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Syzygites megalocarpus (Mucorales, Zygomycetes) in Illinois

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ABSTRACT

Syzygites megalocarpus Ehrenb.: Fr. (Mucorales, Zygomycetes), which occurs on fleshy fungi and was previously unreported from Illinois, has been collected from five counties--Cook, Gallatin, Jackson, Union, and Williamson. In Illinois, *S. megalocarpus* occurs on 23 species in 18 host genera. Fresh host material collected in the field and appearing uninfected can develop *S. megalocarpus* colonies after incubation in the laboratory. The ability of *S. megalocarpus* to colonize previously uninfected hosts was demonstrated by inoculation studies in the laboratory. Because the known distribution of potential hosts in Illinois is much broader than documented here, further attention to *S. megalocarpus* should more fully elucidate the host and geographic ranges of this Zygomycete in the state. Using light and scanning electron microscopy, the heretofore unmeasured warts on the zygosporangium were 4-6 μm broad and 5-8 μm high, providing additional information for circumscription of this genus.

INTRODUCTION

Syzygites (Mucorales, Zygomycetes) is a presumptive mycoparasite that occurs on fleshy fungi (Figs. 1-2) and contains a single species, *S. megalocarpus* Ehrenb.: Fr. (Hesseltine 1957). It is homothallic and forms erect sporangiophores which are dichotomously branched and bear columellate, multispored sporangia at their apices (Fries 1832, Hesseltine 1957, Benny and O'Donnell 1978, O'Donnell 1979). *Syzygites* has been isolated and grown in pure culture (Hesseltine 1957, Poff 1965, Jong and Gantt 1984).

Information on the host range of *Syzygites* is scant and fragmentary, and, with exception of a brief mention in a previously published abstract (Kovacs and Sundberg 1994), no literature exists on the occurrence of this genus in Illinois. Therefore, the general objectives of this study were to document the features and range of *Syzygites* in the state.

MATERIALS AND METHODS

Infected fleshy fungi (e.g., basidiomata) were gathered in southern Illinois in a variety of habitats from May to December in 1993 and 1994 and sporadically thereafter. Some specimens were photographed. All were then either air dried or dried via convection current and deposited as permanent voucher specimens in the Mycological Collections of Southern Illinois University Herbarium (SIU).

Field collected host specimens, which appeared parasite free, sometimes developed visible parasite colony growth when stored in a refrigerator or cold room for several days. Therefore, host material that appeared parasite free was also collected, wrapped in clean wax paper, wax paper bags, and/or brown paper bags, and stored at room temperature or in a cold room or refrigerator at 5-10°C. These collections were checked weekly, for up to four weeks, for growth of the parasite.

To test for the potential of *S. megalocarpus* to grow on other selected fleshy fungi, inoculations were conducted in the laboratory by placing hyphae from an actively growing culture of *S. megalocarpus* directly on the pileus, lamellae, stipe, or peridium of possible host fungi. Cultures used were NRRL 6288 (from the United States Department of Agriculture Research Laboratories, Peoria, Illinois) and/or WC-94 isolated from a collection (Sundberg 94-V-1) of *S. megalocarpus* on *Boletinellus merulioides* (Schw.) Murr. made in Williamson County, Illinois in May, 1994. Both were maintained on corn meal plus agar (CM+; Wicklow and Sundberg 1976). Inoculated specimens were incubated at room temperature in ambient light in clean glass or plastic containers, loosely sealed to maintain humidity, and examined daily for evidence of growth.

To enhance completeness of the study, herbarium specimens of *Syzygites megalocarpus* (and/or its synonyms) were also requested on loan from 21 institutions within the United States.

A composite description of *S. megalocarpus* was complied and host identifications were made from data obtained from personal fresh collections, herbarium specimens collected by others, and cultures of the two isolates noted above. Macro- and micro-morphological features of *S. megalocarpus* and its hosts were described using standard procedures (e.g., Smith 1949, Largent 1977, Largent et al. 1977). Ten or more measurements were made for each fungal structure unless limited by the amount of material in the collection. The term zygosporangium was used to denote the structure that develops and is held in place between the suspensors (Alexopoulos et al. 1996). To supplement micro-morphological observations, scanning electron microscopy (SEM) was used following the standard preparation methods described in Postek et al. (1980). When possible, hosts were identified to species.

A host list for *Syzygites megalocarpus* was prepared from available data. Abbreviations for herbaria with collections noted herein are according to Holmgren et al. (1990).

RESULTS

Syzygites megalocarpus Ehrenb.: Fr. Systema Mycologicum 3: 329, 1832.

Sporangiophores (Fig. 3) 0.5-40 mm high, erect, up to 6 times dichotomously branched, septate, striate or rough at least on the lower part, hyaline to pale brown, and with terminal sporangia. Sporangia 50-150 μm broad, globose to irregularly globose, thin-walled, and yellow (gray in reflected light). Columella (Fig. 3) present, 30-100 μm broad, subglobose to irregularly globose. Sporangiospores (Figs. 3-4) 5-35 μm broad, globose to irregularly globose to ovoid, surface verrucose, hyaline to pale brown. Homothallic. Zygosporangia 160-375 μm in diam, pallid at first, but turning dark brown to black when mature, globose to irregularly globose, surface developing short, stout warts that are blunt and somewhat flattened at the apex. Warts (Fig. 6) 4-6 μm broad and 5-8 μm high when viewed and measured with SEM. Suspensors (Fig. 5) lateral, nearly globose to ovoid except where attached to the zygosporangium and supporting hyphae. Hyphae 3-60 μm broad, non-septate except near reproductive structures, hyphal surface striate or rough.

Habit and Habitat: Colonies single to scattered (Fig. 1) on various fleshy fungi (Table I). In lawns, wetland areas, and a variety of woodland habitats. May through October.

Specimens examined: Cook Co.: F 523958, River Forest, Oct. 1898, (F). Gallatin Co.: Methven 8019, Rim Rock Trail, Pounds Hollow Recreation Area, Oct. 15, 1994, (EIU). Jackson Co.: ILLS 38157, Turkey Bayou, Sept. 27 1978, (ILLS); Akers 93/10-03/002, Trail of Tears State Forest, Oct. 8, 1993, (SIU); Sundberg s. n., developed in laboratory, summer 1993, (SIU); Kovacs IX-M-94-M, Carbondale, Sept. 1994, (SIU); Kovacs V-25-94-1, Giant City State Park, May 25, 1994, (SIU); Kovacs V-94-2, Giant City State Park, May 1994, (SIU); Kovacs VI-94-A, Giant City State Park, June 1994, (SIU); Kovacs I-V-94-11, laboratory inoculated, June 1994, (SIU); Kovacs C-95-3, dried culture of NRRL-6288 on CM+, 1995, (SIU); Kovacs C-95-4, dried culture of WC-94 on CM+, 1995, (SIU); Kovacs C-94-2, dried culture of WC-94 on host and CM+, 1995, (SIU); Kovacs I-94-4, laboratory inoculated, 1994, (SIU); Kovacs I-94-2a, laboratory inoculated, Oct. 1994, (SIU); Kovacs I-94-2b, laboratory inoculated, Oct. 1994, (SIU); Kovacs I-94-3a, laboratory inoculated, Oct. 1994, (SIU); Kovacs I-94-3b, laboratory inoculated, Oct. 1994, (SIU); Kovacs I-IV-95-1, laboratory inoculated, April 1995, (SIU); Kovacs I-94-1, laboratory inoculated, Oct. 1994, (SIU); Kovacs I-95-1a, laboratory inoculated, 1995, (SIU); Kovacs I-95-2a, laboratory inoculated, 1995, (SIU); Kovacs C-94-1, dried culture with host on CM+, June 1994, (SIU); Bray 23, DeSoto City State Park, Oct. 24, 1995, (SIU); Overton 960731.1, Murphysboro, Jul. 1996, (SIU). Union Co.: Kovacs VI-94-1, Trail of Tears State Forest, June 1994, (SIU); Kovacs VI-94-2, Trail of Tears State Forest, June 1994, (SIU); Kovacs VI-94-3, Trail of Tears State Forest, June 1994, (SIU); Kovacs VI-94-4, Trail of Tears State Forest, June 1994, (SIU); Kovacs VI-94-5, Trail of Tears State Forest, June 1994, (SIU); Kovacs VI-94-7, Trail of Tears State Forest, June 1994, (SIU); Sundberg 98-X-23-1, Carbondale, October 23,1998 (SIU). Williamson Co.: Sundberg 94-V-1-1 Crab Orchard Lake area, May 1, 1994 (SIU)--culture WC-94 isolated from this collection.

Host List

Table 1 provides a complete list of presently known mycohosts for *Syzygites megalocarpus* in Illinois. Although institutions throughout the United States were contacted, specimens of *S. megalocarpus* from Illinois were found only in the holdings of Illinois herbaria. Of the 33 voucher collections of *Syzygites* from Illinois, two genera (*Pluteus* and *Tylopilus*) were noted earlier as new hosts (Kovacs and Sundberg 1994) and five genera--*Boletinellus*, *Ganoderma*, *Morchella*, *Omphalotus*, and *Tricholoma*--and 15 host species are reported herein as new host records in the United States.

Five species--*Agaricus bisporus* (Lange) Sing., *Agaricus campestris* L.: Fr., *Calvatia cyathiformis* (Bosc.) Morg., *Ganoderma lucidum* (Curt.: Fr.) Karst., and *Morchella esculenta* (L.) Pers.--are currently known as hosts for *Syzygites* only from laboratory inoculations.

DISCUSSION

Macro- and micro-morphological data collected on *S. megalocarpus*, although somewhat variable, agree with previously published descriptions (e.g., Fries 1832, Hesseltine 1957, Benny and O'Donnell 1978, O'Donnell 1979). In earlier descriptions, the warts on the surface of the zygosporangium (Fig. 6) were described as blunt in appearance, but measurements were lacking. Use of light and scanning electron microscopy demonstrated that these blunt warts are 4-6 μm broad and 5-8 μm high.

Syzygites megalocarpus is known to occur in the United States on at least 65 host genera in 22 families of Basidiomycetes as well as few Ascomycetes in the Pezizales and Helotiales (Kovacs 1995). However, in Illinois, *S. megalocarpus* has been found on only 18 genera in 11 families (see Table I). Given the broad distribution in Illinois of fleshy fungi recorded as hosts of *S. megalocarpus* from elsewhere in the country, it seems reasonable to assume that *S. megalocarpus* should be more widely distributed in the state and on more hosts than current records indicate.

Ingold (1953) states that *Syzygites* occurs on agarics in the fall, however, our data indicate a longer potential growth period--from May through October. The temperature range for vegetative growth of *Syzygites* is is 5-30°C (Baker 1931, Wenger and Lilly 1966), suggesting the potential for growth during much of the year (assuming no other limiting factors). Sporangiospores of *Syzygites* can survive freezing (Goos et al. 1967), apparently can survive throughout the winter months, and may be a source of inoculum for new infections the following season. Alternatively, zygospores readily germinate (Gauger 1978) and, thus, may perform this function.

SUMMARY

Syzygites megalocarpus occurs in Illinois on 18 different host genera and 23 host species of fleshy fungi (including seven species in six genera which were laboratory inoculated during this study). *Syzygites* was collected on hosts from a variety of habitats from May through October in five counties--Cook, Gallatin, Jackson, Union, and Williamson. Since potential hosts for *S. megalocarpus* occur throughout Illinois, more attention to specimen collecting would undoubtedly add to its known host list and geographic range

within the state. Warts on the surface of its zygosporangia are noted herein as short, stout projections that are blunt, somewhat flattened at the apex, and 4-6 μm broad x 5-8 μm high.

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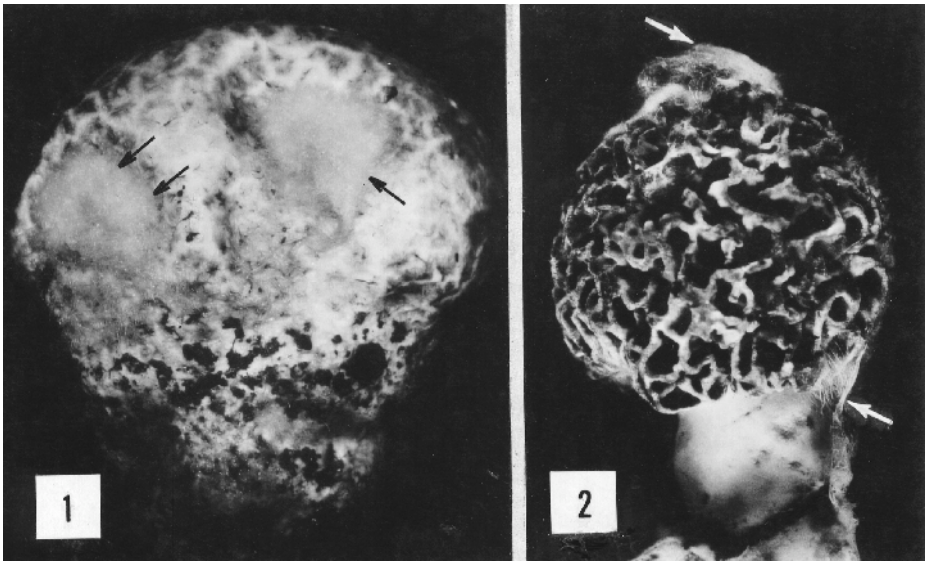
Table 1. Host list for *Syzygites megalocarpus* occurring in Illinois.

Host Higher Taxa	Host[1,2]	Voucher Specimen Location[3]
ASCOMYCETES:		
"Discomycetes"		
Pezizales		
Morchellaceae:	*Morchella esculenta* (L.) Pers.[5]	SIU[4]
BASIDIOMYCETES:		
"Hymenomycetes"		
Aphyllophorales		
Ganodermataceae:	*Ganoderma lucidum* (Curt.: Fr.) Karst.[5]	SIU
Agaricales		
Agaricaceae:	*Agaricus bisporus* (Lange) Sing.[5,6]	SIU
	Agaricus campestris L.: Fr.[5]	SIU
	Agaricus subrufescens Pk.	SIU
Amanitaceae:	*Amanita thiersii* Bas	SIU
Boletaceae:	*Boletus affinis* Pk.	ILLS
	Boletus ornatipes Pk.[4]	SIU
	Boletus sp.[4]	SIU
	Boletinellus merulioides (Schw.) Murr.[4]	SIU
	Suillus americanus (Pk.) Snell[5]	SIU
	Tylopilus sp.[4]	SIU
Coprinaceae:	*Psathyrella* sp.	F
Cortinariaceae:	*Cortinarius* sp.[4]	SIU
Pluteaceae:	*Pluteus cervinus* (Schaef.: Fr.) Kumm.	SIU
Russulaceae:	*Lactarius piperatus* (Fr.) Gray	SIU
	Russula sp.[4]	SIU
Tricholomataceae:	*Lentinus edodes* (Berk.) Sing.[5,6]	SIU
	Omphalotus olearius (DC.: Fr.) Sing.	SIU
	Tricholoma resplendens (Fr.) Quét .	SIU
	Tricholoma sp.	SIU
"Gasteromycetes"		
Lycoperdales		
Lycoperdaceae:	*Calvatia cyathiformis* (Bosc.) Morg.[5]	SIU
	Lycoperdon pyriforme Pers.	EIU

[1] Underline = new host record for the United States.
[2] sp. or spp. = species not determined.
[3] Herbarium abbreviation = specimen examined; herbarium abbreviations from Holmgren et al. (1990).
[4] Field collected host material which developed infection after incubation in the laboratory.
[5] Laboratory inoculation of host with *Syzygites megalocarpus*.
[6] Host obtained from local grocery store.

Figures 1-2. *Syzygites megalocarpus* on two inoculated fleshy fungi. 1. On *Calvatia cyathiformis*. 3/4x. 2. On *Morchella esculenta*. 1x.



Figures 3-6. Scanning electron micrographs showing some features of *Syzygites megalocarpus*. 3. Sporangiophores displaying typical dichotomous branching. S = sporangiospore, C = columella. (ca. 1,200x). 4. Sporangiospores showing surface decorations. S = sporangiospore. (ca. 12,300x). 5. Young zygosporangium with suspensors. Z = zygosporangium, Su = suspensor. (ca. 1,200x). 6. Surface of more mature zygosporangium showing blunt warts. W = wart. (ca. 6,100x).

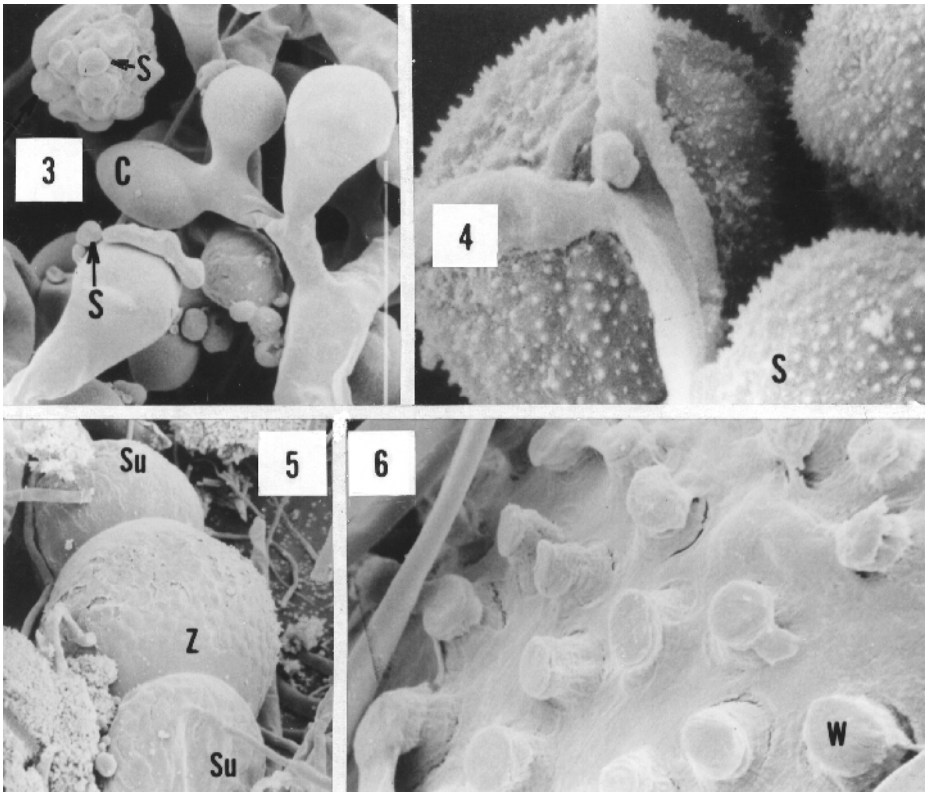


Figure 7. Voucher specimen supported distribution of *Syzygites megalocarpus* in Illinois.