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Some Aquatic Hyphomycetes from Sri Lanka

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Abstract: Eighteen types of aquatic Hyphomycete conidia were found in foam samples collected from rivers and streams. Of these 11 were identified to species level and 4 to generic level; three were not identified at all. The number and types of conidia were greater in Sinharaja Forest streams than in rivers and streams flowing through urbanized and agricultural areas.

1. Introduction

The aquatic Hyphomycetes are a relatively small group of water-inhabiting fungi. Some of these fungi complete their entire life cycle including growth, sporulation, spore liberation and dispersal below the surface of water, but some are amphibious and may have telomorphs on substrata exposed to air. Very little was known about these fungi until Ingold[7] published his now famous paper on aquatic Hyphomycetes of decaying alder leaves. Aquatic Hyphomycetes often grow on submerged, partially decayed leaves and twigs present in fast flowing streams in wooded areas.[21]

About 200 species of aquatic Hyphomycetes have already been described. These have been assigned to 60 form genera. A guide to the identification of the commonly encountered forms is now available.[11] Basically, two spore shapes can be seen: the tetraradiate form with four long arms and the sigmoid form with curvature in more than one plane.[11] These spores are concentrated in a remarkable way by air bubbles which under certain conditions collect as persistent foam and scum often captured behind barriers of twigs and rocks in rivers and streams. This foam and scum provide an excellent source for collecting aquatic Hyphomycetes, although it is recognised that the spore content of foam may not actually reflect the spore content of water.[14]

Aquatic Hyphomycetes were first recorded in Europe. They are now known to have a worldwide distribution with the possible exception of North and South poles. Many species are world-wide in distribution, but some are more characteristic of either the warmer regions or the colder regions of the globe. Some species such as *Lunulospora curvula* and *Triscelophorus monosporus* although occurring in temperate colder regions are much more abundant in warmer tropical parts of the world.[11]

Most fresh water biologists would regard these fungi as insignificant and unimportant members of the fresh water biota; but it is now known that in many fresh water habitats they are very abundant.

No organism with a spore concentration of 10,000/l in stream water[14] can be considered as insignificant. The vital role they play as a link in the food chain between the detritus derived from the dead leaves and many invertebrates that feed on aquatic Hyphomycetes has become clear mainly as a result of the studies of Kaushik and Hynes, [15,16] Bärlocher and Kendric[1,2,3] and Berrie.[4]

Aquatic Hyphomycetes have not been hitherto recorded from Sri Lanka. This is a preliminary report of some of the observations made in the rivers and streams mainly in the south-western part of Sri Lanka.

2. Materials and Methods

Samples of foam, scum and decaying submerged tree leaves were collected from 12 streams in the island. Four samples were collected from the stream at Sinharaja Forest and one sample each from the other sites enlarging the total sampling sites to 15. These sampling sites are shown in Figure 1.

Foam and scum samples were scooped into clean screw capped bottles. Within a few minutes foam breaks down and the resulting liquid is fixed by adding 3 - 6 drops of 40% formalin. It is necessary to fix at once, for otherwise conidia will germinate when they settle at the bottom. The bottles were brought to the laboratory, the contents allowed to settle and a drop of the bottom deposit pipetted onto a slide for microscopic examination.

In addition, decaying submerged leaves (which are dark brown, soft and beginning to skeletonise) were collected in polythene bags and brought to the laboratory. They were washed in tap water to remove surface and other debris. Each was then placed in a Petri-dish and covered with distilled water and left for 1 - 2 days at room temperature (30 $\pm$ 2°C) in the dark. The leaf was then scanned under a binocular microscope for aquatic Hyphomycete conidia and mycelia.

3. Results

Eighteen types of aquatic Hyphomycete conidia were encountered in the rivers and streams sampled. Of these 11 were identified to species level and 4 to generic level. Three types were not identified. The occurrence and the distribution of different species appear in Table 1. The results show that these aquatic Hyphomycetes are particularly abundant in streams flowing through the broad-leaved natural vegetation of the Sinharaja Forest.

TABLE 1. Occurrence and distribution of conidia of aquatic Hyphomycete species at 15 sampling sites. (+ present; — absent)

Species \ *Sampling site*	*Minuwangoda*	*Sinharaja Forest Streams Sub-sites* A	B	C	D	*Mee-Oya*	*Kala-Oya*	*Elpitiya stream*	*Aperakka stream*	*Uduwara-Oya*	*Attanagalu-Oya*	*Ma-Oya*	*Mawanella stream*	*Ambanapitiya stream*	*Habarana stream*
Lunulospora curvula	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Triscelophorus monosporus	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Flagellospora sp.	+	+	+	+	+	—	+	—	+	+	+	+	—	+	+
Anguillospora sp.	+	+	+	+	+	+	+	+	—	+	+	—	—	+	—
Anguillospora crassa	—	+	+	+	+	—	—	+	—	—	+	—	+	—	—
Centrospora aquatica	—	+	+	+	+	—	—	—	—	+	+	—	+	—	—
Filosporella sp.	—	+	+	+	+	—	—	—	—	—	+	—	+	—	—
Lunulospora cymbiformis	—	+	+	+	+	+	—	—	—	—	—	—	—	—	—
Dactylella submersa	—	+	+	+	+	—	—	—	—	—	—	—	—	—	—
Lemonniera aquatica	—	—	—	+	+	+	+	—	—	—	—	—	—	—	—
Tricladium sp.	—	+	—	+	+	—	—	—	—	—	+	—	—	—	—
Alatospora accuminata	—	+	—	+	+	—	—	—	—	—	—	—	—	—	—
Tricladium angulatum	—	—	—	—	—	—	—	—	+	+	—	—	—	—	—
Wayaangam cornuta	+	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Tetracladium setigerum	—	—	—	—	—	—	—	—	—	+	—	—	—	—	—
Unidentified sp.	—	+	+	+	+	—	—	—	—	—	+	—	—	—	—

3.1 Genera with unbranched elongated conidia

Lunulospora curvula Ingold

Conidia were found in all streams and rivers examined in fairly large numbers. They are crescent shaped with a conspicuous notch at the point of attachment (Figure 2A). Conidial development was observed on decaying mango (*Mangifera* sp.) and jak (*Artocarpus integrefolia*) leaves under laboratory conditions. The species was reported to be worldwide in distribution.[11]

Flagellospora sp.

Conidia were found in foam from nine streams including four sites at the Sinharaja Forest. Conidia are sigmoid in shape and resemble an open S with curvature in more than one plane (Figure 2B). Conidia were not observed on incubating decaying leaves. Although the conidia resemble those of *Flagellospora curvula* Ingold, no definite identification could be made to species level from detached conidia without observing phialides which bear these conidia.

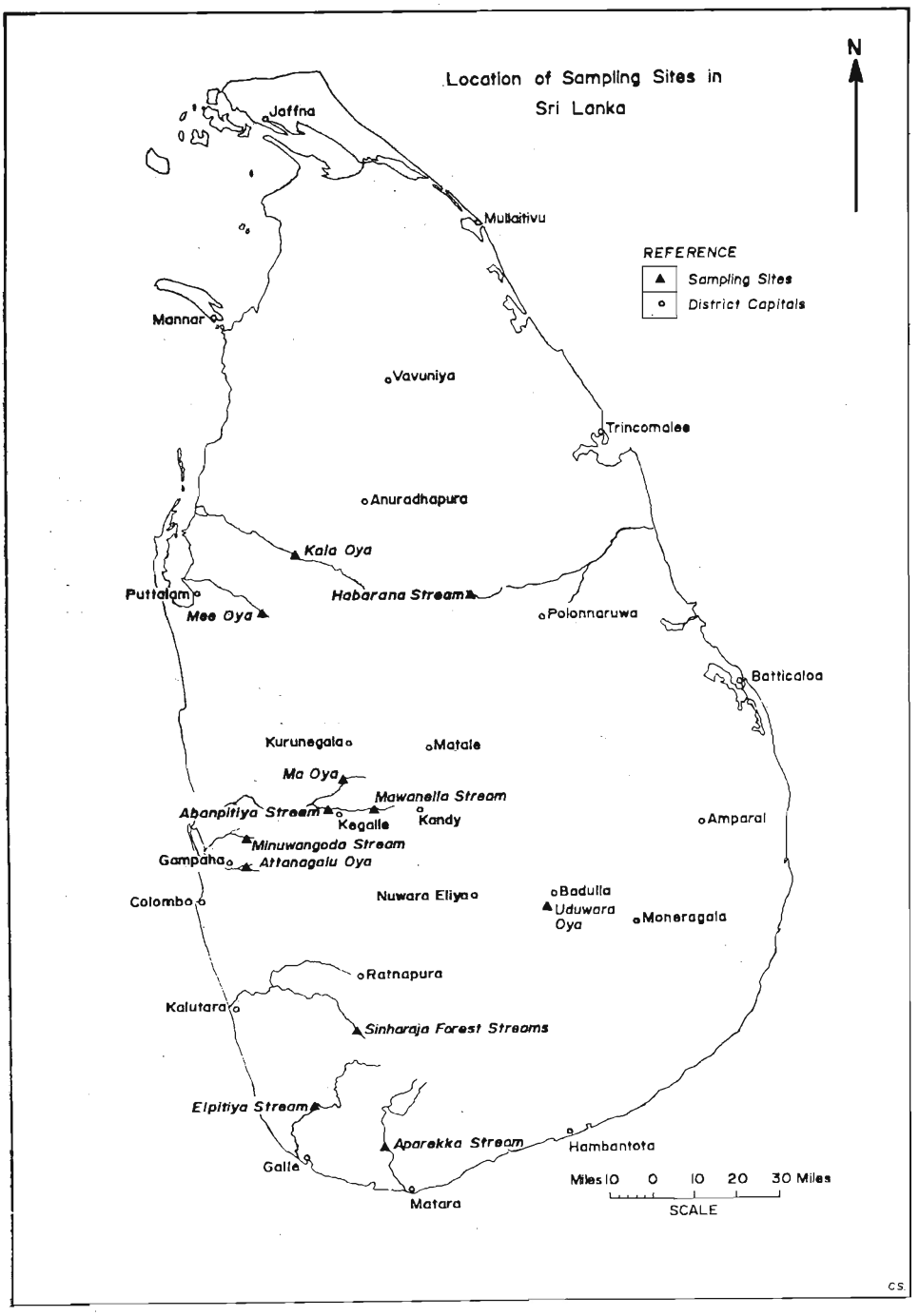

FIGURE 1 — Location of sampling sites.

Note — Four sampling sites in the streams at Sinharaja Forest.

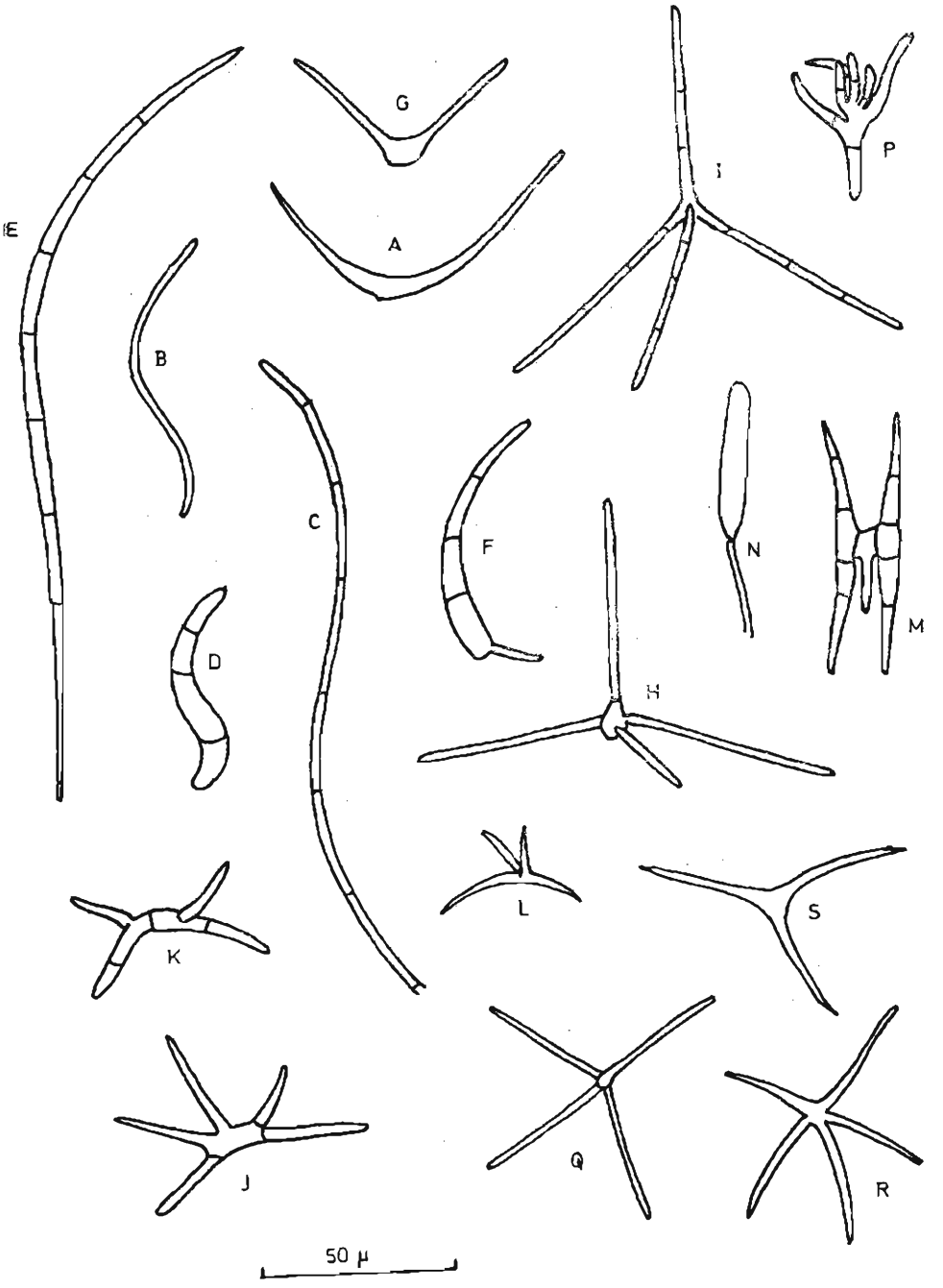

Figure 2

Eighteen types of conidia obtained from foam samples collected from some rivers of Sri Lanka

A. Lunulospora curvula
B. Flagellospora sp.
C. Anguillospora sp.
D. Anguillospora crassa
E. Filosporella sp.
F. Centrospora aquatica
G. Lunulospora cymbiformis
H. Triscelophorous monosporus
I. Lemonniera aquatica
J. Tricladium sp.
K. Tricladium angulatum
L. Alatospora accuminata
M. Triscelophorus monosporus
N. Dactylella submersa
P. Tetracladium setigerum
Q. R. S. Unidentified

Anguillosphora sp.

Conidia were found in foam from nine streams including Sinharaja streams.

They are septate often sigmoid and curved (Figure 2C). On incubating decaying leaves from Sinharaja stream beds mature conidia were observed. Webster and Descals[20] have shown that two species of *Anguillospora*, viz. *A. longissima* and *A. furtiva*, have conidia which are indistinguishable but have quite distinct telomorphs. Hence, without further critical observations on conidiophores and telomorphs it is difficult to assign *Anguillospora* conidia encountered to species level.

Anguillospora crassa Ingold

Conidia were found in small amounts in foam from seven streams including Sinharaja streams. Conidia were septate and curved (Figure 2D), but much wider and and shorter than those of *Anguillospora* sp. described earlier. Ingold[11] reported *Anguillospora* to be common in Britain and worldwide in distribution. Conidia were not observed on incubating decaying leaves.

Filosporella sp.

Conidia were encountered in Sinharaja streams and two other streams (Table 1). These conidia are long (often around 200 μm) and have 6 - 12 septa (Figure 2E). Conidia appear in large numbers on incubating decaying leaves from above streams in the laboratory. A number of such conidia seem to arise from one place in the leaf. The genus could possibly be identical with *Filosporella* sp. of Webster and Descals[20] or *Filosporella aquatica* of Nawawi[18] or *Rogersia annelidica* of Shearer and Crane.[19]

Centrospora aquatica Iqbal

Conidia resembling *C. aquatica* were found in foam samples collected from Attanagalu-oya, Uduwara-oya and streams located at Sinharaja Forest. These conidia were rather slender, elongated and markedly curved with a truncate base (Figure 2F). The species was reported to be common in temperate regions.[13] Conidia were not observed on incubating decaying leaves.

Lunulospora cymbiformis Miura

Conidia were found only in the Sinharaja Forest streams and were distinguished by a swelling in the middle region of the conidium (Figure 2G). The species was previously recorded only from Japan.[17] Webster and Nawawi (unpublished) have also found it in Malaya.

3.2 Genera with tetraradiate conidia

Triscelophorus monosporus Ingold

Conidia were found in all rivers and streams examined in fairly large numbers. These tetraradiate conidia were easily recognised from the projecting knob of the main axis and the whorl of three backwardly directed laterals (Figure 2H). The species was reported to be abundant in tropical streams.[7] Conidia were produced on incubating decaying leaves.

Lemmoniera aquatica de Wild

Conidia resembling those of *L. aquatica* were found in foam samples collected from Mee-oya, Kala-oya, and two streams at Sinharaja Forest (Table 1). These conidia have four divergent septate arms of similar length (Figure 2I). Abundant conidia were formed on leaves, decayed beyond recognition, collected from Mee-oya. The species was reported to be abundant in Britain and common throughout temperate regions.[7]

Tricladium sp.

Tricladium type of conidia (Figure 2J) were found in foam samples from Attanagalu-oya and three streams at Sinharaja Forest. The conidia on one hand resemble those of *Tricladium anomalum*[8] but were of considerably smaller size. On the other hand conidia closely resemble those of *Tricladium angulatum*, both in shape and size, recorded from Spain.[5]

Tricladium angulatum Ingold

Conidia resembling *T. angulatum*[7] were found only in foam samples collected from Uduwara-oya and this too in very small amounts. The conidium consists of a long axis and two laterals arising at two different levels (Figure 2K). The main axis of the spore is bent at points where the laterals arise.

Alatospora accuminata Ingold

Conidia were found only in foam samples collected from three streams at Sinharaja Forest. These tetraradiate conidia consist of a main axis forming two arms and two laterals forming the other two arms (Figure 2L). This species was reported to be abundant in Britain and well distributed in the temperate world.[7]

3.3 Genera with other types of conidia

Wayaangam cornuta Descals

Conidia were found only in foam samples collected from Minuwangoda (Figure 2M). This type of conidium was first recorded by Ingold & Ellis[12], Willoughby & Archer[22] as an unidentified species—and has been subsequently described by Descals and Webster.[6]

Dactylella submersa (Ingold) Nilsson syn. *Pyricularia submersa* (Ingold)

Conidia were found in large numbers only in foam samples collected from streams located at Sinharaja Forest. Conidia were ellipsoid (Figure 2N) and were produced in large numbers under laboratory conditions on incubating decaying leaves.

Tetracladium setrigerum (Gove) Ingold

These conidia were found only in foam samples collected from Uduwara-oya in small quantities. Mature conidia consist of four divergent arms with three parallel finger like projections of which one appears to be derived as a basal branch from another (Figure 2P). Conidia were not observed under laboratory conditions.

Three unidentified types of conidia (Figures 2 Q, R, S,) were frequently found in foam samples collected from Sinharaja Forest streams. Most noteworthy were the five armed type (Figure 2R) and the three armed type (Figure 2S).

4. Discussion

This preliminary survey of aquatic Hyphomycetes is primarily floristic in nature and is the first in Sri Lanka.

L. curvula and *T. monosporus* conidia were found in large numbers at all sites sample and can be considered as widely distributed, confirming the view that they are abundant in warmer parts of the world.[11] *Flagellospora* and *Anguillospora* can be placed next in the order of abundance and distribution. These four spore types along with *D. submersa* (found only in Sinharaja streams) and *Filosporella* sp. can be considered abundant. Other types in Table 1 have restricted distribution and that too in low numbers in the foam samples examined. Conidia of *T. setigerum* and *W. cornuta* have been encountered only once in this survey.

Species diversity (Table 1) and their abundance in Sinharaja forest streams could be possibly attributed to two factors. Firstly, these streams flow through a natural undisturbed broad-leaved vegetation yielding a perennial supply of dead leaves and twigs and secondly, the presence of rocks and larger plant debris which induce abundant formation of foam. Other streams, except Attanagalu-oya, used for sampling were placid and near either urbanized or agricultural areas and the presence of urban residues and agro-chemicals coupled with the smaller amounts of foam present may have contributed to the fewer numbers of conidia in the samples. The high species diversity at Attanagalu-oya where the sampling site was located upstream from the urbanized and agricultural area and the abundance of rocks etc., which cause turbulence inducing foam formation adds supporting evidence for the suggested possibilities.

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