E. Bonkerae Thornber & Bonker has a more restricted range than *E. Boyce-Thompsoni* and probably is no more than a short-spined variety of that species. Two illustrations may be found, opposite pages 28 and 72, in *The Fantastic Clan* (MacMillan Co., 1932), where the original description appeared.

E. Ledingii Peebles, Cact. and Succ. Jour. 8, no. 3 (1936), has no close relative and occurs only on the slopes of Mt. Graham, in the Pinaleno Mts., Arizona. Adequate illustrations accompany the original description.

KEY TO PURPLE-FLOWERED ARIZONA SPECIES

Central spines wanting; areoles elliptic, the radial spines pectinate .... *E. rigidissimus* [5]

Central spines present; areoles orbicular.

- Central spines usually 2 to 6, or more, all well developed, more or less curved or twisted, the lower ones deflexed, commonly flattened and angled toward base; stems stout .... *E. Engelmanni*
- Central spine solitary, terete, often accompanied by superposed accessory centrals, these much shorter and more or less like the radials.
  - Spines translucent, straw-colored, monochromatic; principal central curved near base, deflexed; accessory centrals 1 to 4, or wanting... *E. Ledingii*
  - Spines opaque, reddish-brown, dark-brown, whitened or ashy-gray, usually variegated.
    - Ribs 12 to 22, usually 14 to 18; principal central spine porrect or deflexed; 1 or 2 accessory centrals present on at least some areoles.
      - Spines 15 to 35 mm. long, the central sometimes longer; stems somewhat obscured by dense armament ...... *E. Boyce-Thompsoni*
      - Spines not more than 10 mm. long; stems not obscured .... *E. Bonkerae*
    - Ribs 9 to 13, usually 8 to 10.
      - Centrals ordinarily curved and strongly ascending; except sometimes in age, flexible, 2.5 to 4.5 cm. long; accessory centrals wanting; radials straight or curved; stems rarely more than 10 or 12 cm. long, flaccid. *E. Fendleri*
      - Centrals porrect; all spines straight; accessory centrals usually present on at least some areoles; stems rarely less than 15 cm. long, rigid.
        - Spines 1.0 to 2.6 cm. long, stout and rigid; stems few, usually 1 to 5 in number, 8 to 25 cm. long .... *E. rectispinus*
        - Spines 2.5 to 6.0 cm. long, relatively more slender and flexible; stems 5 to 15 in number, 25 to 45 cm long. *E. rectispinus* var. *robustus*

[5] A related form with 4 or 5 short central spines has been collected recently in Cochise County, Arizona, by Wyatt W. Jones of Douglas.

Echinocereus Boyce-Thompsoni Orcutt, Cactography, no. 3, part 1, 1926.—*Reprint of original description:* Plant cespitose, with the aspect of E. Engelmanni, few to a dozen or more heads from one root; stems 6–8 inches high, 2 in diameter; ribs 10–12, 10 mm. high, more or less tuberculated; radials 10, 8 mm. long, white, or often tipped with chocolate; central spines 1–2, 6–25 mm. long, erect, straight, terete; areoles ovate, 10 mm. apart, white-woolly when young, naked in age; flowers said to be variable in color, fruit unknown. Type locality: grounds of the Boyce Thompson Southwestern Arboretum, near Superior, Arizona, at an elevation of about 2300 feet.

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THE GENUS BLASTOSPORA [1]

E. B. Mains

BLASTOSPORA WAS described by Dietel in 1908. It was based on *Blastospora Smilacis,* which was described from a collection on *Smilax Sieboldi* obtained by T. Yoshinaga at Engyôji, Tosa, Japan, in October 1907. Dietel compares it to Uromyces. He emphasized the thin, hyaline walls of the teliospores, the absence of differentiate pores for the teliospores, and the separation of the promycelium from the empty germinated teliospore by a convex wall. Four additional species have been described in the genus, *B. Butleri* and *B. Hygrophilae* by the Sydows and Butler in 1912, *B. Itoana* by Togashi and Onuma in 1931, and *B. ascotela* by Sydow and Mitter in 1935.

A study [2] of this genus has resulted in the discovery of an interesting situation. The type specimen of *Blastospora Smilacis* bears minute telia. These do not develop within the tissue of the host but on the exterior. The mycelium emerges through the stomata and the spore-producing cells develop outside. These form a compact pulvinate mass, 50–60 μ in diameter. From them, the teliospores arise. These are globoid, with very thin hyaline walls. They germinate at once with cylindrical basidia. Apparently the wall of the basidium is not a continuation of the wall of the teliospore, as stated by Dietel. Several germinating teliospores were seen in which the protoplasm had contracted somewhat, showing a clear separation from the wall of the teliospore and the young basidium projecting through an apical opening in it. The wall of the basidium is as thick as that of the teliospore, and the difference usually

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[2] The writer is indebted to Dr. G. Samuelsson of the Naturhistoriska Riksmuseet, Sweden, to Dr. N. Hiratsuka of Tottori Agriculture College, Japan, and Dr. D. H. Linder of the Farlow Herbarium, Harvard University for a number of the collections studied in this investigation.

is not very evident. The telia often occur in groups, and specially after the teliospores have started to germinate, they form fairly large pulverulent masses.

The situation in regard to the uredinia is puzzling. In some collections urediniospores are produced in the telia. These are globoid or broadly ellipsoid, 20–25 × 24–28 μ and coarsely echinulate. The type specimen also bears uredinia which differ markedly from the telia. They are subepidermal and rupture the epidermis. The urediniospores are larger (16–22 × 23–32 μ) than those from the telia and less prominently echinulate.

Blastospora Itoana has also been described from *Smilax* in Japan. The specimens of this species which have been available for study have telia similar to those of *B. Smilacis*, the teliospores being somewhat smaller. Only teliospores have been described for this species. In this study, uredinia have been found on several collections. These resemble the telia. The mycelium emerges through the stomata and develops compact masses of spore-producing cells on the surface of the leaf. The question therefore arises whether or not the subepidermal uredinia occurring on the type of *Blastospora Smilacis* really belong to that species.

A study of type specimens of the other species of *Blastospora* has resulted in the conclusion that these do not belong in the genus. *Blastospora Butleri* was described from a collection on *Jasminum malabaricum* made by S. L. Ajrekar at Matheran, Bombay India, Nov. 15, 1911. It has subepidermal telia. The teliospores are cylindric or clavate, sessile, thin-walled, hyaline, arising in groups of 5–9 from basal cells. This is evidently a species of *Chaconia*, and the combination **Chaconia Butleri** (Syd.) nov. comb. is proposed.

Blastospora Hygrophilae was described from a collection on *Hygrophila salicifolia* made by R. Sen at Chittagong, India, Sept. 11, 1911. The telia are subepidermal. The teliospores are broadly ellipsoid, thin-walled, hyaline, pedicellate, arising from a compact sporogenous layer. This is evidently a species of *Maravalia*, and the combination, **Maravalia Hygrophilae** (Syd. & Butler) nov. comb. is proposed.

Blastospora ascotela was described from a collection on *Hedyotis stylosa* made by J. H. Mitter (107), Ootacamund, British East India, Oct. 6, 1932. The telia are subepidermal, and the teliospores are cylindric, thin-walled, hyaline, pedicellate, arising from a compact sporogenous layer. This is evidently a species of *Maravalia*, and the combination **Maravalia ascotela** (Syd.) nov. comb. is proposed.

Dietel (1928) has placed *Blastospora* in the tribe Eriosporangieae of the Pucciniaceae. The manner of development of the telia excludes it from this tribe. In Dietel's classification it clearly belongs in the Hemileieae. It differs from *Hemileia* and *Gerwasia* in that the sporogenous cells develop outside the host. In *Hemileia* the basal cells develop within the host, and the pedicels of the teliospores project through the stoma. It is nearer *Gerwasia*. *Gerwasia* was described by Raciborski (1909) from a rust of *Rubus*, *G. Rubi*, from Java. Apparently this is known only from the original collection which has not been available for this study. Raciborski's description of the telia indicates important differences. He states that the teliospores are borne on a cell which projects through the stoma. This cell swells outside of the stoma, and from the swelling 4–15 teliospores develop. The teliospores are globoid and pedicellate.

Blastospora Dietel, Ann. Mycol. 6: 222. 1908.—Uredinia superstomatal (possibly also subepidermal), spore-bearing cells forming a small compact group above the stoma from mycelium emerging from it; urediniospores obovoid or ellipsoid, echinulate, pedicellate.

Telia superstomatal, spore-bearing cells forming a small compact group above the stoma from mycelium emerging from it; teliospores globoid or ovoid, the wall very thin, hyaline, pedicellate, germinating at once.

Type species: *Blastospora Smilacis* Dietel.

Blastospora Smilacis Dietel, Ann. Mycol. 6: 223. 1908.—Uredinia associated with the telia (connection doubtful), subepidermal, the urediniospores broadly obovoid or ellipsoid, 16–22 × 22–32 μ, the wall yellowish, 1.5–2 μ, moderately echinulate; urediniospores in the telia subgloboid or broadly ellipsoid, 20–25 × 24–28 μ, the wall yellowish, 1.5–2 μ, coarsely echinulate, the pores obscure.

Telia hypophyllous, superstomatal from hyphae emerging through the stomata, spore-bearing cells forming a compact lenticular mass above the stomata, often crowded into groups 1–2 mm. across, soon pulverulent from germination; teliospores ovoid or subgloboid, 26–36 × 40–55 μ, the wall hyaline, very thin, 1 μ or less, pedicellate, the pedicels 6–12 × 16–32 μ, germinating immediately through an apical opening, producing basidia 20–26 × 90–100 μ.

Specimens examined: *Smilax Sieboldi* Miq. Engyôji, Mikaszuki-mura, prov. Tosa, Japan, Oct. 1907, T. Yoshinaga, type; Hashiratani, Jûroku-mura, prov. Tosa, Oct. 31, 1909, T. Yoshinaga; Mt. Iwayama, pref. Iwate, Oct. 30, 1932, K. Togashi.

Subepidermal uredinia were found on two specimens, the type and Yoshinaga's collection of Oct. 31, 1909. They differ considerably in their development from the telia and from the uredinia of the following species, and the question arises whether or not they belong to this species. However, no other species on *Smilax* in Japan has been reported having uredinia which resemble them.

Blastospora Itoana Togashi and Onuma, Bot. Mag. 45: 6. 1931.—Uredinia minute, scattered in discolored areas, superstomatal from hyphae emerging through the stomata, the spore-bearing cells forming a compact mass above the stomata; urediniospores globoid or subgloboid, 16–20 × 16–22 μ, the wall yellowish, 1.5–2 μ moderately echinulate, the pores obscure.

Telia minute, scattered in discolored areas, superstomatal from hyphae emerging through the stomata, the spore-bearing cells forming a compact mass above the stomata; teliospores globoid or ovoid, 24–38 × 30–44 μ, the wall hyaline, thin, 1μ or less, pedicellate, germinating at once.

Specimens examined: *Smilax Oldhami* Miq. Mt. Daisen, prov. Hôki, Japan, Aug. 20, 1930, Naohide Hiratsuka; Aug. 24, 1931, Naohide Hiratsuka; Skinkeiji (Soto-kongô) prov. Kôngen, Korea, Aug. 24, 1934, Naohide Hiratsuka.

Uredinia were found on all the specimens, most abundantly on the collection of Aug. 24, 1934.

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LITERATURE CITED

Dietel, P. 1908. Uredineen aus Japan. II. Ann. Mycol. 6: 222–229.

———. 1928. Uredinales in Engler and Prantl. Naturl. Pflanzenfamilien. 6: 24–98.

Raciborski, M. 1909. Opizy kilku rdzy Jawy. Über einige javanische Uredineae. Bull. Acad. Sci. Cracovie Cl. Sci. Math. Nat. 266–280.

Sydow, H., P. Sydow, and E. J. Butler. 1912. Fungi Indiae orientalis. IV. Ann. Mycol. 10: 243–280.

———, and J. H. Mitter. 1935. Fungi indici. II. Ann. Mycol. 33: 46–71.

Togashi, K., and F. Onuma. 1931. A new species of *Blastospora*. Bot. Mag. 45: 4–7.

THE REACTIONS OF MYXOMYCETOUS SWARM-CELLS TO TEMPERATURE [1]

Robert F. Smart

Temperature, accepted as an environmental factor generally influential in protoplasmic activity, has been shown by de Bary (1884), Constantineau (1906), and the writer (Smart, 1937), to exert a definite influence upon the germination of myxomycetous spores. In so far as the writer is aware, however, the literature reveals no attempt on the part of students of this interesting group of organisms to study the influence of temperature upon the behavior of the flagellate swarm-cells derived from the spores of representative species. The writer (1937), while studying the influence of temperature upon spore germination, was impressed by the reaction of the swarm-cells to the temperatures used in those experiments. For example, it was evident that the swarm-cells of most species studied were able to continue their activity at temperatures much higher than those at which the spores of the same species had been able to germinate.

As the influence of temperature upon the behavior of active protoplasm is of considerable biologic interest in itself, the investigation of its influence upon the simple, presumably primitive, naked swarm-cells which typically initiate the life cycle in the Myxomycetes is of distinct significance.

It seemed desirable, therefore, to investigate this point to determine whether or not the various species show specific differences in their behavior. Accordingly a series of preliminary experiments were first performed upon the swarm-cells of species such as *Fuligo septica*, *Enteridium rozeanum*, and *Reticularia lycoperdon* selected because of their high percentage of germination and normally long swarming period (usually 4 days or more). The work was then extended to a larger and more representative number of species (cf. table 2). The experiments were carried on both in hanging drop cultures in electrically

Table 1. *Reactions of the swarm-cells of Fuligo septica to high temperatures.*

Trial	Temperatures			
	Quiescence	1st. motion	Flagellate motion	Normal activity
1	41°C.	38°C.	36°C.	33.5°C.
2	40°C.	38°C.	35°C.	32°C.
3	41.5°C.	37°C.	34.5°C.	33°C.
4	39.5°C.	38°C.	35°C.	31°C.
5	41°C.	37°C.	34°C.	32°C.
6	40°C.	38°C.	35°C.	33°C.
7	39°C.	37.5°C.	34°C.	31°C.
8	41°C.	39°C.	35°C.	33°C.
9	41.5°C.	39°C.	36°C.	32.5°C.
10	40°C.	37°C.	34°C.	33°C.

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