicularis</i>)..... | <i>Ur. pedicularis</i> |
| - | On <i>Violaceae</i> (<i>Viola</i>) | 22 |
| 22. | Sori in flowers and ovaries; spore balls composed of 1–8(–9) spores | <i>Ur. kmetiana</i> |
| - | Sori on petioles and leaves; spore balls composed of (1–)3–20 or more spores | <i>Ur. violae</i> |

58. *Urocystis agropyri* (Preuss) A.A. Fisch. Waldh., Bull. Soc. Imp. Naturalistes Moscou 40: 258, 1867.

Uredo agropyri Preuss, in Sturm 1848. – *Polycystis agropyri* (Preuss) J. Schröt., in Cohn 1877. – *Tuburcinia agropyri* (Preuss) Liro 1922.

Urocystis preussii J.G. Kühn, in Rabenh. 1874.

Tuburcinia elymi Cif. 1931. – *Urocystis elymi* (Cif.) Schwarzman 1960.

Tuburcinia agropyri-juncei Vienn.-Bourg. 1954 '1953' (nom. inval.). – *Urocystis agropyri-juncei* (Vienn.-Bourg.) H. Zogg 1986 '1985' (comb. illegit.).

Sori in leaves, sheaths and culms, often also in the rachis of the aborted inflorescence, as short to long streaks parallel to the veins, initially lead-coloured and covered by the epidermis which soon ruptures to expose the dark brown, dusty spore mass. *Spore balls* globose to elongate, 16–32 µm long, composed of 1–3(–4) spores and a completely or almost completely investing layer of sterile cells. *Spores* globose, subglobose or ovoid, sometimes with flattened sides, 9.5–15 × 12–17.5 µm, reddish brown, smooth. *Sterile cells* hyaline to yellowish, 4–12 µm long; wall thin, c. 1 µm, collapsing with age giving a ridged appearance to the spore ball surface, in SEM very finely punctate-verruculose. *Spore germination* results in aseptate basidia, usually with four, apical, cylindrical basidiospores that fuse in pairs to form dikaryotic hyphae.

On *Poaceae*: *Agropyron intermedium* (Host) P. Beauv., Zanjan Prov.

59. *Urocystis behboudii* (Esfand.) Vánky, Symb. Bot. Upsal. 24(2): 154, 1985a.

Tuburcinia behboudii Esfand., in Esfand. & Petrak 1950.

Sori in leaves forming striae between the veins, initially covered by the epidermis which ruptures longitudinally exposing the black, semi-agglutinated to powdery mass of spore balls. *Spore balls* subglobose, ovoid, ellipsoidal to slightly irregular, 20–32(–36) × 21–40(–48) µm, composed of 1–4(–5) spores and a completely investing layer of sterile cells. *Spores* globose, ellipsoidal, elongate or irregular, 13–17 × 14.5–21.5 µm, reddish brown. *Sterile cells* subglobose, ellipsoidal or irregular, 6–13 µm long, yellowish brown; wall uneven, 0.5–1 µm thick, smooth.

On *Poaceae*: *Arrhenatherum kotschyi* Boiss., Kermanshah Prov., Ghalachjeh Mt., Ghalachjeh pass, GZU (holotype), HUV 14807, IRAN 4398 F.

60. *Urocystis bolivarii* Bubák & Gonz. Frag., in Bubák, Bol. Soc. Españ. Hist. Nat. 22: 205. 1922. (as '*bolivari*').

Tuburcinia bolivarii (Bubák & Gonz. Frag.) Gonz. Frag., in Cif. 1933 (as '*bolivari*'). – *Tuburcinia bolivarii* (Bubák & Gonz. Frag.) Uljan., in Lavrov 1938 (comb. superfl.). – *Tuburcinia occulta* [var.] *bolivarii* (Bubák & Gonz. Frag.) Cif. 1963 (as '*bolivari*'; comb. illegit.).

Tuburcinia lolii Kawecka-Starmachowa 1939.

Sori in leaves, sheaths, culms and inflorescence as long streaks between the veins, initially lead-coloured, covered by the epidermis which soon ruptures exposing the blackish brown, powdery mass of spore balls. *Spore balls* globose, ovoid to irregular, 16–44 µm in diam., composed of 1–6 spores almost completely invested by sterile cells. *Spores* globose, ovoid, sometimes irregular, 10.5–16 × 13–18.5 µm, pale brown, smooth. *Sterile cells* globose to irregular, 5–12 µm, yellowish brown (Fig. 47).

On *Poaceae*: *Lolium loliaceum* (Bory & Chaub.) Hand.-Mazz., Golestan Prov., Gorgan city, Golestan National Park, Abshar area, IRAN 8324 F.

On *Lolium rigidum* Gaudin, Ardebil Prov., Moghan city, between Ultan village & Ghara-aghaj village, IRAN 8592 F; Golestan Prov., Gorgan city, 150 km W. Bojnourd city, 34 km SW of Maraveh tappeh village, IRAN 7269 F; Ardebil Prov., Moghan city, between Germi village & Parsabad village, IRAN 8591 F.

On *Lolium* sp., Sistan va –Baluchestan Prov., Saravan city, Suran village, IRAN 10339 F.

61. *Urocystis ceratocephali* Zambett. ex Vánky, Mycotaxon 33: 370, 1988b.

Tuburcinia ceratocephali Zambett. 1971 (nom. inval.).

Sori on the stems forming fusiform swellings up to 1 cm long, covered by a greyish silvery membrane which ruptures longitudinally exposing the black, granular-dusty mass of spore balls.

Spore balls subglobose, elongate or rounded irregular, 16–35 × 20–45 µm, composed of 1–7 spores surrounded by an incomplete layer of, sometimes only a few, sterile cells. *Spores* subglobose to ellipsoidal, often flattened on contact sides, 11–15 × 14–20 µm, dark reddish brown, smooth. *Sterile cells* subglobose, elongate to pyriform and irregularly flattened, 5–12(–14) µm long, pale yellowish brown, smooth (Fig. 48).

On *Ranunculaceae*: *Ceratocephalus falcatus* (L.) Pers., Esfahan Prov., on the way between Shahreza and Semirom cities, IRAN 7238 F.

62. *Urocystis colchici* (Schltdl.) Rabenh., Fgi. eur. no. 396, 1861.

Caecoma colchici Schltdl. 1826. – *Uredo colchici* (Schltdl.) Endl. 1830. – *Sporisorium colchici* (Schltdl.) Libert, 1832. – *Polycystis colchici* (Schltdl.) Lév. 1847. – *Polycystis colchici* (Schltdl.) F. Strauss, in Sturm 1853 (comb. superfl.). – *Tuburcinia colchici* (Schltdl.) Liro 1922.

Erysibe arillata Wallr. var. *colchici* Wallr. 1833.

Urocystis colchici-lutei Zundel 1944.

Sori in leaves and petioles as slightly elevated, pustular, elongate areas of various size and shape, often confluent, visible on both sides of the leaf, initially lead-coloured and covered by the epidermis which ruptures exposing the powdery, black mass of spore balls. Infection systemic. *Spore balls* globose, subglobose, ovoid to irregular, (16–)20–40 µm in diam., composed of 1–3(–4) spores and a more or less complete investing layer of sterile cells. *Spores* globose, subglobose, ovoid, irregularly oblong or subpolyhedral, 9–14.5(–15) × (11–)12–20(–23) µm, medium reddish brown, smooth. *Sterile cells* subglobose, ovoid to irregular, 5–10 × 6–15 µm, pale yellow, with smooth, 1–2 µm thick wall, collapsed in old specimens (Fig. 49).

On *Colchicaceae* (*Liliaceae* s. lat.): *Colchicum persicum* Baker, Golestan Prov., Jahannama protected region, IRAN 8329 F.

On *Colchicum procurrens* Baker, Tehran Prov., Karaj city.

On *Colchicum* sp., Khorasan Prov., 10 km E of Bojnourd city, Baba-Aman area. IRAN 7268 F; Tehran Prov., Lavasan city, at Latian dam, IRAN 8215 F; Kordestan Prov., Dalahu Mt., Rijab city, IRAN 8327 F; Mazandaran Prov., IRAN 7128 F; Tehran Prov., Tehran city, Central Albroz, Darabad area, IRAN 8032 F.

63. *Urocystis corsica* (Mayor & Terrier) Vánky, Publ. Herb. Univ. Uppsala 9: 12, 1982.

Sorosporium corsicum Mayor & Terrier 1959. – *Tuburcinia corsica* (Mayor & Terrier) Guyot & Massenot, in Guyot, Malençon & Massenot 1969.

Sori in congested uppermost leaves and in more or less aborted inflorescence as long, dark lead-coloured striae between the leaf veins, often covering the entire leaf surface, initially protected by a delicate, silvery membrane which ruptures exposing the black, powdery mass of spore balls. *Spore balls* globose, ellipsoidal to elongate ovoid, 30–50 × 35–65(–75) µm, dark chestnut brown, opaque, composed of (3–)6–15(–20?) spores surrounded by a continuous layer of sterile cells. *Spores* subglobose, ellipsoidal, elongate or slightly irregular by mutual pressure, 10–14 × 12–16(–20) µm, dark reddish brown, smooth. *Sterile cells* variable in shape and size, (5–)7–20 µm long, thick-walled (1.5–3 µm), thickest at their basal and lateral parts (Fig. 50).

On *Poaceae*: *Stipa capensis* Thunb. (*S. tortilis* Desf.), Gilan Prov., N. shore of White River dam, IRAN 7239 F; Bushehr Prov., Dashtestan County, Borazjan city, IRAN 8296 F.

64. *Urocystis ficariae* (Liro) Moesz, Budapest és környékének gombái: 137, 1942.

Caecoma ficariae "Schltdl." sensu Unger 1833 (non sensu orig., q.e. *Uromyces ficariae* Lév.). – *Tuburcinia ficariae* "(Unger)" Liro 1922. – *Urocystis ficariae* "(Unger)" Zundel 1953. – *Urocystis ficariae* "(Unger)" D.M. Hend. 1955 (comb. superfl.).

Sori in leaves and petioles as pustular swellings, initially covered by the epidermis which soon ruptures revealing the black, powdery mass of spore balls. *Spore balls* globose to ovoid or irregular, 20–32 × 24–40(–44) µm, composed of 1–3(–4) central spores and a discontinuous to continuous layer of peripheral sterile cells. *Spores* globose to ovoid, dark reddish brown, 11–17.5 × 13–20 µm;

wall even, c. 0.8 μm thick, smooth. *Sterile cells* globose, hemiglobose to elongate or irregular, pale yellowish brown, 5–11 \times 5.5–15 μm , smooth (Fig. 51).

On *Ranunculaceae*: *Ranunculus ficaria* L. (*Ficaria ranunculoides* Roth), Tehran Prov., Haraz road, Emamzadeh Hashem shrine, IRAN 7236 F; Golestan Prov., 37 km SW of Gorgan city; Kordkuy city, Deraznu forest, IRAN 7237 F; Esfahan Prov., 140 km NW of Esfahan city, Khonsar city; Golestan Mt., IRAN 7266 F; Mazandaran Prov., Chalus road, Siahisheh village, IRAN 10478 F; Chaharmahal va-Bakhtiari Prov., Chelgerd city, Kuhrang Dam, IRAN 8209 F.

65. *Urocystis fischeri* Körn. ex G. Winter, Rabenh. Krypt.-Fl., 2 Aufl. 1(1): 120, 1881.

Urocystis fischeri Körn. 1877b (nom. nud.). – *Tuburcinia fischeri* (Körn. ex G. Winter) Liro 1922.

Urocystis caricis Ule 1884.

Tuburcinia rigida Liro 1939. – *Urocystis rigida* (Liro) Zundel 1953.

Sori in leaves, rarely in culms as short to long, inflated streaks between the veins, sometimes confluent, initially lead-coloured, covered by the epidermis which ruptures longitudinally to expose the powdery, dark brown mass of spore balls. *Spore balls* globose, ovoid to irregular, 20–40 μm , composed of 1–3(–4) spores completely invested by a layer of sterile cells. *Spores* globose to elongate or slightly irregular, polyhedral, 11–16 \times 14.5–19 μm , light to dark reddish brown, smooth. *Sterile cells* globose, hemiglobose, elongate to irregular, 5–15 μm in diam., pale yellowish brown, smooth (Fig. 52).

On *Cyperaceae*: *Carex* sp., Tehran Prov., Karaj-Chalus road, Jei & Charan bifurcation, bogs at the Gholgholak spring, IRAN 10908 F.

66. *Urocystis gladiolicola* Ainsw., Trans. Brit. Mycol. Soc. 32: 257, 1949.

Tuburcinia gladiolicola (Ainsw.) Cif. 1963 (non *Uredo gladioli* Req.).

Sori in leaves, scapes and scales of the bulb as greyish brown, blister-like, 1 mm to several cm long striae between the veins, initially covered by the epidermis which ruptures exposing the dark brown, powdery mass of spore balls. Infection systemic; mycelium hibernating in the corms. *Spore balls* globose, ovoid, occasionally elongate, 16–23 \times 18–30(–35) μm , each composed of 1–2(–3) spores, completely invested by an irregular layer of sterile cells. *Spores* globose, ovoid to slightly angular, 12–15 \times 12–18 μm , reddish brown. *Sterile cells* pale yellowish brown, 6–12 μm in diam., collapsing with age (Fig. 53).

On *Iridaceae*: *Gladiolus segetum* Ker Gawl., Kohgiluyeh va-Buyerahmad Prov., Dehdasht city, Tol-Chogha area, IRAN 8008 F.

67. *Urocystis ixiolirii* Zaprom., Materialy po mikoflore Srednei Azii 2: 23, 1928.

Tuburcinia ixiolirii (Zaprom.) Lavrov 1937.

Sori in leaves as pustules, 1–2 \times 6–10 mm, initially covered by a greyish membrane of host tissue which ruptures at maturity exposing the semi-powdery, dark brown mass of spore balls. *Spore balls* globose, ellipsoidal to slightly irregular, 22–35 \times 25–50 μm , composed of 1–2(–3) spores, completely surrounded by sterile cells. *Spores* globose, ovoid, ellipsoidal to slightly irregular with flattened sides, 12–16 \times 15–20 μm , reddish brown; wall evenly thick, c. 0.5 μm , smooth. *Sterile cells* irregular, 5–12 μm long, yellow, collapsed in old specimens; wall unevenly thick, 1–2 μm , smooth (Fig. 54).

On *Amaryllidaceae*: *Ixiolirion pallasii* Fisch. & C.A. Mey. ex Ledeb. (*I. tataricum* Roem. & Schult.; *I. montanum* (Lab.) Herb.), Kerman Prov., Khan-Sorkh Pass, IRAN 4396 F; Sistan va-Baluchestan Prov., Chah-Bahar port, IRAN 4397 F; Sistan va-Baluchestan, Khash city, Tamandan village, IRAN 10424 F.

On *Ixiolirion* sp., Kerman Prov., Kerman city.

68. *Urocystis kmetiana* Magnus, Verh. Bot. Vereins Prov. Brandenburg 31: 19, 1890.

Tuburcinia kmetiana (Magnus) Liro 1922.

Sori in flowers and ovaries which are destroyed although the calyces usually remain intact, occasionally also producing distortion in the stems, 3–5 mm in diam. Spore mass powdery, black. *Spore balls* globose to ovoid, 28–36 × 28–44(–52) µm, composed of 1–8(–9) central spores and a complete investing layer of peripheral sterile cells. *Spores* subglobose, ovoid to slightly polyhedral, (9.5–)10.5–13 × 11–20 µm, reddish brown; wall smooth, c. 0.8 µm thick. *Sterile cells* globose, ovoid to irregular, 5.5–14.5 µm in diam., yellowish brown, smooth, collapsing with age (Fig. 55).

On *Violaceae*: *Viola occulta* Lehm., Tehran Prov., Karaj-Chalus road, 20 km NE of Karaj city, near "Amir-Kabir" dam, IRAN 7235 F; Quazin Prov., 50 km NW of Qazvin city, IRAN 7234 F.

On *Viola tricolor* L., Kermanshah Prov., Tange Chovar, IRAN 6561 F.

69. *Urocystis magica* Pass., in Thüm., Mycoth. univ. no. 223, 1875, s. lat.

Tuburcinia magica (Pass.) Liro 1922.

Urocystis cepulae Frost, in Farlow 1877. – *Tuburcinia cepulae* (Frost) Liro 1922.

Urocystis colchici (Schltdl.) Rabenh. f. *allii-subhirsuti* Beltrani, in Thümen 1878.

Urocystis allii Schellenb. 1911. – *Tuburcinia allii* (Schellenb.) Liro 1922.

Tuburcinia oblonga Massenot 1953. – *Urocystis oblonga* (Massenot) H. Zogg 1986.

Sori in leaves and bulbs as pustules, often confluent, 1 mm to several cm long, initially covered by the epidermis which ruptures to expose the dusty, blackish brown mass of spore balls. *Spore balls* globose to ovoid, composed of 1–2 central spores and a discontinuous to continuous layer of peripheral sterile cells. *Spores* globose, subglobose, ovoid to slightly irregular, 10.5–13.5 × 13–16(–19) µm, medium to dark reddish brown. *Sterile cells* globose, ovoid to irregular, 5–10 µm in diam., pale yellowish brown. In SEM spores and sterile cells sparsely to moderately densely, very finely verruculose. *Spore germination* results in a hemispherical or shortly cylindrical, aseptate basidium from which 4–8, septate, ramified hyphae arise (Fig. 56).

On *Alliaceae* (*Liliaceae* s. lat.): *Allium akaka* Gmel. ex Roem. & Schult, reported by Khabiri (1958), without mentioning locality.

On *Allium cepa* L., East Azarbaijan Prov., Tabriz, IRAN 4391 F.

70. *Urocystis muscaridis* (Niessl) Moesz, A Kárpát-medence üszöggombái: 199, 1950.

Polycystis colchici (Schltdl.) Lév. var. *muscaridis* Niessl 1861. – *Tuburcinia muscaridis* (Niessl)

Liro 1922. – *Urocystis muscaridis* (Niessl) Zundel 1953 (comb. superfl.).

Urocystis colchici (Schltdl.) G. Winter f. *muscari* Bizz. 1885.

Urocystis colchici "Strauss" f. *muscari-comosi* Thüm. 1874 (nom. nud).

Sori in leaves as ellipsoidal, 2–10 mm long pustules, covered by the lead-coloured epidermis, until it ruptures longitudinally and the black, powdery mass of spore balls becomes scattered. *Spore balls* globose, ovoid to irregular, 20–40 × 20–48 µm, composed of 1–5(–9) spores surrounded by a continuous layer of sterile cells. *Spores* globose, ovoid to irregular, often slightly polyhedral, 10.5–16 × 14–22.5(–24) µm, dark reddish brown. *Sterile cells* variable in shape and size, globose, ovoid to irregular, 4–12 × 6–20 µm, yellowish brown, smooth (Fig. 57).

On *Hyacinthaceae* (*Liliaceae* s. lat.): *Muscari* sp., Khuzestan Prov., Baghmalek city, IRAN 11799 F.

71. *Urocystis ornithogali* Körn. ex A.A. Fisch. Waldh., Ann. Sci. Nat. Bot. 4: 240, 1877a1876';
Aperçu Syst. Ustil.: 41, 1877b.

Tuburcinia ornithogali (Körn.) Liro 1922. – *Tuburcinia ornithogali* (Körn.) S. Ito 1935 (comb. superfl.).

Urocystis hypogaea Körn., in Fuckel 1876 (nom. nud.). – *Tuburcinia hypogaea* (Körn.) S. Ito, in Ito & Homma 1938 (comb. illegit.).

Sori in leaves and stalks as ovoid, small to large pustules and swellings, initially lead-coloured and covered by the epidermis which ruptures and the powdery, black mass of spore balls becomes scattered. *Spore balls* globose, subglobose to ovoid, 20–32 × 23–44 µm, composed of 1–3(–4) central spores and a completely investing layer of sterile cells. *Spores* globose, subglobose to ovoid,

sometimes with a flattened side, 11–17 × 14.5–20 µm, dark reddish brown. *Sterile cells* globose, ovoid to irregular, 5–13 µm in diam., with thick (1–2 µm), smooth, yellow or yellowish brown wall, collapsing with age (Fig. 58).

On *Hyacinthaceae* (Liliaceae s. lat.): *Ornithogalum kurdicum* Bornm., Lorestan Prov., Khorramabad city, Hashtad-Pahlou Mt., IRAN 11658 F.

72. *Urocystis orobanches* (Mérat) A.A. Fisch. Waldh., *Aperçu Syst. Ustil.*: 42, 1877.

Rhizoctonia orobanches Mérat 1821. – *Tubercinia orobanches* (Mérat) Fr. 1832. – *Ustilago orobanches* (Mérat) Lév. 1846. – *Polycystis orobanches* (Mérat) Lév. 1847. – *Thecaphora orobanches* (Mérat) Lév. in d'Orbigny 1849. – *Schinzia orobanches* (Mérat) Cocc., in Cif. 1938.

Sori in roots and underground stem, swollen, filled with a blackish brown, powdery mass of spore balls. *Spore balls* globose, ellipsoidal to rounded irregular, 20–30 × 24–40 µm, composed of 1–2(–3) spores completely surrounded by one, or in places two layers of sterile cells. *Spores* globose to ovoid, 9–14 × 11–18 µm, dark reddish brown, smooth. *Sterile cells* subglobose, ovoid to irregularly elongate, 4–8 × 5–13 µm, pale brown, smooth.

On *Orobanchaceae*: *Orobanche ramosa* L.

Reported by Magnus (1893) on *Orobanche (Phelipaea)* sp., Bushehr Prov., Bushehr city.

73. *Urocystis pedicularis* (Golovin) Vánky, *Mycotaxon* 99: 48, 2007.

Sorosporium pedicularis Golovin, in Gutner 1941 (nom. inval.). – *Sorosporium pedicularis* Golovin 1950.

Sori in all capsules of an inflorescence, swollen, deformed, filled with blackish brown, granular-powdery mass of spore balls. *Spore balls* subglobose, ovoid, ellipsoidal, elongate to irregular, 25–75 × 35–90 µm, reddish brown, composed of a few to tens of spores that separate under pressure. *Spores* variable in shape and size, subglobose, ovoid, ellipsoidal, elongate, irregular, subcuneiform, 8–14.5 × 10.5–22 µm, reddish brown; wall even, 0.5–1 µm thick, apparently smooth, in SEM very finely, low verruculose. *Sterile cells* lacking (Fig. 59).

On *Scrophulariaceae*: *Pedicularis sibthorpii* Boiss., Mazandaran Prov., Haraz road, Nava village, IRAN 8312 F.

Remarks – Typical for *Urocystis pedicularis* is the lack of sterile cells around the spores.

74. *Urocystis phalaridis* Vánky, in Vánky & Abbasi, *Rostaniha* 12(2):189, 2012b.

Sori on leaves as long striae between the veins, at first lead coloured, covered by the epidermis which ruptures longitudinally disclosing the dark reddish brown, powdery mass of spore balls. *Spore balls* subglobose, irregular to elongated, 20–40 × 25–50 µm, composed of 1–7(–9) spores and a completely investing layer of sterile cells. *Spores* subglobose, ovoid, ellipsoidal, elongated or subpolyhedrally irregular, with one or several flattened sides, 9–15 × 11–19 µm, reddish brown. *Sterile cells* subglobose, ellipsoidal, elongated or irregular, 6.5–14 µm long, yellow; wall uneven, 0.5–2.5 µm thick, thinner on the free surface, thick on the contact sides, in SEM finely verruculose (Fig. 60).

On *Poaceae*: *Phalaris* sp. Golestan Prov., Gorgan, 1.I.1993, leg. Sh. Daemi, holotypus HUV 21977, isotypus IRAN 10352 F. Known only from the type locality.

75. *Urocystis primulae* (Rostr.) Vánky, *Symb. Bot. Upsal.* 24(2): 176, 1985a.

Sorosporium primulae Rostr. in A.A. Fisch. Waldh. 1879a. – *Tubercinia primulae* (Rostr.) Liro 1922. – *Ginanniella primulae* (Rostr.) Cif. 1938.

Sori in ovaries; when the seed pods open at their tops, the black, powdery mass of spore balls becomes scattered. *Spore balls* globose, ovoid to elongate, 32–60 × 40–88 µm, composed of (1–)3–15 (or more) spores completely invested by a layer, sometimes in places two layers, of sterile cells which often collapse upon drying and resemble an enveloping membrane around the spores. *Spores* globose, subglobose, ovoid to elongate or irregular, somewhat angular, 11–16(–20) × 12–21 µm, medium to dark reddish brown; wall c. 0.8 µm thick, smooth. *Sterile cells* variable in shape, size,

colour and wall thickness; globose, subglobose, ovoid, elongate, pyriform to irregular, 5.5–14.5 × 8–17.5 µm, yellow to pale reddish brown; wall 1–3 µm thick, smooth. Spore formation preceded by a farinose, white *anamorph* in the flowers (*Paepalopsis irmischiae* J.G. Kühn).

On *Primulaceae*: *Primula veris* subsp. *macrocalyx* (Bunge) Lüdi (*Primula macrocalyx* Bunge), Tehran Prov., Chalous road, 55 km NE of Karaj city.

76. *Urocystis ranunculi* (Lib.) Moesz, A Kárpát-medence Üszöggombái: 213, 1950.

Sporisorium ranunculi Lib. 1832. – *Tuburcinia ranunculi* (Lib.) Liro 1922.

Tuburcinia ranunculi-muricati Vienn.-Bourg. 1968.

Sori in leaves, petioles and stems, as conspicuous pustules of various shape and size, initially covered by the host epidermis which soon ruptures exposing the black, powdery mass of spore balls; later the leaves often become perforated. *Spore balls* globose to elongate or irregular, 12–28 × 14–36(–44) µm, composed of (0–)1–3(–5) spores and a few peripheral sterile cells or sterile cells may be lacking. *Spores* variable in shape and size, globose, ovoid, elongate or irregular, 10.5–15 × 12–22.5 µm, light to dark reddish brown, contents finely granular; wall c. 1 µm thick, smooth. *Sterile cells* globose, ovoid to irregular, 6.5–10.5(–11) × 7–14.5(–16) µm, pale yellowish brown; wall 1–1.5 µm thick, smooth.

On *Ranunculaceae*: *Ranunculus muricatus* L., Gilan Prov., Anzali port.

77. *Urocystis sorosporioides* Körn. ex A.A. Fisch. Waldh., Aperçu Syst. Ustil.: 41, 1877b; Ann. Sci. Nat. Bot., Sér. 6, 4: 241, 1877a '1876'.

Urocystis sorosporioides Körn. in Fuckel 1876 (nom. nud.). – *Tuburcinia sorosporioides* (Körn. ex Fuckel) Liro 1922.

Sori as blister-like swellings, usually on the abaxial side of the leaves, or on the petioles and stems, initially lead-coloured and covered by the epidermis which ruptures to expose the black, powdery mass of spore balls. *Spore balls* globose, ovoid, elongate and irregular, 20–40 × 23–52(–60) µm, dark reddish brown, composed of 1–10(–12) spores and a completely or almost completely investing layer of peripheral sterile cells. *Spores* globose, ovoid to elongate or subpolyhedral, irregular, 11–15(–17) × 12–21 µm, dark reddish or olive-brown, smooth. *Sterile cells* variable in shape and size, 5–13 µm long, yellowish brown; wall smooth, collapsing with age (Fig. 61).

On *Ranunculaceae*: *Thalictrum foetidum* L., Mazenderan Prov., Chalous road, IRAN 7126 F.

On *Thalictrum sultanabadense* Stapf, Khorasan Prov., c. 40 km NE of Mashhad city, IRAN 7267 F.

78. *Urocystis tianschanica* Golovin, Sredneaz. Gosud. Univ., N.S., Vyp. 14, Biol. Nauk, Kniga 5: 12, 1950.

Sori in leaves forming long striae, initially lead-coloured, covered by the epidermis which ruptures longitudinally disclosing the blackish brown, granular powdery mass of spore balls. *Spore balls* globose, ovoid, ellipsoidal, elongate or irregular, 16–36 × 20–40(–44) µm, yellowish brown, composed of 1–4(–5) spores completely surrounded by sterile cells. *Spores* subglobose, ovoid, ellipsoidal or irregular, with one or two flattened sides, 9.5–14.5 × 12.5–19 µm, yellowish brown; wall even, c. 0.8 µm thick. *Sterile cells* subglobose, ellipsoidal or irregular, 5–13 µm long, yellow; wall 1–1.5 µm thick, smooth (Fig. 62).

On *Poaceae*: *Critesion violaceum* (Boiss. & Hohen.) Á. Löve (*Hordeum violaceum* Boiss. & Hohen.), Tehran Prov., Alafchin, S slope of Damavand Mountain, 13.VI.1991, M. Abbasi, IRAN 8335 F, HUV 21988.

79. *Urocystis tritici* Körn., Hedwigia 16: 33, 1877.

Tuburcinia tritici (Körn.) Liro 1922.

Tuburcinia hispanica Syd. 1924. – *Urocystis hispanica* (Syd.) Zundel 1953.

Sori in leaves, sheaths and stems as long striae, initially lead-coloured, covered by the epidermis which ruptures longitudinally to expose the powdery, blackish brown mass of spore balls. Badly

infected plants do not head. *Spore balls* subglobose, ellipsoidal to irregular, 16–30 × 20–40 μm, composed of 1–3(–5) spores completely surrounded by sterile cells. *Spores* globose, ovoid, elongate or slightly irregular, 10–15 × 12–18(–22) μm, yellowish to reddish brown, smooth. *Sterile cells* subglobose to ovoid, 5–8 × 6–13 μm, pale yellowish brown; wall c. 1 μm thick, smooth. *Spore germination* results in holobasidia apically producing (1–)2–4(–6) cylindrical basidiospores measuring 3–5 × 12–30 μm. Basidiospores germinate giving rise to slender infection hyphae and/or secondary sporidia (Fig. 63).

On *Poaceae*: *Triticum aestivum* L. and *Triticum* sp. Common in Iran.

80. *Urocystis violae* (Sowerby) A.A. Fisch. Waldh., Bull. Soc. Nat. Moscow 40: 258, 1867.

Granularia violae Sowerby 1809. – *Polycystis violae* (Sowerby) Berk. & Broome 1850. – *Tuburcinia violae* (Sowerby) Liro 1922.

Uredo (*Caecoma*) *vesicaria* J.S. Kaulf., in Kunze & J.C. Schmidt 1817. – *Erysibe arillata* Wallr. var. *violarum* Wallr. 1833 (nom. nov. illegit. pro *Uredo vesicaria*). – *Polycystis vesicaria* (J.S. Kaulf.) Mont. 1856. – *Urocystis vesicaria* (J.S. Kaulf.) Brockm. 1863.

Sori usually in the petioles as fusiform swellings up to several cm long, often causing distortions, but also in stems, rootstocks, leaf veins or, infrequently, on the leaf blades as irregular, multilocular, blister-like swellings, rather persistently covered by the host tissues, which ruptures exposing the blackish brown, powdery spore mass. *Spore balls* globose, ovoid to elongate, irregular, 20–55 × 20–75 μm, reddish brown, composed of (1–)3–20 or more spores surrounded by a complete layer of sterile cells. *Spores* globose, ovoid, elongate, usually subpolyhedral, irregular, 9–15 × 11–20 μm, medium reddish brown, smooth. *Sterile cells* variable in shape and size, 7–16 μm long, yellow, smooth, collapsing with age. *Spore germination* results in holobasidia producing apically 3–8 basidiospores on narrowly ovate lobes (Fig. 64).

On *Violaceae*: *Viola* sp., East Azarbaijan Prov., Arasbaran protected area, Kaleibar city towards Esku city, IRAN 14201 F.

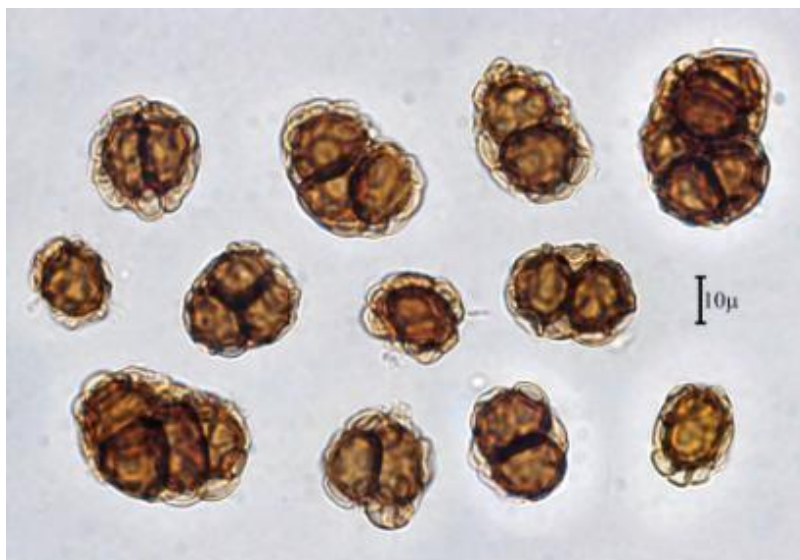


Fig.47 – *Urocystis bolivarii* on *Lolium* sp. (10339)

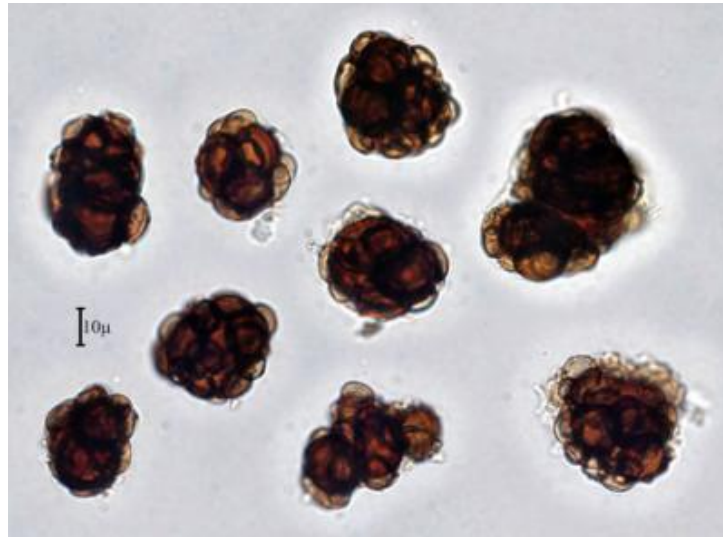


Fig.48 – *Urocystis ceratocephali* on *Ceratocephalus falcatius* (7238)

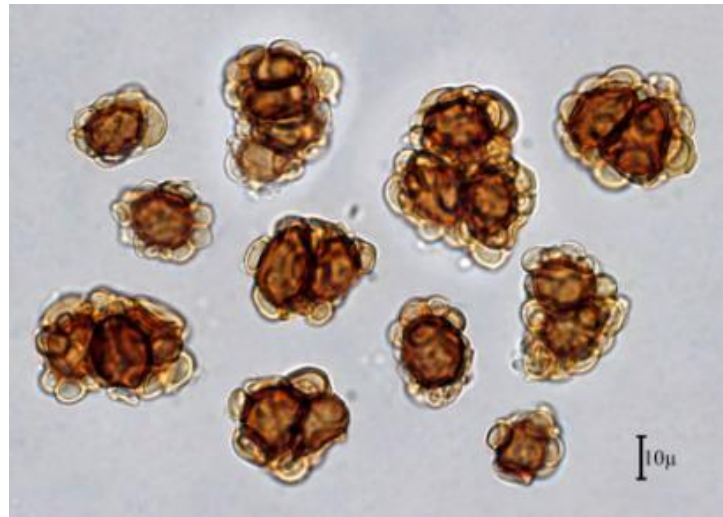


Fig.49 – *Urocystis colchici* on *Colchicum persicum* (8329)

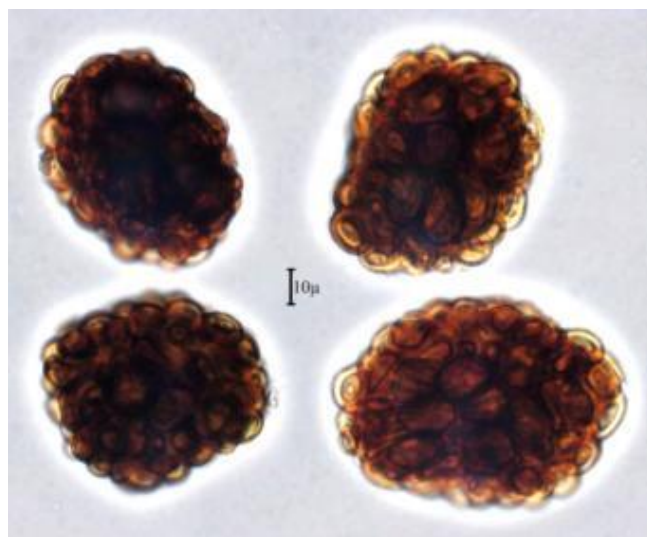


Fig.50 – *Urocystis corsica* on *Stipa capensis* (8296)

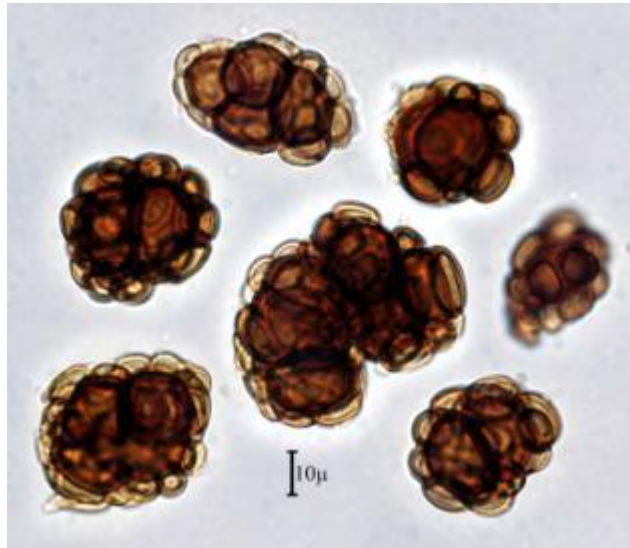


Fig.51 – *Urocystis ficariae* on *Ranunculus ficaria* (7237)

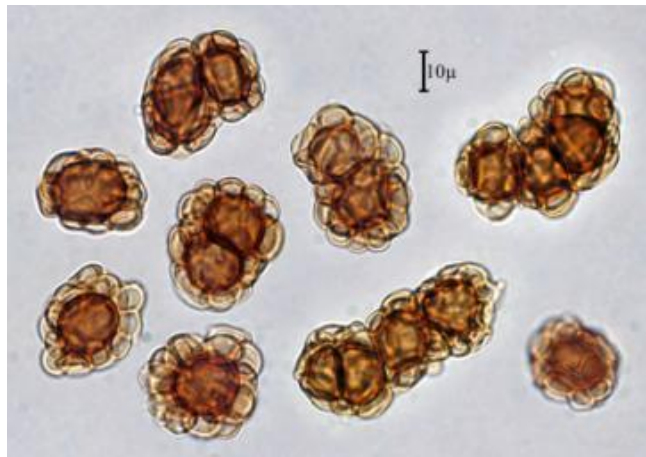


Fig.52 – *Urocystis fischeri* on *Carex* sp. (10908)

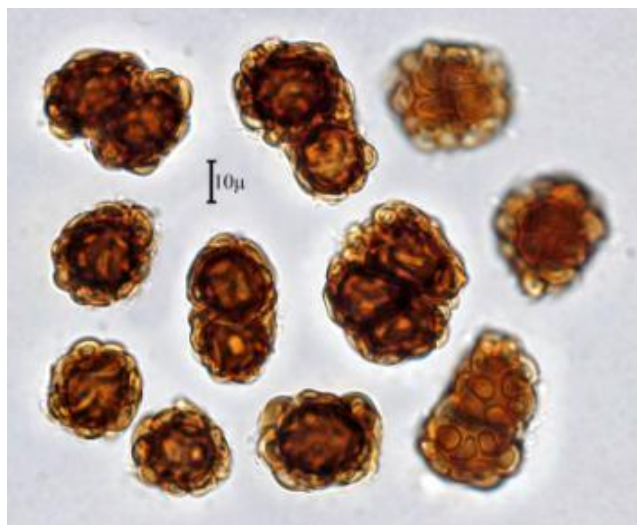


Fig.53 – *Urocystis gladiolicola* on *Gladiolus segetum* (8008)

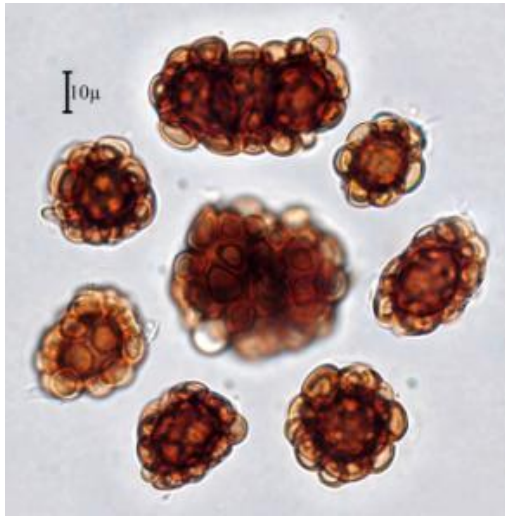


Fig.54 – *Urocystis ixiolirii* on *Ixiolirion pallasii* (10424)

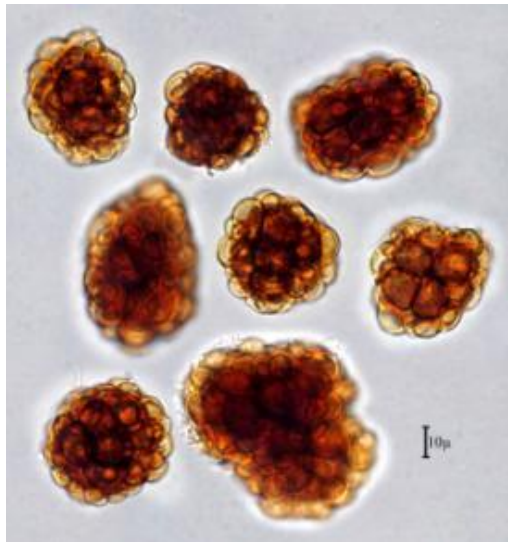


Fig.55 – *Urocystis kmetiana* on *Viola occulta* (7235)

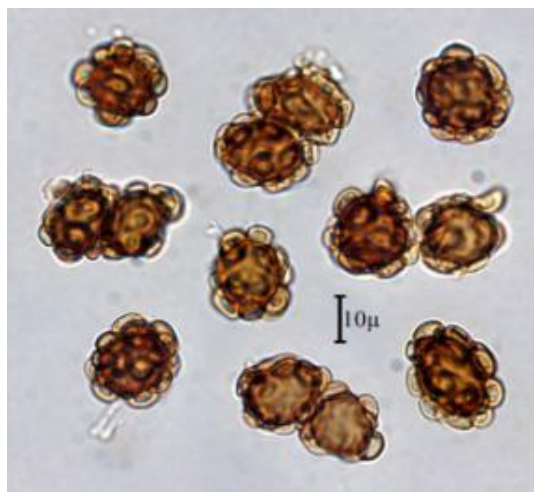


Fig.56 – *Urocystis magica* on *Allium cepa* (4391)

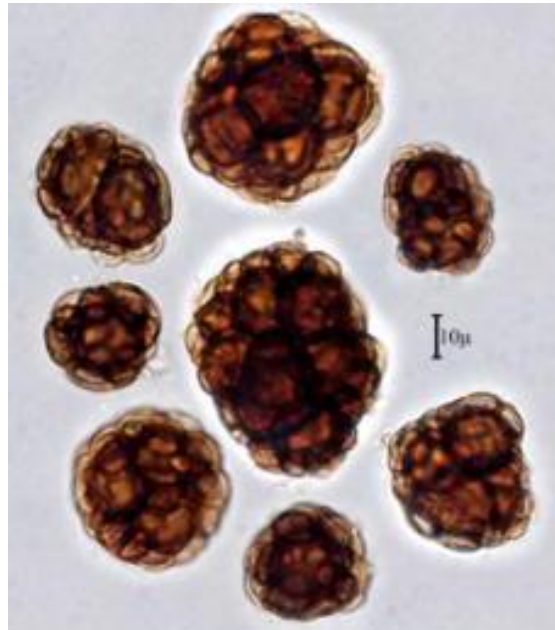


Fig.57 – *Urocystis muscaridis* on *Muscari* sp. (11799)

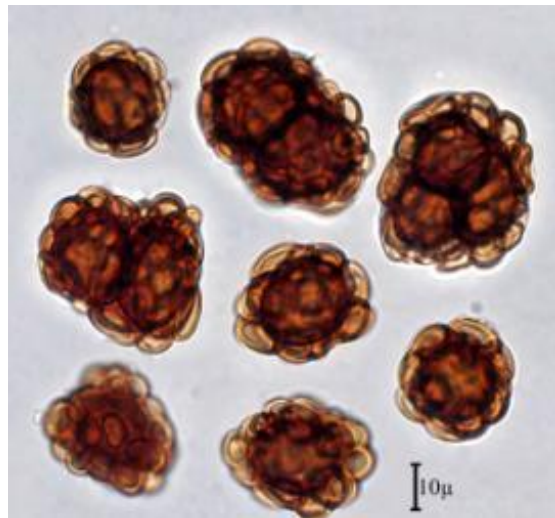


Fig.58 – *Urocystis ornithogali* on *Ornithogalum kurdicum* (11658)

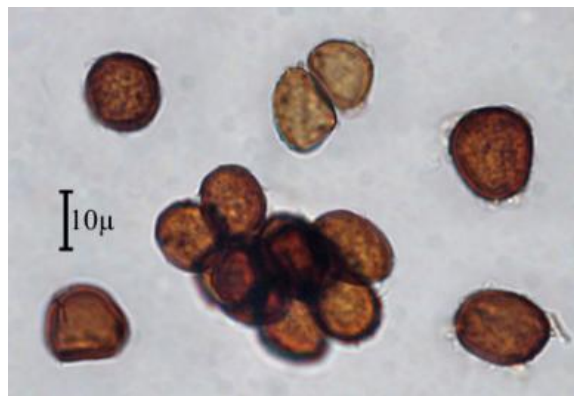


Fig.59 – *Urocystis pedicularis* on *Pedicularis sibthorpii* (8312)

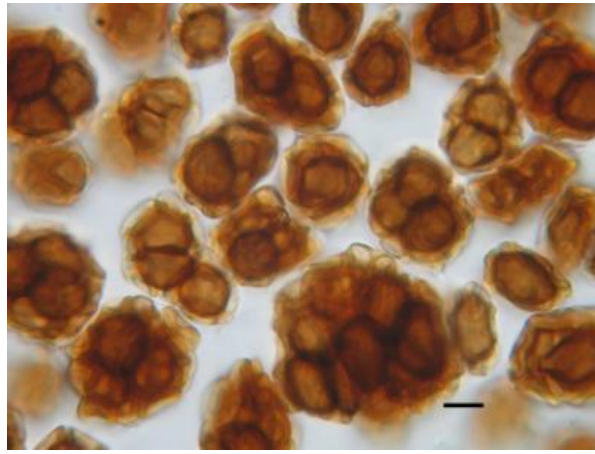


Fig.60 – *Urocystis phalaridis* on *Phalaris* sp. (10352), Bar=10 μ m

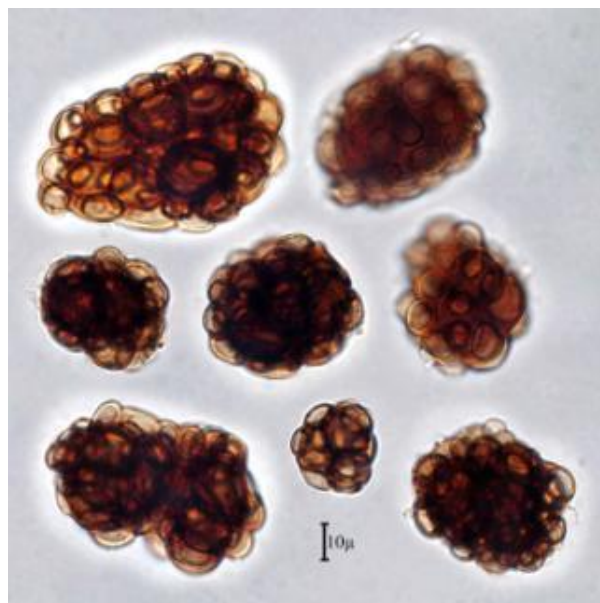


Fig.61 – *Urocystis sorosporioides* on *Thalictrum sultanabadense* (7267)

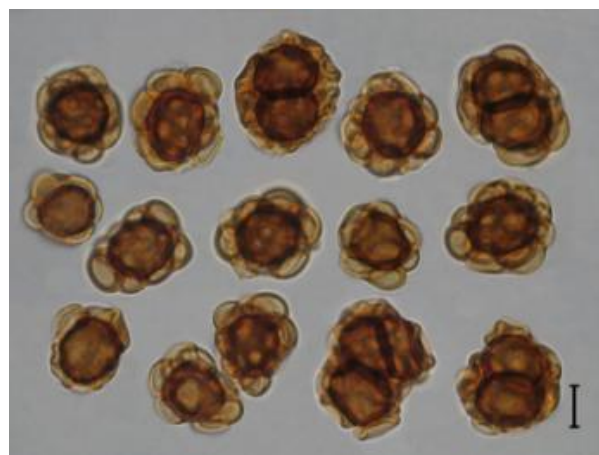


Fig.62 – *Urocystis tianschanica* on *Critesion violaceum* (8335), Bar=10 μ m

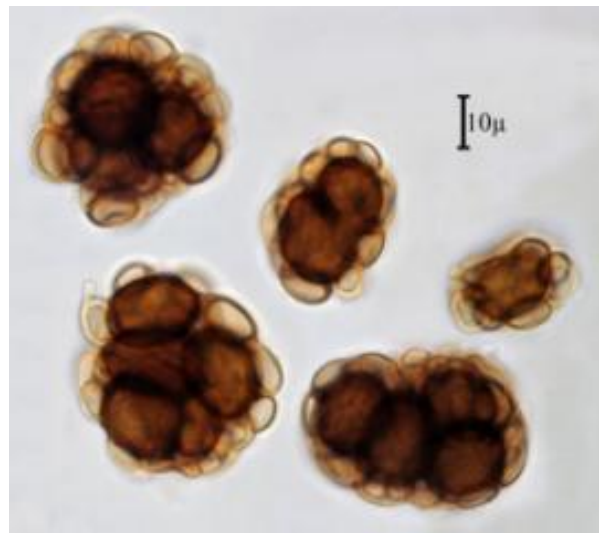


Fig.63 – *Urocystis tritici* on *Triticum aestivum* (13875)

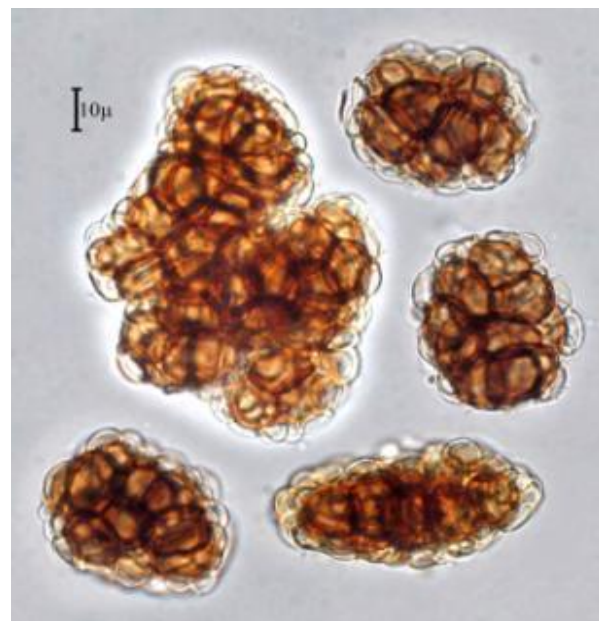


Fig.64 – *Urocystis violae* on *Viola* sp. (14201)

***Ustilago* (Pers.) Roussel**

Key to the *Ustilago* species based on host plant taxonomy

- 1. On *Aeluropus* *U. aeluropodis*
- Not on *Aeluropus* 2
- 2. On *Aegilops* *U. avenae* / *U. tritici*
- Not on *Aegilops* 3
- 3. On *Avena* *U. avenae*
- Not on *Avena* 4
- 4. On *Brachypodium* *U. bromivora*
- Not on *Brachypodium* 5
- 5. On *Bromus* 6
- Not on *Bromus* 9
- 6. Sori around the stem and floral axis, often comprising also the basal part of the floral envelopes *U. pamirica*

Sori not so.....	7
7. Sori in spikelets, on basal part of floral envelopes, bullate	<i>U. bromivora</i>
- Sori in leaves and leaf sheaths as striae, rarely also in the inflorescence	8
8. Spores 9–15(–16) µm long, echinulate; sori in leaves	<i>U. striiformis</i>
- Spores 4–7 µm long, punctate-verruculose; sori also in distorted inflorescence	<i>U. trebouxii</i>
9. On <i>Cynodon</i>	<i>U. cynodontis</i>
- Not on <i>Cynodon</i>	10
10. On <i>Dactylis</i>	<i>U. striiformis</i>
- Not on <i>Dactylis</i>	11
11. On <i>Echinochloa</i>	<i>U. trichophora</i>
- Not on <i>Echinochloa</i>	12
12. On <i>Eremopyrum</i>	<i>U. turcomanica</i>
- Not on <i>Eremopyrum</i>	13
13. On <i>Glyceria</i>	<i>U. filiformis</i>
- Not on <i>Glyceria</i>	14
14. On <i>Hordeum</i>	15
- Not on <i>Hordeum</i>	16
15. Spores minutely echinulate.....	<i>U. hordei</i>
Spores smooth.....	<i>U. nuda</i>
16. On <i>Poa</i>	<i>U. striiformis</i>
- Not on <i>Poa</i>	17
17. On <i>Saccharum</i>	<i>U. scitaminea</i>
- Not on <i>Saccharum</i>	18
18. On <i>Setaria</i>	<i>U. crameri</i>
- Not on <i>Setaria</i>	19
19. On <i>Taeniatherum</i>	<i>U. phrygica</i>
- Not on <i>Taeniatherum</i>	20
20. On <i>Triticum</i>	<i>U. tritici</i>
- On <i>Zea</i>	<i>U. maydis</i>

81. *Ustilago aeluropodis* (Trotter) Vánky, Publ. Herb. Ustilag. Vánky (HUV) 1: 11, 1985b.

Sphacelotheca aeluropodis Trotter, in Sacc. & Trotter 1913. – *Crozalsiella aeluropodis* (Trotter) Maire 1917.

Sorosporium aeluropodis S. Ahmad 1956 (as '*aeluroidis*').

Sori on the tip of culms replacing the inflorescence, ovoid or fusiform, 1–2 cm long, invested by a rosette of leaf sheaths and young leaves, later rupturing laterally to expose the dark brown, powdery spore mass. Peridium, sterile cells and columellae lacking. Spores variable in shape and size, globose, subellipsoidal or ellipsoidal, often slightly flattened, 12–17 × 13.5–20 µm, golden brown; wall uniform, 0.5–1 µm thick, in LM sparsely to moderately densely, minutely punctate-verruculose; the verrucae do not or only slightly affect the spore profile, in SEM minutely verruculose-echinulate. Spore germination results in septate basidia and hyphae (Fig. 65).

On *Poaceae*: *Aeluropus littoralis* (Gouan) Parl., Khuzestan Prov., Ahvaz city.

On *Aeluropus* sp., Hormozgan Prov., Persian Gulf, Ghesm Island, IRAN 11342 F.

82. *Ustilago avenae* (Pers. : Pers.) Rostr., Overs. Kongel. Danske Vidensk. Selsk. Forh. Medlemmers Arbejder: 13, 1890 (March).

Uredo segetum Pers. var. *avenae* Pers. 1797. – *Uredo segetum* Pers. var. *Uredo avenae* Pers. : Pers. 1801. – *Uredo carbo* DC. var. *avenae* (Pers. : Pers.) DC. 1815. – *Erysibe vera* Wallr. var. *avenae* (Pers. : Pers.) Wallr. 1833. – *Ustilago segetum* var. *avenae* (Pers. : Pers.) Brunaud 1878. – *Ustilago segetum* var. *avenae* (Pers. : Pers.) J.L. Jensen 1888 (comb. superfl.). – *Ustilago avenae* (Pers. : Pers.) J.L. Jensen, in Kellerm. & Swingle 1890 (June).

Erysibe vera Wallr. var. *holci-avenacei* Wallr. 1833 (nom. nud.). – *Ustilago holci-avenacei* (Wallr.) Cif. 1938 (comb. illegit.).

Ustilago perennans Rostr. 1890b (March).

Ustilago medians Biedenk. 1894.

Ustilago arrhenatheri Ferle 1912 (nom. nud.).

Ustilago decipiens ("Wallr.") Liro 1924.

Ustilago nigra Tapke 1932.

Ustilago aegilopsidis Picb. 1932.

Ustilago festucae Zundel 1933.

Ustilago haynaldiae Becer. 1970.

Sori in spikelets destroying the ovaries and more or less destroying the palea, lemma and glumes ("loose smut"). Spore mass first firm, then powdery, dark olivaceous to chocolate-brown. *Spores* globose, ovoid to elongate, (4–)5–7 × 6–9 μm, yellowish brown to olive-brown, paler on one side, minutely echinulate, ornamentation usually more prominent on the paler side, in SEM with more or less densely spaced, rounded to subacute warts. *Spore germination* results in 4-celled basidia producing basidiospores on artificial media. Either compatible basidial cells or basidiospores fuse to form dikaryotic hyphae which infect seedlings. Infection is systemic (Fig. 66).

On *Poaceae*: *Aegilops triuncialis* (L.) Á. Löve, West Azerbaijan Prov., Orumieh-Salmas road.

On *Avena barbata* Pott ex Link, Golestan Prov., Golestan National Park, Dashte Kalpush area, IRAN 8315 F.

On *Avena fatua* L., Khuzestan Prov., between Ahvaz city & Andimeshk city, IRAN 7124 F; Golestan Prov., Gorgan city, c. 50 km SW of Maraveh-tappeh village, IRAN 7275 F.

On *Avena ludoviciana* Durieu, Yazd Prov., Meibod city, IRAN 13873 F.

On *Avena sativa* L., Khuzestan Prov., Dezful city, IRAN 4390 F; Yazd Prov., Meibod city, Shamsabad village, IRAN 14572 F.

On *Avena* sp., Kohgiluyeh va -Buyerahmad Prov., Nil Mt., IRAN 9852 F.; Kohgiluyeh-Buyerahmad Prov., Dehdasht city; Kermanshah Prov., Sahneh city, IRAN 6635 F; Yazd Prov., Meibod city, IRAN 13874 F.

On *Hordeum vulgare* L., Khuzestan Prov., Ahvaz city; Khuzestan Prov., Andimeshk city; Khuzestan Prov., Masjed Soleiman city; Mazandaran Prov., Babolsar city; Mazandaran Prov., Kelardasht city; Gilan Prov., Rudbar city; Fars Prov., Firuzabad city, Ghirokarzin road, 15 km NW of Ghirokarzin city, IRAN 13193 F; Golestan Prov., Gorgan city, c. 35 km SE of Azadshahr city, IRAN 7276 F.

83. *Ustilago bromivora* (Tul. & C. Tul.) A.A. Fisch. Waldh., Bull. Soc. Nat. Moscou 40: 252, 1867.

Ustilago carbo (DC.) Tul. & C. Tul. var. *vulgaris* Tul. & C. Tul. d *bromivora* Tul. & C. Tul. 1847. –

Yenia bromivora (Tul. & C. Tul.) Liou 1949.

Ustilago lorentziana Thüm. 1880.

Cintractia patagonica Cooke & Masee, in Cooke 1889. – *Ustilago patagonica* (Cooke & Masee)

Cif. 1928. – *Ustilago patagonica* (Cooke & Masee) Lavrov 1951 (comb. superfl.).

Ustilago holwayi Dietel 1893.

Ustilago hordeicola Speg. 1909.

Ustilago brachypodii-distachyi Maire 1919.

Ustilago bromi-arvensis Liro 1924.

Ustilago bromi-mollis Liro 1924.

Ustilago jamalainenii Liro 1939.

Sorosporium maroccanum Unamuno 1940.

Ustilago grossheimii Uljan. 1950.

Ustilago zernae Uljan. 1950.

Ustilago compacta G.W. Fisch. 1952.

Sorosporium lavrovianum Smarods 1963.

Ustilago pospelovii Uljan. 1968.

Sori in spikelets, usually destroying the basal parts of the glumes and even the ovaries; 4–10 mm in diam., bullate, initially agglutinated and covered by the epidermis but finally becoming dusty, black or blackish brown. Infection systemic (seedlings and older shoots are infected). *Spores* globose to subglobose, occasionally ovoid or irregularly polyhedral, $6.5\text{--}9.5 \times 8\text{--}11 \mu\text{m}$, olivaceous to reddish brown often with a darker equatorial band; wall even to slightly uneven, 1–1.5 μm thick, in LM from finely to rather coarsely verrucose, more pronounced on the polar regions, in SEM coarsely verrucose. *Spore germination*: each spore usually forms two, two-celled basidia (occasionally one three-celled and one one-celled) on which terminal and lateral ovoid basidiospores are borne. Sometimes only one two-celled basidium is produced, the two cells conjugate giving rise to a dikaryotic hypha or, rarely to two basidiospores (Fig. 67).

On *Poaceae*: *Brachypodium distachyon* (L.) P. Beauv. (*Trachynia distachya* (L.) Link), Ilam Prov., Ilam city, IRAN 4389 F; Lorestan Prov., on the road of Khorramabad city to Andimeshk city; IRAN 8302 F; Kermanshah Prov., Rijab area, Shalan village, IRAN 14785 F, HUV 21827; Golestan Prov., 50 km SW of Maraveh tappeh village, IRAN 7248 F; Gilan Prov., at the lake of White River dam, IRAN 7247 F.

On *Bromus danthoniae* (Desf.) Trin. ex C.A. Mey, East Azarbaijan Prov., between Azarshahr city and Ajabshir city; Sistan va -Baluchestan, Zabol city, IRAN 11698 F; Tehran Prov., Sorkhehesar National Park, E of the Park, Ala-Khancheshmeh spring, IRAN 6447 F; Hamadan Prov., Hamadan city.

On *Bromus japonicus* Thunb., Tehran Prov., Karaj city, Chalus road, 38 km N of Karaj city, at Tochal hotel, IRAN 11146 F.

On *Bromus madritensis* L., Gilan Prov., N of White River dam, IRAN 7244 F; Golestan Prov., Gorgan city, c. 35 km SE of Azadshahr city, IRAN 7242 F; Tehran Prov., Tehran city, Saadatabad area, IRAN 8089 F; Golestan Prov., Gonbad city, Beshelan village, IRAN 4388 F.

On *Bromus rubens* L., Bushehr Prov., Khormuj city, IRAN 9850 F; Tehran Prov., Tehran city to Ghom city, 55 km N of Ghom city, Emamzadeh Allali-Sallali area, IRAN 9849 F.

On *Bromus sterilis* L., Tehran Prov., Campus of Iranian Research Institute of Plant Protection, IRAN 11189 F; Fars Prov., Shiraz city, Imam Hossein orchard, IRAN 13285 F; Tehran Prov., Jajroud city, Saeidabad village, beside Khojir National Park, IRAN 6452 F.

Bromus tectorum L., Tehran Prov., Tehran city, Darband area; Hamadan Prov., Malayer city; Tehran Prov., Karaj-Chalus road, at the Amirkabir dam, IRAN 11149 & 7225 F; Tehran Prov., Karaj city, Baraghan village, IRAN 8767 F; Tehran Prov., Karaj-Chalus road, at the road of Kondor village, IRAN 10772 F; Tehran Prov., Karaj-Chalus road, Sira village, IRAN 7224 F; Tehran Prov., Karaj-Chalus road, Khor ski slope road, Jei & Charan bifurcation, at the Gholgholak spring, IRAN 10898 F; Golestan Prov., Golestan National Park, Dashte Kalpush area. IRAN 8322 F; Khorasan Prov., Mashhad city, IRAN 8500 F; Tehran Prov., Karaj-Chalus road, on the road of Kalvan & Sira villages, 11148 F; Tehran Prov., Tehran city, Central Elburz Mts., Darabad area, IRAN 7241 F; Tehran Prov., Chalus road, Amirkabir dam; Qazvin Prov., c. 50 km NW of Qazvin city, IRAN 7243 F; Tehran Prov., Sorkhehesar National Park, Ala-Khancheshmeh area, IRAN 1808 F; Tehran Prov., Parchin road, Khojir National Park, 18 km after guard post, IRAN 1823 F; Tehran Prov., Karaj city, Manzarieh area, Vahdat town, IRAN 11147 F; Chaharmahal va -Bakhtiari Prov., Shahre Kord city, Emamieh Garden, IRAN 11569 F; Tehran Prov., Jajroud protected area, Parchin road, 4 km after guard station, E. slopes of road, IRAN 6434 F; Tehran Prov., Jajroud protected area, Saeedabad village, W. slopes of Khojir National Park, IRAN 6391 F.

On *Bromus* sp., Hamadan Prov., Toyserkan city, IRAN 11754 F.

On *Hordeum glaucum* Steud., Ilam Prov., Dehloran city, IRAN 10534 F.

On *Trachynia distachya* see *Brachypodium distachyon*.

84. *Ustilago crameri* Körn., in Fuckel, Jahrb. Nassauischen Vereins Naturk. 27–28: 11, 1874, '1873–74'.

Sori in all spikelets of an inflorescence destroying the ovaries and the basal part of the inner floral envelopes which become bullate, while the upper parts of the envelopes and the two glumes are

normally developed. Sori initially covered by a green, yellow or silvery peridium of host origin which ruptures irregularly exposing the dark brown, powdery mass of spores. *Spores* variable in shape, subglobose to elongate, slightly bent, irregular, subpolyhedral, pyriform, lemon- or drop-shaped, sometimes with an acute tip, (6–)7–9.5 × 8–12(–15) μm, medium dark reddish brown; wall even, c. 0.5 μm thick, smooth; in SEM smooth or with sparsely situated, low warts.

On *Poaceae*: *Setaria italica* (L.) P. Beauv., Mazandaran Prov., Kojur; Mazandaran Prov., Nur; Mazandaran Prov., Kelardasht.

On *Setaria viridis* (L.) P. Beauv., Tehran Prov., Karaj city; Tehran Prov., Tehran city.

85. *Ustilago cynodontis* (Henn.) Henn., Bull. Herb. Boissier 1: 114, 1893.

Ustilago segetum ("Bulliard") Ditmar var. *cynodontis* Henn. 1892.

Uredo digitariae Rabenh. 1847 (later homonym, not Kunze 1830). – *Ustilago pallida* Körn. 1877b (March), nom. nov.

Ustilago carbo (DC.) Tul. & C. Tul. [var.] *cynodontis* Pass. 1871. – *Ustilago cynodontis* (Pass.) Curzi, in Curzi & Barbaini 1927. (later homonym, not (Henn.) Henn.).

Ustilago nebrodensis Gonz. Frag. 1919.

Sporisorium agropyri Bag & D.K. Agarwal 2001.

Sori in inflorescence destroying the spikelets and covering the spikes with a dark brown, dusty spore mass; sometimes the infection is localised to the basal parts of the inflorescence, usually with abortive spikelets in its distal parts; young sori often more or less hidden by enveloping leaf sheaths. Infection systemic. *Spores* globose to subglobose, 5.5–8 × 6–8(–8.5) μm, yellowish brown to light olive-brown, smooth, in SEM with dense, minute warts. Young spores often in readily separable chains, connected by small, hyaline hyphal remnants. *Spore germination* results in 4-celled basidia (in 3 + 1 arrangement) producing successively, lateral and terminal, ovoid to long ellipsoidal basidiospores. Basidiospores bud or germinate by hyphae on which lateral or terminal aerial sporidial systems develop (Fig. 68).

On *Poaceae*: *Cynodon dactylon* (L.) Pers. Common in Iran.

On *Cynodon* sp., Golestan Prov., Minoudasht city, Nil Mt., IRAN 4378 F.

86. *Ustilago filiformis* (Schrank) Rostr., Festschr. Bot. Foren. Kjöbenhavn 1890: 136, 1890a.

Lycoperdon filiforme Schrank 1793.

Uredo longissima Sowerby 1799. – *Caecoma longissimum* (Sowerby) Schltldl. 1824. – *Erysibe longissima* (Sowerby) Wallr. 1833. – *Ustilago longissima* (Sowerby) Meyen 1841. – *Ustilago longissima* (Sowerby) Tul. & C. Tul. 1847 (comb. superfl.). – *Yenia longissima* (Sowerby) Liou 1949.

Uredo (Ustilago) fuscovirens Ces., in Rabenh. 1850, 1851.

Ustilago longissima var. *dubiosa* Liro 1924. – *Ustilago dubiosa* (Liro) Liro 1938 (later homonym, not *U. dubiosa* Speg. 1881). – *Ustilago agropyrina* Lavrov 1936 (nom. nov., not *U. dubiosa* Speg.). – *Ustilago liroae* Zundel 1953 (not *U. dubiosa* Speg.).

Ustilago glyceriae Cif. 1931.

Entyloma peninsulae Crowell 1942.

Sori in leaves and sheaths as long striae between the veins, initially lead-coloured, covered by the epidermis which soon ruptures longitudinally and the pale brown, powdery spore mass becomes scattered. Infection systemic, infected plants usually do not flower. *Spores* globose, subglobose or ovoid, 4–5 × 4–6(–7) μm, pale olive-brown; wall c. 0.5 μm thick, very finely punctate, spore profile smooth or very finely wavy, in SEM coarsely low verrucose to echinulate. *Spore germination*: meiosis occurs in the germinating spore. The developing basidium separates into a three- and a one-celled piece both of which elongate considerably and also increase in width. The basidiospores developed from the various bits of the basidium are long and narrow. On liberation they undergo considerable elongation and give rise to daughter cells in lateral or terminal positions (Fig. 69).

On *Poaceae*: *Glyceria plicata* Fr., Fars Prov., Arzhan plain, toward Chero waterfall, Juk spring, IRAN 12787 & 12822 F; Tehran Prov., Firuzkuh city toward Tehran city, 118 km E of

Tehran, Emamzadeh Esmail, on river-bank, IRAN 12848 F; East Azarbaijan Prov., Arasbaran protected area, Kaleibar city toward Makidi village, IRAN 14216 F.

87. *Ustilago hordei* (Pers. : Pers.) Lagerh., Mitt. Bad. Bot. Vereins 1889: 70, 1889 (March).

Uredo segetum Pers. var. *hordei* Pers. 1797. – *Uredo segetum* Pers. var. *Uredo hordei* Pers. : Pers. 1801. – *Uredo carbo* DC. var. *hordei* (Pers. : Pers.) DC: 1815. – *Erysibe vera* var. *hordei* (Pers. : Pers.) Wallr. 1833. – *Ustilago segetum* (Pers.) Roussel var. *hordei* (Pers. : Pers.) Rabenh. 1856. – *Ustilago segetum* (Pers.) Roussel var. *hordei* (Pers. : Pers.) Brunaud 1878. (comb. superfl.).

Reticularia segetum Bull. 1791 (pro parte, as includes all covered- and loose smuts of cereals, nom. rejic.). – *Uredo segetum* ("Bull.") Pers. 1797, p.p. – *Ustilago segetum* ("Bull.") Roussel 1806, p.p.

Ustilago segetum (Pers.) Roussel var. *hordei* (as '*Hordii*') f. *tecta* Rostr. & J.L. Jensen, in Jensen 1888 (nom. nud.). – *Ustilago jensenii* Rostr. 1890b (March).

Ustilago avenae (Pers. : Pers.) Rostr. var. *levis* Kellerm. & Swingle 1890. – *Ustilago levis* (Kellerm. & Swingle) Magnus 1894.

Ustilago kollerii Wille 1893.

Ustilago dura Appel & Gassner 1907.

Ustilago arrhenatheri Schellenb. 1915.

Ustilago rostrupii Kitunen 1922.

Sori in all spikelets of an inflorescence as a blackish brown, adherent spore mass, initially covered by a membrane of host tissue origin ("covered smut"), later exposed to various degrees depending on the extent of destruction of the spikelet parts. *Spores* globose, subglobose to ovoid, 5–9(–10) μm in diam., paler coloured on one side, smooth. *Spore germination* results in 4-celled basidia (often of the 3 + 1 pattern) producing basidiospores on artificial media; dikaryons formed between either compatible basidial cells or basidiospores infect seedlings (Fig. 70).

On *Poaceae*: *Hordeum leporinum* Link, Ghom Prov., Ghom city; Guilan Prov., Manjil city.

On *Hordeum vulgare* L. Common in Iran.

On *Hordeum* sp. Numerous collections.

88. *Ustilago maydis* (DC.) Corda, Icones Fungorum Hucusque Cognitorum 5: 3, 1842.

Uredo maydis DC. 1815. – *Erysibe maydis* (DC.) Wallr. 1833. – *Mycosarcoma maydis* (DC.) Bref. 1912.

Lycoperdon zae Beckm. 1768.

Uredo segetum Pers. var. *mays-zae* DC. 1805. – *Uredo segetum* Pers. var. *Uredo zea-mays* DC. in Poiret 1808 (var. nov. illegit.). – *Ustilago zae-mays* (DC.) G. Winter, in Rabenh. 1881 (comb. illegit.). – *Ustilago mays-zae* (DC.) Magnus 1896a('1895').

Uredo [subgen.] *Ustilago zae* Schwein. 1822.

Caecoma zae Link 1825 (nom. illegit. as it includes *Uredo maydis*). – *Ustilago zae* (Link) Unger 1836 (comb. illegit.).

Ustilago euchlaenae Arcang. 1882.

Sori in stems, leaves or inflorescence (both male and female ones) as pustules or irregular galls of considerable size, initially covered by a thin, greyish silvery, later brown, smooth membrane which ruptures irregularly to expose the medium to dark brown, powdery spore mass. *Spores* globose, subglobose, ovoid to sometimes elongate or slightly irregular, 7–11 \times 7–13 μm , light olive-brown; wall c. 0.5 μm thick, finely, rather densely echinulate. *Spore germination* results in a 4-celled basidia laterally and terminally bearing basidiospores. Often, the upper half of the young basidium separates from the lower half by a fragmentation zone. Mycelium mostly intracellular (Fig. 71).

On *Poaceae*: *Zea mays* L. Not uncommon.

89. *Ustilago nuda* (C.N. Jensen) Kellerm. & Swingle, An. Rep. Kans. Agr. Exp. Sta. 2: 277, 1890 (June).

Ustilago segetum (Pers.) Roussel var. *hordei* (as '*Hordii*') Rostr. & C.N. Jensen f. *nuda* C.N. Jensen 1888 (nom. nud.). – *Ustilago nuda* (C.N. Jensen) Rostr. 1889 (nom. nud.).

Ustilago nuda var. *foliicola* Trotter, in Sacc. & Trotter 1913.

Sori in all spikelets of an inflorescence, dark olive-brown, dusty ("loose smut"), usually destroying all floral parts leaving behind only the naked rachis; occasionally also on leaves, sheaths and culms as striae. *Spores* globose to subglobose or ovoid, 5–7 × 6–9 µm in diam., olive-brown, paler on one side, minutely echinulate. *Spore germination* results in septate, 4-celled basidia. On artificial media and in nature fusion between compatible basidial cells gives rise to dikaryotic hyphae which infect the embryo resulting in a systemic disease Hyphae both intercellular and intracellular (Fig. 72).

On *Poaceae*: *Hordeum vulgare* L. Common in Iran.

90. *Ustilago pamirica* Golovin, Sredneaz. Gosud. Univ., N.S., Vyp. XIV, Biol. Nauk., Kniga 5: 11, 1950.

Ustilago pamirica Golovin, in Gutner 1941 (nom. inval.).

Sori around the stem and floral axis, often comprising also the basal part of the floral envelopes, initially covered by a silvery membrane which ruptures exposing the blackish brown, powdery mass of spores. *Spores* globose, subglobose to ovoid, 11–13(–14) × 11–15(–16) µm, reddish brown; wall 1–1.5 µm thick, densely, coarsely verrucose. *Spore germination* results in a whorl of four, ellipsoidal, one-celled germ tubes (basidia), producing apical chains of long-ellipsoidal basidiospores and later also lateral basidiospores (Fig. 73).

On *Poaceae*: *Bromus gracillimus* Bunge, Esfahan Prov., between Shahreza city and Semirom city, IRAN 7251 F, HUV 15080, also in Vánky, Ust. exs. no. 789.

91. *Ustilago phrygica* Magnus, Bull. Herb. Boissier 3: 574, 1903.

Ustilago hordei-criniti Barbarin, in Zaprom. 1928.

Ustilago tuberculata Golovin 1952.

Ustilago mesatlantica Malençon & Massenot, in Guyot, Malençon & Massenot 1969.

Sori usually destroying all spikelets in a spike, leaving intact only the more or less stunted and deformed awns, confluent, cylindrical, slightly bullate, subepidermal, lead-coloured, for a long time remaining covered by the epidermis which ruptures exposing the blackish brown, powdery spore mass. Infection at seedling stage. *Spores* globose, ellipsoidal to slightly irregular, (6–)7–8 × 7–10(–11) µm, medium olive-brown; wall uniformly 1–1.5 µm thick, in LM moderately densely, somewhat irregularly verrucose or low tuberculate, in SEM densely, minutely tuberculate. *Spore germination*: A spore produces 1–2, one-, two- or three-septate basidia bearing ovoid basidiospores which bud abundantly (Fig. 74).

On *Poaceae*: *Taeniatherum caput-medusae* (L.) Nevski, Tehran Prov., Jajroud protected area; Parchin road, toward Parchin, 17 km S of guard station, IRAN 6386 F; Tehran Prov., Parchin road, 13 km S. of guard station, IRAN 1791 F; Tehran Prov., Karaj-Chalus road, near Amirkabir dam, road side, IRAN 10897 F; Tehran Prov., 20 km NE of Karaj city, at "Amir-Kabir" barrage, IRAN 7245 F; Tehran Prov., Northern part of Khojir national Park, IRAN 1761 F.

On *Taeniatherum crinitum* (Schreb.) Nevski, Fars Prov., at Daryun village, IRAN 13547.

On *Taeniatherum* sp., Tehran Prov., Khojir National Park, IRAN 1764 F.

92. *Ustilago scitaminea* Syd., Ann. Mycol. 22: 281, 1924 (nom. cons.).

Sporisorium scitamineum (Syd.) M. Piepenbr., M. Stoll & Oberw. 2002.

Ustilago amadelpa Syd., P. Syd. & E.J. Butler 1912 (nom. rejic.).

Sphacelotheca miscanthi W.Y. Yen 1937a. – *Sporisorium miscanthi* (W.Y. Yen) L. Guo 1990.

Ustilago scitaminea Syd. var. *sacchari-barberi* Mundk. 1939b.

Ustilago scitaminea Syd. var. *sacchari-officinarum* Mundk. 1939b.

Sori in floral stems which are transformed into long, flagelliform, often curved bodies; basal part of the sori concealed by leaf sheaths, distal part free and tapering, initially covered by a silvery peridium of host tissue which flakes away exposing the blackish brown, dusty mass of spores mixed

with irregular groups of sterile cells. *Spores* globose, subglobose to subovoid, 5.5–7.5 × 6.5–8(–10) µm, reddish brown; wall uniform, 0.5–0.8 µm thick, from almost smooth, finely and sparsely punctate-verruculose to sparsely or moderately densely echinulate. *Sterile cells* variable in shape and size, larger than the spores (8–23 µm in diam.), yellow or pale yellowish brown, smooth. *Spore germination* results in 4-celled basidia (often of 3 + 1 pattern; the 4th basidial cell remaining within the spore) on which laterally and terminally, ovoid to long ellipsoidal basidiospores are produced. Basidiospores bud or fuse in pairs, giving rise to dikaryotic hyphae. Under natural conditions, on sugarcane (and on certain media), basidial cells conjugate and produce septate, dikaryotic infection hyphae (Fig. 75).

On *Poaceae*: *Saccharum officinarum* L., Khuzestan Prov., Dezful city, Haft-tappeh Sugar Cane Company, IRAN 4343 F; Mazandaran Prov., Sari city, Dashte Naz area, IRAN 10712 F.

93. *Ustilago striiformis* (Westend.) Niessl, Hedwigia 15: 1, 1876, **s. lat.**

Uredo striiformis Westend. 1851 (as '*striaeformis*'). – *Tilletia striiformis* (Westend.) Sacc. 1877. –

Tilletia striiformis (Westend.) G. Winter 1881 (comb. superfl.).

Ustilago salweyi Berk. & Broome 1850 (as '*salveii*'; nom. ambig.). – *Uredo salweyi* (Berk. & Broome) Oudem. 1866. – *Tilletia salweyi* (Berk. & Broome) P. Karst. 1884.

Uredo (Ustilago) longissima Sowerby var. *megalospora* Riess, in Rabenh. 1854. – *Ustilago megalospora* (Riess) Cif. 1933.

Tilletia debaryana A.A. Fisch. Waldh., in Rabenh. 1866 (as '*de Baryana*').

Tilletia milii Fuckel 1870. – *Ustilago milii* (Fuckel) Liro 1924.

Ustilago denotarisii A.A. Fisch. Waldh. 1877c (as '*de Notarisii*').

Tilletia alopecurivora Ule 1884. – *Ustilago alopecurivora* (Ule) Liro 1924.

Tilletia avenae Ule 1884. – *Ustilago scaura* Liro 1924 (not *U. avenae* (Pers. : Pers.) Rostr 1890b).

Tilletia brizae Ule 1884. – *Ustilago brizae* (Ule) Liro 1924.

Ustilago washingtoniana Ellis & Everh. 1895.

Ustilago poarum McAlpine 1895.

Tilletia? airae-caespitosae Lindr. [Liro] 1904. – *Ustilago airae-caespitosae* (Lindr.) Liro 1924.

Tilletia corcontica Bubák 1912. – *Ustilago corcontica* (Bubák) Liro 1924.

Ustilago festucarum Liro 1924.

Ustilago bromina Syd. 1924.

Ustilago striaeformis f. *agrostis-palustris* W.H. Davis 1928 (nom. nud. et eventuale). – *Ustilago agrostis-palustris* W.H. Davis ex Cif. 1931.

Ustilago striaeformis f. *phlei-pratensis* W.H. Davis 1928 (nom. nud. et eventuale). – *Ustilago phlei-pratensis* W.H. Davis ex Cif. 1931.

Ustilago striiformis f. *hierochloae-odoratae* Săvul. & Rayss 1932. – *Ustilago hierochloae-odoratae* (Săvul. & Rayss) Cif. 1938.

Ustilago johnstonii Cif. 1933.

Ustilago kairamoi Liro 1939.

Ustilago clintoniana W.H. Davis 1935 (later homonym and nom. nud.; not *U. clintoniana* Ciferri 1928).

Ustilago poae-annuae W.H. Davis 1935 (nom. nud. et eventuale).

Ustilago poae-pratensis W.H. Davis 1935 (nom. nud. et eventuale).

Ustilago poae S. Ito 1936 (nom. inval.).

Ustilago jaczevskyana Lavrov var. *jaczevskyana* (as '*var. typica* Lavrov') 1936.

Ustilago jaczevskyana var. *sibirica* Lavrov 1936.

Ustilago triseti Liro 1939.

Ustilago anthoxanthi Liro 1939.

Ustilago linearis (Berk. & Broome) Petch 1924.

Ustilago loliicola Cif. 1938.

Ustilago taenia Cif. 1938.

Ustilago poae-bulbosae Săvul. 1951.

Ustilago poae-nemoralis Vienn.-Bourg. 1951.

Ustilago duriusculae L. Guo 2006b.

Sori in leaves, leaf sheaths and culms as streaks parallel with the veins, occasionally by fusion covering most of the leaf surface, rarely also in the inflorescence and exceptionally in the ovaries, initially covered by the epidermis which soon ruptures, the dark brown, semi-powdery to powdery spore mass becoming scattered and the leaf-blades often shred. Infection systemic. The fungus perennates as mycelium in crowns, stolons or other organs. *Spores* globose, ovoid to irregular, 8–12(–13) × 9–15(–16) μm, light olive-brown, finely to prominently echinulate, profile serrulate. *Spore germination* results in septate basidia which produce lateral branches or, under other conditions, basidiospores (Fig. 76).

On *Poaceae*: *Bromus stenostachyus* Boiss., Mazandaran Prov., Kelardasht city, Roodbarak village, IRAN 8347 F.

On *Dactylis glomerata* L., Tehran Prov., Fasham city; Tehran Prov., Darakeh village, Palangchal area, IRAN 8331 F; Tehran Prov., Afjeh village, IRAN 8068 F.

On *Poa annua* L., Chahar-Mahal va -Bakhtiari Prov., Zard-kuh Mt., IRAN 8033 F.

On *Poa trivialis* L., Khorasan-e Razavi Prov., 45 km W of Mashhad city, Abardeh-Olia village, IRAN 7286 F.

On *Poa* sp., Tehran Prov., Karaj-Chalus road, on the road Shahrestanak, 7 km after bifurcation towards Shahrestanak village, in orchard, IRAN 10896.

On unknown *Poaceae*, Tehran Prov., Karaj-Chalus road, Azadbar village, IRAN 10499 F.

Remark. Report of *U. striiformis* on *Scirpus pumilus* Vahl from Tehran Prov., Darakeh Valley, Palangchal area, Espiu spring, IRAN 8311 F (Ershad 2001: 196) is erroneous. The host plant is a *Poaceae*.

94. *Ustilago trebouxii* Syd. & P. Syd., Ann. Mycol. 10: 214, 1912.

Ustilago sitanii G.W. Fisch. 1938.

Ustilago kazachstanica Gutner & Sergeeva 1941.

Ustilago underwoodii Zundel 1942.

Ustilago helictotrichi Schmied., in Schmied. & Puncag 1966.

Sori in upper leaves and leaf sheaths as long, dark brown, dusty striae, but also in distorted inflorescence, more or less destroying them. Spore mass exposed early. *Spores* globose, subglobose, ovoid to slightly irregular, (3.5–)4–5.5 × 4–7 μm, light olive-brown tending to be paler on one side, apparently smooth to finely, sparsely punctate-verruculose. *Spore germination* results in long, 4-celled basidia, producing navicular basidiospores on well-developed sterigmata (Fig. 77).

On *Poaceae*: *Bromus tomentellus* Boiss., Chaharmahal va -Bakhtiari Prov., Farsan city, Deh Cheshmeh village, Pirghar spring, IRAN 8088 F.

On unknown *Poaceae*, Khorashan-e Shomali Prov., 13 km W of Bojnurd city, Badranlu Pass, IRAN 7274 F.

95. *Ustilago trichophora* (Link) Kunze ex Körn., Hedwigia 16: 36, 1877.

Caeoma trichophorum Link 1825.

Ustilago sphaerogena Burrill, in Sacc. 1888. – *Cintractia sphaerogena* (Burrill) H.H. Hume 1902.

Ustilago crus-galli Tracy & Earle 1895. – *Cintractia crus-galli* (Tracy & Earle) Magnus 1896b. –

Ustilago trichophora var. *crus-galli* (Tracy & Earle) Lavrov 1936.

Ustilago panici-frumentacei Bref. 1895. – *Ustilago trichophora* var. *pacifica* Lavrov 1936. –

Ustilago trichophora (Link) Kunze ex Körn. var. *panici-frumentacei* (Bref.) Mundk. 1943.

Cintractia seymouriana Magnus 1896b.

Ustilago globigena Speg. 1899.

Ustilago holubii Syd. 1935.

Ustilago crus-galli Tracy & Earle var. *minor* Zundel 1953 (nom. inval.).

Sphacelotheca almora A. Krishna & R.A. Singh 1980.

Sori in scattered flowers in the spike (usually affecting all floral parts, including ovaries), and on vegetative parts (leaves, stems) as bullate bodies from a few mm in diam. to 10 cm long swellings (especially on the stems), covered by a hispid peridium composed of an inner, fungal layer and an outer layer of host origin, which ruptures irregularly to expose the first agglutinated, later pulverulent, dark brown spore mass. *Spores* globose, subglobose to ovoid, 6–11 × 7–12 µm, pale olive-brown, sparsely to moderately densely verrucose-echinulate, spore profile wavy to sparsely serrulate, in SEM sparsely to moderately densely, minutely verruculose between the spines. *Spore germination* of *Ustilago*-type; basidium often two-celled or a short, aseptate basidium, occasionally with a lateral branch, successively produces ovoid to ellipsoidal basidiospores apically (Fig. 78).

On *Poaceae*: *Echinochloa crus-galli* (L.) P. Beauv., Golestan Prov., Bandargaz city; Khuzestan Prov., Ramin city; Kohgiluyeh va -Buyerahmad Prov., Dogonbadan city, IRAN 4401 F.

96. *Ustilago tritici* (Pers. : Pers.) Rostr., Overs. Kongel. Danske Vidensk. Selsk. Forh. Medlemmers Arbejder, 1890: 15, 1890b (March).

Uredo segetum Pers. var. *tritici* Pers. 1797. – *Uredo segetum* Pers. var. *Uredo tritici* Pers. : Pers. 1801. – *Uredo carbo* DC. var. *tritici* (Pers. : Pers.) DC. 1815. – *Erysibe vera* Wallr. var. *tritici* (Pers. : Pers.) Wallr. 1833. – *Ustilago segetum* ("Bulliard") Roussel var. *tritici* (Pers. : Pers.) Brunaud 1878. – *Ustilago segetum* (Pers.) Roussel var. *tritici* (Pers. : Pers.) Rostr. & C.N. Jensen, in Jensen 1888. – *Ustilago tritici* (Pers. : Pers.) C.N. Jensen, in Kellerm. & Swingle 1890 (June; later homonym).

Ustilago passerinii A.A. Fisch. Waldh. 1877b.

Ustilago ehrenbergiana A.A. Fisch. Waldh. 1879a, b.

Ustilago hordei Bref. 1888 (nom. ambig.).

Ustilago schumanniana Henn. 1893b.

Ustilago vavilovii Jacz. 1925.

Ustilago ugamica Golovin 1952.

Ustilago tritici (Pers. : Pers.) Rostr. [forma] *folicola* Henn. 1894.

Sori in spikelets, dark olive-brown, dusty ("loose smut"), usually destroying all floral parts leaving behind only the naked rachis, but in rye usually only parts of the lower spikelets are destroyed; occasionally also on leaves, sheaths and culms as striae. *Spores* globose to subglobose or ovoid, 5–7 × 6–9 µm, olive-brown, paler on one side, minutely echinulate. *Spore germination* results in septate, 4-celled basidia. On artificial media and in nature fusion between compatible basidial cells gives rise to dikaryotic hyphae which infect the host via ovary at flowering, resulting in a systemic disease (Fig. 79).

On *Poaceae*: *Aegilops kotschyi* Boiss., West Azarbaijan, Orumiyeh lake, Kabudan Island, IRAN 4348 F; Fars Prov., Bamu National Park, IRAN 13289 & 13290 F.

On *Aegilops triaristata* Willd., Ghazvin Prov., 50 km NW of Ghazvin city, IRAN 7280 F.

On *Aegilops triuncialis* L., Tehran Prov., Evin village, IRAN 6839 & 8545 F; Ardebil Prov., Moghan city, between Ultan and Gharehaghaj villages, IRAN 8769 F; Fars Prov., Darab city, Layzangan village, IRAN 11537 F; Lorestan Prov., between Khoramabad and Alashtar cities, IRAN 8768 F; Ghazvin Prov., Chenarkhani village, IRAN 10425 F.

On *Triticum aestivum* L. (*T. vulgare* Vill.). Common in Iran.

97. *Ustilago turcomanica* Tranzschel ex Vánky, Mycotaxon 31: 404, 1988a.

Ustilago turcomanica Tranzschel, in Tranzschel & Serebrianikow 1912 (nom. nud.).

Sori in spikelets, in ovaries and at the base of paleae and glumes, swollen, covered by a delicate membrane which ruptures exposing the dark brown, semi-powdery spore mass. Infection systemic; all flowers in a spike and usually all spikes of a plant affected. *Spores* globose, subglobose, ellipsoidal to somewhat irregular, 9–11 × 9.5–14(–15) µm, medium olive-brown with slightly paler polar areas; wall 1–1.5 µm thick, rarely almost smooth, usually densely and finely verruculose. *Spore germination* results in 2–3-septate basidia with 2–4 basal branches, in water giving rise to hyphae, in nutrient media developing lateral and terminal basidiospores (Fig. 80).

On *Poaceae*: *Eremopyrum bonaepartis* (Spreng.) Nevski, Ghazvin Prov., 11 km W of Takestan, on the road of Takestan towards Ahar.

On *Eremopyrum distans* (K. Koch) Nevski, Semnan Prov., 20 km NE of Semnan city, IRAN 7252 F.

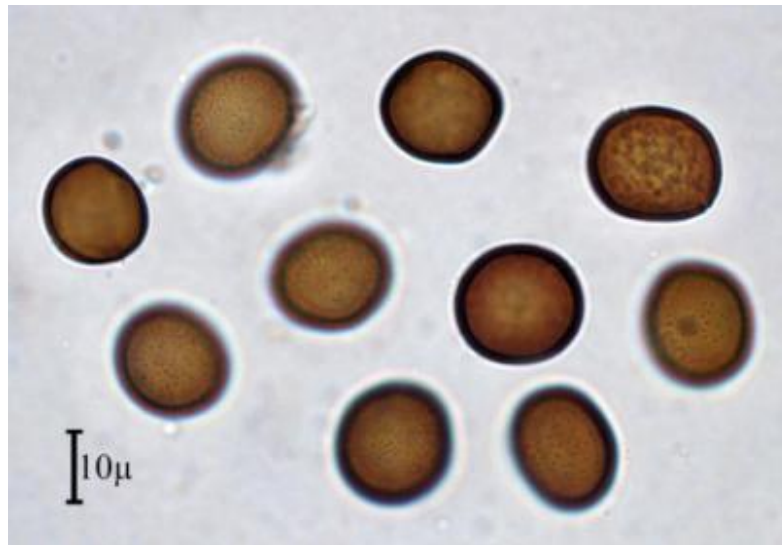


Fig.65 – *Ustilago aeluropidis* on *Aeluropus* sp. (11342)

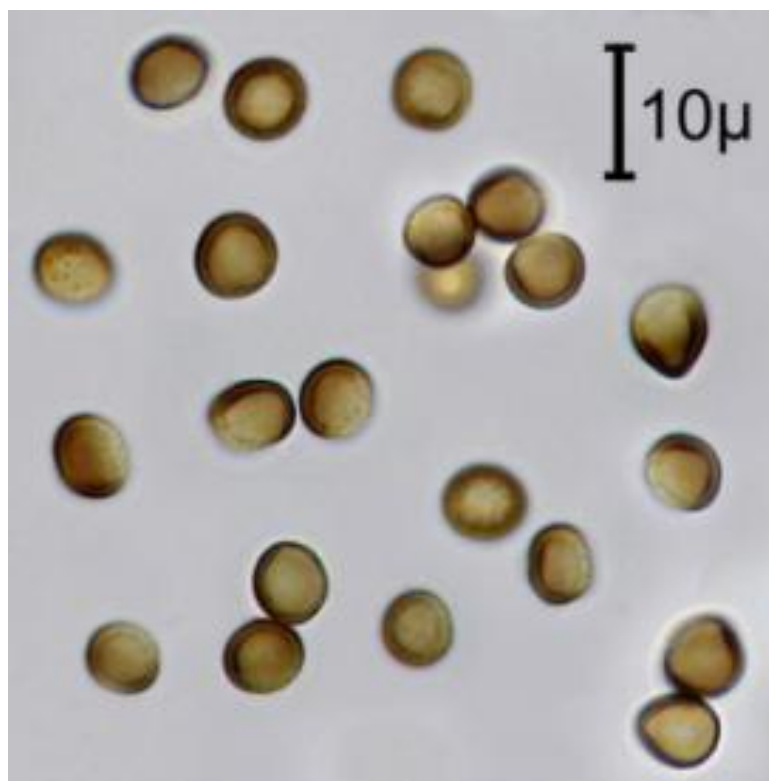


Fig.66 – *Ustilago avenae* on *Avena ludoviciana* (13873)

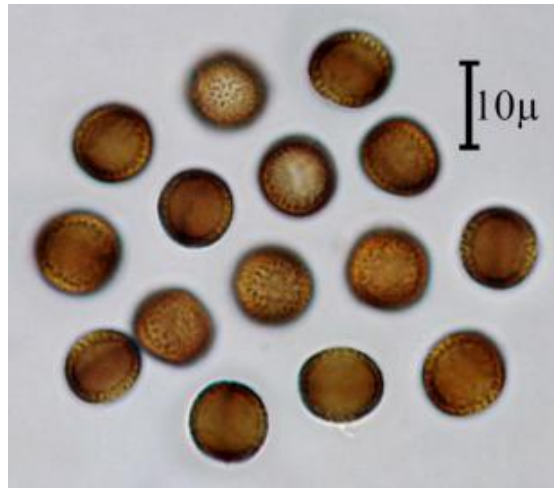


Fig.67 – *Ustilago bromivora* on *Brachypodium distachyon* (14785)

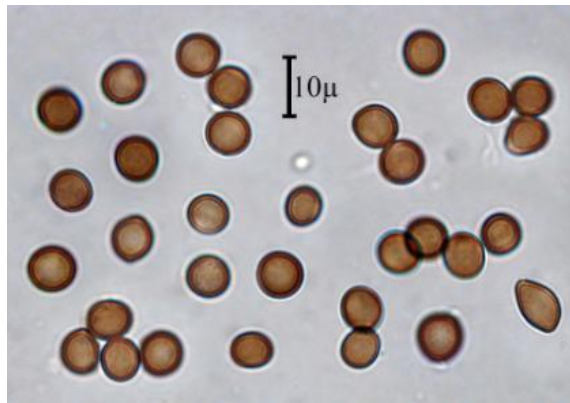


Fig.68 – *Ustilago cynodontis* on *Cynodon dactylon* (13284)

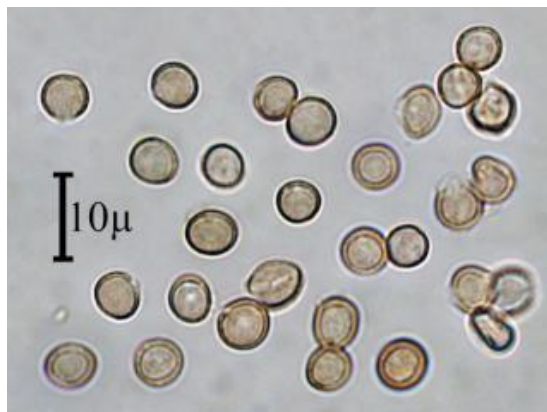


Fig.69 – *Ustilago filiformis* on *Glyceria plicata* (14216)

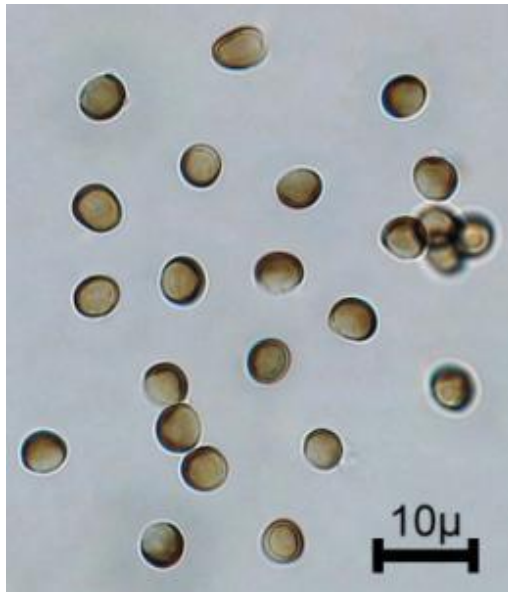


Fig.70 – *Ustilago hordei* on *Hordeum vulgare* (13870)

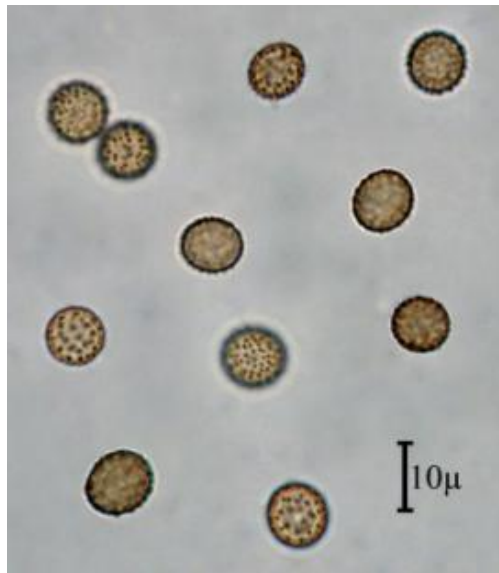


Fig.71 – *Ustilago maydis* on *Zea mays* (14571)

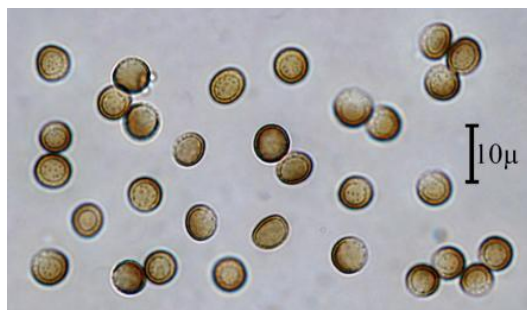


Fig.72 – *Ustilago nuda* on *Hordeum vulgare* (10528)

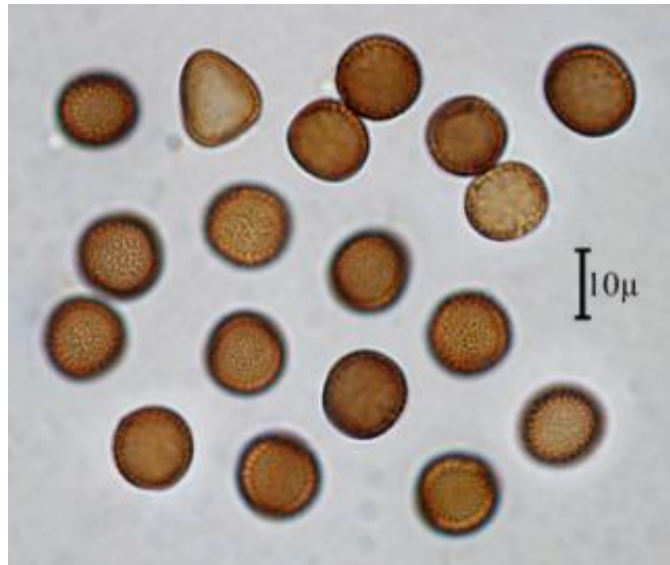


Fig.73 – *Ustilago pamirica* on *Bromus gracillimus* (7251)

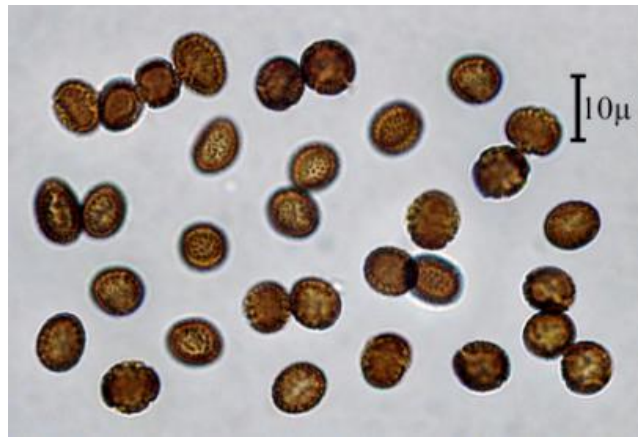


Fig.74 – *Ustilago phrygica* on *Taeniatherum* sp. (1764)

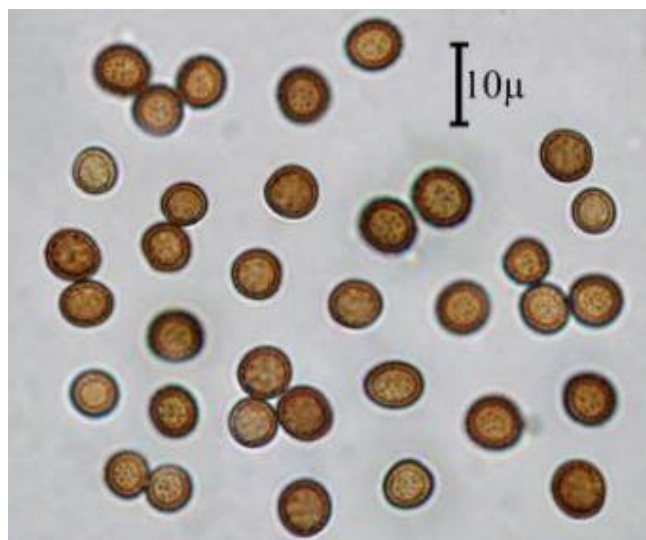


Fig.75 – *Ustilago scitaminea* on *Saccharum officinarum* (10712)

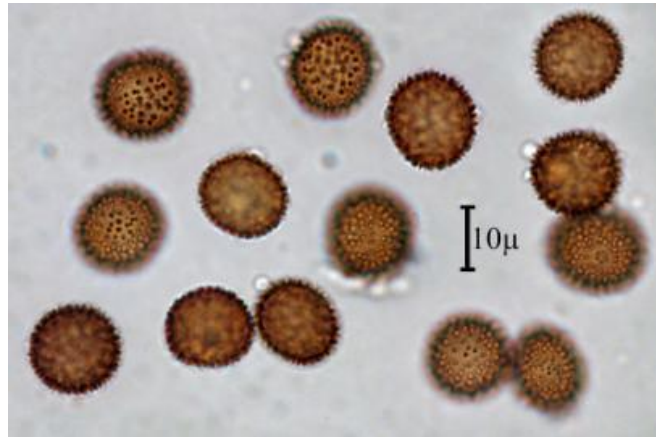


Fig.76 – *Ustilago striiformis* on unknown Poaceae (10499)

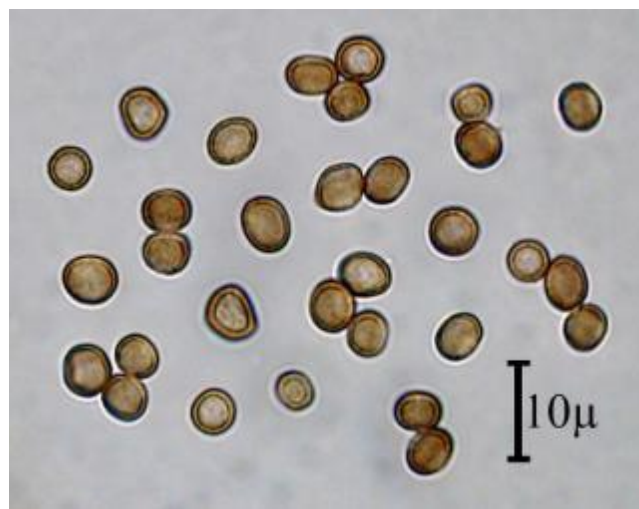


Fig.77 – *Ustilago trebouxii* on *Bromus tomentellus* (8088)



Fig.78 – *Ustilago trichophora* on *Echinochloa crus-galli* (4401)

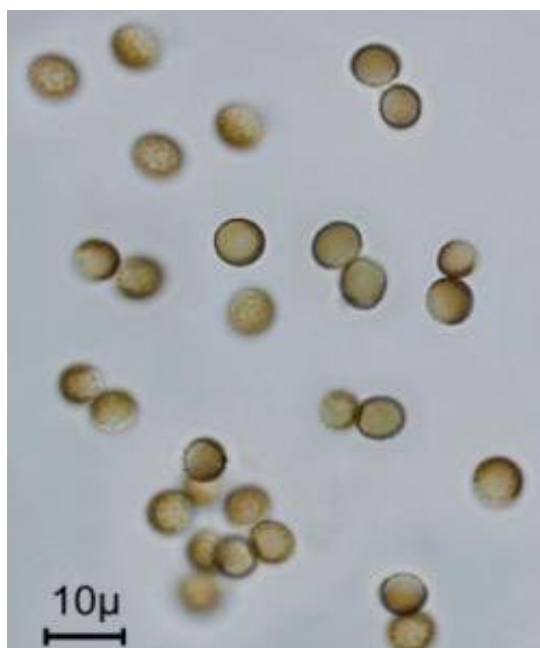


Fig.79 – *Ustilago tritici* on *Triticum aestivum* (14574)

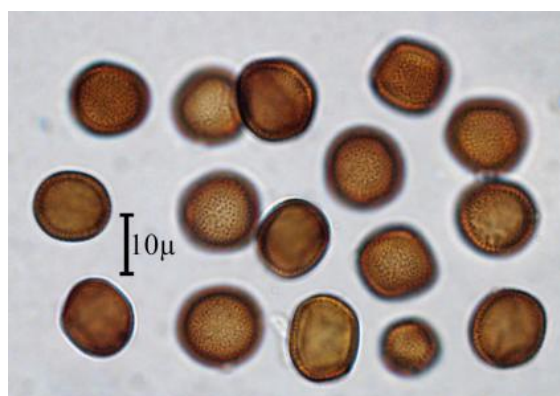


Fig.80 – *Ustilago turcomanica* on *Eremopyrum distans* (7252)

***Vankya* Ershad**

Key to the *Vankya* species

1. Spores 15–23 μm long; wall 1.5–3 μm thick, with spines embedded in the exospore
 *V. heufleri*
- Spores 10.5–19(–24) μm long; wall 0.5–1.5 μm thick, apparently smooth *V. ornithogali*

98. *Vankya heufleri* (Fuckel) Ershad, Rostaniha 1: 68, 2000.

Ustilago heufleri Fuckel 1870.

Urocystis pompholygodes (Klotzsch) Rabenh. f. *tulipae* Rabenh. 1866 (nom. nud.) – *Ustilago tulipae* (Rabenh.) G. Winter 1881 (nom. illegit., superfl. pro *U. heufleri*).

Ustilago erythronii G.P. Clinton, in Peck 1873. – *Ustilago ornithogali* (J.C. Schmidt & Kunze) J.G.

Kühn f. *erythronii* (G.P. Clinton) De Toni, in Sacc. 1888.

Sori in leaves as elongate pustules, initially covered by a thin, whitish membrane which ruptures irregularly and flakes away to expose the blackish brown, dusty spore mass. *Spores* globose, subglobose to ovoid or slightly irregular, 13–19 \times 15–23 μm , olive-brown; spore wall two-layered, inner layer dark brown, c. 0.5 μm thick, with sparsely, unevenly dispersed, 1–2 μm high spines, the

spines often arranged in irregular rows or groups, embedded in the outer, yellowish brown, 1–2.5 µm thick layer, sometimes reaching the spore surface but never exceeding it, in SEM almost smooth or with sparsely or moderately dense, low and wide warts. *Sterile cells* solitary, rarely in loosely connected pairs, indistinct, subglobose, ellipsoidal, to slightly irregular, collapsed in old specimens, 11–17(–20) µm long, yellowish to pale olivaceous brown, wall evenly or slightly unevenly 1.5–3(–4) µm thick, one-layered, smooth. *Spore germination* results in two- to four-septate basidia, 4–5 × 70–80 µm, producing lateral, ovoid basidiospores which bud or germinate into hyphae (Fig. 81).

On *Liliaceae*: *Tulipa biflora* Pall., Esfahan Prov., Semirom city.

On *Tulipa humilis* Herb., Tehran Prov., Central Alborz, Tochal Mt., IRAN 8595 F.

On *Tulipa montana* Lindl., Tehran Prov., N. of Tehran city, Darabad Mt., IRAN 8510 F.

On *Tulipa montana* var. *chrysantha* (Boiss.) Wendelbo ex Rech. f., Tehran Prov., Alborz mountain, Palang-chal area, IRAN 8594 F.

On *Tulipa polychroma* Stapf, Esfahan Prov., c. 135 km S. of Esfahan city, c. 20 km N. of Semirom city, IRAN 8509 F.

On *Tulipa* sp., West Azarbaijan Prov., Orumieh city, Ghushchi pass, IRAN 8761 F; Markazi Prov., Arak city, Lateh Dar Mt. IRAN 15001 F.

99. *Vankya ornithogali* (J.C. Schmidt & Kunze) Ershad, Rostaniha 1: 66, 2000.

Uredo ornithogali J.C. Schmidt & Kunze 1819. – *Ustilago ornithogali* (J.C. Schmidt & Kunze)

Magnus 1875. – *Ustilago ornithogali* (J.C. Schmidt & Kunze) J.G. Kühn, in Rabenh. 1875.

Caeoma ornithogali Schldl. 1824.

Ustilago ornithogali J. Schröt., in Schneider 1869. (nom. nud.).

Ustilago umbrina J. Schröt. 1869.

Ustilago heterospora Niessl 1872.

Sori in leaves and bracts as 1–5(–10) mm long, fusiform swellings, initially covered by the epidermis, which ruptures longitudinally to expose the blackish brown, powdery spore mass. Infection systemic, appearing year after year on the same host plant. *Spores* variable in shape and size, irregular, subpolyhedral, elongate, acute, ovoid or subglobose, 9.5–15 × 10.5–19(–24) µm, olive-brown, sometimes with a short pedicel; wall 0.5–1.5 µm thick, apparently smooth but actually very finely and densely punctate, spore profile smooth. *Sterile cells* few, solitary or in groups of 2–4, subglobose, ellipsoidal, slightly irregular, rarely elongate, collapsed in old specimens, 11–20 µm long, usually of the same colour as the spores; wall 1.5–3(–4) µm thick, one-layered, smooth (Fig. 82).

On *Hyacinthaceae* (Liliaceae s. lat.): *Gagea confusa* Terracc., Tehran Prov., 10 km N. of Tehran city, Darabad Mt., IRAN 8521 F.

On *Gagea dubia* Terracc., Tehran Prov., Tehran city, Tochal Mt., IRAN 8597 F; Chaharmahal va Bakhtiari Prov., 19 km W of Shahr-e-Kord city, Sureshjan village, IRAN 8522 F; Tehran Prov., Tehran city, Evin area, campus of Iranian Research Institute of Plant Protection, IRAN 9564 F.

On *Gagea fistulosa* (Ramond ex DC.) Ker Gawl., Chaharmahal va Bakhtiari Prov., Chelgerd city, Kuhrang city, IRAN 8208 F.

On *Gagea gageoides* (Zucc.) Vved., Tehran Prov., Tehran city, Tochal Mt. IRAN 8596 F; Tehran Prov., 60 km E of Tehran city, Elburz Mt., "Emamzadeh-Hashem" shrine, IRAN 7281 F; Tehran Prov., N. of Tehran city, Darabad Mt., IRAN 7282 F; Chaharmahal va Bakhtiari Prov., Chelgerd city, Zard-kuh Mt., IRAN 8085 F.

On *Gagea* sp., Chaharmahal va Bakhtiari Prov., Shahre Kord city, Sureshjan city, IRAN 8328 F; Esfahan Prov., 140 km NW of Esfahan city, Golestan Kuh Mt., IRAN 7284 F; Tehran Prov., N. of Tehran city, Darabad Mt., IRAN 7285 F.

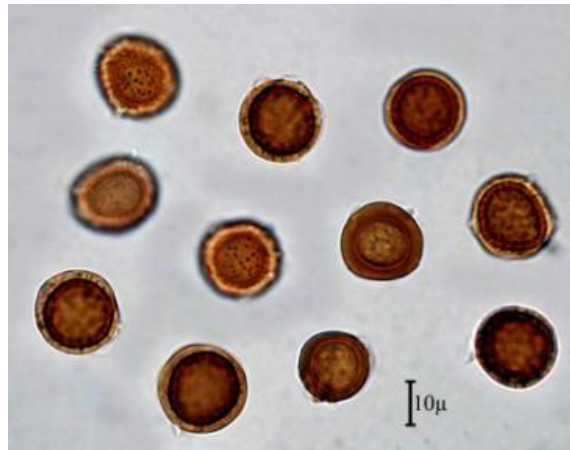


Fig.81 – *Vankya heufleri* on *Tulipa polychroma* (8509)

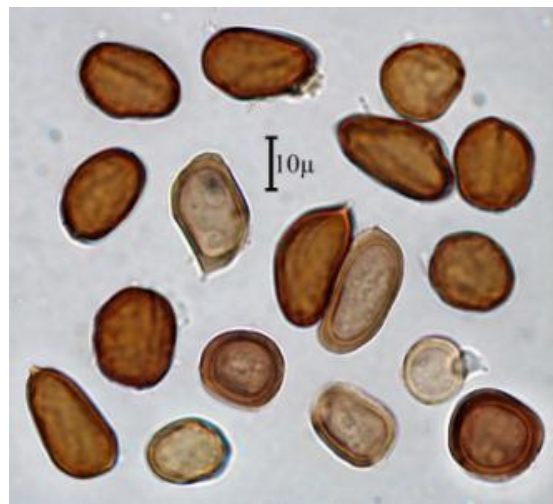


Fig.82 – *Vankya ornithogali* on *Gagea confusa* (8521)

Host plant – smut fungus index

- Aegilops kotschy* – *Ustilago tritici*
Aegilops trinucialis – *Tilletia contraversa*; *T. caries*; *Ustilago avenae*; *U. tritici*
Aegilops. triaristata – *Ustilago tritici*
Aeluropus littoralis – *Ustilago aeluropodis*
Agropyron intermedium – *Urocystis agropyri*
Allium akaka – *Urocystis magica*
Allium cepa – *Urocystis magica*
Arrhenatherum kotschy – *Urocystis behboudii*
Avena barbata – *Ustilago avenae*
Avena fatua – *Ustilago avenae*
Avena ludoviciana – *Ustilago avenae*
Avena sativa – *Ustilago avenae*
Avena sp. – *Ustilago avenae*
Bellevalia glauca – *Antherospora tourneuxii*
Bellevalia saviczii – *Antherospora tourneuxii*
Brachypodium distachyon – *Ustilago bromivora*

Bromus danthoniae – *Ustilago bromivora*
Bromus gracillimus – *Ustilago pamirica*
Bromus japonicus – *Ustilago bromivora*
Bromus madritensis – *Ustilago bromivora*
Bromus rubens – *Ustilago bromivora*
Bromus sp. – *Ustilago bromivora*
Bromus stenostachyus – *Ustilago striiformis*
Bromus sterilis – *Ustilago bromivora*
Bromus tectorum – *Ustilago bromivora*
Bromus tomentellus – *Ustilago trebouxii*
Carex diluta – *Anthracoidea caricetorum*
Carex flacca ssp. *serrulata* – *Anthracoidea pratensis*
Carex halleriana – *Schizonella cocconii*
Carex liparocarpos – *Anthracoidea caryophylleae*
Carex melanostachya – *Anthracoidea melanostachyae*
Carex michelii – *Anthracoidea michelii*
Carex riparia – *Farysia thuenenii*
Carex songorica – *Anthracoidea songorica*
Carex sp. – *Anthracoidea caricis*; *A. eleocharidis*; *Urocystis fischeri*
Carex stenophylla – *Anthracoidea eleocharidis*
Carex tomentosa – *Anthracoidea tomentosae*
Ceratocephalus falcaus – *Urocystis ceratocephali*
Colchicum procurrens – *Urocystis colchici*
Colchicum sp. – *Urocystis colchici*
Critesion bulbosum – *Tilletia contraversa*
Critesion marinum – *Tilletia hordei*
Critesion murinum – *Tilletia hordei*
Critesion murinum subsp. *leporinum* – *Tilletia hordei*
Critesion violaceum – *Urocystis tianschanica*
Cymbopogon olivieri – *Sporisorium lanigeri*
Cynodon dactylon – *Ustilago cynodontis*
Cynodon sp. – *Ustilago cynodontis*
Dactylis glomerata – *Jamesdicksonia dactylidis*; *Ustilago striiformis*
Dianthus caryophyllus – *Microbotryum dianthorum*
Dianthus orientalis – *Microbotryum dianthorum*
Dianthus tabrisianus – *Microbotryum dianthorum*
Dichanthium annulatum – *Sporisorium andropogonis*; *Sp. foveolati*
Dichanthium foveolatum – *Sporisorium foveolati*
Dichanthium ischaemum – *Sporisorium andropogonis*
Echinochloa crus-galli – *Moesziomyces bullatus*; *Ustilago trichophora*
Elymus hispidus – *Tranzscheliella hypodytes*; *Tilletia contraversa*
Elymus hispidus subsp. *barbulatus* – *Tilletia contraversa*; *Tranzscheliella hypodytes*
Elymus repens – *Tranzscheliella hypodytes*
Elymus sp. – *Tranzscheliella hypodytes*
Eremopyrum bonaepartis – *Ustilago turcomanica*
Eremopyrum distans – *Ustilago turcomanica*
Gagea confusa – *Vankya ornithogali*
Gagea dubia – *Vankya ornithogali*
Gagea fistulosa – *Vankya ornithogali*
Gagea gageoides – *Vankya ornithogali*

Gagea sp. – *Vankya ornithogali*
Geranium tuberosum – *Entyloma atlanticum*
Gladiolus segetum – *Urocystis gladiolicola*
Glyceria plicata – *Ustilago filiformis*
Hordeum bulbosum – *Jamesdicksonia dactylidis*
Hordeum glaucum – *Ustilago bromivora*
Hordeum leporinum – *Ustilago hordei*
Hordeum sp. – *Ustilago hordei*
Hordeum spontaneum – *Jamesdicksonia dactylidis*
Hordeum vulgare – *Tilletia contraversa*; *Ustilago avenae*; *U. hordei*; *U. nuda*
Hydrocharis morsus-ranae – *Tracya hydrocharidis*
Hyparrhenia hirta – *Sporisorium vanderystii*
Imperata cylindrica – *Sporisorium schweinfurthianum*
Ixiolirion pallasii – *Urocystis ixiolirii*
Ixiolirion sp. – *Urocystis ixiolirii*
Lasiurus indicus – *Sporisorium desertorum*
Linaria sp. – *Entyloma linariae*
Lolium subulatum – *Tilletia lolii*
Lolium loliaceum – *Urocystis bolivarii*
Lolium rigidum – *Tilletia lolii*; *Urocystis bolivarii*
Lolium sp. – *Urocystis bolivarii*
Muscari sp. – *Antherospora vaillantii*; *Urocystis muscaridis*
Myosotis sylvatica – *Entyloma fergussonii*
Ornithogalum kurdicum – *Urocystis ornithogali*
Orobanche ramosa – *Urocystis orobanches*
Panicum miliaceum – *Sporisorium destruens*
Pedicularis sibthorpii – *Urocystis pedicularis*
Pennisetum orientale – *Sporisorium penniseti*
Phalaris sp. – *Urocystis phalaridis*
Physalis alkekengi – *Entyloma australe*
Poa annua – *Ustilago striiformis*
Poa sp. – *Ustilago striiformis*
Poa trivialis – *Ustilago striiformis*
Primula veris subsp. *macrocalyx* – *Urocystis primulae*
Psathyrostachys fragilis – *Tilletia hordei*
Ranunculus ficaria – *Entyloma majewskii*; *Urocystis ficariae*
Ranunculus muricatus – *Entyloma microsporum*; *Urocystis ranunculi*
Ranunculus sceleratus – *Entyloma ranunculi-repentis*
Rhagadiolus stellatus – *Entyloma rhagadioli*
Rostraria cristata – *Tilletia rostrariae*
Saccharum officinarum – *Ustilago scitaminea*
Schismus arabicus – *Sporisorium aegyptiacum*
Scorzonera caliculata – *Microbotryum scorzonerae*
Setaria glauca – *Macalpinomyces neglectus*
Setaria italica – *Ustilago crameri*
Setaria viridis – *Ustilago crameri*
Sorghum bicolor – *Sporisorium cruentum*; *Sp. ehrenbergii*; *S. reilianum*; *Sp. sorghi*
Sorghum cernuum – *Sporisorium sorghi*
Sorghum halepense – *Sporisorium cruentum*; *Sp. reilianum*; *Sp. sorghi*
Sorghum sp. – *Sporisorium cruentum*; *Sp. sorghi*

Sorghum vulgare – *Sporisorium reilianum*
Spodiopogon pogonanthus – *Sporisorium persicum*
Stipa capensis – *Urocystis corsica*
Stipa hohenackeriana – *Tranzscheliella williamsii*
Stipa pulcherrima – *Tranzscheliella williamsii*
Stipa sp. – *Tranzscheliella iranica*
Stipagrostis plumosa – *Sporisorium aristidae-lanuginosae*
Taeniatherum asperum – *Tilletia bornmuelleri*
Taeniatherum caput-medusae – *Ustilago phrygica*
Taeniatherum crinitum – *Ustilago phrygica*
Taeniatherum sp. – *Ustilago phrygica*
Thalictrum foetidum – *Urocystis sorosporioides*
Thalictrum sultanabadense – *Urocystis sorosporioides*
Tragopogon graminifolius – *Entyloma tragopogonis*; *Microbotryum tragopogonis-pratensis*
Tricholaena teneriffae – *Sporisorium tricholaenae*
Triticum aestivum – *Tilletia caries*; *T. contraversa*; *T. indica*; *T. laevis*; *Urocystis tritici*; *Ustilago tritici*
Triticum sp. – *Tilletia caries*; *Urocystis tritici*
Tulipa biflora – *Vankya heufleri*
Tulipa humilis – *Vankya heufleri*
Tulipa montana – *Vankya heufleri*
Tulipa montana var. *chrysantha* – *Vankya heufleri*
Tulipa polychroma – *Vankya heufleri*
Tulipa sp. – *Vankya heufleri*
Viola occulta – *Urocystis kmetiana*
Viola sp. – *Urocystis violae*
Viola tricolor – *Urocystis kmetiana*
Zea mays – *Sporisorium reilianum*; *Ustilago maydis*

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