



OBSERVATION AND DISCUSSION

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Temperature, moisture and humidity play key role in the production of fruit bodies in the macromycetes. Though, the fungal mycelia are present in various substrates throughout the year, they flourish best in the monsoon season with the production of fruit bodies. In Kerala, the monsoon season starts with the onset of south west monsoon in the month of June and end up by the retreating monsoon in the month of November or early December. It is evident from the data (Table III) obtained during the present study that both monsoon seasons are equally important for the occurrence of Pluteaceae Roze members. It is also observed that isolated showers in the month of January, February and April also bring out some species during these periods.

During the present study, collections were made from various forests of Kerala in addition to the daily forays of TBGRI campus which is spread over 121 hectares of forest land. Out of the several hundred collections made during the period 1993-1997 by the author, 212 belonged to Pluteaceae Roze. After careful study of the macroscopic and microscopic characters of each collection and comparison with world literature, the Kerala collections were assigned to fifty three taxa.

This treatise presents the results of the preliminary floristic study of the as it occurs in Kerala, together with a comprehensive review of the family. A total of fifty three taxa belonging to two genera, *Volvariella* Spg. and *Pluteus* Fr. are included in the thesis.

VOLVARIELLA Speg.

An attempt was here made to compare the ten species of *Volvariella* Speg. from Kerala with the species reported from other parts of India by various workers (Berkeley 1850, 1852; Masee 1899, 1912; Hennings 1901; Bose 1920; Ghosh et al 1967; Sing & Mehrotra 1974; Pathak et al 1978; Natarajan 1978; Natarajan & Purushothama 1987; Sathe & Kulkarni 1983; Sathe & Rahalkar 1978; Saini et al 1983; Manjula 1983; Purkayastha & Chandra 1985; Verma et al 1983; Manimohan et al 1988; Abraham 1994 and Atri et al 1996) and other parts of the world, (Pegler 1977, 1983, 1986; Shaffer 1957, 1962; Velinga in Bass et al 1990; Heinemann, 1975; Courtecuisse 1984,1991; Orton 1974, 1986; Monoson et al 1993).

Out of the ten species described here, only the following six species have earlier been reported from other parts of India.

1. *Volvariella bombycina* (Schaeff. : Fr.) Sing.
2. *Volvariella hypopithys* (Fr.) Moser
3. *Volvariella pusilla* (Pers. : Fr.) Sing.
4. *Volvariella pseudovolvacea* (Berk. & Br.) Sing.
5. *Volvariella speciosa* (Fr. : Fr.) Sing.
6. *Volvariella volvacea* (Bull. : Fr.) Sing.

The following species viz., *Volvariella nigrodisca* Shaffer, *Volvariella apalotricha* (Berk. & Br.) Pegler, *Volvariella taylori* (Berk.) Sing. and *Volvariella glandiformis* (Berk. & Br.) Pegler are therefore additions to the Indian agraric flora.

Comparison with the East African *Volvariellas* (Pegler, 1977) showed that out of the four species reported from that country *Volvariella speciosa* (Fr. : Fr.) Sing. *Volvariella volvacea* (Bull.: Fr.) Sing. and *Volvariella pusilla* (Pers.: Fr.) Sing.(=*V.parvula*) were common to both countries.

Four species viz., *Volvariella volvacea* (Bull. : Fr.) Sing, *Volvariella taylori* (Berk.) Sing., *Volvariella pseudovolvacea* (Berk. & Br.) Pegler and *Volvariella pusilla* (Bull. : Fr.) Sing. (= *V.parvula*) were found to be common with species of *Volvariella* Speg. from Lesser Antilles (Pegler, 1983).

Comparison of the *Volvariella* species reported from Kerala with those from Sri Lanka showed that three species, *Volvariella pseudovolvacea* (Berk. & Br.) Sing., *Volvariella apalotricha* (Berk. & Br.) Pegler and *Volvariella glandiformis* (Berk. & Br.) Pegler are common to both regions.

When compared with the North American species of *Volvariella* Speg. (Shaffer, 1957, 1962), out of the ten species described from Kerala seven species viz.,

1. *Volvariella nigrodisca* Shaffer
2. *Volvariella taylori* (Berk.) Sing.
3. *Volvariella volvacea* (Bull. : Fr.) Sing.
4. *Volvariella speciosa* (Fr. : Fr.) Sing.
5. *Volvariella bombycina* (Schaeff. : Fr.) Sing. var. *bombycina*
6. *Volvariella pusilla* (Pers. : Fr.) Sing.
7. *Volvariella hypopithys* (Fr.) Shaffer

are recorded from North America (Shaffer, 1957, 1962).

The genus is cosmopolitan and widely distributed both in the tropical and temperate regions of the world (Shaffer, 1957). Out of the thirteen species of *Volvariella* Speg. described from Britain and Europe (Eaton, 1974, 1986), the following six species are represented in Kerala.

1. *Volvariella bombycina* (Schaeff. : Fr.) Sing. var. *bombycina*
2. *Volvariella speciosa* (Fr. : Fr.) Sing.
3. *Volvariella volvacea* (Bull. : Fr.) Sing.
4. *Volvariella taylori* (Berk.) Sing.
5. *Volvariella pusilla* (Pers. : Fr.) Sing. (= *V. parvula*)
6. *Volvariella hypopithys* (Fr.) Moser

In a recent study on the genus from the state of Illinois, USA by Monoson et al (1993) six species were described from that country and these were recorded from Kerala by the present worker.

var. *bombycina* and *Volvariella glandiformis* (Berk. & Br.) Pegler were found on dead decaying wood.

The number of times a species could be collected, is an indication of the frequency of the species and it varies from one to seven (Table III). Of the total collections made 50% of the species were collected only once or twice and the other 50% were encountered three to seven times. All the collections were studied in great detail both macroscopically and microscopically and compared with relevant literature and assigned to respective taxa.

Majority of the species of *Volvariella* Speg. were collected during the south west monsoon period from middle of May to August. A few species viz., *Volvariella apalotricha* (Berk. & Br.) Pegler, *Volvariella pusilla* (Pers. : Fr.) Sing. and *Volvariella nigrodisca* Shaffer were encountered in both seasons. *Volvariella hypopithys* (Fr.) Shaffer and *Volvariella pseudovolvocea* (Berk. & Br.) Sing. were occasionally encountered during isolated showers in the month of January and February.

PLUTEUS Fr.

The forty three species of *Pluteus* Fr. collected from Kerala during the present study are compared with previous Indian records and with those from other parts of the world, especially from the tropical and subtropical regions. Of the sixteen species known from India so far (Table II) only two species viz., *Pluteus cervinus* (Schaeff. : Fr.) Kumm. and *Pluteus cubensis* (Murr.) Dennis were recorded from Kerala.

Out of the forty three taxa described in the genus *Pluteus* Fr., three species belong to section *Pluteus*, twenty six species to section *Hispidoderma* and fourteen species to section *Celluloderma*. This is in agreement with reports from other parts of the world where more species belong to section *Hispidoderma* followed by *Celluloderma*. The section *Pluteus* is rather poorly represented in Kerala while it is well represented in other tropical regions (Singer, 1956, 1958).

The section *Pluteus* though poorly represented by only three species, all the three species are of considerable interest. *Pluteus cervinus* (Schaeff. : Fr.) Kumm. is the type specimen not only of the family but also of the genus and section and known from the world over (Banerjee & Sundberg, 1995). *Pluteus martinicensis* Sing. & Fiard so far known only from the type specimen (Pegler 1983) was collected during the present study. Another member of the section *Pluteus* is *Pluteus amphicystis* Sing., a remarkable species so far reported only from Bolivia and Martinique (Pegler 1983) was also collected from Kerala.

It is found that out of the forty three species of *Pluteus* Fr. collected during the present study, eighteen species were unable to match with any described species and therefore are described here as new species.

1. *Pluteus pulvinatus* sp. nov.
2. *Pluteus silentvallianus* sp. nov.
3. *Pluteus striatulus* sp. nov.
4. *Pluteus cacainus* sp. nov.
5. *Pluteus pruinosus* sp. nov.
6. *Pluteus agasthyamalayanus* sp. nov.
7. *Pluteus incarnatus* sp. nov.
8. *Pluteus squamulosus* sp. nov.
9. *Pluteus umbrinus* sp. nov.
10. *Pluteus palmicolus* sp. nov.
11. *Pluteus limosus* sp. nov.
12. *Pluteus xanthobrunneus* sp. nov.
13. *Pluteus brunneodiscus* sp. nov.
14. *Pluteus armeniacus* sp. nov.
15. *Pluteus griseostipitatus* sp. nov.
16. *Pluteus vesiculosus* sp. nov.
17. *Pluteus delicatulus* sp. nov.
18. *Pluteus umbonatus* sp. nov.

When the species of *Pluteus* Fr. reported from South America and North America including North American tropics (Singer, 1958) were compared with the forty three species of *Pluteus* Fr. from Kerala, it is seen that only the following fourteen species are found common.

1. *Pluteus ampicystis* Singer
2. *Pluteus eupigmentatus* Singer
3. *Pluteus glyphidatus* (Berk. & Br.) Sacc.
4. *Pluteus atriavellaneus* Murr.
5. *Pluteus fastigiatus* Sing.
6. *Pluteus unakensis* Murr.
7. *Pluteus cubensis* (Murr.) Dennis
8. *Pluteus depauperatus* Romag.
9. *Pluteus haywardii* Sing.
10. *Pluteus eugraptus* (Berk. & Br.) Sacc.
11. *Pluteus pulverulentus* Murr.
12. *Pluteus fluminensis* Sing.
13. *Pluteus jamaicensis* Murr.
14. *Pluteus albolineatus* (Berk. & Br.) Sacc.

Comparison of *Pluteus* Fr. species from Kerala with those from East Africa (Pegler, 1977) showed that out of the eleven species known from that country, only four species viz., *Pluteus fusconigricans* (Berk. & Br.) Sacc., *Pluteus pulverulentus* Murr., *Pluteus albolineatus* (Berk. & Br.) Sacc. and *Pluteus eugraptus* (Berk. & Br.) Sacc. are common.

Of the known thirteen species from Lesser Antilles (Pegler, 1983) only six species are found to be common with the taxa from Kerala. These are *Pluteus martinicensis* Sing. & Fiard, *Pluteus ampicystis* Sing., *Pluteus cubensis* (Murr.) Dennis, *Pluteus haywardii* Sing., *Pluteus pulverulentus* Murr. and *Pluteus jamaicensis* Murr. *Pluteus martinicensis* Sing. & Fiard. so far known only from the type material (Pegler, 1983) could be collected twice during the study period from Kerala. *Pluteus ampicystis* Sing., a remarkable member of the section *Pluteus* reported so far only from Bolivia and Martinique (Pegler, 1983) was also encountered in Kerala during the present study.

Pluteus is rather well represented by eighteen species in Sri Lanka (Pegler, 1986). Though the ecophysiological conditions of both regions are some what comparable only four species, *Pluteus glyphidatus* (Berk. & Br.) Sacc., *Pluteus eugraptus* (Berk. & Br.) Sacc., *Pluteus albolineatus* (Berk. & Br.) Sacc. and *Pluteus fusconigricans* (Berk. & Br.) Sacc. are found to be the common species.

Except for *Pluteus cervinus* (Schaeff. : Fr.) Kumm. and *Pluteus cubensis* (Murr.) Dennis, which have been reported already from India, all others are additions to the Indian agaric flora. As far as Kerala is concerned, forty-two species of *Pluteus* Fr. described here are being reported for the first time.

The observations made in the genus *Pluteus* regarding their occurrence, distribution and habitat preference are interesting and are presented in Table III. It is seen that majority of species prefer thick forests and are only rarely encountered in open areas. The habitat preference of this genus in Kerala showed that out of the forty-three taxa, twenty-six are wood inhabiting and the rest terrestrial. This, in general agrees with the genus character.

As in the case of genus *Volvariella* Speg., majority of the *Pluteus* Fr. species also occur in rather solitary, isolated manner and only rarely in groups. According to Singer (1958), in South America many species and forms of *Pluteus* Fr. are known only from limited material and many species occur rather solitary and in isolated manner. The same is the experience of Walker (1919) and according to him "while the various species of *Pluteus* Fr. are abundant in most regions, the fruit bodies are usually found singly or only a few closely associated". These observations of Singer and Walker are very much applicable to Kerala also.

The frequency of collection of *Pluteus* Fr. in Kerala varies from one to nine (Table III). Majority of species, thirty six out of forty-three were collected only once or twice. The most commonly encountered species are *Pluteus depauperatus* Romang., *Pluteus umbrinus* sp. nov. and *Pluteus umbonatus* sp. nov.

It is observed that eighteen species were collected during the south west monsoon and fourteen species in the north east monsoon season. Eleven species are found throughout the season. *Pluteus martinicensis* Sing. & Fiard., *Pluteus squamulosus* sp. nov. and *Pluteus vesiculosus* sp. nov. were recorded during off season showers in April. However these species were again collected during the normal monsoon seasons.

Contradictory to the observations made on genus *Volvariella* Speg., the genus *Pluteus* Fr. in Kerala shows more affinity towards tropical flora. Seasonal variation of species was also noticed in the two genera. In *Volvariella* Speg. majority of species appear during the south west monsoon whereas species of *Pluteus* Fr. appear in both the seasons almost equally and a good number of them are found throughout the season.

The author does not consider this work as the final word on Pluteaceae Roze of Kerala. However as Singer (1958) observed, “the availability of a monograph-as incomplete as it may be-will greatly facilitate and stimulate future studies, particularly in regions thus far little known”- the author considers it as the main objective of the present study.

Table - III

DESCRIPTION OF GROWTH HABIT, HABITAT, SEASON, FREQUENCY OF COLLECTION AND NAME OF SPECIES OF *VOLVARIELLA* AND *PLUTEUS* REPORTED FROM KERALA DURING 1993-1997

No.	Species Name	Habit	Habitat	Season	Frequency of collection
1.	<i>V. apalotricha</i>	Solitary	Soil	September-October	02
2.	<i>V. bombycina</i> var. <i>bombycina</i>	Solitary	Wood	June	01
3.	<i>V. glandiformis</i>	Solitary/pairs	Wood	June-November	04
4.	<i>V. hypopithys</i>	Solitary	Soil	January-May	02
5.	<i>V. nigrodisca</i>	Solitary	Soil	July-December	03
6.	<i>V. pseudovolvacea</i>	Solitary/scattered	Soil	February-November	05
7.	<i>V. pusilla</i>	Solitary/scattered	Soil	May-November	03
8.	<i>V. speciosa</i>	Solitary	Soil	May	01
9.	<i>V. taylori</i>	Solitary	Soil	May	01
10.	<i>V. volvacea</i>	Solitary/groups	Composte	April-July	07

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No.	Species Name	Habit	Habitat	Season	Frequency of collection
11.	<i>P. agathyamalanus</i> sp. nov.	Solitary	Dead wood	June	01
12.	<i>P. albolineatus</i>	Solitary/scattered	Dead wood	August-November	02
13.	<i>P. ampicystis</i>	Solitary/scattered	Dead wood	June-August	03
14.	<i>P. armeniacus</i> sp. nov.	Solitary	Dead wood	July	01
15.	<i>P. atriavellaneous</i>	Solitary	Soil	September-November	02
16.	<i>P. brunneodiscus</i> sp. nov.	Scattered	Dead wood	May	01
17.	<i>P. cacinus</i> sp. nov.	Solitary/scattered	Soil/litter	August-November	03
18.	<i>P. cervinus</i>	Groups	Dead wood	May	01
19.	<i>P. cubensis</i>	Solitary	Dead wood	September	02
20.	<i>P. delicatulus</i> sp. nov.	Solitary/scattered	Dead wood	September-November	05
21.	<i>P. deliquescens</i>	Scattered	Dead wood	May	01
22.	<i>P. depauperatus</i>	Solitary/scattered	Dead wood	July-October	09
23.	<i>P. dryophiloides</i>	Solitary/pairs	Dead wood	July	02
24.	<i>P. espeletiae</i>	Solitary	Dead wood	June-November	02
25.	<i>P. eugraptus</i>	Scattered	Soil/litter	September	01
26.	<i>P. eupigmentatus</i>	Solitary/scattered	Soil/litter	July-November	02
27.	<i>P. fasstigiatus</i>	Scattered/groups	Soil	September-October	04
28.	<i>P. fluminensis</i>	Solitary	Soil	May	01
29.	<i>P. fusconigricans</i>	Solitary	Litter	July-November	02
30.	<i>P. glyphidatus</i>	Solitary	Soil	June-October	02

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No.	Species Name	Habit	Habitat	Season	Frequency of collection
31.	<i>P. griseostipitatus</i> sp. nov.	Solitary	Dead wood	August	01
32.	<i>P. haywardii</i>	Solitary/scattered	Dead wood	May-July	04
33.	<i>P. incarnatus</i> sp. nov.	Solitary/pairs	Dead wood	June-November	03
34.	<i>P. jamaicensis</i>	Solitary	Soil	September-December	02
35.	<i>P. limosus</i> sp. nov.	Solitary	Dead wood	July	01
36.	<i>P. martinicensis</i>	Solitary	Dead wood	April-June	02
37.	<i>P. palmicolus</i> sp. nov.	Solitary/pairs	Dead palms	July-September	03
38.	<i>P. pluvialis</i>	Solitary	Litter	November	01
39.	<i>P. podospileus</i>	Scattered	Dead wood	September	01
40.	<i>P. pulverulentus</i>	Solitary	Soil/litter	September-December	02
41.	<i>P. pulvinatus</i> sp. nov.	Solitary	Dead wood	October	01
42.	<i>P. punctipes</i>	Solitary	Dead wood	November	01
43.	<i>P. pruinatus</i> sp. nov.	Solitary	Litter	November	01
44.	<i>P. riberaltensis</i> var. <i>missionensis</i>	Scattered	Soil	August	01
45.	<i>P. seticeps</i>	Solitary	Soil/litter	June-December	03
46.	<i>P. silentvallianus</i> sp. nov.	Solitary/scattered	Dead wood	May	02
47.	<i>P. striatulus</i> sp. nov.	Solitary/groups	Dead wood	July	02

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No.	Species Name	Habit	Habitat	Season	Frequency of collection
48.	<i>P.squamulosus</i> sp. nov.	Solitary	Soil	April- September	02
49.	<i>P. umbonatus</i> sp. nov.	Solitary/pairs	Dead wood	May-October	07
50.	<i>P. umbrinus</i> sp. nov.	Solitary/pairs	Dead wood	July-November	07
51.	<i>P. unakensis</i>	Scattered	Soil	July	01
52.	<i>P. vesiculosus</i> sp. nov.	Scattered	Soil/litter	April	01
53.	<i>P. xanthobrunneus</i> sp. nov.	Solitary/pairs	Dead wood	November	01