Mycoparasitic activity of *Zygosporium gibbum* against *Cladosporium cladosporioides* and other fungi

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Accepted 31. July 2015

Key words: *Quercus leucotrichophora.* – Mycoparasitism, biocontrol, antagonistic interaction.

Abstract: Mycoparasitic activity of *Zygosporium gibbum* is recorded for the first time against the plant pathogenic fungi *Cladosporium cladosporioides, Alternaria* sp. and *Papulospora* sp. These furhter observations of mycoparasitism confirm that *Z. gibbum* might be used as biocontrol agent against plant pathogenic fungal species as has been assumed already 2011 by MANIMOHAN & MANNETHODY in Mycosphere **2**: 219–222.

Zusammenfassung: Die pilzparasitische Aktivität von *Zygosporium gibbum* wird erstmals gegen die phytopathogenen Pilze *Cladosporium cladosporioides, Alternaria* sp. und *Papulospora* sp. nachgewiesen. Diese weiteren Beobachtungen des Mykoparasitismus bestätigen, dass *Z. gibbum* vielleicht in der biologischen Schädlingsbekämpfung gegen pflanzenpathogene Pilze eingesetzt werden könnte, wie bereits 2011 von MANIMOHAN & MANNETHODY in Mycosphere 2: 219–222 vermutet.

In recent years studies on antagonistic interactions among fungal species have received great attention due to their importance and implication in biological control and competitive survival of a pathogen in the absence of suitable host (MC BRIDE 1971; IKEDIUGWU & WEBSTER 1970 a, b; UPADHYAYA & al. 1983; SKIDMORE & DICKINSON 1976; UPADHYAYA & GUPTA 1995; MANIMOHAN & MANNETHODY 2011; GUPTA 2013). Interfungal interactions and hyphal parasitism are amenable to basic research dealing with the physiology and control of diseases in a variety of hosts, but in contrast to the voluminous literature pertaining to dual culture studies, there is little information regarding the biology of hyperparasitism in nature (BOOSALIS 1964). *Cladosporium* and *Alternaria* are important fungal pathogens that cause leaf spot diseases in various plants including vegetables. We know that the organic debris of host and non-host plants is the main source of their survival and maintenance of inoculum potential which is of substantial importance in disease development (GARRETT 1970). The present study briefly illustrates the parasitic activity of *Zygosporium gibbum* against *Cladosporium cladosporioides, Alternaria* sp. and *Papulospora* sp. on decaying oak (*Quercus leucotrichophora*) leaves by a new and simple adhesive cellophane technique in nature.

Materials and methods

The interfungal interaction and hyperparasitic behaviour of *Zygosporium gibbum* and the pathogenic host fungi were observed by using a simple and quick cellotape method. A small piece of transparent common adhesive cellotape (1.5 cm wide and 3.0 cm long) was taken and pressed against decomposing banj oak (*Quercus leucotrichophora*) leaf litter. Then the cellotape piece was pulled up and mounted on the glass slide with cotton blue and lactophenol. In fact this technique is regularly used by various workers for investigating the activity of litter decomposing fungi. During such investigations the hyphal interference between two fungi can be observed in natural conditions.

Results and discussion

During our studies hyphal interaction and parasitism was recorded frequently between *Zygosporium gibbum* and *Cladosporium cladosporioides*, *Alternaria* sp. and *Papulospora* sp. Hyphal interference indicates changes in permeability of susceptible fungal species. Different types of interference reactions were observed of which coiling and penetration were much pronounced and in some instances intense coiling indicated strong antagonistic behaviour of the parasite. In the literature it was suggested that the coiling may be affected by thigmotropic and/or chemotropic factors (IKEDIUGWU & al. 1970, DENNIS & WEBSTER 1971, GUPTA & al. 1983). In the present investigation the internal parasitic mycelium of *Z. gibbum* was branched; and short branches formed appressorium-like structures which penetrated the wall of the host from inside by developing fine hyphae (Fig. 1 a–d). This indicates that the antagonistic fungal species might be producing some cell wall degrading enzymes. The internal hyphae also attacked the conidia of *Alternaria* and *Papulospora* (Fig. 1 e, f), where the branching behaviour was quite significant. Formation of conidia and conidophores of the mycoparasite on the host hyphae emphasized the necrotrophic nature of the former. The counteraction of the host hyphae resulted in distortion and swellings in the infection hyphae. Ultimately the host hyphae were lysed and replaced by parasitic hyphae. BARNETT & BLINDER (1973), DENNIS & WEBSTER (1971) SKIDMORE & DICKINSON (1976) have also reported similar mycoparasitic interactions.

The observed characters are in accordance with the description given by MANIMOHAN & MANNETHODY (2011):

Hyperparasite on antagonistic fungi on decomposing oak leaf litter. Conidiophore: with single stalk cell, 6–10 to 3–4.5 µm, cylindrical, black, characteristically curved, and along with a stalk cell forming a 'question mark' shaped structure (Fig. 1 b–d), conidiogenous cell (phialids) 3 per vesicle, 6–8 × 3.5–4.5 µm, ampullaceous, hyaline. conidia 4.5–6 µm in diameter, spherical aseptate, hyaline, smooth to finely verruculose.

The hyperparasite was identified as *Zygosporium gibbum* (SACC., M. ROUSSEAU & E. BROMMER) S. HUGHES (anamorphic Pezizomycotina) using ELLIS & ELLIS (1985) and WHITTON & al. (2003). Hyphae of the hyperparasite were seen around the infected the conidia of *Alternaria* and *Papulospora* (Fig. 1 e, f).

Already GROVE (1888) and PIM (1899) described and illustrated *Zygosporium gibbum* (under its synonym *Pimina parasitica*) as mycoparasite on *Polyactis*, which most probably is a *Botrytis* species (www.indexfungorum.org). MANIMOHAN & MANNETHODY (2011) reported *Z. gibbum* as a rust hyperparasite and discuss the literature

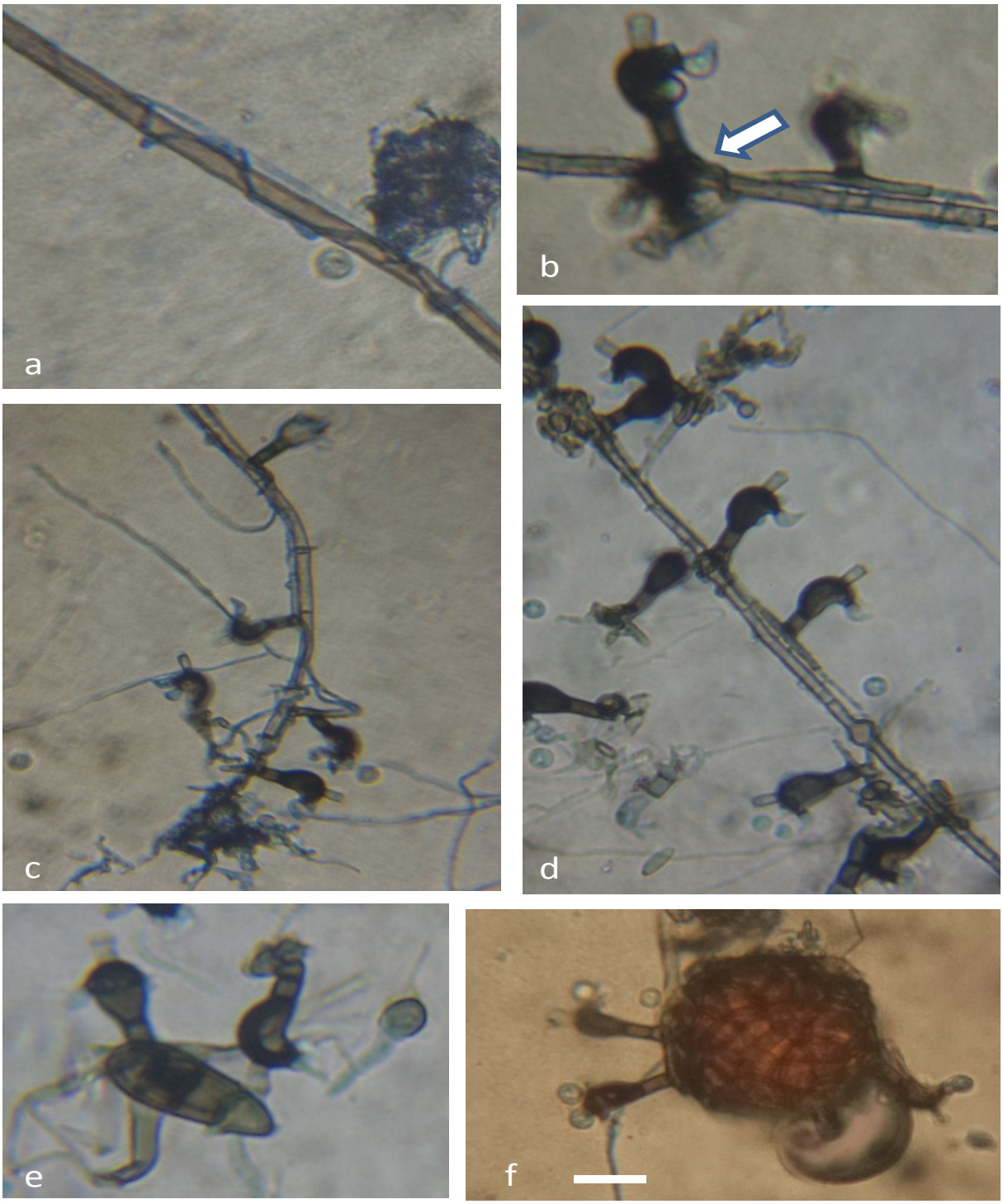

Fig. 1. *Zygosporium gibbum. a-d* parasitic on *Cladosporium cladosporioides: a* coiling, *b* foot-like appressorium (arrow), *c–d* conidia and conidiophore formation on conidiophores of host, *e* parasitic on conidia of *Alternaria* sp., *f* parasitic on *Papulaspora* sp.– Bar for a–f 10 µm.

about the invasion strategy of the parasite. This mitosporic ascomycete is a cosmopolite and is known as a saprotroph and a parasite (WHITTON & al. 2003).

Interfungal parasitism is affecting the survival of fungi in natural habitats. It is important to determine hyperparasites in nature and it could give new insights to biocontrol of plant pathogenic fungi (BOOSALIS 1964). This first report of *Z. gibbum* as a hyperparasite of *C. cladosporioides*, *Alternaria* and *Papulospora* reveals that *Z. gibbum*

might be a potential biocontrol agent against plant pathogenic fungi and could be of great interest for plant pathologists.

The authors are thankful to the Head, Department of Botany, Kumaun University, S.S.J. Campus, Almora, for providing laboratory facilities and Director, VIVEKANAND PARVATIYA KRISHI ANUSANDHANSHALA for providing library facilities. Further thanks for valuable hints and literature go to two anonymous reviewers of our paper.

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