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SPORANGIAL ONTOGENY OF *PHYTOPHTHORA PALMIVORA* (Butler) Butler FROM BLACK PEPPER *(PIPER NIGRUM* Linn.)*

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The association of *Phytophthora* species with black pepper *(Piper nigrum* Linn.) has been reported from all pepper growing tracts of the world. There exists quite a lot of confusion regarding the taxonomy of *Phytophthora* species from black pepper. The earlier workers like Venkata Rao (1929) and Leefmans (1934) identified this pathogen only upto the generic level, Muller (1936) first identified the *Phytophthora* isolates from black pepper as *P. palmivora* because its cultural characters resembled with those of *P. palmivora* from coconut, cocoa, papaya and rubber rather than those of *P. parasilica* from tobacco, citrus, egg plant, castor and cassava and added a varietal epithet *piperis* on the grounds of its pathogenicity to *Piper nigrum* and its high optimum temperature for growth. But the later workers treated it as *P. palmivora* without giving any importance to the variety (Holiday and Mowat, 1963; Turner, 1969; Alconero *et al.*, 1972; Nambiar and Sarma, 1976 and Mammootty, 1978).

Holliday and Mowat (1963) found that different isolates of *P. palmivora* from black pepper differed in their *in vitro* growth, sporangial production and pathogenicity and they were close to the atypical rather than the typical strains of Ashby (1929). Turner (1971) after comparing a large number of isolates from different geographic locations and hosts concluded that all *Phytophthora sp.* from *Piper* in SE Asia belong to the same species and they should be referred to as typical strains of *P. palmivora.* He also reported that the pepper isolates of *P. palmivora* from Sarawak are highly host specific. In contrast, Brasier (1972) described that the *P. palmivora* isolated from pepper differed from the typical strains in forming only a few sporangia on agar media which are not shed and are difficult to dislodge, and in developing sex organs in single cultures in some isolates. He demonstrated both A1 and A2 compatibility groups in those isolates. Finally, Waterhouse (1974) considered *Phytophthora* isolates from *Piper (P. betle* and *P. nigrum* mostly) as atypical strains and stated that black pepper strains are nearer to *P. meadii.* In the Cocoa Phytophthora Workshop held at the Rothamsted Experimental Station, England Tsao (1976) suggested that the pepper isolates of *P. palmivora* should be described as a separate species. He reported obvious similarities between black pepper isolates from Malaysia and Thailand and the MF4 cocoa isolates from Brazil. Later, Tsao and Tummakatte (1977) reported that the Thailand black pepper isolates differed from any atypical strain of *P. palmivora* reported to be pathogenic on black

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pepper by exhibiting extremely long pedicels, double septate sporangia and fan shaped or umbellate arrangement of sporangia. They found that the black pepper isolates from Malaysia, Central America and Africa also possessed the unique sporangial characters. Recently, Tsao (1980) reported that all black pepper isolates of *P. palmivora* from SE Asia, Central America and Africa are similar in many morphological features and can be called *P. palmivora* MF4. Sarma *et al.* (1980) grouped *P. palmivora* isolates from **foot** rot and root rot affected black pepper vines in India as MF4 based on morphological characters. They also reported that these isolates differed from the Thailand isolates in that the double septate sporangia were absent.

Materials and Methods

The cultural and morphological characters of black pepper isolates of *P. palmivora* collected from six different locations of north Kerala namely Vellani-kkara, Kannara, Meenangadi, Ambalavayal, Panniyur and Alakkode were studied in detail and compared with each other. The morphoiogical characters were studied by slide culture method with culture discs intact except for the deciduous sporangia. Hyphal tips from seven day old cultures were transferred to 5 mm diameter discs of carrot agar and incubated at 22±1 °C. Deciduous sporangia were collected by dripping sterile water on culture discs. Morphological characters such as breadth of hypha, length of sporangiophore, length and breadth of deciduous sporangium and length of pedicel were observed by using four day old cultures, and the mean of 50 observations of each character was taken.

Results and Discussion

All the six isolates of *P. palmivora* from black pepper exhibited similar cultural and morphological characters. The variations in the dimensions of somatic hypha, sporangiophore and sporangium between these isolates was negligible. Growth on carrot agar produced very sparse aerial mycelium. Mycelium was hyaline and coenocytic. The thickness of the hypha ranged from 4.00—6.00 *I'm.* The tip of the sporangiophores which arose from the somatic hyphae became swollen and developed into sporangia. The sporangiophores were 25.00—252.50 /"m long and were of indeterminate growth. Fully matured sporangia were ovoid to limoniform with round base and well pronounced papillae at the apex. They measured 30.00—42.50 x 22.50—37.50 /"m with their L/B (length by breadth) ratio ranging from 1.07—1.67. They were borne terminally on the sporangiophores in a simpfe sympodia! fashion and were caducous. Deciduous sporangia had short and thick stalks filled with semitransparent plugs which measured 2.00—6.00 /"m long. Germination of the sporangia took place in the presence of free water. Zoospores came out in a mass through the papilla and rested for a while at the mouth of the sporangium. Then motile zoospores got separated from the mass and swarm away in the film of water. After a few minutes the swarming zoospores came to rest, got encysted and later germinated by means of germtube. Abundant

chlamydospores were produced by all the isolates on oat meal agar. They were slightly coloured and more or less spherical. None of these isolates produced sexual stages on culture media (Table 1, Fig. 1-3, Plates 1–5).

The colony characters on carrot agar, sporangial ontogeny, development, shape and germination pattern, shape of encysted zoospores and chlamydospores of all the six black pepper isolates collected from the different locations of north Kerala were similar. The variations between the isolates in the dimension of somatic hypha and sporangium were found to be negligible when compared to the variation within the same isolates. The morphological characters of the somatic hypha and sporangium of all these black pepper isolates are found almost agreeing with Butler's (1907 and 1919) descriptions of *P. palmivora.*

Based on the growth characteristics on carrot agar, L.B ratio and pedicel length of the sporangium which were the major criteria used for the grouping of *P. palmivora* at the Cocoa Phytophthora Workshop held at Rothamsted (Griffin, 1977) all the black pepper isolates collected from the different locations of north Kerala can be accommodated in either MFI, MF2 or MF3. **On** considering the sporangial caducity, shape and pedicel length as criteria for dividing the *P. palmivora* isolates into different groups as suggested by Zentmyer *etaf.* (1977), all the isolates collected during the present investigation can be accommodated into group I or II. It is not possible to place an isolate precisely, based on morphological characters of the asexual structures, in any of the above categories, due to the overlapping of the characteristics described for them. After considering the morphological characters of the sporangium there seems no justification in continuing the four morphological forms arrived at the Cocoa Phytophthora Workshop (Griffin, 1977) as the range given for the L/B ratio is overlapping and that for the pedicel length is very narrow. This is also the case with the four groups described by Zentmyer *et al.* (1977). The morphological forms 1, 2 and 3 should be merged into a single form giving wider range for L/B ratio and pedicel length. Similarly, the group I and II of Zentymyer *et al.* (1977) should be considered as a single group. Brasier and Griffin (1979) had correctly pointed out the withdrawal of MF1, MF2, and MF4 to avoid confusion. The morphological and physiological studies including the chromosome type conducted by them revealed the existence of only three distinct forms namely L (MF3), S (MF1) and MF4 in *P. palmivora* and suggested that these forms should be considered as separate species. They described L type as a new species *P. megakarya* and proposed that only S type should be referred to as *P. palmivora* and the term MF1 should be superseded.

None of the black pepper isolates of *P. palmivora* obtained in the present investigation exhibited the sporangial characters such as extremely long pedicels, high L/B ratio, tapered base, umbelloid ontogeny and double septation as observed by Tsao and Tummakatte (1 977} with the black pepper isolates from Thailand, Sarma *et al.* (1980) had identified the black pepper isolates from India as MF4

Table 1

Morphological characters of black pspper isolates of *Phytophthora* from six different locations on carrot agar (in

Sl. no.	Isolate	Breadth of hypha	Length of sporangio-phore	Length of sporangium	Breadth of sporangium	L/B ratio of sporangium	Length of pedicel
1	Vellanikkara						
	Mean	5.02	118.50	36.65	26.90	1.34	3.50
	Mode	5.00		37.50	25.00	1.33	4.00
	Range	4,00-6.00	27.50-247.50	32 50-40.00	2250-37.50	1.07-1.67	2.00-5.00
2	Kannara						
	Mean	5.00	108,60	37,15	28.65	1.30	3.80
	Mode	5.00		37.50	30.00	1.25	4.00
	Range	4.00-6.00	42,50-242.50	32,50-40.00	22.50-37.50	1.07-1.67	2.00-6.00
3	Meenangadi						
	Mean	5.08	114.55	36.60	27.70	1,30	3.56
	Mode	5.00		35.00	27.50	1.27	3.00
	Range	4.00-6.00	42.50-227,50	35,00-42.50	25.00-32.50	1.07-1.50	2.00-6.00
4	Ambalavayal						
	Mean	5.00	127.60	36.95	27.55	1.34	3.88
	Mode	5.00		37.50	25.00	1.33	4.00
	Range	4.00-6.00	25.00-247.50	32.50-40.00	22.50-37.50	1,07-1.67	2 00-500
5	Panniyoor						
	Mean	4.98	131.15	37.10	27.90	1.33	3.52
	Mode	5.00		37.50	30.00	1.25	4.00
	Range	4,00-6.00	42.50-242.50	32.50-40.00	22.50-37.50	1.07-1.56	2.00-5.00
6	Alakkode						
	Mean	4.96	126.50	36.85	27.40	1.39	3.68
	Mode	5.00		37,50	27.50	1.33	4.00
	Range	4.00-6.00	25.00-252.50	30 00-40.00	22.50-35.00	1.14-1.67	2.00-5.00

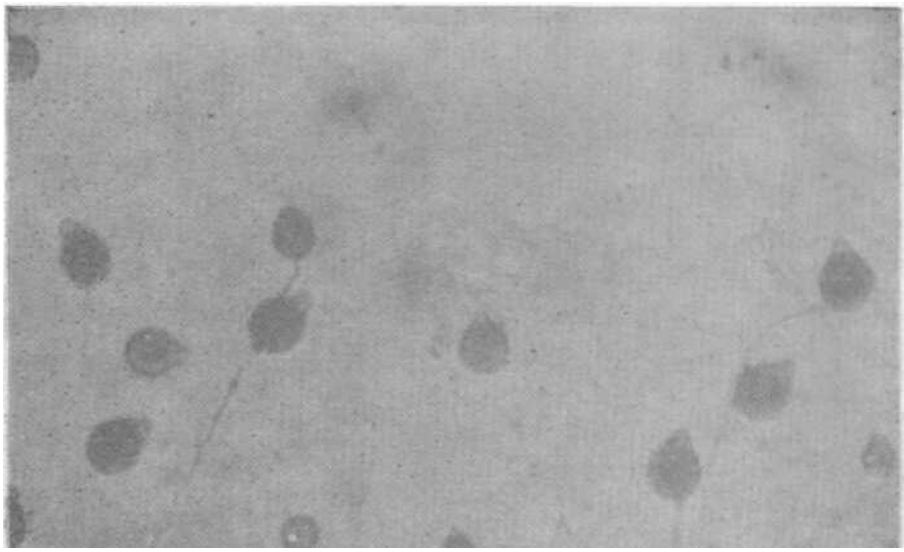

Plate 1 Sporangia of *P. palmivora* black pepper isolate from Vellanikkara on carrot agar (x 31 2)

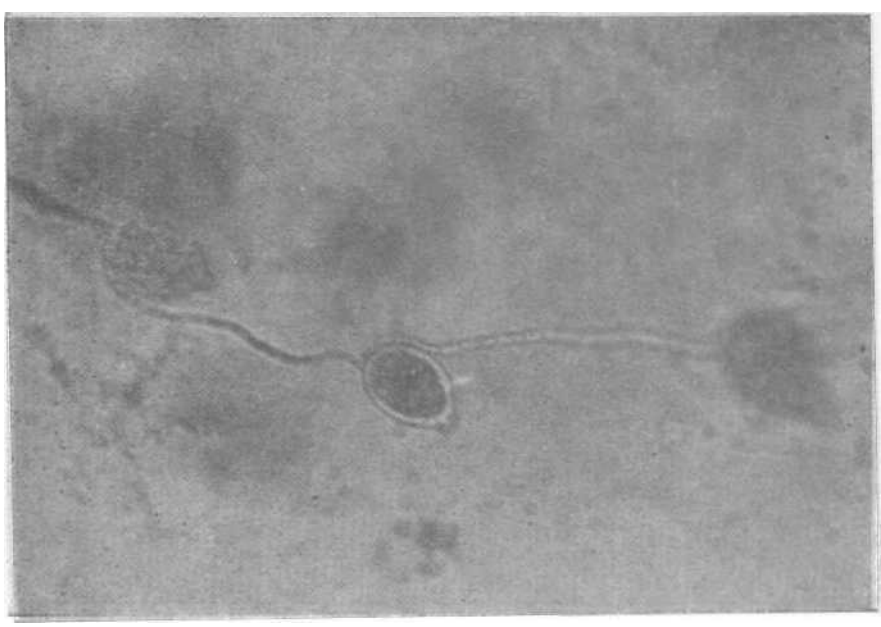

Plate 2 Sporangial ontogeny of *P. palmivora* black pepper isolate from Vellanikkara on carrot agar (x 507)

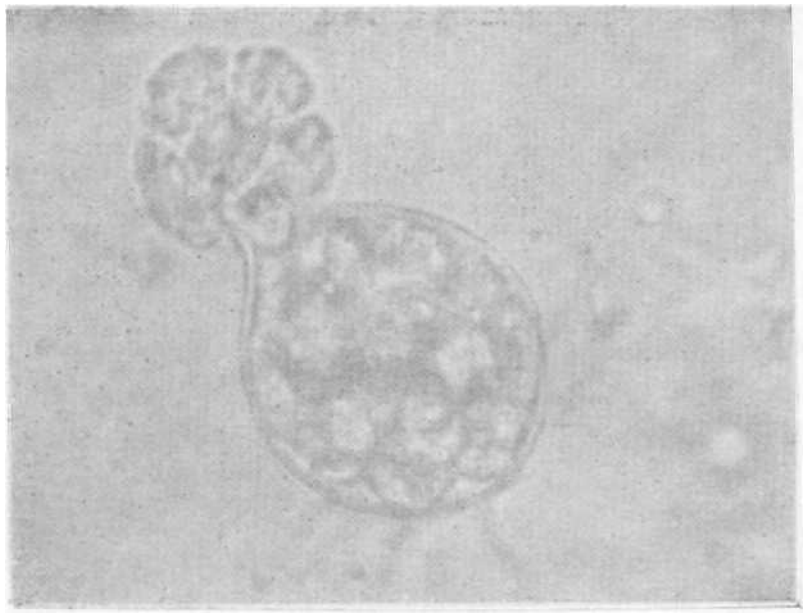

Plate 3 Germinating sporangium of P. *palmivora* black pepper isolate from Vellanikkara (x 1563)

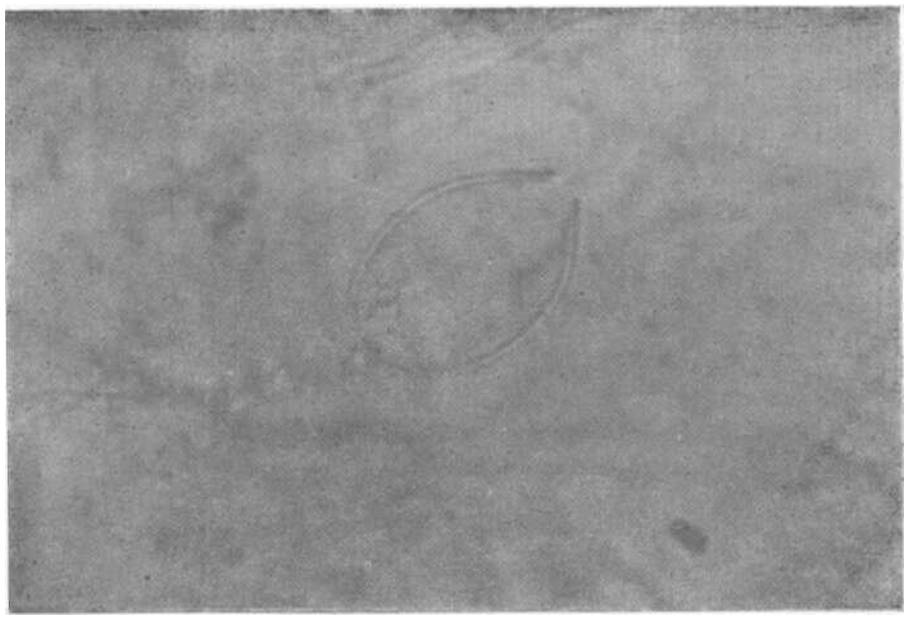

Plate 4 Empty sporangium of *P. palmivora* black pepper isolate from Vellanikkara (x **12501**

Plate 5 Germinating zoospores of *P. palmivora* black pepper isolate from Velianikkara (x 977)

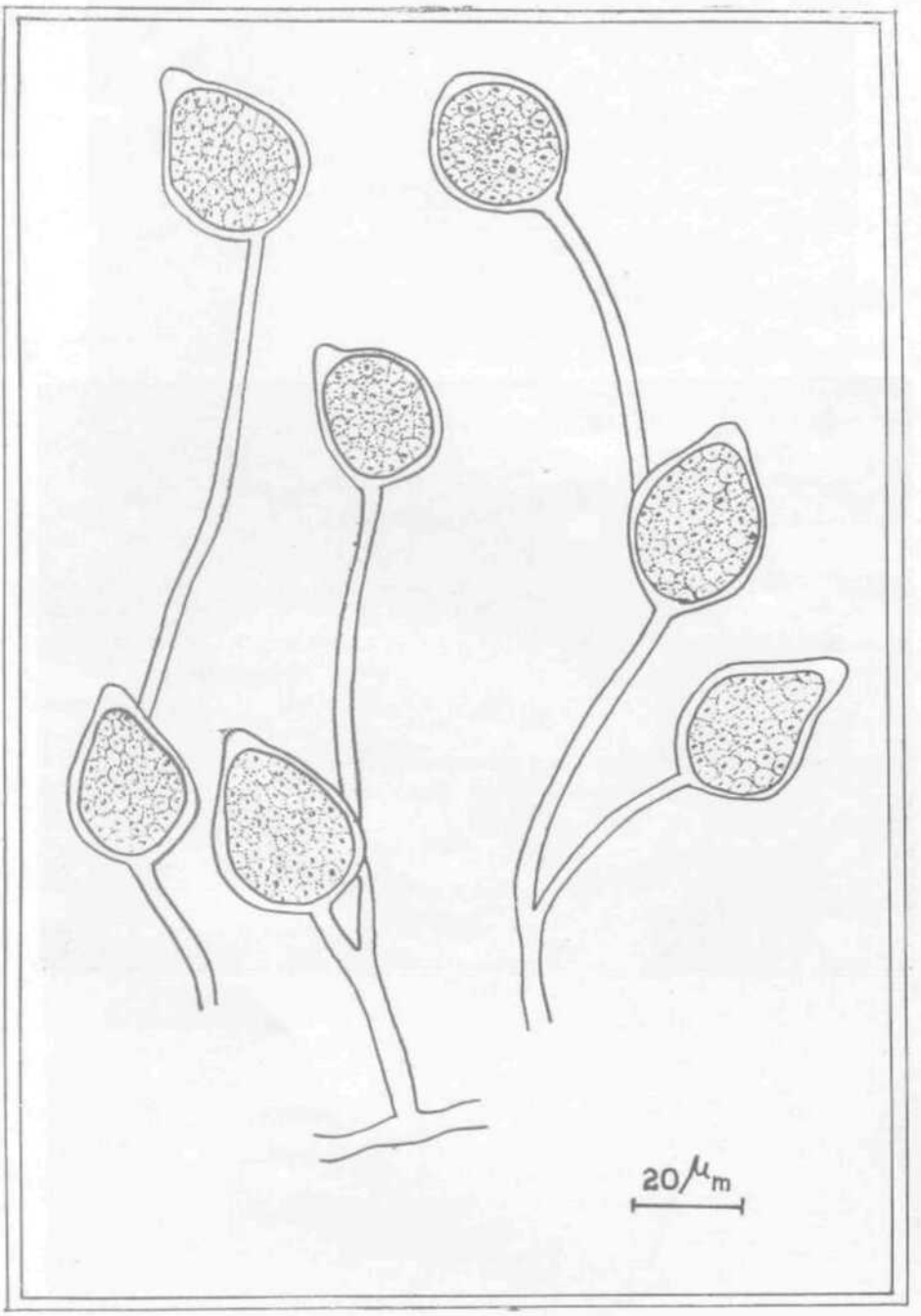

Fig 1 Sporangial ontogeny of *P. palmivora* black pepper isolate from Vellanikkara on carrot agar

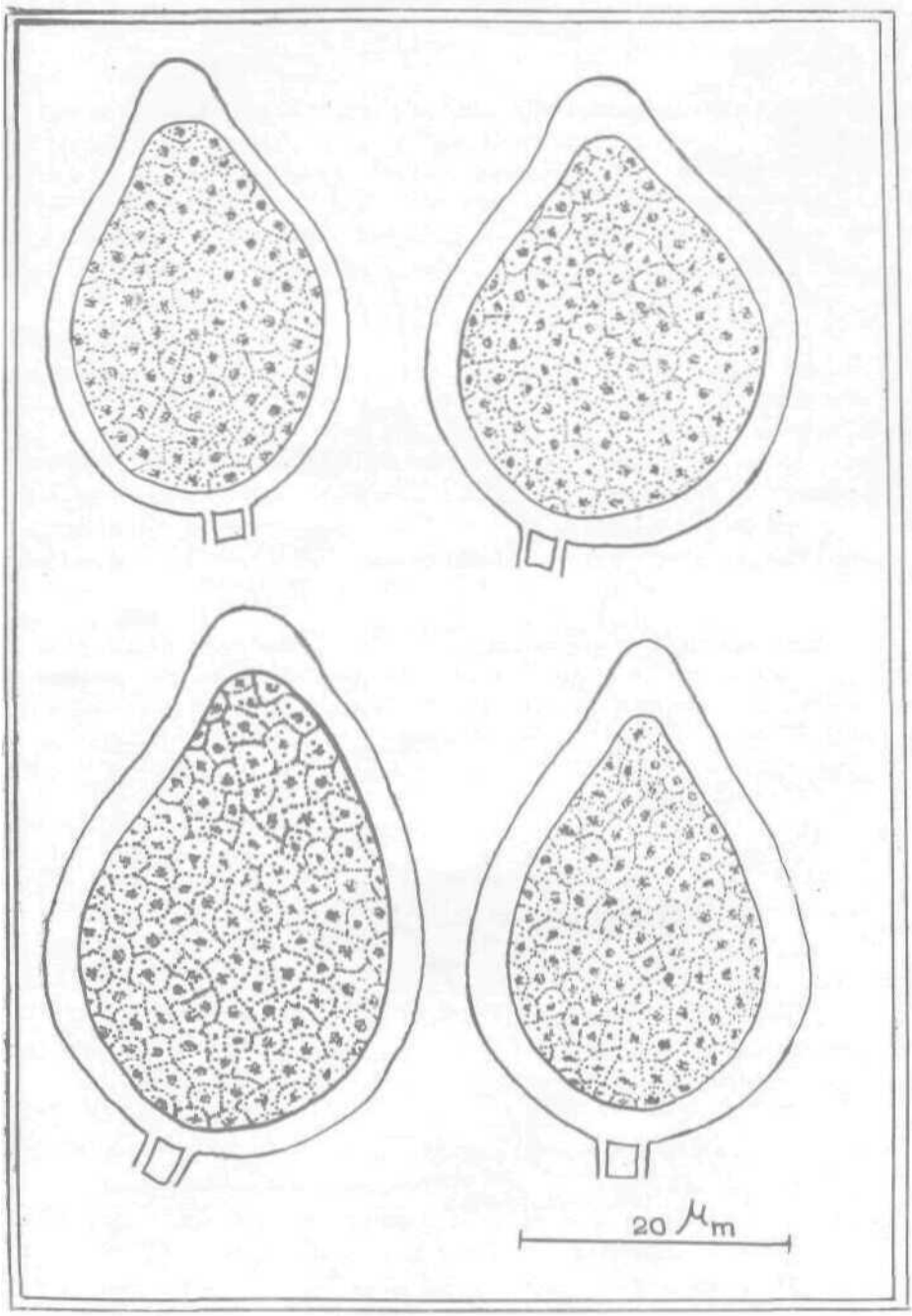

Fig 2 Sporangia of *P. palmivora* black pepper isolate from Vellanikkara

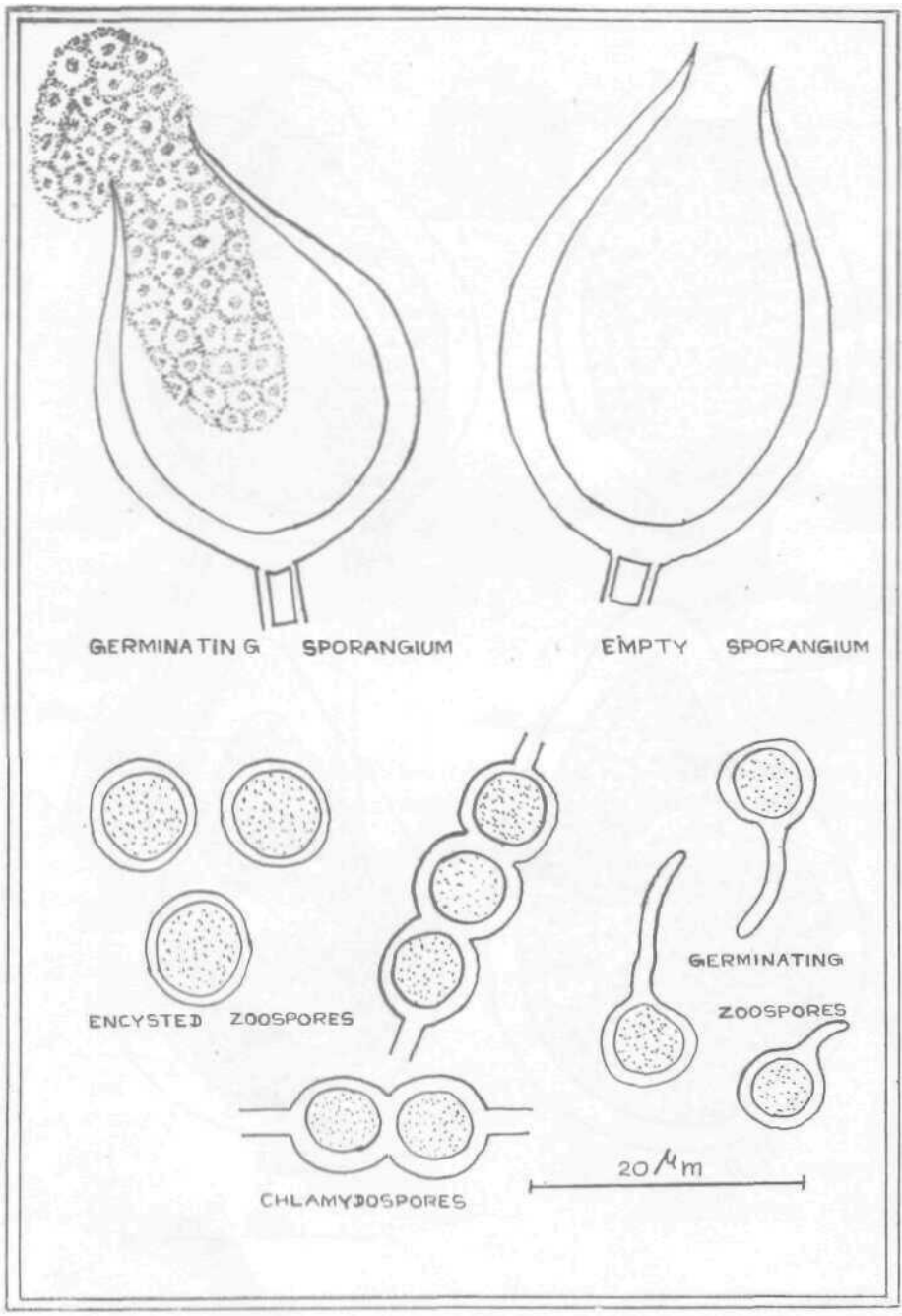

Fig 3 *P. palmivora* black pepper isolate from Vellanikkara

based on the umbelloid type of sporangiophore, ellipsoid sporangium with tapering base, L/B ratio exceeding two and long pedicels ranging from 1 6-1 80 /*m*. Tsao (1980) has also referred the black pepper isolates of P. *pa/mivora* from SE Asia, Central America and Africa as MF4. All the P. *palmivora* isolates from black pepper collected from the different locations of north Kerala were totally different from those reported by the above workers.

Summary

The *Phytophthora* species collected from black pepper from the different locations of north Kerala showed similar morphological characters and were identified as *Phytophthora palmivora* (Butler) Butler. Based on the growth characteristics on carrot agar, L/B (length by breadth) ratio and pedicel length of the sporangium all the black pepper isolates *of P. pa/mivora* obtained in the present investigation can be placed in MF1 or MF2 or MF3 (Griffin, 1977) or group I or II (Zentmyer *et al.,* 1977) due to the overlapping of characteristics described for them.

സംഗ്രഹം

കേരളത്തിലെ വടക്കൻ ജില്ലകളിലെ പല ഭാഗങ്ങളിൽ നിന്നും ശേഖരിച്ച കുരുമുള കിലെ ഫൈറോഫ്തോറ എന്ന കുമിളിനെ പഠിച്ചതിൽ നിന്നും, അവയെല്ലാം പൊ തുവായ ബാഹ്യ സ്വഭാവങ്ങളോടുകൂടിയവയാണെന്നും, ഇത് *ഫൈറോഫ്തോറ പാമിവോറ* (ബട്ലർ) ബട്ലർ എന്നതാണെന്നും മനസ്സിലാക്കാൻ കഴിഞ്ഞു.

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