

Review

Fungal research in ASEAN countries

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A preliminary survey on the mycological activities and areas of research in ASEAN countries was conducted. This survey was carried out through a literature search and correspondence with some ASEAN mycologists. The results of the survey showed that there is a high level and standard of mycological research in various ASEAN countries. These include research on fungal flora and taxonomy, physiology and development, biochemistry, molecular biology, genetics, fungal-plant interactions, bioconversion, biodeterioration, and edible mushrooms. Compilation and publication of works of ASEAN mycologists is important for the promotion of contacts and collaborative research. This short paper is a preliminary step towards this objective.

Key Words—ASEAN mycology; fungal research; mycological research.

A wide range of mycological research and activities are pursued in various institutions and universities in ASEAN countries. A preliminary survey on some of the mycological research in Brunei, Indonesia, Malaysia, Philippines, Singapore and Thailand was carried out through correspondence with mycologists in the respective countries, and through a literature search of the more available publications and recent reports of regional mycological meetings. The information that has been gathered are presented in this paper. However, this is not as exhaustive and well covered as it should be, because many mycologists on the mailing list did not respond to the survey. Hence, there must be many other mycological activities which the author is not aware of and has omitted in this paper. Nevertheless, the information gathered, albeit not necessarily representing all or the main thrusts of mycological research in any particular country, would be useful to mycologists in this region. This is especially so because there is a dire need for ASEAN mycologists to know more of their counterparts and their activities, and to establish more common ties and collaborations.

The areas of mycological interest and activities in this region known to the author include flora and taxonomy of terrestrial fungi, fungal physiology and development, biochemistry, molecular biology and genetics, plant pathology, mycorrhiza, aquatic fungi, fungal air-spores, mushroom research, fungal bioconversion, fungal biodeterioration, aflatoxin production, and fungal culture collection: some of these research activities are high-lighted.

Studies on fungal flora and taxonomy through collection, identification and description are one of the oldest and longest standing interest in mycological research in several ASEAN countries. In Malaysia, a major focus has been on fungi of terrestrial and submerged decaying

leaf litter. Many new fungi have been described by Kuthubutheen and his coworkers (Kuthubutheen, 1987a; Kuthubutheen and Nawawi, 1988, 1990, 1991a, b, c, 1993). The authors have reported a diversity of *Dic-tyochaeta* and *Cryptophiale* species, and provided keys to these fungi (Kuthubutheen, 1987b; Kuthubutheen and Nawawi, 1991d). Recently, a new anamorph, *Paracryptophiale kamaruddinii* Kuthub. & Nawawawi, was described (Kuthubutheen and Nawawi, 1994). In Singapore, the *Clavaria* and allied genera, and the boleti were documented in the early monographs of Corner (1950) and Corner (1972) respectively. More recent interests and publications include a report by Tokumasu et al. (1988) on the microfungi of fallen pine needles, and a comparison of fungi on litter of primary and secondary forests (Sim, 1994). Taxonomic studies of fungi in Thailand include those focussing on *Termitomyces* (Pichyangkura, 1993), *Pythium* (Farungsang et al., 1993), *Fusarium* (Charoenwattana et al., 1993), *Chaetomium* (Soytong, 1991a), boleti (Chandrasrikul, 1991), pine litter fungi (Manoch et al., 1986; Tokumasu et al., 1990), and general soil fungi (Soytong, 1991b; Witteman and Soytong, 1991).

Comparatively, there are fewer studies on fungal physiology and development. Information is scant except for some reports from Thailand on studies on induction of zoospore formation in *Pythium* (Chaiprasert et al., 1991), growth and sporulation of *Mycogone perniciosus* (Magnus) Delacroix (Pitakpaivan et al., 1991) and the effects of essential oils on fungal growth (Atisongkroh et al., 1993). Some of the physiological studies are carried out in conjunction with biochemical investigations (e.g. enzyme secretion) and other areas of studies covered elsewhere in this report.

Much of the interest in the biochemistry of fungi is

focussed on fungal enzymes and their applications. The enzymes of major interest are proteases and glucoamylases from *Rhizopus* spp. (Gandjar et al., 1991), glucoamylase from *Sporotrich* sp. (Lumyong et al., 1991), lignin degrading enzymes from *Phanerochaete chrysosporium* Burdsall (Promachotikool, 1993); and cellulase, particularly β -glucosidase from *Aspergillus* spp. (Tan et al., 1986; Yeoh et al., 1988; Hoh et al., 1992a, b, 1993).

Fungal genetics is a long standing area of research, but not widely pursued. On the other hand, molecular biology is a more recent and fast-growing interest. Reports in these areas of study include that on the gene encoding β -glucuronidase in *Saccharomyces cerevisiae* Meyer ex Hansen (Phonphok et al., 1991), mutagenesis of *Monascus kaoliang* lizuka & Minaki for increased pigment formation (Yongsmith et al., 1991), sexuality in *Ganoderma lucidum* (Leyss. ex Fr.) Karst. (Tritatana and Chairasert, 1991), molecular characterization of *Pythium insidiosum* (Borisuth et al., 1993), and mechanism of MBC resistance in *Monilinia fructicola* (Winter) Honey (Sanoamuang, 1993).

Plant pathology is a major research interest in several countries, primarily because of the impact of fungal plant diseases on agriculture and economy. Some of the more recent studies on plant diseases and fungal pathogens include the infection of: *Asystasia* (a potential vegetable) by *Colletotrichum gloeosporioides* Penz. (Tan and Tow, 1992) and *C. capsici* (Syd.) E. J. Butler & Bisby (Tan and Tow, 1994); *Allium cepa* Linn by *C. gloeosporioides* (On-goagwanit et al., 1991), fruit trees by *Colletotrichum*, *Botryodiplodia* and *Alternaria* (Visarathanonth, 1993), forest plants by *Phyllachora pterocarpi* Sydow, *Meliola*, *Uncinula tectonae* Salm and other undescribed ascomycetes (Pongpanich, 1993), and sunflower plants (*Helianthus*) by *Alternaria* spp. (Prathuangwong et al., 1991). In several studies, emphasis is placed on the biology of the fungal pathogens, as well as on disease control measures. These measures include the use of antagonists such as *Trichoderma* spp. (Chamswang and Gesnara, 1993) and *Chaetomium* spp. (Soytong, 1993); and breeding of disease resistant plants such as smut-resistant sugar cane (Vajrabhaya, 1991) and Tobacco (*Nicotiana*) resistant to frog-eye disease (Poreang and Laixuthai, 1991).

Research on mycorrhiza, although important, is not as intensive or pursued on the same urgent note as that for plant pathology. Nevertheless, mycorrhiza research is active in Indonesia (Supriyanto et al., 1991), the Philippines (Khagge et al., 1991; Luis et al., 1991) and Thailand (Vasuvat, 1991). In Thailand, several studies are focussed on inoculum compatibility between ectomycorrhiza and timber trees such as *Eucalyptus* (Chaiwongkeit, 1991) and *Dipterocarpus* (Sangwanit and Santhian, 1993). Report on endomycorrhiza research include that of Wadisirusak et al. (1988), Nopamornbodi et al. (1993) and Suwanarit and Suwana-adth (1993). In Singapore, mycorrhiza research is a recent interest (Tan and Wong, 1993). The emphasis is on the tripartite symbiosis involving ectomycorrhiza, *Rhizobium* and leguminous tree hosts.

Research on freshwater fungi has been ongoing in Malaysia, Singapore and Thailand for many years. Most of these studies are floristic in nature with the hyphomycetes commanding a wider interest than other fungal groups. The freshwater hyphomycetes in Malaysia are well documented by Nawawi (1985) and Kuthubutheen (Kuthubutheen and Nawawi, 1992, 1993). Isolated reports include that of Tubaki et al. (1993) for Singapore and Tubaki et al. (1983) for Thailand. Interest in the marine and mangrove fungi is comparatively recent, but actively pursued. Perhaps, this is the area most widely reported as far as mycological research in Brunei is concerned. This area of research in Brunei is attributed mainly to Hyde who has published several papers on the flora and ecology of mangrove fungi in Brunei (Hyde, 1988a, b; 1989a, b; 1990a, b). Work done on marine and mangrove fungi in other ASEAN countries have been reported by Hyde (1989c) and Jones and Hyde (1990) (Indonesia); Jones and Tan (1987), Jones and Kuthubutheen (1989), Jones (1992), and Tan and Leong (1992) (Malaysia); Jones et al. (1988) (Philippines); Leong et al. (1988, 1990, 1991a, b), Tan et al. (1989a, b), Tan and Leong (1990), Tan et al. (1994) (Singapore); and Hyde (1989d) and Hyde et al. (1990) (Thailand).

Interests in fungal airspora is sporadic, with reports from Malaysia (Ho, 1992), Singapore (Tan et al., 1992b) and Thailand (Phanichyakarn et al., 1989; Dhorraintra et al., 1988, 1991). In Singapore, outdoor airspora is being monitored along with hospital admissions for allergic respiratory disorders and allergy-testing with fungal spore extracts.

Among the ASEAN countries, research on edible mushrooms is especially active in Thailand where the cultivation of *Agaricus bisporus* (Lange) Imbach (Ponglux and Tritatana, 1991), *Lentinus edodes* (Berk.) Singer (Chalermpongse and Lertprasert, 1991; Nutalaya and Pataragetvit, 1991), *Termitomyces* (Pichyangkura, 1993); hybridisation of *Ganoderma lucidum* (Tritatana and Chairasert, 1991) and disease control of *Mycogone* infection of *A. bisporus* (Pitakpaivan, 1991) are being investigated. In Malaysia, attempts are being made to cultivate the edible *Termitomyces heimii* Natarajan (Sepiah, 1992), while a comprehensive guide to low cost mushroom cultivation in the tropics and the Philippines was earlier published by Quimio (1986). Mushroom research in Singapore, active in the early eighties (Yong and Leong, 1983), is now limited and confined to one or two commercial mushroom farms.

Research on the utilisation of fungi for bioconversion of native materials is a major activity in Indonesia where palm sap, pineapple peel, soybean waste and raw starch are used as substrates (Hariantono, 1991). Likewise in Thailand, fungal bioconversion of cassava starch by *Sporotrich* sp. (Lumyong et al., 1991) and sisal fibres by *Candida utilis* (Henn.) Lodder & Kreger-ran Rij (Punnapayak and Nudasomboon, 1991), and biopulping by *Phanerochaete chrysosporium* (Promachotikool, 1993) are being studied. Aspects of these research include strain selection, optimisation of culture conditions and enzyme studies.

Fungal biodeterioration is a major problem in the tropics and hence a subject of research. Research interest ranges from fungal biofouling of buildings (Lim et al., 1989; Tan et al., 1992a) to wood rots and wood staining (Veenin, 1993; Thienhirun, 1993), deterioration of paint surfaces (Punyauppa-path et al., 1991) and deterioration of stored food products and mycotoxin production (Hongthong and Chansa-ngavej, 1991).

The preservation of fungal germplasm is an especially important aspect for research on fungi and their utilisation. For this purpose, culture collections of yeasts, filamentous fungi and edible mushrooms are maintained by various research institutions and universities in Indonesia, Malaysia, Philippines (Tapay et al., 1991), Singapore and Thailand (Artjariyasriping et al., 1993). Most of these are small collections meant to meet local teaching and research needs. An important set-up in this geographical region is the Bangkok MIRCEN which acts as the centre for cooperation in mycological and microbiological work among ASEAN and Asian countries.

In conclusion, there is a high level of activity and standard of mycological research in various ASEAN countries. However, more could be done to further enhance the status of mycological research in this region. These would include the compilation and publication of works of ASEAN mycologists, and the promotion of contacts among these mycologists for cooperative research and communications. In this respect, the Committee for Mycology in Asia has the potential to play a major role.

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