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My dates with Perithecial Fungi

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ABSTRACT

Perithecial fungi traditionally known as *Pyrenomycetes*, a class under division *Ascomycota* has recently been treated under class *Sordariomycetes* of sub division *Pezizomycotina* under *Ascomycota*. Several fungi belonging to this group of fungi have been reported by the author and his associates from various regions of North -West India. In the recent years several monographic contributions on various families and genera have been made by the experts in the field. Based on these recent works, various taxa of perithecial fungi, reported from this region of India have been reassessed and assigned to their respective taxonomic groups.

Keywords : Ascomycetous fungi, perithecia, taxonomy, Indian contribution

First of all I feel proud to be one of Prof. K.S.Thind's students. The Father of Asian mycology, Prof. Thind, laid the foundation of fungal taxonomy at Panjab University Chandigarh, some five decades ago. Since then it has flourished to heights of excellence in the country. More than two dozens of his students contributed to the taxonomy of Himalayan higher fungi (both from western and eastern Himalayas), belonging to *Basidiomycota* and *Ascomycota*, in addition to a world class work on *Myxomycota* and Physiology of Fungi. At the same time, I express my gratitude to Prof. N.S Atri, Chief Editor, Kavaka, for inviting me to contribute an article towards Prof. K.S.Thind commemorative volume.

THE BEGINING

It was in the summer month of July 1969, when I was first introduced to the fascinating world of fungi by Prof. K.S. Thind. My first collection was of *Xylaria thyrsus* (Berk.) Fr. from Chandigarh forests which ultimately created in me a life long passion for perithecial fungi. First step towards this journey was joining a PL480, US sponsored research project entitled "Mycoflora of western Himalayas" under Prof. Thind in 1971 in Punjab University, Chandigarh. Extensive explorations were undertaken to hunt various taxa of perithecial fungi, in several localities of Himachal Pradesh, Jammu and Kashmir , Uttaranchal and some sub-mountainous parts of Punjab and Haryana during the five years of the project. The explorations were continued in the subsequent years at Punjabi University, Patiala by the author and his students, after joining the department of Botany as a faculty member, through various major research projects : "Pyrenomycetous fungi of North West India" sponsored by UGC, "Pyrenomyctous fungi of eastern Himalayas" sponsored by UGC and "Biological studies on wood-rot fungi of North west India" sponsored by CSIR and a project on wood rotting fungi of Punjab, financed by Government of Punjab.

WHAT ARE PERITHECIAL FUNGI?

Perithecial fungi are traditionally grouped into class '*Pyrenomycetes*' of *Ascomycotina*. The term "Pyrenomycetes" is no longer used in a taxonomic sense and have been replaced by the term *Sordariomycetes* which is recognized as a class of fungi in the subdivision *Pezizomycotina* of Division *Ascomycota* (Kirk *et al.*, 2008) and Miller and Huhndorf (2009) in -"*Pyrenomycetes* of the World: http://www-s.life.illinois.edu/pyrenos".

Sordariomycetes generally produce their asci in perithecial ascomata (flask-shaped fruiting bodies) on a wide range of substrates including soil, dung, leaf litter, decaying wood, as well as other fungi. These "little black dots" comprise the largest numbers of fungi in the Phylum *Ascomycota*. *Sordariomycetes* are economically and ecologically important since they contain the "fruit flies" of the fungal world (e.g. *Neurospora crassa, Podospora anserina*, *Sordaria fimicola*) as well as significant destructive pathogens including the causative agents of chestnut blight (*Cryphonectria parasitica*), dutch elm disease (*Ophiostoma ulmi*), and the recently discovered beech bark disease (*Nectria coccinea*). These fungi occur in all ecosystems and geographical areas throughout the world primarily as saprobes where they play an integral role in nutrient cycling and decomposition of organic matter.

Sordariomycetes possess great variability in morphology, growth form, and habitat. Except for having perithecial (flask-shaped) fruiting bodies, ascomata can be less frequently cleistothecial, fruiting bodies may be solitary or gregarious, superficial, or immersed within stromata or tissues of the substrates and can be light to bright or black. Members of this group can grow in soil, dung, leaf litter, and decaying wood as decomposers, as well as being fungal parasites, and insect, human, and plant pathogens.

Systematics of perithecial fungi has been extensively undertaken by the author and his students in the North west and eastern Himalayan region of India. In this paper, however, an account of the fungi met with in north- west region is given. Western Himalayas, the area surveyed falls in the states of Jammu and Kashmir, Himachal Pradesh, Uttaranchal and shivalik hills near Union territory of Chandigarh and some areas of District Roopnagar, Hoshiarpur, Nawanshar and Gurdaspur districts of Punjab with altitude ranging from few hundred meters to more than 700 m. It presents a varied topography, climate and vegetation. The author and his associates have done extensive study on these fungi, from various localities of North-west India, during the last four decades.

These studies reveal that many important families of these fungi are fairly well represented in the study area where practically no such systematic studies had been undertaken earlier. As many as three orders namely *Xylariales*, *Hypocreales* and *Diaporthales* of the class have been investigated from the study area. In view of the latest literature on taxonomy of these fungi, the concepts of families and genera have undergone few changes. In view of this an up to date positions and diversity of the fungal taxa, reported from the region, is given in this paper.

Detailed descriptions with illustrations of individual taxa have been published, by the author, in the series of papers mentioned against each family.

TAXONOMY

Class : *Sordariomycetes* (**Sub class: *Xylariomycetidae*) Order: *Xylariales***

Characteristic features of the order include production of well-developed stromata, perithecial ascomata with thick walls, eight-spored unitunicate asci with a J+ apical apparatus. Paraphyses are apically free and develop from a hymenial layer, while ascospores, usually pigmented, possess germ pores or germ slits, and may or may not be transversely septate, or have a mucilaginous sheath (Kirk *et al*., 2008)

Xylariales is the only order, under the sub class *Xylariomycetidae*, created by Nanfeldt (1932). Seven families *Amphisphaeriaceae*, *Cainiaceae*, *Clypeosphaeriaceae*, *Diatrypaceae*, *Graphostromatace*, *Hyponectriaceae*, and *Xylariaceae* have been recognized in the recent edition of Dictionary of Fungi. (Kirk *et al*., 2008). Out of these only two families of the order namely Family *Xylariaceae* and Family *Diatrypaceae* were investigated during the present study.

Family *Xylariaceae* : This is an old and traditional family of order *Xylariales* and is considered as one of the specialized groups of *Sordariomycetes* under *Ascomycota*. It was established by Tulsane, L. and Tulsane, C. (1863) to include members with predominantly dark colored stomata and dark unicelled ascospores a concept subsequently embodied in the studies of later workers in this field. It includes 85 genera and 1343 species (Kirk *et al.*,2008). The family is characterized by well developed, effused to pulvinate, sometimes stipitate and branched, usually black stromata. The internal tissue is white or concolorous with surface; ascomata perithecial, black, globose, the ostioles periphysate, interascular tissue well developed, paraphysis present. Asci cylindrical, persistent ± thick walled almost always with a large ± complex J+ structure. Ascospores usually dark brown aseptate with a germ slit.

The floristics of the family in India, had never been specifically studied until later part of the twentieth century and whatever was known during this time, was through the scattered reports of different workers of fungi in general. Many members of the family were reported with different names, from time to time. Although search of the literature reveals that many of the previously reported species are synonyms while a few are altogether wrongly identified and some do not even belong to *Xylariaceae*. Approximately 250 taxa belonging to only 13 genera have been reported so far from India. A complete review of the family *Xylariaceae* in India, with its all aspects and present status was presented in the Presidential address to the Mycological Society of India in its annual meeting at Bangalore in 2006 (Dargan, 2006)

There has been a major thrust in the systematics of *Xylariaceae*, during the last four decades, through contributions of K. S. Thind , J. S. Dargan and their coworkers mainly from Northwest Indian region (Dargan 1976,80,82,83,84,87a,b, 2003; Dargan and Mann 1985; Dargan and Singh1982a,b c,86 ; Dargan, Singh and Bhatia 1982; Dargan, Singh and Rogers 1984; Dargan and Sood 1996; Dargan and Thind 1979,80,82 84a,b; Sood and Dargan 1994; Thind and Dargan 1975, 1978 a,b,c,80) Comprehensive study of more than 100 taxa relating to 6 genera, namely *Daldinia, Rosellinia, Hypoxylon, Xylaria, Kretzschmaria,* and *Helicogermslita* have been studied by the author and his co workers. Genera *Peridoxylon* and *Camarops,* earlier reported from this region have been now placed under family *Boliniaceae*

Daldinia Ces. & De Not. *Commentario della Società Crittogamologica Italiana* **1**(4): 197 (1863)

The genus is a small assemblage of 30 species. Some of the species seem uncommon and are thus not frequently encountered. Stromata spherical, turbinate, clavate, or cylindrical, sessile, sub sessile to definitively stipitate, solitary to aggregated, surface colored, darkened and dull or blackened and varnished in age; the tissue below the perithecial layers composed of alternating zones, the darker zones and the lighter zones. Perithecia obovoid to tubular. Asci eight-spored, cylindrical, stipitate with ascospores arranged uniseriately or partially biseriately, with apical ring discoid, amyloid. Ascospores light brown, brown, or dark brown, unicellular , ellipsoid, or nearly equilateral, with narrowly or broadly rounded ends, with straight or slightly sigmoid germ slit .

The genus is world wide in its distribution. The first comprehensive monographic account of the genus was given by Child (1932), who recognised only 13 taxa in it. Ju, Rogers and Martin (1997) revised the genus and recognised 22 taxa. Many of the previous species have been treated as synonyms and few more new species have been added. Stadler *et al*. (2014), in "Polyphylatic taxonomy of *Daldinia*", however, recognised 48 taxa under the genus.

Dargan and Thind (1984a), based on the anatomical features of the stromata and various tissue types met within different species of the genus, seggregated the genus into two new subgenera:

Sub genus *Eu-Daldinia* Dargan & Thind

Sub genus *Ento-Daldinia* Dargan & Thind.

Daldinia is a well represented genus in India. Approximately 12 or more taxa have been previously reported. However, on account of revision of the genus by Ju, Rogers and Martin (1997), only 8 established species are known from India, 7 of which are reported from N.W. India. The recognized species are listed below under the respective subgenus.

Sub genus *Eu- Daldinia* Dargan & Thind : Six species , namely *Daldinia concentrica* (Bolt.:Fr.) Ces.&de not, *D. eschscholzii* (Ehrnb.:Fr.) Rehm, *D. bakeri* Lloyd, *D.caldariorum* Henn. (=*D.gollani* Henn. (Fr.) Rehm), *D.concentrica* var. *eschscholzii* Reh., *D.childiae* Rogers (=*D.concentrica* var. *minuta* Waraitch) and *D. fissa* Lloyd (=*D.vernicosa* (Schw.) Ces. & de Not belong to this subgenus.

Subgenus *Ento-Daldinia* Dargan & Thind :Two species, namely *Daldinia gramnis* Dargan & Thind and *D. saccharii* Dargan & Thind belong to subgenus *Ento-Daldinia*.

Genus *Rosellinia* de Not. *Giornale Botanico Italiano* **1**: 334 (1844)

It is an important cosmopolitan genus with 142 species (Petrini 2013 -"*Rosellinia* a world monograph")

Stromata superficial, normaly uniperitheciate , usually occurring in dense swarms upon a common blackish hyphal mass, the subiculum which may sometimes be absent. Perithecia globose to ovoid, prominent, sometimes closely aggregated with prominent black ostiolar papillae. Asci 8-spored, long cylindrical, stalked with broad ascal plug with constriction which stains blue with Melzer's reagent. Ascospores uniseriate, inequilateral ellipsoid, with or without prominent, hyaline apiculii at the ends, with longitudinal germ slit. Its species may cause many plant diseases. *Rosellinia aquila* causes root rot of *Morus*, *Rosellinia necatrix* causes white root rot of woody and herbaceous plants, *R. minor* causes *Rosellinia* blight of Spruce, *R. quercina* causes seedling blight of oak. Members of the genus are also known to be endophytic or saprobic on a variety of plants. According to Petrini (2013), three sub genera have been recognized under this genus.

Subgenus *Rosellinia* : Subiculum present around perithecia, at least at young stages and persistent at the base of mature stromata. Ectostroma thicker, hard, smooth to rugulose

Subgenus *Corrugata* : Subiculum present around perithecia at young stages, and persistent at the base of mature stromata. Ectostroma thin, brittle.

Sub genus *Calomastia* : Subiculum absent or non persistant around mature stroma.

The genus is well represented in India. Approximately 40 *Rosellinia* taxa are reported in literature. On account of recent revision of the genus by (Petrni 2013), only 30 established species are known from India. As many as following 10 species, namely *Rosellinia aquila* (Fr.) de Not, *R. corticium* (Schw.) Sacc., *R. himalayensis* Dargan & Thind, *R. thelena* (Fr.) Rab., *R. apiculata* Sacc. var. *macrospora* Dargan, *R. mammiformis* (Pers.) Ces. & de Not., *R. Medullaris* (Wallr.) Ces.&de Not., *R. indica* Dargan & Thind, *R.sublimbata* (Dur.& Mont.) Pass.and *R. thindii* Dargan have been reported from North -west India.

Genus *Hypoxylon* Bull. *Histoire des champignons de la France.* **1**: 168 (1791)

Hypoxylon Bull. as delimited by Ju & Rogers (1996) encompasses Xylariaceous fungi with unipartite, never erect stromata with a solid and homogenous basal tissue below the perithecial layer. Stromata are very frequently waxy with coloured granules yielding pigments in 10% KOH. Ascospores often have a dehiscent perispore and usually have the germ slit on the more convex side and ascal apical rings are discoid or flattened. It is a cosmopolitan genus with 130 species the world over. Highest diversity of the genus is in tropics and sub-tropics. Many of them are weak to damaging pathogens causing cankers.

Majority of them usually found fruiting on dead wood, following invasion of living host tissue. The genus is well represented in India. Approximately 65 *Hypoxylon* taxa are reported in literature. Ju and Rogers (1996) in an excellent account of the genus "A Revision of the Genus *Hypoxylon*", gave a new circumscription of the genus. They recognised under the genus two sections.

Section *Hypoxylon*: Ostioles usually lower than the level of stromal surface, never encircled with annular disc.

Section *Annulata*: Ostioles always higher than the level of surrounded stromal surface, with or without annular disc .

On account of recent revision of the genus by Ju and Rogers (1996), only 36 established species are reported from India, The revised list of recognized 26 species reported from the study area is given under respective section.

Section *Hypoxylon*: *Hypoxylon crocopeplum* Berk. & Curt., *H. haematostroma* Mont, *H. howeianum* Berk., *H. hypomiltum* Mont., *H. investens* (Schw.) Berk., *H.investiens* var. *epiphaeum* Mill., *H. mulleri* Mill., *H. notatum* Berk. & Curt., *H. rubigineo-areolatum* Rehm., *H. rubiginosum* (Pers.) Fr., *H. rubiginosum* var. *dieckmanni*. Mill., *H. rubiginosum* var. *tropica* Mill., *H. rubrostromaticum* Mill, *H. rubrostromaticum* var., *macrospora* (Theiss.) Mill., and *H.vogesiacum* Pers.: Sacc.

Section *Annulata*: *Hypoxylon annulatum* (Schw.) Mont., *H. archeri* Berk., *H. cohaerens* (Pers.:Fr.) Fr., *H. multiforme* (Fr.) Fr., *H. stygium* (Lev.) Sacc. and *H. truncatum* (Schw.:Fr.) Mi.

Xylaria Hill ex Schrank. *Baierische Flora* **1**: 200 (1789)

It is a well established genus, known the world over by approximately 300 species. (Kirk *et al.* 2008). Stromata erect, elongated, simple or branched, variable in shape and size cylindrical, fusiform, clavate, massive or filiform, capitate or strap like, long or short stalked. Colour ranging from greyish brown to copper brown or black. Flesh (Entostroma), white to creamish or yellow within, usually dark and carbonaceous above, solid. Perithecia may be completely or semi immersed in the stroma or may be superficial on wiry axis. Asci cylindrical, stalked eight spored and with prominent ascal plug, staining deep blue with Melzer's reagent. Ascospores usually uniseriate, light brown to dark brown or black usually with longitudinal or spiral germ slit.

Majority of the species are saprophytic and grow on dead stumps, branches and leaves of various types of hard wood tree species. However, a few may also grow on coniferous wood, cones or needles. A few species are terricolous, while some may be associated with termite nests. As many as 40 taxa of the genus are stated to be reported from India. Out of

these following 31 species including 2 sub species, have been reported from North west India. These are *X. nigripes* (Klotzsch) Ck., *X. thyrusus* (Berk.) Fr., *X. papyrifera* (Link) Fr., *X. convoluta* Dargan, *X. polymorpha* (Pers.: St. Amans) Grev., *X. anisopleura* (Mont.) Fr., *X. phosphorea* Berk., *X. rogersii* Dargan & Bhatia, *X. alpina* Speg., *X. robustus* Dargan, *X. trachelina* (Lev.) Lev., *X. longipes* Nits., *X. feejeensis* (Berk.) Fr., *X. feejeensis* (Ber.) Fr. sub species *faveolis* (Lloyd) D. Hawks., *X. grammica* (Mont.) Fr., *X. nainitalensis* Dargan, *X. aristata* Mont., *X. heloidea* Penz. & Sacc., *X. hypoxylon* (L: Fr.) Grev., *X. hypoxylon* (L : Fr.) Grev. sub species *adscendens*, *X. maitlandii* (Denn.) D. Hawks., *X. mellisii* (Berk.) Cke., *X. multiplex* (Kunze) Fr., *X. gracillima* (Fr.) Fr., *X. punjabensis* Dargan & Singh, *X. mussooriensis* Dargan, *X. coccophora* Mont., *X. filiformis* (Alb. & Schw.) Fr. *X. dehradunensis* Dargan, *X. carpophila* Fr. and *X. putranjivii* Dargan & Mann,

Kretzschmaria Fr. *Summa vegetabilium Scandinaviae* **2**: 409 (1849)

The genus has been circumscribed by Swedish mycologist E.M. Fries in 1849, and is worldwide in distribution. Rogers and Ju (1998) revised the genus and recognized only 16 species. However, Kirk *et al*. (2008) mentioned 28 species of the genus in 'Dictionary of Fungi'.

Stromata erect, short stalked, terminated by a clavate or flat topped, umbonate clava, closely aggregated in swarms. Perithecia completely immersed. Ascospores dark, slightly curved. In India, the genus is represented by five species, namely *K. micropus* (Fr.) Sacc., *K. microspora* P. Henn., *K. Phonencis* Kale & Kale, *K. clavus* (Fr.) Sacc. And *K. heliscus* (Mont.) Massee. Only one species, *K. heliscus* is reported from the study area.

Helicogermslita Lodha & Hawksw. *Transactions of the British Mycological Society* **81** (1): 91 (1983)

The genus has been erected by Hawksworth and Lodha (1983) based on a single species, *H. celastri* (Kale & Kale) Lodha & Hawksw. It is a small genus and is represented by only 4 species (Kirk *et al*. 2008). In North West India it is represented by *H. celastri*. The distinctive feature of the genus are: Uniperitheciate to multi peritheciate stromata, dark ascospores with a helical germ slit running from end to end.

Family *Diatrypaceae:* Morphologically, the members of *Diatrypaceae* are characterized by perithecial ascomata, long stalked asci and allantoid ascospores (Glawe and Rogers, 1984). The family contains 13 genera and 229 species and the most common diatrypaceous genera consist of *Cryptosphaeria* Ces. & De Not., *Cryptovalsa* (Ces. & De Not.), *Diatrype* Fr., *Diatrypella* (Ces. & De Not.) De Not., *Eutypa* L. Tul. & C. Tul., and *Eutypella* (Nitschke) Sacc. Several species in this family have been shown to cause plant diseases. *Eutypa lata* (Pers.) L. Tul. & C. Tul., the causal agent of *Eutypa* dieback, is the best known plant pathogen in this family. This fungus has a cosmopolitan distribution and occurs on many woody plant species (Carter, 1991; Trouillas and Gubler, 2004). Other diatrypaceous taxa, such as *Eutypa leptoplaca* (Mont.) Rappaz, *Eutypella parasitica* Davidson & Lorenz and *E. vitis* (Schwein.) Ellis & Everh. were also shown to cause canker diseases and wood decay in various woody plants.

During the present study four genera: *Diatrype* Fr., *Diatrypella* Ces. & de Not.. *Eutypella* (Nitsch.)Sacc**.** and *Eutypa* Tul.&Tul. have been investigated from the study area (Bhatia and Dargan, 1988, 89, 90; Dargan, 1994; Dargan and Bhatia, 1986b, 88b,89a, c, 91; Dargan and Gill, 1996).

Diatrype Fr. *Summa vegetabilium Scandinaviae* **2**: 384 (1849)

The genus was erected by Fries (1849) and recognized by subsequent workers. Kirk *et al.* (2008) in the latest edition of Dictionary of fungi recognized the genus with 59 species all over the world.

It is marked by stromata of various sorts within the bark of woody stems. Stromata may be applanate or pulvinate, erumpent to superficial, determinate to indefinitely effused, discoid, circular or irregular in shape; surface smooth or rough due to slightly projecting ostioles, light brown to black . Flesh white to yellow or brown to black. Perithecia elliptic to pyriform or tubular, numerous, closely packed, ostiolate ;ostioles simple to clefted ,sometimes flattened, hemispherical to conical. Asci 8- spored, cylindrical to clavate with long cylinder stalks; apex obtuse with or without apical ring. Ascospores uniseritely or biseritely or irregularly arranged, allantoid, hyaline to pale yellow collectively giving light brown appearance. Paraphyses thin, filiform, slender, simple , aseptate, hyaline.

The genus is well represented in India and approximately 40 species have been reported. As many as 31 species of the genus have been reported from the study area. These are : *D. albocarnis* Dargan & Bhatia, *D. albopruinosa* (Schw.) Ell. & Ev., *D. asterostoma* Berk. & Curt., *D. azadirachatae* Tilak, *D. bacillaris* Dargan, *D. aurantii* (de Not.) Sacc., *D. brunneocarnis* Dargan, *D. bullata* (Hoff.:Fr.) Fr., *D. calicicarpae* Cke., *D. capnostroma* Ber. & Curt., *D. dalhousiensis* Dargan, *D. disciformis* (Hoffm.:Fr.) Fr., *D. himalayensis* Dargan & Bhatia, *D. hochelgaea* Ell. & Ev., *D. hullensis* Ell. & Ev., *D. indica* Dargan & Bhatia, *D. infuscans* Ell. & Ev., *D. macularae* Ell. & Ev., *D. microstega* Ell. & Ev., *D. minima* Ell. & Ev., *D. nainitalensis* Dargan & Bhatia, *D. nigroannulata* (Grev.) Ell. & Ev. var.*capilli* Dargan & Bhatia, *D. oliveus* Dargan & Bhatia, *D. platystroma* (Schw.)Ell.& Ev., *D. punjabensis* Dargan, *D. sambucivora* (Schw.) Ell.& Ev., *D. simlensis* Dargan & Bhatia, *D. stigma* (Hoffm.: Fr.) Fr., *D. verrucoides* Pk. var. *microspora* Dargan & Bhatia, *D. Virescens* (Schw.) Ell. & Ev. and *D. whitmanensis* Rogers & Glaw.

Diatrypella (Ces. & De Not.) De Not. *Commentario della Società Crittogamologica Italiana* **1** (4): 205 (1863)

It is a well recognized and well spread genus of the family with 33 species the world over (Kirk *et al.* 2008). It is characterized by solitary to gregarious, erumpent, determinate or indefinitely effused, rounded pulvinate or irregular stromata with elliptic to pyriform tubular perithecia and projecting ostioles. Asci clavate, multispored with hyaline stalk. Ascospores allantoid, irregularly crowded in ascus, hyaline.

As many as 18 Species are reported from India out of which 13 species, namely *Diatrypella aspera* (Fr.) Nke., *D. borasii* Chona & Munjal, *D. bougainvilli* Dargan & Bhatia, *D. discoidea* Cke. & Pk., *D. herbacea* Ell. & Ev., *D. himalayensis* Dargan & Bhatia, *D. linearis* Dargan & Bhatia, *D. nigroanuulata* (Grev.) Ell. & Ev. var. *capillosa* Dargan & Bhatia, *D. opaca* Cke., *D. paontensis* Dargan & Bhatia, *D. ribesia* (Schw.) Ell. & Ev., *D. tocciaena* de Not and *D. verrucaeformis* (Ehr.) Nk. have been collected from the study area.

Eutypa Tul. & C. Tul. *Selecta Fungorum Carpologia: Xylariei- Valsei- Spaeriei* **2**: 52 (1863)

The widespread genus is estimated to contain 32 species. (Kirk *et al.*, 2008). It is characterized by poorly developed, widely extended stromata beneath the surface layer of wood with flask shaped single layered perithecia with cylindrical strongly protruded necks. Asci cylindrical long stipitate, 8 spored. Ascospores cylindric allontiod, pale yellow.

The genus is represented in India by only 12 species. Only two species, namely *E. leioplaca* (Fr.) Ell. & Ev. and *E. milliaria* (Fr.) Ell. & Ev. have been reported from the study area.

Eutypella (Nitschke) Sacc. *Atti della Società Veneziana-Trentina-Istriana di Scienze Naturali* **4**: 80 (1875)

It is a large wide spread genus and is known the world over by as many as 78 species (Kirk *et al.*, 2008). It is characterized by possession of dark brown to black, poorly developed stromata, made up of host and fungal tissue with rough surface due to protruding, sulcate ostioles, embedded in stroma; 8 spored, cylindrical to clavate, stipitate asci with allontoid (slightly to moderately curved) ascospores. The genus is represented by 40 species in India. However, only six following species, namely *E. aleuriana* (Berk. & Curt.) Ell. & Ev., *E. punjabensis* Dargan & Bhatia, *E. prunastri* (Las.) Nits., *E. nainitalensis* Dargan & Bhatia, *E. russoides* (Berk.& Curt.) Berl. and *E. stellulata* (Fr.) Ell. & Ev. var. *microspora* Dargan & Bhatia are known from North- west India.

Order *Diaporthales* Nannf.

The members of *Diaporthales* are characterized morphologically by brown to black perithecial fruiting bodies immersed in a stroma or the substrata, lack of true paraphyses at maturity, and unitunicate asci that float free within the centrum at maturity and have a refractive ring in the apex (Barr, 1978; Samuels and Blackwell, 2001). According to Kirk *et al.* (2008), the order contains 10 families. However, only one family *Valsaceae* is represented from the study area.

Family ***Valsaceae*** Tul. & Tul.: The family is created by Tulsane and Tulsane (1861), based on genus *Valsa* Fr. As many as 19 genera are recognized in the family. However, only two genera viz: *Valsa* Fr. and *Valsella* Fuck. are reported from the study area ((Bhatia & Dargan, 1988; Dargan & Bhatia, 1988 a) .

Valsa Fr. *Summa vegetabilium Scandinaviae* **2**: 410 (1849)

Genus is characterized by having rudimentay stroma as web of hyphae in between perithecial necks; perithecia in valsoid clusters within bark, oblique or crowded with long necks; necks oblique or laterally converging and erumpent through a small grayish black stromatic disc; asci 6-8 spored, club shaped, sessile or short stipitate with refractive non amyloid apical invaginations; ascospores allantoid, hyaline.

Valsa Fr. has 60 species, the world over. Only 13 species are known from India, of which following 10 species, namely *V. abietis* (Fr.) Ell. & Ev., *V. capillaris* Dargan & Bhatia, *V. ceratophora* Tul. & Tim., *V. decorticans* (Fr.) Ell. & Ev., *V. disciformis* Dargan & Bhatia, *V. floriformis* Ell. & Ev., *V. himalayaensis* Dargan & Bhatia, *V. intermedia* Nke. var. *microspora* Dargan & Bhatia, *V. lutescens* Ell. & Ev. and *V. nainitalensis* Dargan & Bhatia are reported from the study area (Dargan and Bhatia, 1988a; Dargan and Kaur, 1991).

Valsella Fuckel. *Jahrbücher des Nassauischen Vereins für Naturkunde* **23-24**: 203 (1870)

The genus is known only by 34 species in the world. Stromata valsoid, cortical,generally limited by a black circumscribing line. Perithecia clustered in small groups within dead bark, flak shaped with long necks; necks converging and erumpent through a pale stromatic disc; ostioles entire. Asci polusporous, cylinderic clavate, sessile with refractive apical invaginations, apical ring inamyloid. Ascospores allantoid , hyaline to pale yellow. The genus is poorly known from India and is represented by *V. acaciae* Tilak & Kale and *V. clopima* (Fr.) Ell.& Ev. However, during the study from North west India, only *V. clopima* was recorded.

Sub class *Hypocreomycitdae*

Order *Hypocreales* Lindau.

The *Hypocreales* is an order consisting of seven families, namely *Bionectriaceae, Cordycipitaceae, Clavicipitaceae, Hypocreaceae, Nectriaceae, Niessliaceae* and *Ophiocordycipitaceae.* Species of *Hypocreales* are usually recognized by their brightly colored, perithecial ascomata, or spore-producing structures, sometimes ornamented, rarely setose, stromal tissue fleshy, brightly coloured , often yellow, orange or red ; asci cylindrical, thin walled, sometimes with a small non amyloid apical ring ; ascospores varied, haline or pale brown, usually septate, sometimes eolongate and fragmenting, without a sheath. Members may be saprobes or parasites of plants, often fungicolous, rarely caprophilous, cosmopolitan. Only three families, namely *Nectriaceae. Hypocreacrae* and *Clavicipitaceae* are investigated from the study area.

Family *Nectriaceae* Tul. & Tul.: The family *Nectriaceae* is characterised by uniloculate ascomata that are white, yellow, orange-red or purple. These ascomata change colour in KOH, and are not immersed in a well-developed stroma. They are associated with phialidic asexual morphs producing amerosporous to phragmosporous conidia (Rossman *et al.*, 1999 and Rossman, 2000). This family includes around 55 genera. The majority of these species are soil-borne saprobes or weak to virulent, facultative or obligate plant pathogens, while some are facultative fungicolous.

Nectria (Fr.)Fr. *Summa vegetabilium Scandinaviae* **2**: 387 (1849)

The genus is characterized by weakly to well developed stroma with solitary or aggregated, globose to pyriform,

smooth or rough walled, brightly coloured perithecia; cylindrical clavate asci having oval to ellipsoid, bi-celled, light brown to hyaline ascospores.

Nectria (Fr.) Fr. is a cosmopolitan genus of the family and is represented by 82 species (Kirk *et al*., 2008). The genus is represented by approximately 34 species in India. Some of the species have been reported to cause diseases such as coral spots of woody plants and canker and eye rot of apple and pear, whereas others inhabit dead wood and twigs of various plant species.

During the investigations from North- west India, 20 species of the genus have been reported (Dargan and Bhatia, 1989b;Dargan, Bhatia and Singh, 1983, 85; Dargan and Gill, 1989; Dargan and Mann, 1988; Dargan and Tinna, 1985). These are : *N. aurantiaca* (Tul.) Jacz., *N. capillosa* Dargan & Mann, *N. cinnabarina* (Tode: Fr.) Fr., *N. coccinea* (Pers.: Fr.) Fr., *N. cylinderospora* Dargan & Bhatia, *N. ditissima* Tul., *N. episphaeria* (Tode :Fr.) Fr., *N. flavor-virdis* (Fuck.) Wall., *N. fuckeliana* Booth, *N. galligena* (Bres.) Berk., *N. himalayensis* Dargan & Bhatia, *N. lecanoides* Ces. & de Not., *N. mammoidea* Phil., *N. mussooriensis* Dargan & Bhatia, *N. pinea* Dingley, *N. punicea* (Schm.: Fr) Fr., *N. purtnii* (Grev.) Berk., *N. ralfsii* Berk. & Broom, *N. synopica* Fr. and *N. veuillotiana* Roum. : Sacc.

Family *Hypoceraceae* de Not.: Species of *Hypocreaceae* are usually recognized by their brightly colored, perithecial ascomata, typically yellow, orange or red. The *Hypocreaceae* is similar to the *Nectriaceae* but differ in having more extensive stromata**.** Family is represented by 22 genera and 454 species throughout the world. One species each of genus *Hypocrea* Fr. (*H. rufa* (Pers.: Fr.) Fr.) and *Hypomyces* (Fr.) Tu. & Tul.(*H. aurantius* (Pers.:Fr.) Tul. var. *microspora* Dargan& Bhatia) are reported from the study region. (Dargan and Singh, 1982a; Dargan and Bhatia, 1986a).

Family *Clavicipitaceae* Ericss.: *Clavicipitaceae* is a large family of obligate biotrophs and necrotrophs of plants, arthropods and fungi. It is represented by 43 genera and 321 species as reported by Kirk *et al.* (2008). During our investigations on perithecial fungi in the North-west India, a peculiar fungus was collected parasitizing on Bamboo, which on detailed study was found to be belonging to the following new genus (Doi, Dargan & Thind, 1977).

Cavimalum Yoshim. Doi, Dargan & K.S. Thind. *Bulletin of the National Science Museum Tokyo* **3**: 23 (1977)

The genus was proposed by Doi *et al.* (1977) based on a Himalayan collection The characteristic feature of the genus are subglobose, yellowish and wholly fertile stromata with watery cavities at their central portion ; perithecia obclavate, immersed in stromata; asci filamentous 8 spored ; ascospores filamentous, septate, non separable at maturity. It is a small genus and is known by only two species, *C. indica* Yoshim. Doi, Dargan & Thind and *C. bornensis* Yoshim, Doi, Dargan & Thind. The former being type species of the genus.

North -west India is one of the nine floristic regions of India, recognized by Champion and Seth (1968), from where the above perithecial fungi are reported by the author and his associates. More fungal forays are needed by enthusiastic workers to investigate many more remaining taxa of different orders and families of the group from this region and remaining eight regions of the country.

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