
Mycology and its future in the Asia-Pacific region

K.D. Hyde*

Centre for Research in Fungal Diversity, Department of Ecology & Biodiversity, The University of Hong Kong, Pokfulam Road, Hong Kong, SAR, China; e-mail: kdhyde@hkucc.hku.hk

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To fulfil their commitments to the Convention on Biological Diversity (CBD), countries of the Asian region must understand that taxonomic expertise is vital for effective implementation. The Global Taxonomy Initiative (GTI) therefore states “understanding taxonomy to be a priority in implementing CBD”. Fungi, in particular, are a group of organisms where countries in the region lack taxonomists to carry out the roles of the CBD. Previously, several Asia countries had groups of taxonomists, but in recent years the number of active mycologists has dwindled because of other commitments, retirement of the mycology population without replacement and more importance being placed on other disciplines, such as biotechnology. This paper will briefly review the history of the study of fungi in the Asian region and then examine the current situation using publications in international journals. It will address the effects of the CBD on mycological taxonomic research in the region. It will then look at the future for taxonomic mycology in Asian. Suggestions on how improvements to mycological expertise in a country can be made are given with particular reference to the successes in Hong Kong and Thailand.

Key words: fungal diversity, inventory, mycology, systematics, taxonomy

Introduction

In order to fulfil commitments to the Convention on Biological Diversity (CBD) countries in the Asian region must understand that taxonomic expertise is vital for effective implementation (Hyde, 2003). The Global Taxonomy Initiative (GTI) therefore states “understanding taxonomy to be a priority in implementing CBD” (CBD, 2002). Fungi, “stand out”, as they represent a group of organisms where most countries in Asian and other regions lack taxonomists to carry out the roles of the CBD (Hyde, 2003).

Despite this need and the fact that fungi are important potential sources of novel compounds (Hyde, 2001), the number of fungal systematists is rapidly declining throughout most of the world and Asia is no exception (Hyde, 2003).

*Corresponding author: K.D. Hyde; e-mail: kdhyde@hkucc.hku.hk

In 1991 there were only 32 fungal taxonomists in Australia (Grgurinovic and Hyde, 1993). The majority of these spent less than one week per month on taxonomic research. The situation has since become worse with several mycologists retiring. The situation with microfungi is particularly critical. In the last decade there have been very few monographs or treatments of microfungal groups, very few research groups in the world are carrying out microfungal diversity research and very few young taxonomists are being trained. We are, therefore, at a critical point where existing expertise is rapidly disappearing and before long it will become very difficult to train any new fungal systematists.

The purpose of this paper is to briefly review the history of fungal systematics in the Asian region. It will then discuss the problems and difficulties facing fungal systematics in Asia and highlight the acute shortage of mycologists in the region. Finally, ways in which mycologists can help advance the situation and examples in Hong Kong and Thailand where fungal diversity studies are taking place will be outlined.

Taxonomic mycology in Asia – the past

With the exception of the Japanese (e.g. K. Hara), most mycologists who worked in Asia before the 2nd world war were visiting scientists. Alternatively, collectors worked in the region and collected and preserved fungi. Material was then sent to eminent mycologists of the day (1900-1920) in Europe to be examined and described. Material was described from Indonesia (P. Hennings, F. Höhnelt, O. Penzig and P.A. Saccardo) and the Philippines (P. Sydow, H. Sydow and H. Rehm) in this way. Some expatriate mycologists living in various countries also made significant inputs to taxonomic mycology. In Sri Lanka T. Petch made significant contributions to the study of fungi, while substantial contributions were made by E.J.H. Corner in Malaysia and Singapore.

Studies on microfungi however, were less common, although several post war Japanese researchers made substantial contributions (e.g. I. Hino, K. Katamoto, T. Matsushima, K. Tubaki). In Malaysia A. Kuthubutheen and A. Nawawi made substantial contributions to our knowledge of microfungi, C.V. Subramanian in India, M. Rifai in Indonesia and S.C. Teng in China made similar contributions. Unfortunately, most of these researchers are either deceased, retired or have moved to other non-research disciplines and have not been replaced.

Taxonomic mycology in Asia – the present

A survey of publications in fungal taxonomy is one means by which a tangible evaluation of the status of fungal systematics in the region can be obtained and is relatively easily to carry out by searching the Bibliography of Systematic Mycology (Anonymous, 1989-2001) where all accessible mycological publications in taxonomy are listed (from both international and national journals). This is possibly the most accurate way to express involvement in taxonomic mycology as it undoubtedly indicates which mycologists are functioning in the region. Quimio (1998) lists more than 170 mycologists in the region in the International Mycological Association Committee for Asia (IMACA) “*Asian Systematic Mycologists Directory*”. This directory, however, is misleading, as the majority of researchers are either not publishing, work in other fields or have retired. Many are also students that now work on other subjects or have left the region. The years 1989, 1994 and 1999 were chosen for survey, as five yearly intervals were considered to be adequate to indicate trends in publications of mycologists. The latest year that could be accessed fully was 1999 as there is a lag time of 1-2 years in listing of all publications in the Bibliography. China, Hong Kong, Macau and Taiwan are treated as separate regions.

The number of taxonomic mycological publications are listed by country from the Asian region over the last three, eight and 13 years (Table 1). In 1989 there were 62 publications in the Asian region with 17 publishing researchers. Researchers in India (7), Japan (3), and Taiwan (3) were particularly productive. Of the 22 listed countries there were no publications from 16 countries and no publishing taxonomic mycologists in 18 countries. Therefore, most countries in the region lacked publishing taxonomic mycologists. The situation became worse in 1994 with only 42 publications and 10 publishing researchers. There were no longer any publishing researchers in India. Japanese (6), Chinese (2) and Hong Kong (2) were the actively publishing researchers in the region. Of the 22 listed countries there were no publications from 16 countries and no publishing taxonomic mycologists in 19 countries. The situation appears to have improved in 1999 with 117 publications and 32 publishing taxonomic mycologists. Researchers in Hong Kong (21), Japan (6) and Taiwan (6) were particularly productive. Of the 22 listed countries there were no publications from 14 countries and no publishing taxonomic mycologists in 16 countries.

There are general trends in the results of this survey. The majority of countries (72.7-81.8%) did not have any publications during the years surveyed and thus had no productive taxonomic mycologists. India was previously

Table 1. Numbers of publications in mycological taxonomy in international and national journals and number of active mycologists* in 1989, 1994 and 1999 in the Asian region.

Country/ region	1989		1994		1999	
	Public- ations	Active mycologists	Public- ations	Active mycologists	Public- ations	Active mycologists
Bangladesh	-	-	-	-	-	-
Brunei	-	-	-	-	-	-
Cambodia	-	-	-	-	-	-
China	6	2	4	2	18	3
Hong Kong	-	-	13	2	54	21^s
India	30	7	4	-	4	-
Indonesia	-	-	-	-	-	-
Japan	15	3	17	6	22	6
Korea	1	-	-	-	3	1
Lao	-	-	-	-	-	-
Macau	-	-	-	-	-	-
Malaysia	3	2	1	-	2	1
Mongolia	-	-	-	-	-	-
Myanmar	-	-	-	-	-	-
North Korea	-	-	-	-	-	-
Pakistan	-	-	-	-	-	-
Papua New Guinea	-	-	-	-	-	-
Philippines	1	-	-	-	-	-
Singapore	-	-	-	-	-	-
Taiwan	6	3	3	-	13	6
Thailand	-	-	-	-	1 [#]	-
Vietnam	-	-	-	-	-	-
Total	62	17	42	10	117	38
Total	49	13	22	6	32	8
excluding China, Hong Kong and Taiwan						

*Publications in journals listed in the Bibliography of Systematic Mycology. Publications in taxonomy and checklists only considered (i.e. plant pathology, biology, industrial mycology excluded).

[#] This figure has increased dramatically in 2002 so that there are probably more than 20 taxonomic publications and more than 10 active researchers.

^s Many of these are students that were undergoing PhD training in Hong Kong and have now returned to other countries (e.g. Australia, China, Philippines, New Zealand).

productive, but with a rapid decline in both publications and active taxonomic mycologists after 1989. The results for China, Japan and Taiwan were relatively consistent, maintaining a number of publications and having between 2-6 effective taxonomic mycologists. In Hong Kong there was a rapid rise in

both publications and active taxonomists, mainly as a result of the Centre for Research in Fungal Diversity.

The results for China, Hong Kong and Taiwan indicate that there is a relatively healthy group of publishing systematic mycologists. The situation for other countries in the region is, however, depressing. If China, Hong Kong and Taiwan are excluded from the results, then the publications since 1989 have decreased and so have the numbers of publishing mycologists. There are, however, some improvements not shown in these results. The numbers of taxonomic mycologists in South Korea has steadily increased, although there is still a low number. Thailand now has more than 10 publishing taxonomic mycologists and the numbers are increasing at a fairly rapid rate.

Problems facing fungal systematics and fungal biodiversity inventory

There are numerous problems facing taxonomic research in mycology and there are few obvious solutions.

Funds

It has become extremely difficult to obtain funds for basic inventorying and identification of fungi, particularly in developing countries where decision makers often prefer to fund applied research (e.g. biotechnology). This is unfortunate as fungal taxonomy is relatively inexpensive to fund, while biotechnological research may be expensive to conduct, is often simplistic and lacks industrial application (e.g. Yoshida *et al.*, 1999). Much of the funds that may have previously been awarded to fungal systematics in the developed world is now being awarded to groups studying phylogenetics. These groups need elaborate equipment and expensive consumables to carry out their work. Many fungal systematists have opted to use molecular techniques to solve taxonomic problems, which has taken place at the expense of morphological taxonomy. No doubt these are powerful tools, but wrong identification of cultures could cloud taxonomic reality and thus minimise the value of funds spent.

Effects of the Convention of Biological Diversity on fungal studies

The Convention on Biological Diversity (CBD), signed at the United Nations Conference on Environment and Development in Rio De Janeiro in 1992 (and associated schemes, e.g. Global Biodiversity Strategy, Agenda 21), gave hope to mycologists, that at last there was a future in fungal systematics (e.g. Hyde and Hawksworth, 1997; Wildman, 1997). Unfortunately, the

following 10 years has generally seen a decline in fungal systematics research in many parts of the world (Hyde, 2003), with researchers either retiring and not being replaced or funds being directed elsewhere (e.g. molecular phylogeny). With the exception of a small number of countries (e.g. Hong Kong, Thailand) a sharp decline in the number of mycologists practicing systematics has been witnessed over the past 10 years. The CBD that offered promise, had both good and bad affects. Countries became aware of the value of their biological resources and began to protect them. This meant that it became more and more difficult to obtain permission to collect fungi in various countries, and thus there was less rationale for mycologists in developed countries to train and collaborate with local mycologists. Developing countries lacked the resources to train mycologists themselves and most locally funded mycologists were poorly equipped, to the extent that they lacked research quality microscopes and even the basic recent mycological literature. The result was, therefore, a decrease in the number of mycologists in most developing countries. The CBD in most countries, therefore, failed in its promise to promote biodiversity study.

Impact factors

ISI presently awards impact factors to journals (Science Citation Index Expanded) and these have important implications. Many universities and scientific institutions internationally use impact factors as a basis for evaluating a scientist's performance or appraising whether they should be promoted. This is proving problematic to taxonomic mycologists, as the highest impact factor journal that mycologists can publish in is *Mycologia* (IF = 1.604, April 2003). Impact factors are calculated by a relatively simple formula (see <http://isi8.isiknowledge.com/>). Simplistically, an impact factor for a single year is calculated, based on the number of times papers in a journal are cited (previous two years publications only), divided by the number of papers in that journal over the previous two years. There are numerous arguments against the use of impact factors in judging science (Hawksworth, 2003) and these do not need to be addressed here. For now, however, impact factors appear to be a problem that we have to live with. Shelf life, which measures the importance of a journal over a long period, is probably a better measure of the "impact" of a taxonomic mycological journal, but this is rarely mentioned. We therefore need to understand the issues involved in the award of impact factors and shelf life and use these issues to argue to our advantage as best we can.

The way forward

Taxonomic expertise of fungi is vital for effective implementation of the Convention on Biological Diversity (Hyde, 2003). Fungi are also extremely important organisms in agriculture and biotechnology. The larger basidiomycetes are also aesthetically pleasing organisms, often being used in jewellery, children's books and other images and artefacts (Taylor-Hawksworth, 2001). The ingredients for the promotion of fungi as important organisms and thus fungal research already exist and it is up to mycologists themselves to promote their cause. An action plan for such a promotion is outlined by Hawksworth (2003) and all mycologists should be involved. Most important of all, as an orphan group (Hyde, 1997) all mycologists should support each other in any way possible. This can include: positive reviews of grant applications; reviewer help to improve manuscripts rather than negative rejection, supportive references in promotion applications, and collaboration and training. There is no room for bickering or territorialism between mycologists. There are enough fungi for everyone to study without having an effect on the scientific advances of others. We are at a critical point, with existing expertise rapidly disappearing. The future of mycology is in the hands of the small number of fungal systematists remaining and we cannot, therefore, be complacent.

Global Taxonomy Initiative

Moves are now underway with the aim of increasing the number of systematists in developing countries. Recently 183 countries which are parties to the CBD reached agreement on the Global Taxonomy Initiative (Anonymous, 2002). A summary of the GTI can be download (www.biodiv.org/programmes/cross-cutting/taxonomy/default.asp). Basically the purpose of the Global Taxonomy Initiative is to remove or reduce what is referred to as the taxonomic impediment. The taxonomic impediments are the knowledge gaps in the taxonomic system, the shortage of trained taxonomists and curators, and the impact this has on the ability to conserve, use and share the benefits of biological diversity. GTI Focal Points have been appointed for country taxonomic needs assessment (download from www.bionet-intl.org) and recommendations have now been made as to their roles (Anonymous, 2003). It is therefore our responsibility as mycologists that we lobby these parties to make sure that fungal systematics is given priority in any programmes resulting from the GTI.

An important player in the GTI is BioNET INTERNATIONAL (www.bionet-intl.org). “BioNET INTERNATIONAL is dedicated to supporting sustainable development by helping countries to overcome the taxonomic impediment by becoming self-reliant in taxonomy, i.e. self-reliant in the skills, infrastructure and technologies needed to discover, identify, name, classify and to understand the relationships of all organisms”. Amongst other activities BioNET INTERNATIONAL produce monthly bulletins that keep readers updated re-GTI developments. A set of regional information networks (LOOPS) have also been set up under the umbrella of BioNET INTERNATIONAL. Two of particular interest to Asia are the EASIANET (<http://easianet.ecoport.org>) and ASEANET (www.mardi.my/aseanet/). Another important source for GTI information in Japan can be consulted at www-gti.nies.go.jp. It is important that we as mycologists become actively involved in these initiatives and make sure the needs of taxonomic mycologists are heeded. It is heartening to see these internet initiatives taking place so that taxonomists can be aware of other taxonomic developments in the region. Fungal taxonomic expertise is, however, gained from hours of stolid study at the microscope bench and it is a worry that the funds spent on developing internet services for taxonomy, as opposed to training new taxonomists, will result in further decline in the number of fungal taxonomists.

Taxonomic mycology in Asia – the future

The present level of productivity in fungal systematics (based on publications in international journals) is disappointing, with very few countries having active mycologists. This should provide a startling wake up call to politicians if they are serious about implementing the GTI. The predicament now is that the base of taxonomic mycologists in the region is remarkably small. If we are to resolve this situation we have to take action now before all expertise has diminished. In reality there are only a small number of Centers of Taxonomic Mycological expertise in the region. These include BIOTEC, in Bangkok, Thailand, The Department of Biology, Chiang Mai University, Thailand, The Centre for Research in Fungal Diversity, The University of Hong Kong, Hong Kong and the Systematic Mycology and Lichenology Laboratory, Academia Sinica in Beijing, China. Unfortunately, within these Centers, only the Department of Biology, Chiang Mai University, Thailand and The Centre for Research in Fungal Diversity, The University of Hong Kong, have extremely good taxonomic library resources, which are essential for taxonomic mycological research.

The only effective way to move forward is to develop these existing Centres and utilize them to provide higher degree training for students in the region. This is already happening to a certain extent. More than 40 students have been trained at the Centre for Research in Fungal Diversity, The University of Hong Kong. Many of these students are from the region and have returned to their respective countries and have become active mycologists (e.g. L.D. Guo, Systematic Mycology and Lichenology Laboratory, Academia Sinica, Beijing, China). There are three resident taxonomic mycologists and more than 10 Thai students undergoing training at BIOTEC, Bangkok, Thailand and eight students undergoing taxonomic training at Chiang Mai University. There is a need for the Thai Centres to train other nationalities and in this way it may be possible to train enough students to return to their respective countries who can then be concentrated in their own Centres. The problem, however, exists as to where funds for such training can be acquired.

The next five years may be a turning point for taxonomic mycology in Asia. The region now has its own fungal biodiversity journal (<http://www.hku.hk/ecology/mycologyFDP.html>) which is publishing articles from different countries in the region, e.g., China, Yang *et al.*, 2001; Lui *et al.*, 2001; Hong Kong, Hyde *et al.*, 2001; India, Suryanarayanan and Vijaykrishna, 2001; Indonesia, Risna and Suhirman, 2002; Philippines, Leaño *et al.*, 2001; Russia, Núñez *et al.*, 2001; Taiwan, Hsu and Agoramoorthy, 2001 and Thailand, Somrithipol *et al.*, 2002. China (Mycosystema), India (Kavaka), Korea (Mycobiology), Taiwan (Fungal Science) and Japan (Mycoscience) also have local journals, and many countries in the region have their own mycological societies. Either under the umbrella of International Mycological Association Committee for Asia (IMACA, <http://imaca1.tripod.com/imaca/>), or as local societies, it is important that mycologist lobby governments and actively promote fungi in future GTI developments. The responsibility falls on each of us, and if we fail we only have ourselves to blame.

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